R E P O R T R E S U M E S

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A PROJECT TO IMPROVE LEARNING IN CHEMISTRY AT EL CAMINO COLLEGE BY INTRODUCING CHEM STUDY FILMS IN THE EIGHT MILLIMETER CARTRIDGE FORM FOR OUT-OF-CLASS USE BY STUDENTS.

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THE USE OF SIX 16-MILLIMETER FILMS IN CHEMISTRY CLASSES WAS SUPPLEMENTED BY PURCHASE OF THEIR 8-MILLIMETER CARTRIDGE VERSIONS AND PROJECTION EQUIPMENT TO ENABLE STUDENTS TO VIEW THE FILMS AS AN INDEPENDENT STUDY PROCEDURE. STUDY GUIDES, QUIZZES AND EVALUATION FORMS WERE PREPARED FOR USE BY INDIVIDUAL STUDENTS. TOTAL COST FOR THE PROJECT WAS $1,552. THE FILMS INCLUDED IN THE PROJECT WERE (1) CHEMICAL FAMILIES, (2) EQUILIBRIUM, (3) ACID-BASE INDICATORS, (4) ELECTROCHEMICAL CELLS, (5) CRYSTALS AND THEIR STRUCTURES, AND (6) IONIZATION. EXAMPLES OF THE INSTRUCTIONAL MATERIALS ARE INCLUDED IN THE DOCUMENT. (WO)

A PROJECT

TO IMPROVE LEARNING IN CHEMISTRY AT EL CAMINO COLLEGE

BY INTRODUCING

CHEM STUDY FILMS IN THE EIGHT MILLIMETER CARTRIDGE FORM

FOR OUT-OF-CLASS USE BY STUDENTS

One of a Series of Projects Designed to

Improve Instruction and Learning in the Physical Sciences

at El Camino College

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Division of Physical Sciences
El Camino College
September 1, 1965

TABLE OF CONTENTS

A PROJECT TO IMPROVE LEARNING IN CHEMISTRY AT EL CAMINO COLLEGE BY INTRODUCING CHEM STUDY FILMS IN THE EIGHT MILLIMETER CARTRIDGE FORM FOR OUT-OF-CLASS USE BY STUDENTS

I. Purpose

The purpose of this project is to improve instruction in chemistry at El Camino College by introducing the CHEM Study films in the eight millimeter cartridge form for out-of-class use by students.

II. Reason for the Project

The subject matter requirements in the college chemistry curriculum are increasing rapidly in both the amount of material and the sophistication of the topics which must be included. We believe there are ways of dealing with the problems associated with these changes without adding courses or hours to our present courses. At the same time, we believe there is much value in having students made more responsible for their own learning.

Recently, many outstanding films have been developed for use in beginning, general, organic, and analytical chemistry. Many of these films are superior to any text or reference treatment of the topic currently available and they bring to the student views and understandings of various chemical systems and principles which we are not able to do at El Camino College because of the limitations of equipment, material, and facilities of a highly specialized nature.

We are using these new films, in 16mm form, in classes and feel students should have the opportunity to see them more than once for purposes of study and review. Reshowing of 16mm films is not practical on either an in or out-of-class basis. Students who transfer to El Camino, or have an interruption in their chemistry course sequence, will find these films of great value in overcoming deficiencies or updating their chemistry knowledge.

There are other worthy films available but instructors do not feel they can take the class time to show them in class. However, they feel the students would benefit if they could view them.

In summary, we are commencing the use of the 8mm film cartridges and projector because we believe they will contribute to more effective learning among the chemistry students of El Camino College, as outlined above.

III. Organization of the Project

During the spring semester of 1965, the chemistry faculty selected six of the CHEM Study films to be included in the initial phase of the project. Members of the department also investigated the operation of the 8mm Fairchild cartridge projector.

During the summer session of 1965, the project coordinator prepared study guides and quizzes for each of the six films, information sheets for faculty and students,

and an evaluation card. Copies of each of these items are attached to this report. The six films in 8mm cartridge form and one Fairchild Mark IV sound cartridge film projection system, including earphones and attachments for four students, were purchased. The staff time, films, and projector were made available by the El Camino College administration after submission of a proposal for the project.

The operation of the project and additional information about the study guides, quizzes and evaluation cards will be found in the information sheets for faculty and students which are attached.

It is anticipated that when and if additional funds can be made available to the division for the project, that additional films will be purchased in this series and form, and that study guides and examinations will be prepared for these films.

An evaluation of the project in terms of faculty and student reaction to the project will be prepared at the end of the 1965-1966 school year.

IV. Cost of the Project

The special costs of putting this project into operation were as follows:

1. Mark IV 8mm sound cartridge film projection system (including earphones and attachments for 4 students)		$ 510.80
2. Six films		
CHEMICAL FAMILIES	#4812	140.00
EQUILIBRIUM	#4824	153.00
ACID-BASE INDICATORS	#4830	128.00
ELECTROCHEMICAL CELLS	#4833	140.00
CRYSTALS AND THEIR STRUCTURES	#4839	102.00
IONIZATION ENERGY	#4851	140.00
3. Tax on film and projector		72.55
4. Instructor time for preparation of study guides and quizzes (12.5 percent of Mr. Kallan's time for 6 weeks during the summer, 1965).		208.20
TOTAL		$ 1,522.00

Clerical and mimeographing services for the project were supplied by the division office and the Mimeograph Department of the college.

The time required for the preparation of the materials for the project was considerably more than allowed but the Project Coordinator, Mr. Kallan, graciously spent the time necessary to do the project work required. Considerable time of

the Project Director, Mr. Mooney, was also required and this is not specifically set forth in the cost, above, for it was assumed as part of his summer work. A summary of the time spent by Mr. Kallan and Mr. Mooney on the project during the summer is as follows:

(1)	Viewing of film and evaluation prior to actual study guide preparation	Mr. Kallan - 1½ hrs. (each film)	Mr. Mooney - 3/4 hr. (each film)
(2)	Preparation of initial drafts of study guides & quizzes	Mr. Kallan - 5 hrs. (each film)	
(3)	Revision and editing of study guides & quizzes	Mr. Kallan - 2 hrs. (each film)	Mr. Mooney - 1½ hrs. (each film)
(4)	Preparation of teacher & student instructions for use of study guides and of the film evaluation form	Mr. Kallan - 4 hrs.	Mr. Mooney - 1½ hrs.
(5)	Miscellaneous work	Mr. Kallan - 2 hrs.	Mr. Mooney - 2 hrs.
	TOTAL	Mr. Kallan - 57 hrs.	Mr. Mooney - 17 hrs.

The time assigned for the project was 12½% of Mr. Kallan's load in summer school, which figured out to 5 hours a week for 6 weeks, or a total of 30 hours.

Approximately five hours of clerical time per film (total of 35 hours, including information sheets and evaluation card) was required for the typing, dittoing and distributing of preliminary drafts and the typing of stencils of the final draft of the study guides, quizzes, information sheets, and evaluation cards.

V. Project Materials

Copies of the faculty and student information sheets, six study guides, six quizzes, and the evaluation card are attached.

EL CAMINO COLLEGE
Division of Physical Science
Chemistry Department

INFORMATION FOR THE CHEMISTRY FACULTY ABOUT THE CHEM STUDY FILM PROJECT

Facilities are now available at the audio visual center, Communications Building, Room 201, for individual student viewing of the six CHEM Study films selected by the chemistry faculty. The films available are as follows:

Title	Film Number	Time	Type
Chemical Families	4112	22 min.	color
Equilibrium	4124	24 min.	color
Acid-Base Indicators	4130	19 min.	color
Electrochemical Cells	4133	22 min.	color
Crystals and Their Structures	4139	22 min.	black & white
Ionization Energy	4151	22 min.	color

The films offer an excellent opportunity for the instructor to supplement and complement classroom and laboratory instruction through the use of animation and time lapse photography. Dangerous and difficult demonstrations visually reinforce laboratory and lecture experiments. Manipulative details and laboratory techniques are highlighted and the student is introduced to the fundamentals of instrumentation.

Study Guides

To aid the instructor in the use and application of these films, individual film study guides have been prepared for each film. The study guides are divided into three sections and are to be distributed by the instructor to the students in their classes as they deem it appropriate. A brief description of each of these sections is as follows:

I. Purpose - Statement of the overall philosophy of the film and what it attempts to accomplish.

II. Notes - A. Basic concepts required to understand the film. This lists the background and prior preparation a student should have to obtain maximum advantage from the film viewing.

B. After viewing the film. This states the general expectation of level of achievement from the film, delineated by individual chemistry courses.

III. Outline - A detailed outline of the film is provided in the form of questions. These questions are phrased so as to involve the student in the material presented and to alert him to the important concepts presented. The student is urged to carefully study these outline questions before viewing a film so as to help him to know what is of importance in the film and what to concentrate on while viewing it.

(over)

Procedure for Film Viewing and The Film Quiz

The student may view any of the films at the audio visual center daily between the hours of 8 a.m. and 9 p.m., Monday through Thursday, and 8 a.m. through 4:30 p.m. on Friday. He may obtain an 8mm file in a cartridge from the audio visual attendant and return it to the attendant after a single viewing. The attendant will then hand him a ten question multiple choice quiz and a film evaluation card. The quiz is self-administered and a key for the quiz is posted in the audio visual center so that answers may be checked immediately. The student may review the film as often as he chooses provided that other students are not waiting to use the equipment. He may retain the quiz for his future reference or review. The film evaluation card must be completed and left with the audio visual attendant prior to the students departure.

The ten question quiz is comprised of five questions (1-5 inclusive) directly related to the film and five questions (6-10) involving application and extrapolation of the information gained from the film. The instructor should indicate particular quiz and study questions he wishes to emphasize at the time the student is given the film study guide. It is suggested that the student allow 45 minutes for a single viewing and quiz. Four headphones have been provided and students should be encouraged to view a film simultaneously with other students enrolled in the same course.

Instructions for using the projector are posted near the machine. Please submit any comments or problems relative to availability and use of study guides or quizzes to Mr. L. E. Kallan.

EL CAMINO COLLEGE
Division of Physical Sciences
Chemistry Department

INFORMATION FOR STUDENTS ABOUT THE CHEM STUDY FILM PROJECT

A series of chemistry films has been provided for ECC chemistry students. The films have been selected by the chemistry faculty as aids toward more effective learning of chemical principles, concepts, and techniques. These films may be viewed by individual students or by small groups of up to four students in the Audio Visual Center, Room 201 of the Communications Building. The films available are as follows:

Title	Film Number	Time	Type
Chemical Families	4112	22 min.	color
Equilibrium	4124	24 min.	color
Acid-Base Indicators	4130	19 min.	color
Electrochemical Cells	4133	22 min.	color
Crystals and Their Structures	4139	22 min.	black & white
Ionization Energy	4151	22 min.	color

Study Guides

Study guides for the individual films in the series will be distributed to students by their chemistry instructor. The study guides are designed to assist students in deriving maximum benefit from film viewings. Students should study film outline questions thoroughly before viewing the film so they know what is important in the film and what to look for.

Procedure for Film Viewing and The Film Quiz

An 8mm film in a film cartridge may be obtained from the audio visual center attendant between the hours of 8 a.m. and 9 p.m., Mond. thru Thurs., and 8 a.m. and 4:30 p.m. on Friday. After one viewing of the film, the film cartridge should be returned to the attendant who will then hand the student a ten question, multiple choice quiz and the film evaluation card. The quiz is to be self-administered and a key for the quiz is posted in the audio visual center near the viewing room, so that answers may be checked immediately. If the student is dissatisfied with his performance on the quiz, he should re-view the film and carefully check his responses. The quiz may be retained by the student for his future use and review.

The film evaluation card is to be completed and submitted to the audio visual center attendant prior to the student's leaving the audio visual center.

Since the film running time ranges from 19 to 24 minutes, it is suggested that at least 45 minutes be allowed for a single viewing and quiz. The student may view the films as often and as many times as he wishes if other students are not waiting to use the equipment. Four headphones have been provided and students are encouraged to view a film simulteaneously with other students enrolled in the same course.

Instructions for using the projector are posted near the machine. Students should report difficulties regarding the operation of the equipment to the audio visual center attendant. Students should discuss any problem related to the availability of the film and/or use of the study guides or quizzes with their chemistry instructor.

EL CAMINO COLLEGE
Chemistry Department

STUDY GUIDE FOR THE FILM ACID-BASE INDICATORS
(CHEM Study Film No. 4130-Color-19 minutes)

I. PURPOSE

To present a quantitative study of the proton donating ability of several indicators and to relate indicator color changes to acid-base equilibria.

II. NOTES

A. Basic concepts required to understand the film

1. Equilibrium is a dynamic condition in which forward and reverse rates of reaction are equal.
2. pH is the negative logarithm of the molarity of the H^+.
3. A titration is a process in which carefully measured quantities of an acid and a base are allowed to react in the presence of an indicator.
4. Acid strength refers to the ability of an acid to donate a proton. A strong acid donates a greater number of protons than does a weaker acid of the same concentration at a given temperature.
5. The equilibrium constant for acid HA is $K_A = \dfrac{[H^+][A^-]}{[HA]}$

Where $[H^+]$ = molarity of H^+ at equilibrium, $[A^-]$ = molarity of A^- at equilibrium and $[HA]$ = molarity of unionized acid at equilibrium.
(If the above concepts are not completely understood, it is suggested that the student review his text materials and, if necessary, consult other sources of information.)

B. After viewing the film

1. Chemistry 10 students should recognize that indicators are organic acids which change color with a change of H^+ concentration. They should be familiar with some common indicators and their color changes at various H^+ concentration. (First 8½ minutes of film)
2. Chemistry 3 students should, in addition, understand the reversibility of indicator reactions and be able to write the acid-base equations. (First 8½ minutes of film)
3. Chemistry 3X, 1A and 1B students should be able to apply the equilibrium constant expression to acid-base equilibria and make quantitative calculations of H^+ concentration and pH from experimental data.

III. OUTLINE

1. What color change is observed when a drop of hydrochloric acid is placed on blue litmus paper? Explain.

2. What is observed when lemon juice or vinegar is placed on litmus paper? Explain.

3. What are the relative concentrations of H^+ (H_3O^+) and OH^- in an acid? In a base? In distilled water?

4. What colors are observed when bromthymol blue is added to an acid? To a base? How are these colors explained in terms of H^+ concentration? Equations?

5. What is a definition of an indicator? What are the requirements of an indicator?

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Study Guide - Acid-Base Indicators (CHEM Study Film 4130)

6. What is the equilibrium constant expression and value for the equilibrium $RBb \rightleftharpoons H^+ + Bb$?

7. Write an equation illustrating proton transfer of bromthymol blue in acid, base, and water solutions. Explain color changes of bromthymol blue in terms of this equation.

8. Write an equation illustrating proton transfer of methyl orange in acid, base, and water solutions. What is the equilibrium constant expression and value for K_{HMo}?

9. What colors are observed when methyl orange indicator is exposed to a H^+ concentration of $10^{-3}M$? $10^{-4}M$? $10^{-5}M$?

10. Write an equation illustrating proton transfer and colors of methyl red in acid, base and water solutions. Write the equilibrium constant expression for HMr and give value for K_{HMr}.

11. Write an equation illustrating proton transfer and colors of phenolphthalein in acid, base, and water solutions. Write the equilibrium constant expression for HPth and give value for K_{HPth}.

12. Using experimental data and calculations from the film, list strengths of the four acids starting with the strongest at the top of the list.

13. What is meant by a universal indicator? Over what H^+ concentration range could the universal indicator made in the film be applied?

EL CAMINO COLLEGE
Chemistry Department

STUDY GUIDE FOR THE FILM CHEMICAL FAMILIES
(CHEM Study Film No. 4112 - Color - 22 minutes)

I. PURPOSE:

To show that organization of observations of many properties of elements measured under comparable conditions leads to recognition of the inert gas group of elements as a chemical family; furthermore, that arranging elements by atomic number provides the clue to other chemical families, such as the halogens and the alkali metals.

II. NOTES

A. Basic concepts required to understand the film
   1. Chemical symbols are used to describe the elements.
   2. The atomic number of an element is equal to the total number of electrons in the neutral atom.
   3. A simple conductivity apparatus is often used to show the flow of electrically charged particles.
   4. Characteristics of the elements are related to their physical and chemical properties.

(If the above concepts are not completely understood, it is suggested that the student review his text material and, if necessary, consult other sources of information.)

B. After viewing the film
   1. Chemistry 10, 3 and 3X students should understand all concepts in the film, as a basis for future course development.
   2. Chemistry 1A and 1B students should understand all concepts in the film, as background material for more rigorous study in these courses.

III. OUTLINE

1. What is observed when potassium is exposed to air? to water? Equations?
2. What is observed when phosphorous is exposed to air? to water? Equations?
3. What properties are used for classifying elements as metals and non-metals?
4. Non-metals may be further subdivided into what categories?
5. Which gaseous elements are inert with potassium" react with potassium"
6. What, if anything, is observed when lithium and nitrogen are mixed? Equation?
7. What, if anything, is observed when phosphorous and fluorine are mixed? phosphorus and the inert gases? Equations?
8. What conclusions may be drawn from the answers to question number 7?
9. Recall the reaction of fluorine and phosphorus; fluorine and potassium. How is this reactivity related to the number of valence electrons in fluorine?
10. What is observed when phosphorous is mixed with hydrogen, chlorine, bromine and iodine? Are the reactions and/or reaction products similar? Explain with the use of equations.
11. What is observed when potassium is mixed with bromine? with iodine? Are the reactions and/or reaction products similar? Explain with the use of equations.
12. What is observed when water is added to the potassium reaction products? Equations?
13. What is the experimental evidence for concluding that the halogens are a chemical family? Is hydrogen included in the family? Why or why not?
14. What similarities are observed in the reaction of lithium, sodium, potassium, rubidium and cesium with chlorine? with water? Equations?
15. What is the experimental evidence for concluding that the alkali metals are a chemical family?
16. How are the inert gases used as a key to finding chemically similar elements?
17. How is the atomic number used to group elements into chemical families?
18. List some properties of xenon tetrafluoride.
19. How does the discovery of xenon tetrafluoride influence our belief that xenon is a member of the inert gas family?

EL CAMINO COLLEGE
Chemistry Department

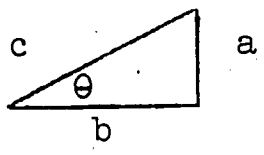
STUDY GUIDE FOR THE FILM CRYSTALS AND THEIR STRUCTURES
(CHEM Study Film No. 4139 - Black & White - 22 minutes)

I. PURPOSE:

To explain the nature and properties of crystals, to relate crystal structures to their nature and properties, and to illustrate how crystal structures are determined by means of X-ray diffraction.

II. NOTES

A. Basic concepts required to understand the film.
1. A crystal is a physical uniform solid with long-range, repetitive order in three dimensions.
2. A unit cell is the smallest repetitive volume that comprises the complete pattern of a crystal.
3. The linear space between centers of atoms (or ions) in a unit cell are called interatomic (or interionic) distances.
4. Crystalline materials are often represented by close-packed models with spherical particles packed as closely as possible. A NaCl crystal may be represented by closely packed spheres representing Na^+ and Cl^- ions.
5. An angstrom unit is 1×10^{-8} cm.
6. Angle of incidence is the angle formed by an electromagnetic radiation and a perpendicular arising from the point of incidence; angle of reflection is the angle formed by the reflected wave of an electro-magnetic radiation and a perpendicular arising from the point of reflection.
7. The trigonometric sine of a right-angled triangle is the ratio of the side opposite the angle fo the hypotenuse of the triangle.
Example:



$$\text{SINE } \theta = \frac{a}{c}$$

(If the above concepts are not completely understood, it is suggested that the student review his text materials and, if necessary, consult other sources of information.)

B. After viewing the film
1. Chemistry 10 students should understand the general concepts of the solid crystalline state and the application of the criteria of melting and cleavage in differentiating crystals and glasses. (First 7 minutes of film)
2. Chemistry 3 and 3X students should, in addition, have a non-quantitative understanding of the use of X-ray diffraction in the determination of interatomic distances.
3. Chemistry 1A and 1B students should understand all provisions of items 1 and 2 above and be able to apply experimentally determined X-ray data to the determination of interatomic distances and angles through the use of the Bragg equation.

(over)

Study Guide - Crystals and Their Structure (CHEM Study Film 4139)

III. OUTLINE

1. What is observed when a cube of NaCl is struck sharply with a hammer and a cleaver? When glass is struck similarly? Explain.

2. What is observed when a piece of NaCl is strongly heated? When a piece of glass is strongly heated? Explain.

3. What conclusions regarding bond strength, packing, and geometry may be drawn from observations 1 and 2? Compare crystals and glasses with regard to surfaces, cleavage and melting point.

4. What are the cubic dimensions of a mole of copper? Assuming spherical contact, how many atoms are there along the edge of the cube? What is the distance between the centers of adjacent atoms? (called the inter-atomic distance)

5. What is the wave length range of visible light? of X-rays? Which of these is used for measuring interatomic distances? Explain.

6. What is observed when water waves in a ripple tank are directed against a thin nail? A thick bolt? How does this experiment explain why you cannot see Cu atoms with visible light?

7. What is observed when water waves in a ripple tank are directed against immersed pegs when peg spacing and wave length are approximately equal? What relationship was developed between wave length, angle of pegs and distance between the pegs?

8. What is the relationship found between wave length, angle of incidence of wave and the distance between atoms in a crystal?

9. What experimental measurement must be made to determine interatomic distances and atomic arrangement of a crystalline material?

10. What is meant by diffraction?

EL CAMINO COLLEGE
Chemistry Department

STUDY GUIDE FOR THE FILM ELECTROCHEMICAL CELLS
(CHEM Study Film No. 4133 - Color - 22 minutes)

I. PURPOSE:

To show details of the construction and operation of electrochemical cells, the nature of the electrode reactions, the direction of electron and ion flow, the relationships between concentration and cell voltage, and the tendency toward equilibrium.

II. NOTES

A. Basic concepts required to understand the film
1. An electrochemical cell consists of two electrodes immersed in an ionic solution with provisions for the flow of ions and electrons.
2. Electric current flows by means of the movement of charged particles.
3. Electrons flow through a solid conductor; ions flow in a solution of an electrolyte.
4. In an electrochemical cell, oxidation takes place at the anode and reduction takes place at the cathode.
5. Oxidation and reduction are opposed processes which occur simultaneously.
6. Oxidation results in an increase of oxidation state due to a loss of electrons. Reduction results in a decrease in oxidation state due to a gain of electrons.
7. A salt-bridge or porous membrane allows ions to flow from one solution to another without direct mixing.
8. There is no flow of current in an electrochemical cell at equilibrium.
9. An ammeter is an instrument used to measure the rate of current flow. A voltmeter is an instrument used to measure potential difference.
10. Indicators are organic substances which change color with varying hydrogen ion concentrations.

(If the above concepts are not completely understood, it is suggested that the student review his text material, and, if necessary, consult other sources of information.)

B. After viewing the film
1. Chemistry 10 students should understand the meaning of oxidation, reduction, gain and loss of electrons, ion and electron flow, anode and cathode reactions, and be able to write and balance simple half-cell reaction equations.
2. Chemistry 3 and 3X students should understand all concepts listed in item 1 above and be able to use E^{o} values for predicting the spontaneity simple oxidation-reduction reactions. Chemistry 3X students should, in addition, be able to write and make predictions for oxidation-reduction reactions of a more involved nature, such as those using water and hydrogen ion (or hydroxide ion) in balancing.
3. Chemistry 1A and 1B students should have a thorough mastery of the concepts in item 2 above and understand the Nernst equation application.

III. OUTLINE

1. Solutions of sodium nitrate and silver sulfate are separated by a porous barrier in a flask. What is observed when a strip of copper is placed in the sodium nitrate solution and a strip of silver placed in the silver sulfate solution?

2. What is observed when the electrodes of the system described in question number 1 are connected by external wire through a voltmeter? Equations?

(over)

Study Guide - Electrochemical Cells (CHEM Study Film 4133)

3. What is the direction of flow of atoms in the electrode and ions in the solution when a single electrode is placed in an ionic solution? Equation?

4. What is the direction of flow of electrons in the external circuit of the copper-silver cell? What is the evidence for this conclusion?

5. What is the direction of flow of anions and cations in the solutions comprising the copper-silver cell? Evidence?

6. What effect on the cell potential is observed during the operation of the copper-silver cell? Explain.

7. What change is observed in the concentration of Ag^{+} and Cu^{2+} as the copper-silver cell approaches equilibrium? Equation? Explain.

8. What is observed when the indicator bromthymol blue is added to the solution of NaOH surrounding an operating hydrogen electrode? Explain.

9. Which electrode in the hydrogen-silver cell is the anode? the cathode? Why?

10. What is observed when sulfide ion is added to the silver sulfate solution of the hydrogen-silver cell? Which electrode is the anode? the cathode? List three observations, write equations and explain why the potential changes.

11. What factors determine the cell voltage of the copper-silver cell and the hydrogen-silver cell?

12. What is the meaning of E^{o} as applied to electrochemical cells?

13. How are E^{o} values experimentally determined? How are E^{o} values used in predicting the spontaneity of chemical reactions?

14. What half-cell reaction is used as the arbitrary standard for the establishment of E^{o} values?

15. What is meant by "standard conditions of temperature and pressure"?

EL CAMINO COLLEGE
Chemistry Department

STUDY GUIDE FOR THE FILM EQUILIBRIUM
(CHEM Study Film No. 4124 - Color - 24 minutes)

I. PURPOSE:

To develop what chemical equilibrium is, how the chemist recognizes it and how he explains it. These questions are answered by presenting experimental evidence that chemical equilibrium is a dynamic balance between opposing reactions as characterized by a constancy of macroscopic properties.

II. NOTES

A. Basic concepts required to understand the film
1. Molecular models are often used to illustrate and explain chemical phenomena.
2. Molecular motion and diffusion of particles are explained by the kinetic molecular theory.
3. Pressure is a function of the number of molecules of a gas present at a given temperature and is measured by barometer or manometer.
4. Le Chatelier's Principle applies when systems in a condition of equilibrium are subjected to a disturbance of the equilibrium.
5. A saturated solution is one in which the rates of solution and crystallization are equal.
6. A Geiger counter is an electronic instrument used to detect and measure the intensity of radiation being emitted from radioisotopes.

(If the above concepts are not completely understood, it is suggested that the student review his text material and, if necessary, consult other sources of information.)

B. After viewing the film
1. Chemistry 10 students should understand the dynamic nature of equilibrium, how it is recognized and how it is explained.
2. Chemistry 3 and 3X students should understand, in addition, the concept of solubility equilibrium and pressure equilibrium and the application of Le Chatelier's Principle to explain the behavior of systems disturbed by changes of concentrations of reactants or products. Chemistry 3X students should be able to write and interpret balanced equations for all chemical reactions shown in the film. Chemistry 3 students should be able to interpret these equations.
3. Chemistry 1A and 1B students should understand all concepts in the film and be able to write and interpret equations for all chemical reactions shown in the film as background material for more rigorous study in these courses.

III. OUTLINE

1. What is observed when solid iodine is added to an ethyl alcohol-water solution? Equation?

2. What is the evidence that the iodine alcohol-water solution is a saturated solution?

3. What is the evidence that equilibrium is attained in the iodine-alcohol-water solution?

4. What relationship exists regarding goldfish population in each fishbowl at equilibrium?

(over)

5. What is observed when bromine vapor in one flask is allowed to flow into connected evacuated flask of identical size?

6. What two physical properties indicate that equilibrium has been attained in the system composed of bromine vapor in the two connected flasks of identical size?

7. What occurs when sodium hydroxide is added to the iodine-alcohol-water solution? Equation?

8. What is observed when lead nitrate solution is added to the iodine-alcohol-water equilibrium solution? Equation?

9. How are the results in questions number 7 and 8 explained by Le Chatelier's Principle?

10. What is observed when marked fish are added to the fish bowl system at population equilibrium? What does this observation signify?

11. How is radioactive bromine used to illustrate the dynamic nature of equilibrium?

12. What relationship exists at equilibrium between the rate of dissolving of a solute and its rate of crystallization from solution?

13. How is radioactive iodine used to illustrate the dynamic nature of equilibrium? (two examples)

EL CAMINO COLLEGE
Chemistry Department

STUDY GUIDE FOR THE FILM IONIZATION ENERGY
(CHEM Study Film No. 4151 - Color - 22 minutes)

I. PURPOSE:

To develop the concept of ionization energy and provide an experimental background for the use in ionization energy in correlating chemical activity. To show by experiment the measurement of ionization energy and to explain via animation what occurs at the atomic level during photo-ionization and electron bombardment.

II. NOTES

A. Basic concepts required to understand the film

1. Electrical current flows by means of the movement of charged particles through a medium.
2. The ammeter and voltmeter are instruments used to measure the rate of flow and potential difference of an electrical current.
3. When an electron is excited to a higher orbital and subsequently returns to a lower one, energy is emitted in the form of photons.
4. The type of spectrum obtained when light emitted by an object is passed through a prism is called an emission spectrum.
5. Light is radiant energy having color and intensity. The color varies with the wave length and the intensity varies with the wave amplitude.
6. Visible light has wave lengths in the region 4000 angstrom units (an angstrom unit is 1×10^{-8} cm) for violet light to 8000 angstrom units for red light.
7. Atomic numbers refer to the number of protons in the nucleus of the atom and this is equal to the number of electrons in a neutral atom.
8. $E = h\nu$ (energy = Planck's constant x wave frequency) expresses the relationship between the energy of the photon in the photoelectric emission of electrons and the frequency of the wave causing the emission.

(If the above concepts are not completely understood, it is suggested that the student review his text material and, if necessary, consult other sources of information.)

B. After viewing the film

1. Chemistry 10 students should understand the concept of ionization energy, how it is measured, and its relationship to the properties and activities of the common elements.
2. Chemistry 3 and 3X students should understand fully the relationship of ionization energy and the properties of the elements in both the vertical groups and the horizontal periods in the periodic table. Details of experimental means for obtaining ionization energy data and calculations involved should be understood. All equations expressing physical and chemical relationships should become part of the students background.
3. Chemistry 1A and 1B students should understand all concepts developed in the film and be able to apply and elaborate on the principles emphasized. Ionization values should become a working tool of students at this level of training.

(over)

Study Guide - Ionization Energy (CHEM Study Film 4151)

III. OUTLINE

1. What is observed when chlorine gas is exposed to molten sodium? Equation?
2. How is ionization energy defined?
3. What three sources of energy may be used to ionize an atom in the vapor state?
4. What is the mechanism for the ionization of a sodium atom in the vapor state? What orbitals are involved? Equation?
5. What is the function of a photo-ionization cell in the determination of ionization energy?
6. What is meant by an electron volt? What is the value for the ionization energy for sodium in electron volts?
7. How does the electrical conductivity of distilled water illustrate the sensitivity of the microammeter?
8. Using photoionization experimental data, how is the ionization energy in kcal/mole determined?
9. What frequency (cycles/sec) is required to produce ionization of a gaseous sodium atom?
10. What is the ionization energy for sodium from the experiment performed in the film? How does this value compare with the accepted value?
11. What is the function of the electron bombardment cell in the ionization of sodium?
12. Which elements are ionized in the film by means of electron bombardment?
13. How do the ionization energies of the elements vary as they proceed in a chemical family from the alkali metals to the inert gases?

EL CAMINO COLLEGE
Chemistry Department

Quiz on the film ACID-BASE INDICATORS
(CHEM Study Film No. 4130 - Color - 19 minutes)

This quiz is to be taken by students after viewing the film. Students will correct their own quiz. It is suggested that students who miss questions on the quiz review the film to aid them in properly answering these questions.

Directions: Multiple choice questions. Place the letter of the correct, or most nearly correct choice in the blank at the left of the number.

The following information will be useful in answering these questions:

HMo	(methyl orange)	$K_{HMo} = 10^{-4}$
HMr	(methyl red)	$K_{HMr} = 10^{-5}$
HBb	(bromthymol blue)	$K_{HBb} = 10^{-7}$
HPth	(phenolphthalein)	$K_{HPth} = 10^{-9}$

____1. A solution with a H^+ concentration of 10^{-3}M would turn (a) methyl red to yellow, (b) methyl orange to orange (c) bromthymol blue to yellow (d) phenolpthalein to pink.

____2. A solution with a H^+ concentration of 10^{-10}M would turn (a) bromthymol blue to yellow (b) methyl red to red (c) methyl orange to red (d) phenolphthalein to pink.

____3. Which solution would be basic (a) H^+ and OH^- are in equal concentration (b) H^+ concentration is 10^{-9}M and OH^- concentration is 10^{-5}M (c) H^+ concentration is 10^{-3}M and OH^- concentration is 10^{-3}M (d) H^+ concentration is 10^{-4}M and OH^- concentration is 10^{-10}M.

____4. When HBb changes color from yellow to blue the indicator molecules (a) lose protons (b) lose electrons (c) accept OH^- ions (d) lose OH^- ions.

____5. Of the four indicators studied in the film (a) HMo is a stronger acid than HBb (b) HMr is a stronger acid than HMo (c) Bb^- is a stronger base than Pth^- (d) Mr^- and Mo^- are equal in strength.

____6. If indicator HIn has a K_{HIn} of 10^{-11} (a) it is a stronger acid than HMr (b) a color change will occur in the acid range (c) In^- is a stronger base than Mr^- (d) it would be useful in the titration of KOH and HCl.

____7. HMo would be a suitable indicator to use when titrating (a) KOH and HCl (b) NH_4OH and CH_3COOH (c) NaOH and HCN (d) NH_4OH and HCl

____8. When HBb is added to a solution a blue color results. We may conclude that (a) the H^+ concentration exceeds the OH^- concentration (b) the H^+ and OH^- concentrations are equal (c) phenolphthalein would remain pink if added to a solution of similar concentration (d) the H^+ concentration must be greater than 10^{-6}M.

____9. A solution which would turn phenolphthalein pink is (a) 0.10M HCl (b) 0.0001M H_2SO_4 (c) 0.50M NH_4OH (d) 0.05M NH_4Cl.

____10. Indicator HW is blue when H^+ concentration is 10^{-5} and red when H^+ concentration is 10^{-7}. It may be assumed that (a) HW changes color at an H^+ concentration of 10^{-7}M (b) the blue coloration is due to the loss of a proton (c) the red coloration is due to the acceptance of a proton (d) W^- would be red in basic solution.

EL CAMINO COLLEGE
Chemistry Department

Quiz on the film CHEMICAL FAMILIES
(CHEM Study Film No. 4112 - Color - 22 minutes)

This quiz is to be taken by students after viewing the film. Students will correct their own quiz. It is suggested that students who miss questions on the quiz review the film t aid them in properly answering these questions.

Directions: Multiple choice questions. Place the letter of the correct, or most nearly correct choice in the blank at left of the number.

____1. Elements may be classified as metallic or non-metallic in character by reference to their (a) density and color (b) ductility and conductivity (c) atomic numbe and atomic mass (d) melting point and boiling point.

____2. Iodine is classified as a non-metal because (a) it contains two atoms per molecu (b) it is not shiney (c) it combines with potassium (d) it does not conduct the electric current.

____3. Nitrogen is not classified as an inert gas because (a) it combines with lithium (b) it combines with the inert gases (c) it combines with the halogens (d) nitr gen atoms combine with each other to form diatomic molecules.

____4. As the alkali metal elements increase in atomic number (a) they react more vigor ously with water (b) they react less vigorously with chlorine (c) they react to form increasingly stable hydrides (d) they react more readily with the inert gas

____5. Hydrogen is not classified as a member of the halogen family because (a) hydrogen does not react with water (b) phosphorous reacts with chlorine, bromine, and iodine, but not with hydrogen (c) chlorine reacts with hydrogen (d) potassium halides do not react with water, potassium hydride does.

____6. Elements may be classified as metallic or non-metallic in character on the basis of their conductivity, luster, and ductility. Two elements which are not clearly metallic or non-metallic by these standards are (a) potassium and lithium (b) carbon and silicon (c) mercury and copper (d) phosphorus and sulfur.

____7. Which elements would not have predominantly metallic properties? (a) calcium and barium (b) aluminum and magnesium (c) osmium and iridium (d) selenium and tellurium.

____8. An element having two less electrons per atom than an inert gas (a) would probably react rapidly with air (b) would have an odd number of electrons in each atom (c) would form ionic products with sodium (d) would tend to give up two electrons per atom in a chemical change.

____9. An element having two more electrons per atom than an inert gas would: (a) be a good electrical conductor (b) be relatively inert (c) be a non-metal (d) tend to form covalent halogen compounds.

____10. Which of the following will combine to form a product vigorously reactive with water? (a) potassium and chlorine (b) barium and bromine (c) nitrogen and phosphorous (d) lithium and hydrogen.

EL CAMINO COLLEGE
Chemistry Department

Quiz on the film CRYSTALS AND THEIR STRUCTURES
(CHEM Study Film No. 4139 - Black & White - 22 minutes)

This quiz is to be taken by students after viewing the film. Students will correct their own quiz. It is suggested that students who miss questions on the quiz review the film to aid them in properly answering these questions.

Directions: Multiple choice questions. Place the letter of the correct, or most nearly correct choice in the blank at left of the number.

___1. Which is false regarding the properties of crystalline materials (a) they cleave along smooth plane surfaces (b) the angle between faces is the same for all crystals of the same material (c) they melt at a sharply defined temperature (d) the bond between particles varies in strength over a narrow range.

___2. The size of a mole of copper is approximately (a) 63.54 cubic Å (b) 63.54 cubic cm (c) 8 cubic cm (d) 10^{24} cubic Å.

___3. X-rays are similar in nature to ordinary light waves. Select the false statement. (a) they have a frequency and wave length (b) they can be treated as waves or as photons (c) they can be seen by eye in a slightly darkened room (d) they can be reflected, refracted and diffracted.

___4. X-rays (a) are electromagnetic radiations having a wave length greater than that of visible light (b) have a frequency less than visible light (c) have a frequency approximately equal to that of visible light (d) have a wave length of approximately one angstrom unit.

___5. The x-ray diffraction pattern of a substance is dependent upon the (a) geometry of the atoms (b) kind of atoms occupying positions (c) bond strength between atoms (d) the number of valence electrons of the atoms.

___6. X-rays of wave length 1.540 Å give a reflection of 10.46° from a certain crystal. The interatomic distance in the crystal is (sine 10.46° = 0.182) (a) 0.237 Å (b) 0.561 Å (c) 4.24 Å (d) 8.48 Å.

___7. The intensity of a diffracted beam of x-rays is not a function of (a) the wave length of the x-rays used (b) the interatomic distance of the crystal atoms (c) the attractive forces between crystal atoms (d) the incident X-ray angle.

___8. A mole of a metal occupies a cube approximately 4.2 cm on edge. Assuming that the atoms are in spherical contact along the edge, the distance from one atom center to the next is approximately (a) 4.2×10^{-12} cm (b) 5.0×10^{-8} cm (c) 2.54×10^{12} cm (d) 6.02×10^{-23} Å .

___9. Which is true regarding a specific crystal (a) interatomic distances may be of the order of 20 Å (b) intensity of reflected x-ray beams is dependent only on wave length (c) intensity of reflected x-ray beams is high at some angles, lower at others (d) the angle of incidence of a reflected x-ray beam is the sine of the angle of reflection.

___10. X-rays of wave length 1.540 angstroms when diffracted by crystalline copper give reflections at angles of 21.65°, 25.21°, 37.06°, 44.96°, and 47.58°, among other angles. This data may be reasonable evaluated to signify that (a) a high experimental error exists (b) the angle of incidence and angle of reflection are equal (c) crystalline copper is composed of atomic isotopes (d) interatomic distances within the crystal are not all the same.

EL CAMINO COLLEGE
Chemistry Department

Quiz on the film ELECTROCHEMICAL CELLS
(CHEM Study Film No. 4133 - Color - 22 minutes)

This quiz is to be taken by students after viewing the film. Students will correct their own quiz. It is suggested that students who miss questions on the quiz review the film to aid them in properly answering these questions.

Directions: Multiple choice questions. Place the letter of the correct, or most nearly correct choice in the blank at left of the number.

___1. In the terminology associated with electrochemical cells (a) oxidation means a gain of electrons (b) reduction means an increase in oxidation state (c) electrons are lost at the anode (d) reduction means a loss of electrons.

___2. During the operation of an electrochemical cell (a) electrons diffuse through the porous plate toward the anode (b) negative ions diffuse through the porous plate toward the cathode (c) electrons flow through the external circuit from anode to cathode (d) positive ions flow through the external circuit from cathode to anode.

___3. Experimental evidence for the theory that oxidation and reduction occur at the electrodes of the copper-silver cell is (a) the solution surrounding the copper anode turns blue as the cell is operated (b) the silver cathode decreases in size (c) the copper anode increases in size (d) the silver electrode has a reddish-brown deposit formed on it.

___4. Maximum voltage occurs in the copper-silver cell when (a) there is a large concentration of Cu^{2+} and a small concentration of Ag^{+} (b) there is a large concentration of Ag^{+} and a small concentration of Cu^{2+} (c) the concentration of Cu^{2+} and Ag^{+} are equal (d) the cell has attained equilibrium.

___5. Which is false regarding the theory of operation of an electrochemical cell? (a) oxidation and reduction occur at the electrodes (b) there is a net diffusion in solution of cations in one direction and anions in the other (c) the anions and cations diffusing through the electrolytes are equal in number (d) electrons flow through the external circuit from anode to cathode.

___6. Given the half-cell reactions $Ag \rightleftharpoons Ag^{+} + e^{-}$ $E^{o} = -0.80$ volts

$Pb \rightleftharpoons Pb^{2+} + 2e^{-}$ $E^{o} = +0.13$ volts

A properly assembled electrochemical cell using these solutions will give an observed voltage of (a) -0.67 (b) +0.54 (c) +0.93 (d) +1.73

___7. An electrochemical cell is made up of a silver electrode in $AgNO_3$ solution and a copper electrode in $CuSO_4$ solution. The dilution of the $CuSO_4$ solution with water will (a) decrease the tendency for the $Cu_{(s)}$ to release electrons (b) decrease the voltage (c) increase the tendency of $Cu_{(s)}$ to accept electrons (d) increase the voltage.

(over)

Quiz - Electrochemical Cells (CHEM Study Film 4133)

___8. In the electrochemical cell described in question number 7, the reaction at the anode will be (a) $Ag_{(s)} \longrightarrow Ag^+ + e^-$ (b) $Cu(s) \longrightarrow Cu^{2+} + 2e^-$
(c) $Ag^+ + e^- \longrightarrow Ag(s)$ (d) $Cu^{2+} + 2e^- \longrightarrow Cu(s)$

___9. Given the half-cell reactions $Zn \rightleftharpoons Zn^{2+} + 2e^-$ $E^\circ = +0.76$ volts
$Pb \rightleftharpoons Pb^{2+} + 2e^-$ $E^\circ = +0.13$ volts

When this cell is in operation (a) oxidation takes place at the Zn electrode (b) electrons flow in the external circuit from the Pb electrode to the Zn electrode (c) diffusion of anions proceeds in the direction of the Pb - Pb^{2+} half-cell (d) the Zn electrode increases in size.

___10. Given the half-cell reactions $Zn \rightleftharpoons Zn^{2+} + 2e^-$ $E^\circ = +0.76$ volts
$Cu \rightleftharpoons Cu^{2+} + 2e^-$ $E^\circ = -0.34$ volts

If a solution of sulfide ion is added to the Cu-Cu^{2+} half-cell causing a dark precipitate to form (a) the cupric ion concentration will increase (b) the cell voltage will be unaffected (c) the cell voltage will decrease (d) the electrolyte in the Zn-Zn^{2+} half-cell will become basic.

EL CAMINO COLLEGE
Chemistry Department

Quiz on the film EQUILIBRIUM
(CHEM Study Film No. 4124 - Color - 24 minutes)

This quiz is to be taken by students after viewing the film. Students will correct their own quiz. It is suggested that students who miss questions on the quiz review the film to aid them in properly answering these questions.

Directions: Multiple choice questions. Place the letter of the correct, or most nearly correct choice in the blank at left of the number.

____1. Chemical equilibrium is referred to as "dynamic" because (a) the particles of reactants and products are in constant motion (b) there is a balance between the rates of the forward and reverse reactions (c) the products and reactants exert an equal pressure on the walls of the container (d) all chemical reactions involve energy.

____2. When bromine vapor is allowed to flow from one bulb into a connected evacuated bulb, the pressures in the bulbs are measured by mercury manometers. After the stop cock is opened to allow bromine to flow, and before the system reaches equilibrium the mercury levels in the manometers (a) remain the same (b) both decrease (c) both increase (d) one increases and the other decreases.

____3. When solid iodine is added to an iodine-alcohol-water system at equilibrium (a) the iodine is reduced to iodate ion (b) the iodine is oxidized to iodide ion (c) the iodine is both oxidized and reduced (d) no oxidation or reduction is involved.

____4. In the equilibrium reaction: $3I_2 + 3H_2O \rightleftharpoons 5I^- + IO_3^- + 6H^+$ (a) the addition of naOH results in the formation of a precipitate (b) the addition of NaOH increases the color intensity of the solution (c) the addition of $Pb(NO_3)_2$ results in the formation of a precipitate (d) the addition of $Pb(NO_3)_2$ reduces the concentration of H^+.

____5. When a crystalline solid is placed in a pure solvent and begins to dissolve, the rate with which molecules (a) leave the crystal is a function of solution pressure (b) leave the crystal is a function of temperature (c) crystallize is a function of temperature (d) leave the crystal generally increases with time.

____6. A plausible reason for demonstrating an iodine-alcohol-water system rather than an iodine-water system is (a) iodine is a polar molecule and therefore not appreciably soluble in water (b) an iodine solution in water is colorless (c) iodine is more soluble in ethyl alcohol than in water (d) iodine forms unstable compounds with water.

____7. Equilibrium in a system: $PbI_{2(s)} \rightleftharpoons Pb^{2+} + 2I^-$ exists when (a) half of the Pb^{2+} ions have reacted with all of the I^- ions (b) the number of I^- ions in solution is equal to twice the number of Pb^{2+} ions (c) a large amount of precipitate is present (d) the number of I^- ions crystallizing in unit time is equal to twice the number of Pb^{2+} ions dissolving.

(over)

Quiz - Equilibrium (CHEM Study Film No. 4124)

___8. Given the following system in equilibrium: $Cl_2 + H_2O \rightleftharpoons H^+ + Cl^- + HClO$ which is correct? (a) the addition of Cl_2 would have no effect on the equilibrium (b) the addition of KOH would increase the amount of Cl_2 present at equilibrium (c) the addition of Ag^+ would cause the reaction to proceed to the right (d) heating the reaction gently would increase the H^+ concentration.

___9. Liquid benzene is in equilibrium with its vapor in a closed container at a constant temperature. Which statement is false? (a) an increase in temperature will result in an increase in vapor pressure (b) an increase in the container volume will result in a decrease in vapor pressure (c) the addition of more liquid benzene to the container will not affect the vapor pressure (d) the addition of helium to the container will increase the total pressure but not affect the benzene vapor pressure.

___10. Given the following chemical system:

$$\text{rate} = r_f$$
$$A + B \rightleftharpoons C + D$$
$$\text{rate} = r_r$$

One mole of A and one mole of B are allowed to react to form C + D and the rates of both the forward and reverse reactions are measured. Which is true? (a) As C + D are formed, the concentrations of A + B will become less (b) r_f will be less than r_r until equilibrium is reached (c) r_f will be equal to r_r until equilibrium is reached (d) r_r will decrease with time.

EL CAMINO COLLEGE
Chemistry Department

Quiz on the film IONIZATION ENERGY
(CHEM Study Film No. 4151 - Color - 22 minutes)

This quiz is to be taken by students after viewing the film. Students will correct their own quiz. It is suggested that students who miss questions on the quiz review the film to aid them in properly answering these questions.

Directions: Multiple choice questions. Place the letter of the correct, or most nearly correct choice in the blank at left of the number.

____1. When sodium is reacted with chlorine (a) the reaction is spontaneous on contact of chlorine gas and solid sodium metal (b) chlorine molecules react with sodium atoms in the liquid state (c) the sodium must be vaporized before an observable reaction occurs (d) the reaction is endothermic.

____2. The term "ionization energy" refers to the energy involved in the (a) ionization of a molecular substance such as HCl gas (b) formation of an ion from a neutral atom (c) removal of an electron from a gaseous atom (d) dissolving of an ionic compound.

____3. When sodium atoms are ionized (a) electrons are absorbed by the sodium atoms (b) ultra-violet light is absorbed by the 1s electrons (c) photons are emitted by the sodium atoms (d) ultra-violet light is absorbed by the 3s electrons.

____4. The ionization energy for sodium is (a) 118 electron volts (b) 118 kcal-mole (c) 5 kcal/mole (d) 118 kcal/mole.

____5. Given Planck's constant of 9.53×10^{-14} $\frac{\text{kcal-sec}}{\text{mole}}$ and a frequency of 12.4×10^{14} cycles/sec, the energy of the photon could be determined by the expression (a) $h = \frac{v}{E}$ (b) $v = hE$ (c) $v = \frac{E}{h}$ (d) $E = \frac{h}{v}$

____6. The frequency of light required to ionize sodium gas (atomic number 11) by photo-ionization is 12.4×10^{14} cycles/sec. The frequency of light required to ionize potassium gas (atomic number 19) would be (a) less than 12.4×10^{14} cycles/sec (b) approximately 12.4×10^{14} cycles/sec (c) approximately $\frac{19}{11}$ (12.4×10^{4}) cycles/sec (d) approximately $\frac{11}{19}$ (12.4×10^{4}) cycles/sec.

____7. The predicted ionization energy of xenon is (a) approximately equal to that of sodium (b) greater than that of helium (c) less than that of neon (d) approximately equal to that of argon.

____8. If the energy difference between two electronic states is 46.12 kcal/mole the frequency of light emitted when the electron drops from the higher state to the lower state will be (a) 118 cycles/sec (b) approximately 5.3 cycles/sec (c) 4.40×10^{-12} cycles/sec (d) $4.84 = 10^{14}$ cycles/sec.

____9. In general, the value of ionization energy will (a) increase with increase in atomic number in a vertical group (b) remain constant for transition elements (c) increase with increase in the number of valence electrons (d) decrease with decrease in atomic radius.

____10. If the value of ionization energy for element A exceeds the ionization energy for element B then (a) if A is a non-metal, B must be a metal (b) if both A and B are metals, A must be more active (c) if both A and B are non-metals, B would be more electronegative (d) if A and B are in the same vertical group, then B is the more metallic element.

STUDENT EVALUATION - 8mm CHEM STUDY CARTRIDGE FILMS

Check film viewed

Equilibrium	_____
Crystals & Structure	_____
Ionization Energy	_____
Acid-Base Indicators	_____
Electrochemical Cells	_____
Chemical Families	_____

Name:_____

Course:_____ Instructor: _____

Date:_____

DIRECTIONS: Please evaluate the film checked by completing below:

1. I have viewed this film this semester approximately _____ times.

2. Total hours spent this semester viewing this film, using the study guide and taking quiz is:
   less than 1_____ 1 to 3_____ 4 to 6_____ 7 to 9_____ 10 or more _____

3. Do you feel that the time spent viewing the film and using the study guide and quiz might have been more profitably spent studying the text? _____ studying lecture notes? _____ studying other material? _____ (please specify) _____

4. Do you feel that the use of the film, study guide, and quiz helped you in the understanding of chemical concepts and ideas? Yes_____ No_____

5. If your response to (4) is yes, please specify concepts and/or ideas. _____

6. Would you recommend that the chemistry department make available for out of class use audio-visual aids covering other topics? Yes_____ No_____

7. If your response to (6) is yes, what other topics should be included? _____

8. Did the study guide aid you in understanding the subject presented in the film? Yes_____ No_____

9. If your response to (8) is no, how can the study guide be improved? _____

10. Did the quiz help you in the observation of chemical systems and the application of important principles? Yes_____ No_____

11. If your response to (10) is no, how can the quiz be improved? _____

12. Suggestions for improvement of the content or administering of this self-viewing film project are as follows: _____

Thank you.