LIFEPAC®

SCIENCE

STUDENT BOOK

11th Grade

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Alpha Omega PUBLICATIONS

SCIENCE 1101

ESTIMATE AND MEASUREMENT

LIFEPAC Test is located in the center of the booklet. Please remove before starting the unit.

Elements, Compounds, and Mixtures

Introduction

Chemistry is an ancient science. Early in Genesis (Genesis 4:22) record is made of man's use of chemistry. In man's quest for ways to "subdue the earth and have dominion over it," chemistry has played a major role. Our synthetic world of today with its many different forms of plastic is a result of the knowledge man has gained about chemistry.

On the other hand, our polluted streams, dirty atmosphere, and trash-laden landfills are also a result of our knowledge of chemistry. Knowledge is neither good nor bad, but man's use of it can be either good or bad. Because of man's innate sinful nature, self is first, encouraging the misuse and poor stewardship of God's creation.

In this LIFEPAC® you will study the history of chemistry, the classification of matter, and man's knowledge of the world about him.

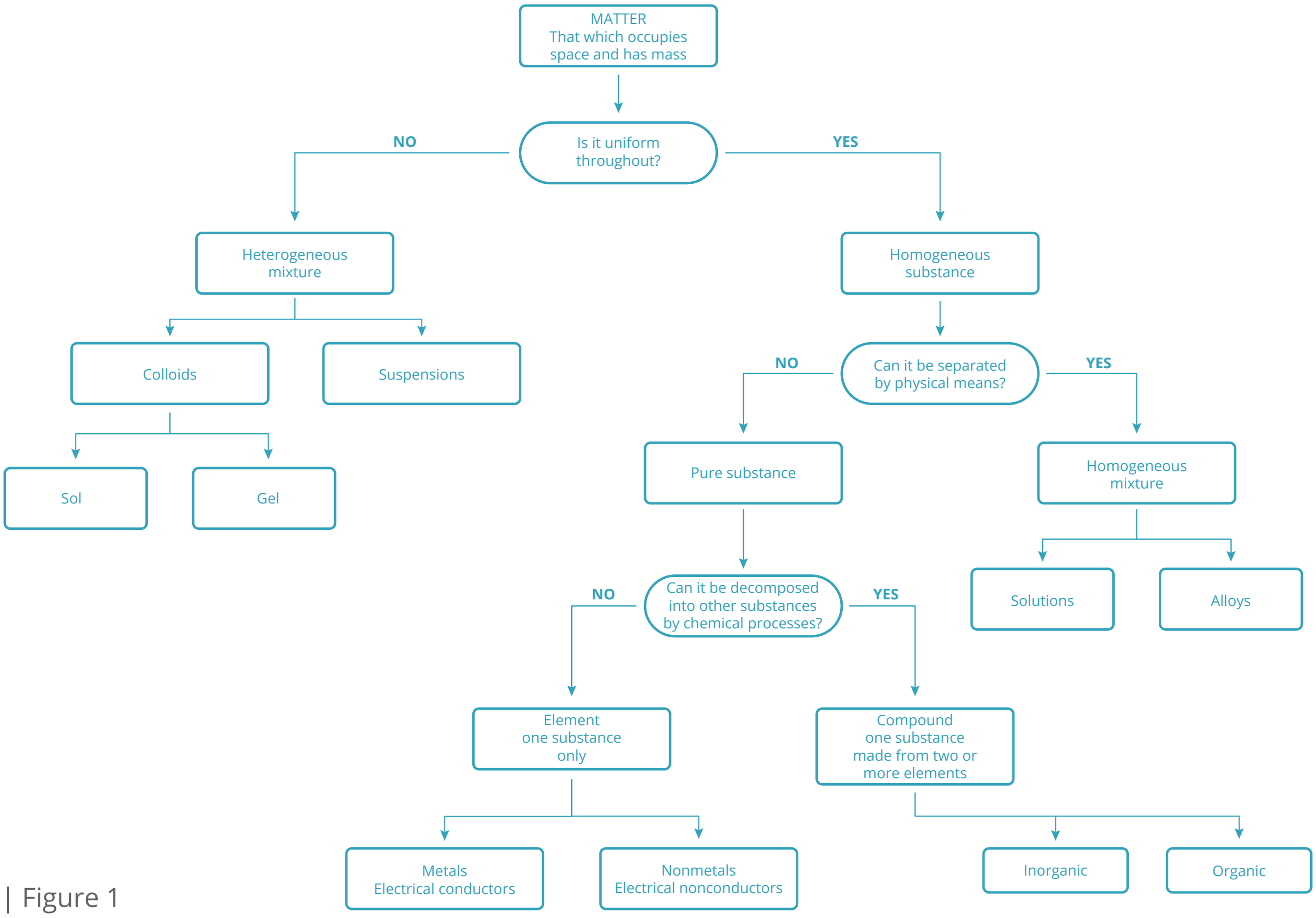
Objectives

Read these objectives. The objectives tell you what you will be able to do when you have successfully completed this LIFEPAC. When you have finished this LIFEPAC, you should be able to:

1. Trace the history of chemistry to about 1750.
2. Describe alchemy and what it has contributed to us.
3. Describe elements.
4. Distinguish between and describe chemical, physical, and phase changes.
5. Describe compounds and distinguish them from elements.
6. Classify compounds as organic or inorganic.
7. Describe and give examples of various types of mixtures.

1. ELEMENTS

All matter can be classified in the following classification scheme:



| Figure 1

We will use this classification scheme for our study of chemistry.

In man's effort to find order in the universe, he has learned to classify. Man has always been curious about the world around him. The word *science* comes to us from the Latin verb *scio* which means *to know*. The Latin noun *scientia* means knowledge. In both cases the meaning is broader than mere recognition. In this section you will study the history of alchemy, the contributions of alchemy, and the properties of the simplest parts of matter, elements.

Section Objectives

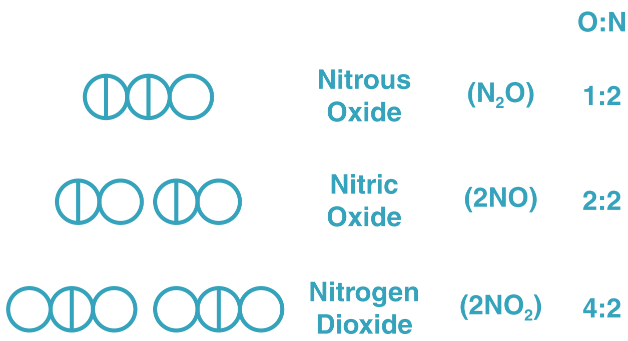
Review these objectives. When you have completed this section, you should be able to:

1. Trace the history of chemistry to about 1750.
2. Describe alchemy and what it has contributed to us.
3. Describe elements.
   - 3.1 Give the symbols of several common elements.
   - 3.2 Classify elements by properties.
   - 3.3 Define atoms.

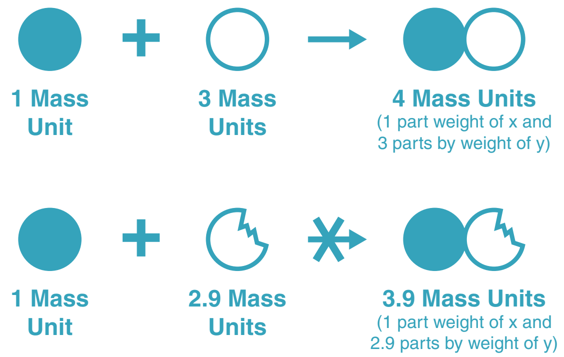
He tried to work out the relative masses of atoms; but his calculations were wrong, although the principle was correct. He was, however, the first to establish a table of **atomic masses**, with hydrogen, the lightest atom, as the standard.

Contribution to atomic science. Dalton occupies an important place in the history of atomic hypothesis from Democritus and Newton to his own day, primarily because he based his theory on scientific observation rather than on philosophical speculation.

After Dalton's work was published, it was widely accepted in a short time and eventually his atomic theory became the basis of all chemistry.



| Figure 3: The Law of Multiple Proportions



| Figure 4: According to Dalton's atomic theory, only whole atoms may combine. The second scheme is not possible.

Answer this question.

1.6 Who is considered the father of atomic theory? ______

Explain these concepts.

1.7 Law of Multiple Proportions ______

1.8 Law of Definite Proportions ______

1.9 Dalton's model of the atom ______

FORMULA PREDICTION

When the sodium atom, magnesium atom, aluminum atom, and chlorine atom change their outer electron shells to a more stable configuration, they become **ions**. This change means that they have gained or lost electrons and now have an unequal number of electrons (-) and protons (+). Since in a chemical reaction the atomic number [number of protons (+)] *always* remains the same, a gain or loss of electrons will result in the particle having a net electrical charge. An example might be lithium. A lithium atom enters a chemical reaction with three electrons and three protons, but generally loses one electron. This loss means that lithium has a net charge of +1, meaning one excess positive charge or one more proton than electron.

Before: 3+ and 3- = net charge of 0
After: 3+ and 2- = net charge of +1 (lost one electron)

Complete the following table using the ideas from the previous paragraph.

	ELEMENTS	ELECTRON STRUCTURE OF ATOM	ELECTRON STRUCTURE OF ION	NET ION CHARGE
	Lithium	$1s^2\ 2s^1$	$1s^2$	1+
1.14	Beryllium	a.	b.	c.
1.15	Chlorine	a.	b.	c.
1.16	Sodium	a.	b.	c.
1.17	Fluorine	a.	b.	c.
1.18	Oxygen	a.	b.	c.
1.19	Magnesium	a.	b.	c.
1.20	Calcium	a.	b.	c.
1.21	Boron	a.	b.	c.
1.22	Phosphorous	a.	b.	c.
1.23	Sulfur	a.	b.	c.
1.24	Aluminum	a.	b.	c.
1.25	Nitrogen	a.	b.	c.
1.26	Silicon	a.	b.	c.
1.27	Carbon	a.	b.	c.

CHECK ____________ ____________
Teacher Date

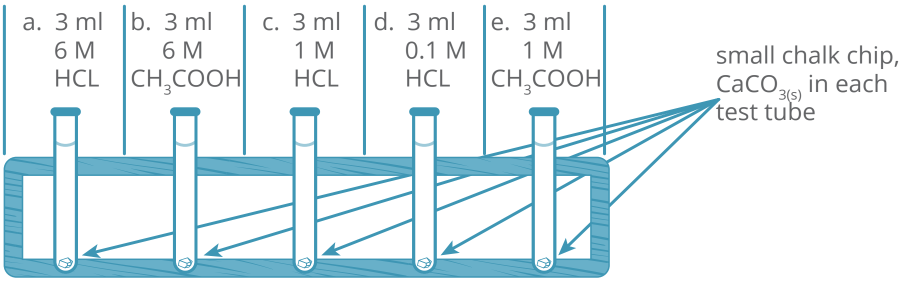
Do this experiment. Wear goggles.

These supplies are needed:

- concentrated HCl (hydrochloric acid) – purchased from a building contractor, pool supply, concrete mason, or chemical company; common name is muriatic acid.
- glacial acetic acid – purchased from a chemical supply store
- 6 M HCl – made by putting 50 ml of concentrated HCl into H_2O to make 100 ml
- 1 M HCl – made by putting 8.3 ml HCl into H_2O to make 100 ml
- 0.1 M HCl – made by putting 10 ml of the 1 M HCl in H_2O to make 100 ml
- 6 M acetic acid – made by putting 34.8 ml glacial acetic in H_2O to make 100 ml
- 1 M acetic acid – made by putting 5.8 ml glacial acetic acid in H_2O to make 100 ml
- 5 small chips of blackboard chalk (white is best) or calcium carbonate chips
- 5 small test tubes (purchased from a hobby shop or a chemical supply company)

Follow these directions and complete the activities. Put a check in the box when each step is completed.

☐ 1. Set up the following experiment.



1.12 What do the reactants look like? ______________________________

____

____

____

1.13 What did each reaction look like?

a. ______________________________

____

b. ______________________________

____

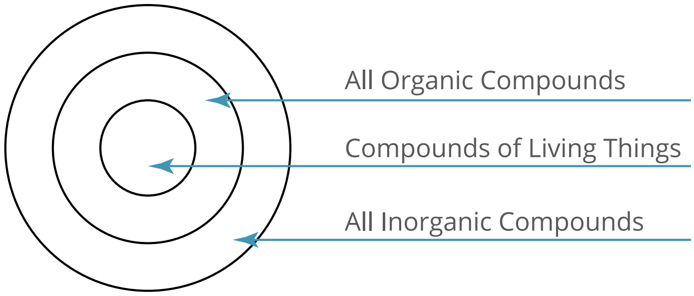
c. ______________________________

____

Gas Formation Experiment (Continued on next page)

Do this activity.

1.5 The following circle represents all chemical compounds. Crosshatch organic compounds vertically and inorganic compounds horizontally on the drawing.



Answer *true* **or** *false***.**

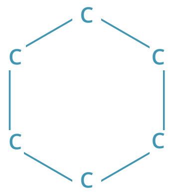
1.6 ____________ Compounds of carbon are organic.

1.7 ____________ Organic compounds can not be synthesized.

SOURCES OF ORGANIC COMPOUNDS

Since Vitalism is dead, what is so special about compounds of carbon that they should be studied separately from the compounds of the other hundred or so elements? In part, the answer seems to be that so many carbon compounds exist. About 50,000 compounds of all the elements other than carbon are known to exist. Well over a million organic compounds are known, and every year more than 100,000 new organic compounds are produced.

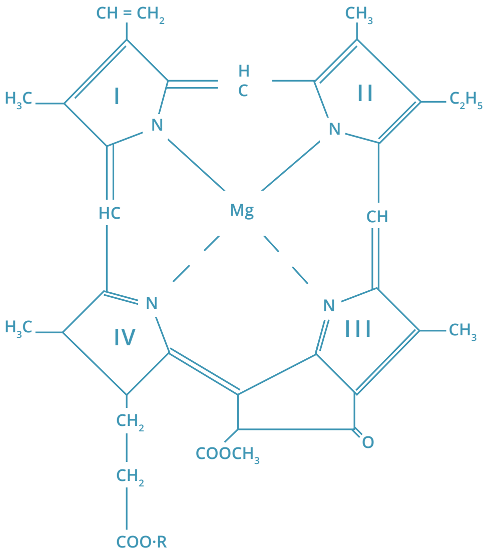
What is significant about carbon that it forms so many compounds?



Carbon atoms can attach themselves to one another to an extent not possible for atoms of any other element. Carbon atoms can form chains thousands of atoms long or rings of all sizes, such as chains made of paper clips or strings of popcorn. The chains and rings can have branches and cross-links with atoms of other elements (chiefly hydrogen) attached to the carbon atoms. Each different arrangement of atoms corresponds to a different compound, and each compound has its own physical and chemical properties.

Therefore, the order in which atoms are attached to each other and the electrons which hold them together are very important in accounting for the properties of compounds. Structural formulas and wood models representing molecules can be used to account for the physical and chemical properties of compounds.

Man himself is a walking organic chemical machine.



| Chlorophyll a: A green pigment in plants

The intricate balance between life and death, learning and forgetting, growing or not growing, fighting disease or becoming sick is organic in nature. Any student of medicine or nursing will certainly need to understand and appreciate the beauty of this branch of chemistry. The delicate balance of nature has its foundation in the study of organic chemistry. Much of our modern day technology and pollution, especially ecological, is organic in nature.

Not only is organic chemistry contemporary, but it is also a clue to the past. Much of the history of the earth and the study of petrology involves the study of the world of carbon. For example, natural gas, petroleum, and coal are the largest sources of carbon compounds. Although many of these materials are used as they are, many compounds from these sources are used as raw materials for synthesizing new compounds. Coal, for example, has become such an important source of medicines that some are advocating developing atomic energy more rapidly and saving our coal reserves.

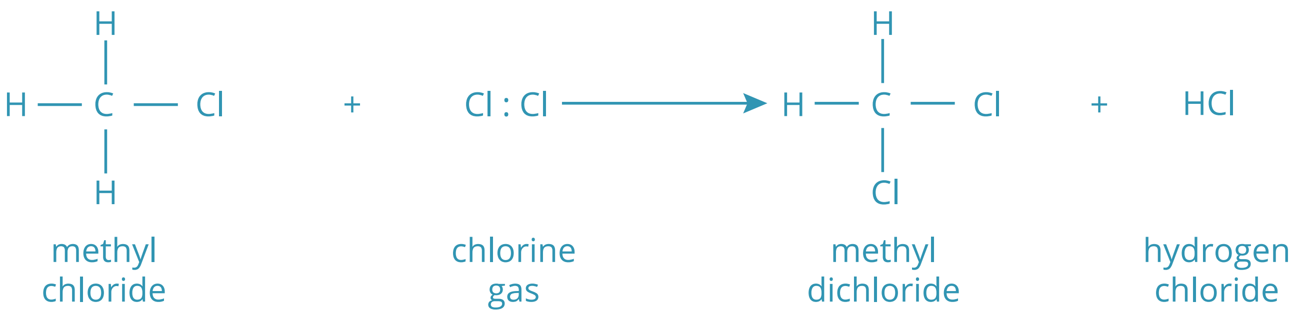
Petroleum. Natural gas is about 90 percent methane (CH_4) with some ethane (C_2H_6) and propane (C_3H_8) in it. Natural gas is found in certain porous rock formations. Natural gas is used for heating buildings, for cooking food, and for a starting compound to produce other organic substances. Methane, ethane, and propane are colorless and are practically odorless. By law, a sulfur-containing

Alkanes			Boiling Point
natural gas (mostly)	methane	CH_4	-162° C
	ethane	C_2H_6	-88° C
bottled gas (mostly)	propane	C_3H_8	-42° C
	butane	C_2H_{10}	0° C
gasoline	pentane	C_5H_{12}	36° C
	hexane	C_6H_{14}	69° C
	heptane	C_7H_{16}	98° C
	octane	C_8H_{18}	126° C
	nonane	C_9H_{20}	151° C
	decane	$C_{10}H_{22}$	174° C
		$C_{11}H_{24}$	
		$C_{12}H_{26}$	

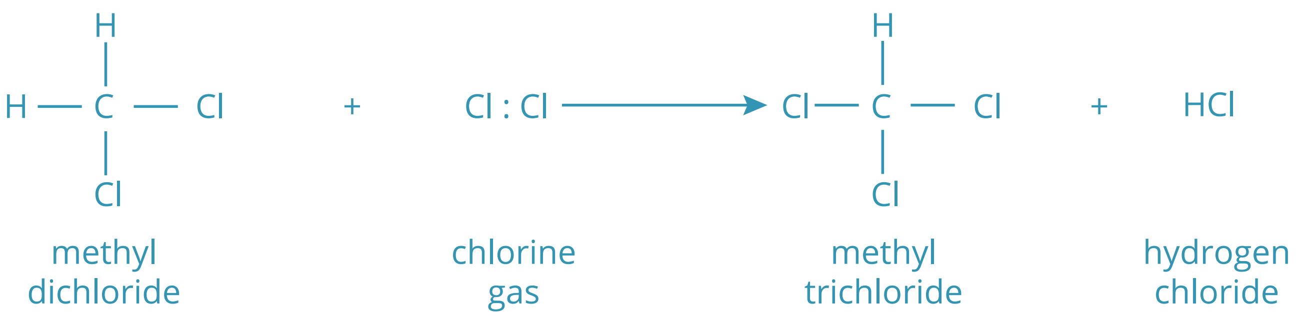
Table 1: Fractions of Petroleum

Fraction	Distillation Temperature C°	Carbon Number	Percent Crude Oil
natural gas	below 20°	C_1 - C_4	2%
petroleum ether	20 - 60°	C_5 - C_6	
ligroin	60 - 100°	C_6 - C_7	2%
gasoline	40 - 206°	C_5 - C_{10}	32%
kerosene	175 - 325°	C_{12} - C_{18}	18%
fuel oil	above 275°	C_{12} and higher	20%
lubricating oil	nonvolatile liquids	long chains	
asphalt	nonvolatile solids	polycyclic structures	

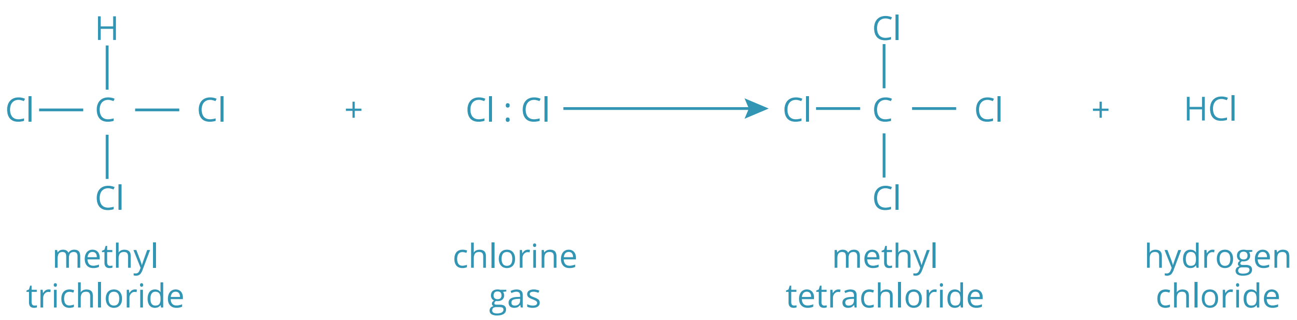
If the methane-chlorine mixture is left to continue reacting, successive hydrogens will be replaced and the substitution reaction will continue until all hydrogens have been replaced.



| Reaction 2



| Reaction 3



| Reaction 4

This substitution series is an equilibrium series and will finally become a mixture of all four methyl halides. The equilibrium can be shifted to the right in each case by the removal of hydrogen chloride and the use of excess chlorine gas. (If you need a review of equilibriums, review Science LIFEPACs 1106 and 1107.) Since the HCl is an acid and is very soluble in water, the reaction mixture can be pumped through water and the HCl removed. This process leaves the methyl halide to react with chlorine gas until complete substitution has been accomplished. This reaction procedure is common in the production of halides from saturated hydrocarbons.

Examples. Many saturated halide hydrocarbons are common to us in our everyday life. A few examples are listed in Table 1.

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TEACHER'S GUIDE

11th Grade

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SCIENCE 1100

Teacher's Guide

INSTRUCTIONS FOR SCIENCE

The LIFEPAC curriculum from grades 2 through 12 is structured so that the daily instructional material is written directly into the LIFEPACs. The student is encouraged to read and follow this instructional material in order to develop independent study habits. The teacher should introduce the LIFEPAC to the student, set a required completion schedule, complete Teacher checks, be available for questions regarding both content and procedures, administer and grade tests, and develop additional learning activities as desired. Teachers working with several students may schedule their time so that students are assigned to a quiet work activity when it is necessary to spend instructional time with one particular student.

The Teacher Notes section of the Teacher's Guide lists the required or suggested materials for the LIFEPACs and provides additional learning activities for the students. The materials section refers only to LIFEPAC materials and does not include materials which may be needed for the additional activities. Additional learning activities provide a change from the daily school routine, encourage the student's interest in learning and may be used as a reward for good study habits.

If you have limited facilities and are not able to perform all the experiments contained in the LIFEPAC curriculum, the Science Project List may be a useful tool for you. This list prioritizes experiments into three categories: those essential to perform, those which should be performed as time and facilities permit, and those not essential for mastery of LIFEPACs. Of course, for complete understanding of concepts and student participation in the curriculum, all experiments should be performed whenever practical. Materials for the experiments are shown in Teacher Notes—Materials Needed. Videos of many of the labs may be available from online sources. These are useful as a demonstration of the lab procedure and for suggestions on alternate materials and equipment that can be used.

NOTE: Data tables can be found throughout the curriculum. They should be available to the student (where appropriate) anytime they are answering problems in section exercises, Self Tests, or LIFEPAC Tests.

LAB SAFETY

A few simple rules will guide your safe use of chemicals and equipment in a science laboratory.

1. Always wear safety goggles and a lab apron. Surgical gloves are also helpful.
2. Wipe up all spills immediately with a wet sponge. Wash out the sponge with lots of water.
3. Wash off any chemicals from hands or other body parts with lots of water.
4. Handle all equipment and chemicals with care and caution.
5. Keep focused on the task at hand. Distractions lead to accidents.
6. Plan ahead. Read through each experiment before you start. Be sure to have plenty of room to work.
7. Carry out the experiments on a level, hard, non-porous table top. This makes cleanup easy.
8. Wash and clean up all equipment exposed to chemicals as soon as the activity is completed. Dirty equipment can mean danger.
9. Be sure to use a well-ventilated room. Sometimes chemicals can have a very strong odor.
10. Have fun.

SCIENCE PROJECTS LIST

Key

(1) = Those essential to perform for basic understanding of scientific principles.

(2) = Those which should be performed as time permits.

(3) = Those not essential for mastery of LIFEPACs.

S = Equipment needed for homeschool or Christian school lab.

E = Explanation or demonstration by instructor may replace student or class lab work.

H = Suitable for homework or for homeschool students. (No lab equipment needed.)

Science 1101

pp	12	(2)	S & H
	14	(2)	S & H
	16	(2)	S & H
	18	(2)	S & H
	25	(1)	S & H

Science 1102

pp	9	(1)	S & H
	16-19	(1)	S & H
	25	(2)	H
	35	(1)	H
	40	(1)	S

Science 1103

pp	17	(1)	S
	28	(1)	S
	60	(1)	S

Science 1104

pp	9	(1)	S
	10	(1)	S
	11	(2)	S
	31	(1)	S or H
	33	(1)	S

Science 1105

pp	27	(1)	S

Science 1106

pp	6	(1)	S
	7	(1)	S
	9	(1)	S
	11	(1)	S
	35	(1)	S
	38	(2)	S
	45	(1)	S

Science 1107

pp	26	(1)	S
	36	(1)	S
	45	(1)	S
	72	(1)	H

Science 1108-10

none

TEACHER NOTES

MATERIALS NEEDED FOR LIFEPAC	
Required	Suggested
• metric rulers or meter sticks • small beakers or glass jars • 10 ml, 50 ml, and 100 ml graduated cylinders • balance • 125 ml and 250 ml Erlenmeyer flasks (two bottles, like ketchup bottles, with lids can be used for Erlenmeyer flasks) • candles (birthday and household will work) • soda straws • Limewater: To make limewater, secure a medium-sized jar with tight-fitting lid. Add water (preferably distilled or purified water) until $^2/_3$ full. Add a teaspoon of lime to the jar, replace the lid and shake. Let the mixture set for 24 hours. The clear liquid on top is the limewater, so when used pour off the clear liquid and leave the solid in the jar. To replenish the limewater, just add more water, shake, and let stand. Lime can be purchased from a hardware, garden, or lumber supply store as lime or whitewash.	(none)

ADDITIONAL LEARNING ACTIVITIES

Section 1: Metric Units

None.

Section 2: Instrumentation

1. Provide materials for students to measure using metric rulers, triple-beam balance, and graduated cylinders.
2. Measure distances and objects with friends.
   Average these measurements.
   Measure again those that vary greatly.
3. Make a 1,000 cm^3 box of cardboard or wood with a friend.
4. Make a box that is 10 cm on each side. Compare this box with one of 1,000 cm^3.

ANSWER KEY

SECTION 1

1.1 Reports will vary.

1.2 **kilometer:**

a. 0.1
b. 0.0012
c. 0.000001
d. 0.063
e. 0.0001263
f. 0.0315
h. 0.0000192
i. 0.00684
j. 0.0000093
l. 0.0001516
m. 0.000000031
n. 0.1234
p. 0.00366

meter:

b. 1.2
c. 0.001
e. 0.1263
g. 536
h. 0.0192
j. 0.0093
k. 61,390
m. 0.000031
n. 123.4
o. 0.00036
p. 3.66

centimeter:

a. 10,000
d. 6,300
e. 12.63
f. 3,150
g. 53,600
i. 684
j. 0.93
k. 6,139,000
l. 15.16
n. 12,340
o. 0.036
p. 366

millimeter:

a. 100,000
b. 1,200
c. 1
d. 63,000
f. 31,500
g. 536,000
h. 19.2
i. 6,840
k. 61,390,000
l. 151.6
m. 0.031
o. 0.36

1.3 **cm^3:**

b. 2,100
c. 1.05
d. 941
e. 100.5
f. 10,300
g. 0.025
h. 22,400
i. 12.86
j. 321
k. 22.4
l. 25

ml:

b. 2,100
c. 1.05
e. 100.5
h. 22,400
j. 321
l. 25

L:

d. 0.941
f. 10.30
g. 0.000025
i. 0.01286
k. 0.0224

SECTION 3

3.1 Hint:
The observations of each person must be evaluated separately. Different people will draw different conclusions.

3.2 Hint:
Include the wind factor as part of your answer.

3.3 Observations will vary.

3.4 Answers will vary, but must match with 3.3.

3.5
a. There is no specific answer. Observations will vary.
b. Answers will vary, but must be consistent with facts observed.
c. Hint:
Hypothesis must be logical and reasonable.

3.6 The flask with the candle gases should change the limewater to a cloudy white mixture. The control should remain colorless and unchanged.

3.7 The control is the standard of comparison and is used to check to see what a change in the experiment does to the experiment.

3.8 A cloudy film forms on top. When swirled, the liquid becomes cloudy as did the candle gases but with less intensity.

3.9 The results are the same as the candle, but less in amount

3.10 yes; the reactions were the same.

3.11 The candle container;
Example:
Candle produced something that is in the air.

3.12 candle; the reaction was greater and faster.

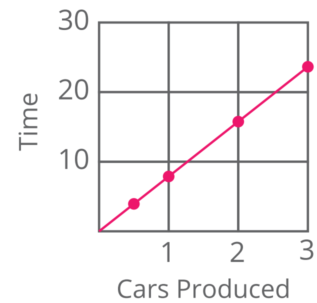
3.13 Some results occur.

3.14 water and carbon dioxide; carbon dioxide; of course; carbon dioxide

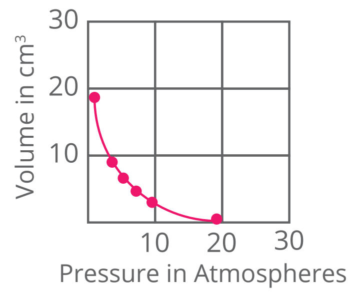
3.15 The candle is burning and produces carbon dioxide as a product.

3.16 k = 65.6

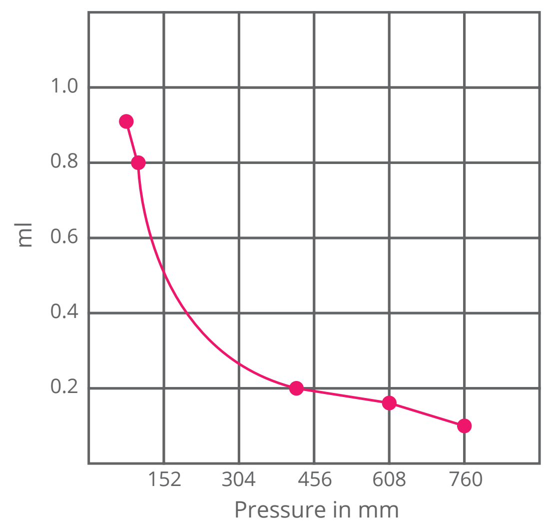
3.17
a. 0.5; 4
b. 1; 8
c. 2; 16
d. 3; 24



3.18
a. 18
b. 9
c. 6
d. 3
e. 2
f. 1

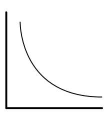


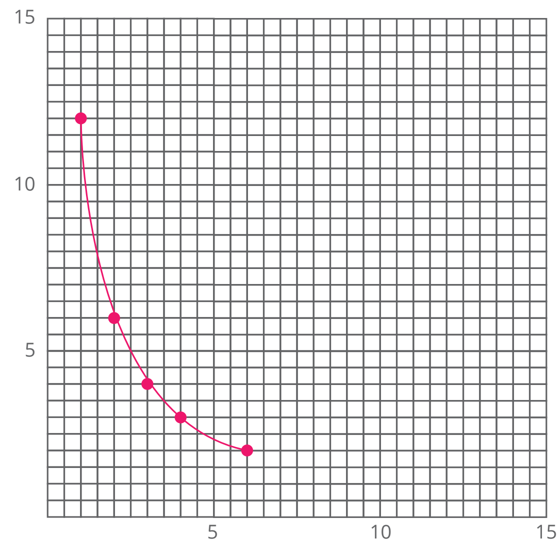
3.19



3.20 81.4

LIFEPAC TEST

1. f. ml
2. h. ± 0.2
3. i. quantitative
4. a. milli
5. j. hypothesis
6. k. kilogram
7. b. cm
8. c. instrument of volume
9. g. $xy = k$
10. d. centi
11. c. mm
12. a. ± 0.1 ml
13. a. 6.02×10^6
14. a. law
15. d. 0.000391
16. b. ml
17. d. 
18. d. ml
19. c. ± 0.05
20. c. ml
21. inverse
22. hypothesis
23. law
24. ± 0.1 mm
25. accuracy
26. 1.386×10^{-2} or 1.4×10^{-2}
27. $6.528 \times 10^7 = 6.5 \times 10^7$
28. 1.697×10^{-1}
29. $7.8744 \times 10^4 = 7.87 \times 10^4$
30. 4.802×10^1
31. Teacher check
32. Sample data:
    a. 1; 12
    b. 2; 6
    c. 3; 4
    d. 4; 3
    e. 6; 2



33. Hint:
    Comparisons should clearly show that quantitative observations involve a "how much" while a quantitative does not.
34. Example:
    The chemical technician is responsible for the laboratory tests, analysis, and quality checks on products and production of a product. This career links the theoretical with the practical application.
35. A hypothesis is an "educated" guess as an explanation to a set of data or phenomena. A hypothesis may or may not be true, and several hypotheses may explain the same observations.
    Example:
    My hypothesis is that the drought caused this tree to die.

SCIENCE 1101

ALTERNATE LIFEPAC TEST

NAME ______________________

DATE ______________________

SCORE ______________________

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Match these items (each answer, 2 points).

1.	________	*xy = k*	**a.**	1/100
2.	________	primary unit of mass	**b.**	direct relationship
3.	________	±	**c.**	unit of distance
4.	________	qualitative	**d.**	milliliter
5.	________	centi	**e.**	1/1000 kg
6.	________	theory	**f.**	explanation accepted without question
7.	________	mm	**g.**	inverse relationship
8.	________	ml	**h.**	accuracy
9.	________	straight-line graph	**i.**	well accepted explanation
10.	________	g	**j.**	type of observation
			k.	kilogram

Write the letter for the correct answer on each line (each answer, 2 points).

11. The best way to write 960,200 in scientific notation is _______ .
a. 9.60200×10^5 b. 9.602×10^5
c. 9.6×10^4 d. $9,602 \times 10^2$

12. The accuracy of an instrument is the _______ of the instrument.
a. quality b. cost
c. precision d. size

26. Secure three unknowns from your teacher. Perform the appropriate measurements to determine the mass, length, and volume of the three quantities.

a. mass ______________ b. mass ______________ c. mass ______________

volume ______________ volume ______________ volume ______________

length ______________ length ______________ length ______________

27. Express $(7.16 \times 10^1) \div (2.00 \times 10^1)$ in scientific notation. ______________________________

28. (9.094)(19.20) = ______________________________ (express in scientific notation).

Complete this activity (this answer, 5 points).

29. Develop a set of data and plot the data for an equation showing an inverse relationship when *k* = 9.

	x	***y***	***k***
a.			9
b.			9
c.			9
d.			9
e.			9