



SCIENCE

STUDENT BOOK

► **12th Grade | Unit 1**

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SCIENCE 1201

KINEMATICS

INTRODUCTION | 3

1. **UNITS, SCALARS, AND VECTORS** **5**

UNITS | 5

SCALARS | 10

VECTORS | 11

SELF TEST 1 | 13

2. **MEASUREMENT OF LENGTH** **14**

DISTANCE | 14

DISPLACEMENT | 17

SELF TEST 2 | 18

3. **RATE OF LENGTH CHANGE** **20**

SPEED | 20

VELOCITY | 25

SELF TEST 3 | 27

4. **RATE OF VELOCITY CHANGE** **29**

ACCELERATION | 29

ACCELERATION DUE TO GRAVITY | 34

FREE FALL | 35

SELF TEST 4 | 38

5. **FIELDS AND MODELS** **41**

FIELDS | 41

MODELS | 44

SELF TEST 5 | 48

GLOSSARY **51**



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

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Rock Rapids, IA 51246-1759**

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Kinematics

Introduction

You are about to begin a study of physics, the fundamental science of the natural world. This course is your opportunity to study laws that God established when he created heaven and earth. We will start with kinematics, which is a branch of mechanics dealing with the mathematical methods of describing motion.

Objectives

Read these objectives. The objectives tell you what you will be able to do when you have successfully completed this LIFEPAK®

1. Identify the fundamental units of physics.
- 2.
- 3.
4. Identify and explain scalar quantities.
5. Calculate vectors using vector arithmetic.
6. Distinguish between distance and displacement.
7. Calculate problems involving distance and displacement.
8. Calculate problems involving area, volume, and density.
9. Distinguish between speed (a scalar) and velocity.
10. Calculate problems involving speed and velocity.
11. Distinguish between average speed and average velocity.
12. Calculate problems involving average speed and average velocity.
13. Identify the circumstances that produce acceleration.
14. Calculate problems involving acceleration.
- 15.
- 16.

Survey the LIFE PAC. Ask yourself some questions about this study and write your questions here.

Handwriting practice area with 15 rows of dashed lines on a light gray background.

1. UNITS, SCALARS, AND VECTORS

Prior to studying motion, you will need to become acquainted with units used in this course—the metric system or SI units—and the concept of **scalar** and **vector** quantities.

Section Objectives

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

1. Identify the fundamental units of physics.
2. Use scientific notation in calculations.
3. Use prefixes of the metric system.
4. Identify and explain scalar quantities.
5. Calculate vectors using vector arithmetic.

Vocabulary

Study these words to enhance your learning success in this section.

component
resultant

inertia
scalar

kinematics
scientific notation

length

mass
time

prefix
vector

Note: All vocabulary words in this LIFEPAK appear in **boldface** print the first time they are used. If you are not sure of the meaning when you are reading, study the definitions given.

UNITS

You will use primarily the *MKS* (meter-kilogram-second) *system* or the *cgs* (centimeter-gram-second) *system* in this course. Let's review these systems.

Time. **Time**, according to Sir Isaac Newton, is that which flows onward uniformly. It is a fundamental,

of time. However, the reason for dividing the day into twenty-four portions called *hours* is obscure. The hour is divided into sixty equal portions called *minutes*, and the minute into sixty equal portions called *seconds*.

Length. **Length** is the measurement describing the distance from one location to another. Historically, every nation had its own unit of length. We will use the *meter* (a little longer than a yard) and the *centimeter* (a little less than half an inch) as units of

unit in physics.

Mass. The third fundamental unit in physics is **mass**

matter that a body possesses. We will use the *kilogram* (approximately the mass of an object weighing two pounds at sea level) or the *gram*, which is one-thousandth of a kilogram. Please note that the kilogram is *not equal* to 2.2 pounds, because a pound is a unit of force and not a unit of mass.

to the mass that weighs 2.2 pounds at sea level. This distinction between mass and weight is important and is quite often misstated.

inertia, which is the apparent resistance of matter to a change in motion.

All other measurements (with the exception of temperature, time, length, and mass.

You should understand these concepts before continuing. Figure 1 lists the fundamental metric units and their multiples and subdivisions. Notice the abbreviations given.

Length	Time	Mass
1 meter (m) = the standard unit = 39.37 inches = 3.28 feet	1 second (s) = the standard unit	1 kilogram (kg) = the standard unit
1 centimeter (cm) = 0.01 meter	1 minute (min) = 60 seconds	1 gram (g) = 0.001 kilogram
1 millimeter (mm) = 0.1 centimeter = 0.001 meter	1 hour (hr) = 60 minutes = 3600 seconds	1 milligram (mg) = 0.001 gram = 0.000001 kg
1 kilometer (km) = 1000 meters = 0.621 mile	1 day = 24 hours = 86,400 seconds	(1 kilogram corresponds to 2.21 pounds in the sense that the weight of 1 kilogram is 2.21 pounds at sea level.)

| Figure 1: Metric Units

Complete these sentences.

- 1.1 That which flows onward uniformly, of which a day is a logical portion, is called _____.
- 1.2 The distance from one place to another is _____.
- 1.3 The term used to describe the quantity of matter that a body possesses is _____.
- 1.4 The branch of mechanics dealing with the mathematical methods of describing motion is called _____.

Measure Small Objects Experiment

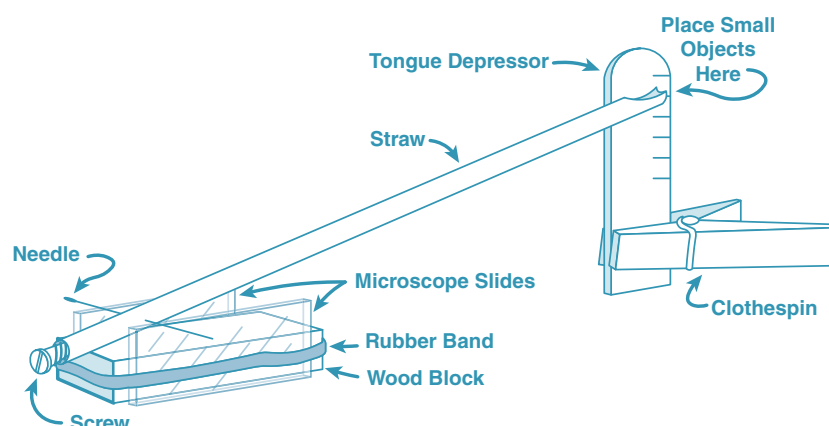


Try this investigation. Anyone can measure most masses using equal-arm or triple-beam balances, but what about measuring very small objects? Expensive equipment is not necessary.

These supplies are needed:

- 1 screw
- 1 paper straw
- 2 microscope slides
- 1 needle
- 1 ruler
- 1 razor blade or scissors
- 1 small wood block
- 1 tongue depressor
- 1 clothespin
- 100 sheets paper
- balance or electronic kitchen scale

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



| Figure 2: Soda Straw Balance

- ☐ 1. Place the screw about half its length into the straw and determine where the balance is.
- ☐ 2. Balance the straw containing the screw on
- ☐ 3. Push the needle through the straw at the balance. The needle should be slightly above the centerline of the straw.
- ☐ 4. Cut open the other end so that a lip is formed to hold objects.
- ☐ 5. Balance the straw on the glass slides by turning the screw.
- ☐ 6. Hold the tongue depressor upright with the clothespin.
You have now constructed a “soda straw” balance. Your “soda straw” balance must be calibrated.
- ☐ 7. Count out 100 sheets of paper (all the same type), and measure the mass in grams on any available scale. Record this answer in 1.5.
- ☐ 8. Measure the length and width of one sheet of paper in centimeters (cm) and calculate the number of square centimeters (cm²) in one sheet. Record this answer in 1.7.

1.5 What is the mass of 100 sheets of paper?

1.6 What is the mass of one sheet of paper? 

(Continued on next page)

- 1.7 How many square centimeters are in the one sheet of paper?

1.8 What is the mass of 1 cm² (square centimeter) of paper?

9. Cut about ten square centimeter pieces from your paper by using a ruler and razor blade or scissors. Do not mark your paper with a pencil; graphite will contribute mass. Be careful in handling your paper; perspiration will also contribute undesirable mass.

10. Place a 1 cm² piece of paper on the lip of your scale; and, if necessary, cut your 1 cm² piece into smaller pieces so that each piece will move the soda straw no more than one-

1.9 What size piece of paper will you use?

1.10 What is the mass of this piece of paper?

11. Make several pieces of paper precisely the same size.

12. Mark the tongue depressor 0 for no paper on the straw, 1 for one piece of paper on the straw, 2 for two pieces, and so on. You have now calibrated your balance.

1.11 Which strand of hair had the most mass?






CHECK

Teacher



Date

Scientific notation. In physics (and in other sciences) we often deal with very large and very small dimensions. A method has been devised for expressing large and small numbers. This method, called **scientific notation**, expresses numbers as multiples of powers of ten.

First, let us learn to express place values as powers of ten.

1000	=	10•10•10	=	10 ³
100	=	10•10	=	10 ²
10	=	10	=	10 ¹
1	=		=	10 ⁰
0.1	=		=	10 ⁻¹
0.01	=		=	10 ⁻²
0.001	=		=	10 ⁻³

Once this pattern is understood, the following steps should be obvious:

2,000	=	2 • 1,000	=	2 • 10 ³
54,300	=	5.43 • 10,000	=	5.43 • 10 ⁴
0.02	=	2 • 	=	2 • 10 ⁻²
0.0006	=	6 • 	=	6 • 10 ⁻⁴

Notice that with numbers larger than 1, count the number of places moved to the left and this number becomes a positive exponent.

186,000 =  = 1.86 • 10⁵

For numbers less than one, count the number of decimal places moved to the right. This number becomes the negative exponent.

0.0000067 =  = 6.7 • 10⁻⁶

ally expressed as shown:

$a.bc \cdot 10^n$,

where a , b , and c are whole numbers, and n may be a positive or negative integer.

When adding or subtracting numbers expressed the same. If they are not the same, then one must be changed in order that they be the same. For example,

$$4.80 \cdot 10^6 + 7.2 \cdot 10^5$$

$$4.80 \cdot 10^6 = 48.0 \cdot 10^5$$

$$+ 7.2 \cdot 10^5$$

$$55.2 \cdot 10^5 = 5.52 \cdot 10^6$$

Notice that the coefficients are added, but the exponents are not.

When multiplying or dividing, follow the rules for multiplying or dividing the coefficient of the notation. If multiplying add the exponents. For example,

$$(6.0 \cdot 10^5) (5.0 \cdot 10^3) =$$

$$30 \cdot 10^{5+3} =$$

$$30 \cdot 10^8 =$$

$$3.0 \cdot 10^9$$

$$(6.0 \cdot 10^4) (7.0 \cdot 10^{-2}) =$$

$$42 \cdot 10^{4+(-2)} =$$

$$42 \cdot 10^2 =$$

$$4.2 \cdot 10^3$$

If dividing, subtract the exponents. For example,

$$6.0 \cdot 10^5 \div 3.0 \cdot 10^3 =$$

$$\frac{6.0}{3.0} \cdot 10^{5-3} =$$

$$2.0 \cdot 10^2$$

$$6.0 \cdot 10^5 \div 3.0 \cdot 10^{-3} =$$

$$\frac{6.0}{3.0} \cdot 10^{5-(-3)} =$$

$$2.0 \cdot 10^8$$

see Science LIFEPAK 1101.

Calculate each answer and record in scientific notation.

1.12 Calculate $8 \cdot 10^{-4}$ divided by $2 \cdot 10^2$.

1.13 Calculate $1.6 \cdot 10^3$ times $3.0 \cdot 10^{-6}$.

1.14 Calculate $9 \cdot 10^{-5}$ divided by $3 \cdot 10^{-9}$.

Prefixes are another means of expressing large or small numbers. For example, if you were referring to 3000 m, you could express it as $3 \cdot 10^3$ m, or as 3 kilometers (3 km) because *kilo* means 1000, or 10^3 .

of-ten equivalents, and abbreviations. An example memorized.



804 N. 2nd Ave. E.
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800-622-3070
www.aop.com

SCI1201 – Sept '17 Printing

ISBN 978-1-58095-591-1

