
STUDY
CHEMISTRY with

STUDY GUIDE TO MOELLER *et al.*: CHEMISTRY with Inorganic Qualitative Analysis

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0 YOUR STUDY GUIDE

Understanding chemistry is not easy for most students even though many claim to put in many long hours of study. How much time is needed? Most educational experts suggest a minimum of three hours of study outside the classroom for each hour in the classroom each week. This means that for a typical general chemistry class which meets each week for three lectures, a recitation, and a laboratory, at least 18 hours of outside study each week would be required.

Activities such as rewriting lecture notes, reviewing old examinations and quizzes, writing laboratory reports, doing homework assignments, and "cramming" for tests are essential parts of a typical plan of study, but before any of these learning techniques will be beneficial, you should understand the material--and <u>that</u> is the purpose of this study guide.

Each chapter of this study guide has the same major sections. The purpose and use of each section are summarized below.

CHAPTER OVERVIEW

This section presents a very brief survey of the major topics presented in the textbook chapter. When studying a chapter for the first time, you should make a quick survey of the chapter to identify the major topics, to see where the chapter is leading, etc.

COMPETENCIES

This section lists in greater detail the major topics that should be learned in the chapter. These topics are catagorized into important terms that should be defined, qualitative concepts

that should be learned, and numerical calculations that should be understood. As you read the chapter for the first time, you should refer to these lists to help you identify the sections that will require extra study.

CHAPTER OUTLINE

After reading the entire chapter, now is the time for really detailed study. One of the best ways to organize your thoughts while studying is to prepare an outline of the material.

Preparation of an outline is an effective learning technique because you are interacting (analyzing, evaluating, etc.) with the material rather than simply reading it in a passive manner. You should read each section a couple of times to learn the details and then prepare the outline. The outline given in the study guide will help you check yours for organization, missed concepts, errors, etc. Of course, your outline will be useful for organizing lecture notes, reviewing for tests, studying for comprehensive final examinations, etc.

QUESTIONS

This section presents a series of "multiple choice", "matching", and "fill in the blank" questions designed to check your understanding of the new terms and of some of the concepts presented in the chapter. Answers are provided so that you can check your progress.

SKILLS

This section presents the in-depth studies of certain concepts that must be mastered. Usually you are referred to previously-learned skills that are important in understanding the material in the chapter and then any new skills are presented. Following the explanation and examples presented in each new skill, a set of questions (with answers) is provided to test your competency.

NUMERICAL EXERCISES

This section is designed to help you with the quantitative material presented in the chapter. Although the textbook contains

numerous example problems, additional examples are presented in this section along with exercises (with answers) to check your understanding. You are also referred to earlier examples in the study guide to help in learning the new material or in solving the exercises at the end of the textbook chapter.

PRACTICE TEST

Here is your chance to check your overall understanding of the material in the chapter. The practice test consists of a mixture of "multiple choice" and "matching" questions as well as a few problems. Most of the questions have been used on actual examinations. Answers are provided so that you may check your progress.

ADDITIONAL NOTES

Because each course, instructor, and student is different, this section is left for you to include additional material presented in class, notes from outside reading assignments, doodles, etc.

Now you are ready to attend the first lecture on the subject. You can pay attention to and understand the talk, demonstration, etc., and not worry about writing down every word that the instructor has to say. By now you have noticed that the words "you" and "your" have appeared many times in this chapter. Why? It is you who must do the work to learn.

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1 CHEMISTRY: THE SCIENCE OF MATTER

CHAPTER OVERVIEW

In this chapter basic definitions are given for science, matter, and chemistry and then the subdivisions of chemistry are described. The modern units of measurement are reviewed and the factor-dimensional method for problem solving is discussed. A short discussion about the role of chemistry in society concludes the chapter.

COMPETENCIES

(1) Meaningful definitions for the following terms should be learned:

biological sciences
chemical properties
chemical reaction
chemistry
compound
density
descriptive chemistry
heterogeneous mixture
homogeneous mixture
hydrocarbons
hypothesis
inorganic chemistry
law
mass
mixture
organic chemistry
physical properties
physical sciences
principles of chemistry
pure substance
states of matter
theory
weight

(2) General concepts that should be learned:

(a) the different parts of the scientific method
(b) the various states of matter and their general properties
(c) the identification of chemical and physical properties

(d) the kinds of matter
(e) the subdivisions of chemistry
(f) the basis for the systems of measurements

(3) The types of numerical exercises that should be understood:
(a) calculating the density from mass and volume measurements (or using the density and mass or volume to calculate the volume or mass)
(b) converting values of heat, length, volume, mass, or temperature given in one system of units to another system using the factor-dimensional method

CHAPTER OUTLINE

I. Science and matter

1.1 Science

a. natural science is a classification of knowledge about things that are observable in nature, in the material world, and in the universe
1. biological sciences pertain mainly to things that are alive
2. physical sciences pertain mainly to things that are not alive

b. scientific method
1. the first step is usually a series of systematic observations
2. a hypothesis is a tentative explanation for a set of observations
3. a series of experiments are devised to test the hypothesis
4. a law is a statement of a relation between observed phenomena
5. a theory is a unifying principle or group of principles that explains facts and laws

1.2 States and properties of matter

a. matter occupies space, has mass, and can usually be seen and touched

b. states of matter
1. gas
(a) infinite compressibility and expandability
(b) takes shape of container (flows)
(c) high energy content of molecules makes gases completely disordered

2. liquid
   (a) slight compressibility and expandability
   (b) takes shape of container (flows) but with fixed volume and surface
   (c) intermediate energy content so that there are limited regions of ordering of molecules
3. solid
   (a) very small compressibility and expandability
   (b) fixed shape (negligible flow)
   (c) lowest energy content of the three states so that there is nearly complete ordering of molecules

c. properties of matter
   1. physical properties can be exhibited, measured, or observed without resulting in a change in the composition and identity of a substance
   2. chemical properties can only be observed in a chemical reaction in which at least one substance is changed in composition and identity

1.3 Kinds of matter

a. a pure substance is a form of matter that has defined physical and chemical properties and chemical composition no matter what its source
   1. an element cannot be converted into a simpler form of matter by any chemical reaction
   2. a compound is a substance of definite composition in which two or more elements are chemically combined

b. a mixture is any combination of variable properties of two or more substances in which the substances combined retain their identity
   1. in a heterogeneous mixture the individual components remain physically separate and can usually be seen, e.g., concrete
   2. in a homogeneous mixture the individual components are thoroughly intermingled and the mixture appears uniform throughout, e.g., air

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II. Chemistry: the science of matter

1.4 Chemistry

a. chemistry is the branch of science that deals with matter, with the changes that matter can undergo, and with the laws that describe these changes

b. the principles of chemistry are the explanations of chemical facts

c. descriptive chemistry is the description of the elements and compounds, their physical states, and how they behave

1.5 Subdivisions of chemistry

a. organic chemistry is the study of compounds containing carbon and hydrogen (hydrocarbons) and their derivatives

b. inorganic chemistry is the study of all the elements and their compounds except the hydrocarbons and their derivatives

c. analytical chemistry involves the measurements of amounts and composition of substances and the separation of the components of mixtures

d. physical chemistry involves the measurements of physical properties and the theoretical interpretation of physical and chemical properties

e. biochemistry is the study of the pure substances and chemical reactions in living systems

III. Units of measure: problem solving

1.6 Systems of measurement

a. the "metric" or "SI system" is being used by most major countries and by the scientific and engineering community, although some modifications occurred during the changeover from older systems

b. fractions and multiples of basic units are represented by the prefixes given in Table 1.4 of the text

c. conversion factors between systems are given in Table 1.5 of the text--it is recommended that one conversion factor for length, one for mass, and one for volume be memorized

1.7 Length

a. the SI basic unit is the meter (m)

1.8 Volume

a. the SI basic unit is the cubic meter (m^3) which is derived from the meter

b. common laboratory units are liters (1 liter = 1 dm^3) and milliliters (1 ml = 1 cm^3)

1.9 Mass vs. weight

a. mass is an intrinsic property and represents the quantity of matter in a body

b. weight is the force a body exerts because of the pull of gravity on the mass of the body

c. the SI basic unit is the kilogram (kg)

d. the density is the mass per unit volume (d = m/v)

1.10 Heat

a. heat energy flows from a body with the higher temperature to one with the lower temperature

b. the SI basic unit of energy is the joule (J)

c. a common laboratory unit is the calorie (1 cal = 4.184 J)

1.11 Temperature

a. the SI basic unit is the Kelvin (written as °K in the text)

b. a common laboratory scale is the Celsius (or centigrade) scale (°C = °K - 273.15)

c. a common scale is the Fahrenheit scale which is related to °C by °C = (5/9)(°F - 32) and °F = (9/5)°C + 32

1.12 The factor-dimensional method of calculation

a. retain all units with numbers

b. units are canceled in the same manner as numbers

c. a correct solution to a problem will always have the correct units and an incorrect answer may be recognized by the wrong units for the answer

IV. Chemistry and the future

QUESTIONS

1. Complete the sentences given below by filling in the various blanks using the following terms: (i) hypothesis, (ii) law, and (iii) theory.

Each time you reach a certain intersection it seems that the traffic light is red. You formulate the following (a) _____: the traffic light is always red when approached. You perform a series of carefully-designed tests to see if the traffic light is always red and the results confirm your statement. You are not ready to announce a (b) _____. After a little thinking, you develop a (c) _____ which explains the phenomenon based on a timing sequence of a series of traffic lights by the street commissioner.

2. Complete the sentences given below by filling in the various blanks using the following terms: (i) chemical properties, (ii) chemical reactions, (iii) compound, (iv) densities, (v) heterogeneous mixture, (vi) homogeneous mixture, (vii) hydrocarbons, (viii) physical properties, (ix) pure substance.

   Consider a rain puddle with a drop of motor oil floating on top of it. This is an example of a (a) _____ in which the two layers are easily seen. The reason for the layer formation is that the two materials are not soluble in each other and have different (b) _____--examples of the (c) _____ of the materials. The layers can be separated giving water which is an example of a (d) _____ and a (e) _____ of (f) _____ (compounds containing carbon and hydrogen) which makes up the motor oil. Each (g) _____ in the motor oil has a set of unique (h) _____ which can be observed by a series of (i) _____.

3. Match the correct term to each definition.

(a) a collection of knowledge which pertains mainly to things that are alive	(i) biological sciences
(b) a collection of knowledge which pertains mainly to things that are not alive	(ii) chemistry
(c) the condition or form in which matter exists (e.g., gas, solid, or liquid)	(iii) descriptive chemistry
(d) the branch of science that deals with matter, with the changes that matter can undergo, and with the laws that	(iv) inorganic chemistry
	(v) mass
	(vi) mixture
	(vii) organic chemistry
	(viii) physical sciences
	(ix) principles of chemistry
	(x) states of matter
	(xi) weight

describe these changes

(e) the explanations of chemical facts

(f) the description of the elements and compounds, their physical states, and how they behave

(g) the study of compounds of carbon and their derivatives

(h) the study of all the elements and their compounds except the hydrocarbons and their derivatives

(i) an intrinsic property representing the quantity of matter in a body

(j) the force a body exerts because of the pull of gravity on the mass of the body

(k) a combination (of variable composition) of two or more substances in which the substances combined retain their identity

Answers

1. (a) i, (b) ii, (c) iii. 2. (a) v, (b) iv, (c) viii, (d) iii, (e) vi, (f) vii, (g) ix, (h) i, (i) ii. 3. (a) i, (b) viii, (c) x, (d) ii, (e) ix, (f) iii, (g) vii, (h) iv, (i) v, (j) xi, (k) vi.

SKILLS

(1) Review of previously-learned skills

(a) Skill 1.1: Using scientific notation for large and small numbers

Standard scientific notation is the representation of a number in which the significant figures of the number (see Appendix A.1 of the text) are retained in a factor between 1.00... and 10.00... and the decimal point is given by a power of ten--see Appendix A.2 of the text. Briefly, for numbers greater than unity, the decimal point is moved to the left in the number until reaching a number that is between 1 and 10 and the power of ten is equal to the number of digits that the decimal point was moved. For numbers less than unity, the decimal point is moved to the right in the number until reaching a number that is between 1 and 10 and the power of ten is equal to the number of digits that the decimal point was moved except that a negative sign appears in the power. For example,

$$\underbrace{1700}_{} = 1.7 \times 10^{3} \qquad 0.\underbrace{07}_{}230 = 7.230 \times 10^{-2}$$

To check your competency, express the following numbers in standard scientific notation: (a) 460; (b) 7,294,000; (c) 1.6;