SUBCOURSE
SS0513

EDITION
9

PHOTOGRAPHIC QUALITY CONTROL

THE ARMY INSTITUTE FOR PROFESSIONAL DEVELOPMENT

ARMY CORRESPONDENCE COURSE PROGRAM

A
I
P
D

READINESS / PROFESSIONALISM THRU GROWTH

SIGNAL SUBCOURSE 513

PHOTOGRAPHIC QUALITY CONTROL

EDITION 9
3 CREDIT HOURS
REVIEWED: 1988

INTRODUCTION:

This subcourse is designed to teach you how to mix and store chemicals used in the pH meter and hydrometer, and you will learn about sensitometry and photo process control. No amount of emphasis could be enough to stress the importance of this information. Quality control is the most important single element in the operation of a photo lab. Using good quality control procedures can save you valuable time and money.

LEARNING STRATEGY:

This subcourse consists of four lessons and an examination.

Lesson 1. Chemical Mixing and Storage.

Lesson 2. Determining pH and Specific Gravity.

Lesson 3. Sensitometry and Photographic Process Control.

Lesson 4. Operate Sensitometer, Densitometer, and Plotting Control Chart.

Examination.

The following tasks are covered in this subcourse.

113-578-3004, Process B&W/Color Neg/Color Slide Film Manually.

113-578-3013, Mix Photographic Solutions.

113-578-3014, Evaluate B/W Photographic Negatives.

113-578-6004, Initiate Safety Program.

RESOURCE REQUIREMENTS:

Subcourse booklet and examination answer sheet are furnished. No other material is needed.

CREDIT HOURS -- hrs.

GENERAL INFORMATION:

The subcourse consists of learning material and exercises for each lesson. Read the material and answer all the exercises as they appear in the lesson. Lesson 1 contains subject matter information followed, by programmed instruction for each of the objectives, followed by exercises.

Lessons 2, 3 and 4 contain subject matter information followed by exercises.

Solutions to the exercises are located at the end of this subcourse. Upon completion of this subcourse, you must answer all of the questions in the examination and return it for grading.

We wish you good luck.

POC: DENNIS FOSTER
TRAINING DEVELOPER
AUTOVON: 926-2522
COMM: (303) 370-2522

***** IMPORTANT NOTICE *****

THE PASSING SCORE FOR ALL ACCP MATERIAL IS NOW 70%.

PLEASE DISREGARD ALL REFERENCES TO THE 75% REQUIREMENT.

LESSON 1

CHEMICAL MIXING AND STORAGE

OBJECTIVE:

In this lesson you will gain a knowledge of chemical mixing and storage. Chemistry is essential for all photography. The photographer must depend on the chemical processes to produce the negatives and prints which are his/her ultimate goal. In some instances, in Army photography, compounded chemicals known as prepared chemicals, or ready mixes, are not available because of economic or other reasons. In any event, it may be up to you to mix your own processing solutions, and unless they are safely, carefully, and properly handled and mixed, the results may be inferior or even DISASTROUS.

The learning objectives of this lesson are as follows:

1. STATE why chemicals should be stored in airtight containers.
2. STATE why a chemical formula would require more monohydrated chemicals then desiccated chemicals.
3. LIST four ways to purify water.
4. STATE why equipment and containers made of iron, tin, or zinc should not be used for mixing or storing chemical solutions.
5. STATE why solutions should not be mixed with the shaft of the electric mixer in the center of the container.
6. REARRANGE in their proper sequence, a given list of steps that are required when mixing a photographic solution from bulk chemicals.
7. STATE how all chemicals should be regarded and handled.
8. STATE the recommended publication to reference for obtaining information about photographic chemicals, solutions, and formulas.

9. MATCH a list of containers and chemicals with the proper method of storage for each.

10. STATE three ways photo lab personnel could become poisoned when working with photographic chemicals.

11. MATCH the chemical classification with the potential hazard of each class.

CREDIT HOURS.. hrs

MATERIAL REQUIRED..None

SECTION I

1-1. WHY CHEMICALS SHOULD BE STORED IN AIRTIGHT CONTAINERS.

a. If chemicals are exposed to air for any great length of time, they will deteriorate and be of no further use. To prevent this, they should be kept in airtight containers.

b. There are three ways chemicals deteriorate. Either they give off moisture to the air, termed efflorescence, or they absorb moisture from the air, called hydroscopic or deliquescence, or they combine with oxygen, known as oxidation. The following six frames of programmed text, will help to explain the storage of chemicals.

	(1) If chemicals are exposed to air for any great length of time, they will deteriorate and be of no further use. Chemicals should not be ___________ to air for any great length of time.
exposed	(2) Chemicals should be stored in airtight storage containers to prevent their deterioration. Chemicals exposed to air will _______________.
deteriorate	(3) (Chemicals may deteriorate for one of the following reasons:

	(a) They give off their moisture to the air. (Termed efflorescence.) (b) They absorb moisture from the air. (Termed hydroscopic or deliguescence.) (c) They combine with oxygen. (Termed oxidation). (NO RESPONSE REQUIRED.
	(4) To prevent deterioration of chemicals, you must store chemicals in ___________________ containers.
airtight	(5) Storing chemicals in airtight containers prevents them from _______ ______________.
deteriorating	(6) State why chemicals should be stored in airtight containers. ____________________________ ____________________________ ____________________________

To prevent them from deteriorating (any words that mean the same thing).

EXERCISE

1. To prevent the deterioration of photographic chemicals, all containers used for storage must be (select one)

   a. well ventilated.
   b. made of iron.
   c. airtight.
   d. made of thick glass.

1-2. WHY A CHEMICAL FORMULA WOULD REQUIRE MORE MONOHYDRATED CHEMICALS THAN DESICCATED CHEMICALS.

a. Chemicals are manufactured in three states.

Liquid

Crystals (contain a portion of water)

Dry (anhydrous or desiccated, meaning free of water)

b. Desiccated chemicals contain more of the active ingredients, weight for weight, than chemicals containing water.

c. If you are mixing a solution and the formula calls for sodium carbonate desiccated and all you have is sodium carbonate monohydrated, you would have to weigh out 17% more monohydrated to allow for the extra weight of water.

The following frames of programmed text will help to explain the chemical formula.

	(7) Chemicals are manufactured in three states: (a) Liquid. (b) Crystals (contain a portion of water. (c) Dry (anhydrous or dessicated, meaning free of water). A chemical that is labeled as anhydrous or desiccated would contain no ________________ and would be in a _________________ state.
water dry	(8) ANHYDROUS AN = NOT . . . . . . HYDRO = WATER The word ANHYDROUS means ____________________________

not water or no water	(9) MONO means one part. The word MONOHYDRATED means ________ part ___________________.
one water	(10) Desiccated means the same as anhydrous. A desiccated chemical ________________ (would/would not) contain water.
would not	(11) Desiccated chemicals contain <u>more</u> of the active ingredients, weight for weight, than chemicals containing water. Two pounds of desiccated (dry) chemical would be _______________ (stronger/weaker) than two pounds of monohydrated (one part water) chemical.
stronger	(12) If you are mixing a solution and the formula calls for sodium carbonate desiccated and all you have in stock is sodium carbonated weigh out 17% more monohydrated to allow for the extra weight of the ___________________________.
water	(13) A chemical formula would require more monohydrated chemical (by weight) than desiccated, because a monohydrated chemical contains water and a desiccated chemical is dry. Monohydrated chemicals __________________ (contain water/ are dry). Desiccated chemicals _____________ ______________ (contain water/are dry).
contain water are dry	(14) State why a formula would require more monohydrated than desiccated chemicals. _______________________________ _______________________________ _______________________________

<u>Monohydrated contains water. Desiccated is dry.</u>

EXERCISE

2. If a formula calls for sodium carbonate desiccated, and all you have in stock is sodium carbonate monohydrated, you would (select one):

a. use the same amount.

b. increase the amount by 17%.

c. wait until you have the chemical called for before mixing the solution.

d. decrease the amount by 17%.

1-3. WATER PURIFICATION TECHNIQUE

Water used in photography should be as pure as possible for best photographic quality.

(1) Boiling water causes the mineral, vegetable, and animal matter in the water to coagulate. When the water is allowed to coal and stand, the impurities will settle to the bottom and clean water on the top can be poured off.

(2) Chemical precipitation. By adding certain chemicals to the water you can cause the impurities to coagulate or precipitate and settle to the bottom.

(3) Distillation requires a "still," whereby water is changed to steam, separating it from its impurities.

(4) Filtration means to pass water through a fine mesh cloth or cotton.

	(15) Water used in photography should be as pure as possible for best photographic quality. For best results in photography, you should use water that is as _________________ as possible.
pure	(16) Boiling water causes the mineral, vegetable, and animal matter in the water to coagulate. When the water is allowed to cool and stand, the impurities will settle to the bottom and the clean water on top can be poured off.

	One method used to purify water is by ______________________.
boiling	(17) The coagulation and settling of impurities in water is termed “precipitation”. (NO RESPONSE REQUIRED)
	(18) By adding certain chemicals to water, you can cause the impurities to precipitate or coagulate and settle to the bottom (chemical precipitation). List two methods used to purify water. (a) ______________________ (b) ______________________
(a) Boiling (b) Chemical precipitation	(19) Distillation requires a “still,” whereby water is changed to its gaseous form, separating it from impurities. Two methods used to purify water are: (a) Boiling. (b) Chemical precipitation. Another method of purifying water is by ______________________.
distillation	(20) List three methods used to purify (a) ______________________________ (b) ______________________________ (c) ______________________________

(a) Boiling (b) Chemical precipitation (c) Distillation	(21) Filtration means to pass the water through a fine mesh cloth or absorbent cotton. Impurities will be collected by the cloth or cotton. Add the two missing methods used to purify water to list below. (a) Boiling. (b) Chemical precipitation. (c) ______________________ (d) ______________________
(c) Distillation (d) Filtration	(22) List four methods used to purify water. (a) ______________________ (b) ______________________ (c) ______________________ (d) ______________________
(a) Boiling. (b) Chemical precipitation.	(c) Distillation. (d) Filtration.

EXERCISE

3. Impurities can be removed from water used to mix photographic materials by (select one)

   a. boiling.

   b. filtering through a wire mesh.

   c. boiling and adding formaldehyde.

   d. adding 3% acetic acid.

1-4. WHY EQUIPMENT AND CONTAINERS MADE OF IRON, TIN, OR ZINC SHOULD NOT BE USED FOR MIXING OR STORING CHEMICAL SOLUTIONS.

A chemical reaction will take place and ruin the solution if mixed or stored in a container made of iron, tin or zinc. Glass, hard rubber, and stainless steel materials are best suited for mixing or storing chemicals.

	(23) Equipment and containers made of tin, iron, or zinc should not be used for mixing or storing chemical solutions. A container made of tin _________ (should/should not) be used to ____________ or ______________ chemical solutions.
should not mix store	(24) Glass, hard rubber, and stainless materials are best suited for mixing or storing chemical solutions. (NO RESPONSE REQUIRED)
	(25) A chemical reaction will take place and ruin the chemical solution if mixed or stored in a container made of ________, _________, or ________.
tin iron zinc (Any order)	(26) Equipment and containers made of tin, iron, or zinc, if used to mix or store a chemical solution, will cause a _________ ________ that will ___________ the solution.
chemical reaction ruin	(27) State why equipment and containers made of tin, iron, or zinc should not be used to mix or store chemical solutions. _________________________________ _________________________________ _________________________________

They will cause a chemical reaction that will ruin the solution.

EXERCISE

4. Chemicals mixed in containers made of iron, tin, or zinc will (select one)

   a. react with the metal and give better results.

   b. give off toxic fumes.

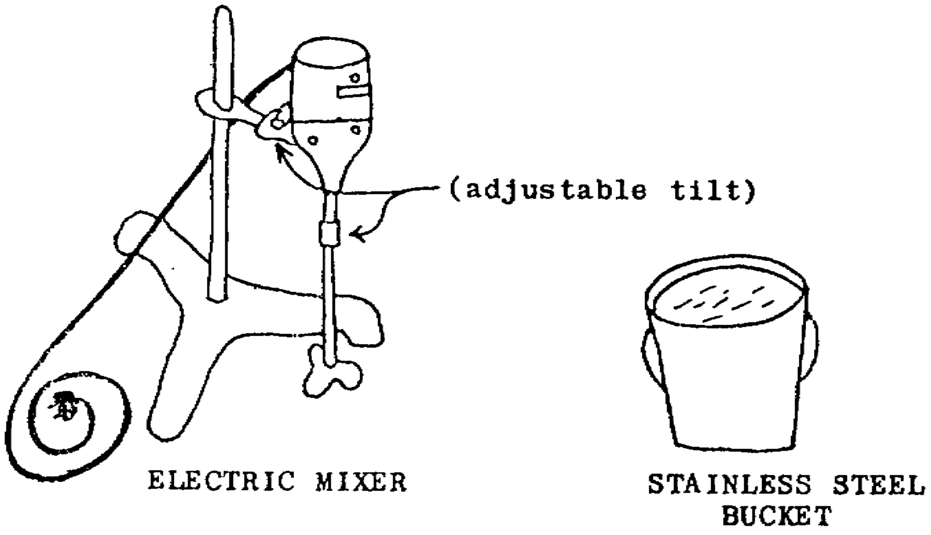
   c. create a fire hazard.

   d. react with the metal and ruin the solution.

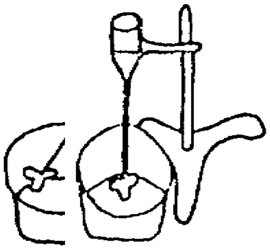
1-5. WHY SOLUTIONS SHOULD NOT BE MIXED WITH THE SHAFT OF THE ELECTRIC MIXER IN THE CENTER OF THE CONTAINER.

An electric mixer and stainless steel bucket are available in most photo labs and are used to mix chemicals. The shaft of the motor should be adjusted about 25 degrees off vertical, and to the right of the center of the container when mixing a chemical solution. If the shaft of the mixer is placed in the center of the bucket, it will cause a whirlpool effect which introduces air into the solution, and will ruin it by oxidation.

(28)



An electric mixer and stainless steel bucket are available in most photo labs and are used to mix chemical solutions.
(NO RESPONSE REQUIRED)

	(29) The shaft of the mixer should be adjusted about 25° off vertical, and to the right of the center of the container when mixing a chemical solution. Which figure illustrates the correct shaft and propeller for most efficient mixing? ANS. _________ A B
A	(30) If the shaft of the mixer is placed in the center of the bucket, it will cause a whirlpool effect, which introduces air (oxidation) into the solution and will ruin the solution. Oxidation will ________ the solution.
ruin	(31) Do not place the shaft of the mixer in the center of the bucket because it will cause the solution to _________________________.
oxidize	(32) Another reason for not placing the shaft of the mixer in the center of the bucket is that the chemicals will pile up and not dissolve beneath the end of the shaft, because of very little agitation about the center of the bucket. (NO RESPONSE REQUIRED)
	(33) To prevent <u>oxidation</u> of the chemical solution is the main reason for not

placing the shaft of the mixer in
the center of a bucket (container).

	If the shaft of the mixer is placed in the center of a bucket, ________ will occur.
oxidation	(34) State the main reason why solution should not be mixed with the shaft of the electric mixer in the center of the container. ________________________________ ________________________________

To prevent oxidation of the solution.

EXERCISE

5. If the shaft of the electric mixer is placed in the center of the mixing container, air will be introduced into the solution resulting in (select one)

a. air being forced out, thus ruining the solution.

b. oxidation, which will ruin the solution.

c. the chemicals dissolving too rapidly and ruining the solution.

d. failure of oxidation, thus ruining the solutions.

1-6. REARRANGE, IN THEIR PROPER SEQUENCE, A GIVEN LIST OF STEPS THAT ARE REQUIRED WHEN MIXING A PHOTOGRAPHIC SOLUTION FROM BULK CHEMICALS.

a. When mixing a photographic solution from bulk chemicals, you must <u>first weigh out the required amounts of chemicals</u> called for in the formula.

b. <u>Secondly</u>, you must <u>fill the mixing container with hot water</u> to the desired level, usually about 2/3 of the final amount of solution desired. Use 90°-125°F water for most mixing.

c. The <u>third step</u> is to <u>dissolve the weighed chemicals in hot water</u>, pouring the chemicals slowly into the water.

NOTE: EACH CHEMICAL MUST BE COMPLETELY DISSOLVED BEFORE ADDING THE NEXT CHEMICAL TO THE SOLUTION.

d. After all of the chemicals have been mixed thoroughly, add cold water to bring the solution level up to the required level, then store the solution in airtight containers and allow them to cool before use.

e. Finally, label the containers with the name of the solution, the date prepared, and the name of the person mixing the solution.

	(35) The next sequence of frames pertains to Mr X, who is going to mix a photographic solution from bulk chemicals. Mr X has a chemical formula which tells him the chemicals he needs, how much to weigh, the proper mixing order, the required amount of water, water temperature and other instructions. (NO RESPONSE REQUIRED)
	(36) First, Mr X must weigh out the desired amounts of chemicals called for in the formula. The first step Mr X must perform is to _______________ ________________ the chemicals.
weigh out	(37) Secondly, Mr X must fill the mixing container with hot water (always less than the amount of solution desired, usually 90° to 125° F). After weighing the chemicals, Mr X must fill the mixing container with hot _________.
water	(38) The third step is to dissolve the weighed chemicals in the hot water. Pour the chemicals slowly into the water.

	NOTE: Each chemical must be completely dissolved before adding the next chemical to the solution. In step 1, Mr X ____________ the ________________. In step 2, Mr X filled the mixing container with hot ____________. In step 3, Mr X ____________ each chemical ____________.
weighed chemicals water dissolved completely	(39) If Mr X were making three gallons of solution, only two gallons of hot water would be used to dissolve the chemicals. After the chemicals have been dissolved completely, Mr X would add cold water to the solution to make the required three gallons. After dissolving the chemicals, the fourth step is to add __________ _____________ to make the desired amount of solution.
cold water	(40) Complete the list of steps below which describe how to mix a photographic solution from bulk chemicals. (a) ________________ the chemicals. (b) Fill the mixing container with ________ ______________. (c) ________________ the chemicals completely. (d) Add____________ ____________.
(a) Weigh (b) hot water (c) dissolve (d) cold water	(41) The fifth step is to store the chemical solution in airtight containers and allow it to cool before use.

	The fifth step Mr X must do is to __________ the solution in an __________ __________.
store airtight container	(42) List in their proper sequence, the first five steps that Mr X must perform when mixing a photographic solution from bulk chemicals. a. ______________________________ b. ______________________________ c. ______________________________ d. ______________________________ e. ______________________________
a. Weigh chemicals. b. Fill-mixing container with hot water. c. Dissolve the chemicals. d. Add cold water. e. Store in airtight containers.	(43) In step 6, Mr. X must LABEL the container that the solution is stored in with the following information: (a) Name of solution. (b) Date prepared. (c) Name of person who mixed the solution.
	After the solution is stored in an airtight container, Mr. X must ________________ the contents of the container.
label	(44) Rearrange in their proper sequence, the steps listed on the following page for mixing a photographic solution from bulk chemicals.

IMPROPERLY ARRANGED STEPS	PROPERLY ARRANGED STEPS
a. Dissolve chemicals.	a. ________________________
b. Store in airtight container.	b. ________________________
c. Weigh chemicals.	c. ________________________
d. Fill mixing container with hot water.	d. ________________________
e. Label.	e. ________________________
f. Add cold water.	f. ________________________

---

a. Weigh chemicals.
b. Fill mixing container with hot water.
c. Dissolve chemicals.
d. Add cold water.
e. Store in an airtight container.
f. Label.

EXERCISE

6. After a photographic solution has been properly mixed, it is (select one)

   a. allowed to cool and then stored in an airtight container.

   b. stored in an open container, ready for use.

   c. stored in an airtight container and allowed to cool before use.

1-7. HOW ALL CHEMICALS SHOULD BE REGARDED AND HANDLED.

a. All chemicals should be regarded as <u>poisonous</u> and handled with <u>CAUTION</u>. Anyone working with chemicals should wear protective clothing such as aprons, rubber gloves, and goggles.

> <u>NOTE</u>: WHEN MIXING ACID AND WATER TOGETHER, ALWAYS ADD THE ACID <u>SLOWLY</u> TO THE WATER. <u>ALWAYS ADD ACID</u> TO WATER, <u>NEVER</u> THE REVERSE.

---

	(45) All chemicals should be regarded as POISONS and handled with CAUTION. Formaldehyde is a poisonous chemical and should be handled with _____________.
caution	(46) Chemicals should be handled with caution because all chemicals should be regarded as _______________.
poisons	(47) Acids and caustic chemicals can cause severe skin burns. Avoid breathing fumes and vapors. (NO RESPONSE REQUIRED)
	(48) Anyone working with chemicals should wear protective clothing such as aprons, rubber gloves, and goggles. The reason you should wear protective clothing when working with chemicals is because all chemicals should be regarded as _____________ and should be handled with _______________________.
poisons caution	(49) When mixing acid and water together, always add the acid slowly to the water. Acids generate heat suddenly if water is added to the acid. Remember the three “A's”. <u>A</u>lways <u>A</u>dd <u>A</u>cid. (NO RESPONSE REQUIRED)
	(50) All chemicals should be handled with _____________ because they should be regarded as _______________.
caution poisons	(51) Acid, when mixed with cyanide, gives off a poisonous gas that can KILL. All chemicals should be regarded as _________ and handled with _________.

poisons caution	(52) Photographic solutions contain many poisonous and dangerous chemicals. It is very easy to contaminate one's fingers or cigarettes with these chemicals. For some additional information regarding the mixing of photographic chemicals, read the information following the next exercise. (NO RESPONSE REQUIRED)

EXERCISE

7. When mixing or storing photographic chemicals, you should regard them as (select one)

   a. being explosive and should handle with care.

   b. being poisonous and should handle with care.

   c. being inflammable and should handle with gloves.

   d. acids and should handle with caution.

INTRODUCTION:

The art of chemical mixing seems simple enough until a slight error is made and some important negatives are ruined. An inexperienced man should never be placed on a chemical mixing detail unless under close supervision. Chemical mixing should not be done in an area where sensitized materials are handled or stored; chemical dust settling on sensitized materials will ruin them. It should be done where there is sufficient ventilation. The area where chemical mixing is carried out should be kept clean at all times. If a chemical is spilled, it should be cleaned up immediately.

Requirements for Chemical Mixing:

<u>The utensils</u> used should be clean and all enamelware should be free from chips. Only equipment made of <u>stainless steel</u>, <u>hard rubber, glass</u>, or <u>enamelware</u> should be used, since there is a reaction with the chemicals when they come in contact with other types of material such as iron and tin.

Using a power mixer: When this type of mixer is used, care should be taken that the shaft is NOT placed in the center of the solution being mixed. When the shaft is in the center, a whirlpool effect is formed and air is admitted rapidly into the solution, causing it to oxidize. Also, a little pile of chemicals will form directly beneath the blades and these chemicals will dissolve very slowly.

Weighing chemicals:

Chemicals should be weighed or measured to the exact amount called for in the formula. Deviations of as little as a few grains may change the working characteristics of the solution.

To insure that there will be no contamination of one chemical with another, graduates should be washed thoroughly after measuring a chemical. The pans on scales should be covered with a separate sheet of paper for each chemical. Plain paper, used for writing, and typing paper contain a small amount of sulfur. This may contaminate and ruin some chemicals; therefore, the paper used to cover the pans on scales should be the black paper which separates each sheet of film in a box. This black paper has no sulfur content. A new sheet of paper should be used for each chemical weighed.

Dissolving the chemicals:

Chemicals should be completely dissolved in the order given in the formula.

One chemical should be completely dissolved before the next is placed in the solution.

When mixing large quantities of developer containing Metol, the Metol sometimes begins to oxidize before the preservative is dissolved. To prevent this oxidization, 5% of the preservative may be dissolved in solution before the Metol; then, the Metol; then the remainder of the preservative, and the rest of the chemicals in the order given.

Water:

Water which contains a large amount of iron or other impurities should not be used for photographic purposes. These metals tend to cause decomposition of some of the chemicals in the solution. Distilled water is the best to use since it is free from all foreign matter. Often, developer troubles can be traced to impurities in the water.

The temperature of the water in which the chemicals are being dissolved has a great deal to do with the speed at which they are dissolved. The temperature should be that which is prescribed in the particular formula being used.

Preparation of percentage solutions of dry chemicals:

To prepare correctly a 10% solution of any dry chemical, dissolve 1 ounce of the chemical desired in 8 ounces of water; then add water to make 10 ounces.

EXAMPLE: If a formula calls for 2 ounces of a 10% solution of potassium bromide, dissolve 1 ounce of potassium bromide in 8 ounces of water, then add water to make 10 ounces. Measure out 2 ounces of this solution for the formula. There are many times when it is desired to have more or less than a 10% solution or more or less than 10 ounces of the solution. In these cases, it will be found to be more desirable to use the following formula:

> To have the answer in ounces: Multiply the amount desired in ounces by the percentage desired as a decimal.
>
> To have the answer in grains: Multiply the above answer by 440. (There are actually 437-1/2 grains to an ounce, but to simplify math formulas, we use 440 grains as an ounce.)

Preparation of a percentage solution of liquid chemicals:
Multiply the amount desired by the percentage desired; divide this product by the percentage on hand.

EXAMPLE: A formula calls for 32 ounces of 28% acetic acid. Glacial acetic acid (99 1/2%) is the chemical on hand.

$$\frac{32 \text{ times } 28}{99.5} = \frac{896}{99.5} = 9.0 \text{ ounces of } 99\ 1/2\%$$

Add 9.0 ounces of 99 1/2% glacial acetic to 23 ounces of water to obtain 32 ounces of 28% solution of acetic acid.

Stock solutions: A stock solution is a solution in a concentrated form. It must be diluted for proper use.

Replenisher solutions: A replenisher solution will not revive an exhausted developer solution. A replenisher solution is used mainly to maintain the desired level of the developer solution. It helps to prolong the life of a developer.

Replenisher may be added to a developer when the quantity has fallen below the working level of the tank. Enough may be added to return the developer to its proper working level.

Replenisher may be added to a developer after a certain amount of film has been developed. After 800 square inches of film have been developed in a 4-gallon solution, 8 ounces of replenisher may be added to the developer, even if this involves discarding a small amount of the original developer.

A good check on the strength of the developer solution is to shoot a dozen pictures of a subject. Develop one when the developer is first mixed. As the developer is used, develop another one. Compare the last negative with the first negative developed; when the contrast and density of the negative fall below normal, discard the developer solution.

Water of crystallization

Care must be taken in the proper use of chemicals as to the amount of water they contain. The less water a dry chemical contains, the stronger it is. There are three common forms of chemicals used in photography. They are classified according to their water content.

a. Desiccated--Contains no water; dry.

b. Monohydrated--Contains one molecule of water per hydrate.

c. Decahydrated--Contains 10 molecules of water per hydrate.

One question which usually comes to mind about water of crystallization is, “Why not make all chemicals desiccated or dry?” This brings into the discussion the stability of that chemical to remain in the form in which it was made. Some chemicals absorb moisture form the air and others give off moisture into the air. The stability of a chemical is expressed in the following manner:

a. A stable chemical is one which will not absorb from, or give off moisture into, the air. It remains in its original form.

b. An efflorescent chemical is one which will become drier by giving off moisture to the air.

c. A hygroscopic chemical is one which will absorb moisture from the air, thereby making that chemical contain more water.

d. A deliquescent chemical is one which will absorb moisture from the air to such an extent that it will dissolve in the absorbed water.

Thermometers--The common-type thermometers are Fahrenheit and Centigrade. Freezing point on the Fahrenheit is 32 degrees; boiling point is 212 degrees. The freezing point on Centigrade is 0 degrees; the boiling point is 100 degrees.

To change Fahrenheit to Centigrade: Subtract 32 from Fahrenheit temperature; divide by 1.8.

To change Centigrade to Fahrenheit: Multiply Centigrade temperature by 1.8; add 32.

1-8. THE RECOMMENDED PUBLICATION TO REFERENCE FOR OBTAINING INFORMATION ABOUT PHOTOGRAPHIC CHEMICALS, SOLUTIONS, AND FORMULAS.

The Photo Lab Index, published by Morgan and Morgan, is available in most photographic laboratories. It contains a wealth of information and is the primary reference source for information of a technical nature pertaining to photography.

	(54) The Photo Lab Index, published by Morgan and Morgan, is available in most photographic laboratories. It is an accountable publication. An accountable publication available in most photo labs is the _________ __________ __________.
Photo Lab Index	(55) The Photo Lab Index contains a wealth of information and is the primary reference source for information of a technical nature. Information pertaining to photographic chemicals, solutions, and formulas can be obtained from the _________ __________ __________.

Photo Lab Index	(56) The Photo Lab Index is the recommended publication to reference for information pertaining to photographic chemicals, s __________ and f __________.
solutions formulas	(57) State the recommended publication reference for obtaining information about photographic chemicals, solutions, and formulas. ______________________________

EXERCISE

8. The recommended publication for obtaining information concerning photographic chemicals, solutions, and formulas is

a. photographic technical bulletins.

b. the Manual of Naval Photography.

c. The Photo Lab Index.

d. TM 11-401-1, Pictorial Fundamentals.

1-9. IDENTIFY CONTAINERS AND CHEMICALS WITH THE PROPER METHOD OF STORAGE FOR EACH.

a. When chemicals are received from supply and unpacked and checked into the storeroom, they should be stored and arranged so that as little damage as possible will occur.

b. All liquids should be stored on the bottom shelves. If a bottle should accidentally break, less damage would occur to the other chemicals. Chemicals in large bottles and containers are stored on the lower shelves for ease in handling.

c. Chemicals that react violently with each other should be stored separately to prevent explosion or fire.

d. In the Mobile Photo Labs (ES-38, ES-82), chemical solutions in glass or hard plastic containers should be separated by sheets of cardboard, have rubber matting underneath, and be lashed down in small lots when the mobile lab is on the move.

	(58) When chemicals are received from supply and have been unpacked and checked into the storeroom, they should be stored and arranged so that as little damage as possible will occur. (NO RESPONSE REQUIRED)
	(59) All liquids should be stored on the bottom shelves. If a container should accidentally break, only the bottom shelf and the floor will be damaged. All _________ should be stored on the _________ shelves.
liquids bottom	(60) Chemicals in large bottles and containers are stored on the lower shelves for ease in handling. For ease in handling, store large containers on the _________ shelves.
lower	(61) Chemicals that react violently with each other should be stored separately to prevent an explosion or fire. State how chemicals that react violently with each other should be stored, and why. ______________________________ ______________________________ ______________________________
separately to prevent an explosion or fire	(62) Match the list of chemicals and containers on the following page with the proper method of storage for each, by placing the letters in front of Column 1 in the blanks by Column 2.

Column 1 Chemicals & Containers	Column 2 Methods of Storage
a. Chemicals in large containers.	___ Separately to prevent explosion or fire.
b. Chemicals that react violently with each other.	___ Bottom shelves to prevent excessive damage if accidentally broken.
c. Liquids in bottles.	___ Lower shelves for ease in handling.

Column 2
b.
c.
a.

(63) Corrosive acids are stored in thick-walled glass containers protected by by a wooden frame or box.

State how corrosive acids are stored.
____
____

In thick-walled glass containers protected by a wooden frame or box.

(64) Loaded in the photo vans, chemical solutions in glass containers should be separated by sheets of cardboard, have rubber matting underneath, and be lashed down in small lots when the photo van is on the move.

Chemical solutions in glass containers in photo vans should be stored with _________ between the containers and _________ _________ underneath the containers.

cardboard
rubber matting

(65) Match the list of chemicals and containers below with the proper method of storage for each, by placing the letters in front of Column 1 in the blanks by Column 2.

Column 1
Chemicals & Containers

a. Liquids in bottles.

b. Corrosive acids.

c. Glass containers in photo van.

d. Chemicals in large containers.

e. Chemicals that react violently with each other.

Column 2
Method of Storage

___ Lower shelves for ease in handling.

___ Rubber matting underneath and cardboard in between.

___ Separately, to prevent explosion or fire.

___ Bottom shelves to prevent excessive damage if accidentally broken.

___ Stored in thick-walled glass containers protected by a wooden frame or box.

Column 2

a.
c.
e.
a.
b.

EXERCISE

9. Chemicals that react violently with each other should be stored (select one)

   a. in airtight containers to prevent oxidation.

   b. separately, to prevent an explosion or fire.

   c. on bottom shelves to prevent excessive damage if accidentally broken.

   d. separated by sheets of cardboard, and placed on sheets of rubber matting.

1-10. WAYS PHOTO LAB PERSONNEL COULD BECOME POISONED WHEN WORKING WITH PHOTOGRAPHIC CHEMICALS.

When working around chemicals, precaution should be taken to prevent poisoning. There are three ways photographic personnel can become poisoned:

(1) INGESTION - The taking of chemicals into the digestive system by using beakers or similar vessels as drinking cups. Also by contamination of cups from chemicals. Don't mix chemicals in vessels used by personnel for drinking purposes.

(2) INHALATION - The taking of chemicals into the respiratory system by breathing of fumes, mist, or dust. Wear protective breathing apparatus when working with chemicals. Keep adequate ventilation in the area at all times and use fans or other devices when mixing chemicals.

(3) SKIN CONTACT - The most likely means of poisoning. Be aware of antidotes for chemicals you are using and follow recommended procedures with even the slightest contact.

---

(66) When mixing or working around photographic chemicals, precautions should be taken to prevent poisoning. There are three ways in which photo lab personnel can become poisoned:

	(a) Ingestion - The taking of chemicals into the digestive system by using beakers or similar vessels as drinking cups. (b) Inhalation of fumes, mist, and dust. (c) Skin contact - This is the most likely method of becoming poisoned. (NO RESPONSE REQUIRED)
	(67) Photo lab personnel may become poisoned by _________, _________ or skin contact.
ingestion inhalation	(68) The most likely method of becoming poisoned is by _________ __________.
skin contact	(69) Photo lab personnel can become poisoned by one of three methods: (a) _____________________________ (b) _____________________________ (c) _____________________________
(a) Ingestion (b) Inhalation (c) Skin contact	

EXERCISE

10. Of the several ways in which photo lab personnel can become poisoned, the most likely method is by (select one):

a. ingestion.

b. inhalation.

c. injection.

d. skin contact.

1-11. CHEMICAL CLASSIFICATION WITH THE POTENTIAL HAZARD OF EACH CLASS.

a. All chemicals should be considered as potentially hazardous. They are classed in the following manner:

CLASS I - EXTREMELY DANGEROUS -- can cause blinding, paralysis, or death.

CLASS II - CORROSIVES -- can cause severe skin damage.

Example: Strong acids, such as Glacial acetic acid, and caustic chemicals.

CLASS III - ALLERGY PRODUCERS -- allergies may develop within a few days or may take years.

Example: sodium sulfate, sodium borate, etc.

CLASS IV - POISONOUS -- good ventilation is a MUST.

Example: Carbon tetrachloride.

	(70) All chemicals should be considered as potentially hazardous. Some of the most dangerous chemicals are listed as: Classes 1, 2, 3, and 4. All chemicals are ________ to be potentially _________________.
considered hazardous	(71) The most dangerous chemicals are listed as classes _________________, ______________, ______________ and __________________.
1, 2, 3 and 4	(72) Chemicals listed in class 1 are extremely dangerous, can cause blindness, paralysis, or death and should NOT be used in a photo lab. Class _______ chemicals are _____ ______ and should NOT be used in a photo lab. Methanol (Methyl or wood alcohol) is a class 1 chemical.

1 extremely dangerous	(73) Class 1 chemicals are extremely dangerous, can cause blindness, paralysis, or death and should NOT be used in the photo lab. An example of a class 1 chemical is _____________.
Methanol (Methyl or wood alcohol)	(74) Class 2 chemicals are corrosives. Strong acids and caustic chemicals which will burn, blister, or destroy skin tissue are class 2 chemicals. Corrosives such as strong acids and caustic chemicals are ____________ ___________ chemicals.
class 2	(75) Class 2 chemicals can cause severe damage to eye and skin tissue. Every precaution should be taken to prevent class 2 chemicals from splashing into the eyes or making contact with the skin. (NO RESPONSE REQUIRED)
	(76) Allergy producers, such as phenylenediamine, mono-methylamine phenol, hydroquinone, sodium bisulfite, sodium borate, and sodium sulfate are listed as class 3 chemicals. Allergy producers are class ______ chemicals.
3	(77) Solvents are listed as class 4 chemicals and should be regarded as poisonous. When working with solvents, good exhaust venting and forced ventilation are a MUST. Class 4 chemicals should be regarded as _______ and used ONLY with a good ventilation.

poisonous

(78) Match the chemical classification in Column 1 with the potential hazard of each in Column 2 by placing the letters in Column 1 in the appropriate blanks in Column 2.

Column 1 Classes	Column 2 Potential Hazard
a. Class 1	___ Corrosives, which can cause burns, blisters, and destroy skin tissue.
b. Class 2	___ Extremely dangerous, can cause blindness, paralysis, or death.
c. Class 3	___ Should be regarded as poisonous and used ONLY with good ventilation.
d. Class 4	___ Considered to be allergy producers.

Column 2

b.
a.
d.
c.

EXERCISE

11. Photographic chemicals considered most dangerous are listed as classes (select one)

a. 1, 2, 3, and A.
b. A, B, C, and D.
c. 1, 2, 3, and 4.
d. A, B, 3, and 4.

12. Burns, blisters, and destruction of skin tissue can result from contact with class _____ chemicals. (Select one.)

a. 1

b. 2

c. 4

d. 3

1-12. For additional information regarding the classification, handling, safeguard and antidote for poisonous chemicals, read the following ENRICHMENT MATERIAL.

Classification of Dangerous Chemicals

All chemicals should be considered potentially hazardous. Some of the most dangerous chemicals are listed as Classes 1, 2, 3, and 4.

Class 1--Chemicals listed as class 1 are extremely dangerous and should NOT be used in the photo lab. Methanol (methyl or wood alcohol) is a class 1 chemical. If taken internally, methanol can cause blindness, paralysis, or death.

Class 2--These chemicals are corrosives. Class 2 chemicals are strong acids and caustic chemicals which will burn, blister, and destroy skin tissue. The following are examples of class 2 chemicals:

a. Glacial acetic acid--One of the most dangerous chemicals commonly used in the photo lab.

b. Formaldehyde, 37% solution (Formalin) --Vapors from formaldehyde are irritating to the nose, throat, and chest areas. Severe eye damage can result from splashing and vapors.

c. Bromine--Exposure to 15 parts per million (ppm) causes throat irritation. Concentration of 1,000 ppm for a few minutes is fatal.

d. Sulfuric acid--A strong oxidizing agent, which can destroy the skin and cause severe and painful burns. The fumes from sulfuric acid can severely damage lung tissue.

e. Sodium hydroxide–A chemical used in many developers for machine processing. It is very corrosive and may cause burns and dermatitis if it comes into contact with the skin. EVERY PRECAUTION SHOULD BE TAKEN TO PREVENT CLASS 2 CHEMICALS FROM SPLASHING INTO THE EYES OR MAKING CONTACT WITH THE SKIN.

Class 3 chemicals are allergy producers–Allergies may develop within a few days after exposure, or they might not be detected for years. The degree of sensitivity to a chemical varies with individuals. Phenylenediamine, mono-methylamine phenol, hydro-quinone, sodium bisulfite, sodium borate (borax), and sodium sulfate are examples of class 3 chemicals.

Class 4, Solvents–All solvents and their vapors should be regarded as poisonous. When working with any type of solvent, good exhaust venting and forced ventilation are a MUST. Tetrachlorethylene is considered the safest of all the solvents. Carbon tetrachloride, on the other hand is considered the most dangerous. Carbon tetrachloride can cause liver and kidney damage, or death as a result of paralysis of the brain. When heated, carbon tetrachloride gives off phosgene gas. THIS SOLVENT IS SO DANGEROUS THAT IT HAS BEEN OUTLAWED IN THE ARMY.

Fire/Explosive Hazard chemicals:

Many photographic chemicals are potential fire or explosive hazards and must be handled as such. Among the most common are:

Sulfuric acid--A strong dehydrating agent that extracts moisture from most materials. Film, wood, and paper can be ignited by sulfuric acid.

Glacial acetic acid--In strong concentrations is a very dangerous chemical.

NOTE: FOR DARKROOM USE, ACETIC ACID SHOULD BE DILUTED TO 28%.

Acetic acid is incompatible with chromic acid (tray cleaner), nitric acid, and sodium peroxide. If combined with strong oxidizing chemicals, acetic acid will explode.

Hydrogen peroxide--In concentrations of 30% to 70% is a fire hazard.

Sodium hydroxide--A combustible chemical which heats spontaneously when in contact with moisture and air.

Potassium permanganate is explosive when treated with sulfuric acid, and a fire hazard if mixed with glycerine.

Alcohols--Vaporize at low temperatures, and due to the low flash point, are a dangerous fire hazard.

A CYANIDE AND AN ACID SHOULD NEVER BY MIXED, BECAUSE THEY WILL PRODUCE A DEADLY POISONOUS GAS.

POISONING

There are three ways in which photo lab personnel could be poisoned.

Ingestion--The taking of chemicals into the digestive system by using beakers or similar vessels as drinking cups.

Inhalation of fumes, mist, and dust--The chemical mixing room is a hazardous area. The chemical mix area must have a good ventilation system.

Skin contact--This is the most likely method of becoming poisoned. Photographers are often reluctant to use rubber gloves or print tongs. This is not only foolish but potentially dangerous.

BASIC CHEMICAL SAFETY RULES:

ALWAYS WEAR PROTECTIVE CLOTHING WHEN POURING STRONG ACIDS OR ALKALIES.

ALWAYS ADD ACID TO WATER--NEVER ADD WATER TO ACID.

NEVER MIX AN ACID AND A CYANIDE.

PROMPTLY WASH DOWN ANY SPILLS.

READ AND OBEY ALL WARNING LABELS ON DANGEROUS CONTAINERS.

POST A LIST OF ANTIDOTES IN STORAGE AND MIXING ROOMS.

STORE ALL CHEMICALS IN A COOL, DRY, DARK SPACE.

<u>NEVER</u> STORE DANGEROUS CHEMICALS UNLESS THE CONTAINERS ARE MARKED PLAINLY AND LEGIBLY.

<u>NEVER</u> STORE POISONOUS OR CORROSIVE CHEMICALS ON HIGH SHELVES.

<u>NEVER</u> KEEP CYANIDES IN THE PHOTO LAB.

<u>ALWAYS</u> USE COVERS ON STORAGE AND REPLENISHER TANKS.

<u>USE COMMON SENSE</u>

The following list is comprised of the most dangerous chemicals you will encounter at a photo lab and their antidotes. It is recommended that you keep this list handy during any chemical mixing in anticipation of an accident.

<u>DANGEROUS PHOTOGRAPHIC MATERIALS AND THEIR ANTIDOTES:</u>

1. ACETIC ACID, GLACIAL (99 1/2% pure compound of acetic acid)

   Clear, colorless, strongly acid FLAMMABLE liquid. When pure, undergoes partial or complete crystallization if kept below its melting point (61.9°F) for any appreciable length of time. Flash point: 110°F; very pungent odor; DANGEROUS FIRE HAZARD! Burns skin on contact; CAUSTIC vapors injure eyes, penetrate and burn skin, and injure respiratory areas.

   Add acid slowly to water, stirring constantly. Acid can cause serious burns.

   <u>Antidote, external</u>--Flood with water immediately.

   <u>Antidote, internal</u>--Give magnesia, chalk, or whiting in water.

2. ACETONE

   Colorless liquid; characteristic odor. Flash point: 15°F.; EXTREMELY FLAMMABLE! DANGEROUS! Use with adequate ventilation; POISONOUS and NARCOTIC volatile vapors.

   <u>Antidote, external</u>--Flood with water immediately.

   <u>Antidote, internal</u>--Give magnesia, chalk, or whiting in water.

3. ACIDS - <u>See specific kind</u>:

   ACETIC ACID, GLACIAL
   BENZOIC ACID
   HYDROCHLORIC ACID
   NITRIC ACID
   OXALIC ACID
   SULFAMIC ACID
   SULFURIC ACID

4. ALCOHOLS - <u>See specific kind</u>:

   ETHYL ALCOHOL (Grain alcohol)
   ISOPROPYL ALCOHOL
   METHYL ALCOHOL (Wood alcohol)
   TERTIARY BUTYL ALCOHOL

5. 2-AMINO-5-DIETHYLAMINOTOLUENE MONOHYDROCHLORIDE

Pinkish crystals. WARNING: This chemical contains 5% or more of an aromatic amine. Avoid contact with solutions, and do NOT inhale its dust!!

This is an organic reagent used in color forming and color coupling developers, and has been responsible for serious skin eruptions in the case of users susceptible to it. It has the property of sensitizing persons previously immune, so that negative reaction in the past does not necessarily insure against positive reaction from present use. ALWAYS WEAR RUBBER GLOVES WHEN HANDLING EITHER THE POWDER OR SOLUTION FORM, AND DO NOT INHALE ITS DUST OR FUMES.

It may be assumed that it is a violent POISON if taken internally; at present, it has not been in wide enough use for specific antidotes to be known and listed. As soon as such information becomes available, it will be published as a supplement.

<u>Antidote, external</u>--Use speed in removing contaminated clothing, and flush affected areas with copious amounts of water.

<u>Antidote, internal</u>--Give emetics of mustard and water, or emulsion of soap and water.

6. AMINO DIMETHYLANILINE MONOHYDROCHLORIDE

Pinkish to red crystals or powder. WARNING: This chemical contains 5% or more of an aromatic amine. Avoid contact with solutions, and do NOT inhale its dust!!

This is an organic reagent used in color forming and color coupling developers, and has been responsible for serious skin eruptions in the case of users susceptible to it. It has the property of sensitizing persons previously immune, so that negative reaction in the past does not necessarily insure against danger from present use. ALWAYS WEAR RUBBER GLOVES WHEN HANDLING EITHER THE POWDER OR SOLUTION FORM, AND DO NOT INHALE ITS DUST OR FUMES.

It may be assumed that it is a violent poison if taken internally; at present, it has not been in wide enough use for specific antidotes to be known and listed. As soon as such information becomes available, it will be published as a supplement.

<u>Antidote, external</u>--Use speed in removing contaminated clothing and flush affected areas with copious amounts of water.

<u>Antidote, internal</u>--Give emetics of mustard and water, or emulsion of soap and water.

7. AMMONIUM BICHROMATE--(See Ammonium Dichromate)

8. AMMONIUM DICHROMATE

Yellow needles. EXPLOSIVE when in contact with many substances. HAZARDOUS: Can irritate and ulcerate skin and tissues to a serious degree. (Used in lithographic solutions.)

<u>Antidote, external</u>--Wash affected areas immediately and copiously with water; follow with saturated solution of boric acid.

9. AMMONIUM HYDROXIDE

Colorless liquid. Fire and explosion hazard present, but considered small. CAUTION: Liquid causes burns, and vapor is extremely irritating. (Used in lithographic solutions.)

Antidote, external--Wash affected areas immediately and copiously with water; follow with saturated solution of boric acid.

10. ANILINE

Oily liquid; colorless when freshly distilled, darkening on exposure to light and air. POISONOUS when absorbed through the skin, and when vapors or dust are inhaled. FLAMMABLE!! COMBUSTIBLE!!

Antidote, external--Remove contaminated clothing, flood affected areas with water, and wash with soap. If eyes are affected, irrigate with warm water for 15 minutes.

Antidote, internal--Give emetic (mustard and water, or soap and water). Give cold effusions and stimulants such as ammonia, fresh air, and oxygen. Also, give plenty of milk or black coffee, camphor, or ether-but no alcohol or castor oil.

11. ATHENON–(See Parahydroxyphenol Aminoacetic Acid)

12. BENZENE (Benzol)

Clear, colorless, FLAMMABLE liquid; characteristic odor. Its very harmful POISONOUS and NARCOTIC vapors burn with a very smoky flame. Flash point: 12°F. DANGEROUS FIRE and EXPLOSION HAZARD!!

Antidote, external--Flood affected areas with water; follow with saturated solution of boric acid.

Antidote, internal--Give magnesia, chalk, or whiting suspended in water; follow with mustard emetic.

13. BENZOIC ACID

White crystalline needles or scales. FLAMMABLE!! A moderate FIRE HAZARD.

14. BENZOL–(See Benzene)

15. CALCIUM CHLORIDE

White deliquescent crystals, granules, lumps, or flakes. CAUTION: Keep container tightly closed! This chemical liberates much heat when dissolved in water, so its use as a dehydrating agent generally has been replaced by silica gel.

Antidote, external--Flood affected areas with water; follow with saturated solution of boric acid.

Antidote, internal--Give magnesia, chalk, or whiting suspended in water; follow with mustard emetic.

16. CARBOLIC ACID (See Phenol)

17. CARBON TETRACHLORIDE

Colorless liquid; peculiar odor, yielding heavy vapors. POISONOUS! VAPOR AND LIQUID VERY HARMFUL!! Use of this chemical has been outlawed for use in the Navy because of its EXCEEDINGLY HARMFUL TOXIC QUALITIES!! Absorption of poison through the skin also is dangerous.

Use only in well ventilated areas. Avoid exposure to fumes and contact with skin.

Antidote, external--Flood affected areas with water immediately.

Antidote, internal--Remove patient into fresh air immediately; give magnesia, chalk, or whiting suspended in water; follow with mustard emetic.

18. CUPRIC SULFATE (Copper sulfate)

Blue crystals, slowly efflorescing in air--Almost white when dehydrated. POISONOUS!!

Antidote, internal--Give emetics, or use stomach siphon; after patient has been relieved, give white of eggs freely, also charcoal, iron filings, magnesia, and pure potassium ferrocyanid. DO NOT GIVE MILK OR FATTY ACIDS!!

19. ETHYL ALCOHOL (Grain alcohol)

Colorless, limpid, volatile liquid. Flash point: 57°F. DANGEROUS, FIRE HAZARD!

Antidote, external--Flood affected areas with water.

Antidote, internal--Give emetic of mustard, followed with bicarbonate of soda in water. Repeat soda at short intervals.

20. FERRIC OXALATE

Pale yellow amorphous scale or powder; odorless; POISONOUS!!

Antidote, external--If affected externally, wash with water; notify the medical officer.

Antidote, internal--Give magnesia, chalk, or whiting suspended in water; follow with mustard emetic.

21. FORMALDEHYDE (Formalin)

Clear, colorless, liquid; suffocating, pungent odor. POISONOUS! Causes intense irritation of nose, eyes, and throat. Avoid contact with skin.

Antidote, external--Give inhalation of ammonia.

Antidote, internal--Give ammonia in dilute solution, and follow with mustard emetic; then provide demulcent drinks.

22. FORMALIN (See Formaldehyde)

23. GLYCIN (See Parahydroxyphenol Aminoacetic Acid)

24. GRAIN ALCOHOL (See Ethyl Alcohol)

25. HYDROCHLORIC ACID

Clear pungent, colorless, FUMING liquid, or colorless gas. HIGHLY CORROSIVE! POISONOUS! Liquid burns flesh on contact; vapor exceedingly injurious to tissues. On contact with metals, can evolve hydrogen gas, an EXPLOSION and FIRE HAZARD!

Add acid slowly to water, stirring constantly. NEVER add the water to the acid, so as to avoid splattering of solution and glass container breakage caused by heat evolved by mixing.

Antidote, external--Flood with water immediately, and wash with copious lather of soap; then cover with moist sodium bicarbonate, or magnesia.

Antidote, internal--Give a tablespoonful or more of magnesia, chalk, whiting, wall plaster, or soap flakes in water, milk, mucilage, or raw egg whites.

26. HYDROGEN PEROXIDE

Colorless, heavy liquid. CORROSIVE and active oxidizing agent; not combustible in itself, but can produce violent combustion if brought into contact with combustible materials (catalytic metals--iron, copper, chromium and their salts or vapors). Concentrated solutions (over 27.5%) and their mists and vapors are extremely irritating.

DANGEROUS: Liquid burns skin on contact; mists or vapors injure eyes, penetrate and burn skin, and respiratory areas.

<u>Antidote, external</u>--Flood with water immediately.

<u>Antidote, internal</u>--Give whites of eggs, flour, or starch mixed with water; follow with mustard emetic. Give strong tea, coffee, stimulants of diluted alcohol, whiskey, or aromatic spirits of ammonia (1 teaspoonful in water). Provide demulcent drinks, if needed.

27. HYDROXYLAMINE HYDROCHLORIDE

Monoclinic colorless crystals. TOXIC! Can be absorbed through skin and cause toxic symptoms.

28. p-HYDROXYPHENOL GLYCIN (See Parahydroxyphenol Aminoacetic Acid)

29. IODINE

Heavy, grayish-black or violet-black plates or crystals with metallic lustre and characteristic odor. POISONOUS and CORROSIVE! Exposure to vapors constitutes an occupational hazard (skin eruptions) for photo processors, medical personnel and others in frequent contact with iodine.

<u>Antidote, external</u>--Flood with water immediately.

<u>Antidote, internal</u>--Give starch, whites of eggs, or flour mixed with water; follow with mustard emetic. Give strong tea, coffee, stimulants of diluted alcohol or whiskey or a teaspoonful of aromatic spirits of ammonia in water. Provide demulcent drinks, if needed.

30. ISOPROPYL ALCOHOL

Clear, colorless, mobile liquid. FLAMMABLE! Flash points: 91% = 62°F; 99% = 59°F. DANGEROUS FIRE HAZARD.

Antidote, external–Flood affected areas with water immediately.

Antidote, internal–Give mustard emetic; follow with dose of bicarbonate of soda in water. Repeat soda at short intervals.

31. MERCURIC CHLORIDE

White crystals or powder. VERY POISONOUS!! Do not breathe dust. When heated, this substance gives off poisonous mercury vapor. EXTREMELY DANGEROUS to handle and use. Use only in well-ventilated areas.

Antidote, external–Flood affected areas with water.

Antidote, internal–Give powdered charcoal, whites of eggs, flour, or starch mixed with a little water, followed by mustard emetic. Give strong coffee, tea, stimulants of diluted alcohol or whiskey, or spirits of ammonia (1 teaspoonful in water). Provide demulcent drinks, if needed.

32. MERCURIC IODIDE

Tetragonal red crystals or powder, or rhombic yellow crystals or powder. POISONOUS! EXTREMELY DANGEROUS!! Use only in well-ventilated areas.

Antidote, external–Flood affected areas with water.

Antidote, internal–Give powdered charcoal, whites of eggs, or flour or starch mixed with water; follow with mustard emetic. Then give strong tea or coffee, or stimulants of diluted alcohol or spirits of ammonia (1 teaspoonful in water).

33. METHYL ALCOHOL (Wood Alcohol)

Clear, colorless, mobile, volatile, FLAMMABLE liquid. POISONOUS. Flash point: 60°F. DANGEROUS FIRE HAZARD.

Antidote, external–Flood affected areas with water.

Antidote, internal--Give mustard emetic; follow with dose of bicarbonate of soda in water. Repeat soda at short intervals.

34. NITRIC ACID

Transparent, colorless or yellowish FUMING, SUFFOCATING, CAUSTIC, and CORROSIVE liquid. Burns flesh severely on contact; vapor extremely corrosive to tissues. DANGEROUS FIRE and EXPLOSION HAZARD. Causes fires and explosions on contact with organic materials or other easily oxidizable materials. When in contact with substances with which it reacts, it throws off toxic fumes which are likely to be the highly injurious oxide of nitrogen. It also increases the FLAMMABILITY of wood, cotton, and similar materials.

Add acid slowly to water, stirring constantly. Splattering acid could cause serious burns.

Antidote, external--Flood affected areas with water immediately, and wash with copious lather of soap; then cover with moist sodium bicarbonate or magnesia.

Antidote, internal--Give a tablespoonful or more of magnesia, chalk, whiting, wall plaster, or soap flakes in water, milk, mucilage, or raw egg whites.

35. OXALIC ACID

Transparent, colorless crystals. POISONOUS. Has strong, local CAUSTIC action on contact with skin and tissues. Avoid inhalation of dust, or mist from dust and room moisture, as well as contact with solutions.

Antidote, external--If affected externally, wash with water; notify medical officer.

Antidote, internal--Give magnesia, chalk, or whiting suspended in much water; follow with mustard emetic.

36. PARAFORMALDEHYDE

White, crystalline powder. A moderate FIRE HAZARD. When heated, it evolves a vapor which is FLAMMABLE and TOXIC. Its dust can form EXPLOSIVE mixtures with air.

Antidote, external--If this material gets into the eyes, irrigate immediately with warm water for 15 minutes, and report to an eye specialist.

Antidote, internal--Give milk freely, or one tablespoonful of ammonium acetate in a glass of water. In any event, cause vomiting three (3) times, and repeat dosage of milk, and raw eggs. Remove patient to fresh air, and keep him quiet and warm. Give stimulants such as strong coffee or tea, smelling salts, or aromatic spirits of ammonia (1 teaspoonful in a little water).

37. PARAHYDROXYPHENOL AMINOACETIC ACID (pHydroxyphenol Glycin; Glycin; Ansco; Athenon: Eastman Kodak Co.)

Glistening white or gray powder. POISONOUS.

38. PHENOL (Carbolic Acid)

White crystalline mass which turns pink or red under the influence of light, or if not perfectly pure, absorbs moisture from air and liquefies; has distinctive odor.

STRONG CORROSIVE POISON. Solid, solutions, and vapors corrosive on contact with skin and tissues. Exposure to toxic amounts can be LETHAL.

Antidote, external--Wash affected parts with alcohol or whiskey.

Antidote, internal--GIVE NO FATS OR OILS. Give emetic of 60 grains of zinc sulfate, or a tablespoonful of sodium chloride in a glass of warm water; then give epsom salts followed by demulcent drinks, such as flour and water, barley and oatmeal gruel.

39. POTASSIUM BICHROMATE

Bright, yellowish-red, transparent crystals. POISONOUS and powerful oxidizing agent. DANGEROUS FIRE and EXPLOSION HAZARD.

Antidote, internal--Give a tablespoonful of 3% hydrogen peroxide, and stimulants of diluted alcohol, or a tablespoonful of aromatic spirits of ammonia. Apply cold water to head and spine, and give inhalation of ammonia, and artificial respiration.

40. POTASSIUM CHLORATE

Transparent, colorless crystals or white powder. A very powerful oxidizing agent, and therefore a DANGEROUS FIRE and EXPLOSION HAZARD. POISONOUS.

41. POTASSIUM CYANIDE

White, granular salt. EXTREMELY POISONOUS. CAUTION: Dangerous to handle.

Cyanide is a deadly poison. Avoid exposure to its fumes, and always wear rubber gloves when handling it. Use it only in well-ventilated areas. Keep it away from acids, as it can react with acids to form deadly gases; mixed with hydrochloric acid, it forms deadly hydrogen cyanide gas.

Antidote, internal--Give a teaspoonful of hydrogen peroxide; apply cold water to head and spine; give stimulants of diluted alcohol; teaspoonful of aromatic spirits of ammonia in water; inhalation of ammonia; artificial respiration.

42. POTASSIUM FERRICYANIDE

Bright red, lustrous crystals or powder. POISONOUS.

Antidote, internal--Give a teaspoonful of 3% hydrogen peroxide, and stimulants of diluted alcohol, or a teaspoonful of aromatic spirits of ammonia. Apply cold water to head and spine, and give inhalation of ammonia, and artificial respiration.

43. POTASSIUM FERROCYANIDE

Lemon-yellow crystals or powder; efflorescent. POISONOUS.

Antidote, internal--Prompt treatment imperative. Give a tablespoonful of hydrogen peroxide, and apply cold water to head and spine. Give stimulants of diluted alcohol, or teaspoonful of aromatic spirits of ammonia in water; inhalation of ammonia; artificial respiration.

44. POTASSIUM HYDROXIDE

White, deliquescent pieces, lumps, sticks, pellets, or flakes having a crystalline fracture. Both solid and liquid forms are DANGEROUS CAUSTIC.

This substance is an alkali which causes burns on contact, and whose dusts or mists destroy tissues.

Always use COLD water to dissolve potassium hydroxide (caustic soda) and stir solution constantly while mixing to dissipate evolved heat that would crack glass containers and cause splattering and serious burns.

Antidote, external--Flood with water immediately, then wash with vinegar or diluted acetic acid (stop bath). For affected eyes, wash out with 5% boric acid solution.

Antidote, internal--Give vinegar or copious amounts of juice of lemon, grapefruit, or orange. Follow with olive oil.

45. POTASSIUM OXALATE

Colorless, transparent crystals. POISONOUS.

46. POTASSIUM PERMANGANATE

Dark purple crystals with blue metallic sheen. A powerful oxidizing agent; DANGEROUS FIRE and EXPLOSION HAZARD: POISONOUS if swallowed. CORROSIVE.

Antidote, external--Flood affected areas with water.

Antidote, internal--Give mustard emetic, and large amounts of water, strong tea or coffee, and demulcent drinks.

47. QUINONE

Yellow crystals; characteristic, irritating odor. TOXIC. Particularly dangerous to the eyes.

Antidote, external--Remove personnel showing toxic symptoms (eye irritation, photophobia, lachrymation, and burning sensations) to fresh air as soon as possible.

48. SILVER NITRATE

Colorless, transparent, tubular, rhombic crystals, becoming gray or gray-black on exposure to light in the presence of organic matter; odorless. CAUSTIC, CORROSIVE, and POISONOUS. A powerful oxidizing agent; DANGEROUS FIRE HAZARD: causes burns on contact, and mists or dusts destroy tissue.

Antidote, external--Flood with water immediately, then wash with salt solution.

Antidote, internal--Give copious draughts of table salt in water, followed by mustard emetic. Then give dose of magnesium sulfate (epsom salts) and follow with milk, raw eggs, or boiled starch.

49. SODIUM CYANIDE

White deliquescent granules or lumps. CAUTION: DANGEROUS to handle. It is CORROSIVE, EXTREMELY POISONOUS, and DANGEROUSLY REACTIVE. It can cause poisoning by ingestion as well as from skin contact, and in contact with acids or acid fumes, liberates hydrogen cyanide, a DEADLY, TOXIC, FLAMMABLE GAS and a DANGEROUS FIRE HAZARD.

Cyanide is a deadly poison. Avoid exposure to its fumes, and always wear rubber gloves when handling it. Use only in well-ventilated areas. Keep it away from acid, as it reacts with hydrochloric acid to form deadly hydrogen cyanide gas.

Antidote, external--Remove contaminated clothing, and flood affected parts with water, using soap to wash away all traces of the poison from the skin. If eyes are affected, irrigate for at least 15 minutes with copious amounts of warm water.

Antidote, internal--Give emetic of mustard and warm water, soapy water, or a pint of 1% solution of sodium thiosulfate solution every 15 minutes until vomiting occurs. Break an amyl nitrite pearl in a cloth and hold lightly over patient's nose for not more than 15 to 20 seconds. This treatment can be repeated every 5 minutes for 25 minutes. If patient is unconscious but breathing, give artificial respiration.

50. SODIUM HYDROSULFITE

A white to grayish-white crystalline powder with a sulfide odor. FLAMMABLE. DANGEROUS FIRE HAZARD. TOXIC. It can heat up spontaneously in moist air; when burning, it evolves sulfur dioxide fumes.

Antidote, external--Get affected personnel into fresh air; if eyes are affected, irrigate with copious amounts of warm water.

51. SODIUM HYDROXIDE (Caustic Soda; Lye)

White deliquescent pieces–lumps or sticks. DANGEROUS. Handle with care–it destroys organic tissues. COMBUSTIBLE. It heats spontaneously in contact with moisture and air, and may ignite nearby combustible materials. CAUTION: VERY CORROSIVE.

Always use COLD water to dissolve sodium hydroxide (caustic soda) and stir solution constantly while mixing to dissipate evolved heat that could crack glass containers and cause splattering and serious burns.

Antidote, external--Flood with water immediately, then wash with vinegar or dilute acetic acid (stop bath). For affected eyes, irrigate with warm water, then wash out with 5% boric acid solution.

Antidote, internal--Give vinegar or copious amounts of juice of lemon, grapefruit, or orange. Follow with olive oil.

52. SODIUM SULFIDE

Yellow or brick-red lumps or flakes. DANGEROUS FIRE HAZARD. In heat or acid fumes, it evolves highly TOXIC hydrogen sulfide; when it burns in air or oxygen, it liberates sulfur dioxide.

Antidote, external--Remove affected personnel to fresh air; if eyes are affected, irrigate with copious amounts of warm water.

53. SUCCINALDEHYDE

Kodak color prehardening agent HA-1 found in E-4, EA-4, EA-5, ME4, ME-5 color prehardener. An ASPHIXIATING chemical.

54. SULFAMIC ACID

White or colorless nonhygroscopic crystals; stable when dry–Slowly hydrolizes in solution, forming ammonium bisulfate. TOXIC. Harmful to unprotected eyes.

55. SULFURIC ACID

Dense oily, liquid; color variable, from colorless to dark brown, depending on purity. Miscible with water in all proportions, but use great caution in mixing, due to evolution of much heat which causes EXPLOSIVE splattering. Very reactive; always add acid to water, NOT water to acid. HIGHLY CORROSIVE–Dissolves most metals; concentrated acid oxidizes, dehydrates, or sulfonates most organic compounds. ALWAYS HANDLE WITH GREAT CAUTION. Physical contact with this acid rapidly destroys tissues, causing severe burns. When acid attacks metals, it generates highly FLAMMABLE hydrogenous gas, so it is a DANGEROUS FIRE HAZARD.

Always add sulfuric acid to the water slowly, and stir the solution constantly while mixing, to dissipate evolved heat that could crack glass containers. Water added to the acid would cause explosive splattering and inflict serious burns.

Antidote, external--Flood with water immediately, and wash with copious lather of soap; then cover with moist sodium bicarbonate or magnesia.

Antidote, internal--Give a teaspoonful or more of magnesia, chalk, whiting, wall plaster, or soap flakes in water, milk, mucilage, or raw egg whites.

56. TERTIARY BUTYL ALCOHOL

Colorless liquid, or rhombic prisms or planes. A FLAMMABLE liquid and a DANGEROUS FIRE HAZARD; a skin irritant.

Antidote, external--Removal from exposure is important.

Antidote, internal--Report ingestion or overexposure to the medical officer.

57. TERTIARY BUTYLAMINE BORANE (T BAB)

Kodak color redeveloping agent RA-1 found in E4, EA-4, EA-5, ME-4, ME-5 color developers.

A caustic chemical causing skin sensitization and infection (dermatitis).

58. WOOD ALCOHOL (See Methyl Alcohol).

LESSON 2

DETERMINING pH AND SPECIFIC GRAVITY

OBJECTIVE:

In this lesson you will learn how to utilize the pH meter to determine the acidity and alkalinity of a photographic developer and fixer, and you will use a hydrometer to measure the specific gravity of a photographic developer and fixer.

Upon completion of this lesson you will be able to:

1. Identify whether two or more solutions are acid or alkaline, given their pH readings.

2. Identify whether two or more solutions are lighter or heavier than distilled water, given their specific gravity readings.

3. List the steps used to operate a Beckman pH meter.

CREDIT HOURS... Hours

MATERIAL REQUIRED..None

SECTION I

2-1. pH METER. "pH" can be defined as the measurement of the acidity or alkalinity of a solution. The instrument used to measure pH is called a pH meter.

> NOTE: THERE ARE ALSO TWO CHEMICALLY INPREGNATED INDICATOR PAPERS USED TO READ THE pH OF SOLUTIONS. ONE IS CALLED LITMUS PAPER; THE OTHER PHYDRION. WHEN IMMERSED IN A SOLUTION THESE PAPERS WILL CHANGE COLOR. THEIR PARTICULAR CHANGE IN COLOR IS COMPARED TO A COLOR SCALE TO DETERMINE THE APPROXIMATE pH. FOR THIS LESSON, HOWEVER, CONCERN YOURSELF ONLY WITH THE pH METER.

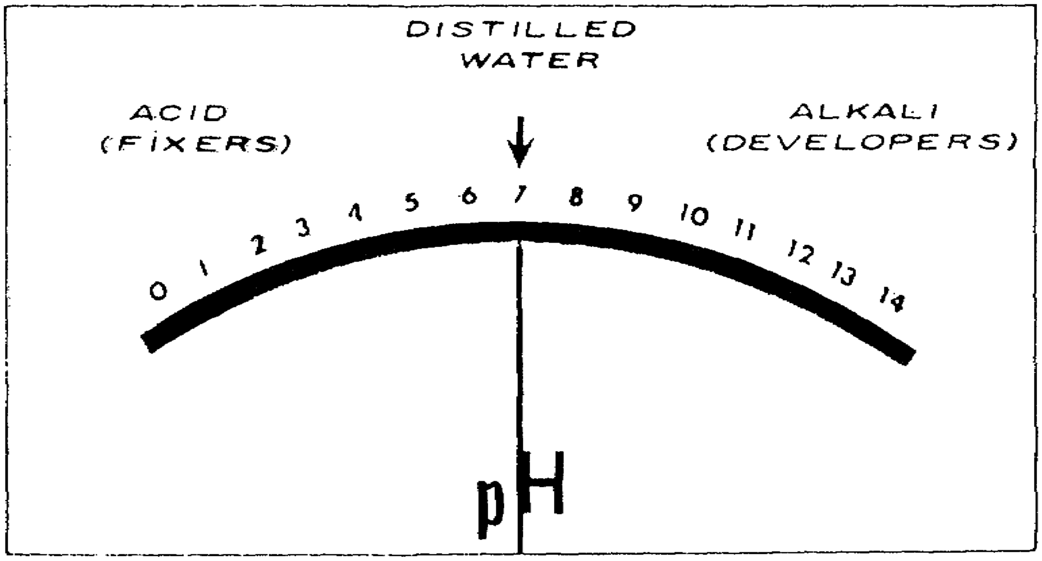


Figure 1

pH Scale

a. The pH scale on the meter (figure 1) ranges from 0 to 14. The center of the scale is a pH of 7 and represents distilled water, which is chemically pure water. It is neither acid nor alkaline.

b. Acids are found in the range from 7 to 0 on the pH meter. The closer to 0 the pH reads, the stronger the acid content of the solution being measured.

c. Alkalines are found in the range from 7 to 14 on the pH meter. The closer to 14 the pH reads the stronger the alkaline content of the solution that is being measured.

d. In photographic processing, you are concerned primarily with two solutions -- the developer and the fixer.

NOTE: THERE ARE, OF COURSE, OTHER SOLUTIONS UTILIZED IN PHOTOGRAPHIC PROCESSING AND EACH IS DESIGNED TO FUNCTION WITHIN A SPECIFIC pH RANGE. FOR NOW, WE WILL JUST TALK ABOUT THE DEVELOPER AND FIXER IN RELATION TO pH.

e. Developer solutions are alkaline; therefore, the pH readings would be between 7 and 14. (See figure 7).

f. Fixer solutions are acid, and read between 7 and 0 on the pH meter.

EXERCISE

1. Match the solutions in List B with the list of pH Readings.

pH Readings	List B
____ 1. pH2	A. strong acid.
____ 2. pH5	B. strong alkaline.
____ 3. pH7	C. distilled water.
____ 4. pH8	D. weak acid.
____ 5. pH12	E. weak alkaline.

2-2. IDENTIFY WHETHER TWO OR MORE SOLUTIONS ARE LIGHTER OR HEAVIER THAN DISTILLED WATER, GIVEN THEIR SPECIFIC GRAVITY READINGS.

a. “Specific Gravity” can be defined as the measurement of the weight of a solution in relation to the weight of distilled water.

b. The instrument used to measure the specific gravity of a solution is called a hydrometer. Distilled water is the standard for measurement of other solutions and has a specific gravity of 1.000. Solutions which are lighter than distilled water have specific gravities less than 1.000. Solutions which are heavier than distilled water have specific gravities greater than 1.000.

EXERCISE

2. A solution with a specific gravity of 1.520 is LIGHTER/HEAVIER than distilled water. (Circle the correct choice.)

2-3. THE FUNCTION AND OPERATION OF THE BECKMAN pH METER.

pH.

The Beckman pH meter (figure 2) is a laboratory instrument designed for rapid and accurate pH and millivolt measurement of liquids, pastes, and semisolids. The large meter face contains two scales. The pH scale is calibrated in 0.1 pH units with a range of 0 to 14. Temperature corrections may be made for 0° Centigrade to 60° Centigrade with plus or minus 1° Centigrade accuracy, and 60° Centigrade to 100° Centigrade with plus or minus 2° accuracy. A Beckman thermocompensator probe #39069 may be used for automatic temperature compensation. Memory variations must be recorded to compensate for amplifier drift. A class electrode #41263 and reference electrode, are supplied with the pH meter which provides satisfactory readings for a wide variety of analyses.

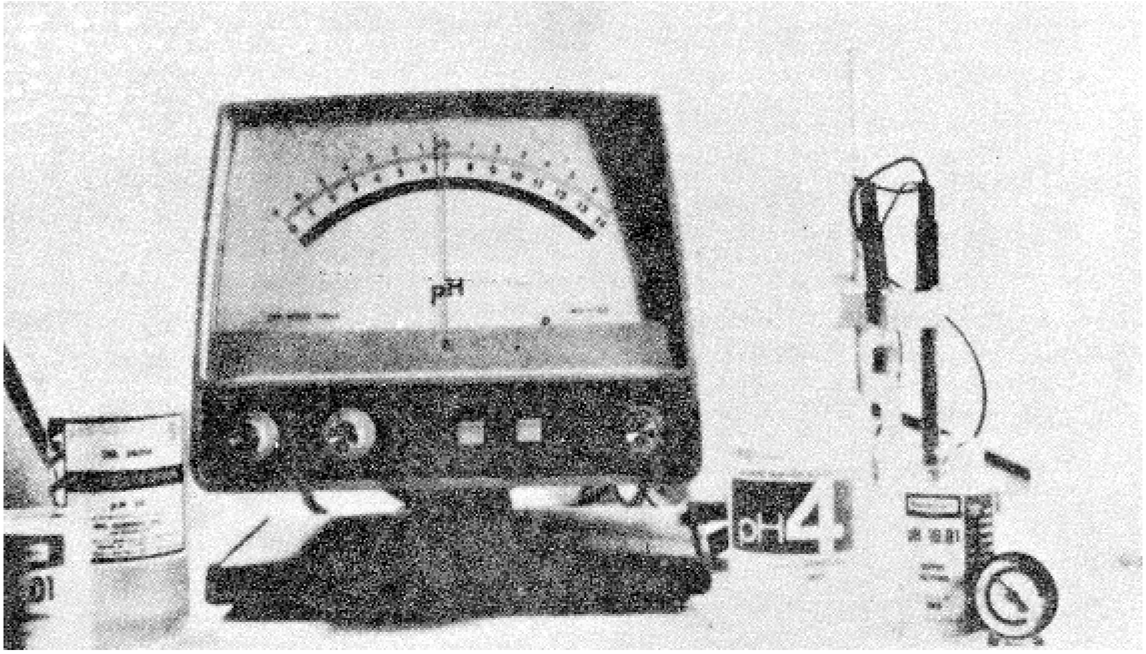


Figure 2

Overall View of the Beckman SS3 pH Meter.

OPERATION PROCEDURE:

1. Depress the STANDBY button and set the FUNCTION switch to pH. (Figure 3.)

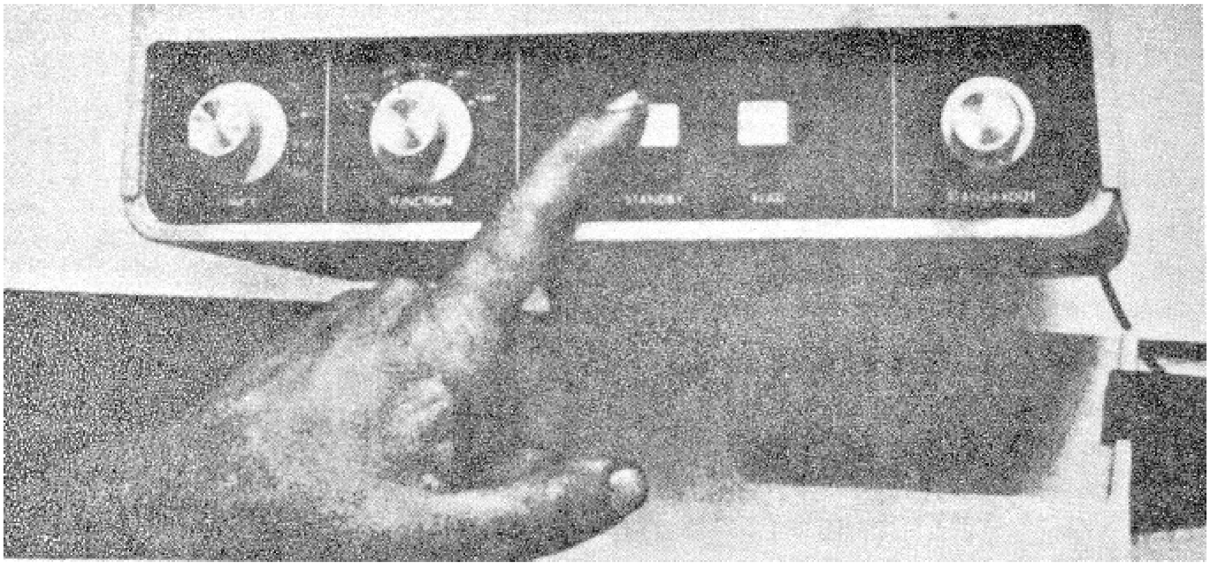


Figure 3

2. Obtain a buffer solution (figure 4) with a pH value as close as possible to the probable pH of the sample which is to be analyzed. EXAMPLE: pH 10 for developers or pH 4 for fixer.

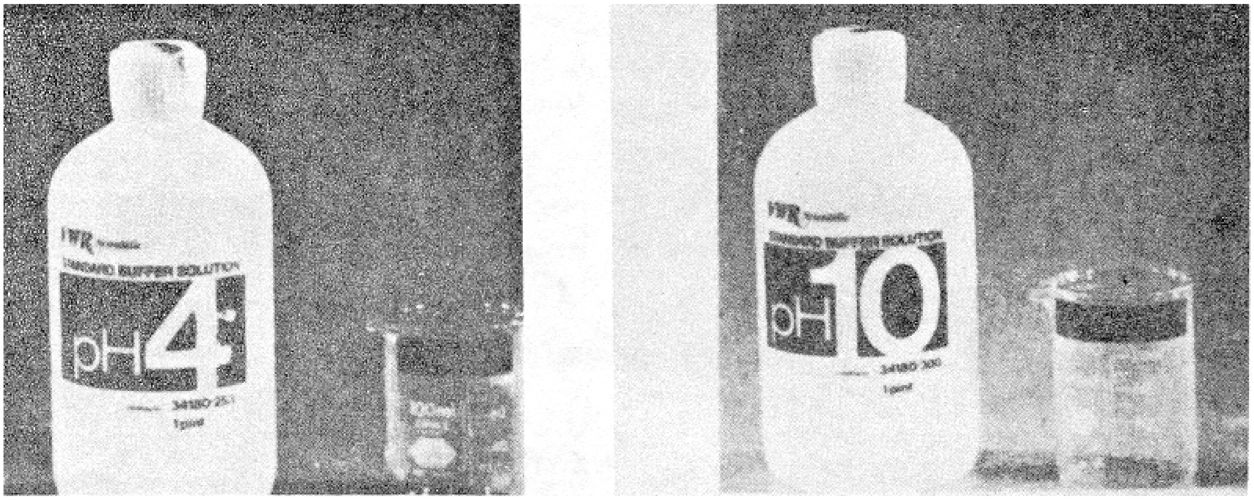


Figure 4

3. The buffer solution should be at the same temperature, if possible, as the sample to be analyzed. Measure the temperature of the buffer with a thermometer (figure 5) and set the temperature compensation dial (figure 6) at that temperature in degrees Centigrade.

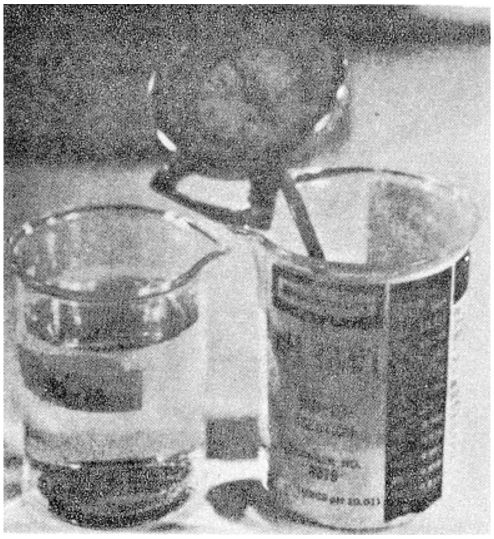


Figure 5

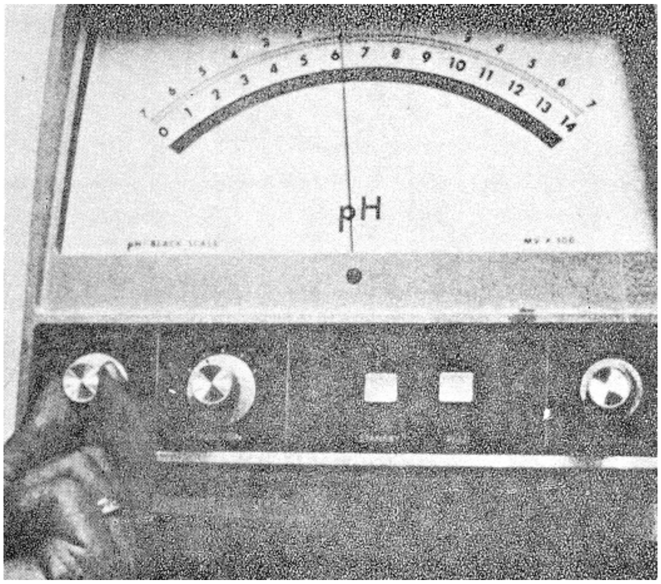


Figure 6

4. Grasp the electrode holder in the back, squeeze and raise the electrodes to the top of the rod (figure 7).

CAUTION: THE ELECTRODES ARE VERY FRAGILE, HANDLE CAREFULLY.

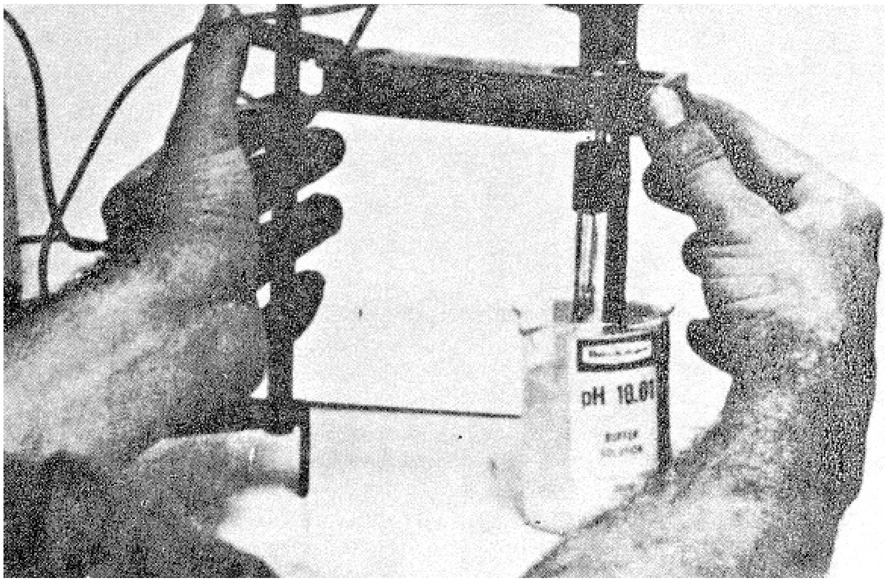


Figure 7

5. Slide the sleeve covering the filling hole of the electrode (figure 8) down, and check to see that the solution in the electrode is at the maximum level (figure 9). If not, check with the Work-Center Supervisor.

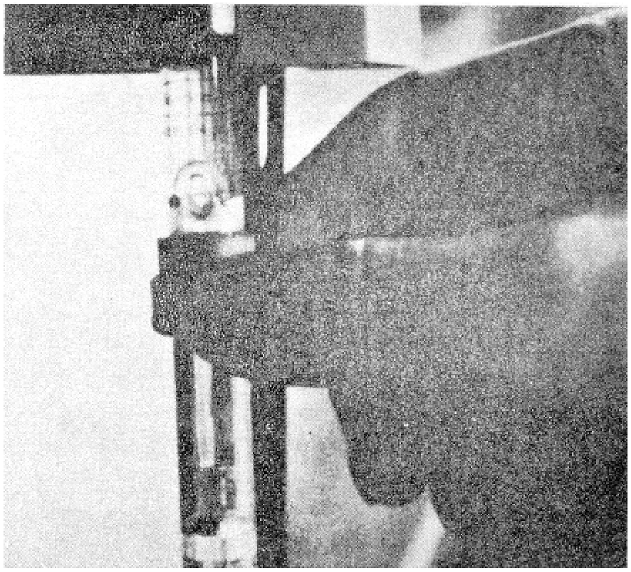


Figure 8

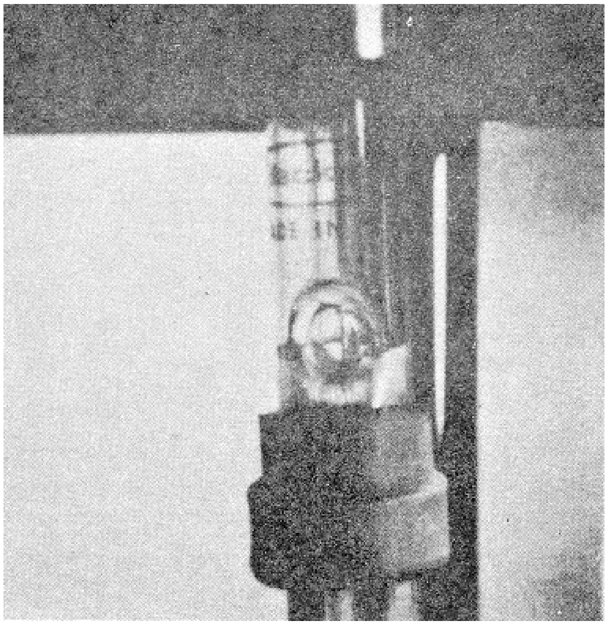


Figure 9

6. Using a large beaker, rinse the electrode with distilled water (figure 10) and wipe off the excess water with a soft tissue (figure 11).

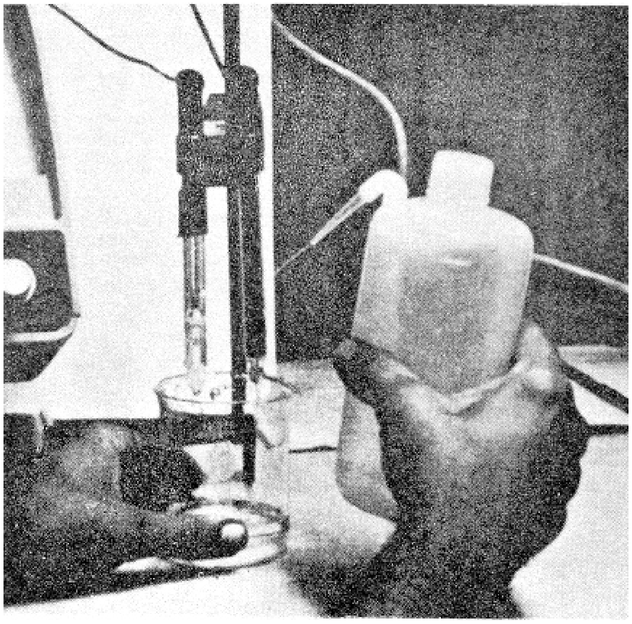


Figure 10

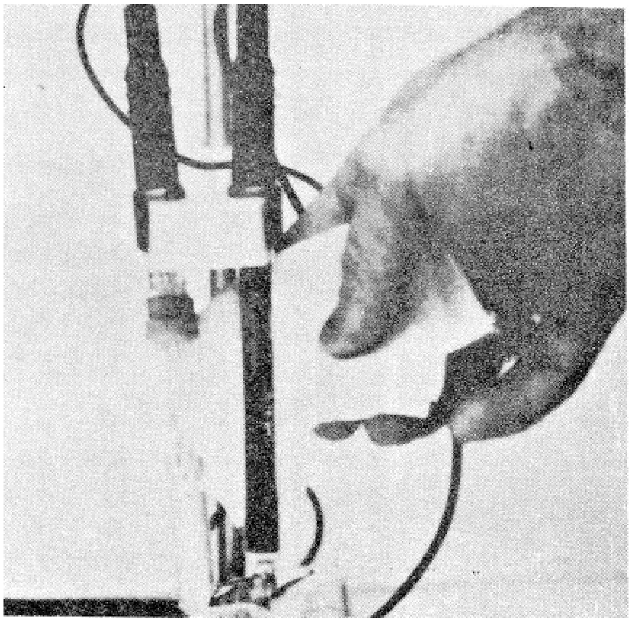


Figure 11

7. Carefully immerse the tip (approximately 1/2 inch) into the pH10 buffer solution by squeezing the rear of the electrode holder and lowering the electrodes (figure 12).

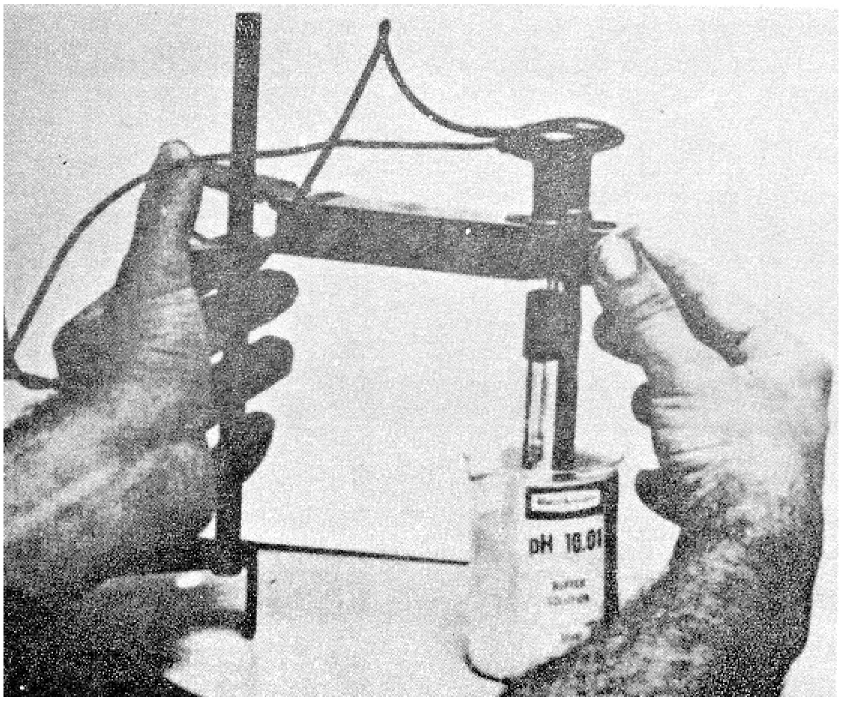


Figure 12

8. Depress the READ push button (figure 13).

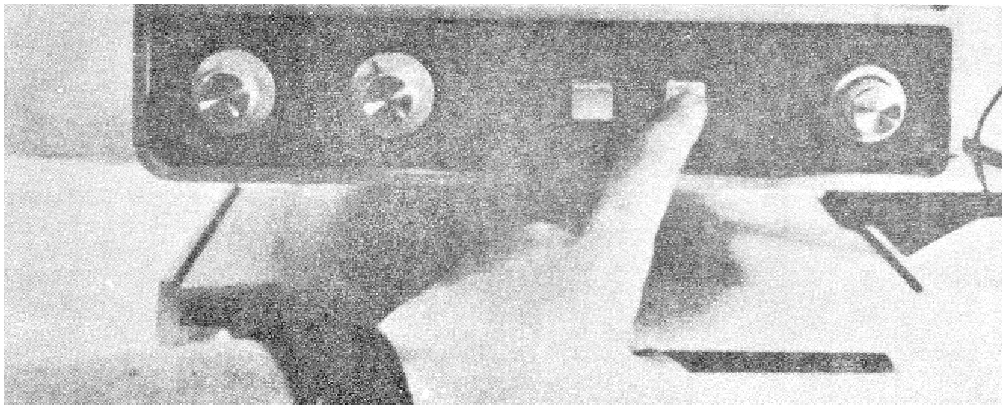


Figure 13

9. Unlock the STANDARDIZE knob rotating the outer ring counterclockwise and adjust the pH scale (black dial) to correspond with the pH of the buffer (figure 14).

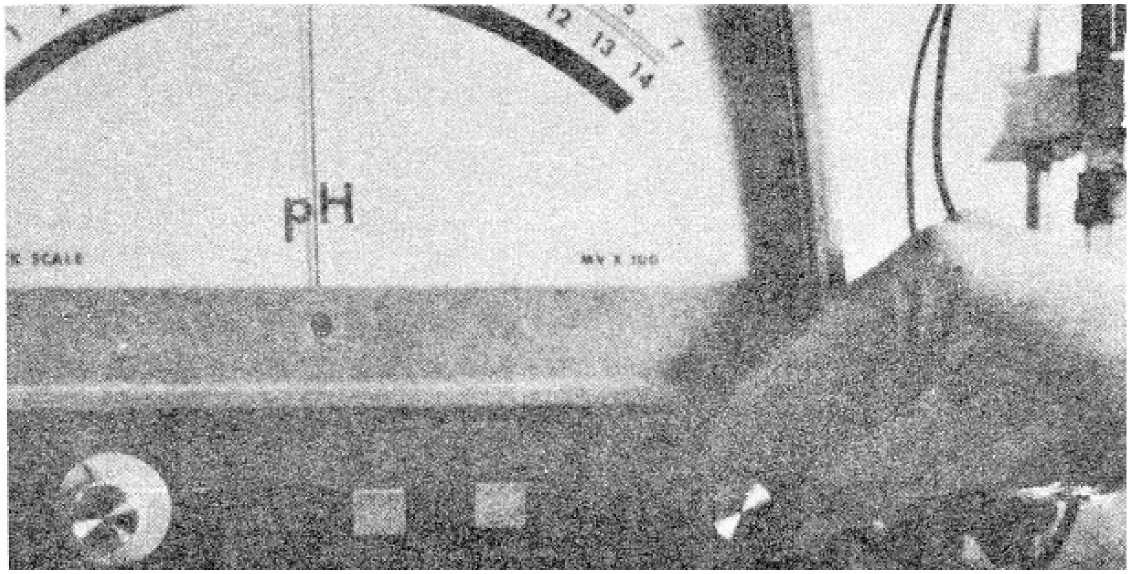


Figure 14

10. Depress the STANDBY push button (figure 15).

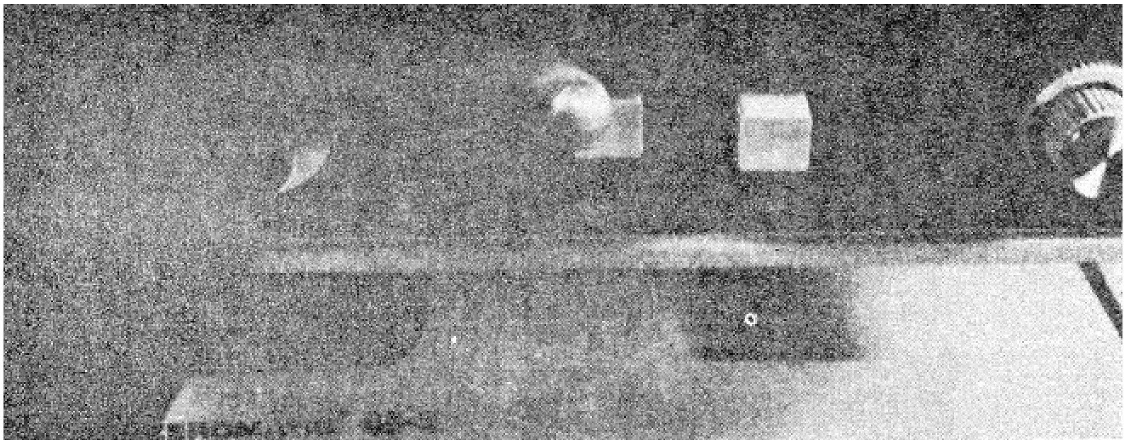


Figure 15

<u>NOTE</u>: ANY DRIFT IN THE NEEDLE POSITION SHOULD BE RECORDED AT THIS TIME.

11. Remove the electrode from the buffer solution. Rinse it with distilled water (figure 16), and wipe off the excess water with a soft tissue (figure 17).

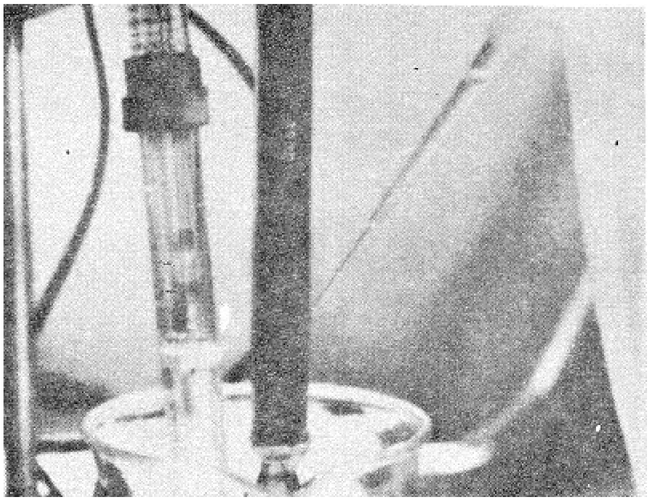


Figure 16

Figure 17

12. Immerse the electrode tip in the developer sample.

13. Depress the READ pushbutton, read, and record the pH of the sample from the pH scale (figure 18). Record your reading on the TRS.

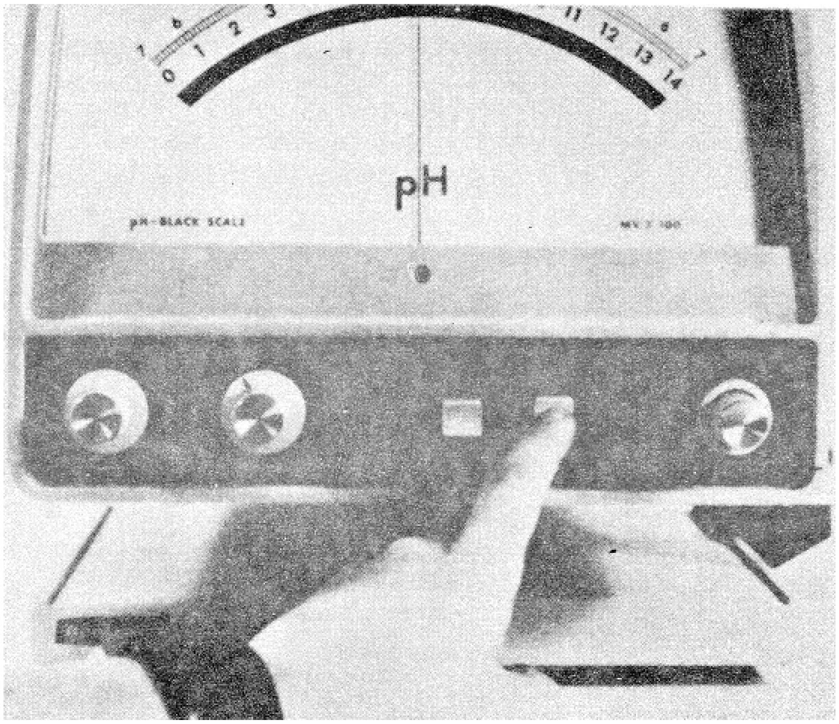


Figure 18

14. Determine if the sample read in Step 13 is acid or alkali and record your answer on the TRS.

15. Depress the STANDBY pushbutton (figure 19).

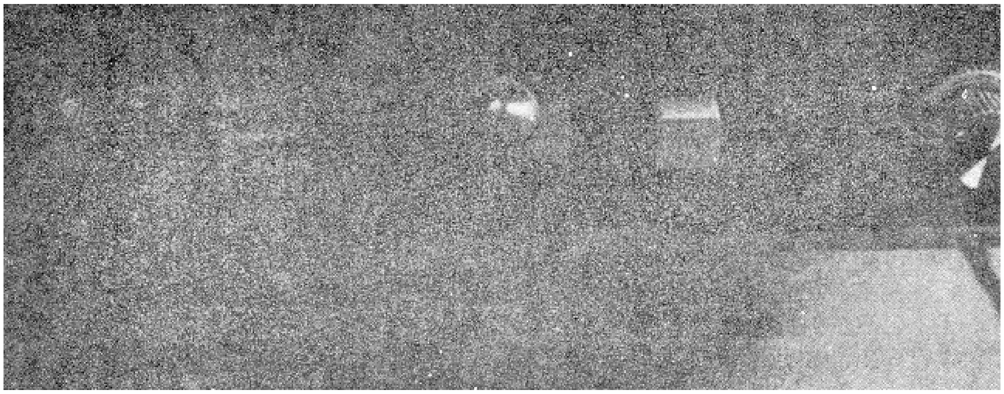


Figure 19

16. Rinse the electrode with distilled water and wipe it before proceeding with the next measurement.

<u>NOTE</u>: STANDARDIZATION MUST BE ACCOMPLISHED FOR EACH BUFFER PRIOR TO READING SAMPLES OF THE APPROXIMATE SAME pH.

17. Using the buffer pH4 and the fixer sample repeat Steps 7 through 16. Then continue with Step 18.

18. Leave the STANDBY pushbutton depressed.

19. Slide the sleeve over the filling hole.

20. Immerse the electrodes in clean distilled water (figure 20).

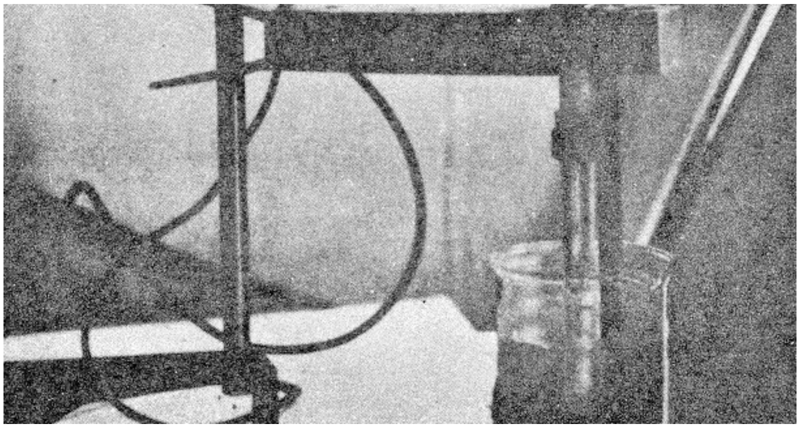


Figure 20

21. This concludes the pH meter checkout. Clean your work area and verify your readings with the Work-Center Supervisor. Upon receiving a GO on the Performance Checklist, proceed with the specific gravity Checkout.

SPECIFIC GRAVITY.

A hydrometer is an instrument calibrated to the weight of distilled/pure water, and is used to determine the specific gravity of other solutions (figure 21).

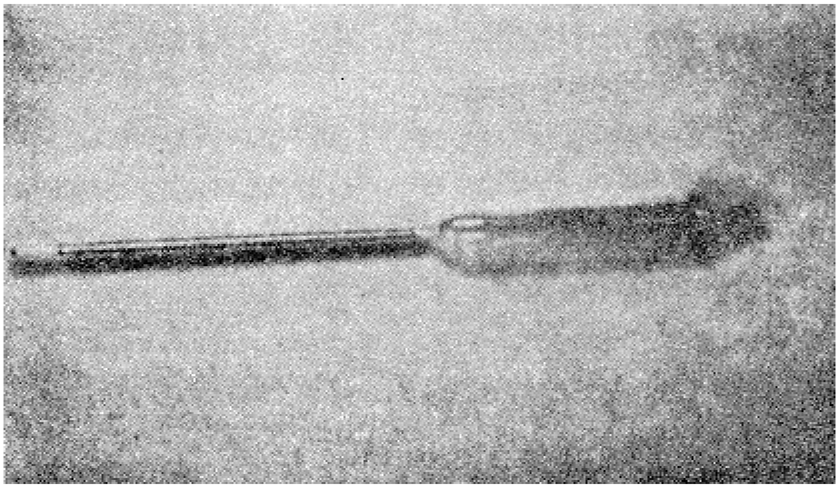


Figure 21

Hydrometer

All measurements should be made at the same temperature. Readings which correspond with known standards indicate proper mixing and/or replenishment. The hydrometer is graduated in units of 0.002 and reads from the top down. All readings will be four digits (EXAMPLE 1.082, 1.065).

OPERATION PROCEDURE:

1. Take a sample of the developer and fixer (approximately 550 mil) from the EH-38.

2. Pour the samples into large beakers.

3. Gently immerse the hydrometer into the solution to be tested. The amount of solution must be sufficient for the hydrometer to float (figure 22).

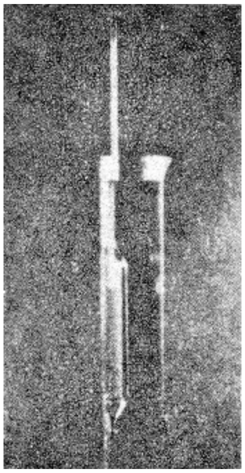


Figure 22

<u>NOTE</u>: THE HYDROMETER MUST FLOAT FREELY. IF IT CLINGS TO THE SIDE OF THE BEAKER, GENTLY SPIN IT FREE. (Figure 22.)

4. The specific gravity is read at the point at which the solution clings to the hydrometer (figure 23).

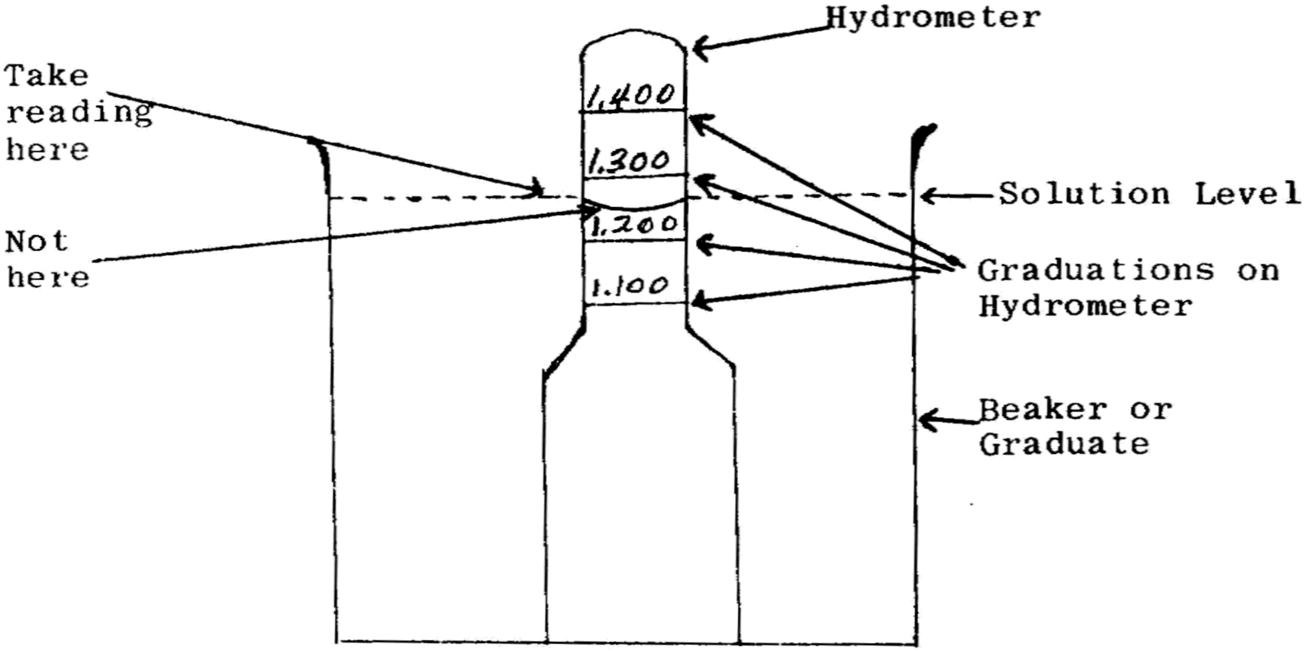


Figure 23

NOTE: THE POINT AT WHICH THE SOLUTION LEVEL IS IN CONTACT WITH THE HYDROMETER IS CALLED THE MENISCUS. THE SPECIFIC GRAVITY READING IS TAKEN AT THE TOP OF THE MENISCUS.

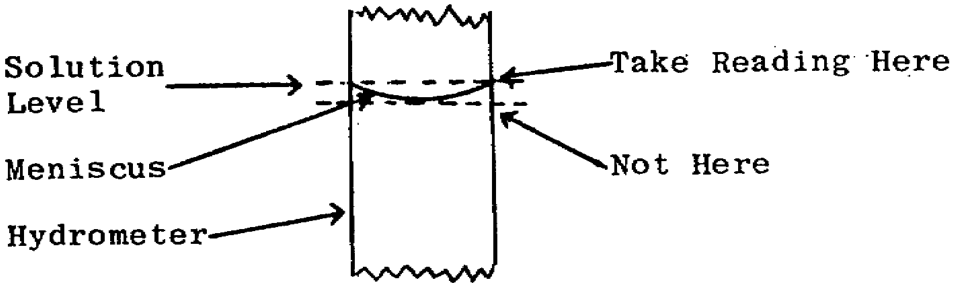


Figure 24

5. Using distilled water and soft tissue, rinse and wipe off the hydrometer and repeat Steps 1 through 5 for the second and third solutions.

LESSON 3

SENSITOMETRY AND PHOTOGRAPHIC PROCESS CONTROL

OBJECTIVE:

In this lesson you will be told how to produce a photographic sensistrip, determine the gamma from it, and plot that gamma on a process control chart. You will then evaluate the process control chart and initiate the action it requires.

Upon completion of this lesson you will be able to:

1. State the purpose of sensitometry.
2. State the four processing variables and select the one which is the most difficult to control.
3. State the purpose served by a process control chart.
4. State which fact, when plotted on a process control chart, is used to monitor replenishment.

CREDIT HOURS.. Hours

MATERIAL REQUIRED...None

SECTION I

3-1. THE PURPOSE OF SENSITOMETRY.

Sensitometry is the science of measuring film sensitivity. Its purpose is to provide photographers with an objective testing and quality control service. It also provides a wealth of information, not available otherwise, concerning photographic materials and processing.

EXERCISE

1. Sensitometry is the science of measuring the sensitivity and providing the photographer with an objective testing and (select one)

   a. planning system.

   b. educational system.

   c. quality control system.

   d. organizational system.

3-2. THE FOUR PROCESSING VARIABLES AND THE DEGREE OF DIFFICULTY TO CONTROL.

The photographic process for quality work must be accurately controlled and repeatable. There are four variables that must be dealt with in order to control the process.

(1) TIME -- In machine-processing, the time is based on the speed of the machine, which is controlled electronically. If the machine speed is properly monitored and maintained, the variability of time will be insignificant.

(2) TEMPERATURE -- Like time, temperature is controlled within the machine and must be properly monitored and maintained.

(3) AGITATION -- In automatic machine processing the film is agitated by its continuous movement through the chemicals.

(4) SOLUTION STRENGTH -- The variables that you will be <u>most</u> concerned with and that MUST be monitored continually. The strength of the developer (or solution strength) is controlled primarily by replenishment. This makes it the <u>most difficult</u> of the four variables to <u>control</u>.

EXERCISE

2. The four processing variables that must be controlled are ___________, ___________, ___________, and ___________.

3. The processing variable which is most difficult to control is (circle one)

a. agitation.

b. solution strength.

c. time.

d. temperature.

3-3. THE PURPOSE SERVED BY A PROCESS CONTROL CHART

The purpose of a process control chart is to graphically display the performance of the process. Though the term "control chart" is a misnomer (since a graph can control nothing), it does, however, provide as easily interpreted pictorial representation of what has occurred and when it occurred. As data is collected and plotted on the control chart, a graphic history is obtained. An acceptable standard is established from which any variation can easily be detected.

EXERCISE

4. An accurate graphic representation of the process performance is provided by a ___________ ___________ ___________ (complete statement)

3-4. HOW FACTORS PLOTTED ON A PROCESS CONTROL CHART ARE USED TO MONITOR REPLENISHMENT.

An accurate graphic representation for monitoring the processing solution strength is achieved by means of a process control chart.

(1) In order to make use of a process control chart, you must first produce a sensistrip.

(2) The sensistrip must then be read and plotted to determine gamma.

(3) The gamma value is then plotted on the process control chart in relation to an average gamma value established as being acceptable.

(4) The gamma value plotted on the process control chart will then be evaluated in relation to previous plots to determine if replenishment of the solution has been correct.

(5) Solution strength is then determined to be either correct, too strong, or too weak and, if necessary, a correction is made.

EXERCISE

5. The factor plotted on a process control chart to monitor solution replenishment is _________________.

3-5. THE PROCESS CONTROL CHARTS - HOW THEY ARE USED.

a. At this point you must learn how to evaluate a group of plots on the control chart, and determine what to do with your evaluation. Figure 25 is an illustration of a process control chart showing variations over a 31-day period.

Figure 25

b. The solid horizontal line through the center of the process control chart represents the target or Mean line (figure 26). It (target line) represents the central gamma or the optimum gamma desired for the process.

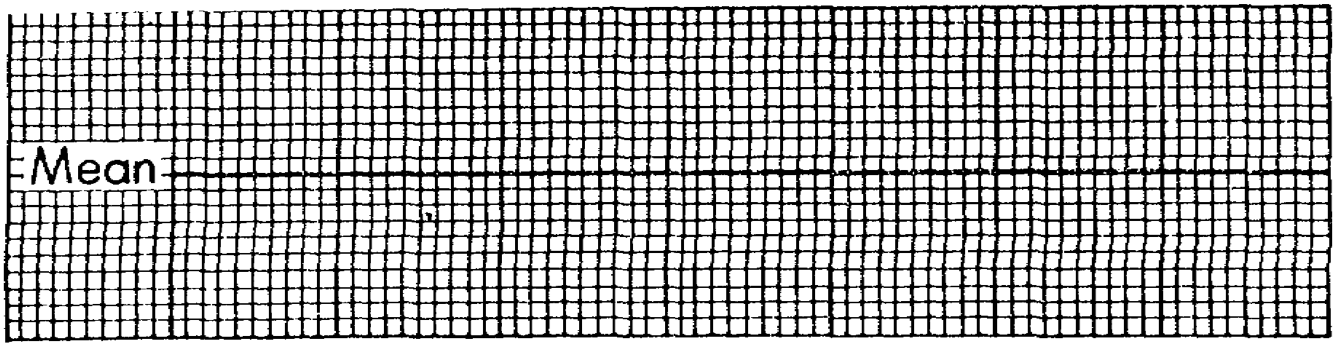


Figure 26

c. The broken lines (figure 27) represent the control limits of the process. The area between these lines is the maximum variation (above and below the target line) permissible to maintain the desired quality in the end product.

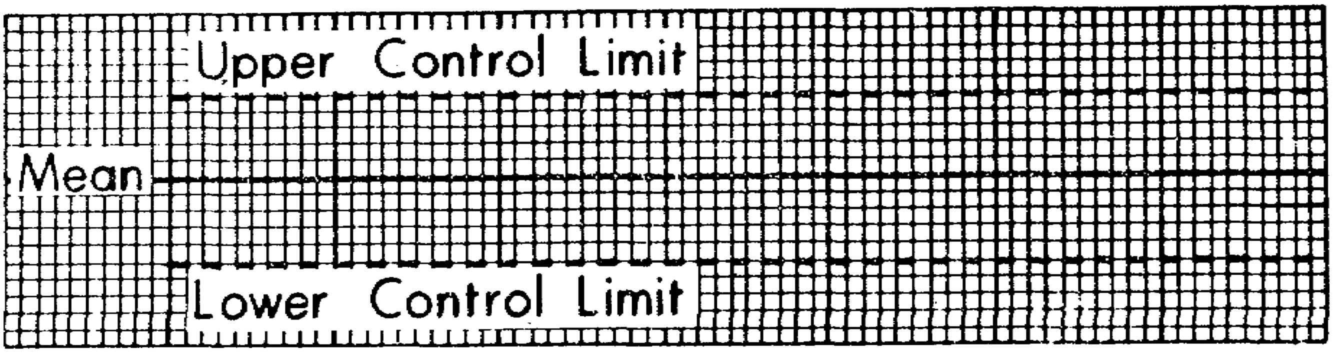


Figure 27

Figure 27 illustrates the basic construction of any control chart. The actual number value these lines represent in practical application are determined by the individual process being monitored.

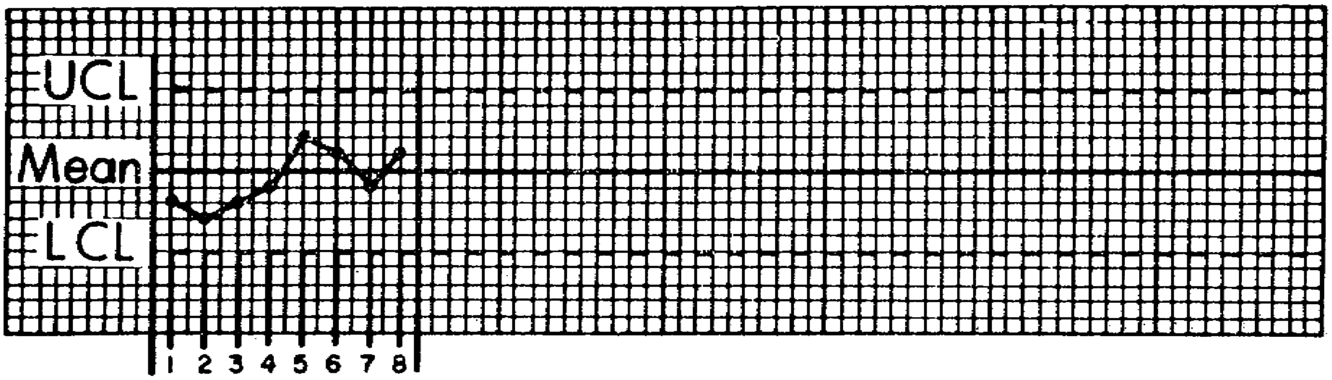


Figure 28

d. In figure 28 we have added some dots, connected by lines. These dots, for the purpose of this control chart, are plotted gamma values for eight consecutive days. By merely connecting the dots we make them easier to follow. Notice that all the dots are within the central limits, which means they are acceptable. These are called "chance causes." They are both above and below the target line, which is what we call <u>random</u> <u>variation</u>.

The evaluation of these plots indicates the process is performing acceptably, and that no change to the process is needed.

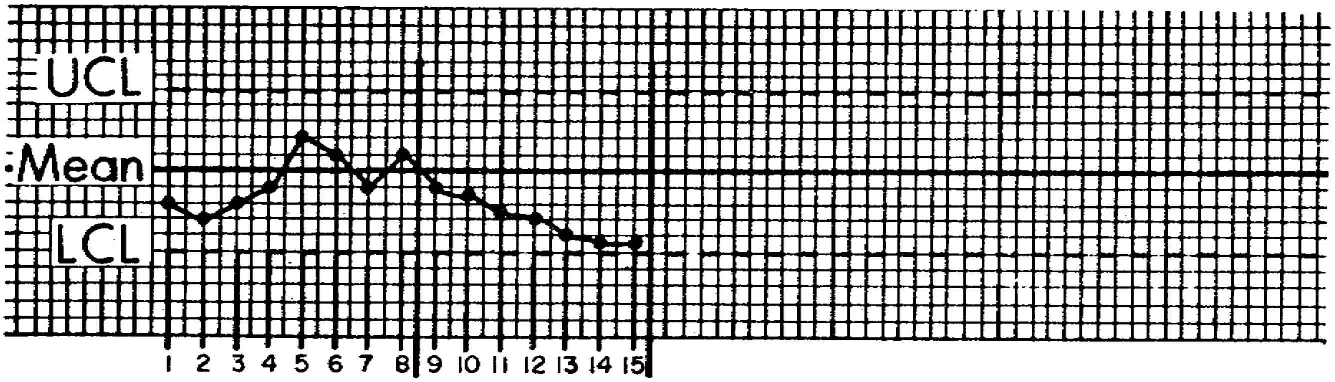


Figure 29

e. Figure 29 represents the next seven days' plots. The first consideration is that all plots are chance causes (within the control limits); however, they are all moving in the direction of the lower control limit. <u>Five</u> <u>plots</u> or more in one direction, either high or low, is considered a <u>trend</u>. Even though all the plots are within the control limits, they indicate that the solution strength is decreasing and that the gamma will soon plot outside the control limits.

The evaluation of this group of plots is:

(a) the solution strength is decreasing.

(b) replenishment rate must be increased to bring the gamma back up to the target line.

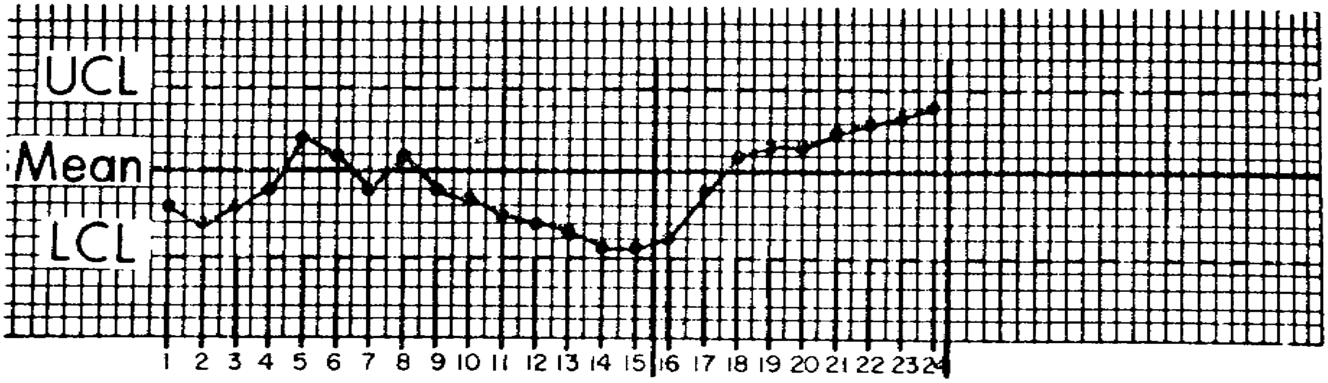


Figure 30

f. Figure 30 shows the same thing, only in reverse. Apparently the operator overcorrected the replenishment (from the low trend) and now there is a high trend.

Evaluation:

(a) Solution strength is increasing.

(b) Solution replenishment must be decreased to bring gamma back down towards the target line.

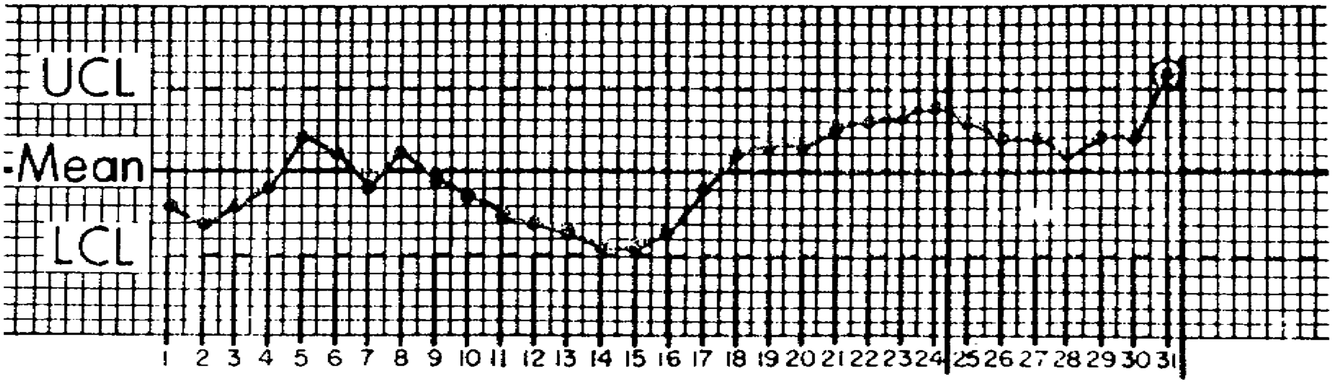


Figure 31

g. To evaluate this group of plots (Figures 25-31), you must first consider the first six by themselves. They show the gamma returning back towards a random variation on the target line. Now concentrate on the seventh plot of that group, which is the last one on the control chart. It indicates that the process is OUT OF CONTROL--unacceptable because it has plotted outside the control limits. A plot that is out of control is called an ASSIGNABLE CAUSE. Any time you make a plot that is an assignable cause, you must STOP THE PROCESS at once. The quality of the end product, with the process out of control, would be inferior; so you MUST find why the process is out of control and correct it (bring it back into control) before resuming production.

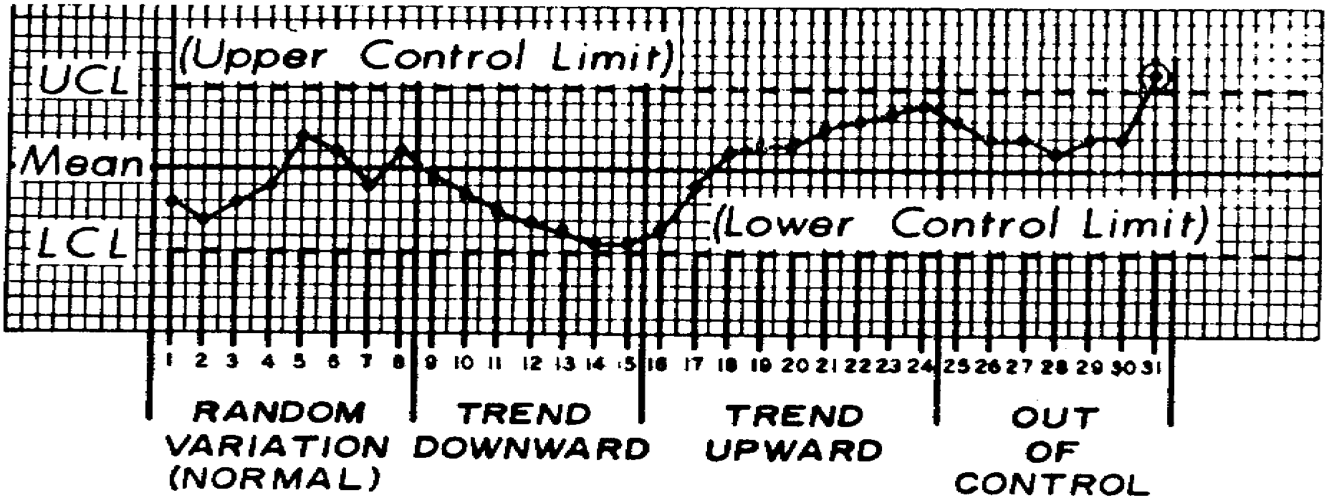


Figure 32

h. Figure 32 is the same basic chart as figure 31. The process control chart has been labeled to indicate the various process performances in an overall view.

i. At this time you have a completed process control chart for a 31-day period. Take a moment and review it; if there is anything on or about the chart you do not understand, go back to that portion of the lesson topic.

EXERCISE

6. What is the term applied to a plot or a group of plots that indicate

a. the process is operating normally. _____

b. a need to increase the replenishment. _____

c. a need to decrease the replenishment. _____

d. a need to stop the process. _____

LESSON 4

OPERATE SENSITOMETER, DENSITOMETER, AND PLOTTING CONTROL CHART

OBJECTIVE:

In this lesson you will be told how to operate the Macbeth TD102 Densitometer, the Kodak Model 101 Sensitometer, and how to transfer the readings onto a plotting control chart.

At the completion of this lesson you will be able to:

1. Describe the function of an Eastman Kodak sensitometer and produce a sensistrip.
2. Describe the function of the Macbeth TD-102 densitometer; read, record, and plot the densities of a sensistrip; and determine the gamma.
3. Plot the determined gamma on a control chart and describe the action required.

CREDIT HOURS.. Hours.

MATERIAL REQUIRED..None

SECTION I

NOTE: FOLD OUT FIGURE 33, PAGE 79, AS YOU READ ABOUT THE KODAK SENSITOMETER.

4-1. HOW TO PRODUCE A SENSISTRIP.

Prepare the sensitometer for use.

(1) Insure that the sensitometer is plugged into a 110-volt, 60-cycle outlet.

(2) Turn the sensitometer ON by rotating the lamp control knob (1) clockwise until it clicks ON.

(3) Record the time you turned the sensitometer ON in the sensitometer log.

NOTE: THE TIME THE SENSITOMETER LAMP IS ON IS RECORDED, TO SHOW WHEN THE 100 TO 150-HOUR LIFE OF THE LAMP HAS EXPIRED.

(4) Rotate the lamp control knob (1) clockwise slowly and set the ammeter (2) at the reading posted on the calibration card (3) located above the ammeter.

NOTE: FOR ACCURATE CALIBRATION–LOOK STRAIGHT AT THE AMMETER WHEN SETTING THE NEEDLE.

(5) Open the dark slide (4) on the top of the sensitometer.

(6) Push and release the exposure button (5) on the right side of the sensitometer to check the shutter (6) operation. The shutter should rotate one time only.

(7) Locate the two filter holders (7) and (8) between the shutter (6) and the step wedge (9).

(8) Check to insure that the required neutral density filter (10) is properly installed in the neutral density filter holder (7).

NOTE: THE AMOUNT OF NEUTRAL DENSITY IS NORMALLY DETERMINED BY THE FILM SPEED; HOWEVER, IT IS PROVIDED FOR YOU HERE AND IS POSTED ON TOP OF THE SENSITOMETER.

(9) Push the exposure button (5) to insure that the neutral density filter completely covers the shutter opening.

(10) Close the dark slide (4) on top of sensitometer.

(11) Check the ammeter (2) and readjust it to the calibration setting if necessary.

NOTE: AT THIS POINT YOU HAVE MADE EVERYTHING READY FOR YOUR NEXT STEP, WHICH IS TO EXPOSE YOUR SENSISTRIP. THIS IS NORMALLY DONE IN TOTAL DARKNESS. HOWEVER, TO INSURE THAT YOU CAN PERFORM THE EXPOSURE STEPS IN TOTAL DARKNESS, WE RECOMMEND THAT YOU PRACTICE THE FOLLOWING STEPS WITH YOUR EYES CLOSED OR BLINDFOLDED, TO AID YOU IN ADAPTING TO A DARKROOM SITUATION.

EXERCISE

1. The electrical current used for the Kodak densitometer must not exceed ____________________ (select one).

   a. 220 volt, 50 cycle.

   b. 120 volt, 60 cycle.

   c. 110 volt, 60 cycle.

   d. 250 volt, 50 cycle.

2. To insure that the shutter is operating properly, which of the following steps should you take? (Circle one.)

   a. Check the filter holder.

   b. Remove neutral density filter.

   c. Operate exposure button.

   d. Rotate lamp control knob.

4-2. HOW TO EXPOSE THE SENSISTRIP.

CAUTION: PROCEED THROUGH THE NEXT STEP WITH CAUTION. WHEN OPENING THE FILM GATE, THE STEP WEDGE ASSEMBLY MAY COME LOOSE IF IT HAS NOT BEEN INSTALLED CORRECTLY.

a. Expose the sensistrip.

(1) Open the film gate (11) with the film gate release lever (14). Push the exposure button (5) and note the area of least density on the step wedge (9).

(2) Insert the film across the pressure pad (12) with the emulsion facing the step wedge (9). Place the film notching code on the same side of the sensitometer as the end of least density on the step wedge (9).

NOTE: AFTER THE FILM IS PROCESSED, THIS WILL RESULT IN THE DENSEST AREA OF SENSISTRIP BEING NEXT TO THE NOTCHING CODE.

(3) Reset the film on the 4 x 5 film guide (13) below the pressure pad (12).

(4) Center the film horizontally on the pressure pad (12). Now, close the film gate (11).

<u>CAUTION</u>: INSURE THAT THE FILM GATE IS COMPLETELY CLOSED.

(5) Press and release the exposure button (5) for one exposure.

(6) Open the film gate (11) and remove the film.

EXERCISE

3. To insure that the film (4 x 5 sheet) is correctly placed in the sensitometer, it must be placed in the following manner. (Circle one.)

a. Film notching code opposite the least density of the step wedge.

b. Emulsion side away from the step wedge.

c. Film placed vertically on the pressure guide.

d. Emulsion side facing the step wedge.

<u>NOTE</u>: AT THIS TIME YOU WOULD NORMALLY PROCESS YOUR SENSISTRIP, THEN SECURE THE SENSITOMETER; HOWEVER, WE WILL COVER THE PROCESSING STEPS A LITTLE LATTER -- WE WILL GO THROUGH THE STEPS NEEDED TO SECURE THE SENSITOMETER FIRST.

4-3. SECURE THE SENSITOMETER.

a. Turn on lights in the darkroom.

b. Turn off the sensitometer by rotating the lamp control knob (1) counterclockwise until it clicks OFF.

c. Record the time you turned off the sensitometer in the sensitometer log book and record the total running time (your time of use plus the previous total time).

d. Close the film gate (11) completely.

e. Record on separate sheet of paper the number of the sensitometer which you used to expose your sensistrip. Retain the number for entry on the sensitometer data sheet and plot sheet.

4-4. Obtain 15 sheets of the most commonly used film in your photo section from the photo lab NCOIC, plus neutral density requirements, and technical data sheet

4-5. Proceed to your photographic darkroom to expose and process your sensistrip, utilizing the procedures you will receive from the laboratory NCOIC.

4-6. Adjust the chemical temperature to the prescribed chemical temperature to insure the maximum result of gamma from the processing.

4-7. Set the development time on the timer, arrange your film and film holder to be used, turn off room light, load the film into film holder, and proceed with the film processing as you normally would.

4-8. After you have exposed and processed your sensistrip,

a. secure the sensitometer.

b. log the time the sensitometer is ON in the sensitometer log book.

c. clean up your work area.

4-9. You will need the following data prior to starting the next step, reading and recording the densities of the sensistrip.

Type of film. ______________________

Neutral density value. ______________________

Date exposed. ______________________

Type of processing. ______________________

Developer temperature. ______________________

Work order number. ______________________

Sensitometer serial number. ______________________

Sensitometer shutter speed. ______________________

Date processed. ______________________

Type of developer. ______________________

Number of sheets developed. ______________________

Illuminance value of sensitometer lamp. ______________________

EXERCISE

4. Why must you record the time you turn OFF the sensitometer in the sensitometer log book? (In your own words.)

ANS: ____

____

____

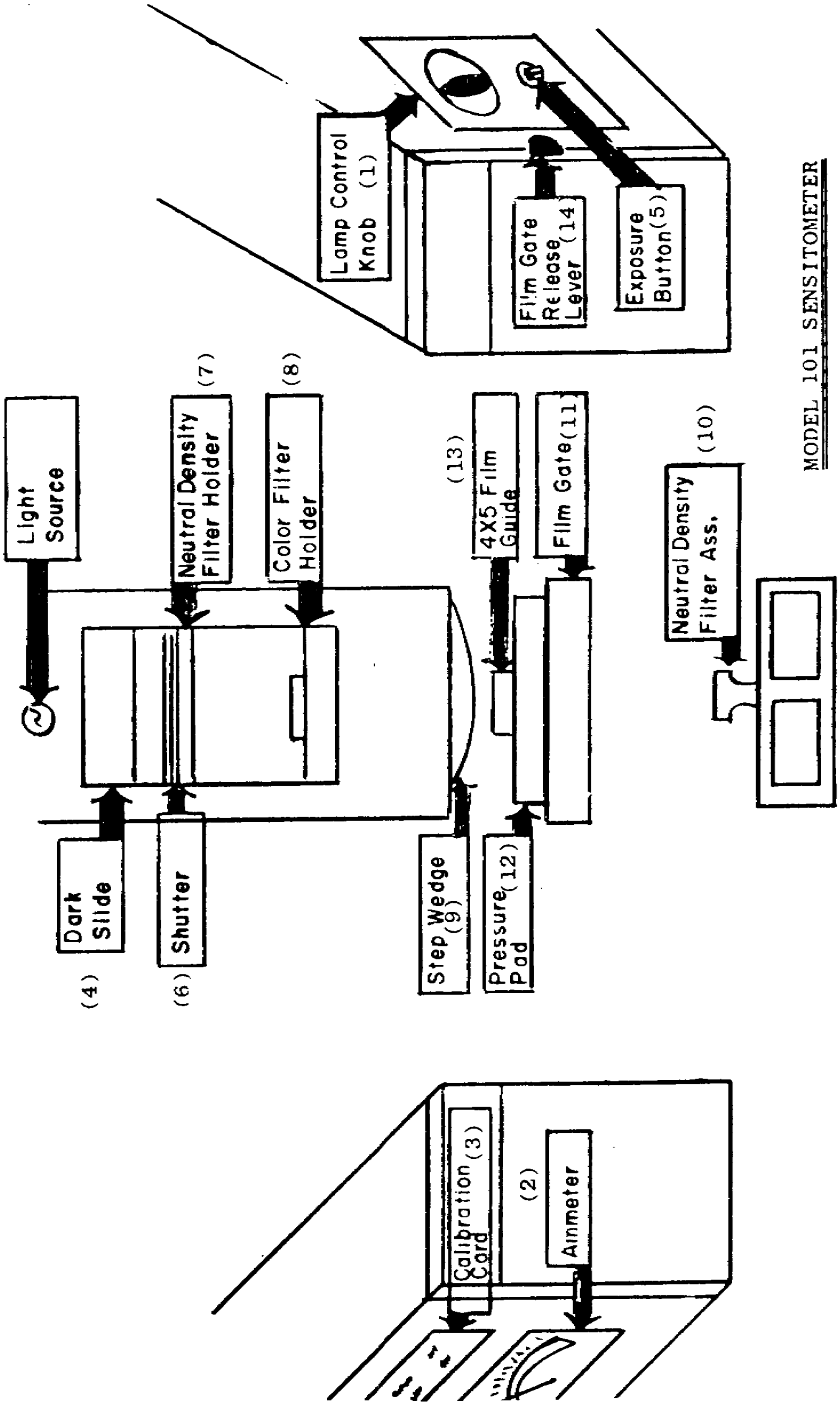

MODEL 101 SENSITOMETER
Lamp Control Knob (1)
Film Gate Release Lever (14)
Exposure Button (5)
Light Source
Neutral Density Filter Holder (7)
Color Filter Holder (8)
4X5 Film Guide (13)
Film Gate (11)
Neutral Density Filter Ass. (10)
Dark Slide (4)
Shutter (6)
Step Wedge (9)
Pressure Pad (12)
Calibration Card (3)
Ammeter (2)

Figure 33

SECTION II

4-10. READ, RECORD, AND PLOT THE DENSITIES OF THE SENSISTRIP; DETERMINE THE GAMMA.

a. With the data recorded from section I, proceed to the densitometer and record the data on the sensitometer data sheet and the sensitometric plot sheet in the appropriate places.

> NOTE: SAMPLES OF SENSITOMETER DATA SHEET AND THE SENSITOMETRIC PLOT SHEET ARE LOCATED ON PAGES _____ AND _____. THESE CAN BE REMOVED FROM THIS BOOKLET AND REPRODUCED LOCALLY.

(1) Record the type of film used in the space beside MATERIAL.

(2) Record film emulsion number from the side of the 4 x 5 box beside the space marked EMULSION NUMBER.

(3) Record the serial number of the sensitometer in the space beside SENSITOMETER number.

(4) Record the value of the neutral density filter in the space beside NEUTRAL DENSITY.

(5) Record the value of illuminance of the sensitometer lamp in the space beside ILLUMINANCE.

(6) Record the shutter speed of the sensitometer in the space beside EXPOSURE TIME.

(7) Record the appropriate dates beside DATE EXPOSED, DATE PROCESSED.

(8) Record the type of processing used in the space beside AGITATION.

(9) Record the type of developer used for processing beside the DEVELOPER.

(10) Record the temperature at which the developer was used beside the words DEVELOPER TEMPERATURE.

(11) Record the time which was used for the development of your sensistrip beside the words DEVELOPMENT TIME.

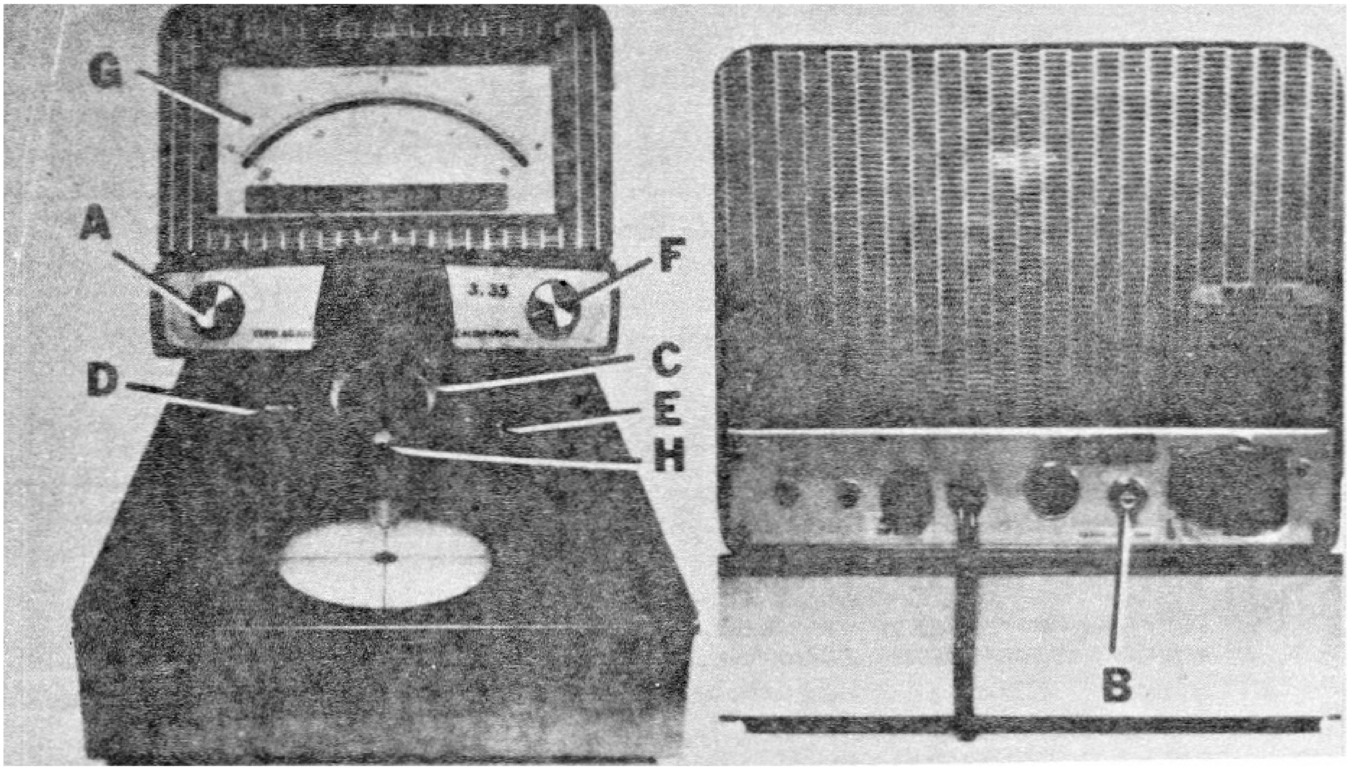
(12) Record the number of developer racks used in the space beside the words NUMBER OF DEVELOPER RACKS.

(13) Record the work order number in the space beside the words <u>PROJECT NUMBER</u>.

<u>NOTE</u>: YOU ARE NOW READY TO READ AND RECORD THE DENSITY VALUES OF YOUR SENSISTRIP -- OBTAIN A FRENCH CURVE, STRAIGHT EDGE, AND GAMMA METER FROM YOUR PHOTO LAB SUPERVISOR, AND PROCEED TO THE DENSITOMETER TABLE.

---

b. Prepare the densitometer for reading the sensistrip.



Front View of TD-102

Rear View of TD-102

Figure 33

(1) TURN on the densitometer power by rotating the ZERO ADJUST knob (A) slightly to the right.

> <u>NOTE</u>: THE DENSITOMETER IS NORMALLY LEFT IN THE <u>ON</u> POSITION. ALLOW A THIRTY-MINUTE WARM-UP PERIOD IF THE DENSITOMETER WAS TURNED <u>OFF</u>. IF YOUR DENSITOMETER IS ALREADY <u>ON</u>, PROCEED WITH STEP TWO.

(2) LOCATE the 1mm/OFF/2 & 3mm aperture toggle switch (B) on the rear panel of the densitometer. MOVE this switch to the 2 & 3mm position, which provides the correct light output to utilize the 2 & 3mm aperture.

(3) RETURN to the front of the machine and rotate the filter selector (C) until the GOLD filter trim control (H) is in the bottom position.

(4) SET the calibration reference center (E) in the forward position (toward you).

(5) DEPRESS the snout lever (D) gently until the meter needle (G) deflects.

(6) ROTATE the ZERO ADJUST knob (A) as required until ZERO indication is obtained on the meter scale.

> <u>NOTE</u>: IF <u>ZERO</u> METER INDICATION CANNOT BE OBTAINED, THE GOLD FILTER TRIM CONTROL (H) MAY ALSO BE ADJUSTED SLIGHTLY.

(7) Push the CALIBRATION reference lever (E) toward the rear. KEEP the snout lever depressed.

(8) ADJUST the CALIBRATION control knob (F) as required to obtain the density reading that is posted next to the CALIBRATION control knob.

(9) RETURN the CALIBRATION reference lever (E) to its original position and RECHECK the ZERO ADJUST setting. If a zero adjustment is required, RECHECK the CALIBRATION setting also. CONTINUE until both settings are correct.

(10) You are now ready to make density readings. Two readings, D/MIN and base-plus-fog, are required to determine the accuracy of the sensistrip exposures. PLACE what appears to be thinnest area of the image over the aperture, emulsion side up, DEPRESS the snout lever, and READ the density indicated by the needle on the meter face.

NOTE: EACH DIVISION OF THE METER SCALE IS EQUAL TO 0.02 DENSITY UNITS. (SEVERAL READINGS MAY BE REQUIRED TO INSURE THAT YOU HAVE READ THE MINIMUM DENSITY WHEN READING NORMAL NEGATIVES).

(11) RECORD D/MIN (Density Minimum), on a separate sheet of paper.

(12) RECORD D/MAX (Density Maximum), on the same sheet of paper.

(13) SUBTRACT D/MIN from D/MAX. The result is density range (DR).

EXAMPLE:

D/MAX 1.42
D/MIN 0.23
DR 1.19

EXERCISE

The meter force on the densitometer is divided into __________________ density units.
(fill in)

a. 0.2

b. 0.02

c. 0.002

d. 2.00

---

c. Read base-plus-fog of the film.

d. Record the density value on the sensitometer data sheet in the space marked B+F.

e. Read the lightest area of the sensistrip and record the density value on the sensitometer data sheet beside the number 21.

f. Read the remaining steps of the sensistrip and record the density values on the sensitometer data sheet beside Steps 20 thru 1.

g. Transfer your density values to your sensitometric plot sheet. The Steps 1 thru 21 correspond to the same steps on the sensitometer data sheet.

EXAMPLE: 21 step sensi-strip readout. Base + fog at the bottom.

Step	Density
1	1.82
2	1.78
3	1.70
4	1.60
5	1.50
6	1.40
7	1.30
8	1.20
9	1.10
10	0.99
11	0.90
12	0.79
13	0.70
14	0.59
15	0.49
16	0.40
17	0.32
18	0.26
19	0.21
20	0.19
21	0.18

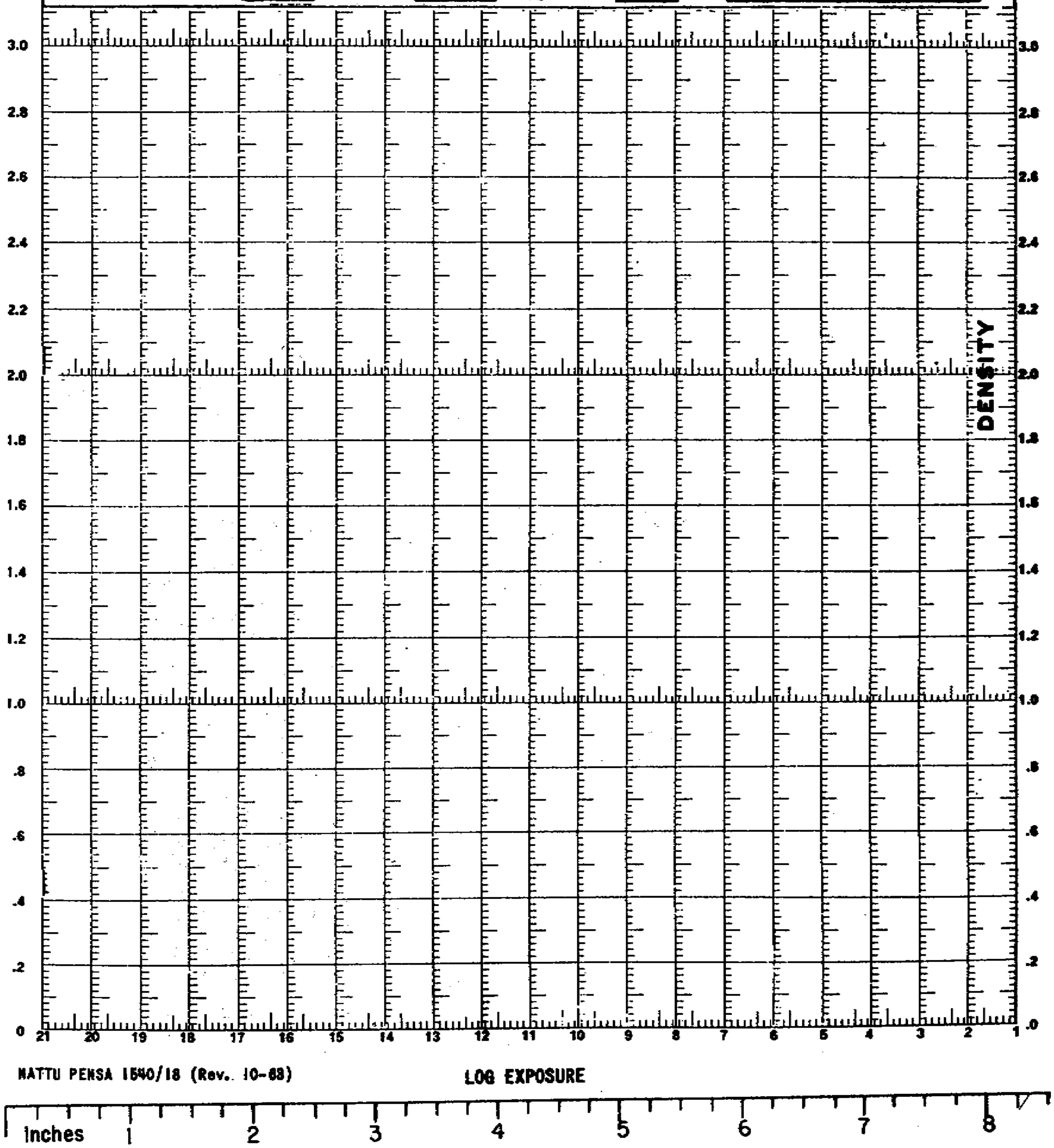
Base + fog 0.12

4-11. THE SENSITOMETRIC PLOT SHEET.

NOTE: THE GRAPH ON YOUR SENSITOMETRIC PLOT SHEET IS DIVIDED INTO LOG INCREMENTS VERTICALLY AND HORIZONTALLY. DENSITY VALUES RUN VERTICALLY AND EXPOSURE VALUES RUN HORIZONTALLY. EACH INCREMENT HAS A LOG VALUE OF 0.02.

NOTE: FOR TRAINING PURPOSE, YOU WILL USE THE READ OUT SAMPLE GIVEN, AND START PLOTTING THE READING AS FOLLOWS:

Material__________ Emulsion No.__________ Date Exp.__________ Date Dev.__________
Sensitometer No.______ Neutral Density______ Exp. Time______ Illuminance__________
Strip No. 1 — Devlpr.______ Temp.______ Dev. Time______ Agitation______ Gamma______
Strip No. 2 — Devlpr.______ Temp.______ Dev. Time______ Agitation______ Gamma______
Strip No. 3 — Devlpr.______ Temp.______ Dev. Time______ Agitation______ Gamma______
Strip No. 4 — Devlpr.______ Temp.______ Dev. Time______ Agitation______ Gamma______
Densitometer No.______ Date Read______ Project No.______ Name____________________



Plotting sheet.

a. Plot Step 21 at the intersection of the vertical line numbered 21 and the density value you read and recorded on the sensitometer data sheet.

b. Plot the remaining Steps, 20 through 1, using the same procedures.

c. With a straight edge and French curve, connect the plots. Use the following method:

NOTE: REFER TO FIGURE 34, FOR STEPS C AND D.

(1) Position the straight edge along the portion of the curve with as many of the plots as possible lined up along the straight edge.

NOTE: SOME OF THE PLOTS WITHIN THIS AREA MAY NOT BE EXACTLY ON THIS STRAIGHT EDGE.

(2) Using a sharp pencil, draw a line connecting the plots that fall along the straight edge. Include only the straight-line portion of the characteristic curve on this line.

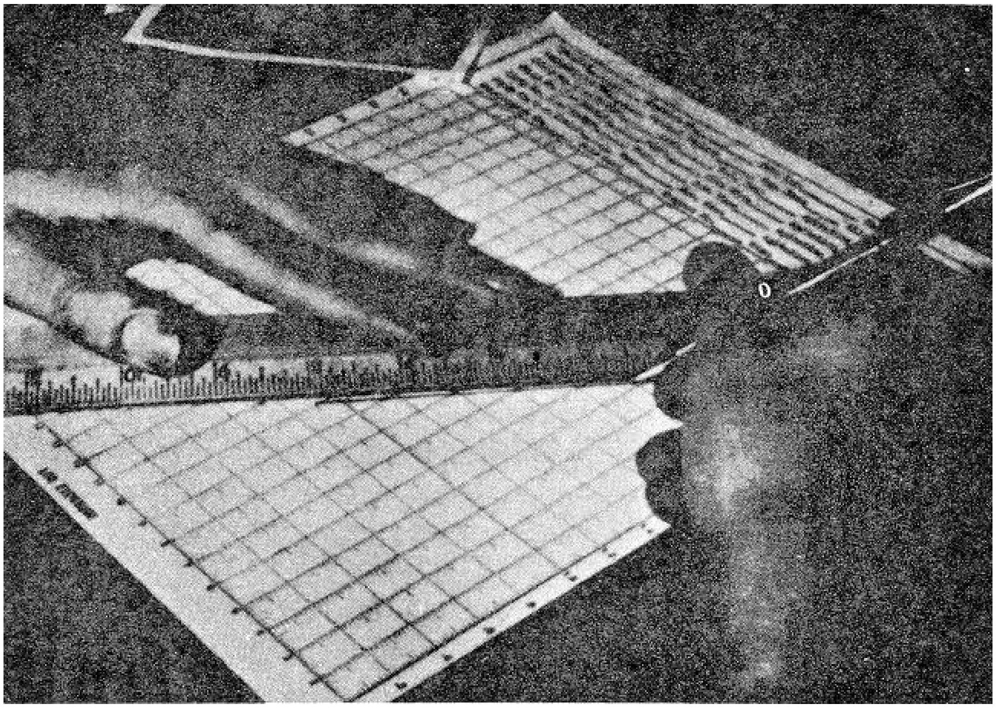


Figure 34.

Drawing straight portion of curve.

(3) Position the French curve (figures 35 and 36) extended from each end of the straight line so that the plots line up on the edge of it. Connect those plots with a smooth line.

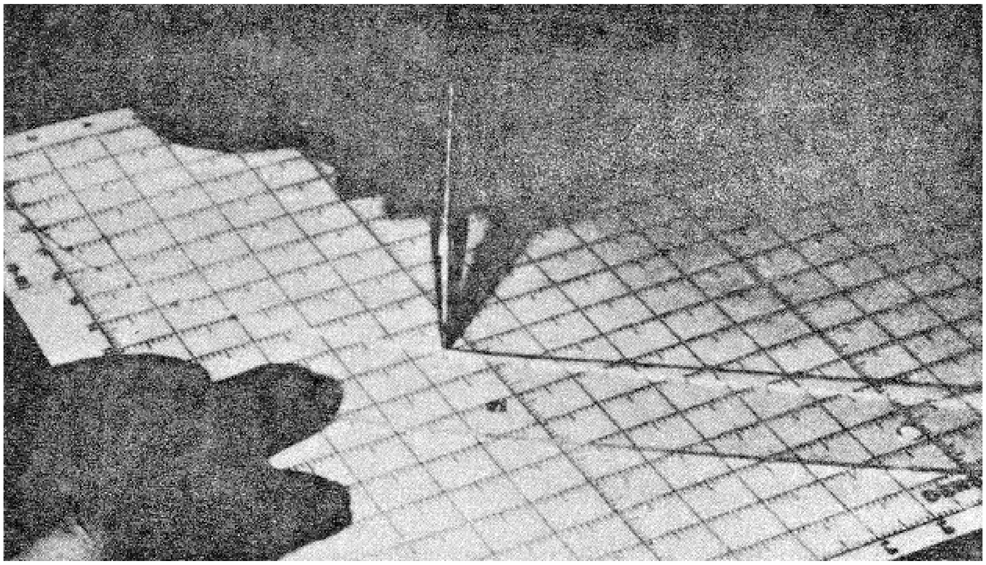


Figure 35

Using French curve.

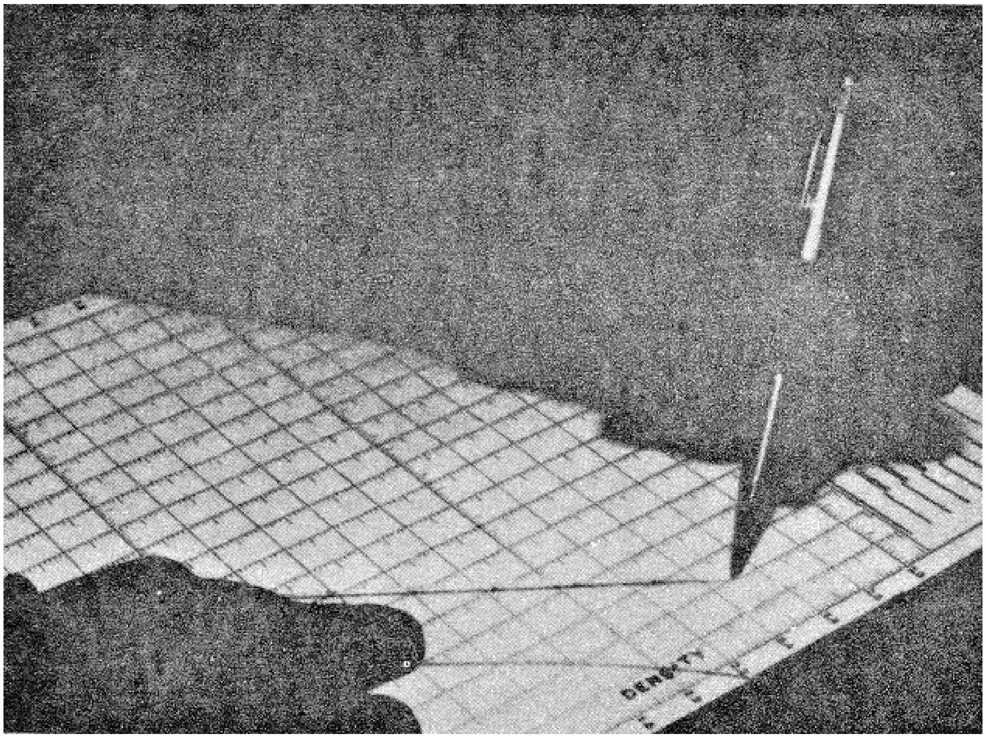
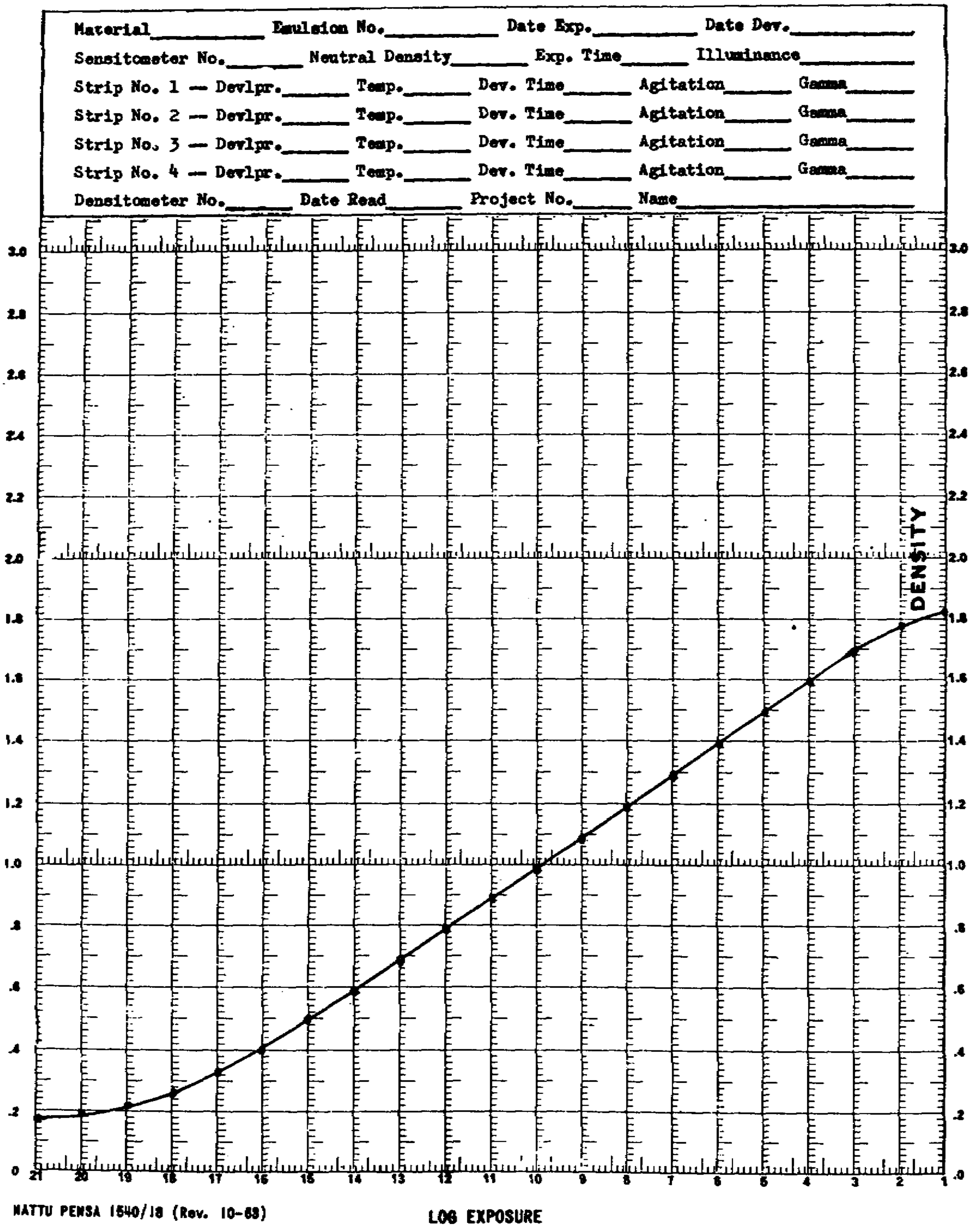


Figure 36

Using French curve



Material__________ Emulsion No.__________ Date Exp.__________ Date Dev.__________

Sensitometer No.________ Neutral Density________ Exp. Time______ Illuminance__________

Strip No. 1 — Devlpr.______ Temp.______ Dev. Time______ Agitation______ Gamma______

Strip No. 2 — Devlpr.______ Temp.______ Dev. Time______ Agitation______ Gamma______

Strip No. 3 — Devlpr.______ Temp.______ Dev. Time______ Agitation______ Gamma______

Strip No. 4 — Devlpr.______ Temp.______ Dev. Time______ Agitation______ Gamma______

Densitometer No.______ Date Read______ Project No.______ Name__________

Figure 37

Plotting a characteristic curve.

d. Once you have connected all the plotted densitometer readout on the plotting sheet, you are ready to perform the GAMMA readout. This is done with the help of a gamma meter. Before we go on with the gamma meter and how it is to be used, we will first tell you something about GAMMA and how it helps you in quality control.

4-12. HOW TO DETERMINE GAMMA.

a. GAMMA (Y). In technical terms, gamma (signified by the Greek letter Y) is a sensitometric quantity which indicates the slope or gradient of the straight line portion of the characteristic curve of photographic emulsions. It is commonly interpreted as a measure of the contrast reproduced in a negative image; that is, the ratio of negative contrast to original subject contrast for a given range of tonal values. Therefore, one of the primary uses of gamma is its employment as a yardstick. It measures the degree of development of photographic materials, since changes in development vary contrast or the slope of the curve. (Exposure changes shift the position of the points, right or left, on the log E axis without altering the slope of the curve. Thus, the tendency is to expose to control the density and development to control the contrast of the image reproduced. Remember the expression, “Expose for density - develop for contrast.”)

Gamma may be likened to the slope of a road. Mathematically, it is the ratio of the height gained to the distance traveled in a horizontal direction. In determining gamma, the height is density (D), and the horizontal base is the log of exposure (log E).

Materials capable of producing widely different gamma values are available. Normal photographic subjects call for films with a gamma value of around 1.0, varying from 0.6 to 1.5. Such an emulsion will record the wide range of tones which is present in outdoor scenes. In practice, each of the main groups of negative materials has its own individual characteristics. Gamma is useful to the photographer because it tells him how his photographic material will respond to changes in exposure and processing.

b. From the foregoing discussion, it may be seen that gamma is definable in different terms. Some other useful definitions include the following:

(1) Gamma is the numerical measure of the contrast reproduced in a negative image.

(2) Gamma is a numerical measure of the degree of development (for a given material).

(3) Technically, gamma is the slope of the straight line portion of the characteristic curve.

(4) Mathematically, gamma may be defined as follows:

(a) The ratio of the height gained (difference in any two densities on the straight line part of the curve) to the horizontal difference (difference between the log E's which produced the two densities).

(b) The tangent of the angle formed by the intersection of an extension of the straight line portion of the curve and the horizontal axis.

c. Gamma determination, once the curve has been plotted, can be accomplished by several methods. Four methods are presented here:

(1) Basic method. This method, shown in figure _____, involves the ratio between densities and the exposures which produced them. Any two points on the straight line are chosen. (More reliability tends to result if the points are widely separated.) Gamma is the result of dividing the change, or difference in density, by the difference in log E between the two points. The formula is

$$\text{Gamma} = \frac{\Delta D}{\Delta \text{Log } E} = \frac{D_1 - D_2}{\text{Log } E_1 - \text{Log } E_2}$$

where

Δ (Delta) = Greek symbol for change or difference.

(2) Graphic method. From the inertia point (the point of intersection of the straight line extended to the log E axis), move to the right a distance of 1.00 on the Log E axis. Gamma is the density reading at this point.

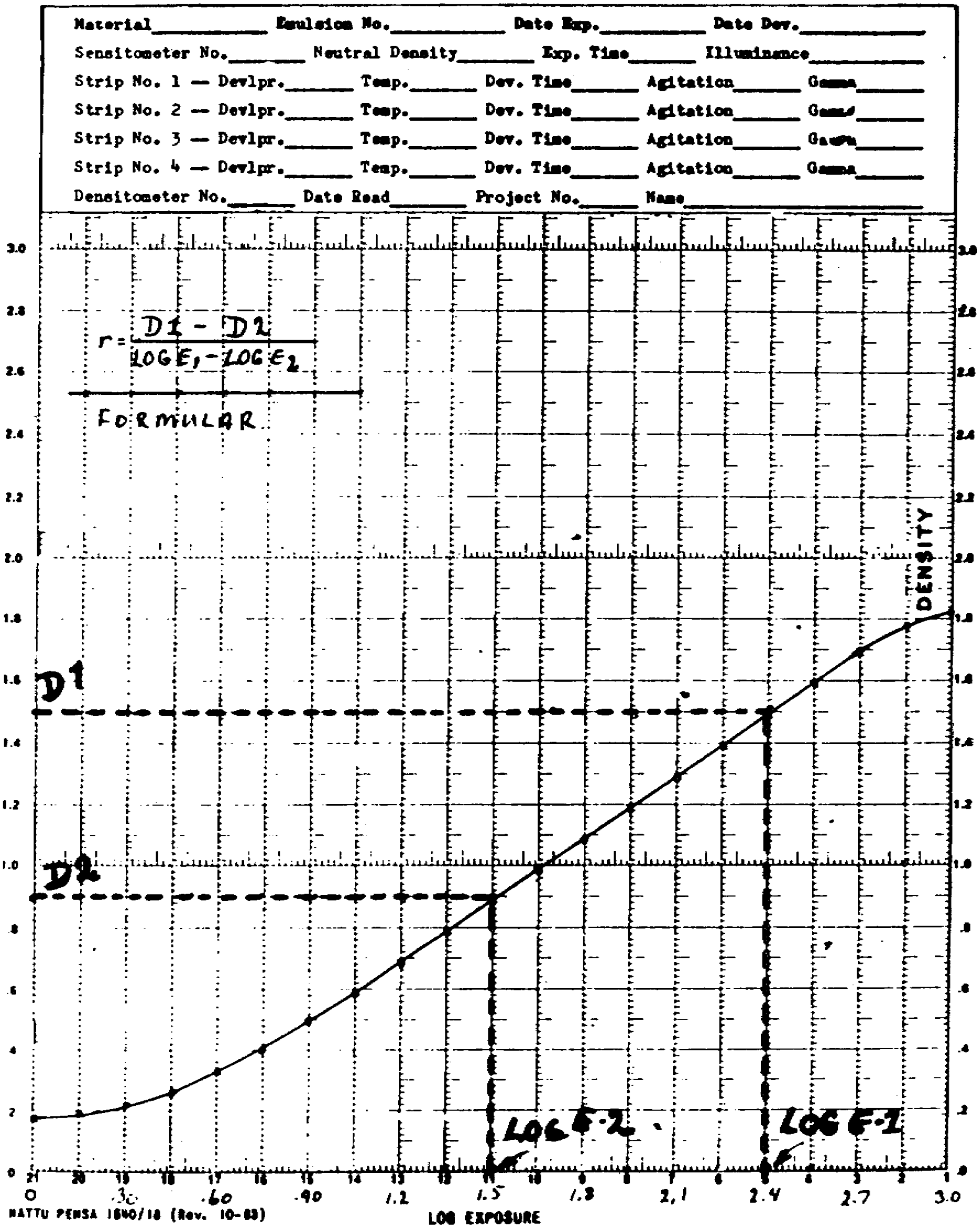

Material________ Emulsion No.________ Date Exp.________ Date Dev.________
Sensitometer No.______ Neutral Density______ Exp. Time______ Illuminance________
Strip No. 1 — Devlpr.______ Temp.______ Dev. Time______ Agitation______ Gamma______
Strip No. 2 — Devlpr.______ Temp.______ Dev. Time______ Agitation______ Gamma______
Strip No. 3 — Devlpr.______ Temp.______ Dev. Time______ Agitation______ Gamma______
Strip No. 4 — Devlpr.______ Temp.______ Dev. Time______ Agitation______ Gamma______
Densitometer No.______ Date Read______ Project No.______ Name________

Figure 38.

Basic method of gamma calculation.

(3) Quick method. This method uses a gamma meter (will be explained later). The arrow point of the meter is placed on the straight line portion of the curve, with the baseline of the meter parallel to the log E axis. Gamma is indicated where the straight line intersects the scale.

(4) Simplified method. A point is selected on the straight line portion of the characteristic curve at one of the minimum densities. From this point, count over 50 spaces in a horizontal direction. Next, count the number of spaces in a vertical direction until the straight line portion of the characteristic curve is intersected. Multiply this figure by 2 and divide by 100. For example, if 40 spaces are counted, the calculations are as follows:

$$\frac{2 \times 40}{100} = 0.80 = 0.8 \text{ gamma}$$

or

$$\frac{40}{50} = \frac{4}{5} = 0.8 \text{ gamma}$$

EXERCISE

6. Using the chart, with the given formula and plotting, determine what the ratio is.

ANS: R = ______________________________

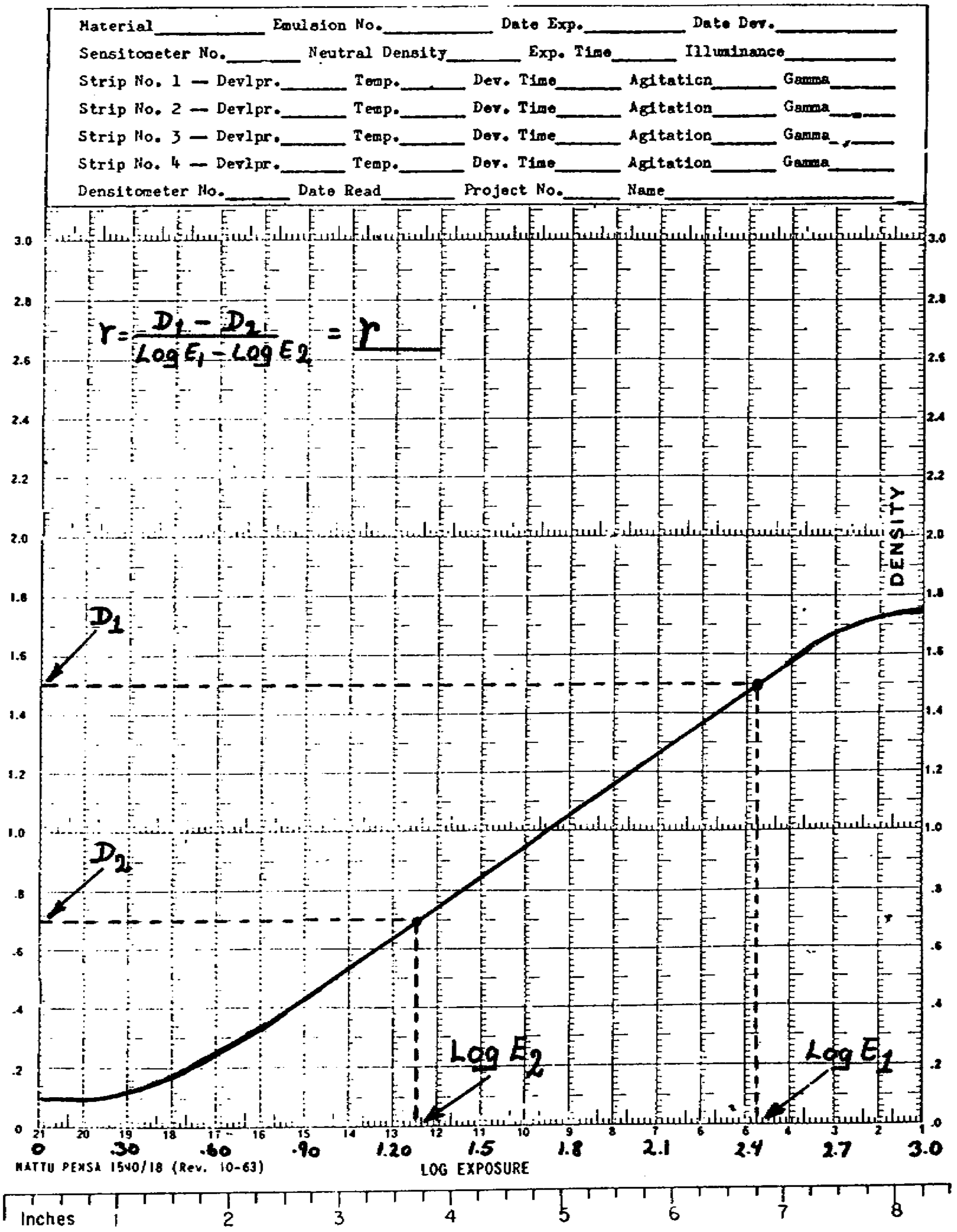


Figure 39

7. Using the chart in exercise #6, solve for the gamma, using the simplified method, given the following information:

Use point .7 on the straight line, solve for the gamma.

ANS ________________________________

4-13. THE GAMMA METER.

Using a gamma meter (figure 40). Place the gamma meter on the characteristic curve in the following manner:

(1) Place the point of the arrow along the straight line portion of the curve (figure 41).

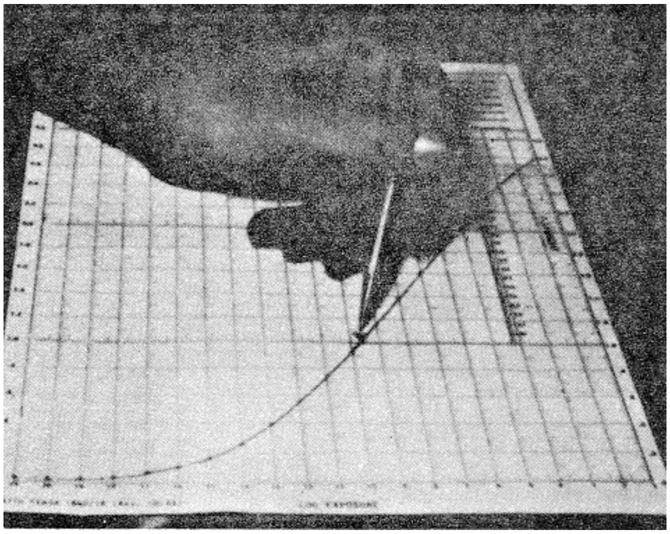


Figure 41

Using a gammeter.

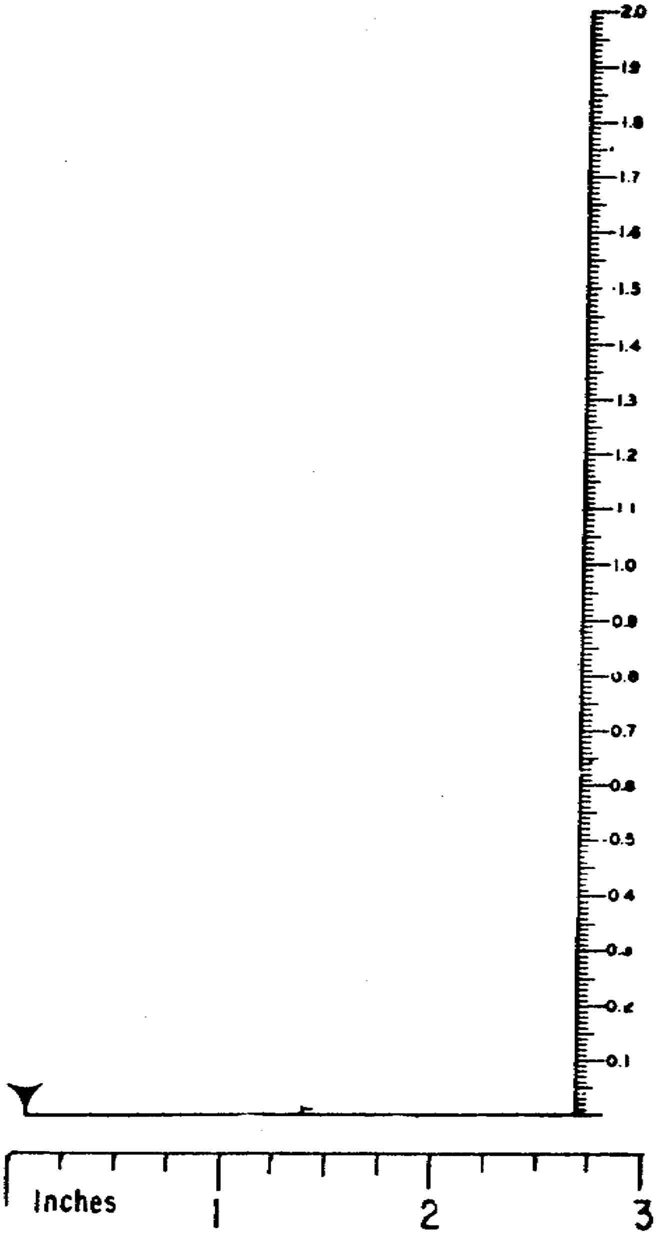


Figure 40

Gamma meter.

(2) Insure that the vertical scale of the gammeter (figure 42) also crosses the curve along the STRAIGHT LINE portion.

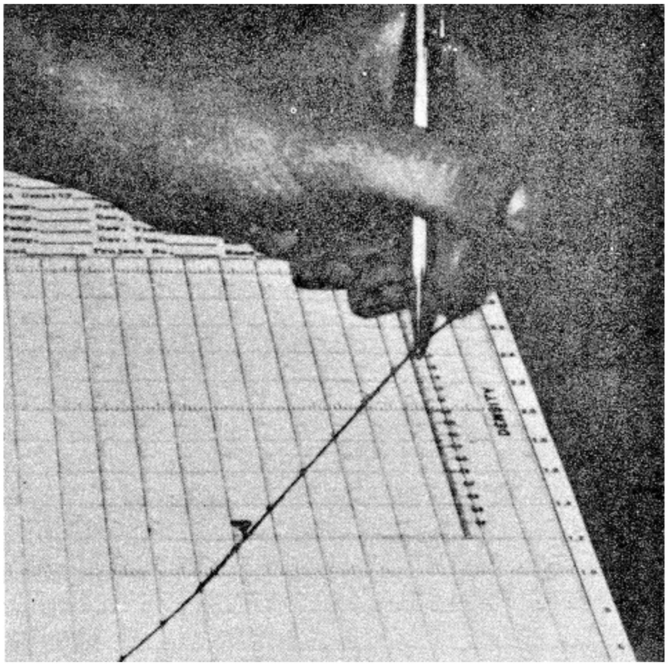


Figure 42.

(3) Overlap the base line of the gammeter (figure 43) on ANY horizontal line (within the straight line portion of the graph paper).

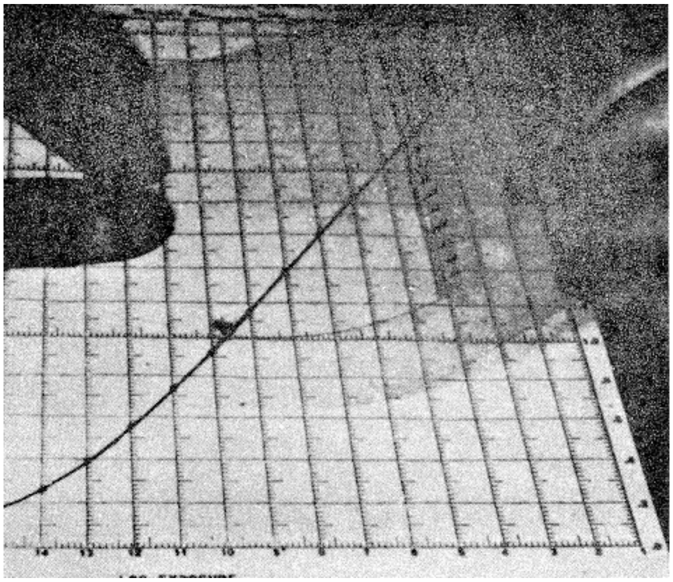


Figure 43.

(4) Read the gamma where the straight-line portion of the characteristic curve intersects the vertical scale of the gammeter (figure 44).

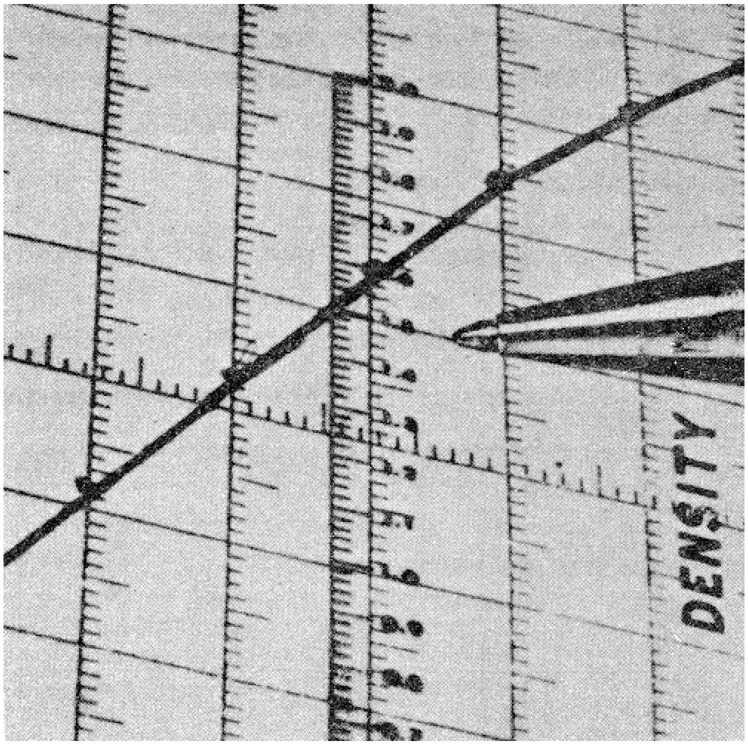


Figure 44.

(5) Record that value in the space beside GAMMA on the sensitometric plot sheet.

EXERCISE

8. The arrow on the GAMMETER must be placed where on the characteristic curve, when reading the gamma.

9. Where on the GAMMETER do you get the GAMMA readout on a particular characteristic curve?

SUMMARY:

You have just completed the subcourse on Photographic Quality Control, SS0513. In this subcourse you have been told about how to mix and store photographic chemicals, some of the hazards in improper handling, safety, and poison antidotes to prevent major injury or possible deaths.

We have talked about the pH and specific gravities, sensitometry and photographic process control. In the last part of the subcourse, we talked about operating a sensitometer, the densitometer, and how to plot all this information on the plotting control chart.

Apply all this information into your daily work routine and both you and the Army will benefit from this subcourse. Now, go ahead and take the final examination and return the completed answer sheet to the test center for full credit on the course.

GOOD LUCK

EXERCISE SOLUTIONS

LESSON #1

1. c (para 1-1).
2. b (para 1-2).
3. a (para 1-3).
4. d (para 1-4).
5. b (para 1-5).
6. c (para 1-6).
7. b (para 1-7).
8. c (para 1-8).
9. b (para 1-9).
10. d (para 1-10).
11. c (para 1-11).
12. b (para 1-11).

LESSON #2

1. A-1
   D-2
   C-3
   E-4
   B-5 (para 2-1)
2. Heavier (para 2-2)

LESSON #3

1. c (para 3-1).
2. Time, Temperature, Agitation, and Solution Strength. (para 3-2).
3. Solution strength (para 3-2).
4. Process control chart (para 3-3).
5. Gamma (para 3-4).
6. a. random variation
   b. trend downward.
   c. trend upward.
   d. out of control (para 3-5).

LESSON #4

1. c (para 4-1)
2. c (para 4-1)
3. d (para 4-2)
4. (para 4-1)
5. b (para 4-10)
6. $\Delta = .66$
7. 0.64 gamma
8. The straight line portion. (para 4-13)
9. Where the vertical scale intersects the characteristic curve. (para 4-13)