

A COMPARATIVE STUDY OF THE COGNITIVE
EFFECTS OF PROGRAMED PRESENTATIONS
ON STUDENT ACHIEVEMENT IN SELECTED
PORTIONS OF COLLEGE LEVEL
ELEMENTARY PHOTOGRAPHY

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CHAPTER I

INTRODUCTION AND NATURE OF THE PROBLEM

The enrollment explosion in the nation's colleges and universities represents one of the major problems faced by administrators and teachers in higher education. Effects of the post World War II "baby boom" are well known, and an increasing number of youngsters was expected on college campuses in the 1960's. This population boom, however, is only one cause of today's crowded classroom.

The nation is also experiencing an increase of aspirations for a college education. Many elements are contributing to this trend: a high school diploma is no longer a guarantee of a good job, and a teenaged population characterized by a high degree of mobility is seeking a college education in order to qualify for employment in desirable fields.

In addition to social and economic pressures encouraging students to seek a higher education, there are increased student loans, more scholarship assistance, and higher family incomes (1).

Federal legislation also has made higher education available to larger numbers. Legislation exercising the

greatest influence today includes the National Defense Education Act, 1958, which was recently amended to include fields in the arts and sciences; Higher Education Facilities Act, 1963, to help colleges increase physical facilities; and the Manpower Development Training Act, 1963, which established programs that largely utilize college facilities and instructors.

It will be several years before the impact of the numerous provisions of the Higher Education Act of 1965 will be felt, but it is a certainty that it will increase the availability of higher education. Colleges and universities also have yet to fully experience the enrollment created by the 1966 Cold War Bill of Rights, the new "GI Bill."

The federal government has committed the United States to the concept of democratic educational opportunity.

That means, as President Johnson has stated it, 'We are not going to stop until every child in this land can have all the education, of the highest quality, which his ambition demands and his mind can absorb' (2).

Higher education is becoming more available as institutions are moving to the student's locale in the form of extension centers, new community colleges, and new junior colleges.

Other factors contributing to the demand for college education include increased need for adult education due to the lengthened life span, more enrollment of women in

higher education, and new students from minority groups who previously had no place in the mainstream of higher education.

The numbers of college students will continue to increase. Richey (3) reported a rise in public school population of 42.8 per cent between 1950 and 1960, compared with a total population increase of 19 per cent during the same period. And in a 1965 speech, President Johnson (4) said public school enrollments will increase by more than 4 million in the next five years.

More of the population will go on in higher education. Total enrollment in 1950 was more than eleven times as great as in 1900, but total population had not quite doubled. About 25 persons in 10,000 were enrolled in higher education in 1900, but in 1950 this figure soared to 176 persons in 10,000 (5).

Opening fall enrollment in American colleges in 1965 was 5,967,411 students, enrolled in 2,238 institutions, an increase of 12.2 per cent over 1964. The 1965 total for freshman students was 1,452,926, 17.7 per cent greater than the previous year (6).

Oklahoma's colleges and universities enrolled 89,326 students in the fall of 1965, a gain of 13.0 per cent over the previous year's enrollment, to slightly exceed the national level. The State's freshman students numbered 23,969, representing an increase of 25.7 per cent over 1964, and exceeding the national mark of 17.7 by a full

8 per cent (6).

Estimates indicate that the crowded classroom problem is just beginning. Projections of the U. S. Office of Education (7) are that the number of college students will rise from 5.0 million in 1964 to 8.7 million in 1974. These projections may be conservative, as the 1965 figures, released before the 1965 enrollment was counted, were more than one-half million short of the actual 1965 count of 5,967,411.

Working with five-year periods, Folger (8) listed enrollment growth as 300,000 between 1950-55; 1 million between 1955-60; and 1.7 million between 1960-65. He projected growth as between 1.7 and 2.5 million between 1965-70, or a total of between 7 million and 7.7 million enrollment. More growth in enrollment will occur between 1965 and 1970 than the total number of students enrolled in higher education in 1954.

Supplying enough qualified teachers may be the most important problem area created by large enrollments. This study deals with auto-instructional methods which would permit a teacher to teach more students and might also give the teacher released time from the classroom.

Figures from the U. S. Office of Education estimate that the nation's college and university instructional staff will rise from the 1965 figure of 320,000 to approximately 433,000 by 1971 (8). To this increase of 113,000 must be added a figure for attrition, estimated by various

agencies as ranging from 1.8 per cent to 6 per cent annually, bringing total needed new faculty to some 160,000. Of 95,000 to 120,000 new doctorates which will be produced in the next six years, about 80,000 or from 60 to 85 per cent must go into college teaching if one-half of the faculty added between 1965 and 1970 are to have doctorates.

Generally, the demand for teachers is outdistancing the supply. McNeil (2) cited new institutions, increased enrollments and new campuses with contributing to the widening gap in adequate numbers of teachers. He predicted that the teacher shortage "undoubtedly will get worse."

Research is attracting many doctorate holders who have chosen academic careers. In the era of the generous federal grant, teaching may often be relegated to a "second-best" position.

Creating perhaps an even more frightening pressure on already overtaxed faculties is the knowledge explosion. Whaley (9) revealed that production of knowledge now doubles every ten years, and there is about one-hundred times as much to know as there was in 1900. "By the year 2000, there will be more than a thousand times as much knowledge of all kinds to record, to sift, to store, to search out, to teach, and --- hopefully --- to use."

Meeting the challenge of educating larger numbers of students with a limited faculty has encouraged methods

that depart from the traditional face-to-face classroom method.

Developments in independent study, work-study programs, study abroad, non-resident terms, and internships serve to remove the student from the campus, as well as to enrich his experiences. Newer dormitories include study and typing rooms as well as classrooms, and the use of the residence hall as a center for learning is now in practice at Stephens, Michigan State, and Antioch (10).

Several colleges and universities are utilizing facilities and faculties on a year-round basis to accommodate rising enrollments. A main criticism of these programs is a literal exhaustion of faculty resources, and the literature indicates that so many problems have been created that few schools are considering a change of this type.

Institutions are also exploring additional sources of personnel. Special advanced degree programs for prospective college teachers are being tailored by some university graduate schools; part-time teachers and graduate assistants are being utilized extensively; and many universities are modifying regulations requiring retirement of faculty members at 65 in order to utilize talented, experienced faculty members who wish to remain active.

A natural outgrowth of the pressures of teaching more students with fewer faculty is the search for new media. Instructional films and closed circuit televised

instruction are being used by a few institutions. Other media used to varying degrees are language laboratories, single concept films, film loops, audio-tutorial study, and computer-controlled teaching systems.

New instructional concepts include learning resource centers, complexes of classroom facilities with a central resources library and media center; and systems models of learning, which are based on computer-controlled teaching systems. However, it appears that the new media have had limited use.

The amazing thing is that they (new media) have been so little used that an institution actually contemplating the adaptation of any one of them to a college situation is regarded as a pioneer ... Relatively few colleges have taken the leap actually to experiment with these on any large scale basis (11).

Although audio-visual materials, television, and films may provide enrichment and stimulate interest, they do not let the student participate, or to practice what he is learning, or to be informed of his progress (12). However, an instructional method which does provide information to the student and seems to offer other advantages is "programed instruction."

Programed materials require the student to answer questions and then provide him with immediate knowledge of results. This knowledge of results reinforces correct responses, and the student travels through a series of sequential steps, always informed of his own progress.

Programed instruction also promises to lower costs.

Although both expense and time are required in their development, programs may be presented in an inexpensive textbook format. This printed programmed material can be arranged in non-consumable form, and may be easily updated and revised. No expensive apparatus or trained personnel are required.

Cost of electronic devices and materials may prohibit their extensive use. Mayhew (11) cited, for example, that an hour-length video tape costs \$300.

Since programmed instruction offers promise in assisting educators to meet the demands imposed by crowded classrooms, the purpose of this study is to investigate programmed instruction at the college level. Specifically, this study seeks to ascertain the effectiveness of programmed instruction as a method of teaching selected portions of college level elementary photography: film exposure and flash in photography. Relatively little work has been done in investigating the programing of college instruction compared with studies of public school instruction, and no literature was found concerning programing in journalism or communications.

If it is found that students can learn selected areas of a course equally well or better through programmed instruction, part of the teacher's time may be released for advising, counseling, individual instruction, keeping up on new developments in his teaching area, and in meeting other demands created by increased numbers of students.

The possibility of released time is far from remote:

It may well be that the typical teacher of the future will spend only a small part of his time providing information. Such time as he does spend may be in a carefully rehearsed demonstration or lecture. The rest of his time may be occupied in conferences with individual students or with small groups of students (11).

This research experiment investigated:

- (1) Whether students in photography receiving only directed programed instruction in film exposure will demonstrate equal or better achievement than students receiving only standard classroom instruction.
- (2) Whether students in photography receiving only non-directed programed instruction in film exposure will demonstrate equal or better achievement than students receiving only standard classroom instruction.
- (3) Whether students in photography receiving only directed programed instruction in flash photography will demonstrate equal or better achievement than students receiving only standard classroom instruction.
- (4) Whether students in photography receiving only non-directed programed instruction in flash photography will demonstrate equal or better achievement than students receiving only standard classroom instruction.

Calculating film exposure is a basic procedure in the

picture-taking process, and is an important and integral part of the elementary photography course. The student must learn to calculate exposure without mechanical aids before he can proceed to other phases of picture taking.

Use of flash in photography is a main unit of instruction in the elementary course.

CHAPTER II

REVIEW OF LITERATURE

Psychological Theory

Programed instruction is a self-instructional system of learning which utilizes content broken down into very small segments and presented in a logical sequence. Each step requires an active response by the student, after which he is given the correct answer, which, in turn, reinforces the correct response he has made or allows him immediately to correct a mistake. Typical methods of presenting programed material are teaching machines and especially constructed textbooks; many other presentation techniques are being studied.

Psychological Principles

The following psychological principles are involved in programed instruction (13)(14):

1. Subject content is broken up into small units called frames; careful control of stimuli produces gradual increments in mastery of the content.
2. Active response is required of the student; he must answer a question or fill in a blank.

3. The student is provided immediate knowledge of results for each response; this immediately reinforces the response or corrects a misunderstanding.
4. Frames are arranged in careful sequence, leading the student toward desired goals.
5. The student paces his own progress, working independently at his own speed.

History and Development of Reinforcement Theory

The theory which underlies the use of programmed instruction and teaching machines has been developed for the most part by Dr. B. F. Skinner (15)(16), a psychologist at Harvard University. Following years of observation of animal behavior, Skinner first applied his reinforcement theory to human learning in 1954 and published later findings in 1958. Both are classic studies and their proposals serve as foundations for the theory of programmed learning.

Skinner (15) introduced his theory by describing techniques of learning as "contingencies of reinforcement," which he explained as relations prevailing between behavior and the consequences of that behavior, resulting in achievement of more effective control of behavior. Skinner recommended making each step of learning very small and proposed reinforcement following the stimulus without delay in order to achieve maximum effect.

Studies of exploratory behavior in terms of being self-reinforcing began with early animal studies by Tolman (17) who noted variable behavior of rats in a maze.

Thorndike (18) reported similar effects with human subjects. A later study by Butler (19) found that when permitted to look out of a window at other monkeys, Rhesus monkeys learned to discriminate colors; the opportunity to look out served as the reinforcing agent.

Although early research included concepts of what Skinner later was to call "reinforcement," Skinner was the first to take the position that only certain behavior was the result of identifiable stimuli, and that other behavior does not originate from any identifiable source of stimulation; this latter kind of behavior he called "emitted" or "operant" behavior. This concept was to have far-reaching implications for educational problems (20).

Skinner's theory of reinforcement is believed to be so influential in the area of programmed instruction because it is in good scientific order, its accomplishments in the laboratory have been impressive, and it is generally thought to be a sound approach to the analysis of learning and teaching (21).

Although there is little doubt of the impact of Skinner's contributions to the field of programmed instruction, some feel that he has been unjustly categorized merely as a programmer and teaching machine inventor:

Skinner's great contribution was far more basic than either of these implementation procedures. His empirical, operational orientation and empirically derived behavior-shaping techniques, so useful for research purposes, have lead

directly to a set of tools that are powerful basic elements of what we now call instructional technology. He also contributed the view that continuous student activity is not something to talk about in the abstract, but is something that must be systematically achieved in a reliable and predictable fashion (22).

Thompson (21) described Skinner's reinforcement principles as a framework from which to study human behavior, explaining that their degree of preciseness and their dynamic qualities give them much of their strength.

Other interpretations of reinforcement are structured according to the drive reduction theory generally credited to Dr. Clark Hull. This theory states that behavior is reinforced because attaining the goal reduces or satisfies the need which motivated the behavior (23). Anything is believed to be reinforcing if it decreases some drive or need within the individual. This need may be one such as hunger, or it may be a learned drive such as the need for approval or acceptance (24).

Hilgard (25) indicated the universality of agreement concerning reinforcement theory:

At this empirical level there is no important dispute about the validity of the principle of reinforcement, and there is no such thing as a non-reinforcement theorist. Even Guthrie, who is often described as holding a non-reinforcement position, maintains such a view only with respect to the so-called theoretical law of effect.

Related Research

Since reinforcement is utilized in varying degrees and through several different techniques in programmed

instruction, it is necessary here to discuss some of its aspects. Considerable research has been conducted, and although the nature of these studies is diverse, an overview of some of the findings may be given in terms of these categories:

1. Immediate or delayed reinforcement.
2. Reinforcement schedules.
3. Direct or vicarious reinforcement.
4. Positive or negative reinforcement.

Immediate or Delayed Reinforcement

The characteristic of reinforcement that appears to be best-established is that immediate reinforcement results in optimum learning (15)(20)(23)(26)(27)(28). Immediacy of reinforcement is a standard procedure in programmed instruction and is believed one of the method's main benefits to the student (13).

Reinforcement Schedules

Research in this area has generally been with three types of reinforcement schedules:

The first of these is known as fixed-ratio reinforcement whereby the behavior to be reinforced is reinforced, for example, the first time in every six times it occurs ... The second is known as fixed-interval reinforcement, whereby the behavior to be reinforced is reinforced every time a given interval has elapsed. Thus one may reinforce a child's efforts to spell once at the end of every five-minute period. The

third type of schedule is that of variable-interval reinforcement, whereby reinforcements are provided at varying intervals (20).

Some investigators use the terms "continuous" reinforcement, or "100 per cent" or "50 per cent" reinforcement. Continuous reinforcement and 100 per cent reinforcement would be a fixed-ratio reinforcement schedule where each response was reinforced. A 50 per cent reinforcement schedule would also be a fixed-interval reinforcement schedule, but only half of the responses, such as every other response, would be reinforced.

Research has found the variable interval schedule generally the most effective for the classroom. This type of reinforcement, also termed "intermittent" reinforcement, is believed by many to be superior to continuous reinforcement in terms of subject output and consistency of effort (20)(29). Resnick (30) confirmed the maximum effectiveness of an intermittent schedule and added that it probably was more effective in making the response more resistant to extinction. This phenomenon was first demonstrated by Humphreys (31) in the area of verbal learning.

However, Krumboltz (26) reported three studies in which continuous reinforcement was found superior to various schedules of intermittent reinforcement in acquiring concepts, and he reported that another study revealed no differences between a 50 per cent variable-ratio schedule and a continuous schedule of reinforcement.

Mech (32) found continuous reinforcement most

effective in a classroom study when compared with subjects reinforced with 50 per cent and zero per cent reinforcement. However, an earlier study by Auble (33) reported no significant differences in level of performance of groups receiving 100 per cent, 50 per cent, and zero per cent reinforcement. A study of verbal reinforcement noted marked differences in mean gain scores of students receiving various schedules of frequency of praise, but differences were not statistically significant (34).

Six different types of reinforcement schedules were utilized in a study by Krumboltz and Weisman (35) using college psychology students. No significant differences were found between continuous reinforcement and various types of fixed-ratio and variable-ratio schedules.

Direct or Vicarious Reinforcement

Vicarious reinforcement generally means that the subject is in the presence of a reinforcer, usually observing and hearing another subject being reinforced. Findings appear to be rather inconsistent regarding effects of vicarious reinforcement. Sechrest (36) reported significant differences in performance of vicariously reinforced subjects in problem solving, while Van Wagenen and Travers (37) found direct reinforcement somewhat more effective regarding meaningful experiences over a long period of time, but not significantly so. One group interacted directly with experimenters and the other group worked in

isolation with teaching machines. Subjects directly reinforced achieved a score of 54 per cent; vicariously-reinforced subjects scored 44.3 per cent.

In a 1963 study, control groups not reinforced did not learn, and vicarious reinforcement significantly facilitated learning in experimental groups with direct reinforcement showing no additional effects. Vicarious reinforcement consisted of the experimenters saying "good" when subjects speaking on a tape gave a response; this was heard by the subjects in the experiment. Direct reinforcement consisted of saying "good" directly to the subject. Control groups heard tapes with fewer critical responses and no vicarious reinforcement (38).

Auble and Mech (39) observed a generalizing effect in the classroom between reinforced subjects and subjects who were merely in the presence of the reinforcement; no overall differential effect was noted. Subjects in the presence of reinforcing stimuli appeared to produce fewer correct responses and more error responses than did subjects who received direct verbal reinforcement, but differences were not statistically significant.

Positive or Negative Reinforcement

Although it is accepted that negative reinforcement can create effective learning, positive reinforcement is considered more desirable in the classroom (13)(20)(40)(41).

Reasons for this position are that negative reinforcement creates anxiety which has uncontrolled effects and may become attached to stimuli not related to the anxiety state; anxiety is not easily dissipated. Aversive stimuli generally also indicate failure, and the subsequent level of student performance is reduced (20).

A study testing a controlled amount of negative reinforcement in a programmed sequence revealed that learning of students in a spaced training negative reinforcement group was not hindered. All-positive reinforcement and spaced negative reinforcement groups showed no significant differences, and both achieved significantly better than a massed training negative reinforcement group (42). Results of a study by Kelly (43) favored negative reinforcement. In both direct and vicarious reinforcement groups, highest operant rates were maintained under negative reinforcement; lowest rates were recorded by groups receiving no reinforcement. Krumboltz (26) gave evidence that the word "wrong" is probably more effective than the word "right" under conditions when irrelevant cues are present.

Although autoinstructional devices offer the capability for negative reinforcement, such as flashing a red light for a wrong answer, it is believed unlikely such machines would be accepted by educators (13).

Punishment or negative reinforcement in education is generally criticized by Deterline (41), who said:

... it may be almost impossible in many classroom situations to provide any kind of motivation except threat and anxiety, and punishment may be the only immediately effective and available method of terminating undesirable behavior. Ideally, and in the long run, however, these techniques are neither desirable nor particularly effective.

Summary of Reinforcement Theory

The following summarize the psychological background of programmed instruction in terms of reinforcement theory

(20)(44):

1. A reinforcer is a condition which follows a response and which results in an increase in the strength of that response on subsequent occasions.
2. The more quickly reinforcement follows the desired performance, the more likely the behavior will be repeated.
3. Well-established habits are best maintained through the use of a reinforcement schedule of less than 100 per cent. Intermittent reinforcement increases the length of time a student will persist at a task without further reinforcement.
4. Learning behavior can be developed gradually by reinforcing desirable behaviors and withholding reinforcement following undesired acts.
5. The successful completion of a task or the discovery of the solution to a problem may be reinforcing for those behaviors that led up to these events.
6. In addition to making repetition of an act more probable, reinforcement increases a student's activity, quickens his pace and heightens his interest in learning.
7. Many reinforcers are conditions that satisfy needs; effective learning commonly takes place when the task involved is related to the satisfaction of a need.

8. The magnitude of a reinforcement is likely to be of much less significance than the fact that a reinforcement will or will not occur. In education, a safe rule, probably, is to use small reinforcements.
9. Experience without active participation and without reinforcement can conceivably produce learning, but the learning process involved is inefficient compared with that which occurs when performance is directly reinforced.
10. Negative reinforcement generally increases the rate at which learning occurs. However, it is not recommended since it may have other harmful effects, such as the development of an aversion for the entire learning process.

Definition of Terms

Terms used in this study are operationally defined as follows:

Achievement -- A measure of the student's mastery of the material of the course.

Automated instruction -- Instructional methods utilizing any material, means, or devices to replace or supplement standard instruction by means of a wholly or partially automated presentation prepared in advance.

Constructed response -- Response originating within the subject, as opposed to choosing from alternative answers.

Criterion instrument -- Instrument measuring the extent to which a desired kind of

competence, proficiency or capability has been achieved.

Conventional instruction -- Instruction utilizing lecture, class discussion and textbook readings during a regularly scheduled class period.

Cue -- Some stimulus which facilitates the desired response from the subject.

Error rate -- Mean percentage of errors made in answering frames of a program.

Exposure study -- Unit of photographic study concerned primarily with learning to calculate correct camera settings to permit a controlled amount of light to pass through the camera lens and record an image on the film.

Fading -- Gradual withdrawal of stimulus support in presenting items.

Flash study -- Unit of photographic study concerned with types of flash units, types of flash techniques, and calculating camera settings when using flash.

Directed programed instruction -- Study utilizing programed materials during a regularly scheduled class period with the instructor overseeing the

group and answering any individual questions.

Feedback -- Communicating to the subject working programed materials the information needed to modify responses in order to eliminate errors and maintain correct responses.

Frame -- A single item exposed to the subject at one time in an instructional program.

Motivation -- Any idea, need, or emotion within the individual that prompts him to action.

Non-directed programed instruction -- Study utilizing programed materials outside of class time; students are released from attending class in order to study the programs at their individual convenience.

Reinforcement -- A condition, which when following a response, increases the probability that the response will occur on subsequent occasions.

Response mode -- The form of the response a student makes while working a program.

Step -- An increment in subject matter to be learned with each succeeding frame in the program.

Related Research

Due to the volume of research in programmed instruction conducted in recent years, guidelines had to be established for selecting related research. It was decided to divide the section into two areas: the first area dealing with historical background and evolution of programmed instruction, and the second with a summary of research concerning the primary variables of programmed instruction. Priority was given to studies conducted on the level of higher education, those dealing with a programmed textbook format, and those comparing programmed instruction with conventional instruction. Only one study was found concerning directed and non-directed programmed instruction, which is pertinent to this particular study.

Historical Background and Evolution of Programmed Instruction

The earliest attempt at automated instruction was recorded in 1809 when a patent was granted for a device designed to teach reading. A device to teach spelling was developed and patented in 1866. In 1914 a patent was granted to Maria Montessori to train the sense of touch

(45). However, Sidney L. Pressey, of Ohio State University, is generally credited with devising the first recognized teaching machine in 1926. Pressey (46) described the apparatus as a testing machine, and visualized it as a time-saving device for the teacher; the machine presented questions to the student and immediately informed him of the correctness of his answers. A question appeared in a small window on the machine and the student was given multiple-choice alternatives. If he pressed the correct button, a new question appeared; however, if he chose incorrectly, the error was tallied and the same question remained until the correct button was depressed.

The following year Pressey (47) published an article describing a machine for presenting drill material, and he stressed the device's significance:

The important feature of the work here reported is the exemplification of the fact that machines can be built which meet, automatically, certain very important requirements of efficient teaching.

In 1932 Pressey (48) summed up his findings from eight years of work with automated teaching devices, describing advantages of teaching machines and predicting widespread development of new apparatus and materials.

The first of several studies which were to suggest the effectiveness of teaching machines was published in 1931 by J. C. Peterson (49), one of Pressey's former students, who reported significant gains in achievement of groups utilizing a "self-instructor and tester" device.

Another of Pressey's students, James K. Little (50), conducted an experiment in 1934 which marked the first time that machines were used systematically as part of the regular routine in university classes. He found that students who were immediately notified of test results and allowed to correct deficiencies scored higher than students not having these advantages. Little reported that students in the lower half of the distribution showed more improvement than those in the upper half. He concluded that drill devices had a practical use in the classroom and that they made possible certain instructional techniques which were not otherwise practical.

Pressey's pioneer work of the 1920's met with little public approval, and in 1932 he announced: "The writer has found from bitter experience that one person alone can accomplish relatively little, and he is regretfully dropping further work on these problems" (48).

Lysaught and Williams (44) give two reasons for the apparent public apathy at that time toward auto-instruction:

First, no provision was made for systematic programing of materials to be used in those machines, and, second, the onset of the depression and its impact on social conditions and education offered an unfavorable environment for an "industrial revolution" in the nation's schools.

Interest in mechanized instruction was revived in the early 1940's. Because of World War II, use of trainers and simulators increased through the military need to

train many men in new skills, and simulators became a permanent part of training procedures in both military and industrial settings (20).

A few studies in the late 1940's were based on Pressey's original work. Angell and Troyer (51) in 1948 developed a self-scoring punchboard device which permitted a student to select an alternative from a test sheet, then punch the appropriate hole in the punchboard. If a red spot was visible where he punched, the answer was correct; if no red spot appeared, he had to punch another hole. The investigators reported two studies from Syracuse University in which significant learning was demonstrated by immediate knowledge of results through the punchboard-testing technique.

The punchboard was utilized again in 1949 by Jensen (52) who used college psychology students in an independent-study laboratory. The experimental group used a set of tests with a punchboard to make them self-instructional. Each question in the tests was followed by a page reference in the readings where the topic was discussed. If the student wished, he could repeat a test after further study, with no limit on time he wished to spend. In final evaluation, 54 per cent of the superior students in the experimental group obtained an "A" in the course, while only 10 per cent of the superior students in the control group received an "A". Jensen concluded that superior, highly-motivated students could handle college

courses by guided independent study if they had sufficient materials.

Pressey (53) renewed his work in the area in 1950, utilizing the punchboard in an experiment with approximately 500 students at Ohio State University. Eight groups were divided into four accelerated seminars, two examination-for-credit groups, and two self-instructional laboratory groups, all using the punchboards. All made superior grades compared with students in the twenty-seven regular class sections in educational psychology.

With Skinner's 1954 publication (15), automated instruction left the realm of testing devices and entered the era of programed instruction based upon reinforcement theory. Skinner wrote that laboratory findings concerning learning could be directly implemented in the classroom by "appropriate instrumentation"; he explained his theory of reinforcement and showed how it was put into practice in a teaching machine.

The first experimental results of the new theory were reported by Porter (54) who worked under Skinner at Harvard in implementing programed instruction. Using simple teaching machines to teach spelling to second grade and sixth grade classes, he found that students in the experimental groups achieved more than those taught by the conventional method. In the sixth grade groups, the experimental group spent only one-fourth as much time studying as did the control group.

In 1958 Skinner (16) contrasted the new teaching machines with those of Pressey, explaining that the new devices "shaped" behavior by utilizing reinforcement; Skinner set forth techniques for programing material for automated instruction, and many of these same techniques are being utilized today.

The vehicle that was to bring programed learning to more persons than any other medium, the programed textbook, reached developmental stages late in 1958. Glaser, Homme and Evans (55), of the University of Pittsburgh, adapted Skinner's teaching machine principles to programed materials in a printed format, with control left to the reader. Subsequent research was to find the programed textbook an effective teaching device, and it was far less expensive than its mechanical counterparts.

Although the early testing devices of Pressey utilized a multiple-choice question, Skinner's theory emphasized strongly the need for a constructed response by the student. Skinner's programs were also characterized by a fixed sequence of material and hence they were termed "linear" programs.

While the early linear programs were being written, Crowder (56) was developing a more flexible type of program designed to adjust for individual learner differences. Crowder termed this technique "intrinsic" programing, and it has also come to be known as "branching". Crowder (56) described the system as adapting itself to the student's

achievement and knowledge:

If the student passes the test question, he is automatically given the next unit of information and the next question. If he fails the question, the preceding unit of information is reviewed, the nature of his error is explained to him and he is retested. The test questions are multiple-choice questions and there is a separate set of correctional materials for each wrong answer that is included in the multiple-choice alternatives.

Generally the branching method permits the more capable student to bypass material he would have covered in a linear program, thereby saving time and eliminating the possibility of boredom. The branched programs were developed in textbook form, commonly called a "scrambled" book, and into programs for teaching machines.

Experimental evidence does not conclusively favor one programing technique over the other; both are in use today, although the majority of programs are linear (57).

Although Pressey's teaching apparatus and those devised by Skinner were box-like, simple, and manually-operated, more sophisticated apparatus for programmed instruction was soon developed. As early as 1958, electronic devices were being utilized in programmed instruction (58). In 1961 a Bendix computer was adapted to a multiple-choice machine used to control a program contained on 600 slides which were projected on a screen. The student's responses were fed into the computer as they were typed on an electronic typewriter, and the computer guided the instruction on a branching basis, determining by the student's responses whether to branch to remedial

material or to proceed with new information (13).

A computer facility for individual or group instruction is being studied by Systems Development Corporation. Called CLASS (computer-based laboratory for automated school systems), the laboratory provides facilities for combining self-instructional programs with conventional instruction. Students work at individual consoles which include a display monitor and buttons with which to answer multiple-choice questions. The computer monitors individual student response behavior, keeping a record of responses, and branching the student to remedial items if necessary (59).

Results are reported as "extremely encouraging" concerning a computer-controlled teaching system in mathematics at the University of Illinois. The system features extensive feedback from the student; students work on an individual basis, but share a digital computer and electronic slide selector. Each student has his own keyset, television display, and electronic blackboard (60).

Today programmed instruction is utilized in varying forms and extensive experimentation is being conducted in new media with increased interest in adapting programmed instruction techniques to computer and electronic technology. Programed instruction is also being built into instructional films and educational television, creating an entire new area for audio-visual instruction.

Findings of Research on Primary Variables of Programed Instruction

Outcomes of related research in programed instruction will be discussed in terms of the following variables:

1. Response mode
2. Form of presentation of material
3. Structure and sequence of material
4. Step characteristics
5. Knowledge of results
6. Pacing
7. Programed instruction compared with conventional instruction
8. Time required for instruction

Research concerning each variable will be discussed separately with the exception of time required which will be included with the main variable or variables being studied. Only one study was found which was designed to study time required as the main variable, but many reported the time factor as a secondary element of the research.

Response Mode

Although programming authorities have traditionally stressed the necessity of an overt response, today there is evidence that the covert response may be more effective. Overt response means that the student writes a response in

a blank space in the program; covert response means that the student is thinking of a response that would fit in the blank space.

In the investigation of the literature, ten studies showed no significant differences in favor of either response mode, (61)(62)(63)(64)(65)(66)(67)(68)(69)(70), five favored the covert response (71)(72)(73)(74)(75), and two favored the overt response (76)(77). In general it was found that students instructed to use the covert response required much less time than those responding overtly.

Lambert and others (61) found no significant differences in learning between response modes, but noted that the covert response mode took significantly less time. Goldbeck and Campbell (63) found no differences in overt and covert response, but reported that a third group which merely read responses already printed in the frame blanks surpassed the other groups in immediate and ten-week retention tests. Alter and Silberman (64) conducted three studies with ninety university students, and in each found no significant differences in learning between groups using various response modes. A study by Stolurow and Walker (65) with fifty-six students in educational statistics found no significant differences in learning or retention measures, but reported that the covert response required significantly less time than the overt response group. Neither Wittrock (69) nor Tuel (70) found significant

relationships between response mode and total achievement, but both produced evidence that non-overt response groups were more efficient than overt response groups, particularly in time expended.

In one of the studies cited which favored covert response, Krumboltz and Weisman (74) found that fifty-four college students revealed no significant differences on an immediate post-test, but a two-week delayed test demonstrated that the group writing answers scored significantly higher than the group thinking the answers and the group with the blanks already filled. Sixty-eight female college students were used in one of the two studies that were in favor of the overt response. The overt group scored significantly higher on verbal and pictorial materials on both immediate and delayed post-tests; however, the overt group also required almost twice the time that the covert group took to complete the program (76). Goldbeck (77) found the overt response mode superior to the covert response mode at intermediate difficulty levels, but noted that it was less efficient, requiring more time than other types of responses.

Another area of study of response mode concerns a comparison of the constructed response and the multiple-choice type of response. In several studies comparing the two types of responses, investigators have found no significant differences between them (66)(68)(78)(79)(80)(81)(82)(83). Few experiments obtained a difference in favor

of the constructed response, and none significantly favored the multiple-choice response (84)(85). It was generally indicated that constructed response groups required much more time than the multiple-choice response groups.

Experimenting with college students using both constructed and multiple-choice response modes with teaching machines, Coulson and Silberman (78) found no differences in learning both on immediate and delayed post-tests; they noted that more time was required by the constructed response group. In another study the following year they reported identical results (80). Della-Pianna (81) found no significant differences in learning among four response treatments, but found that the constructed response group ranked only third in efficiency in terms of time required and errors made.

Fry (84) found significantly superior performance on the part of groups using a constructed response program when a completion type test was used for measurement; however, when a multiple-choice type post-test was administered, differences were not significant. Williams (85) reported a significant advantage for constructed response programs compared with multiple-choice types when complex, technical terminology introduced by the program was required to be learned.

Form of Presentation

A number of studies comparing the effectiveness of various types of programmed presentations found no significant differences between them (68)(86)(87)(88)(89)(90)(91)(92). A single study of 144 college psychology students demonstrated that in achievement, a low verbal ability group performed significantly better with a standard textbook than with a programmed textbook; however, no differences were found with either textbook format for the high verbal ability group (93).

Feldhusen and Birt (86) presented programmed material to 270 college students in teaching machines, programmed textbooks, and simple cardboard folders and found no differences between presentations. Roe (87) administered a linear program to 186 college students using programmed textbooks, programmed lectures and teaching machines; all learned equally well, regardless of type of presentation. Studies which compared teaching machine presentations with programmed textbooks found no significant differences in achievement (68)(88)(90)(91)(92).

No significant differences were obtained in learning outcomes in a study of 113 college students in an algebra course presented by teaching machines, programmed textbooks, filmstrips, and conventional teaching. A study of presentations by teaching machine, televised programmed instruction, and conventional instruction also revealed no

significant difference in student performance (89).

Structure and Sequence of Material

Few studies have been conducted to test the effectiveness of ordered sequence of material, a somewhat traditional convention in programing. But the majority of those show no difference in learning between an ordered sequence or a random sequence of material (71)(79)(94). Roe (95) reported no significant differences occurred in learning if the programs were relatively short, but stated that careful sequencing was necessary for long, complex programs. Silberman and others (96), and Mager and Clark (97) found voluntary sequencing by the learners superior to ordered sequencing.

A second phase of program structure divides programs into two categories: the fixed sequence linear program in which all students take the same steps, and the branched program which offers several sequences according to the student's performance. Although the branched programs seem to offer a more individualized type of instruction and have been proved to require less time than the linear programs, the majority of research studies have failed to show differences in favor of either type of program (78) (80)(95)(96)(98)(99)(100). Four of these studies noted that branched programs were more efficient in terms of time required. A single study by Coulson and others (101) found scores of the branched program group significantly

higher than those of a fixed sequence group, and training time of the two groups was not significantly different.

Step Characteristics

Although several studies supported Skinner's contention (16) that small steps of material were necessary for effective learning by producing significant differences in learning (67)(78)(80), findings are not consistent, for other researchers have found no significant differences in learning because of the size of steps (102)(103). All of the investigators indicated that small step programs consumed more time. Evans, Glaser, and Homme (67) noted that small steps were associated with significantly better immediate performance, better retention, and fewer response errors during the course of learning. Coulson and Silberman (80) cited small item steps as yielding significantly higher test scores on a constructed response criterion subtest.

Knowledge of Results

No definite trends are apparent in studies of various manipulations of knowledge of results. Although some studies found significant differences in learning when students received immediate confirmation (102)(105)(106), several others found that subjects in groups where feedback was withheld altogether did as well as those who had immediate knowledge of results (86)(91)(103)(104). Evans

(71) reported no differences in learning due to immediate or delayed feedback. Krumboltz and Weisman (35) found significant differences in error rate due to varying schedules of reinforcement, reporting that groups receiving fewer confirmations made more errors during learning.

Pacing

The self-pacing property of programmed instruction has been considered one of the method's main advantages, permitting the learner to progress according to his ability and speed of performance (16). However, five studies which investigated self-pacing versus external pacing which was manipulated by the investigators revealed no significant differences regardless of the type of pacing (64)(86)(89)(107)(108). Investigators reported no significant differences in performance of college mathematics students when pacing was varied as much as 20 per cent below and 10 per cent above the average time of a group of self-paced students (89). In another study it was observed that the externally-paced group made more errors on the first trial using a subject matter trainer, but this difference vanished in subsequent trials (107).

Programed Instruction Compared With Conventional Instruction

Research studies comparing programmed instruction with conventional methods of instruction have firmly established

the fact that programed instruction is as effective as conventional methods. Nine studies were found showing no differences between programed instruction and conventional instruction (68)(89)(93)(109)(110)(111)(112)(113)(114). In these studies instructional time typically was reduced with programed instruction groups.

Smith (109) indicated that students using programed instruction felt that they had more opportunity to receive individual assistance from the teacher than under more conventional methods. Goldberg and others (113) studied groups working with conventional instruction, programed textbooks, and teaching machines. The investigators reported the greatest retention after six months to the conventional group, and stated that both programed groups marked a substantial savings in time. Hough (112) found no differences in learning, but wrote that the programed instruction group saved 47 per cent of the time required by the control group. Reed (111) likewise found no differences in learning, but reported that the high ability student performed better with programed materials, whereas the low ability student did better with conventional teaching.

Reid (114) emphasized the value of programed instruction in producing results equal to those of standard instruction. Reporting on three studies of the English 2600 programed textbook on the secondary school level totaling 4,600 subjects and over one-hundred teachers, he stated:

The combined experience reveals the one big point: English 2600 (programed instruction in grammar) brings about the same improvement in language learning as traditional text materials actively taught by classroom teachers. But the savings in teachers' time by virtue of the self-instructional qualities of programed instruction is significant.

Several studies reported significant differences in favor of programed instruction compared with conventional teaching (54)(87)(115)(116)(117)(118)(119). Blyth (117) wrote that college students taking programed French scored 20 per cent higher on the final test than those in the conventional course; students in programed German were also 20 per cent higher; and students in a programed logic course were 10 per cent higher. Roe (87) reported that college engineering students using programed materials in any form did significantly better on the final examination than those in lecture sessions. Brown (118) studied approximately 350 high school students in mathematics and found the experimental group significantly superior.

Wisenthal (120) demonstrated the potential of automated instruction in producing desired behavior in connection with higher education classes. Two groups taking practice teaching and also educational psychology during the same term were used in the study; one group was instructed in programing techniques and reinforcement theory while the other group received little of this training. In practice teaching evaluation, the experimental group showed transfer between program writing behavior and

classroom teaching behavior; difference in favor of the experimental group was significant at the .001 level.

Only one study was found which dealt with supervised and non-supervised programmed instruction, a major variable of this study. Bartz and Darby (121) studied freshman mathematics students at Purdue University in 1963, dividing subjects into four groups: formal instruction, supervised programmed instruction, non-supervised programmed instruction, and no instruction. Students in supervised programmed instruction and students in formal instruction were not found to be significantly different in performance; however, the non-supervised group did not perform significantly better or worse than students receiving no instruction, and scored significantly lower than students in formal instruction and supervised instruction.

Summary of Related Research

In summary, the literature indicates the following:

1. In some cases the covert response mode is found superior to the overt response mode, but the majority of the studies show that students benefit equally well from programmed instruction regardless of whether they write their responses or merely "think" them; the covert response mode generally requires less time.

2. Although some research favors the constructed response, most of it shows no difference between constructed and multiple-choice responses, and most indicates that the constructed response requires more time.
3. No one type of programed instruction presentation, such as teaching machine, programed textbook, programed filmstrip, etc., is significantly better than another.
4. Programs using a random sequence of material are as effective as programs using an ordered sequence of material.
5. Students learn equally well with linear and branched programs, but branched programs consume less time.
6. Small steps of material are generally most effective, although a few studies show no differences in learning between small and longer step programs.
7. Findings are inconsistent regarding whether immediate knowledge of results is more effective than various types of delayed knowledge of results, or no knowledge of results.
8. Student performance is not affected significantly by pacing.

9. Programed instruction is found to teach as well as conventional instruction, and in many cases does better. Programed instruction consumes less time.
10. Findings from one study indicate that although supervised programed instruction compares equally well with conventional instruction, students in non-supervised programed instruction score significantly lower.

CHAPTER III

SPECIFIC STATEMENT OF THE PROBLEM

As introduced in Chapter I, the purpose of this study is to ascertain the effectiveness of programmed instruction as a method of teaching selected units of college level elementary photography at Oklahoma State University. The study is designed to compare the achievement in selected areas of study resulting from conventional instruction with achievement resulting from programmed instruction. The study compares the effectiveness of directed programmed instruction with the effectiveness of non-directed programmed instruction; it also compares the effectiveness of directed programmed instruction and non-directed programmed instruction with the effectiveness of conventional instruction.

Independent Variables

Manipulative elements in this study are the types of instruction received by the subjects: (1) directed programmed instruction, (2) non-directed programmed instruction, and (3) conventional instruction.

Dependent Variables

In this study the dependent variable is the measure of student achievement in selected areas of photography study.

Assumptions

The following assumptions are made: (1) programed instruction is a valid teaching method, (2) instruments used for measuring achievement in selected areas of photography study are reliable and valid measures, and (3) different forms of the measuring instruments prevent the post-test being affected by the pre-test.

Potential Intervening Variables

These are: (1) possible differences in characteristics of the sample used, (2) achievement that subjects could acquire without instruction, and (3) motivation.

Hypotheses

Hypotheses to be tested are:

1. There are no significant differences in achievement scores in film exposure study between the experimental groups receiving directed programed instruction and the control group receiving conventional instruction.
2. There are no significant differences in

achievement scores in film exposure study between the experimental groups receiving non-directed programmed instruction and the control group receiving conventional instruction.

3. There are no significant differences in achievement scores in film exposure study between the experimental groups receiving non-directed programmed instruction and the experimental groups receiving directed programmed instruction.
4. There are no significant differences in the achievement scores in flash photography study between the experimental groups receiving directed programmed instruction and the control group receiving conventional instruction.
5. There are no significant differences in the achievement scores in flash photography study between the experimental groups receiving non-directed programmed instruction and the control group receiving conventional instruction.
6. There are no significant differences in the achievement scores in flash photography study between the experimental groups

receiving non-directed programed instruction
and the experimental groups receiving di-
rected programed instruction.

CHAPTER IV

DEVELOPMENT OF INSTRUCTIONAL MATERIALS AND CRITERION INSTRUMENTS

Development of Instructional Materials

Two units of programmed instruction of the programmed textbook type were developed by the author to use in the study: film exposure and flash in photography.

The first step in developing the programs consisted of several conferences with Professor Harry L. Hix, Oklahoma State University photography instructor, in order to determine instructional objectives. Bloom's Taxonomy of Educational Objectives: The Cognitive Domain (122) was used as a reference in constructing outlines of instructional objectives for each of the photography programs.

During the summer term, 1966, Professor Hix's lectures on film exposure and flash photography were tape recorded, and together with relevant sections of the textbook, were transcribed into detailed outlines of subject content.

After content was listed and objectives drawn up for each program, desired behavioral outcomes were formulated. Criteria for objectives and behavioral outcomes included

identification of performance of the learner as he demonstrates he has reached the objective; naming conditions under which the learner demonstrates his competence; and describing a level of acceptable performance (123). Content, objectives and behavioral outcomes are given in Appendices A-IV and A-V.

A linear model was chosen for both programs, which required each student to proceed in the same order. This model was modified slightly by including review frames to direct the student back to material he had not learned. Both programs were largely of the constructed response type, requiring students to write out answers to each frame; only a few frames in each program utilized multiple-choice type responses.

Designed in a vertical format simulating that of a programmed textbook, the programs were reproduced by fluid duplicator process on 8 $\frac{1}{2}$ by 14-inch paper and stapled into booklets. Answers were located to the right and below each frame, requiring the student to cover all of those frames below the frame presently being studied. This technique was intended: (1) to eliminate the student glancing ahead for information to use in answering the frame upon which he was working, and (2) to permit better utilization of the "conversational chaining" technique, a repetition of a response which appears in the frame immediately following the frame being worked.

Some conventions followed in constructing the two

programs included presenting material in relatively small steps, providing a logical sequence of content, and structuring the frames so that the required responses were relevant.

A variety of specific techniques was utilized in writing the frames. The literature on programing helped provide a rationale, and the writer also examined several programs in order to analyze the programing methods.

One technique utilized, especially at the beginning of the programs, was "cueing" --- giving clues in the context of the frame in order to ensure the correct response. In introductory frames the "fading" technique --- the gradual withdrawal of cues --- also was used. The following frames illustrate cueing and fading:

9. This flash powder, actually magnesium powder, caused fires, burned the photographers, and produced huge clouds of s _ _ _ e which obscured the subjects, making a second picture impossible until the smoke had cleared sufficiently.

* * *

9- smoke

10. This method employed little or no synchronization. The term synchronization means the timing necessary for the camera shutter to be open when the flash is at its peak intensity. The camera shutter being open when the light of the flash is at its peak is called s _ _ _ _ _ n.

* * *

10- synchronization

11. The pioneer photographer quite often would open the camera lens, fire the flash powder, and then close the lens. Proper timing to coordinate the flash and shutter, known as s_____, was merely guesswork.

* * *

11- synchronization

Another technique utilized the implicit logic of the subjects, as illustrated in the following:

99. The lens opening is adjustable, that is, it can be made larger and s_____.

* * *

99- smaller

A technique used extensively was that of parallel grammatical construction to aid students in understanding new concepts:

80. The speed of film (its degree of sensitivity to light) also affects exposure. When the film speed is considered "slow", considerable light is required for correct exposure; whereas a "fast" film requires little light for correct _____.

* * *

80- exposure

81. The slower the film, the more light required for exposure; the faster the film, the _____ light required for exposure.

* * *

81- less

Examples were also used to enhance the concept building power of the programs. The following frames illustrate this:

72. A bright subject would be considered brighter than average, such as a girl in a white dress, or sunlight on a lake. A white building in sunlight would also be an example of a _____ subject.

* * *

72- bright

73. An average subject would be characterized by such things as a person, animal, or neutral-colored building. Youngsters playing ball on a grass field would most likely be _____ subjects.

* * *

73- average

The technique of conversational chaining was used in places in each program in a modified form. This type of program construction in its original form connects each frame by using the response in one frame as the introductory part of the following frame (44):

1. One indication of intelligence is the ability to profit from _____.
2. When we say that an individual has profited from EXPERIENCE, (for instance, from TRAINING), we mean that he has _____ something from the "experience."

This conversational technique was used in the following way in parts of the photography programs:

21. When the flashbulb is fired, an electrical current passes from the camera flashgun into the metal base of the bulb, up the heavy lead wires and into the tiny wire filament connecting the heavy wires. The tiny filament is heated and becomes so hot it is burned out --- this burning ignites the primer material on the ends of the lead wires. The purpose of the tiny filament, then, is to ignite the p _____ material.

* * *

21- primer

22. The primer burns furiously, throwing out sparks into the interior of the bulb which ignite the fine foil. The charge of oxygen in the bulb increases combustion of the f_____.

* * *

22- foil

23. The foil burns rapidly and produces the brief, but extremely bright _____ of light.

* * *

23- flash

(A line drawing of a flashbulb with its components identified is used with the above three frames.)

Repetition was also utilized to ensure learning of important content:

101. The size of the lens opening is governed by what we call the f/stop. For convenience we can consider the f/_____ simply as the hole through which the light passes. (We will refer to the lens opening as the f/stop from here on, since the opening is always set for a particular size.)

* * *

101- f/stop

102. When we take a picture, light passes through a hole called the _____.

* * *

102- f/stop

After the programs were completed, they were submitted to a technical expert, Professor Hix, who checked

the content.

The film exposure program and flash photography program were used in a pilot study in the summer of 1966. Twenty-six students from two journalism classes completed the film exposure program which consisted of 213 frames and a total of 300 responses. Fifteen students from two journalism classes completed the flash photography program which consisted of 153 frames and a total of 165 responses. The students were asked for suggestions, criticisms and comments regarding the programs. Analysis of the pilot study revealed a 5.65 per cent mean error rate for the film exposure program and a 5.63 per cent mean error rate for the flash program.

A tally of errors for each frame of both programs was made in order to determine what frames were causing the most errors. As the result of this analysis, frames were revised, new frames were added, and major changes in format were made, such as the use of asterisks following each frame as a guide to prevent the subjects from sliding the cover sheet past the answers, revealing the answer prematurely. Some frames were combined, and more meaningful responses were edited into others. Both programs were divided into units with review frames located at the end of each unit. Each review frame referred the subject back to relevant frames in the program if his answer on the review frame was incorrect.

In revising the film exposure program, three errors

in answers were found and corrected; 51 frames were revised, 36 frames were added, and the program was divided into five units. The program had been enlarged from 213 frames totaling 300 responses to 232 frames totaling 379 responses.

Two answer errors were found and corrected in the flash program; 63 frames were revised and 14 review frames originally located at the end of the program were combined with 36 new review frames; the program was divided into six units with review frames following each unit. Originally having 153 frames and 165 responses, the flash program had been expanded to 182 frames with 205 responses.

Although mean error rates of first drafts of both programs were low, the programs were subjected to a second pilot study on a larger scale in September, 1966, to test the effect of the revisions. Administered to 42 students in one journalism class, the film exposure program yielded a mean error rate of 2.71 per cent. The flash program, completed by 59 students in four journalism classes, produced a mean error rate of 4.69 per cent. Both error rates were well within the accepted 10 per cent limit (13) (16).

From results of the second pilot study, 13 frames of the film exposure program were revised, and 19 frames of the flash photography program were revised. In most cases the revisions were minor; both programs retained the same number of frames and responses, and both were utilized in

the study without further revision. Both final programs are found in Appendices A-I and A-II. One page of supplementary exposure data used by students working the flash photography program in the pilot studies is found in Appendix A-III.

Development of Criterion Instruments

Two criterion tests, each with pre-test and post-test forms, were developed to measure achievement of subjects in the two units of photography instruction. An objective type test was chosen in order to eliminate judgment and evaluation of the response on the part of the scorer. The multiple-choice type question was selected after a survey of measurement literature was completed. The following description is typical of the support for this type of question (124):

The multiple-choice item is probably the most versatile of the objective recognition types. It lends itself to a wide variety of situations, objectives, and content. The item can be quite objective in its scoring, it provides opportunity for wide coverage in the choice of alternatives, and it is not conducive to chance success or guessing. It is so generally regarded as the best and most widely applicable type of item that it has become the stock-in-trade, the basic type, for most standardized tests today.

The rationale for test items was provided by the two three-way tables of specifications prepared as the initial step in developing the instructional programs; tables listed objectives, content, and desired behavioral outcomes (Appendices A-IV and A-V). Objectives were

structured within the cognitive domain, described by Bloom (122) as containing objectives which emphasize remembering or reproducing something which has been learned, as well as objectives which involve solving some intellectual task. These objectives vary from simple recall of material to original and creative ways of combining and synthesizing new ideas and materials. By clarifying and describing the range of behaviors encompassed by the objectives, it was possible to determine appropriate questions to include in the criterion instruments.

Equivalent test forms were constructed to permit determination of the levels of achievement in film exposure and use of flash by students before they received instruction. Equivalent forms also enabled utilizing the covariance statistic in controlling for possible initial differences in achievement of subjects.

It was decided that each test item would be weighted with the score of "1" and that no correction would be used regarding students answering questions correctly by chance. This decision was based on the fact that the tests would be used only to compare standings of students participating in the experiment (125):

... it is doubtful whether the use of a correction formula is worth the trouble, if the main purpose is to determine the relative standing. ... The teacher, therefore, can be fairly sure that the pupils will be ranked in approximately the same order regardless of whether or not the scores are corrected.

Next, item pools composed of paired-equivalent items

were constructed, with all items composed according to the structure of behavioral outcomes in Appendices IV and V. Item pools totaled 76 pairs of items for the film exposure test, and 71 pairs of items for the flash test. Both item pools were submitted to a pilot study early in September, 1966; the 42 students who studied the film exposure program were administered the items of the film exposure test; the 59 students who studied the flash program were administered the items of the flash test. For the pilot study the paired items were put in separate forms, the first item of each pair going into Form A, and the second item into Form B. Two 50-minute class periods were required to administer the test to the trial groups, with one full day intervening between the testing periods.

Item analysis of data from the pilot study permitted the compilation of item discrimination indices and item difficulty indices. Data were also used to locate defects in items.

The degree of discrimination of an item, described by Noll (124) and Garrett (127) as a measure of validity of a test item, refers to the capacity of an item to distinguish between good and poor students. Garrett (127) explains this:

An often-used method of validating a test item is to determine whether the item discriminates between subjects differing sharply in the function being measured. This 'criterion of internal consistency' admits into the final test or questionnaire only those items which have been found to separate high-scoring and low-scoring members of the group.

Many statistical methods may be utilized to obtain discrimination indices, including the biserial r coefficient of correlation, the critical ratio, the product-moment coefficient of correlation, and the phi coefficient. However, measurement experts admit some weaknesses in each of these techniques and agree that their complexity of calculation and the extremely large samples required limit their usefulness (128)(129)(130).

The procedure used to calculate the discrimination index is well documented in the literature dating back to the 1920's. More recent sources for the procedure are Garrett (128), Denum (131), and Engelhart (132). Test papers of the pilot study group are ranked from high to low, then separated into groups above and below the median test score. A tally sheet is compiled, counting for each test item the number in the upper-group answering it correctly, and the number in the lower-group answering it correctly. The discrimination index is obtained by subtracting the number in the lower-group answering the item correctly from the number in the higher-group answering the item correctly, and then dividing by the number attempting the item in either the higher or the lower-group. The following formula illustrates the calculation (128):

$$(RH - RL)/NH$$

RH = number right in high group

RL = number right in low group

NH = number in high group

The difficulty index is found by using the same symbols:

$$(RH + RL) / (NH + NL).$$

This procedure requires adding the number in the higher-group answering the item correctly and the number in the lower-group answering the item correctly, then dividing by the total number attempting the item, or those in the higher-group plus those in the lower group.

A discrimination index of .10 is considered a minimum level for test items (131), and it is desirable that discrimination indices exceed .20 (128)(129)(131)(132). Items with indices which are lower than minimum levels or ones which are negative must either be revised or discarded.

The difficulty index, a per cent of the number answering the question correctly, permits selection of items of appropriate difficulty for the final test.

"Maximum reliability and dispersion of scores is attained when an item has approximately 50 per cent difficulty" (131). It is also recommended that items be chosen at all difficulty levels in the possible score range with the mean of difficulty indices being near the 50 per cent point (126).

Using discrimination and difficulty indices as

primary criteria for selecting items to use on the tests, the writer also utilized a checklist compiled by Nunnally (126) in evaluating items in the pools of items investigated in the pilot study. Items were reviewed for unclear statements, wrong answers, inappropriate difficulty, and inappropriateness to the item universe. Care was taken to select items which met the above criteria and also adequately sampled the content so that the test would be proportional to the instructional emphasis.

Thirty-five items were chosen for the pre-test (Form A) and their matched pairs were placed in the post-test (Form B) for criterion instruments in film exposure and in flash photography. Discrimination and difficulty indices for all test items are given in Tables I and II, and asterisks are used to denote items chosen for the criterion instruments. Table III gives a summary of the distribution of discrimination indices of items appearing on the final tests, and also gives the means for difficulty indices for items on both final tests.

Both tests were next assembled and were submitted to Professor Hix for review. Then, to determine test reliability, Forms A and B of both tests were administered to 16 students who had completed the course in elementary photography. Form A of both tests was administered in the first 50-minute period, and Form B of both tests was administered in a 50-minute period two days later. The Pearson Product-Moment Correlation Coefficient (133) was

TABLE I
DISCRIMINATION AND DIFFICULTY INDICES
OF THE PRELIMINARY EXPOSURE TEST

Test Item	Form	Discrimination Index	Difficulty Index	Test Item	Form	Discrimination Index	Difficulty Index
1	A	.136	.977	22	A	.090	1.000
1	B	.090	.681	22	B	.046	.977
2	A	.046	.977	23	A	.272	.909
2	B	.046	.977	23	B	.090	.954
3	A	.090	.954	24	A	.090	1.000
3	B	.046	.977	24	B	.000	1.000
4	A	.136	.977	25	A	.090	1.000
4	B	.046	.977	25	B	.090	.954
5	A	.136	.931	26	A	.136	.977
5	B	.182	.909	26	B	.136	.886
6	A	.228	.886	27	A	.136	.977
6	B	.136	.568	27	B	.046	.977
7	A	.136	.977	28	A	.090	1.000
7	B	.090	.909	28	B	-.046	.977
8	A	.318	.840*	29	A	.046	.340
8	B	.136	.840*	29	B	.182	.454
9	A	.136	.977	30	A	.090	.954
9	B	-.046	.931	30	B	.046	.977
10	A	.410	.795	31	A	.090	1.000
10	B	.090	.772	31	B	.182	.909
11	A	.090	.954	32	A	.228	.931*
11	B	.000	1.000	32	B	.136	.931*
12	A	.136	.931	33	A	.228	1.000
12	B	.000	1.000	33	B	.090	.954
13	A	.090	.954	34	A	.182	.863*
13	B	.000	1.000	34	B	.228	.795*
14	A	.228	.840	35	A	.728	.681*
14	B	-.046	.886	35	B	.364	.818*
15	A	.136	.977	36	A	.272	.818
15	B	.000	1.000	36	B	.090	.954
16	A	.228	.931	37	A	.136	.931
16	B	.090	.931	37	B	.410	.795
17	A	.136	.977	38	A	.272	.909*
17	B	.228	.886	38	B	.228	.886*
18	A	.136	.977	39	A	.136	.977*
18	B	.046	.977	39	B	.454	.636*
19	A	.228	.931	40	A	.228	.931
19	B	.090	.954	40	B	.046	.977
20	A	.090	1.000	41	A	.272	.818
20	B	.046	.977	41	B	-.136	-.386
21	A	.272	.909	42	A	.272	.590*
21	B	-.090	.954	42	B	.182	.909*

(*Test items used in final form of test)

TABLE I (Continued)

Test Item	Form	Discrimination Index	Difficulty Index	Test Item	Form	Discrimination Index	Difficulty Index
43	A	.272	.909*	65	A	.272	.863*
43	B	.272	.818*	65	B	.410	.704*
44	A	.090	.909	66	A	.454	.818*
44	B	.182	.636	66	B	.182	.909*
45	A	.090	.954	67	A	.590	.659*
45	B	.000	.000	67	B	.728	.636*
46	A	.136	.977	68	A	.318	.250
46	B	.272	.818	68	B	.090	.545
47	A	.638	.727*	69	A	.500	.750*
47	B	.136	.931*	69	B	.182	.931*
48	A	.364	.818*	70	A	.182	.909
48	B	.318	.750*	70	B	.136	.568
49	A	.546	.727*	71	A	.590	.704*
49	B	.272	.500*	71	B	.364	.500*
50	A	.318	.840*	72	A	.772	.659*
50	B	.136	.886*	72	B	.546	.500*
51	A	.272	.545*	73	A	.364	.454*
51	B	.272	.727*	73	B	.500	.613*
52	A	.590	.750*	74	A	.364	.863*
52	B	.318	.795*	74	B	.272	.863*
53	A	.590	.750*	75	A	.454	.590*
53	B	.318	.795*	75	B	.546	.590*
54	A	.228	.613*	76	A	.590	.704*
54	B	.318	.613*	76	B	.500	.613*
55	A	.364	.863*				
55	B	.272	.863*				
56	A	.410	.750*				
56	B	.410	.795*				
57	A	.410	.695*				
57	B	.546	.568*				
58	A	.546	.681*				
58	B	.228	.886*				
59	A	.590	.613*				
59	B	.454	.727*				
60	A	.546	.772*				
60	B	.318	.657*				
61	A	.182	.909*				
61	B	.454	.636*				
62	A	.364	.318*				
62	B	.364	.727*				
63	A	.228	.704				
63	B	.136	.659				
64	A	.410	.704*				
64	B	.638	.681*				

(*Test items used in final form of test)

TABLE II
DISCRIMINATION AND DIFFICULTY INDICES
OF THE PRELIMINARY FLASH TEST

Test Item	Form	Discrimination Index	Difficulty Index	Test Item	Form	Discrimination Index	Difficulty Index
1	A	.242	.569*	22	A	.344	.759*
1	B	.242	.672*	22	B	.414	.793*
2	A	-.072	.793	23	A	.310	.741*
2	B	.138	.931	23	B	.552	.690*
3	A	-.072	.965	24	A	.552	.655
3	B	.104	.948	24	B	.172	.879
4	A	.310	.465*	25	A	.000	.172
4	B	.380	.776*	25	B	.344	.827
5	A	.070	.896	26	A	.552	.552
5	B	.206	.862	26	B	.172	.707
6	A	-.206	.552	27	A	.206	.759*
6	B	.138	.931	27	B	.344	.759*
7	A	.070	.896	28	A	.206	.827*
7	B	.310	.293	28	B	.448	.948*
8	A	.034	.948	29	A	.380	.707
8	B	.276	.862	29	B	.070	.862
9	A	.310	.431	30	A	.172	.776
9	B	.172	.534	30	B	.206	.896
10	A	.070	.414	31	A	.448	.672*
10	B	.310	.362	31	B	.310	.845*
11	A	.310	.741	32	A	.380	.327
11	B	.138	.483	32	B	.138	.862
12	A	.070	.931	33	A	.482	.621
12	B	.138	.931	33	B	.138	.931
13	A	.138	.276	34	A	.758	.483*
13	B	.242	.879	34	B	.482	.586*
14	A	-.034	.707	35	A	.380	.707*
14	B	.414	.483	35	B	.414	.759*
15	A	.070	.862	36	A	.034	.155
15	B	.104	.948	36	B	.276	.276
16	A	.242	.810*	37	A	.344	.655
16	B	.448	.638*	37	B	.242	.879
17	A	-.104	.879	38	A	.448	.707*
17	B	.138	.896	38	B	.242	.879*
18	A	.448	.707*	39	A	.276	.414*
18	B	.414	.793*	39	B	.380	.741*
19	A	.104	.879	40	A	.138	.414
19	B	.380	.810	40	B	.104	.259
20	A	.242	.845*	41	A	.310	.500
20	B	.414	.759*	41	B	.172	.776
21	A	.344	.621*	42	A	.310	.431*
21	B	.344	.655*	42	B	.276	.517*

(*Test items used in final form of test)

TABLE II (Continued)

Test Item	Form	Discrimination Index	Difficulty Index	Test Item	Form	Discrimination Index	Difficulty Index
43	A	.344	.276	65	A	.344	.655*
43	B	.172	.569	65	B	.482	.759*
44	A	.482	.655*	66	A	.344	.690*
44	B	.276	.827*	66	B	.482	.759*
45	A	.344	.690*	67	A	.344	.655
45	B	.620	.655*	67	B	.104	.569
46	A	.482	.517*	68	A	.380	.672*
46	B	.792	.569*	68	B	.380	.776*
47	A	.034	.362	69	A	.104	.155
47	B	.380	.431	69	B	.000	.483
48	A	.206	.793*	70	A	.276	.379*
48	B	.242	.845*	70	B	.344	.483*
49	A	.172	.879	71	A	.276	.517*
49	B	.242	.879	71	B	.276	.586*
50	A	.206	.690*				
50	B	.276	.862*				
51	A	.242	.293				
51	B	.034	.293				
52	A	.276	.827*				
52	B	.310	.845*				
53	A	.552	.655*				
53	B	.414	.724*				
54	A	.034	.948				
54	B	.206	.896				
55	A	.104	.707				
55	B	.344	.793				
56	A	.070	.241				
56	B	.310	.465				
57	A	.518	.672*				
57	B	.380	.741*				
58	A	.690	.517*				
58	B	.620	.655*				
59	A	.344	.793*				
59	B	.414	.759*				
60	A	.482	.621*				
60	B	.482	.759*				
61	A	.276	.310*				
61	B	.586	.672*				
62	A	.034	.259				
62	B	.172	.879				
63	A	.414	.621*				
63	B	.344	.793*				
64	A	.414	.621*				
64	B	.344	.793*				

(*Test items used in final form of test)

TABLE III
DISTRIBUTION OF DISCRIMINATION INDICES
AND MEANS OF DIFFICULTY INDICES

<u>Film Exposure Test</u>		<u>Flash Test</u>	
Discrimination		Discrimination	
Index		Index	
Interval	N	Interval	N
.100-.199	10	.100-.199	0
.200-.299	15	.200-.299	19
.300-.399	15	.300-.399	22
.400-.499	10	.400-.499	20
.500-.599	15	.500-.599	4
.600-.699	2	.600-.699	3
.700-.799	3	.700-.799	2
Mean Difficulty		Mean Difficulty	
Index = .673		Index = .624	

utilized in obtaining a reliability coefficient between Forms A and B of both tests. This method is suggested as the best approach to use in determining reliability when equivalent forms of a test are available (126)(127)134). Advantages of this method are pointed out by Nunnally (126):

When the reliability coefficient is obtained from equivalent forms, it will manifest more of the sources of measurement error, and more accurately, than any other method. It will contain all of the sources of measurement error found in the retest method and, in addition, will give an indication of the amount of error due to the sampling of content. Although the memory of one test form may give a slight advantage on taking the equivalent form, the effect of memory on the equivalent form reliability coefficient is slight.

A reliability coefficient of .9022 was found for the film exposure test, and a reliability coefficient of .8299 was found for the flash photography test.

Although discrimination indices revealed a measure of item validity, because no accepted criterion was available with which to compare the tests, statements about validity cannot be projected above the level of curricular, or content validity. The tests adequately covered both the content and the objectives of the units of instruction, as items of both tests were closely structured by the tables of specifications. Cureton (135) defends curricular validity:

It (curricular validity) is a special case of logical relevance. ... An ordinary subject matter test has usually been considered to possess curricular relevance to the extent that

it tests the students' knowledge and effective grasp of those facts, principles, relations, patterns, and generalizations which are the de facto immediate objectives of instruction. The usual evidence of curricular relevance is a tabulation showing that the test content actually parallels and covers the course content, that the test operations are those specified in the course objectives, and that the test situation is not such as to bias the responses ... it is perfectly reasonable for the test user to propose to use a test to measure what it actually does measure.

Tests were reproduced by fluid duplicator process and designed so that responses could be recorded on an answer sheet in order to facilitate scoring. Forms A and B of both tests are located in Appendices B-I, B-II, B-III and B-IV.

CHAPTER V

RESEARCH DESIGN AND METHODOLOGY

Research Design

A pre-test - post-test control group design was used for this study because it offers the advantage of control of potential intervening variables (137). The design required pre-testing all subjects, then administering experimental treatments, followed by post-testing, and then testing the significance of experimental treatments.

In addition to equating groups on the basis of age and American College Testing Program composite standard scores, additional controls were utilized in structuring the use of the programmed materials by experimental groups. To be certain that all experimental groups received the same instructions regarding the use of the programmed materials, directions were written and the photography instructor read them to the classes. Directions included cautioning the students to use only the programmed materials, not the textbook or other sources, and not to let other students use the programmed materials.

Sample

The sample population for this investigation consisted of students at Oklahoma State University enrolled in two sections of Journalism 233 and Journalism 303, both of which are elementary photography courses. Lectures to all of these students are identical. Students in each of the Journalism 233 sections were randomly assigned to one of two sub-groups, forming a total of four sub-groups. Randomness was obtained by utilizing a table of random numbers (136). Students in Journalism 303, a smaller class, were placed in a fifth group.

One of the five sub-groups was randomly chosen as the control group to receive conventional instruction; two of the sub-groups were randomly selected as experimental groups to receive directed programmed instruction; and the remaining two sub-groups were designated as experimental groups to receive non-directed programmed instruction. The data of one student who was considerably older than the other students were not used. The data of some late-enrollees in the classes were also excluded from the study. Subjects in the study totaled 71 for the film exposure experiment, and 68 for the flash photography experiment.

Although randomization was utilized to obtain group equality, the research design was strengthened further by testing the five groups in terms of American College Testing Program composite standard scores and in terms of

age (137). The first test was to determine homogeneity of variances between the groups. The F test was used to test the equality of the variances of both ages and ACT composite standard scores (133):

$$F = \frac{s^2(g)}{s^2(l)}$$

$s^2(g)$ = variance of group with the greater variance

$s^2(l)$ = variance of group with the lesser variance.

The variance was found by the following formula (133):

$$s^2 = \frac{\sum x^2}{k-1}$$

s^2 = variance

$\sum x^2$ = sum of the squares

$k-1$ = degrees of freedom.

The sum of the squares was found by the following formula (133):

$$\sum x^2 = \sum X^2 - \frac{(\sum X)^2}{k}$$

$\sum x^2$ = sum of the squares

$\sum X^2$ = sum of the squared scores

$\sum X$ = sum of the scores

k = number in the group.

The F statistic utilizes a ratio of the variance of

the group with the greater variance with the variance of the group with the lesser variance. The F value is then used to obtain probabilities from Snedecor's table of F (133). Use of the statistic in checking the equality of several groups by calculating variances for each of the groups and then testing the largest variance against the smallest is documented by Garrett (138).

The outcomes of the F test used with ages of subjects in the five groups are reported in Table IV. The largest variance of 5.25 (Group C) was tested against the smallest variance of 2.93 (Group B). The obtained F value of 1.79 did not equal or exceed the table value of 2.48 required for significance at the .05 level of confidence. Therefore, the groups were found homogeneous on the basis of age.

Outcomes of the F test used with ACT composite standard scores of the five groups are presented in Table V. The largest variance of 23.92 (Group D) was tested against the smallest variance of 12.46 (Group A). The obtained F value of 1.92 did not equal or exceed the table value of 2.62 required for significance at the .05 level of confidence. Therefore, the groups were found homogeneous on the basis of ACT standard scores.

Since no differences were found in the five groups on the basis of age and ACT composite standard scores, the groups were found to represent a single homogeneous, normally-distributed population in terms of these criteria.

TABLE IV
TABLE OF AGES
(F Test of Extreme Variances Data)

Groups	df	Sum of Squares	Variances	Extreme Variances	F
A (Control)	13	46	3.54		
B (Exper.)	15	44	2.93	2.93	1.79*
C (Exper.)	12	63	5.25	5.25	
D (Exper.)	13	41	3.15		
E (Exper.)	12	56	4.67		

*Failed to Reach 2.48 Value Necessary for Significance

TABLE V
TABLE OF ACT SCORES
(F Test of Extreme Variances Data)

Groups	df	Sum of Squares	Variances	Extreme Variances	F
A (Control)	13	162	12.46	12.46	1.92*
B (Exper.)	15	250	16.66		
C (Exper.)	12	249	20.75		
D (Exper.)	13	311	23.92	23.92	
E (Exper.)	12	191	15.92		

*Failed to Reach 2.62 Value Necessary for Significance

Since the five groups in the study were found to be homogeneous, a t test using pooled variance was utilized in testing group combinations for possible significant differences in age or ACT composite standard scores. The formula used was (133):

$$t = \sqrt{\frac{k_1 k_2 (N - 2) (\bar{X}_1 - \bar{X}_2)^2}{N(\sum x^2(1) + \sum x^2(2))}}$$

k_1 = number in the first group

k_2 = number in the second group

N = number in total of two groups

\bar{X}_1 = mean of first group

\bar{X}_2 = mean of second group

$\sum x^2(1)$ = sum of the squares of the first group

$\sum x^2(2)$ = sum of the squares of the second group.

All possible combinations of the five groups were compared by the t test on the basis of age and on the basis of ACT composite standard scores. Data are reported in Tables VI and VII. None of the computed t values reached significance at the .05 level of confidence; therefore, no significant differences were found in the five groups on the basis of age and ACT composite standard scores.

Methodology

All students were pre-tested at the beginning of the fall semester, 1966. Students were administered Forms A

TABLE VI
RESULTS OF THE t TEST COMPARING GROUPS
ON THE BASIS OF AGE

Group Comparisons	Computed t Value	Table t Value
A vs B	1.130	2.048*
A vs C	.130	2.060*
A vs D	.274	2.056*
A vs E	.266	2.060*
B vs C	1.092	2.052*
B vs D	.216	2.048*
B vs E	.015	2.052*
C vs D	.276	2.060*
C vs E	.266	2.064*
D vs E	.110	2.060*

*Necessary for Significance at
the .05 Level

TABLE VII
RESULTS OF THE t TEST COMPARING GROUPS
ON THE BASIS OF ACT SCORES

Group Comparisons	Computed t Value	Table t Value
A vs B	.022	2.048*
A vs C	.293	2.060*
A vs D	.256	2.056*
A vs E	.305	2.060*
B vs C	.284	2.052*
B vs D	.251	2.048*
B vs E	.292	2.052*
C vs D	.010	2.060*
C vs E	.023	2.064*
D vs E	.028	2.060*
*Necessary for Significance at the .05 Level		

of the film exposure and flash photography criterion instruments.

The following week the film exposure experiment was begun. Students in Group A (control) received conventional instruction for two 50-minute class periods. Students in Groups B and C, (non-directed programmed instruction experimental groups), were given the programmed materials and a brief explanation on their use; they were then released from class for two 50-minute periods and instructed to work the programmed materials at their convenience. Students in experimental Groups D and E, (directed programmed instruction), met class at the regular time. The instructor distributed the programmed materials, read the directions and then remained in the classroom to oversee the groups and to answer any questions about the program or content. All students using programmed materials (Groups B, C, D, E) were permitted to keep the materials for study and review.

After the week-long experimental period, the students were administered the post-test (Form B) as part of the photography instructor's standard hour examination covering film exposure and related content.

At approximately mid-way in the semester, the flash photography experiment was conducted, with procedure being identical to that of the first experiment. The same groups received the same types of instruction and the time of the experiment remained the same, two 50-minute class

periods, or the equivalent in released time for the non-directed experimental groups. Students were administered the post-test (Form B) at the conclusion of the experimental period, again as part of the instructor's standard hour examination.

An interval of five days occurred between the conclusion of the experiment and the post-testing for both of the experiments.

Students in the experiment were informed that the programmed materials were being developed for use in photography classes at Oklahoma State University, but were not told that the data were being used for a doctoral thesis.

A summary of the control and experimental groups, number of subjects in each group, and the experimental treatments received in each experiment is shown in Table VIII.

Tests of Significance

The statistic used to determine the significance of the results of this investigation was the analysis of covariance at the .05 level of confidence.

Data for the one control and four experimental groups were prepared for the Oklahoma State University Computing Center. The multiple analysis of covariance program was utilized in the IBM 7040 computer system (139). This program calculates the F ratio for the adjusted treatment

TABLE VIII
RESEARCH DESIGN

Group	N	<u>Film Exposure Experiment</u>		
		Instrument	Treatment	Instrument
A (Control)	15	pre-test	Conventional Instruction	post-test
B (Exper.)	16	pre-test	Non-directed Programed Instruction	post-test
C (Exper.)	13	pre-test	Non-directed Programed Instruction	post-test
D (Exper.)	14	pre-test	Directed Programed Instruction	post-test
E (Exper.)	13	pre-test	Directed Programed Instruction	post-test
Total	71			
Group	N	<u>Flash Photography Experiment</u>		
		Instrument	Treatment	Instrument
A (Control)	15	pre-test	Conventional Instruction	post-test
B (Exper.)	14	pre-test	Non-directed Programed Instruction	post-test
C (Exper.)	13	pre-test	Non-directed Programed Instruction	post-test
D (Exper.)	14	pre-test	Directed Programed Instruction	post-test
E (Exper.)	12	pre-test	Directed Programed Instruction	post-test
Total	68			

means, the Beta coefficients and their standard errors and t values, and the adjusted treatment means and their accompanying standard errors.

Garrett (138) describes the analysis of covariance statistical test:

Analysis of covariance represents an extension of analysis of variance to allow for the correlation between initial and final scores. Covariance analysis is especially useful to experimental psychologists when for various reasons it is impossible or quite difficult to equate control and experimental groups at the start; a situation which often obtains in actual experiments. Through covariance analysis one is able to effect adjustments in final or terminal scores which will allow for differences in some initial variable.

A typical application of the analysis of covariance is to let the covariate score or initial score represent a pre-test score; therefore, in both photography experiments the pre-test scores were used as the covariate in order to control for any individual differences in achievement at the outset of the study (133)(138).

Sub-Hypotheses

The major hypotheses for the study were divided into eight sub-hypotheses to be tested in each of the experiments:

- 1-a. There are no significant differences in achievement scores between Group A (control) and Group D (experimental, directed programmed instruction).

- 1-b. There are no significant differences in achievement scores between Group A (control) and Group E (experimental, directed programed instruction).
- 2-a. There are no significant differences in achievement scores between Group A (control) and Group B (experimental, non-directed programed instruction).
- 2-b. There are no significant differences in achievement scores between Group A (control) and Group C (experimental, non-directed programed instruction).
- 3-a. There are no significant differences in achievement scores between Group B (experimental, non-directed programed instruction) and Group D (experimental, directed programed instruction).
- 3-b. There are no significant differences in achievement scores between Group B (experimental, non-directed programed instruction) and Group E (experimental, directed programed instruction).
- 3-c. There are no significant differences in achievement scores between Group C (experimental, non-directed programed instruction) and Group D (experimental, directed programed instruction).

- 3-d. There are no significant differences in achievement scores between Group C (experimental, non-directed programed instruction) and Group E (experimental, directed programed instruction).

CHAPTER VI

RESULTS, SUMMARY AND CONCLUSIONS

Raw scores of pre-tests, post-tests, and gain of each subject in the film exposure experiment are found in Table IX, and the same data for the flash photography experiment are found in Table X.

A summary of these data in Tables XI and XII includes mean, median, and standard deviation of scores for each group on pre-tests and post-tests. The mean gain is also reported.

Testing the Hypotheses of the Film Exposure Experiment

A multiple analysis of covariance was used in testing sub-hypotheses at the .05 level of confidence. Results are summarized in Table XIII, and adjusted means of significant comparisons are found in Table XIV.

- 1-a. There are no significant differences in achievement scores between Group A (control) and Group D (experimental, directed programed instruction).

The obtained F value of 1.05 is less than the F value of 4.22 required for significance; therefore, the null

TABLE IX
RAW SCORES, FILM EXPOSURE EXPERIMENT

Group A			Group B			Group C		
Pre-test	Post-test	Gain	Pre-test	Post-test	Gain	Pre-test	Post-test	Gain
24	31	7	16	21	5	27	34	7
14	35	21	16	23	7	23	33	10
12	23	11	15	34	19	19	33	14
12	28	16	14	34	20	19	35	16
11	29	18	13	33	20	16	33	17
11	31	20	13	27	14	15	35	20
10	31	21	11	33	22	14	35	21
10	29	19	10	29	19	14	29	15
10	26	16	9	27	18	14	34	20
10	28	18	9	32	23	12	31	19
10	26	16	6	35	29	10	30	20
8	21	13	6	33	27	7	26	19
4	16	12	5	32	27	7	33	26
3	27	24	5	25	20			
0	28	28	3	32	29			
			3	31	28			

Group D			Group E		
Pre-test	Post-test	Gain	Pre-test	Post-test	Gain
24	35	11	26	35	9
21	32	11	22	35	13
21	33	11	21	35	14
14	34	20	20	28	8
11	35	24	19	33	14
11	31	20	10	31	21
10	33	23	8	30	22
10	28	18	6	32	26
7	23	16	5	29	24
7	26	19	4	11	7
7	11	4	3	29	26
6	28	22	2	33	31
4	34	30	2	34	32
3	33	30			

TABLE X
RAW SCORES, FLASH PHOTOGRAPHY EXPERIMENT

Group A			Group B			Group C		
Pre-test	Post-test	Gain	Pre-test	Post-test	Gain	Pre-test	Post-test	Gain
18	33	15	20	35	15	25	34	9
13	29	16	14	30	16	14	34	20
12	23	11	12	34	22	13	34	21
12	22	10	11	34	23	13	28	15
11	28	17	10	28	18	12	35	23
10	23	13	9	30	21	11	31	20
9	23	14	8	34	26	11	31	20
9	30	21	6	31	25	10	33	23
8	24	16	5	31	26	9	30	21
6	27	21	4	31	27	7	34	27
5	26	21	4	34	30	7	31	24
4	26	22	3	34	31	5	34	29
4	23	19	1	32	31	1	33	32
3	17	14	0	31	31			
0	17	17						

Group D			Group E		
Pre-test	Post-test	Gain	Pre-test	Post-test	Gain
20	35	15	26	33	7
17	33	16	20	33	13
14	35	21	10	34	24
12	32	20	10	34	24
10	31	21	8	35	27
10	34	24	8	24	16
10	26	16	8	35	27
9	35	26	5	33	28
9	33	24	5	34	29
8	18	10	4	33	29
4	27	23	3	33	30
1	33	32	3	33	30
1	22	21			
1	35	34			

TABLE XI
SUMMARY OF DATA, FILM EXPOSURE EXPERIMENT

Group	<u>Pre-test</u>		Stand- ard Devi- ation	<u>Post-test</u>		Stand- ard Devi- ation	Mean Gain
	Mean	Median		Mean	Median		
A	9.93	10	5.23	27.27	28	4.45	17.34
B	9.62	9.5	4.41	30.06	32	4.12	20.44
C	15.15	14	7.08	32.38	33	2.59	17.23
D	11.14	10	6.63	29.71	32.5	6.25	18.57
E	11.38	8	8.48	30.38	32	6.07	19.00

TABLE XII
SUMMARY OF DATA, FLASH PHOTOGRAPHY EXPERIMENT

Group	<u>Pre-test</u>		Stand- ard Devi- ation	<u>Post-test</u>		Stand- ard Devi- ation	Mean Gain
	Mean	Median		Mean	Median		
A	8.27	9	4.51	24.73	24	4.26	16.46
B	8.07	7	4.91	32.07	30	2.02	24.00
C	10.61	11	6.97	32.46	33	1.98	21.85
D	9.0	9.5	5.61	30.64	33	6.57	21.64
E	9.17	8	7.17	32.83	33	2.76	23.66

hypothesis is accepted.

- 1-b. There are no significant differences in achievement scores between Group A (control) and Group E (experimental, directed programed instruction).

The obtained F value of 1.89 is less than the F value of 4.24 required for significance; therefore, the null hypothesis is accepted.

- 2-a. There are no significant differences in achievement scores between Group A (control) and Group B (experimental, non-directed programed instruction).

The obtained F value of 3.07 is less than the F value of 4.20 required for significance; therefore, the null hypothesis is accepted.

- 2-b. There are no significant differences in achievement scores between Group A (control) and Group C (experimental, non-directed programed instruction).

The obtained F value of 5.64 is greater than the F value of 4.24 required for significance; therefore, the null hypothesis is rejected in favor of Group C (experimental, non-directed programed instruction).

- 3-a. There are no significant differences in achievement scores between Group B (experimental, non-directed programed instruction) and Group D (experimental,

directed programed instruction).

The obtained F value of 0.07 is less than the F value of 4.21 required for significance; therefore, the null hypothesis is accepted.

3-b. There are no significant differences in achievement scores between Group B (experimental, non-directed programed instruction) and Group E (experimental, directed programed instruction).

The obtained F value of 0.002 is less than the F value of 4.22 required for significance; therefore, the null hypothesis is accepted.

3-c. There are no significant differences in achievement scores between Group C (experimental, non-directed programed instruction) and Group D (experimental, directed programed instruction).

The obtained F value of 0.54 is less than the F value of 4.26 required for significance; therefore, the null hypothesis is accepted.

3-d. There are no significant differences in achievement scores between Group C (experimental, non-directed programed instruction) and Group E (experimental, directed programed instruction).

The obtained F value of 0.30 is less than the F

value of 4.20 required for significance; therefore, the null hypothesis is accepted.

Testing the Hypotheses of the Flash Photography Experiment

A multiple analysis of covariance was used in testing sub-hypotheses at the .05 level of confidence. Results are summarized in Table XV, and adjusted means of significant comparisons are found in Table XVI.

- 1-a. There are no significant differences in achievement scores between Group A (control) and Group D (experimental, directed programed instruction).

The obtained F value of 11.61 is greater than the F value of 4.22 required for significance; therefore, the null hypothesis is rejected in favor of Group D (experimental, directed programed instruction).

- 1-b. There are no significant differences in achievement scores between Group A (control) and Group E (experimental, directed programed instruction).

The obtained F value of 30.92 is greater than the F value of 4.26 required for significance; therefore, the null hypothesis is rejected in favor of group E (experimental, directed programed instruction).

- 2-a. There are no significant differences in achievement scores between Group A

TABLE XIII
ANALYSIS OF COVARIANCE FOR FILM
EXPOSURE EXPERIMENT

Source of Variation	Adjusted Sum of Squares	df	Variance Estimate	F	F Required for Significance
<u>Group A - D</u>					
Total	739.1492	27			
Between	28.6762	1	28.6762	1.05	4.22
Within	710.4730	26	27.3258		
<u>Group A - E</u>					
Total	698.2738	26			
Between	49.1962	1	49.1962	1.89	4.24
Within	649.0775	25	25.9631		
<u>Group A - B</u>					
Total	624.0572	29			
Between	61.6161	1	61.6161	3.07	4.20
Within	562.4411	28	20.0871		
<u>Group A - C</u>					
Total	372.6888	26			
Between	68.6158	1	68.6158	5.64*	4.24
Within	304.0730	25	12.1629		
<u>Group B - D</u>					
Total	805.9032	28			
Between	2.1366	1	2.1366	0.07	4.21
Within	803.7666	27	29.7691		
<u>Group B - E</u>					
Total	728.6459	27			
Between	0.0589	1	0.0589	0.002	4.22
Within	728.5870	26	28.0225		
<u>Group C - D</u>					
Total	551.0783	25			
Between	12.1565	1	12.1565	0.54	4.26
Within	538.9218	24	22.4550		
<u>Group C - E</u>					
Total	477.5266	24			
Between	6.0609	1	6.0609	0.30	4.28
Within	471.4657	23	20.4985		

*Significant at the .05 level of confidence

TABLE XIV
ADJUSTED MEANS FOR THE FILM EXPOSURE
EXPERIMENT COMPARISONS FOUND
TO BE SIGNIFICANT

Group Comparisons	Adjusted Means	Adjusted Mean Differences
<u>Group A - C</u>		
A	28.0250	
C	31.5096	3.48

(control) and Group B (experimental, non-directed programmed instruction).

The obtained F value of 40.62 is greater than the F value of 4.22 required for significance; therefore, the null hypothesis is rejected in favor of Group B (experimental, non-directed programmed instruction).

2-b. There are no significant differences in achievement scores between Group A (control) and Group C (experimental, non-directed programmed instruction).

The obtained F value of 30.86 is greater than the F value of 4.24 required for significance; therefore, the null hypothesis is rejected in favor of Group C (experimental, non-directed programmed instruction).

3-a. There are no significant differences in achievement scores between Group B (experimental, non-directed programmed instruction) and Group D (experimental, directed programmed instruction).

The obtained F value of 1.25 is less than the F value of 4.24 required for significance; therefore, the null hypothesis is accepted.

3-b. There are no significant differences in achievement scores between Group B (experimental, non-directed programmed instruction) and Group E (experimental, directed programmed instruction).

The obtained F value of 0.50 is less than the F value of 4.28 required for significance; therefore, the null hypothesis is accepted.

- 3-c. There are no significant differences in achievement scores between Group C (experimental, non-directed programed instruction) and Group D (experimental, directed programed instruction).

The obtained F value of 0.92 is less than the F value of 4.26 required for significance; therefore, the null hypothesis is accepted.

- 3-d. There are no significant differences in achievement scores between Group C (experimental, non-directed programed instruction) and Group E (experimental, directed programed instruction).

The obtained F value of 0.15 is less than the F value of 4.30 required for significance; therefore, the null hypothesis is accepted.

Treatment means, adjusted means and standard errors of adjusted means for all groups in both experiments are found in Appendix C-I.

Summary of Results

In the film exposure experiment, significance was obtained in a comparison between an experimental group receiving the non-directed programed instruction

TABLE XV
ANALYSIS OF COVARIANCE FOR FLASH
PHOTOGRAPHY EXPERIMENT

Source of Variation	Adjusted Sum of Squares	df	Variance Estimate	F	F Required for Significance
<u>Group A - D</u>					
Total	728.4942	27			
Between	224.8262	1	224.8262	11.61*	4.22
Within	503.6680	26	19.3718		
<u>Group A - E</u>					
Total	733.4239	25			
Between	412.9006	1	412.9006	30.92*	4.26
Within	320.5233	24	13.3551		
<u>Group A - B</u>					
Total	671.2106	27			
Between	409.2552	1	409.2552	40.62*	4.22
Within	261.9553	26	10.0752		
<u>Group A - C</u>					
Total	591.7054	26			
Between	326.8959	1	326.8959	30.86*	4.24
Within	264.8095	25	10.5923		
<u>Group B - D</u>					
Total	419.1349	26			
Between	19.8871	1	19.8871	1.25	4.24
Within	399.2478	25	15.9699		
<u>Group B - E</u>					
Total	150.8106	24			
Between	3.2226	1	3.2226	0.50	4.28
Within	147.5879	23	6.4168		
<u>Group C - D</u>					
Total	414.4002	25			
Between	15.3371	1	15.3371	0.92	4.26
Within	399.0631	24	16.6276		
<u>Group C - E</u>					
Total	143.5999	23			
Between	0.9656	1	0.9656	0.15	4.30
Within	142.6343	22	6.4833		

*Significant at the .05 level of confidence

TABLE XVI
 ADJUSTED MEANS FOR THE FLASH PHOTOGRAPHY
 EXPERIMENT COMPARISONS FOUND
 TO BE SIGNIFICANT

Group Comparisons	Adjusted Means	Adjusted Mean Differences
<u>Groups A - D</u>		
A	24.8892	
D	30.4758	5.59
<u>Groups A - E</u>		
A	24.8245	
E	32.7194	7.89
<u>Groups A - B</u>		
A	24.6393	
B	32.1722	7.53
<u>Groups A - C</u>		
A	25.0532	
C	32.0925	7.04

treatment and the control group receiving conventional instruction. Significance was in favor of the experimental group.

No other significant differences were found in this experiment testing the following seven group combinations: four combinations of groups receiving directed programmed instruction versus groups receiving non-directed programmed instruction; two combinations of groups receiving conventional instruction versus directed programmed instruction; and one group receiving conventional instruction versus one group receiving non-directed programmed instruction.

In the flash photography experiment, significance was obtained in four of the eight group comparisons, all of which compared conventional instruction with programmed instruction. Significance was in favor of the experimental treatment in each comparison: two combinations of groups receiving conventional instruction versus groups receiving directed programmed instruction; and two combinations of groups receiving conventional instruction versus groups receiving non-directed programmed instruction.

No significant differences in the flash photography experiment were found in testing four combinations of groups receiving directed programmed instruction versus groups receiving non-directed programmed instruction.

Summary of the Study

The purpose of the study was to investigate the

effectiveness of programed instruction as a method of teaching selected units of college level elementary photography; it compared achievement resulting from conventional instruction with that resulting from directed programed instruction, and compared achievement resulting from conventional instruction with that resulting from non-directed programed instruction. It also compared achievement resulting from directed programed instruction with achievement resulting from non-directed programed instruction.

Instructional programs in the areas of film exposure and flash photography were written for the experiment. Two criterion tests, each with pre-test and post-test forms, were developed to measure achievement of subjects in the two units of photography instruction.

Seventy-one students enrolled in two sections of Journalism 233 and one section of Journalism 303 at Oklahoma State University were used as subjects in the film exposure experiment, and sixty-eight students in the same courses were used as subjects in the flash photography experiment.

Students in the two Journalism 233 sections were randomly assigned to four sub-groups; students in Journalism 303 comprised a fifth group. By random assignment one group was chosen to be the control group to receive conventional instruction, two groups were chosen as experimental groups to receive directed programed

instruction, and the two remaining were selected to receive non-directed programed instruction.

Independent variables in the study were the types of instruction: directed programed instruction, non-directed programed instruction, and conventional instruction. The dependent variables were the measures of student achievement in the two areas of photography study.

Students were pre-tested with Forms A of the film exposure and flash photography criterion instruments. The film exposure experiment was conducted and the five subgroups were then administered Form B of the film exposure criterion instrument as a post-test. Mid-way in the semester identical procedure was utilized in conducting the flash photography experiment.

The analysis of covariance statistic was utilized in testing the eight sub-hypotheses of each experiment. The .05 level of confidence was used with the statistical tests.

Eight comparisons were made between groups receiving conventional instruction and groups receiving programed instruction: in five comparisons significance was obtained in favor of the programed instruction treatment --- three non-directed programed instruction groups, and two directed programed instruction groups.

In the eight comparisons between groups receiving directed programed instruction and groups receiving

non-directed programed instruction, no significant differences were found.

Conclusions

On the basis of these findings, it may be concluded that programed instruction proved to be an effective teaching method for the experimental groups in both experiments. In eight comparisons of conventional instruction and programed instruction, three comparisons showed no significant differences in achievement, and five comparisons demonstrated that students receiving programed instruction reached a significantly higher level of achievement.

These findings are consistent with those reported in the review of literature in which either no significant differences have been found between programed instruction and conventional instruction, or when significant differences were found, they were in favor of programed instruction treatments. In none of the literature were groups receiving conventional instruction found superior to those receiving programed instruction.

Results of this study indicate little difference in the effectiveness of either directed programed instruction or non-directed programed instruction when compared with conventional instruction. In the five group comparisons in which programed instruction was found significantly better than conventional instruction, three of the

experimental groups were those receiving non-directed programmed instruction and two were those receiving directed programmed instruction.

Outcomes of this investigation also suggested the conclusion that there were no differential effects on achievement caused by directed programmed instruction as compared with non-directed programmed instruction. In eight comparisons of directed programmed instruction with non-directed programmed instruction, no significant differences were found. These results are not consistent with the study by Bartz and Darby (121) in which groups receiving non-directed programmed instruction performed significantly lower than those receiving conventional instruction and those receiving directed programmed instruction. The "N" of the present study, almost twice that of the study of Bartz and Darby (121), could have contributed to the differences in results.

A consideration in interpreting the results of this investigation is the Hawthorne effect. The experimental groups knew that they were participating in a study which could have affected the results. However, this limitation was considered minimal because all of the subjects received instruction from the regular photography instructor, and the normal classroom setting was utilized for all but the students in non-directed programmed treatment groups.

In summary, it may be concluded that effective

learning resulted from utilizing programed materials with the experimental groups and that programed materials could probably be put to effective use in some other areas of photography instruction and areas of journalism instruction. It would seem that non-directed programed instruction would be the more efficient of the two types of programed instruction to utilize.

On the basis of this investigation, it appears that more research is needed to determine the extent to which photography content is retained, and whether more extensive use of programed instruction in a semester-length course would affect the outcome.

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APPENDIX A-I

Name _____

Before beginning to work the program, study the objectives so that you will understand what you will be expected to know.

When you complete the program, return to the objectives; are you able to demonstrate the abilities and skills set forth?

While working the program if you have difficulty with review questions, review the suggested frames until you no longer have difficulty.

For your work be sure that you:

- (a) study only this program, not your text (you won't need anything else).
- (b) review the program if you don't understand the concepts.
- (c) don't let other students use these materials.

OBJECTIVES --- Programmed Instruction No. 2 (Flash)

The following are objectives in terms of student performance; upon completion of the program the student should be able to demonstrate these abilities and skills:

1. Without aid of reference to relate the difference in exposure necessary with each of the flash techniques.
2. Without aid of reference to construct a diagram of a flashbulb, to label its main components, and then to explain how the flashbulb fires.
3. Without aid of reference to list at least four safety precautions to take when using flashbulbs or electronic flash.
4. Without aid of reference to compare the use of flashbulbs with the use of electronic flash in terms of advantages and disadvantages.
5. Without aid of reference to write f/stop adjustments necessary to achieve correct exposure with flash when subject brightness and/or type of flash reflector vary from the normal.
6. Without aid of reference to differentiate between and to list purposes and advantages of the different flash techniques: on-camera flash, off-camera flash, fill-in flash, multiple flash, open flash, bounce flash, bare-bulb flash, and handkerchief diffusion flash.
7. Without aid of reference to define such terms as: synchronization, millisecond, electronic flash, capacitor, recycling time, low input units and high input units, and flash guide number.
8. With the aid of a flash exposure table, given a hypothetical type of film, shutter speed, and distance from flashbulb to subject, to find the correct guide number and from this to calculate the correct f/stop.
9. Without aid of reference to differentiate on test items between different classes of flashbulbs and to write the proper camera setting to synchronize the shutter with the flash.

10. Without aid of reference to compare the advantages and disadvantages of the two main types of flashguns.

FLASH PROGRAM JOURNALISM 233

1. This is a unit of programmed instruction; it is designed to permit you to learn flash photography well if you follow directions.
2. Each numbered section is called a frame. You will read one frame at a time, and you must cover the other frames below it with your cover sheet. The asterisks (*) serve as a guide so that you won't slide the cover sheet too low and uncover the answer prematurely.
3. In each frame you will be required to write in the missing word or words before sliding the cover sheet down just far enough so that you can read the correct a _ _ _ r below the question at the right-hand side of the page.

* * *

3- answer

4. It is important that you write the answer in the blank space before you move the cover sheet down to c _ _ _ k the correct answer.

* * *

4- check

5. The instruction will be presented in sections with review frames at the end of each section. If you are incorrect on any frame in the review, you will be referred back to the proper frame; then read the review frame again and answer it c _ _ _ _ _ y.

* * *

5- correctly

6. This instruction concerns how flash is utilized in photography and deals with flash techniques. By following instructions and responding by writing in the missing word or words in the blank space before checking your answer, you will learn quite a lot about how f _ _ _ h is used in photography.

* * *

6- flash

7. Be sure you read all of each frame. If a blank appears in the middle of a frame, respond by writing in the correct word or words, but then read the rest of the f _ _ _ e, for there may be important information there.

* * *

7- frame

FLASHBULBS AND HOW THEY WORK

8. You have seen movies in which the photographer of yesteryear posed his group of subjects, cautioned them to be ready, and then fired a pan of flash powder held over his head, producing a billowing cloud of fire and smoke. This is humorous to us today because of the crudeness of the method, but f _ _ _ h p _ _ _ r was virtually the only type of flash used as late as the early 1930's.

* * *

8- flash powder

9. This flash powder, actually magnesium powder, caused fires, burned the photographers, and produced huge clouds of s _ _ _ e which obscured the subjects, making a second picture impossible until the smoke had cleared sufficiently.

* * *

9- smoke

10. This method employed little or no synchronization. The term synchronization means the timing necessary for the camera shutter to be open when the flash is at its peak intensity. The camera shutter being open when the light of the flash is at its peak is called s _ _ _ _ _ n.

* * *

10- synchronization

11. The pioneer photographer quite often would open the camera lens, fire the flash powder, and then close the lens. Proper timing to coordinate the flash and shutter, known as s _____, was merely guesswork.

* * *

11- synchronization

12. In the 1930's flash powder was replaced by flashbulbs. The first flashbulbs were larger than the standard 100-watt lightbulb today. But as time passed, flashbulbs gradually became s _____.

* * *

12- smaller

13. A typical flashbulb size today is the size No. 5 or No. 25 flashbulb. (These are the same size: No. 5 is General Electric and No. 25 is Sylvannia.) These flashbulbs are about the size of a golf ball. Another, the M-25, is less than half the size of the No. 5 or No. ____ flashbulb, but gives nearly as much light.

* * *

13- No. 25

14. The AG-1 flashbulb, which although only as big around as a pencil and less than one inch long, gives about half the l_____ of a No. 5 or No. 25 bulb.

* * *

14- light

15. The newest addition to flash materials is the flashcube. This cube plugs into the top of a camera, requiring no flashgun on the camera. Four flashbulbs are built into the flashcube, each having its own reflector. The cube, which uses AG-1 size bulbs, is discarded after all four of its f_____ are fired. (See illustration No. 1 on Panel 2 at the end of this program for an example of the flashcube.)

* * *

15- flashbulbs

16. The small flashbulbs such as the AG-1 are especially appropriate for use today, since with faster and more efficient films, f_____ as large as the No. 5 and No. 25 can be too bright when the distance to the subject is less than 15 feet.

* * *

16- flashbulbs

17. All sizes of flashbulbs come in either blue or white color, and blue bulbs, although intended for use with color films, may be used to advantage also with black and white films. More than 80 per cent of the bulbs manufactured today are blue; these give a better color balance for both color films and b_____ and white films.

* * *

17- black

18. Although they can be used with black and white films, blue flashbulbs are used primarily with c_____ films.

* * *

18- color

19. Let's briefly describe the construction of a flashbulb so that you will understand how its flash is synchronized with the camera shutter. It is extremely important that you understand what synchronization is --- you will remember that it was described as the timing necessary for the camera s_____ to be open when the flash is at peak intensity.

* * *

19- shutter

Now please tear Panel 2 from the back of this program so that you may study it as you read.

20. Note illustration No. 2 on Panel 2 --- the standard flashbulb has two heavy vertical lead wires (C) which rise from the metal base of the bulb into the center of the glass globe of the bulb. These wires are coated with a primer material (D) and the tips of the wires are connected by a tiny wire filament (A). This apparatus is surrounded by a mass of loosely packed fine aluminum or zirconium foil (B); the interior of the bulb is also charged with oxygen. The center of this bulb, then, is made up of two heavy lead wires connected by a tiny wire f_____.

* * *

20- filament

21. When the flashbulb is fired, an electrical current passes from the camera flashgun into the metal base of the bulb, up the heavy lead wires and into the tiny wire filament connecting the heavy wires. The tiny filament is heated and becomes so hot it is burned out --- this burning ignites the primer material on the ends of the lead wires. The purpose of the tiny filament, then, is to ignite the p_____ material.

* * *

21- primer

22. The primer burns furiously, throwing out sparks into the interior of the bulb which ignite the fine foil. The charge of oxygen in the bulb increases combustion of the f_____.

* * *

22- foil

23. The foil burns rapidly and produces the brief, but extremely bright _____ of light.

* * *

23- flash

24. The flashbulb is burned out after a single flash, so it is no re-useable. The flashbulb, then, may be fired only _____ time.

* * *

24- one

REVIEW---Flashbulbs and How They Work

25. A basic concept is that the timing necessary to permit the shutter to be open when the flash is at peak intensity is called _____.

* * *

25- synchronization

(If you were incorrect, refer to frame 10)

26. Flashbulbs for color film must be _____ in color.

* * *

26- blue

(If you were incorrect, refer to frames 17 and 18)

27. The fine aluminum or zirconium foil inside the flashbulb actually is ignited by _____ material which burns strongly, sending out sparks from the ends of the two heavy lead wires at the bulb's center.

* * *

27- primer

(If you were incorrect, refer to frames 21 and 22)

28. A new flash material which utilizes four AG-1 flashbulbs, each with their own reflector, is called a _____.

* * *

28- flashcube

(If you were incorrect, refer to frame 15)

29. Small flashbulbs are appropriate for use today because _____ flashbulbs can be too bright for close shots with our new films.

* * *

29- large

(If you were incorrect, refer to frame 16)

30. Before flashbulbs were developed, the only way a photographer could illuminate interiors was by firing an explosive pan of _____.

* * *

30- flash powder

(If you were incorrect, refer to frame 8)

FLASHBULB CHARACTERISTICS AND SYNCHRONIZATION

31. Please refer to illustration No. 3 on Panel 2; note the curve for the No. 5 flashbulb which is the lowest one on the graph. This graph shows the way a flashbulb burns; when fired, a flashbulb doesn't burn at constant intensity. The "O" on the graph represents the instant when the shutter release is depressed---there is a delay before the bulb begins to burn; the No. 5 flashbulb begins burning at about _____ milliseconds after it is fired; the light then gradually builds to a peak and after that it _____ until it is fully burned out.

* * *

31- 10 (approximately)
falls, or drops, etc.

32. Time (the horizontal part of the graph) is measured in milliseconds; a millisecond is 1/1000th of a second. The light (vertical on graph) is measured in lumens, but you can merely consider the vertical measurement as "light intensity." The time, then, is measured in milliseconds, and one millisecond is 1/_____th of a second.

* * *

32- 1/1000th

33. To get proper exposure it is necessary that the camera shutter be open at the time the light is brightest. This timing, which has been discussed, is called _____.

* * *

33- synchronization

34. Synchronization is also called and spelled "sync" for short. This is pronounced like "sink." Synchronization, then, is also known as _____.

* * *

34- sync

35. Today even inexpensive cameras are synchronized for flash. The shutters are designed so that they delay; that is, the shutter doesn't _____ until the light of the flash is at its peak intensity.

* * *

35- open

36. All the photographer has to do is to click the shutter release to set off the flash, and the camera's _____ will open when the flash is at peak intensity, if the camera is synchronized.

* * *

36- shutter

37. Cameras with flash synchronized shutters delay the opening of the shutter until the flash is at its _____. This means that the shutter release is pushed, and the bulb begins burning---then when the flash is brightest, the _____ opens.

* * *

37- peak, or brightest, etc.
shutter

38. All flashbulbs do not burn at the same rate; there are medium flashbulbs and fast flashbulbs. The Class M (medium peak) bulb is perhaps the most popular type. Medium peak means that the bulb reaches its peak intensity in a medium amount of time, which is about 20 milliseconds. When using Class M bulbs, the shutter must be delayed some _____ milliseconds so that it will be open during peak intensity of the flash.

* * *

38- 20

39. Again refer to illustration No. 3 on Panel 2; the No. 5 bulb (lowest curve) begins burning at about 10 milliseconds after it is fired. Peak intensity is at about _____ milliseconds, and it is fully burned out at _____ milliseconds.

* * *

39- 20
40 (approximately)

40. The better cameras have adjustable synchronization so that the camera shutter may be synchronized with medium peak or fast _____ flashbulbs.

* * *

40- peak

41. Adjustable synchronization settings are M, for medium peak light, and X for f_____ peak light.

* * *

41- fast

42. When using a medium peak flashbulb with a camera with M-X settings, ____ (M or X) would be the proper setting to synchronize the flash with the shutter.

* * *

42- M

43. When the camera has M-X synchronization, the setting for the fast peak flashbulb is ____ (M or X).

* * *

43- X

44. Flashbulbs No. 5, No. 25, and M-25 are all medium peak bulbs, so they require the synchronization to be set on ____ (M or X). Other medium peak bulbs are No. 11, No. 40, No. 2, and No. 22.

* * *

44- M

45. Class F (fast peak) bulbs reach their peak rapidly. Look at illustration No. 4 on Panel 2; the flash curve shows that the flash for this fast peak bulb reaches its peak quickly, at _____ milliseconds. This type of bulb, which is filled with gas that is ignited to provide the flash, is not in general use.

* * *

45- 5 (approximately)

46. Since Class F bulbs are fast peak, they require the camera synchronization to be set on _____ (M or X) so that the flash and shutter will be properly synchronized.

* * *

46- X

47. X synchronization means there is virtually no delay; the _____ opens instantaneously when the shutter release is depressed. Since the Class F bulb peaks so rapidly, the shutter must open without delay so that it will be open when the light is at peak intensity.

* * *

47- shutter

48. Note No. 5 on Panel 2 (lower curve) which illustrates flash peaks for the Class FP flashbulb. The Class FP (focal plane) reaches a _____ in about _____ milliseconds, but the peak is actually more like a plateau, as it remains at peak level for some time.

* * *

48- peak
15 to 20 (approximately)

49. The Class FP bulb has this "plateau" characteristic because it is designed for cameras equipped with focal plane shutters. This type of shutter utilizes a small slit-like opening which moves across the film during exposure, taking about 20 milliseconds to travel from one side of the film to the other. Therefore, the flash for this shutter must remain at a peak for 20 milliseconds, and maintain a fairly constant light intensity during this time. The FP bulb, then, is for use with cameras having a _____ shutter.

* * *

49- focal plane

50. Since the focal plane shutter requires 20 milliseconds (1/50th sec.) to fully travel across the film, the FP flashbulb must produce a fairly constant light for _____ milliseconds.

* * *

50- 20

51. However, cameras with focal plane shutters may utilize other types of flashbulbs when operating at slow shutter speeds of 1/50th sec., or less. But with fast shutter speeds, these cameras must use the Class _____ flashbulbs.

* * *

51- FP

52. The three classes of flashbulbs we have discussed are easy to remember. The letter names of the first two designate the type of speed of peak light intensity they have: Medium peak is a Class _____ bulb; Fast peak is a Class _____ bulb. The third bulb's letter name describes the type of shutter it is designed to work with, so it is a Class _____ bulb.

* * *

52- M
F
FP

53. Cameras may be synchronized for flash in one of four ways. The first, a fixed synchronization, is found on most box cameras. The flash is _____ with a fixed shutter speed; most of these cameras will synchronize with all of the popular Class M flashbulbs.

* * *

53- synchronize

54. The second type of synchronization is found on some cameras such as the Argus C-3 which must be set on a certain shutter speed so that the shutter will properly synchronize with the _____. This requirement is usually a slow shutter speed such as 1/30th sec., and at other faster speeds there will be no synchronization.

* * *

54- flash, or light, or peak intensity, etc.

55. The third type of synchronization is the adjustable type which was discussed previously. This type has M and X settings. The two choices of settings in the adjustable synchronization are the _____ setting for medium peak bulbs, and _____ for fast peak bulbs.

* * *

55- M X

56. The fourth type of synchronization is rare, as it comes only on a few of the best cameras. These cameras have a dial to set the desired shutter delay; the Leica camera, for example, has a dial from 0 to 20 --- these numbers signify delay in milliseconds, and the photographer sets the dial according to the type of _____ he is using.

* * *

56- flashbulb, or flash

57. The particular flash requirements of a camera will be spelled out in its instruction booklet. You should note if the instructions state that the camera shutter will synchronize with _____ on only one shutter speed, or if a particular type of flashbulb must be used.

* * *

57- flash

58. Electronic flash will be described more fully later, but now we will briefly consider its synchronization. This type of flash unit uses a permanent bulb and produces a light which is extremely fast; since the light is of a very short duration, it is similar in speed to the Class F flashbulb, and therefore requires a setting of ____ (M or X) on a camera with adjustable synchronization.

* * *

58- X

REVIEW---Flashbulb Characteristics and Synchronization

59. With adjustable flash synchronization settings, ____ is for Class F bulbs, and ____ is used for Class M bulbs. Then the ____ setting is used with electronic flash.

* * *

59- X
M
X

(If you were incorrect, refer to frames 42, 43, and 58)

60. The shutter actually opens _____ (when/before/after) the flashbulb is fired.

* * *

60- after

(If you were incorrect, refer to frames 36 and 37)

61. The Class FP flashbulb is for a camera with a _____ shutter.

* * *

61- focal plane

(If you were incorrect, refer to frames 49 and 50)

62. Letters which identify the following flashbulbs are:

_____ for fast peak light
 _____ for focal plane shutter
 _____ for medium peak light

* * *

62- F
 FP
 M

(If you were incorrect, refer to frame 52)

63. The two settings on a camera with adjustable synchronization are ____ and ____.

* * *

63- M and X

(If you were incorrect, refer to frame 41)

64. The type of camera using a fixed synchronization, that is, synchronizing flash with a fixed shutter speed, is a _____ camera.

* * *

64- box

(If you were incorrect, refer to frame 53)

TYPES OF FLASH UNITS

65. There are three basic types of flash apparatus:

- (1) Battery-operated flash
- (2) B-C flash (battery-capacitor)
- (3) electronic flash

The first two flashguns above use standard flashbulbs, but the electronic flash, instead of using a flashbulb, has a _____ type of bulb which may be fired again and again.

* * *

65- permanent

66. The battery-operated flashgun is both the simplest type of unit and also the least efficient. It operates exactly like a flashlight, as it contains batteries, a switch, and a bulb. This flashgun, however, instead of using a flashlight bulb, uses a _____.

* * *

66- flashbulb

67. Several different things may occur to cause improper operation of the battery-operated flashgun. Weak batteries may not have sufficient _____ to ignite a bulb, or they may cause the bulb to fire too late to achieve proper synchronization.

* * *

67- power, or current, etc.

68. Batteries become weak with age even though they have had little or no use; thus the photographer should test his flash before a shooting session, or better yet, if batteries are not very new, he should replace them with fresh batteries. He should be especially cautious when working the batteries in cold conditions, as the low temperatures tend to lower the output of the _____.

* * *

68- batteries

69. Although the battery-operated flash unit may operate on standard size flashlight batteries, the photographer should purchase "photoflash" batteries which are designed especially for use in a _____.

* * *

69- flashgun

70. By using a somewhat different type of flash unit, the B-C unit, some of the problems previously discussed in using the flashgun can be solved; then maximum efficiency may be achieved.

* * *

70- battery-operated

71. B-C is an abbreviation for battery-capacitor. This flash unit utilizes one $22\frac{1}{2}$ -volt battery or two 15 or $22\frac{1}{2}$ -volt batteries which charge a capacitor (also called a condenser). B-C, then, means _____.

* * *

71- battery-capacitor

72. In the B-C unit the current is stored in the capacitor until the flashgun is fired --- then the capacitor empties its electricity, producing a burst of current that _____ the flashbulb immediately.

* * *

72- fires, or ignites, etc.

73. Most B-C units have a minimum of one $22\frac{1}{2}$ -volt battery for power; since only $1\frac{1}{2}$ volts are required to fire a flashbulb, the B-C unit is essentially a _____ (high-powered/low-powered) unit.

* * *

73- high-powered

74. The main advantage of the B-C unit is that it carries considerable power. Weak batteries can still fully charge the _____ in the unit, thus producing maximum output of current. Also, with normal use, the batteries in the B-C unit usually will last one year and up to two years.

* * *

74- capacitor

75. The photographer using the B-C unit can have confidence in it firing a flashbulb, since even weak _____ can fully charge the capacitor.

* * *

75- batteries

76. Output of current of the B-C unit is strong enough to overcome a nominal amount of resistance in the electrical system of the camera and flash unit which could be caused by corrosion. So even if some of the electrical contacts in the system were corroded, the great surge of current from the capacitor would probably still _____ the flashbulb.

* * *

76- fire, ignite, etc.

77. B-C units come in small, compact sizes, some with folding reflectors, and many have a testing light that informs you if the electrical circuit is complete and ready to fire. This _____ light will also inform you of whether your flashbulb is good or bad.

* * *

77- testing

78. The third type of flash is the electronic flash, also called a strobe unit; in the past it was called a "speedlight", but this usage is not current. We have already learned that a main difference in the standard flash unit and the electronic flash unit is that the standard unit uses a "one-shot" flashbulb which is then discarded, but that the electronic flash unit, instead of firing flashbulbs, uses a _____ type of bulb.

* * *

78- permanent

79. The electronic flash unit utilizes a permanent flash tube filled with zelon gas which produces a very powerful flash of extremely short duration when a burst of high voltage is passed through it. Characteristics of the light produced, then, are that the light is powerful and _____ in duration.

* * *

79- short

80. The electronic flash system is similar to the B-C unit system, as a high voltage dry battery is connected to and feeds current into one or more capacitors which produce the current that sparks in the gas-filled tube. The energy, then, is stored in one or more _____ until the unit is fired.

* * *

80- capacitors

81. One characteristic of all electronic flash units is called a recycling time. This is the time required for the batteries to recharge the capacitors after the unit is _____.

* * *

81- fired, or discharged, etc.

82. Most units have a type of "ready light", a small bulb that will begin blinking when the capacitor is fully charged and ready to fire again. The _____ time is normally between 10 to 15 seconds for most units, but longer if the batteries are weak.

* * *

82- recycling

(It is actually "recharging" time, but "recycling" is the correct term)

83. There are two basic types of electronic flash units -- low input and high input. The low input units use low voltage, such as three $1\frac{1}{2}$ -volt flashlight size batteries. The example of this unit, then, tells you that the low input unit may be operated on a low power supply of as little as a total of _____ volts.

* * *

83- $4\frac{1}{2}$

84. The low input unit is usually self-contained, that is, the power supply is built in the unit. Intensity of the flash is rather low, but suitable for most amateur work. In a unit of this type, when the power supply is built in, we say that the unit is _____.

* * *

84- self-contained

85. Some low input units have nickel cadmium batteries which are re-chargeable. These units have a built-in battery charger. A switch is set on "charge" and a cord is simply connected to the unit and plugged into 110-volt wall current. An overnight charge is sufficient for many units, and most will produce around 80 flashes without recharging. So although standard batteries are discarded after they are exhausted, nickel cadmium batteries which come in some units may be _____.

* * *

85- recharged, or charged

86. Most of these low input electronic flash units may also be plugged into wall current and fired, using the wall current instead of the unit's battery for the power supply. A switch on the unit is used to designate whether battery power or wall current is to be used. We could well say that many electronic flash units provide a great many flashes at little cost, especially if they can utilize both battery power and _____ current.

* * *

86- wall, or 110-volt

87. High input units use large voltage dry cell batteries of up to 500 volts which are usually contained in a separate "power pack" connected to the flash head by a heavy insulated wire. High input units utilize _____ (high/low) voltage.

* * *

87- high

88. Light output of the high input unit is great, and this unit is used by professional photographers such as press photographers. Obviously, the high input unit is more expensive than the low input unit. From this discussion, it is apparent that a _____ input unit is sufficient for amateur type photography, but that a _____ input unit is recommended for professional photography.

* * *

88- low
high

89. Although high input units don't usually use rechargeable batteries, the batteries used in these units produce from 1,000 to 2,000 flashes. With the high input units, then, the great number of flashes produced compensates for the batteries not being capable of being _____.

* * *

89- recharged

90. Perhaps the main advantage of the electronic flash unit is that its flash is extremely fast, somewhere between 1/500th sec. and 1/2000th sec., depending upon the power of the unit. A main advantage of the electronic flash, then, its flash is _____.

* * *

90- fast

91. This very fast flash means that the light will stop virtually any action; this is possible as long as existing light in the picture is not strong enough to form an image on the film, and this rarely occurs. With this information in mind, the newspaper photographer taking sports action pictures would probably prefer to use a/an _____.

(flashbulb unit/electronic flash unit)

* * *

91- electronic flash unit

92. Other advantages of the electronic flash are many: the photographer can take many pictures at low cost, the electronic flash can be used well for color photography since its light quality approximates natural daylight, and synchronization is better than that of flashbulbs. These may be summarized as: (1) low cost, (2) good for color photography, and (3) better s_____ than flashbulbs.

* * *

92- synchronization

93. Additional advantages are that the light is softer and more pleasing than light from flashbulbs, light is easier on the eyes of the subjects, and there are no bulbs to change. So, (1) softer, pleasing light, (2) light easy on eyes, and (3) changing _____ is not required.

* * *

93- bulbs

94. A few disadvantages of electronic flash are that a person must take quite a few flash pictures per year in order to benefit from the rather large initial cost of a strobe unit; some units are bulky and all tend to be somewhat fragile; and cameras with focal plane shutters can be synchronized only at very slow speeds. These may be summarized as: (1) large initial cost, (2) units are bulky and fragile, and (3) cameras with focal plane shutters synced only at _____ speeds.

* * *

94- slow

95. Other disadvantages are that some low input units produce less light than flashbulbs, and the units are potentially dangerous since they pack so much voltage. So in addition to the "danger" element, low input units may produce _____ light than a flashbulb.

* * *

95- less

REVIEW---Types of Flash Units

96. The most efficient type of flashgun using a flashbulb is the _____.

* * *

96- B-C unit

(If you were incorrect, refer to frame 70)

97. Electronic flash utilizes high voltage batteries that are connected to _____s which store the current until the unit is fired.

* * *

97- capacitors

(If you were incorrect, refer to frame 80)

98. Light that is the most soft and pleasing to the eye is produced by _____ flash.

* * *

98- electronic

(If you were incorrect, refer to frame 93)

99. The B-C flash unit stores electrical current in a _____ which empties the current when it is fired.

* * *

99- capacitor

(If you were incorrect, refer to frame 72)

100. A small light on the B-C unit which lets you know that the circuit is complete and ready to fire, and which also tests the flashbulb, is called a _____ light.

* * *

100- testing

(If you were incorrect, refer to frame 77)

101. The time required for batteries to recharge an electronic flash capacitor is called _____ time; then a ready light begins _____ when the unit is ready to fire again.

* * *

101- recycling,
blinking, flashing, etc.

(If you were incorrect, refer to frames 81
and 82)

102. The type of electronic flash used by a professional photographer would most likely be a _____-_____ (high-input/low-input) unit.

* * *

102- high-input

(If you were incorrect, refer to frame 88)

103. Electronic flash is _____ (slow/fast), but a disadvantage is that small (low input) units may produce less light than a _____.

* * *

103- fast
flashbulb

CALCULATING EXPOSURE FOR FLASH

104. Determining exposure when using flash depends upon several variables:

- (1) film used
- (2) type and size of bulb
- (3) size and finish of flash reflector
- (4) type of synchronization
- (5) shutter speed used

Although these suggest a complicated system of how to _____ film exposure, the method of using the above variables is actually simple.

* * *

104- determine, or calculate

105. All of the above variables are considered in using a guide number for exposure which is found on the film data sheet with each roll of film, and which can also be found on most flashbulb packages. The guide _____ for exposure is printed on the film data sheet, or on most _____ packages.

* * *

105- number
flashbulb

106. The film data sheet gives _____ numbers for different bulbs for use with that one film, while the flashbulb package data gives sufficient information to permit one to calculate exposure for all types of film using two sizes of reflectors in the flashgun.

* * *

106- guide

107. After this guide number has been obtained, the photographer merely divides it by the bulb-to-subject distance in feet to find the correct f/stop to use. To repeat, to find the correct f/stop, the photographer divides the guide number by the bulb-to-subject _____ in feet.

* * *

107- distance

108. On Panel 1 at the end of this program is an exposure guide. You may tear it off to use in connection with some problems. This is an exposure _____ for two particular kinds of flashbulbs: No. 5 and No. 25, which give the same amount of light.

* * *

108- guide

109. To find the proper guide number, first find the column for the speed of the film you are using; this is located at the top of the guide at the head of each column and is stated in terms of ASA ratings. Remember that ASA ratings indicate the _____, or sensitivity of the film.

* * *

109- speed

110. When you find the proper column with the film speed, travel down that column from one guide number to the next until the guide number is in the same row as the shutter speed you are using; the shutter speeds are listed at the left side of the table. You have the correct guide number when it is in the same row with the _____ you are using.

* * *

110- shutter speed

111. To find the correct f/stop, this guide number is divided by the _____ in feet from the bulb to the subject.

* * *

111- distance

112. Here is a replica of the exposure guide on Panel 1 for No. 5 and No. 25 bulbs:

Film Speed		10 to 16	20 to 32	40 to 64	80 to 125	160 to 250	(320 to 500)
<u>Shutter Speed</u>		<u>Guide Number</u>					
X or M Sync. up to	1/30th	95	140	200	280	400	550
	1/60th	90	130	180	260	360	500
M Sync.	1/125th	75	110	160	220	320	440
	1/250th	60	85	120	180	240	(360)
Only	1/500th	46	65	95	130	190	260

Suppose you are using Tri-X film (ASA 400) at 1/250th with a distance of 15 feet from bulb to subject. What is your f/stop?

First, locate the column coinciding with your film speed of ASA 400, which will be the 320 to 500 circled above. Next, find the guide number in this column which is in the same row as the shutter speed of 1/250th you are using: this is 360, circled above. This 360, then, is your guide number; divide it by your 15-foot bulb-to-subject distance and you

112. (Continued)
get 24 --- which rounded to the nearest f/stop will
be f/_____.

* * *

112- f/22

113. Try another one, using the exposure guide on Panel 1. You are using Panatomic-X film (ASA 40) at 1/125th with a 20-foot distance from bulb-to-subject. The film speed of ASA 40 will place it in the third column of 40 to 64. The guide number in the same row as 1/125th in this third column is 160 --- this is your guide number. This number divided by the 20-foot bulb-to-subject distance will give you an f/stop of f/_____.

* * *

113- f/8

114. Using Panel 1, you can now determine the guide number and subsequent f/stop for a given situation. Let's say you are using Verichrome Pan film (ASA 125) at 1/125th with a 10-foot bulb-to-subject distance.

What is your guide number? _____

What is your f/stop? _____

* * *

114- 220 (guide number)
f/22

115. Now, using Ansco Super Hypan film (ASA 500) at 1/250th, with a 30-foot bulb-to-subject distance:

Guide Number _____

f/stop _____

* * *

(f/stop rounded off from "12") 115- 360
f/11

116. Now, we'll presume that you are using a flashcube; refer to illustration No. 6 on Panel 2 for your guide. Using Verichrome Pan film (ASA 125) at 1/250th, distance of 18 feet.

Guide number _____

f/stop _____

* * *

(f/stop rounded off from 2.2) 116- 40 (guide number)
f/2.8 or f/2

117. Now, with a No. 25 flashbulb (Panel 1), using Plus-X Pan film (ASA 125) at 1/500th, with an 8-foot bulb-to-subject distance:

Guide number _____

f/stop _____

* * *

117- 130
f/16

118. Some flashguns have a small calculator on the back which lets you set a pointer on your guide number, then the correct f/stops are given for various bulb-to-subject distances in feet. The only information you must provide for the calculator is the _____.

* * *

118- guide number

119. If you use one or two types of film for most of your work, you may make a small chart for each type of film, giving guide number and f/stops for various bulb-to-subject distances in feet. This chart may be taped to the back of your camera or flashgun.

Most of the photographic companies stress that guide numbers are guides only; you may have to modify them in terms of the equipment you use and the conditions under which you normally work.

* * *

119- numbers

120. Here's how to make your own guide number:

Position your camera 10 feet away from a subject under normal lighting conditions and take a picture with every f/stop on your camera using your flash equipment. Next, print the best picture possible of each negative which you have taken, recording the f/stop used on the back of each print.

Then, spread the pictures out and examine them in terms of shadow detail and highlight detail, and then pick the one you like best. Now, add a zero to the f/stop used to take that picture you selected, and that is your guide number. (If you picked the picture taken with f/16, add a zero, making 160 your guide number).

If the picture you chose was taken with f/8, your guide number would be _____.

* * *

120- 80

121. So, to make your own guide number, take a picture at every f/stop of your camera with the camera _____ feet away from the subject.

* * *

121- 10

122. To calculate exposure for an electronic flash unit, a guide number provided by the manufacturer is used; this number is based on the ASA rating of various films. Many units include a calculator to assist the photographer in arriving at proper f/stops. If no calculator is given, the photographer divides the guide number by the flash-to-subject distance in _____, just as he would in determining the f/stop for the flash made by a _____.

* * *

122- feet
flashbulb

123. Two last considerations before leaving flash exposure. First, all of the data discussed is formulated in terms of subjects of average brightness. If the subject is dark, the lens must be opened from 1/2 to 1 f/stop, depending upon the degree of darkness; but if the subject is brighter than average, the lens must be closed from _____ to _____ f/stop/f/stops, depending upon the degree of brightness.

* * *

123- 1/2 to 1

124. The other element in exposure is the type of reflector used on the flashgun. The table you have been using on Panel 1 is for 4 or 5-inch polished reflectors; for smaller reflectors or ones that are not polished, it is generally recommended to open 1/2 f/stop from normal. So when you either have a smaller reflector than the 4-5 inch type, or if it isn't polished, you should _____ (open/close) the lens 1/2 f/stop from normal.

* * *

124- open

REVIEW --- Calculating Exposure for Flash

125. To find the proper f/stop for using flash indoors, a table is used to find a _____ which is divided by the distance in _____ from the bulb to the subject.

* * *

125- guide number
feet

(If you were incorrect, refer to frame 107)

126. The proper column in the flash table for the flash guide number is found by finding the correct category for the _____ rating of the film being used.

* * *

126- ASA

(If you were incorrect, refer to frame 109)

127. Using Panel 1, your film is Kodak Tri-X (ASA 400), shutter speed 1/250th, and distance 17 feet. The f/stop should be _____.

* * *

127- f/22 (actually f/21)

(If you were incorrect, refer to frame 112)

128. Using Panel 1, using Verichrome Pan film (ASA 125) at 1/30th, 18 feet, the guide number is _____, and the f/stop is _____.

* * *

128- 280
f/16 (actually f/15)

(If you were incorrect, refer to frame 112)

129. To make your own guide number, a series of pictures is shot, one shot for each f/stop of the camera. This best picture is selected --- to the f/stop used for this picture a zero is added to make the guide number. This series of pictures was taken at a distance of _____ feet.

* * *

129- 10

(If you were incorrect, refer to frames 120 and 121)

***Be sure you can answer the review frames 100% correctly and understand the concepts before you proceed to the next unit.

FLASH TECHNIQUES

130. Flash may be used effectively outdoors as well as for interior pictures. (See No. 5 and No. 6 on Panel 3) Outdoor flash is usually called fill-in flash, or "fill" flash because its main use is filling in additional light to eliminate unwanted shadows. So, even though flash is not needed for pictures in sunlight, it may be used to get rid of _____ on subjects' faces.

* * *

130- shadows

131. With _____ flash outdoors people may be photographed who are backlighted (light behind them), or side-lighted (light to the side), and there will be enough light on their faces to balance light coming from other directions. An advantage of this lighting is that subjects won't have to look into the sun.

* * *

131- fill-in, or fill

***Note No. 5 on Panel 3 which shows backlighting with no flash; and then the improved lighting with flash on No. 6.

132. To calculate exposure for fill-in flash, you are actually determining the distance the camera should be from the subject. First, determine what the normal exposure would be in outside light without flash and set the shutter speed and f/stop accordingly. Next, find the flash guide number from a table such as that on Panel 1, or a flashbulb carton. Then divide this guide number by the f/stop found for outside light conditions. The answer is the number of _____ the flash should be from the subject for proper exposure.

* * *

132- feet

133. Briefly, outside light exposure is determined and the camera set; then the flash guide number is found and this is divided by the f/stop found earlier; this results in the number of feet the flash should be from the _____.

* * *

133- subject

134. A simpler method of calculating exposure when using fill-in flash, but less accurate, is to expose for flash only, ignoring the outside light. You must have a bright, sunny day to use this method. In short, you _____ for flash only, ignoring outside light.

* * *

134- expose, or calculate

135. Flash can be manipulated many ways and these ways are generally called flash techniques. The simplest and the easiest technique, but also the poorest, is on-camera flash. This means that the flashgun is mounted next to the camera on a bracket. Let's discuss why it is both the easiest technique to use, but also the _____ type.

* * *

135- poorest

136. On-camera flash is the easiest technique because the photographer does not handle the flash at all or direct it independently of the camera; wherever the camera points, so does the flash. The easiest type of flash to use, then, is _____ flash.

* * *

136- on-camera

137. Note illustration No. 1 on Panel 3. On-camera flash is the poorest of the flash techniques because it tends to give flat lighting and harsh shadows behind the subjects; it may also produce lack of detail in the photograph. Disadvantages of on-camera flash, then, include producing harsh _____ behind subjects, and giving flat _____ with little depth.

* * *

137- shadows
lighting

138. The first step to combat disadvantages of on-camera flash is to be equipped to hand-hold the flashgun. A flashgun is needed which is detachable from the camera, but still connected with a sync cord so that the flash can be h_____.

* * *

138- hand-held

139. By holding the flashgun (connected to the camera with a sync cord) away and usually above the camera, the photographer can change the shadows usually by dropping them lower behind the subjects where they won't be as noticeable. (See No. 2 on Panel 3.) This technique is called off-camera flash. A main advantage of this technique, then, is placing the shadows _____ the subject rather than where they can be seen.

* * *

139- behind

140. Off-camera flash also improves modeling, that is, the flat lighting is changed into a more rounded, three-dimensional effect. So modeling is created by the _____ flash technique. Camera f/stop settings remain unchanged from normal when using this technique.

* * *

140- off-camera

141. Another technique is called feather flash. This is tilting the flash reflector (by using off-camera flash) to give the majority of light to distant areas and to give only a small part of the light (the feather edge) to the foreground, giving most of the light to the _____.

* * *

141- background, or
distant areas, etc.

142. Feather flash is used to balance the light between near and distant points in the picture which would otherwise be too light in the foreground due to too much flash, and too dark in the background due to insufficient flash there. This type of flash is used to _____ the flash between foreground and background.

* * *

142- balance, or feather

143. Feather flash compensates for a big disadvantage of flash, in that normal or on-camera flash, usually tends to deliver too much light to the foreground and too light to the background. A balanced light in near and far areas from the camera are achieved by using _____ flash. F/stop settings are not changed with this method.

* * *

143- feather

144. The multiple flash technique is simply the use of more than one flash at the same time. Reasons for using _____ flash are to give a "portrait" effect by producing dramatic lighting, to give even illumination to the subjects, particularly subjects which are far apart, and to illuminate a background which would otherwise be too dark.

* * *

144- multiple

145. Briefly, then, multiple flash is used to achieve a "_____ " type of lighting, to give even lighting to varied subjects, and to _____ the background.

* * *

145- "portrait"
illuminate, or light

146. One method of using multiple flash is utilizing long extension sync cords which plug into the flashgun and at the other end plug into one or more flash units which are usually set up on tripods. With this method, flash units are connected to the flashgun on the camera by a long _____.

* * *

146- sync cord

147. A more convenient method for multiple flash is using a "slave unit." This is a self-contained flash unit which flashes when the flashgun on the camera is fired. Although not connected to the camera flashgun, a _____ will flash when the flashgun on the camera is fired.

* * *

147- slave unit

148. The slave unit works by utilizing a photoelectric cell which picks up the change in light intensity caused by the camera flash; the slave unit reacts by firing its own bulb. Any number of slave units may be triggered by the one flashgun on the camera. The slave unit reacts when _____ intensity is changed as the camera flash is fired.

* * *

148- light

149. If the various flash units in multiple flash are being used to light a different part of the subject, exposure is the same as for single flash. However, if two or more flash units are directed at the same subject, settings must be adjusted. Therefore, if various flashes are lighting different areas of the subject, exposure is like a single flash; but when the flash units are on the same subject, exposure settings must be _____.

* * *

149- changed, or adjusted,
etc.

150. A common method for readjusting exposure when multiple flash units are directed on the same subject is:

2 flashbulbs --- multiply single-flash guide number
by 1.4

3 flashbulbs --- multiply by 1.7

4 flashbulbs --- multiply by 2

So actually the guide number is doubled when _____
(2, 3, or 4) flashbulbs are directed at the same
subject.

* * *

150- 4

151. Open flash means manually opening the shutter (set on B or T), then manually firing the flash, and then manually closing the shutter again. No synchronization is required. Exposing the film by manually firing the flash after the shutter has been opened manually is called _____ flash.

* * *

151- open

152. With the open flash technique, one may literally "paint" a whole room or a large object such as a building at night with several separate flashes of light which will be exposed on one negative. The camera must be used on a tripod or a firm support, and an assistant is needed to hold a piece of cardboard in front of the lens between flashes, and to uncover the _____ for each flash.

* * *

152- lens

153. The bounce flash technique is "bouncing" the light from some object before it reaches the subject. The flash is usually bounced from the ceiling, but can be bounced from walls or even from the floor. Bounce flash is usually from the _____.

* * *

153- ceiling

154. The reason for using bounce flash is to diffuse, or scatter the light, eliminating harsh shadows and giving a natural light effect. (See No. 3 on Panel 3.) So, bounce flash gives a natural light look and eliminates _____.

* * *

154- shadows

155. Since even lighting by bounce flash will illuminate the background well, an appearance of depth is achieved by this method. In addition to eliminating shadows and giving a natural light look, bounce flash gives a feeling of _____ by lighting the background.

* * *

155- depth

156. To calculate exposure for bounce flash, measure the total distance the light travels from flash to subject, that is, distance from bulb to ceiling and then to the subject --- and usually you must open another f/stop of exposure to allow for light absorbed by the ceiling. Distance used in determining exposure, then, is from _____ to _____ to _____.

* * *

156- bulb to ceiling to
subject

157. The total distance of bulb to ceiling and then to the subject is divided into the guide number to obtain the correct f/stop when calculating exposure for _____. The lens should be opened at least one more f/stop to compensate for light which is _____ by the ceiling.

* * *

157- bounce flash
absorbed

158. A quicker method, but less accurate, to calculate exposure for bounce flash, is to open the lens two f/stops from what the setting would have been for a normal flash. With this method, the ceiling should be of moderate height and fairly light in color. With this method, the lens is opened _____ f/stops.

* * *

158- two

159. When bouncing the light, avoid an extreme angle where the light is virtually shooting straight up and coming straight down again. This will create shadows under the nose and chin of the subject. It's better to back up from the subject and get more of a gradual angle to avoid getting _____ on the faces of the subjects.

* * *

159- shadows

160. Two other techniques of diffusing the flash to achieve softer light are:
- (1) bare-bulb flash, where the flash reflector is removed, and
 - (2) handkerchief flash, where a layer of handkerchief is placed over the face of the reflector.
- Both of these methods d_____, or scatter the light, making it softer.

* * *

160- diffuse

161. To correct the exposure when using these techniques, under average conditions, open up one f/stop for bare-bulb flash. With one layer of handkerchief, open one f/stop; with two layers, open two f/stops. Generally, when using either of these techniques to diffuse the light, the photographer must (open/close) the lens more than the normal exposure.

* * *

161- open

162. Bare-bulb flash is good for portrait type pictures because it creates soft light and is close up to the subject. (See No. 4 on Panel 3.) The handkerchief over the flash permits close-up photos of the subject, even when the speed of the film won't normally let you get close enough to the subject to get a big image on the negative. Therefore, two techniques good for a "portrait" effect are the handkerchief method and _____ flash.

* * *

162- bare-bulb

REVIEW --- Flash Techniques

(Be sure you answer these frames correctly and understand the content before you proceed to the next unit.)

163. The type of flash which is directed from the flash-gun to the ceiling or wall, then to the subject, is _____ flash.

* * *

163- bounce

(If you were incorrect, refer to frame 153)

164. Of the various flash techniques, _____ flash is considered the poorest in quality.

* * *

164- on-camera

(If you were incorrect, refer to frames 135 and 137)

165. The flash used outdoors to eliminate shadows from subjects is called _____ flash.

* * *

165- fill-in

(If you were incorrect, refer to frame 130)

166. To calculate exposure for fill-in flash, the correct distance in feet from flash to subject is found by dividing the flash guide number by the correct _____ found by calculating exposure for normal outside light conditions.

* * *

166- f/stop

(If you were incorrect, refer to frames 132 and 133)

167. The technique of directing the light away from subjects close to the camera toward subjects in the background is called _____ flash.

* * *

167- feather

(If you were incorrect, refer to frame 141)

168. The apparatus employed to use multiple flash without extension sync cords is called a _____.

* * *

168- slave unit

(If you were incorrect, refer to frames 147 and 148)

169. When using multiple flash and the different lights are lighting different parts of the subject, the exposure is _____ (different/the same) as it would be for single flash.

* * *

169- the same

(If you were incorrect, refer to frame 149)

170. When the shutter is opened manually and then the flash is fired manually, this technique is called _____ flash.

* * *

170- open

(If you were incorrect, refer to frame 151)

171. A rule of thumb in calculating exposure for bounce flash is to _____ (open/close) the lens _____ f/stops.

* * *

171- open
two

(If you were incorrect, refer to frame 158)

172. The technique of removing the reflector from the flashgun to create softer light is called _____ flash.

* * *

172-bare-bulb

(If you were incorrect, refer to frame 160)

SAFETY PRECAUTIONS

173. Since flashbulbs and electronic flash units are potentially hazardous if not handled correctly, note the following safety precautions:

- (1) When firing flash close to subjects, use a shield over the reflector, since occasionally bulbs may shatter.

- (2) A tiny crack in a bulb may cause it to explode when fired; most bulbs will have a blue dot on the face which will turn pink if the bulb is cracked.
- (3) Keep bulbs in the carton until you are ready to use them. Bulbs carried loose may be ignited by friction, and even by static electricity in the body.
- (4) Using the bulb ejector in the flashgun, eject a fired bulb without touching it; a freshly-fired bulb also can ignite other bulbs with which it comes in contact.
- (5) Before inserting a flashbulb in the flashgun at the start of a shooting session, unplug the sync cord; sometimes the unit may have a short, and the electrical circuit will be closed, causing the bulb the fire in your hand, resulting in burns and perhaps temporary blindness. By unplugging the sync cord, the bulb will fire when the cord is plugged back in if the unit is shorted.
- (6) When repairing an electronic flash unit, follow directions carefully, and be cautious when using the unit in the rain, or while in wet clothing or wet shoes. These units carry a tremendous amount of voltage which should be respected.

One should always check bulbs for cracks, because cracked flashbulbs may e_____ when fired.

* * *

173- explode

174. If a flash unit is shorted, the bulb may _____ in your hand when you insert it in the flashgun. Unplug the sync cord first.

* * *

174- fire, or flash, etc.

175. Bulbs should be kept in their carton until ready for use so that they won't be _____ by friction.

* * *

175- ignited, fired, etc.

176. A freshly-fired flashbulb can ignite other _____ if it comes in contact with them.

* * *

176- flashbulbs

177. Be cautious with an electronic flash unit, particularly when weather conditions are wet, because the unit contains a large amount of _____.

* * *

177- voltage, or current, etc.

REVIEW --- Safety Precautions

178. Flashbulbs should be kept in their carton until ready for use because _____ could ignite them.

* * *

178- friction, heat, freshly-fired bulb, etc.

(If you were incorrect, refer to frame 173
(part 3), and frame 175)

179. Cracked flashbulbs should not be used as they may _____ when they are fired.

* * *

179- explode, shatter

(If you were incorrect, refer to frame 173
(part 2))

180. Since a short in the electrical circuit of the camera and flashgun will cause the flashbulb to fire when it is inserted in the flashgun, the sync cord should be _____ before a bulb is inserted at the start of a shooting session.

* * *

180- unplugged

(If you were incorrect, refer to frame 173
(part 5), and to frame 174)

181. Never use an electronic flash unit in the rain or while wearing wet clothing because the unit carries very high _____.

* * *

181- voltage

(If you were incorrect, refer to frame 173
(part 6), and to frame 177)

182. A freshly-fired flashbulb is hot and can _____
other flashbulbs with which it comes into contact.

* * *

182- ignite, fire, etc.

(If you were incorrect, refer to frame 173
(part 4), and to frame 176)

PANEL 1

EXPOSURE GUIDE

No. 5 and No. 25 flashbulbs

		10	20	40	80	160	320
Film Speed		to	to	to	to	to	to
(ASA rating)		16	32	64	125	250	500
Shutter Speed		Guide Number					
X or M sync							
up to . . .	1/30th	95	140	200	280	400	550
	1/60th	90	130	180	260	360	500
M	1/125th	75	110	160	220	320	440
sync	1/250th	60	85	120	180	240	360
only	1/500th	46	65	95	130	190	260

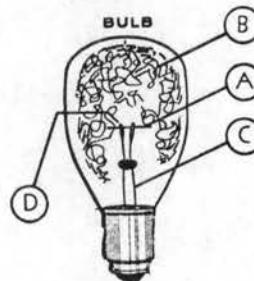
--- Below film speed and across
from shutter speed, read
guide number.

--- For f/stop, divide guide num-
ber by distance in feet from
bulb to subject.

PANEL 2

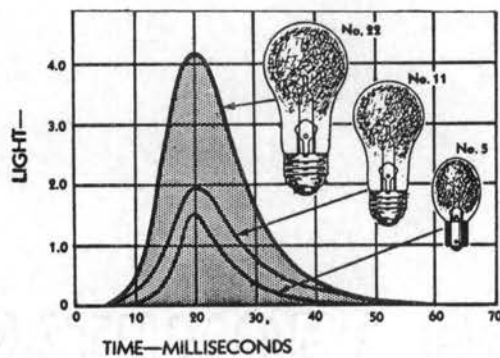


#1

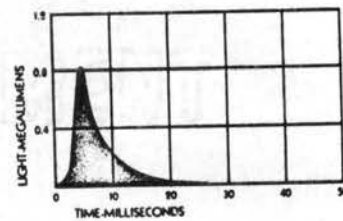


A FILAMENT
B FOIL
C LEAD WIRES
D PRIMER

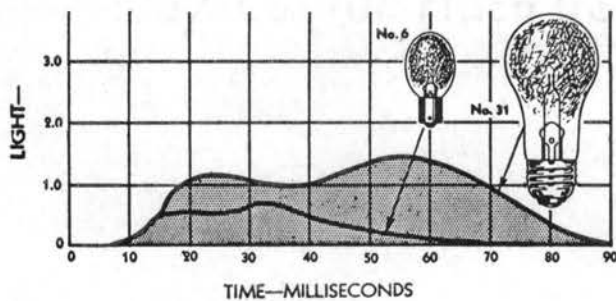
#2



#3



#4



#5

FLASHCUBE

ASA Film Speed	16	20	25	32	40	50	64	80	100	125	160	200	250	320	400	500	640	800	1000	1250	1600
1/30 or slower	37	42	48	60	85	120	170	240	340												
1/50 & 1/60	22	25	28	35	45	70	100	140	200												
1/100 & 1/125	18	20	22	28	40	55	80	110	160												
1/200 & 1/250	12	14	16	20	28	40	55	80	110												
1/400 & 1/500	10	11	12	15	21	30	42	60	85												
1/1000 & 1/1250	7	8	9	11	16	22	32	45	65												

#6

PANEL 3
Flash Techniques



#1 On-camera



#2 Off-camera



#3 Bounce



#4 Bare-bulb



#5 Sunlight



#6 Fill-in

APPENDIX A-II

Name _____

Before beginning to work the program, carefully study the list of objectives preceding the first page of the program; this is important so that you will understand what you will be expected to know.

When you complete the program, return to the objectives; are you able to demonstrate the abilities and skills set forth?

While working the program if you have trouble with review questions, review the suggested frames until you no longer have trouble. You must be able to work the problems given in the program.

For your work, be sure that you:

- (a) study only this program, not your text
(you won't need anything else)
- (b) review the program if you don't understand the concepts.
- (c) don't let other students use these materials.

OBJECTIVES --- Programmed Instruction No. 1 (Exposure)

The following are objectives in terms of student performance; upon completion of the program, the student should be able to demonstrate these abilities and skills:

1. Without aid of reference to list the f/stops of a camera.
2. Without aid of reference to list the two systems of shutter speeds.
3. Without aid of reference to differentiate the five classifications of outside light conditions.
4. Without aid of reference to differentiate between the four types of subject brightness.
5. Without aid of reference to define correctly such terms as: visible light, incident light, reflected light, refraction, ASA rating, film speed, transparent, translucent, and opaque mediums.
6. Given the normal conditions for exposure, but without aid of further reference, to calculate correct exposure from conditions which in part or fully vary from the normal.
7. Without aid of reference to answer questions correctly concerning the function of the shutter and f/stop.
8. Without aid of reference to make correct choices on test items concerning increasing or decreasing exposure by manipulating f/stops and shutter speed settings.
9. Without aid of reference to demonstrate familiarity with the "double or half" principle by writing combinations of f/stops and shutter speeds which will give the same exposure.
10. Without aid of reference to give reasons for selecting particular f/stops and shutter speeds.
11. Without aid of reference to calculate exposure from conditions varying from the normal when given only the ASA rating of the film.

EXPOSURE PROGRAM
JOURNALISM 233

1. This is a programmed unit of instruction; it is designed to permit you to learn the subject matter well if you follow directions closely.
2. Each numbered section is called a frame. Only one frame is read at a time, and you must cover the other frames below it with your cover sheet. The asterisks (*) serve as a guide so you won't slide the cover sheet too low.
3. In each frame you will be required to write in the missing word or words before sliding your cover sheet down just far enough so that you can read the correct a _ _ _ r below the question at the right-hand side of the page.

* * *

3- answer

4. It is important that you write the answer in the blank space before you move the cover sheet down to c _ _ _ k the correct answer.

* * *

4- check

5. The instruction will be presented in sections with a review at the end of each section. If you are incorrect on any frame in the review, you will be referred back to the proper f _ _ _ e to review.

* * *

5- frame

6. This instruction concerns learning to set the camera to achieve correct exposure of the film. By following instructions and writing the missing word or words in the blank space before checking your answer, you will learn to achieve correct e _ _ _ _ _ e of the film.

* * *

6- exposure

7. Be sure you read all of each frame. If the blank appears in the middle of the frame, write in the correct word or words, but always read all of each f _ _ _ e.

* * *

7- frame

CHARACTERISTICS OF LIGHT

8. First, you will need to understand some characteristics of light. Visible light represents only a small part of the entire electromagnetic spectrum. For your purposes, consider this electromagnetic spectrum as being made up of all types of radiation, including x-rays, radio waves, infrared rays, etc. Of this entire spectrum, visible light represents a s _ _ _ l part.

* * *

8- small

9. V _ _ _ _ e light makes up a small part of the electromagnetic spectrum.

* * *

9- Visible

10. This visible l _ _ _ t, however, is the part we use in photography.

* * *

10- light

11. All of this radiation making up the electromagnetic spectrum travels in waves. Different types of radiation have different wave lengths, ranging from cosmic wave l _ _ _ _ s which are the shortest, to radio wave lengths which are the l _ _ _ _ t.

* * *

11- lengths
longest

12. Visible l _ _ _ _ waves are relatively short.

* * *

12- light

13. Each w_____ length has its own color --- but most colors we see are actually a combination of various wave lengths.

* * *

13- wave

14. Light travels in a straight line; an illustration would be the beam from a flashlight; so a beacon or a searchlight which sends out a beam of light also illustrates that light travels in a _____ line.

* * *

14- straight

15. Thinking back about light, the part of the electromagnetic spectrum we use in photography is _____.

* * *

15- visible light

(If you were incorrect, refer to frames 8, 9 and 10)

16. In photography we are concerned primarily with two types of light; incident light and reflected _____.

* * *

16- light

17. Incident light is light which falls upon a scene; therefore, light in a room which "falls" from a source above would be _____ light.

* * *

17- incident

18. The light that is bounced back from a surface is called reflected light; so _____ light is that which falls upon a scene, and that which bounces back from a surface is _____ light.

* * *

18- incident
reflected

19. When light rays traveling in _____ lines strike any "substance," they are either (1) transmitted through it (2) reflected from it, or (3) absorbed by it. In photography terminology, the "substances" we study in connection with the effects of light are called mediums.

* * *

19- straight

(If you were incorrect, refer to frame 14)

20. When light strikes a substance and passes through it, we say the light is transmitted. If this light is undisturbed, the substance is called a transparent medium. Air or clear glass would be an example of a _____ medium.

* * *

20- transparent

21. When light passes through a transparent medium, we say that the light is _____.

* * *

21- transmitted

22. Light passing through a medium such as frosted glass is also transmitted, but it is also diffused, so we call this type of medium translucent; a medium which doesn't disturb light is called _____, but one which diffuses light passing through it is called _____.

* * *

22- transparent
translucent

23. A third type of medium, one which transmits no _____, is called opaque. This medium may absorb or reflect light, and examples of opaque mediums would be a table and a tile floor.

* * *

23- light

24. A black wool sweater and a wooden door would also be examples of a/an _____ medium.

* * *

24- opaque

25. A pane of glass on a store front probably would be a/an _____ medium, but a dark stained-glass window would be a/an _____ medium.

* * *

25- transparent
translucent

26. A red brick wall which transmits no light would be an example of a/an _____ medium.

* * *

26- opaque

27. Of the three mediums, the _____ medium does not disturb the light, while the _____ medium does not transmit light at all.

* * *

27- transparent
opaque

28. Then the medium which transmits light but disturbs (diffuses) it is the _____ medium.

* * *

28- translucent

29. Remember the light which was "bounced back" from a surface? We called it _____ light.

* * *

29- reflected

(If you were incorrect, refer to frame 18)

30. Reflected light has an important characteristic which enables us to build certain optical equipment. When one ray of light strikes a smooth surface, it will be reflected at the same angle. That is, if a ray of light traveling at a 45-degree angle strikes a smooth surface, it will be reflected at a/an _____ angle.

* * *

30- 45 degree

31. However, when the surface is uneven, the rays striking the surface are _____ back at many different angles, causing the light to be diffused or scattered.

* * *

31- bounced, or reflected

32. Light striking a smooth surface at a given angle will be reflected at the _____ angle; but light striking an uneven surface will be scattered at various angles, and when it is scattered we say it is _____.

* * *

32- same, similar, given, etc.
diffused

33. When light rays strike a piece of glass at an angle, they are bent. This bending is called refraction. What actually happens is that the _____ are bent when they pass from a medium of one density (air) into a medium of another density (glass).

* * *

33- rays

34. Refraction, then, is the _____ of light rays as they pass from a medium of one density to a medium of another density.

* * *

34- bending

35. We use the term refraction to describe light slowing down as it hits the medium of heavier density (glass) and speeding up in the air. This slowing down when it hits the glass causes what we call _____.

* * *

35- refraction, or bending

36. The principle of refraction makes it possible for us to have lenses. The light is _____ by the camera lens, and this light forms an image on the film inside the camera.

* * *

36- bent, or refracted

37. The refraction by the camera lens, or the bending of the light, causes the light to form a sharp image on the _____ inside the camera, and this makes the final picture sharp.

* * *

37- film

REVIEW --- Characteristics of Light

(Be sure you answer the review frames 100% correctly and understand the concepts before you proceed to the next unit.)

38. Looking back briefly, the part of the electromagnetic spectrum which we use in photography is _____.

* * *

38- visible light

(If you were incorrect, refer to frames 9 and 10)

39. Visible light waves are relatively _____ (short/long) and visible light travels in a _____ line.

* * *

39- short
straight

(If you were incorrect, refer to frames 12 and 14)

40. Light which falls upon a scene is _____ light;
light which bounces back from a surface is _____
light.

* * *

40- incident
reflected

(If you were incorrect, refer to frames 17
and 18)

41. When light passes through a substance, the substance
(or medium) is said to be _____.

* * *

41- transparent

(If you were incorrect, refer to frame 20)

42. Light may be transmitted through an absolutely clear,
or _____ medium; it also may be transmitted
through a/an _____ medium which diffuses it.
Light is not transmitted at all by the _____
medium.

* * *

42- transparent
translucent
opaque

(If you were incorrect, refer to frames 22
and 23)

43. Light striking a smooth surface is reflected at _____
_____.

* * *

43- the same angle

(If you were incorrect, refer to frame 30)

44. Rather than being reflected at the same angle, light
striking an uneven surface bounces back at many
angles, causing the light to be scattered or
_____.

* * *

44- diffused

44. (Continued)

(If you were incorrect, refer to frames 31 and 32)

45. Light rays are bent when they pass through glass because the glass is of _____ (lighter/heavier) density than the air. This "bending" is called _____.

* * *

45- heavier
refraction

(If you were incorrect, refer to frames 34, 35, and 36)

DETERMINANTS OF EXPOSURE

46. Now that you are more familiar with the behavior of light, we will investigate some principles of exposure. We can define exposure as simply being the amount of light reaching the film in the camera. Exposure, then, is the _____ of light entering the camera.

* * *

46- amount

47. In this program you will learn to calculate exposure without mechanical aids such as a light meter. Use of this system of exposure calculation is limited to outside light conditions. Three elements must be considered in calculating correct exposure:

- (1) outside light conditions
- (2) subject brightness
- (3) kind of film used

The photographer considers the three elements above in order to gather the information necessary to set his camera for correct _____.

* * *

47- exposure

48. Outside light conditions, brightness of the _____, and kind of film must all be considered in calculating exposure.

* * *

48- subject

49. Kind of film, subject brightness, and outside _____ are the three kinds of elements to consider in calculating exposure.

* * *

49- light conditions

50. Besides outside light conditions and subject brightness, another determining factor in exposure is the _____.

* * *

50- film, or film used

51. The first of the three exposure determinants we will discuss will be outside _____. In order of their intensity, they are: Bright Sun, Hazy Sun, Cloudy Bright, Cloudy Dull, and Open Shade.

* * *

51- light conditions

52. The first, B _____ S _____, describes outside light conditions when the sky is bright blue, no clouds are across the face of the sun, and shadows are dark and sharp in outline.

* * *

52- Bright Sun

53. Our brightest light condition, then, is _____.

* * *

53- Bright Sun

54. Since the next light condition is hazy but the sun is still visible, it is termed H____ S____. Here there is a slight overcast of thin clouds; there is still a great deal of bright light; there is very little trace of shadows.

* * *

54- Hazy Sun

55. The light condition almost as bright as Bright Sun, but characterized by a haziness or slight overcast is _____.

* * *

55- Hazy Sun

56. The next light condition has clouds but the sky is still very bright, so we call this one C____ B____. The sky is overcast, probably with fairly heavy clouds; although the sun can't be seen, there is still a great deal of bright light; there is very little trace of shadows.

* * *

56- Cloudy Bright

57. When conditions are characterized by fairly heavy clouds and/or overcast, but still having a great deal of bright light, conditions are _____.

* * *

57- Cloudy Bright

58. The next light condition has very heavy clouds and little light causing a dull appearance in the sky, hence the term C____ D____. Clouds are thick and the sky is stormy looking.

* * *

58- Cloudy Dull

59. A stormy sky with thick clouds characterizes _____ light conditions.

* * *

59- Cloudy Dull

60. The last light condition category is easy to remember because it is always in the shade, but open sky surrounds the shade, so we call it O_____S_____. Here our subject is in the shade of a building or similar object, but there is still clear, brightly lighted sky around it.

* * *

60- Open Shade

61. Lighting conditions for taking a photograph of a person standing in the shade of a tree when the sky is clear and brightly lighted are called _____.

* * *

61- Open Shade

62. In this course, the student must learn several elements of exposure by memory, and outdoor lighting conditions are included. Let's look at the five conditions again:

Bright Sun
Hazy Sun

Cloudy Bright
Cloudy Dull

Open Shade

In the first two light conditions, the s_____ can be seen in the sky; in the second pair of light conditions c_____ are seen in the sky; and in the last light condition it is shady.

* * *

62- sun
clouds

63. The first two conditions deal with a bright and then a "not-so-bright" sun; the second two conditions first with light clouds or haze and then with heavy clouds or haze; and the last condition with s_____, but with a bright sky.

* * *

63- shade

64. The first condition is easy, since our brightest light condition would have to have a _____ Sun. The next condition is not so bright, but we can still see the sun, so it's called H _____ Sun.

* * *

64- Bright
Hazy

65. Our brightest light condition and next to the brightest in that order are _____ and _____.

* * *

65- Bright Sun
Hazy Sun

66. The second pair of light conditions have "Cloudy" as a key first word, as clouds and/or overcast skies are a characteristic of both. The first features clouds, but still a high degree of brightness, so it appropriately is called C _____ B _____. Since the second condition is not as bright, it's called C _____ D _____.

* * *

66- Cloudy Bright
Cloudy Dull

67. The two "Cloudy" light conditions are, in the order of their brightness, _____ and _____.

* * *

67- Cloudy Bright
Cloudy Dull

68. The last light condition, which doesn't have a partner, deals with shady conditions. But since there is open, brightly lighted sky around the shade, we call the light condition _____.

* * *

68- Open Shade

69. Our light conditions in which the sun is visible, in order of their brightness, are _____ and _____ . The pair that comes next, in order of their brightness, are _____ and _____ . And the lone and last light condition is _____ .

* * *

69- Bright Sun
 Hazy Sun
 Cloudy Bright
 Cloudy Dull
 Open Shade

70. Subject brightness is our next consideration in calculating correct exposure. Subject brightness describes the intensity of light reflected from subjects. Different degrees of subject brightness are:

Brilliant
 Bright
 Average
 Dark

The four elements listed above describe _____ brightness.

* * *

70- subject

71. The term "brilliant" describes subjects which have an extreme amount of light reflectance, such as a sunlit snow scene or a sunlit white beach. In fact, the preceding examples of sun on snow and sand represent the only subjects we would describe with the term _____ .

* * *

71- brilliant

72. A bright subject would be considered brighter than average, such as a girl in a white dress, or sunlight on a lake. A white building in sunlight would also be an example of a _____ subject.

* * *

72- bright

73. An average subject would be characterized by such things as a person, animal, or neutral-colored building. Youngsters playing ball on a grassy field would most likely be _____ subjects.

* * *

73- average

74. A dark subject is one that absorbs more light than it reflects; darker than average subjects would be a dark-skinned person, a shaded landscape, a dark building. A Black Angus cow would also represent a _____ subject.

* * *

74- dark

75. Our subject with the greatest light intensity, the _____ subject, is concerned only with sunlit sand or snow, and we won't encounter those conditions too often.

* * *

75- brilliant

76. That leaves bright, average, and _____ in order of their intensity.

* * *

76- dark

77. The lighter than average category, but not brilliant such as sunlit sand or snow, is the _____ subject, which is characterized by white objects.

* * *

77- bright

78. Common, non-white brightness would be considered in the _____ category, and anything darker than this, such as a dark building, is in the _____ category.

* * *

78- average
dark

79. The different degrees of subject brightness, in order of their intensity, are:

(1)
(2)
(3)
(4)

* * *

79- brilliant
bright
average
dark

(If you were incorrect on any of the above,
please review beginning with frame 63.)

80. The speed of film (its degree of sensitivity to light) also affects exposure. When the film speed is considered "slow", considerable light is required for correct exposure; whereas a "fast" film requires little light for correct _____.

* * *

80- exposure

81. The slower the film, the more light required for exposure; the faster the film, the _____ light required for exposure.

* * *

81- less

82. Film speed is indicated by an index number called an ASA rating. (The rating is assigned by the A.S.A., the American Standards Association). ASA, then, is a rating of the film's _____.

* * *

82- speed, or
sensitivity

83. Low ASA ratings such as 36 and 40 identify slow films; high ASA ratings such as 400 and 500 identify _____ films.

* * *

83- fast

84. "Fast" means that the film requires _____ light for correct exposure, while "slow" means that the film requires _____ light for correct exposure.

* * *

84- less
more

REVIEW --- Determinants of Exposure

(As with the previous review, you must answer all of these review frames correctly before you proceed with the next unit. Be positive you understand the content in each frame)

85. Three elements used in calculating correct exposure are: subject brightness, kind of film used, and _____ conditions.

* * *

85- outside light

(If you were incorrect, refer to frame 47)

86. You learned the outside light conditions by grouping the first four into pairs, leaving a single condition. This last condition, although the sky around it was brightly lighted, is called _____.

* * *

86- Open Shade

(If you were incorrect, refer to frames 60 and 61)

87. The sun was visible in the first pair of conditions, which are _____ and _____.

* * *

87- Bright Sun
Hazy Sun

(If you were incorrect, refer to frames 52 through 55)

88. In the second pair of light conditions clouds are dominant; these two conditions are _____ and _____.

* * *

88- Cloudy Bright
Cloudy Dull

(If you were incorrect, refer to frames 56 through 59)

89. Now please list the five outdoor light conditions in order of their intensity:

(1)
(2)
(3)
(4)
(5)

* * *

89- Bright Sun
Hazy Sun
Cloudy Bright
Cloudy Dull
Open Shade

(If you were incorrect on any of the five answers in this frame, review frames 62 through 69)

90. Since we've reviewed outside light conditions, we still must consider the other two elements used in calculating exposure: _____ brightness and kind of _____ used.

* * *

90- subject
film

(If you were incorrect, refer to frame 47)

91. We use the term _____ to describe an extreme amount of light reflectance, such as sunlit sand or snow. Then the next category, brighter than average as exemplified by white objects, is called _____.

* * *

91- brilliant
bright

(If you were incorrect, refer to frames 71 and 75; and frames 72 and 77)

92. The last two elements of subject brightness include first, a subject of average brightness called _____; and second, a subject which is darker than average is called _____.

* * *

92- average
dark

(If you were incorrect, refer to frames 73 and 74)

93. We've reviewed outside light conditions and subject brightness, leaving kind of _____ used as the last of the three elements used in calculating exposure.

* * *

93- film used

(If you were incorrect, refer to frame 47)

94. Concerning the film's speed, or sensitivity, a film was called _____ (slow/fast) if it required considerable light for exposure.

* * *

94- slow

(If you were incorrect, refer to frames 80 and 81)

95. The film's sensitivity is indicated by its _____, which is an index of the amount of light the film requires for proper exposure.

* * *

95- ASA rating

(If you were incorrect, refer to frames 82 and 83)

CAMERA SETTINGS

96. Now let's examine the two elements on the camera which control the amount of light that strikes the film. The amount of light reaching the _____ is controlled by the size of the lens opening and the speed of the shutter.

* * *

96- film

97. Exposure is controlled by (1) the size of the lens opening and (2) the speed of the _____.

* * *

97- shutter

98. (1) Speed of the shutter and (2) size of the _____ work together to control exposure.

* * *

98- lens opening

99. The lens opening is adjustable, that is, it can be made larger and s_____.

* * *

99- smaller

100. When the lens opening is opened wide, more light enters the camera; but when the lens opening is closed considerably, or "stopped down," _____ light enters the camera.

* * *

100- less

101. The size of the lens opening is governed by what we call the f/stop. For convenience we can consider the f/_____ simply as the hole through which the light passes. (We will refer to the lens opening as the f/stop from here, since the opening is always set for a particular size.)

* * *

101- f/stop

102. When we take a picture, light passes through a hole called the _____.

* * *

102- f/stop

103. Considerable light enters the camera when the f/stop is _____ (opened wide/stopped down). Then little light enters when the f/stop is _____ (opened wide/stopped down).

* * *

103- opened wide
stopped down

104. The hole through which the light enters is the _____, and on nearly all lenses it is a standardized number.

* * *

104- f/stop

105. Photographers must know the f/stop system in order to be able to determine correct exposure. As a student you will need to learn the standard f/stops by memory. The standard f/stops are:

1 1.4 2 2.8 4 5.6 8 11 16 22 32

The small numbers at the left end of the scale represent large lens openings; the big numbers at the right end of the scale represent _____ lens openings.

* * *

105- small

106. Actually the f/stops don't seem logical, because the large numbers represent the small lens openings, and the small numbers represent the _____ lens openings.

* * *

106- large

107. Keeping in mind this "illogical" idea, small f/stops represent _____ lens openings, and large f/stops represent _____ lens openings.

* * *

107- large
small

108. Since large numbers at the right are f/stops for small lens openings, the small numbers at the left are f/stops for _____ lens openings.

* * *

108- large

109. Each f/stop is actually a type of fraction of the diameter of the lens diameter, so the larger the f/number, the smaller the fraction of light entering. For example: f/22 could be thought of as 1/22 of the lens diameter compared with f/4, or 1/4 of the lens diameter. Therefore, f/16 could be thought of as _____ of the lens diameter.

* * *

109- 1/16

110. f/11 (or 1/11) would represent _____ (more/less) light than f/2 (or 1/2), because 1/11 lens diameter would admit less light than 1/2 lens diameter.

* * *

110- less

111. f/4 (or 1/4) would represent _____ (more/less) light than f/8 (or 1/8).

* * *

111- more

112. 1 1.4 2 2.8 4 5.6 8 11 16 22 32

These standardized f/stops are spaced so that as you move from left to right, the light is halved at each number. For example: when you move from 1 to 1.4, the light is halved. Therefore, when you move from 2 to 2.8, the light is _____ (doubled/halved).

* * *

112- halved

113. When you move from 4 to 5.6, the light is halved, and when moving from 5.6 to 8, the light is _____ (doubled/halved) again.

* * *

113- halved

114. Moving from 11 to 16 _____ (doubles/halves) the light.

* * *

114- halves

115. Since moving from left to right halves the amount of light entering the camera, moving back from right to left doubles the light. Moving from 32 to 22 would double the light, and moving from 11 to 8 would _____ (double/halve) the light.

* * *

115- double

116. When you move from 22 to 16 the light is doubled, and moving from 16 to 11 the light is _____ (doubled/halved) again.

* * *

116- doubled

117. Moving from left to right (from wide lens openings to small lens openings) we are slowly closing the lens opening, so at each number we are _____ (doubling/halving) the amount of light.

* * *

117- halving

118. Moving from right to left (from small lens openings to wide ones) we are slowly increasing the amount of light and therefore we are _____ (doubling/halving) the amount of light at each number.

* * *

118- doubling

119. 1 1.4 2 2.8 4 5.6 8 11 16 22 32

Moving from 11 to 16 is moving toward a smaller lens opening, and since this move is from one standard f/stop to another, we have _____ (doubled/halved) the light.

* * *

119- halved

120. Moving from 8 to 5.6 is moving toward a larger lens opening; this move is from one full f/stop to another, so we have _____ (doubled/halved) the light.

* * *

120- doubled

121. Moving from 22 to 32 is moving toward a smaller lens opening, so we have _____ (doubled/halved) the light.

* * *

121- halved

122. Moving from 2.8 to 2 is moving toward a larger lens opening, so we have _____ (doubled/halved) the light.

* * *

122- doubled

123. When we move from 16 to 22 we have _____ (doubled/halved) the light.

* * *

123- halved

124. When we move from 11 to 8 we have _____
(doubled/halved) the light.

* * *

124- doubled

125. We will return to the double or half principle later. Since you need to know the standard f/stops by memory, let's look at an easy method: simply, every other number is doubled:

1 1.4 2 2.8 4 5.6 8 11 16 22 32

and

1 1.4 2 2.8 4 5.6 8 11 16 22 32

To remember the f/stops, then, we know that every other number is _____.

* * *

125- doubled

126. Remember that this system is merely to help you memorize the standard f/stops; don't confuse it with the double or half principle, because there is no connection. This is given you merely so you can memorize the f/stops more easily, or recall them when necessary. The only two you have to learn are 1 and 1.4, then since every other number is doubled, the next will be:

1 1.4 _____
* * *

126- 2

127. Let's fill in a few more f/stops by the method of doubling every other number:

1 1.4 2 _____
* * *

127- 2.8
4

128. The only exception we get is when we double 5.6 and get 11. Since this does not follow the rule, you will have to memorize the f/stop ____.

* * *

128- 11

129. Let's finish the series of f/stops, beginning in the middle:

5.6 8 11 ____ ____ ____

* * *

129- 16
22
32

130. Now let's do several f/stops:

1 1.4 ____ 2.8 ____ 5.6 ____ 11 ____ 22 ____

* * *

130- 2
4
8
16
32

131. The other f/stops, then, will be:

1 ____ 2 ____ 4 ____ 8 ____ 16 ____ 32

* * *

131- 1.4
2.8
5.6
11
22

132. The complete series of standard f/stops is:

* * *

132- 1, 1.4, 2, 2.8, 4, 5.6,
8, 11, 16, 22, 32

(If you were incorrect, review beginning with

frame 125; do not proceed with the next unit until you answer frame 132 by memory)

133. We use the term "standard" to describe the series of f/stops commonly found on our cameras, each of which will double or half the light. The maximum (wide open) lens opening of a camera may not be a standard f/3.5 and f/4.5. You must remember that moving to one of these f/stops would not fully double or halve the light entering. If you used a camera with f/6.7 as the maximum lens opening, a f/6.7 setting would not be a _____ f/stop.

* * *

133- standard, or "full", etc.

134. Besides the f/stop there is only one other major setting --- the shutter speed. A camera's shutter is a device which controls the length of time the light is admitted through the lens. So, while the f/stop controls the size of the lens opening, the shutter controls the _____ of time the lens stays open.

* * *

134- length

135. We have two systems of shutter speeds today, and it is necessary for you to learn both systems. In both systems the numbers represent fractions of a second. The older system is:

1 2 5 10 25 50 100 250 500 1000

The "1" above represents a shutter speed of one second, but the remaining numbers represent f _____ s of a second, such as 1/2, 1/5, etc.

* * *

135- fractions

136. The newer system differs slightly:

1 2 4 8 15 30 60 125 250 500 1000

Here again the "1" represents a full second of time, but the other numbers represent fractions of a ____.

* * *

136- second

137. Since the numbers represent fractions of a second, the big numbers at the right, such as 1/500th would be very fast, therefore the lens would be open a very short time. However, the small numbers at the left, such as 1/15th would be fairly slow; therefore, the lens would be open a _____ time.

* * *

137- long

138. Most new cameras use the new system, but some new cameras such as the Graflex press camera still use the old system of shutter _____. Therefore, it is necessary to learn both systems.

* * *

138- speeds

139. Shutter speeds are easy to remember, as they tend to double at each step as they progress from left to right. From 1/15 to 1/30 would be _____ and from 1/30 to 1/60 would be _____.

* * *

139- double
double

140. Both systems of shutter speeds end with 250, 500 and 1000. In the old system multiples of 5 are common. Notice that after it begins with 1 and then 2, it goes from 5, 10, 25, 50 and 100.

In the old system try filling in these blanks:

1 2 5 _____ 250 500 1000

* * *

140- 10 25 50 100

141. The first three speeds in the old system are: _____

* * *

141- 1 2 5

142. Since 250, 500 and 1000 are common to both systems as the last three speeds, you should remember these easily. Let's see if you know the old system up to that point:

—	—	—	—	—	—	—	—	250	500	1000
						*	*	*		
				142-	1	2	5	10	25	50
					100					

143. 1 2 4 8 15 30 60 125 250 500 1000

In the newer system 15 is a dominant multiple after beginning with 1, 2, 4, and 8, it proceeds from 15, 30, 60 and 125. With 15 the dominant multiple, the speeds almost double each time, and the last three speeds it has in common with the old system are:

—	—	—	—	—	—	—	—	—	—	—
						*	*	*		
				143-	250	500	1000			

144. Without reference to the series above, see if you can fill in the blanks in the newer series of shutter speeds:

1	2	4	8	—	—	—	125	250	500	1000
						*	*	*		
				144-	15	30	60			

145. Now try some other parts of the newer system:

1	—	—	—	15	—	—	—	—	—	1000
						*	*	*		
				145-	2	4	8	30	60	
					125	250	500			

146. Now fill in the entire newer system of shutter speeds:

—	—	—	—	—	—	—	—	—	—	—	
						*	*	*			
				146	1	2	4	8	15	30	60
					125	250	500	1000			

147. As is true of the f/stop scale, as you proceed from one shutter speed to another, you are either doubling or halving the light entering the lens at each step. For example, the shutter is set at 1/500th, to double the light it must be moved to 1/250th. Now, if the shutter is set at 1/30th, to halve the light it must be moved to 1/60th.

If the shutter is set on 1/125th and you want to halve the light, you would move it to 1/___th.

* * *

147- 1/250th

148. If the shutter is set on 1/60th and you want to double the light, you would move it to 1/___th.

* * *

148- 1/30th

149. Let's diagram this double or half principle for both the f/stops and shutter speeds, using only the newer shutter speed system. Study this diagram carefully so you will understand when the light is doubled and when it is halved.

shutter speeds:

1	2	4	8	15	30	60	125	250	500	1000
→						←				
each step halves the light						each step doubles the light				

f/stops:

1	1.4	2	2.8	4	5.6	8	11	16	22	32
→						←				
each step halves the light						each step doubles the light				

When we move the f/stop from 2 to 2.8, we _____
(double/halve) the light. When we move the f/stop
from 22 to 16, we _____ (double/halve) the light.

* * *

149- halve
double

150. When we move the shutter speed from 1/125th to 1/60th, we _____ (double/halve) the light; when we move the shutter speed from 1/15th to 1/30th, we _____ (double/halve) the light.

* * *

150- double
halve

151. Now, when we move the f/stop from f/8 past f/11 to f/16, we have _____ (doubled/halved) the light twice, or we could say that we now only have 1/4 as much light.

* * *

151- halved

152. When we move the shutter speed from 1/60th past 1/30th to 1/15th, we have _____ (doubled/halved) the light twice, or we could say that we now have four times as much light.

* * *

152- doubled

153. Shutter speeds do the same thing in controlling the amount of light entering the lens that the f/stops do. With both when we move one step to the left or right, we are either doubling or _____ the light.

* * *

153- halving

REVIEW --- Camera Settings

154. Exposure, which is the amount of _____ reaching the film, is controlled by two camera settings:
(1) _____ and (2) _____.

* * *

154- light
f/stop
shutter speed

(If you were incorrect, refer to frame 96;
and frames 97, 98, 101 and 102)

155. By now you should have the standard f/stops memorized. List them below, beginning with wide lens openings at the left:

* * *

155- 1 1.4 2 2.8 4 5.6 8
 11 16 22 32

(If you were incorrect, refer to frames 105 through 111, and 125 through 132; do not proceed to the next frame until you are 100% correct on this frame)

156. Answer the following problems with "doubled" or "halved". Work the five problems, then check your answers at the end:

- | | | |
|-----------------------------|-------|------------|
| A. Moving from f/4 to f/5.6 | _____ | the light. |
| B. Moving from f/16 to f/22 | _____ | the light. |
| C. Moving from f/8 to f/5.6 | _____ | the light. |
| D. Moving from f/2 to f/2.8 | _____ | the light. |
| E. Moving from f/16 to f/11 | _____ | the light. |

* * *

- 156- A. halves
 B. halves
 C. doubles
 D. halves
 E. doubles

(See next page for review frames)

(If you were incorrect on more than one of the problems, review frames 112 through 124; don't proceed to the next frame until you understand this double or half principle.)

157. Moving from one standard f/stop to another either _____ or _____ the amount of light entering the lens. But settings such as f/3.5 are not _____ f/stops.

* * *

- 157- double or half
 standard

158. Now list the series of shutter speeds for the old system:

* * *

158- 1 2 5 10 25 50 100
250 500 1000

(If you were incorrect, review frames 135, 140, 141 and 142; do not proceed to the next frame until you are 100% correct)

159. List the series of shutter speeds for the new system:

* * *

159- 1 2 4 8 15 30 60
125 250 500 1000

(If you were incorrect, refer to frames 136, 143, 144, 145 and 146; do not proceed to the next frame until you are 100% correct)

160. Moving the shutter speed from 1/250th to 1/125th would _____ (double/halve) the light, and moving from 1/60th to 1/30th would _____ (double/halve) the light.

* * *

160- double - double

(If you were incorrect, refer to frames 147, 148, 150 and 152)

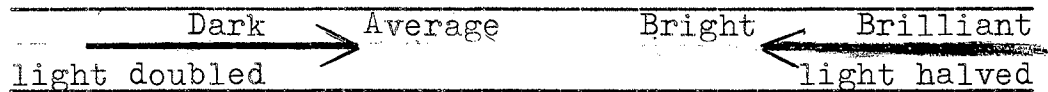
CALCULATING EXPOSURE

161. The PRINCIPLE OF DOUBLE OR HALF is the KEY TO EXPOSURE. Besides being utilized in proceeding from one f/stop to another, and from one shutter speed to another, it is also used with subject brightness and with outdoor light conditions. The main rule we use in exposure, then, is the principle of _____ or _____.

* * *

161- double or half

162. With subject brightness, the light is either doubled or _____ as you move from one to another:



* * *

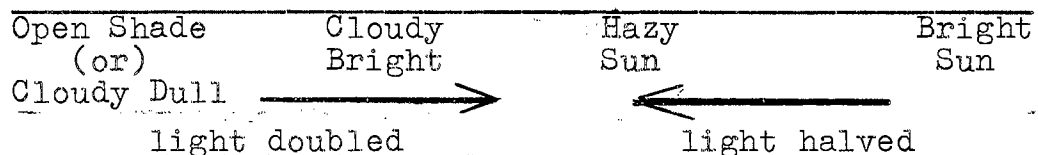
162- halved

163. Light intensity is doubled when you move from average to bright, so when you move from bright to average, the light is _____. When you move from bright to brilliant, the light is _____.

* * *

163- halved
doubled

164. The same principle is true with light conditions:



When you move from Cloudy Bright to Hazy Sun, the light is doubled, but when you move from Bright Sun to Hazy Sun, the light is _____.

You will note that Open Shade and Cloudy Dull represent the same light intensity; so when you move from Open Shade to Cloudy Bright, the light is doubled, and when you move from Cloudy Dull to Cloudy Bright the light is _____.

* * *

164- halved
doubled

165. The double or half principle holds true for all of the elements of exposure we have discussed: (1) outdoor light conditions, (2) subject brightness, (3) f/stops, and (4) _____.

* * *

165- shutter speeds

166. You may now use Panel 1 located at the end of this program for reference; tear it out if you wish so that you may refer to it as you proceed through the frames. In order to use these four elements listed on Panel 1 in calculating correct _____, we must have some additional information.

* * *

166- exposure

167. The additional information we need in order to calculate correct exposure is furnished either on a data sheet enclosed with each roll of film, or is printed on the outside of each roll of film. Two places we may find this information are: (1) printed on the outside of each roll of film, or (2) on a _____ enclosed with each roll of film.

* * *

167- data sheet

168. This information will give you the proper f/stop and shutter speed settings for average conditions: for example, these settings are for average conditions for Verichrome Pan film:

Bright Sun---Average Subject---f/16---1/125th sec.

This means that for this particular film when you have Bright Sun and average subject brightness, for exposure the camera should be set at f/____ and 1/____th sec.

* * *

168- f/16
1/125th

169. From frame 168 we found that Bright Sun and Average Subject were considered as average or normal conditions. This brings up the question: "What do we do if the conditions are not _____?"

* * *

169- average, or normal

170. Obviously all conditions won't always be normal; therefore, we will use the double or half principle to adjust our exposure. To do this we must begin with normal conditions given either on the data sheet enclosed with each roll of film, or given by being printed on each _____ of _____.

* * *

170- roll
film

171. Let's keep the same normal conditions used previously: for Bright Sun and average subject (normal conditions), set camera on f/16 at 1/125th sec. But now suppose that our actual conditions are Bright Sun but with a bright subject; our camera is set on 1/125th sec. for the shutter speed and our _____ is the unknown factor.

* * *

171- f/stop

172. Since our light has been doubled by the bright subject, we will need to close the lens opening more to compensate for the brightness. Since the incoming light has been doubled, we will halve the light by moving from the normal f/16 to f/22. Our settings for these light conditions then will be 1/125th sec. at f/22.

* * *

172- halve

173. With the same normal data, a new situation is Cloudy Bright, average subject, 1/125th sec. We need to determine the f/stop. Since our light conditions have moved two places down the scale, the light has been halved twice, or our light is one-quarter of the normal. This means we will have to _____ the incoming light twice by opening the lens two f/stops, from the normal f/16 to f/8. Our settings for this picture then will be 1/125th sec. at f/8.

* * *

173- double

174. With the same normal data, we'll change both variables: Cloudy Dull, dark subject, 1/125th sec. What is the f/stop? The Cloudy Dull conditions have halved our light three times and the dark subject has _____ the light once, totaling four times the light has been halved. This will require increasing the light by four f/stops, doubling the light each time---from the normal f/16 to f/4.

* * *

174- halved

175. You will notice that in each of the previous examples after we have determined how many f/stops our adjustment will have to be, we began counting from f/____, which is normal for this film.

* * *

175- f/16

176. Try another situation: with the same normal data, we have Hazy Sun, brilliant subject, with 1/125th sec. What is the f/stop? Hazy Sun has halved the light, but the brilliant subject has doubled the light twice; therefore, once of the "doubles" cancels the "halve", and we still have the light doubled once. Therefore, our f/stop moves from the normal f/____ to f/22 in order to _____ the incoming light.

* * *

176- f/16
halve

177. Each time we calculate exposure, we have to determine the extent to which outside conditions and subject brightness have varied from normal conditions so that we can set the _____ and _____ of the camera. We determine this variation from normal in terms of "doubles" or "halves" of light, and compensate for the variation by using new camera settings.

* * *

177- f/stop
shutter speed

178. If we wish to retain a standard f/stop, we may change our shutter speed instead to compensate for variations in light conditions. Again we must use the double or half principle. Using the same normal information (Bright Sun, average subject, f/16 at 1/125th sec), let's say our conditions are Hazy Sun, dark subject, and the camera is set on f/16. What will our shutter speed be?

The Hazy Sun halves the light; the dark subject halves the light again; so we need to double the light twice to compensate. Since f/16 is normal, no change is required here. To double the light twice by manipulating the shutter speed, we will move it from the normal 1/125th sec. past 1/60th sec. to 1/30th sec.

* * *

178- double

179. Now take light conditions as in frame 178, but change the f/stop; conditions are Hazy Sun, dark subject and the camera is set on f/8. What is the shutter speed?

The Hazy Sun halves the light, and the dark subject doubles (doubles/halves) the light again, totaling two halves of light; but since f/8 has already doubled the light twice (normal is f/16), the dark light conditions have been equalized, hence the shutter speed will be the normal 1/125th sec.

* * *

179- halves

180. Now you can try a few problems to find either the correct f/stop or the correct shutter speed for the given conditions. Use Panel 1 for reference until you are instructed to work without it.

Normal conditions for all problems are: Bright Sun, Average Subject, f/16, 1/125th sec.

Bright Sun Average Subject 1/125th sec. f/_____

* * *

180- f/16

181. Bright Sun Bright Subject 1/125th sec. f/_____

* * *

181- f/22

182. Cloudy Dull Bright Subject 1/125th sec. f/_____

* * *

182- f/8

183. Bright Sun Dark Subject 1/250th sec. f/_____

* * *

183- f/8

184. Open Shade Average Subject f/16 1/_____ sec.

* * *

184- 1/15th

185. Bright Sun Bright Subject f/16 1/_____ sec.

* * *

185- 1/250th

186. Hazy Sun Dark Subject f/11 1/_____ sec.

* * *

186- 1/60th

(If you were incorrect on more than one of the
above problems, review beginning with frame
170)

187. Now without referring to Panel 1 or other data, see
how you can work from memory on varying situations:
our normal data for this will be: Bright Sun,
average subject, 1/125th sec. at f/16.

Bright Sun Dark Subject 1/125th sec. f/_____

* * *

187- f/11

188. Cloudy Bright Average Subject 1/125th sec. f/___

* * *

188- f/8

189. Cloudy Dull Bright Subject 1/125th sec. f/___

* * *

189- f/8

190. Cloudy Bright Bright Subject 1/60th sec. f/___

* * *

190- f/16

191. Bright Sun Brilliant Subject f/16 1/____ sec.

* * *

191- 1/500th

192. Hazy Sun Dark Subject f/16 1/____ sec.

* * *

192- 1/30th

193. Bright Sun Bright Subject f/11 1/____ sec.

* * *

193- 1/500th

(If you were incorrect on more than one of the frames from frame 187 to 193, study Panel 1 again and review from frame 170 to frame 179 until you can work the above frames correctly)

SETTINGS GIVING THE SAME LIGHT

194. As either f/stop or _____ may be manipulated to adjust incoming light to achieve correct exposure, several combinations of f/stops and shutter speeds are available to the photographer. For example: f/8 at 1/60th sec. may be changed to f/11 at 1/30th sec. and the same amount of light will be entering the lens.

* * *

194- shutter speed

195. The combination of f/stops and shutter speeds used is the photographer's choice. Obviously, the shutter speed must be f_____ enough to stop normal movement of subjects and to control any camera movement --- about 1/125th sec. is sufficient. However, for faster action, more shutter _____ is necessary.

* * *

195- fast
speed

196. Also, remember that it is difficult to hand-hold a camera at shutter speeds slower than 1/60th sec. So to have passably sharp pictures without camera movement, you should use a shutter speed of at least _____.

* * *

196- 1/60th sec.,
up to 100th, etc.

197. The choice of f/stop depends upon the type of "depth of field" desired; depth of field is simply the distance between the points nearest and farthest from the camera which are in clear focus in the picture. Literally, then, all things in the picture which are in clear focus are within the _____ of _____.

* * *

197- depth of field

198. As the lens opening is made smaller, the depth of field becomes greater, and as the lens opening is made larger, the depth of field becomes _____.

* * *

198- smaller

199. This means that the depth of field becomes greater when the f/stop number is made greater, such as with an f/stop of 32 or 22; the depth of field becomes smaller when the f/stop number is made smaller, such as 4. So a small f/number such as f/1.4 gives a small depth of field, and a large f/number such as f/22 gives a _____ depth of field.

* * *

199- large, or great, etc.

200. An f/stop of f/2.8 would give a relatively _____ (large/small) depth of field.

* * *

200- small

201. An f/stop of f/22 would give a _____ (large/small) depth of field.

* * *

201- large

202. Considerable depth of field is usually called a "long" depth of field; and logically very little depth of field is called a _____ depth of field.

* * *

202- short

203. f/4 would give a _____ depth of field, and f/16 would give a _____ depth of field.

* * *

203- short, or small
long, or large

204. Depth of field is decreased when the camera is focused at a short distance away, so a camera focused at a relatively long distance would give a _____ (longer/shorter) depth of field than when focused at a short distance.

* * *

204- longer

205. Certain pictures such as landscapes and buildings probably would require long depth of field. However, in some pictures where the photographer wanted to de-emphasize undesirable background or give more attention to the main subject in the foreground, he might seek a _____ of _____.

* * *

205- short depth of field

206. If a photographer wished to eliminate the background in his picture and has a choice of two f/stops, he would use _____ (f/2 or f/22).

* * *

206- f/2

207. In most cases the photographer compromises with a medium shutter speed, such as 1/125th sec., and f/stop around the upper-middle of the f/stop series, such as f/____ (f/4 or f/32 or f/16).

* * *

207- f/16

208. Let's look at combinations of f/stops and shutter speeds which will each admit the same amount of light through the lens. The following combinations give the same amount of light:

1/125th sec. at f/16	1/60th sec. at f/22
1/250th sec. at f/11	1/30th sec. at f/32
1/500th sec. at f/8	

All of the above combinations will give the _____ amount of light.

* * *

208- same

209. We'll say our correct settings are $1/250\text{th}$ at $f/16$; we change to $f/11$ and then must change our _____ so that this new combination will admit the same light as the old combination. Since the change to $f/11$ has doubled the light, we must halve the light with our shutter speed; therefore, we move from $1/250\text{th}$ sec. to $1/500\text{th}$ sec., giving us a new combination of $f/11$ and $1/500\text{th}$ sec. which admits the same light as $1/250\text{th}$ at $f/16$.

* * *

209- shutter speed

210. Our settings are $1/125\text{th}$ sec. at $f/22$; we change the shutter speed to $1/250\text{th}$ sec., so we have halved the light; in order to double the light with the f/stop to compensate, we change it to $f/16$, giving a new combination of $1/250\text{th}$ sec. at $f/16$.

* * *

210- double

211. $1/125\text{th}$ sec. at $f/8 = 1/250\text{th}$ sec. at $f/\underline{\hspace{1cm}}$.

* * *

211- $f/5.6$

212. $1/125\text{th}$ sec. at $f/8 = 1/250\text{th}$ sec. at $f/5.6 = 1/500\text{th}$ sec. at $f/\underline{\hspace{1cm}}$.

* * *

212- $f/4$

- | | | |
|------|----------------------------------|--|
| 213. | $1/125\text{th}$ sec at $f/8$ | $1/60\text{th}$ sec. at $f/11$ |
| | $1/250\text{th}$ sec. at $f/5.6$ | $1/30\text{th}$ sec. at $f/16$ |
| | $1/500\text{th}$ sec. at $f/4$ | $1/15\text{th}$ sec. at $f/\underline{\hspace{1cm}}$. |

* * *

213- $f/22$

214. Next change f/stops and calculate new shutter speeds in order that the new combination of settings will give the same light:

$1/60\text{th}$ sec. at $f/16 = 1/\underline{\hspace{1cm}}$ sec. at $f/22$.

* * *

214- $1/30\text{th}$

215. 1/60th sec. at f/16
 1/30th sec. at f/22
 1/_____ sec. at f/32

* * *

215- 1/15th

216. Now fill in the blanks in the combinations of settings which will give the same light:

1/125th sec. at f/11	1/_____ sec. at f/16
1/250th sec. at f/_____	1/_____ sec. at f/22
1/500th sec. at f/_____	

* * *

216- 1/250th sec. at f/8
 1/500th sec. at f/5.6
 1/60th sec. at f/16
 1/30th sec. at f/22

(If you were incorrect on any of the four responses, review beginning with frame 208; do not proceed to the next frame until you are 100% correct.)

REVIEW --- Settings Giving the Same Light

217. When hand-holding a camera, to eliminate camera movement one should use a shutter speed of at least _____.

* * *

217- 1/60th sec.

(If you were incorrect, refer to frame 196)

218. The photographer's choice of f/stop depends upon the _____ of _____ he desires.

* * *

218- depth of field

219. The f/stop giving the shortest depth of field is _____ (f/11 or f/16 or f/8).

* * *

219- f/8

(If you were incorrect on frame 219, refer to frames 199 through 203)

220. Focusing the camera on an object a short distance away would produce a _____ (short/long) depth of field.

* * *

220- short

(If you were incorrect, refer to frame 204)

221. The following combinations of settings will admit the same amount of light through the camera lens: (Check answers after question F)

A. 1/125th sec. at f/11	D. 1/_____ sec. at f/16
B. 1/250th sec. at f/____	E. 1/_____ sec. at f/22
C. 1/500th sec. at f/____	F. 1/_____ sec. at f/32

* * *

221- B. f/8
C. f/5.6
D. 1/60th
E. 1/30th
F. 1/15th

(If you were incorrect on any of the above, review beginning with frame 208; do not proceed to the next unit until you are 100% correct)

"RULE OF THUMB" FOR EXPOSURE

222. One last method of calculating exposure gives the photographer a quick check on other exposure methods. It is also particularly useful when you have no data sheet with your film.

This method uses only one item of information --- the ASA rating of the film being used. For Verichrome Pan film, the ASA rating is 125. This system, then, requires only one item of information, the _____ of the film.

* * *

222- ASA rating

223. This method --- usually called the "rule of thumb" for exposure --- states that when conditions are normal (Bright Sun, average subject), SET THE F/STOP AT F/16 AND CONVERT THE ASA RATING INTO A SPEED. With this system, then, with normal conditions we set the camera at f/16 and convert the ASA rating into a _____.

* * *

223- speed

224. Using Verichrome Pan film (ASA 125) when conditions are normal, we set the f/stop at f/16 and convert the ASA rating to 1/_____ sec. The f/16 is a constant with this system.

* * *

224- 1/125th

225. If conditions are not normal, the double or _____ principle comes into effect to give you compensated f/stops or shutter speeds.

* * *

225- half

226. When ASA ratings won't convert to exact speeds for your camera, take them to the nearest speed. For example: your camera has speeds of 1/250th sec. and 1/500th sec.; your film is Kodak Tri-X (ASA 400); convert the ASA 400 to 1/400th sec. --- but on your camera it will be 1/_____ sec. at the constant of f/_____.

* * *

226- 1/500th
f/16

227. Whether your camera uses the old or new system of shutter speeds won't affect the exposure; 1/100th sec. and 1/125th sec. are so close together that exposure will be virtually the same. This is true of all variations between the two systems.

So 1/60th sec. on the new system is essentially the _____ as 1/50th sec. on the old system.

* * *

227- same

228. Let's take the last few frames for a brief review:

Using the rule of thumb for exposure when conditions are normal and your film ASA is 250, your f/stop would be _____, and your shutter speed _____.

* * *

228- f/16
1/250th

(If you were incorrect, refer to frames 223 and 224)

229. The ASA rating refers to the _____ of the film.

* * *

229- speed, or sensitivity

(If you were incorrect, refer to frames 80, 81 and 82)

230. Given normal conditions of Bright Sun, average subject, 1/125th sec. at f/16:

A. Hazy Sun	B. Open Shade
Average Subject	Bright Subject
1/250th sec.	f/11
f/_____	1/_____ sec.

* * *

230- A- f/8
B- 1/60th

(If you were incorrect, refer to frames 170 through 179)

231. An f/stop of f/32 would give a _____ (long/short) depth of field.

* * *

231- long

232. $1/60\text{th sec. at } f/5.6 = 1/125\text{th sec. at } f/\underline{\hspace{1cm}}.$
 $1/30\text{th sec. at } f/8 = 1/\underline{\hspace{1cm}} \text{ sec. at } f/11.$

* * *

232= $f/4$
 $1/15\text{th}$

(If you were incorrect, refer to frames 208
 through 216)

PANEL 1

LIGHT CONDITIONSSUBJECT BRIGHTNESS

Bright Sun

Brilliant

Hazy Sun

Bright

Cloudy Bright

Average

Cloudy Dull

Dark

or

Open Shade

f/stops 1 1.4 2 2.8 4 5.6 8 11 16 22 32

shutter
speeds 1 2 4 8 15 30 60 125 250 500 1000

(newer system)

APPENDIX A-III

DATA FOR PILOT STUDY --- FLASH PROGRAM

School of Journalism, Oklahoma State University

In order to work the program on the use of flash in photography, you need to know a few basic principles of exposure. Keep this page handy for reference while you are working the program --- and you may also refer to it when you are taking the test over the program.

Exposure is simply the light reaching the film in the camera. It is controlled by (1) the shutter speed, which is the length of time the lens remains open to admit light, and (2) the f/stop, which is the size of the lens opening which admits light.

In summary, the time the lens is open (shutter speed), and the size of the lens opening (f/stop), work together to control exposure (amount of light reaching the film). In this program only the f/stop will be manipulated to control the incoming light for proper exposure.

A partial series of standard f/stops is:

f/2.8 f/4 f/5.6 f/8 f/11 f/16 f/22

The left end of this scale represents the largest lens openings, hence f/2.8 would be the maximum lens opening on this scale. The right end of the scale represents the smallest lens opening, with f/22 being the minimum lens opening on this scale.

As you can see by the arrows on the scale below, as f/stops are changed from one to another, exposure is either doubled or halved. Proceeding from left to right (from large opening to smaller opening), the light is halved at each f/stop. When proceeding from right to left (from small lens opening to larger opening), the reverse is true, as the light is doubled at each f/stop.

f/2.8	f/4	f/5.6	f/8	f/11	f/16	f/22
→					←	
each f/stop					each f/stop	
halves the light					doubles the light	

We use the terms "open" as referring to making the lens opening bigger, and "closing" or "stopping down" as referring to making the lens opening smaller.

- - - - -

One term you need to know is "ASA rating," or "ASA index." This is a rating of the sensitivity of film, which indicates whether it requires a small, medium, or large amount of light for correct exposure.

Films of ASA 20 to ASA 80 are called "slow," and require a large amount of light; films of ASA 100 to ASA 160 are medium and require a medium amount of light; films of ASA 200 to ASA 500 and above are fast and require little light.

APPENDIX A-IV

EXPOSURE TEST
C O N T E N T

TABLE OF SPECIFICATIONS
O B J E C T I V E S

TO ACHIEVE KNOWLEDGE OF:		ABILITY OR SKILL TO:		
Definitions of Technical Terms	Specific Facts	Principles and General- izations	Comprehend Various Kinds of Data and Conditions	Apply Prin- ciples
Light Used in Photography				
1. Visible light (a)		* a-2		
2. Incident light (b)	* b-1		* b-4	
3. Reflected light (c)		* c-2		
4. Refracted light (d)	* d-1	* d-2	* d-3	
Substances Through Which Light Is Transmitted or Not Transmitted				
1. Transparent medium (e)	* e-1		* e-4	
2. Translucent medium (f)	* f-1		* f-4	
3. Opaque medium (g)	* g-1		* g-4	
Standard Camera Settings				
1. f/stops (h)	* h-1	* h-2	* h-3	
2. Shutter speeds (i)	* i-1	* i-2	* i-3	

(* denotes behavioral outcomes)

EXPOSURE TEST
C O N T E N T

TABLE OF SPECIFICATIONS
O B J E C T I V E S

	TO ACHIEVE KNOWLEDGE OF:			ABILITY OR SKILL TO:	
	Definitions of Technical Terms	Specific Facts	Principles and General- izations	Comprehend Various Kinds of Data and Conditions	Apply Prin- ciples
Exposure (j)	* j-1	* j-2	* j-3		
Components of Exposure					
1. Subject brightness (k)				* k-4	
2. Outdoor light conditions (l)		* l-2		* l-4	
3. Film speeds, ratings (m)	* m-1	* m-2	* m-3		* m-5
Double or Half Principle of Light					
1. Used with f/stops (n)			* n-3		* n-5
2. Used with shutter speeds (o)			* o-3		* o-5
3. Used with subject brightness (p)			* p-3		
4. Used with outdoor light conditions (q)			* q-3		
5. Used to Calculate Exposure (r)					* r-5
6. When Necessary to Use (s)			* s-3		

EXPOSURE TEST C O N T E N T

TABLE OF SPECIFICATIONS O B J E C T I V E S

TO ACHIEVE KNOWLEDGE OF:			ABILITY OR SKILL TO:	
Definitions of Technical Terms	Specific Facts	Principles and General- izations	Comprehend Various Kinds of Data and Conditions	Apply Prin- ciples
Data for Correct Exposure When Conditions are Normal (t)	* t-2			
Determining Exposure When Given Only Light Conditions and Type of Film (u)		* u-3		* u-5
Combinations of f/stops and Shutter Speeds Giving the Same Light (v)				* v-5
Reasons for Choosing Particular Combinations of Camera Settings				
1. Depth of Field (w)	* w-1	* w-3		* w-5
2. Action, camera movement (x)		* x-3		

Behavioral Outcomes

Exposure Test

On all "1" level behavioral outcomes (Definitions of Technical Terms), to demonstrate a knowledge of correct definitions, the student will either (1) be given the term and from a set of alternatives select the correct example, attribute, or property of the term, or (2) he will be given an example, attribute, or property, and from a set of alternatives will select the correct term. This procedure will not be repeated, but will be understood with each of the behavioral outcomes at this level.

- a-2. Given several elements of the electro-magnetic spectrum, to select the element used in photography.
- b-1. To correctly define incident light.
- b-4. Given alternative conditions, to correctly select the condition which represents incident light.
- c-2. Given examples of light striking a smooth and a rough surface, to respond whether the light is changed or unchanged when it is reflected.
- d-1. To correctly define refracted light.
- d-2. Given several conditions, to correctly select the condition causing refraction.
- d-3. Given an example of a subject being recorded sharply on film, from given alternatives to correctly select the element causing this sharpness.
- e-1. To correctly define a transparent medium.

- e-4. Given alternative types of mediums, to correctly select the transparent medium.
- f-1. To correctly define a translucent medium.
- f-4. Given alternative types of mediums, to correctly select the translucent medium.
- g-1. To correctly define an opaque medium.
- g-4. Given alternative types of mediums, to correctly select the opaque medium.
- h-1. To correctly define f/stop.
- h-2. Given a series of f/stops, from given alternative f/stops to select the one which should come next in the series.
- h-2. Given a series of f/stops, to select from given alternative f/stops the one which does not belong in the series.
- h-3. Given alternative f/stops, to select the one which admits the most light, and the one which admits the least light.
- i-1. To correctly define shutter speed.
- i-2. Given alternative series of shutter speeds, to select the correct series.
(These may be either old or new series.)
- i-3. Given alternative shutter speeds, to

select the one which admits the most light, and the one which admits the least light. (These may be either the old or new series.)

- j-1. To correctly define exposure.
- j-2. Given several combinations of variables, to select the combination used to calculate exposure.
- j-3. Given several alternatives, to select the correct one to use together with subject brightness and outdoor light conditions to determine correct exposure.
- k-4. Given the name of one of the five types of outside light conditions, to select from several given alternatives a set of conditions of subject brightness which correspond to the name.
- k-4. Given certain conditions of subject brightness, to label the set of conditions correctly as one of the four types of subject brightness.
- l-2. Given alternative sets of outdoor light conditions, to demonstrate a knowledge of the five types of outdoor light conditions by selecting the correct set.
- l-4. Given certain light conditions, to label

the set of conditions correctly as one of the five types of outside light conditions.

- l-4. Given the name of one of the five types of outside light conditions, to select from several given alternatives a set of outdoor light conditions which corresponds to the name.
- m-1. To correctly define film speed and/or film rating.
- m-2. Given a film and its ASA, from given alternatives to choose correctly its relative sensitivity.
- m-3. Given alternative films and their ASA ratings, to select the film requiring the most light for correct exposure, and the film requiring the least light for correct exposure.
- m-5. Given a hypothetical situation, to choose from alternative types of film (given by ASA rating) the correct type the photographer would use.
- n-3. Given a known f/stop, from given alternative f/stops, to select the f/stop which would double the light, or which would halve the light.
- n-5. Given hypothetical lighting conditions

which change so as to either double or halve the light, and given a known f/stop , to correctly change the f/stop to compensate for the new light condition by selecting the correct f/stop from given alternative f/stops .

- o-3. Given a known shutter speed, from given alternative shutter speeds to select the shutter speed which would double the light, or which would halve the light.
- o-5. Given hypothetical lighting conditions which change so as to either double or halve the light, and given a known shutter speed, to correctly change the shutter speed to compensate for the new light condition by selecting the correct shutter speed from alternative shutter speeds.
- p-3. Given a subject of stated brightness, to select from given alternatives the correct element of brightness if the intensity of light entering the camera is doubled or halved.
- q-3. Given an outdoor light condition, to select from given alternative light conditions the correct one if outside light has been doubled, or if outside light

has been halved.

- r-5. When subject brightness varies from normal, to select from alternatives either the correct f/stop or correct shutter speed.
- r-5. When outdoor light conditions vary from normal, to select from alternatives either the correct f/stop or correct shutter speed.
- r-5. When subject brightness and outdoor light conditions vary from normal, to select from alternatives either the correct f/stop or correct shutter speed.
- r-5. When subject brightness and either shutter speed or f/stop vary from normal, from alternatives either to select the correct f/stop or shutter speed.
- r-5. When outdoor light conditions and either shutter speed or f/stop vary from normal, from alternatives either to select the correct f/stop or correct shutter speed.
- r-5. When subject brightness, outdoor light conditions and either shutter speed or f/stop vary from normal, from alternatives to select the correct f/stop or shutter speed.
- s-3. Given several alternative conditions, to

select the one which demonstrates when the double or half principle must be utilized in calculating exposure.

- t-2. Given alternative sets of information, to choose the set which correctly describes data printed on each roll of film.
- u-3. Given alternative f/stops, to choose the correct f/stop for use when calculating exposure by rule of thumb.
- u-3. Given alternatives of f/stops and shutter speeds either being constant or changed, to select the correct alternative describing utilizing the rule of thumb in calculating exposure.
- u-5. Given normal light conditions and the ASA rating of the film used, to choose from alternative combinations of camera settings the correct combinations to give proper exposure using the rule of thumb for exposure.
- u-5. Given lighting conditions and film ASA, from given alternatives to choose correct exposure settings without being directed to use the rule of thumb.
- v-5. Given a known combination of f/stops and shutter speeds, to choose from alternative combinations the set which will give the

same exposure.

- w-1. To correctly define depth of field.
- w-3. Given alternative f/stops, to correctly select the one which will give maximum depth of field, and also to select the f/stop which will give minimum depth of field.
- w-5. Given a hypothetical situation, to demonstrate a skill in manipulating depth of field by selecting correct camera settings from given alternative combinations of camera settings.
- w-5. Given alternative combinations of f/stops and types of camera distance focused, to select the combination giving the most depth of field, and the combination giving the least depth of field.
- x-3. Given alternative shutter speeds, to select the correct shutter speed necessary to control camera movement or subject action.

APPENDIX A-V

FLASH TEST
C O N T E N T

TABLE OF SPECIFICATIONS
O B J E C T I V E S

TO ACHIEVE KNOWLEDGE OF:

ABILITY OR SKILL TO:

Definitions
of Technical
Terms

Specific
Facts

Principles
and
General-
izations

Comprehend
Various
Kinds of
Data and
Conditions

Apply
Prin-
ciples

Evolution of the Flashbulb

1. Flash powder (a)

* a-2

2. Flashbulb sizes (b)

* b-2

* b-3

3. Flashcube (c)

* c-1

4. Flashbulb color (d)

* d-2

Flashbulb Components and
How the Flashbulb Fires (e)

* e-3

Flashbulb Characteristics
and Synchronization

1. Peak intensity and
the flash curve (f)

* f-1

* f-3

2. Shutter synchronization
with peak intensity (g)

* g-1

* g-2

3. Classes of flashbulbs
and synchronization

a. Class M (h)

* h-1

* h-3

* h-4

(* denotes behavioral outcomes)

C O N T E N T

TABLE OF SPECIFICATIONS O B J E C T I V E S

	TO ACHIEVE KNOWLEDGE OF:			ABILITY OR SKILL TO:	
	Definitions of Technical Terms	Specific Facts	Principles and General- izations	Comprehend Various Kinds of Data and Conditions	Apply Prin- ciples
b. Class F (i)	* i-1		* i-3	* i-4	
c. Class FP (j)	* j-1		* j-3		
Fixed Synchronization (k)	* k-1				
Types of Flash Units					
1. Battery-operated (l)	* l-1	* l-2			
2. B-C (m)	* m-1	* m-2			
3. Electronic (n)	* n-1	* n-2			
Calculating Exposure					
1. Variables in exposure (o)		* o-2			* o-5
2. Finding guide numbers (p)		* p-2	* p-3		
3. Determining the correct guide number (q)					* q-5
4. Determining the correct f/stop from the guide number (r)					* r-5

C O N T E N T

TABLE OF SPECIFICATIONS O B J E C T I V E S

	TO ACHIEVE KNOWLEDGE OF:			ABILITY OR SKILL TO:	
	Definitions of Technical Terms	Specific Facts	Principles and General- izations	Comprehend Various Kinds of Data and Conditions	Apply Prin- ciples
5. How to make your own guide number (s)			* s-3		* s-5
Flash Techniques					
1. Fill-in flash (t)	* t-1			* t-4	
2. On-camera flash (u)	* u-1	* u-2			
3. Off-camera flash (v)	* v-1	* v-2			
4. Feather flash (w)	* w-1	* w-2			* w-5
5. Multiple flash (x)	* x-1	* x-2			
6. Open flash (y)	* y-1				
7. Bounce flash (z)	* z-1	* z-2			* z-5
8. Bare-bulb flash (aa)	*aa-1	*aa-2			
9. Handkerchief flash (bb)	*bb-1	*bb-2			
10. Comparison of Techniques (cc)				*cc-4	*cc-5

C O N T E N T

TABLE OF SPECIFICATIONS
O B J E C T I V E S

TO ACHIEVE KNOWLEDGE OF:

ABILITY OR SKILL TO:

Definitions
of Technical
Terms

Specific
Facts

Principles
and
General-
izations

Comprehend
Various
Kinds of
Data and
Conditions

Apply
Prin-
ciples

Safety Precautions

1. Use shield when close
to subjects (dd)

*dd-2

2. Cracked bulbs explode
(ee)

*ee-2

3. Keep bulbs stored in
carton (ff)

*ff-2

4. Freshly-fired bulbs may
ignite other bulbs (gg)

*gg-2

5. Unplug sync cord before
inserting first bulb
(hh)

*hh-2

Behavioral Outcomes

Flash Test

On all "1" level behavioral outcomes (Definitions of Technical Terms), to demonstrate a knowledge of correct definitions, the student will either (1) be given the term and from a set of alternatives select the correct example, attribute, or property of the term, or (2) he will be given an example, attribute, or property, and from a set of alternatives will select the correct term. This procedure will not be repeated, but will be understood with each of the behavioral outcomes at this level.

- a-2. Given alternative materials, to select the material used for flash pictures before flashbulbs were in use.
- b-2. Given alternative flashbulb sizes, to correctly select the smallest size or the largest size.
- b-3. Given alternative choices, to correctly select the choice which describes why smaller bulbs are currently appropriate.
- c-1. To correctly define a flashcube.
- d-2. Given alternative conditions, to indicate those where blue flashbulbs must be used, and/or where blue bulbs may be used.
- e-3. Given alternative flashbulb components, to correctly select the component which causes a particular effect.
- e-3. Given alternative purposes, to correctly select the purpose of a given flashbulb component.

- f-1. To correctly define a millisecond.
- f-3. Given a flash curve, to correctly select from alternative choices the times when a flashbulb begins burning, and time when it burns out.
- g-1. To correctly define synchronization.
- g-2. Given information that it is the moment a flashbulb is fired, to correctly select from alternatives whether the shutter is opened before, after, or during this moment.
- h-1. To correctly define a Class M flashbulb.
- h-3. Given a Class M flash curve and alternative classes of flashbulbs, to correctly select the correct flashbulb as corresponding to the curve.
- h-4. Given an adjustable synchronization setting, from given alternatives to choose the correct class of flashbulb to synchronize with this setting for proper exposure.
- i-1. To correctly define a Class F flashbulb.
- i-3. Given a Class F flash curve and alternative classes of flashbulbs, to correctly select the correct flashbulb as corresponding to the curve.
- i-4. Given an adjustable synchronization

setting, from given alternatives to choose the correct class of flashbulb to synchronize with this setting for proper exposure.

- j-1. To correctly define a Class FP flashbulb.
- j-3. Given a Class FP flash curve and alternative classes of flashbulbs, to correctly select the correct flashbulb as corresponding to the curve.
- k-1. To correctly define fixed synchronization.
- l-1. To correctly define battery-operated flash.
- l-2. Given alternative advantages and disadvantages, to correctly select those which apply to the battery-operated flash.
- m-1. To correctly define B-C flash.
- m-2. Given alternative advantages and disadvantages, to correctly select those which apply to the B-C flash.
- n-1. To correctly define electronic flash.
- n-1. To correctly define recycling time.
- n-1. To correctly define capacitor.
- n-2. Given alternative advantages and disadvantages, to correctly select those which apply to the electronic flash unit, both

low and high input types.

- o-2. Given alternative sets of variables, to select the set in which all of the variables affect exposure when using flash.
- o-5. Given a correct exposure setting for flash, to correctly select from alternative f/stops the one to use to compensate for dark subjects and/or bright subjects.
- o-5. Given a correct exposure setting for flash, to correctly select from alternative f/stops the one to use to compensate for a smaller flash reflector and/or an unpolished flash reflector.
- p-2. Given alternative materials, to correctly select the alternative where guide numbers may be found for several types of flashbulbs, and/or where guide numbers may be found for one type of flashbulb only.
- p-3. To correctly select from alternatives the procedure used to calculate exposure by using the guide number.
- q-5. Given a flash exposure table, and given a hypothetical size of flashbulb, flash-to-subject distance, shutter speed, and film

ASA number, to select from given alternative guide numbers the correct guide number.

- r-5. Given a flash exposure table, and given a hypothetical size of flashbulb, flash-to-subject distance, shutter speed, and film ASA, to select the correct f/stop from given alternative f/stops in order to achieve correct exposure.
- s-3. Given alternative distances in feet, to select the correct alternative to use when calculating a guide number to fit one's own equipment.
- s-5. Given a partial procedure of calculating one's own guide number, to correctly select from alternative procedures the one necessary to complete the calculation.
- t-1. To correctly define fill-in flash.
- t-4. Given the method for determining exposure, to select correctly from alternative flash techniques the correct technique for this method.
- u-1. To correctly define on-camera flash.
- u-2. Given alternative advantages and disadvantages, to correctly select those which apply to on-camera flash.

- v-1. To correctly define off-camera flash.
- v-2. Given alternative advantages and disadvantages, to correctly select those which apply to off-camera flash.
- w-1. To correctly define feather flash.
- w-2. Given alternative advantages and disadvantages, to correctly select those which apply to feather flash.
- w-5. Given a hypothetical situation describing the necessity to photograph a large room full of people, to choose from alternative techniques the correct technique to give even illumination.
- x-1. To correctly define multiple flash.
- x-1. To correctly define slave unit.
- x-2. Given alternative advantages and disadvantages, to correctly select those which apply to multiple flash.
- y-1. To correctly define open flash.
- z-1. To correctly define bounce flash.
- z-2. Given alternative advantages and disadvantages, to correctly select those which apply to bounce flash.
- z-5. Given alternative choices of determining exposure, to select correctly the simplified method for determining exposure for bounce flash.

- aa-1. To correctly define bare-bulb flash.
- aa-2. Given alternative advantages and disadvantages, to correctly select those which which apply to bare-bulb flash.
- bb-1. To correctly define handkerchief flash.
- bb-2. Given alternative advantages and disadvantages, to correctly select those which apply to handkerchief flash.
- cc-4. Given alternative groups of flash techniques, to correctly select those that are similar in the effect they produce.
- cc-5. Given hypothetical picture-taking assignments, to correctly choose from alternative flash techniques the one which best fits the assignment.
- dd-2. Given alternative equipment, to select correctly the safety equipment to use when shooting close to subjects.
- ee-2. Given alternative effects, to correctly choose the effect that will occur when a flashbulb is cracked.
- ff-2. Given alternative conditions, to correctly choose the one to avoid so that flashbulbs won't be fired by friction.
- gg-2. Given alternative conditions, to correctly choose the one to avoid so that flashbulbs won't be accidentally ignited.

hh-2. From alternative precautions, to correctly select the one to utilize to avoid having the bulb fired as it is inserted in the flashgun.

APPENDIX B-I

EXPOSURE PRETEST

Journalism 233

EXPOSURE

(Unless otherwise directed, use the new system of shutter speeds for the problems)

INSTRUCTIONS: On the answer sheet cross out the alternative which best answers the question. Do not write on the test booklet. Use scratch paper for problems.

1. The f/stop on the camera:
 - a. is the single element controlling light entering
 - b. is one of the three settings to control light entering
 - c. controls the size of the lens opening
 - d. delays the shutter a predetermined length of time
2. The correct first five shutter speeds of the old system are:

a. 1	1/5	1/10	1/20	1/50
b. 1	1/2	1/4	1/10	1/20
c. 1	1/2	1/5	1/10	1/25
d. 2	1/4	1/8	1/16	1/25
3. Which of the following conditions best describes average subject brightness?
 - a. white horse in sunlit pasture
 - b. Indian standing in sunlight
 - c. sunlight on water
 - d. girl in white dress in sunlight
 - e. boy walking in sun

4. The camera is set on $f/8$; to double the amount of light entering, it must be moved to:
- a. $f/5.6$ b. $f/6.7$ c. $f/11$ d. $f/16$
 - e. $f/4$
5. The correct series of shutter speeds which belongs to the new system is:
- a. $1/100$ $1/200$ $1/500$ $1/1000$
 - b. $1/4$ $1/8$ $1/16$ $1/32$
 - c. $1/30$ $1/60$ $1/125$ $1/250$
 - d. $1/25$ $1/50$ $1/100$ $1/250$
6. Which of the following best describes dark subject brightness?
- a. person walking in sunlight
 - b. blonde girl in sunlight
 - c. neutral-colored building in sunlight
 - d. Negro man sitting in sunlight
 - e. white can in sunlight
7. A photographer is using Type II film, ASA 32. The speed of this film would be considered:
- a. fast b. slow c. moderate
8. Moving to which of the following would not double or halve the light?
- a. $f/1.4$ b. $f/5.6$ c. $f/3.5$ d. $f/8$
 - e. $f/2.8$
9. The camera is correctly set on $f/8$ for current light conditions of the sun being hidden by thin clouds, but with lots of light and fairly distinct shadows. Suddenly the sun comes out brightly; the new f /stop to compensate for this must be:
- a. $f/6.7$ b. $f/22$ c. $f/11$ d. $f/5.6$
10. The camera is set for a brilliant subject; if subject brightness changes so that the intensity of light entering the camera is halved, the new type of subject brightness would be:
- a. light c. dark e. bright
 - b. average d. dull

11. Normal conditions are: Bright Sun, average subject, f/16 at 1/125th; when actual conditions are Hazy Sun, average subject, 1/125th, the f/stop must be:
- a. f/11 b. f/8 c. f/22 d. f/16
12. The camera is set on 1/60th; to halve the light, it must be moved to:
- a. 1/20th b. 1/125th c. 1/250th d. 1/30th
e. 1/15th
13. Which of the following would require the most light for proper exposure?
- a. ASA 160 b. ASA 240 c. ASA 125
d. ASA 1250 e. ASA 400
14. The camera is set on f/5.6 to shoot in Hazy Sun conditions; the light changes to Cloudy Bright conditions; the new f/stop must be:
- a. f/4 b. f/11 c. f/3.5
d. f/16 e. f/2.8
15. Normal conditions are: Bright Sun, average subject, f/16, 1/125th. When actual conditions are Cloudy Bright, bright subject, 1/125th, the f/stop should be:
- a. f/22 b. f/11 c. f/8 d. f/5.6
16. The camera shutter speed is correctly set at 1/60th for conditions which are a bright sunshine with dark, distinct shadows; the sky becomes slightly overcast and shadows are not as distinct. What must the new setting be?
- a. 1/15th b. 1/30th c. 1/50th
d. 1/125th e. 1/250th
17. The rule of thumb to calculate exposure states that the shutter speed is found by:
- a. doubling the ASA and converting it into a speed
b. dividing ASA by 10 and making it a speed
c. using the ASA as a speed
d. adding a zero to ASA and converting it into a speed

18. Normal conditions are: Bright Sun, average subject, f/16, 1/125th; when actual conditions are Bright Sun, dark subject, f/16, the shutter speed should be:
- a. 1/60th b. 1/250th c. 1/30th
 - d. 1/125th
19. Normal conditions are: Bright Sun, average subject, f/11 at 1/125th; when actual conditions are Open Shade, bright subject, 1/125th, the f/stop should be:
- a. f/5.6 b. f/11 c. f/16 d. f/8
20. In order to use the double or half principle to calculate exposure, one must know:
- a. light meter settings
 - b. exposure settings for adverse conditions
 - c. settings for film for average conditions
 - d. what film to use for particular light conditions
 - e. none of the above
21. The camera is set for Cloudy Dull, but outside light conditions change so that the light is doubled; this means that the new light condition is:
- a. Cloudy Bright d. Open Shade
 - b. Bright Sun c. Cloudy Dark
 - c. Hazy Sun
22. Normal conditions are: Bright Sun, average subject, f/16, 1/125th; when actual conditions are Hazy Sun, bright subject, f/16, the shutter speed should be:
- a. 1/250th b. 1/60th c. 1/125th
 - d. 1/500th
23. The technical term for the distance between near and far points in the picture which is in clear focus is:
- a. area in focus d. depth of field
 - b. resolving area e. none of these
 - c. distance focus
24. Light conditions are Open Shade and the camera is correctly set at 1/30th. Later in the day, conditions are Cloudy Bright, and the new camera setting must be:
- 1. 1/200th b. 1/250th c. 1/60th
 - d. 1/125th e. 1/15th

25. Normal conditions are Bright Sun, average subject, f/11, 1/125th. When actual conditions are Open Shade, bright subject, 1/125th, the f/stop should be:
- a. f/5.6 b. f/11 c. f/16 d. f/8
26. To give the same light as 1/60th at f/8, if the new setting is 1/125th, the f/stop must be:
- a. f/5.6 b. f/3.5 c. f/8 d. f/11
27. The double or half principle of calculating exposure does not have to be employed until:
- a. light conditions are normal
b. light conditions are set into the exposure meter
c. light conditions are not normal
d. light conditions are extremely dim
e. none of the above
28. Normal conditions are Bright Sun, average subject, f/11, 1/60th. When actual conditions are Hazy Sun, dark subject, f/11, the shutter speed should be:
- a. 1/15th b. 1/30th c. 1/125th
d. 1/250th
29. To retain the same light as 1/125th at f/22, if the new f/stop is f/32, the new shutter speed must be:
- a. 1/60th b. 1/250th c. 1/30th
d. 1/500th e. 1/50th
30. The f/stop giving the shortest depth of field is:
- a. f/11 b. f/22 c. f/5.6
d. f/8 e. f/1.4
31. 1/250th at f/8 gives the same light as 1/_____ at f/16.
- a. 1/250th b. 1/60th c. 1/1000th
d. 1/500th
32. The photographer who would want both foreground and background in sharp focus in his picture would most likely select which of the following?
- a. f/5.6 b. f/11 c. f/4 d. f/2
e. f/22

33. The minimum shutter speed necessary to avoid camera movement when hand-holding the camera is:
- a. 1/125th b. 1/60th c. 1/250th
 - d. 1/30th
34. Which of the following would give the longest depth of field?
- a. f/4, focused a long distance away
 - b. f/2.8, focused a short distance away
 - c. f/22, focused a short distance away
 - d. f/32, focused a long distance away
35. A photographer taking outdoor fashion pictures wants all of the emphasis on the clothing; he eliminates virtually all background by choosing:
- a. f/1.4 b. f/8 c. f/16 d. f/6.9
 - e. f/32

(Please turn in this test booklet and get the test booklet for the second half of the test.)

APPENDIX B-II

EXPOSURE POST-TEST

Journalism 233

EXPOSURE

(Unless you are directed otherwise, please use the new system of shutter speeds.)

INSTRUCTIONS: On the answer sheet cross out the alternative which best answers the question.
Don't write on the booklet, but use scratch paper for any problems.

1. The apparatus on the camera which controls the effective lens diameter is the:
 - a. ground glass
 - b. f/stop
 - c. shutter
 - d. depth of field
 - e. M-X setting
2. The last four correct shutter speeds (fastest) in the old system are:

a.	1/100	1/200	1/400	1/1000
b.	1/50	1/100	1/200	1/500
c.	1/125	1/250	1/750	1/1000
d.	1/100	1/250	1/500	1/1000

(Read across)
3. A neutral-colored building in sunlight would be an example of which term for subject brightness?
 - a. brilliant
 - b. bright
 - c. average
 - d. dark
 - e. reflecting
4. The camera is set on f/8; to halve (decrease by half) the amount of light entering, it must be moved to:

a.	f/3.5	c.	f/4	e.	f/2
b.	f/11	d.	f/16		

5. The correct series of shutter speeds belonging to the new system is:
- a. 1 1/2 1/5 1/10
 - b. 1/4 1/8 1/15 1/30
 - c. 1/250 1/500 1/750 1/1000
 - d. 1/10 1/120 1/40 1/80
6. A black cow in a sunlit pasture would be an example of which element of subject brightness?
- a. brilliant d. bright
 - b. average e. dark
 - c. light
7. A photographer is using a film of ASA 500; the speed of this film would be considered:
- a. moderate b. fast c. slow
8. The light entering the camera would not be fully doubled or halved if one moved from a standard f/stop to:
- a. f/16 c. f/6.7 e. none of these
 - b. f/2.8 d. f/5.6
9. The camera is correctly set on f/16 for current light conditions. The sun is shining brightly. But suddenly a light cloud obscures the sun --- there is still plenty of light, but not as much as before and ground shadows aren't as harsh and black as they were. What must the new f/stop be for the new conditions?
- a. f/5.6 c. f/22
 - b. f/11 d. f/32
10. The camera is set for a bright subject; if subject brightness changes so that the intensity of light entering the camera is doubled, the new type of subject brightness would be called:
- a. brilliant d. average
 - b. light e. shiny
 - c. dark
11. Normal conditions are: Bright Sun, average subject, f/16, 1/125th; when actual conditions are Bright Sun, brilliant subject, 1/125th, the f/stop must be
- a. f/11 c. f/22
 - b. f/32 d. f/8

12. The camera is set on 1/125th; to double the light it must be moved to:
- a. 1/30th
 - b. 1/60th
 - c. 1/250th
 - d. 1/15th
13. Which of the following would require the least light for proper exposure?
- a. ASA 80
 - b. ASA 500
 - c. ASA 160
 - d. ASA 400
 - e. ASA 125
14. The camera is set at f/8 to shoot in Cloudy Dull conditions; the light changes to Cloudy Bright conditions; the new f/stop must be:
- a. f/4
 - b. f/5.6
 - c. f/11
 - d. f/16
 - e. f/1.4
15. Normal conditions are: Bright Sun, average subject, f/16, 1/125th. When actual conditions are Hazy Sun, dark subject, 1/125th, the f/stop must be
- a. f/5.6
 - b. f/8
 - c. f/11
 - d. f/22
16. Conditions are cloudy but there is quite a lot of light in the sky; the camera is correctly set for these conditions on 1/125th; conditions then change so that the clouds are extremely thick and dark and there is little light. The new setting must be:
- a. 1/500th
 - b. 1/250th
 - c. 1/30th
 - d. 1/60th
 - e. 1/25th
17. The rule of thumb to calculate exposure states that the f/stop to use is:
- a. f/8
 - b. f/11
 - c. f/16
 - d. f/22
 - e. f/3.5
18. Normal conditions are: Bright Sun, average subject, f/16, 1/125th. When actual conditions are Bright Sun, bright subject, f/16, the shutter speed should be:
- a. 1/250th
 - b. 1/60th
 - c. 1/30th
 - d. 1/500th

19. Normal conditions are: Bright Sun, average subject, $f/22$, $1/125\text{th}$. When actual conditions are Cloudy Bright, dark subject, $1/125\text{th}$, the f/stop must be:
- a. $f/8$
 - b. $f/16$
 - c. $f/4$
 - d. $f/11$
20. Information printed on the outside of each roll of film tells the photographer:
- a. camera settings for unusual light conditions
 - b. whether to double or halve the light
 - c. camera settings for Hazy Sun, Open Shade, etc.
 - d. whether to use M or X synchronization
 - e. camera settings for average conditions
21. The camera is set for Hazy Sun, but outside light conditions change so that the light is halved; this means the new light condition is:
- a. Cloudy Dull
 - b. Cloudy Bright
 - c. Bright Sun
 - d. Hazy Dark
 - e. Cloudy Sun
22. Normal conditions are: Bright Sun, average subject, $f/16$, $1/125\text{th}$. When actual conditions are Cloudy Dull, dark subject, $f/16$, the shutter speed should be:
- a. $1/60\text{th}$
 - b. $1/500\text{th}$
 - c. $1/15\text{th}$
 - d. $1/30\text{th}$
 - e. $1/8\text{th}$
23. Depth of field is:
- a. focal length of the lens
 - b. field of view the camera lens records
 - c. area in the picture which is in focus
 - d. distance from viewing lens to taking lens of camera
 - e. none of the above
24. Light conditions are Hazy Sun and the camera is correctly set on $1/250\text{th}$. Conditions change to Cloudy Bright; the new camera setting must be:
- a. $1/30\text{th}$
 - b. $1/500\text{th}$
 - c. $1/60\text{th}$
 - d. $1/15\text{th}$
 - e. $1/125\text{th}$

25. Normal conditions are: Bright Sun, average subject, f/22, 1/125th. When actual conditions are Cloudy Bright, dark subject, 1/125th, the f/stop must be:
- a. f/8
 - b. f/16
 - c. f/4
 - d. f/11
26. To give the same light as 1/125th at f/11, the new setting is 1/60th, and the f/stop must be:
- a. f/8
 - b. f/22
 - c. f/5.6
 - d. f/16
27. When light conditions are not normal, one finds correct camera settings for exposure by utilizing the principle of:
- a. varying light conditions
 - b. light determination
 - c. light transmission
 - d. double or half
 - e. none of these
28. Normal conditions are Bright Sun; average subject, f/11, 1/250th. When actual conditions are Cloudy Bright, dark subject, f/11, the shutter speed must be:
- a. 1/30th
 - b. 1/60th
 - c. 1/125th
 - d. 1/500th
29. To give the same light as 1/250th at f/16, when the new f/stop is f/11, the new shutter speed must be:
- a. 1/60th
 - b. 1/500th
 - c. 1/30th
 - d. 1/1000th
30. Of the following, the f/stop giving the longest depth of field is:
- a. f/22
 - b. f/8
 - c. f/11
 - d. f/4.5
31. 1/60th at f/11 gives the same light as 1/_____ at f/5.6.
- a. 1/500th
 - b. 1/125th
 - c. 1/250th
 - d. 1/15th

32. The photographer who wants to eliminate undesirable background from his picture would most likely select of the following:

- a. f/2 c. f/8 e. f/16
- b. f/5.6 d. f/32

33. To avoid camera movement when hand-holding the camera, the photographer should:

- a. set camera at minimum of f/11
- b. use at least 1/60th sec.
- c. use at least 1/250th sec.
- d. count to three before taking the picture
- e. be sure he is using M synchronization

34. Which of the following combinations would give the shortest depth of field?

- a. f/2, focused a short distance away
- b. f/4, focused a long distance away
- c. f/32, focused a short distance away
- d. f/22, focused a long distance away

35. Taking a picture of the opening of a new national forest, the photographer has several persons stand about 10 to 15 feet away from the camera and is including them in the picture of the landscape which stretches from some 40 feet away to virtually miles away. For this scenic picture what f/stop will he choose so that virtually everything will be in sharp focus in his picture?

- a. f/1 c. f/8 e. f/32
- b. f/5.6 d. f/16

APPENDIX B-III

FLASH PRETEST

Journalism 233

FLASH

(Unless otherwise directed, use the new system of shutter speeds.)

INSTRUCTIONS: On the answer sheet cross out the alternative which best answers the question. Do not write on the test booklet. Use scratch paper for problems. Use the flash exposure guide at the end of this test to calculate any exposure problems.

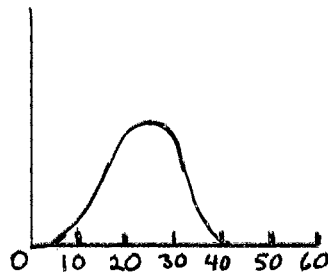
36. Of the following, the largest flashbulb is:

- | | |
|---------|-----------|
| a. M-5 | d. No. 25 |
| b. M-25 | e. M-X-5 |
| c. AG-1 | |

37. The part of the flash which produces the actual flash is the:

- | | |
|---------------|-------------|
| a. foil | d. primer |
| b. filament | e. sparkler |
| c. lead wires | |

38.

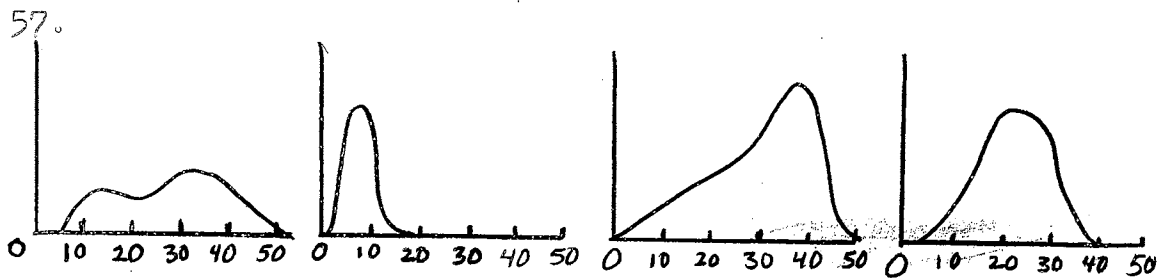


The above flash curve most closely represents what

- type of flashbulb?
- a. Class M
 - b. Class FP
 - c. Class F
 - d. Class MX
 - e. Class X
39. Fixed synchronization is most commonly found on the following type of camera:
- a. press camera
 - b. very expensive camera
 - c. reflex camera
 - d. box camera
 - e. 35mm camera
40. The type of flash unit which may fire late when its power supply is weak would most likely be:
- a. pencil flash
 - b. electronic flash
 - c. high input flash
 - d. battery-operated flash
 - e. B-C flash
41. A flashbulb which has been dropped should be checked because a cracked flashbulb:
- a. won't fire
 - b. may explode
 - c. will cause overexposure
 - d. will flash only about half the normal light
42. Off-camera flash is that which:
- a. is fired manually after the shutter is opened manually
 - b. must point at the same angle that the camera points
 - c. is hand-held by the photographer
 - d. requires camera lens to be opened one f/stop more than normal
43. The flash technique characterized by tilting the flashgun to spill most of the light to distant areas is called:
- a. back flash
 - b. feather flash
 - c. on-camera flash
 - d. fill flash
 - e. model flash
44. In calculating your own flash guide number, a series of pictures is taken, one for each f/stop on the camera, then the best picture is selected. If this best picture was taken on f/16, the flash guide number for your equipment would be:

- a. 80 b. 240 c. 160 d. 32 e. 320
45. A characteristic of bare-bulb flash is that:
- a. light is diffused and made softer
 - b. light has better range
 - c. lens must be closed one f/stop
 - d. light is brighter, outlines subject better
46. You are shooting an audience in an auditorium, from one side wall to the other wall on the other side; subjects are as close as 8 feet, and as far away as 60 feet. The best of the following techniques would be:
- a. bare-bulb flash
 - b. feather flash
 - c. on-camera flash
 - d. back flash
 - e. handkerchief flash
47. Which of the following most closely resembles the B-C flashgun?
- a. efficient, even with weak batteries
 - b. most inefficient type of flash
 - c. faster than electronic flash
 - d. most use nickel cadmium batteries
48. Flash directed at subjects outdoors is called:
- a. open flash
 - b. fill-in flash
 - c. solar flash
 - d. feather flash
49. Before using a flashgun, the photographer should unplug the sync cord, because:
- a. the flash circuit might be complete
 - b. the flashgun can shock the user
 - c. the sync cord might not work
 - d. a shorted sync will ruin the flashgun
50. To photograph a banquet where the room is filled with tables with people eating and the nearest persons are about 10 feet away and the farthest people about 50 feet away, the best technique of the following would be:
- a. bare-bulb flash
 - b. feather flash
 - c. on-camera flash
 - d. fill-in flash
 - e. back flash

51. Guide numbers for one type of flashbulb to be used with many types of films are found:
- a. on flashbulb package
 - b. on camera light meter
 - c. on film data sheet
 - d. on flashbulb calculator
52. Plain off-camera flash would be superior to bare-bulb flash in:
- a. photographing subject for portrait effect
 - b. soft light effect
 - c. photographing room full of people
 - d. natural light effect
53. Which of the following pairs are both of the elements among the variables considered in calculating exposure for flash?
- a. type of flashbulb, time of day
 - b. size of reflector, outside light conditions
 - c. film used, type and size of bulb
54. A friend wants to have a portrait-type picture taken; you have no floodlights. For best results, you would choose from the following:
- a. off-camera flash
 - b. condensed flash
 - c. feather flash
 - d. fill-in flash
 - e. multiple flash
55. Which of the following most closely identifies the B-C flashgun?
- a. uses transistor for power supply
 - b. has extremely rapid flash
 - c. has apparatus to store current obtained from a power supply
 - d. uses permanent type of bulb
56. The type of flashbulb which remains at a fairly even peak for a long time is:
- a. Class M
 - b. Class L
 - c. Class FP
 - d. Class X
 - e. Class F



Which of the above curves most closely represents that of a Class FP flashbulb?

58. Of the following, the technique which gives a natural light look and a feeling of depth is:

- a. bounce flash
- b. fill-in flash
- c. variflash
- d. on-camera flash
- e. none of these

59. The flash unit which picks up the change in light intensity caused by a flash fired on camera and reacts by firing its own bulb is called:

- a. extension unit
- b. auxiliary unit
- c. slave unit
- d. photoflash unit
- e. open flash unit

60. The guide number is used in calculating exposure by:

- a. subtracting light condition index to obtain f/stop
- b. dividing it by shutter speed index to obtain f/stop
- c. multiplying it by distance to obtain f/stop
- d. dividing it by distance to obtain f/stop

61. In calculating the flash guide number to fit your own equipment, the distance used to shoot a series of pictures on every f/stop is:

- a. 15 feet
- b. 12 feet
- c. 10 feet
- d. 20 feet
- e. 25 feet

62. The flash technique considered the poorest in results is:

- a. intermediate flash
- b. handkerchief flash
- c. fill-in flash
- d. bounce flash
- e. on-camera flash

63. Bare-bulb flash is the technique which:
- a. utilizes a flashbulb without plastic coating
 - b. aims flash at ceiling and back to subject
 - c. utilizes a flashgun without reflector
 - d. uses flashgun without shield over the bulb
64. Which of the following is not similar to the others in the effect it produces?
- a. bounce flash
 - b. on-camera flash
 - c. bare-bulb flash
 - d. handkerchief flash
65. Of the following techniques, the one that utilizes a material over the flashgun head is:
- a. cover flash
 - b. feather flash
 - c. handkerchief flash
 - d. portrait flash
 - e. off-camera flash
66. Using the exposure guide, the correct camera setting for the following information would be:
- No. 5 flashbulb, ASA 125 film, 1/160th, 16 feet.
- a. f/5.6
 - b. f/8
 - c. f/11
 - d. f/16
 - e. f/22
67. The correct f/stop for the following would be:
- No. 25 flashbulb, film ASA 15, 1/125th, 9 feet.
- a. f/5.6
 - b. f/8
 - c. f/11
 - d. f/16
 - e. f/22
68. Given the following, the correct f/stop would be:
- No. 5 flashbulb, ASA 320, 1/500th, 23 feet.
- a. f/11
 - b. f/8
 - c. f/5.6
 - d. f/16
 - e. f/22
69. Given the following, the correct f/stop would be:
- No. 25 flashbulb, ASA 200, 1/250th, 11 feet.
- a. f/11
 - b. f/16
 - c. f/22
 - d. f/8
 - e. f/5.6

70. Given the following, the correct f/stop would be:

No. 25 flashbulb, ASA 110, 1/60th, 50 feet.

- a. f/16
- b. f/11
- c. f/8

- d. f/5.6
- e. f/4

EXPOSURE GUIDE
No. 5 and No. 25 flashbulbs

Film Speed	10	20	40	80	160	320
(ASA)	to	to	to	to	to	to
	16	32	64	125	250	500

Shutter Speed	Guide Number					
1/30th	95	140	200	280	400	550
1/60th	90	130	180	260	360	500
1/125th	75	110	160	220	320	440
1/250th	60	85	120	180	240	360
1/500th	46	65	95	130	190	260

APPENDIX B-IV

FLASH POST-TEST

Journalism 233

FLASH

(Unless you are directed otherwise, please use the new system of shutter speeds.)

INSTRUCTIONS: On the answer sheet cross out the alternative which best answers the question. Don't write on the booklet, but use scratch paper for any problems. (Use guide at end of test for flash problems.)

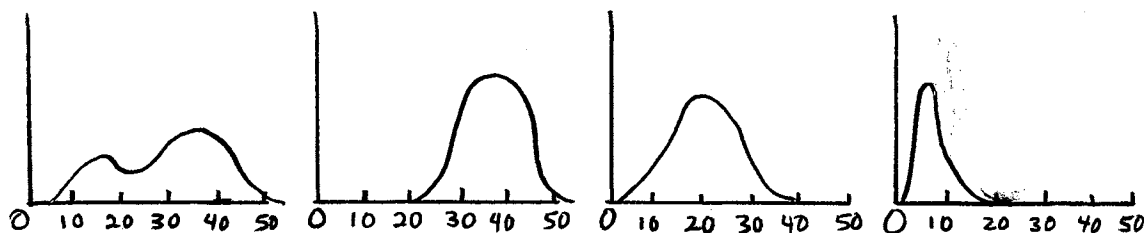
1. Of the following, the smallest flashbulb is:

- | | | |
|----------|---------|-----------|
| a. No. 5 | c. AG-1 | e. No. 25 |
| b. M-25 | d. M-5 | |

2. The function of the foil in the flashbulb is:

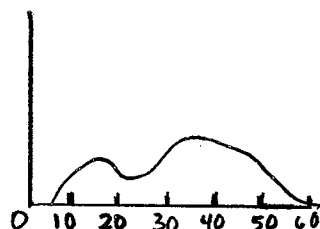
- a. to bring electricity into the bulb
- b. to spark the primer
- c. to ignite the filament
- d. to burn and cause the flash

3.



Which of the curves above most closely represents that of a Class M flashbulb?

4.



The above curve most closely represents the flash of what flashbulb?

- a. Class X
 - b. Class F
 - c. Class P
 - d. Class M
 - e. Class FP
- 5. The most common type of synchronization found on most simple, inexpensive cameras is:
 - a. dial type
 - b. X, F, M
 - c. fixed
 - d. adjustable
 - e. camera must be set on certain shutter speed
- 6. The type of flash unit which produces maximum output of current is:
 - a. EVS unit
 - b. battery-operated flashgun
 - c. flashcube unit
 - d. B-C flash
 - e. M-X flash
- 7. The Class FP flashbulb is one which:
 - a. has a fairly long, level peak
 - b. has a long delay before reaching peak intensity
 - c. produces three times the light intensity of other class bulbs
 - d. begins burning rapidly and peaks quickly
- 8. Fill-in flash is:
 - a. flash used in copy work
 - b. flash combined with sunlight
 - c. flash covering a wide area
 - d. flash from several sources at the same time
- 9. Which of the following is common to the battery-operated flash?
 - a. weak power supply may cause delay in firing flashbulb
 - b. may use 110-volt house current
 - c. low input, but efficient unit
 - d. has apparatus to store current from batteries

10. A flashbulb will explode if:
- a. current igniting it is too weak
 - b. used in an electronic flash unit
 - c. it is cracked
 - d. the filament is damaged
11. The type of flashgun which stores current in an apparatus and then releases the current when the flashgun is fired is:
- a. blink light
 - b. battery-operated flash
 - c. B-C flash
 - d. fixed flash
 - e. X flash
12. Feather flash is that which:
- a. creates an extremely soft light
 - b. illuminates an area in a fan shape about 10 feet from camera
 - c. gives most of the light to distant areas
 - c. gives extremely bright light to close subjects
13. In calculating your own flash guide number, a series of pictures is taken, one for each f/stop of the camera, then the best picture is chosen. The guide number is determined by taking the f/stop used to take the picture, and:
- a. multiply by 2 (double)
 - b. multiply by 1.5
 - c. add 100
 - d. divide by 2
 - e. add a zero
14. The flash technique by which the photographer hand-holds the flashgun, which is connected to the camera with a sync cord, is:
- a. multiple flash
 - b. synchro-sunlight flash
 - c. fill-in flash
 - d. intermediate flash
 - e. off-camera flash
15. If a flash unit is shorted and the circuit is (flashgun) complete:
- a. it will perform satisfactorily
 - b. the bulb will fire when inserted
 - c. the bulb will not fire when it should
 - d. none of these

16. The photo assignment is a setup of actors on a stage. A group of actors is posed about 10 feet from camera at the right; and to the left and about 25 feet behind this group are three more actors who are talking. Of the following, the best technique would be:
- a. feather flash
 - b. handkerchief flash
 - c. diffusion flash
 - d. on-camera flash
 - e. bare-bulb flash
17. A characteristic of bounce flash is that it:
- a. whitens skin tones
 - b. creates resemblance of natural light and feeling of depth
 - c. improves quality of tones, but produces rather harsh shadows behind subjects
 - d. provides excellent lighting for a range limited to about 20 feet
18. A slave unit is:
- a. operated on the same principle as open flash
 - b. connected by a synchronization cord
 - c. fired by a change in light intensity
 - d. dependent upon the direction in which the two main lights are pointed
19. A soft light is created by which of the following techniques?
- a. fill-in flash
 - b. on-camera flash
 - c. off-camera flash
 - d. open flash
 - e. bare-bulb flash
20. Guide numbers for one type of flashbulb to be used with many types of films are found:
- a. on the flashbulb calculator
 - b. on the camera light meter
 - c. on the flashbulb package
 - d. on the film data sheet
21. The guide number is used in calculating exposure in the following way:
- a. light condition index subtracted to obtain shutter speed
 - b. distance to subject multiplied by guide number to obtain f/stop
 - c. distance to subject divided into guide number to obtain f/stop
 - d. distance to subject divided into guide number to obtain shutter speed

22. To find the flash guide number for your own equipment, each f/stop of the camera is used to take a picture and then the best picture is selected. The distance used for all of these pictures is:
- a. 5 feet c. 15 feet e. 12 feet
 - b. 10 feet d. 20 feet
23. On-camera flash typically produces:
- a. flat lighting and harsh shadows
 - b. pleasant tonal quality
 - c. harsh shadows, but considerable depth and modeling
 - d. generally good modeling effect
24. The flash technique which requires removing the reflector from the flashgun is called:
- a. open flash d. shield flash
 - b. bounce flash e. bare-bulb flash
 - c. fill-in flash
25. Which of the following is similar to handkerchief flash in the effect it produces?
- a. on-camera flash c. fill-in flash
 - b. off-camera flash d. bare-bulb flash
26. In which of the following pairs are both parts among the elements which are considered in calculating exposure for flash?
- a. size of flashbulb, size of subject
 - b. shutter speed used, film used
 - c. type of synchronization, outside light conditions
 - d. film used, time of day
27. Handkerchief flash is the technique which:
- a. intensifies the light by flashing through a white handkerchief
 - b. uses a material over the flashhead primarily as a safety precaution
 - c. bounces the flash from flashgun to a cloth material, then back to the subject
 - d. softens the light by flashing through a handkerchief

28. Bare-bulb flash would be superior to off-camera flash for:

- | | |
|-----------------------|-------------------------|
| a. achieving distance | c. sharp, crisp, effect |
| b. strong light | d. soft portrait effect |

29. Using the exposure guide, the correct camera setting for the following would be:

No. 5 flashbulb, ASA 80, 1/250th, 11 feet.

- | | | |
|---------|---------|---------|
| a. f/22 | c. f/11 | e. f/32 |
| b. f/16 | d. f/8 | |

30. Given the following, the correct f/stop would be: (use guide)

No. 25 flashbulb, ASA 400, 1/125th, 40 feet.

- | | | |
|---------|---------|---------|
| a. f/8 | c. f/11 | e. f/32 |
| b. f/22 | d. f/16 | |

31. Given the following, the correct f/stop would be:

No. 25 flashbulb, ASA 160, 1/30th, 23 feet.

- | | | |
|---------|---------|--------|
| a. f/16 | c. f/32 | e. f/8 |
| b. f/22 | d. f/11 | |

32. Given the following, the correct f/stop would be:

No. 5 flashbulb, ASA 25, 1/250th, 10 feet.

- | | | |
|---------|---------|----------|
| a. f/22 | c. f/11 | e. f/5.6 |
| b. f/16 | d. f/8 | |

33. Given the following, the correct f/stop would be:

No. 25 flashbulb, ASA 50, 1/500th, 8 feet.

- | | | |
|----------|---------|---------|
| a. f/5.6 | c. f/11 | e. f/22 |
| b. f/8 | d. f/16 | |

34. A girl needs a portrait taken to send in to a contest. Of the following, the best technique would be:

- | | |
|--------------------|---------------|
| a. on-camera flash | d. back flash |
| b. feather flash | e. open flash |
| c. bare-bulb flash | |

35. Your assignment is to photograph a classroom full of students for use in the yearbook. You get in a front corner of the room and shoot toward the opposite corner at the back. Subjects range from 10 feet away to 40 feet away. The best technique of the following is:

- | | |
|--------------------|------------------|
| a. feather flash | d. fill-in flash |
| b. bare-bulb flash | e. polyflash |
| c. on-camera flash | |

EXPOSURE GUIDE
No. 5 and No. 25 flashbulbs

Film Speed	10	20	40	80	160	320
(ASA)	to	to	to	to	to	to
	16	32	64	125	250	500

Shutter Speed	Guide Number					
1/30th	95	140	200	280	400	550
1/60th	90	130	180	260	360	500
1/125th	75	110	160	220	320	440
1/250th	60	85	120	180	240	360
1/500th	46	65	95	130	190	260

APPENDIX C-I

ADJUSTED MEANS AND STANDARD ERRORS
OF FILM EXPOSURE EXPERIMENT

Treatment Groups	Treatment Mean	Adjusted Mean	Standard Error of Adjusted Mean
<u>Groups A - D</u>			
A	27.2667	27.4824	1.3532
D	29.7143	29.4831	1.4010
<u>Groups A - E</u>			
A	27.2667	27.4736	1.3190
E	30.3846	30.1459	1.4173
<u>Groups A - B</u>			
A	27.2667	27.2529	1.1575
B	30.0625	30.0754	1.1207
<u>Groups A - C</u>			
A	27.2667	28.0250	0.9478
C	32.3846	31.5096	1.0257
<u>Groups B - D</u>			
B	30.0625	30.1521	1.3703
D	29.7143	29.6119	1.4658
<u>Groups B - E</u>			
B	30.0625	30.1659	1.3287
E	30.3846	30.2573	1.4754
<u>Groups C - D</u>			
C	32.3846	31.7342	1.3518
D	29.7143	30.3183	1.3001
<u>Groups C - E</u>			
C	32.3846	31.8838	1.2771
E	30.3846	30.8854	1.2771

ADJUSTED MEANS AND STANDARD ERRORS OF
FLASH PHOTOGRAPHY EXPERIMENT

Treatment Groups	Treatment Mean	Adjusted Mean	Standard Error of Adjusted Mean
<u>Groups A - D</u>			
A	24.7333	24.8892	1.1379
D	30.6429	30.4758	1.1779
<u>Groups A - E</u>			
A	24.7333	24.8245	0.9449
E	32.8333	32.7194	1.0568
<u>Groups A - B</u>			
A	24.7333	24.6393	0.8204
B	32.0714	32.1722	0.8492
<u>Groups A - C</u>			
A	24.7333	25.0532	0.8511
C	32.4615	32.0925	0.9160
<u>Groups B - D</u>			
B	32.0714	32.2064	1.0722
D	30.6429	30.5079	1.0722
<u>Groups B - E</u>			
B	32.0714	32.0945	0.6795
E	32.8333	32.8064	0.7344
<u>Groups C - D</u>			
C	32.4615	32.3089	1.1372
D	30.6429	30.7845	1.0954
<u>Groups C - E</u>			
C	32.4615	32.4498	0.7086
E	32.8333	32.8460	0.7377

VITA

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