

SCIENTIFIC NOTATION (I)

PART A: Express each of the following numbers using scientific notation.

1. 10,000 _____
2. 0.001 _____
3. 100,000,000 _____
4. 30,000,000 _____
5. 435,000,000,000 _____
6. 108,000,000 _____
7. 67,800,000 _____
8. 9000 _____
9. 0.802 _____
10. 0.000023 _____
11. 54.3 _____
12. 0.00000000660 _____

PART B: Write each of the following numbers in expanded form.

1. 1.0×10^0 _____
2. 1.00×10^1 _____
3. 1×10^{11} _____
4. 4×10^4 _____
5. 6.7×10^8 _____
6. 8.23×10^6 _____
7. 14.76×10^9 _____
8. 7.88×10^3 _____
9. 435.6×10^7 _____
10. 28.5×10^1 _____
11. 9.6800×10^{11} _____
12. 0.987×10^3 _____

SCIENTIFIC NOTATION (II)

DIRECTIONS: Carry out each of the following operations using scientific notation.

1. $100 - 10$ _____
2. $10,000 + 300,000$ _____
3. $100,000 \times 10,000$ _____
4. $40,000 \times 3,000,000$ _____
5. 0.001×0.000004 _____
6. 0.00052×0.0000002 _____
7. $35,000 \times 620,000,000$ _____
8. $103,000,000 \times 56,500$ _____
9. 0.0037×0.0000062 _____
10. $85,000,000 \times 0.0034$ _____
11. $0.000882 \times 61,000,000$ _____
12. $0.3600 \times 0.00064 \times 92,000$ _____
13. $42,000,000 \times 120,000 \times 0.00045$ _____
14. $0.00082 \times 83,400 \times 0.0000025$ _____
15. $4,500,000 \times 12,500 \times 0.0035 \times 0.00009$ _____
16. $\frac{100}{50 \times 400 \times 0.050}$ _____
17. $\frac{45,000 \times 0.0035}{600,000 \times 2,500}$ _____
18. $\frac{4,500,000,000 \times 0.00000034}{8000 \times 0.000027 \times 0.000016}$ _____
19. $\frac{0.00056 (14,500,000 \times 35,000)}{18,900,000(0.0000755)}$ _____
20. $\frac{75,000 \times 0.000082 \times 0.00015}{125,000,000,000 \times 0.0000030}$ _____

NAME _____

SIGNIFICANT FIGURES

Significant figures in a number comprise all digits known with certainty plus the first digit that is uncertain. The position of the decimal point is irrelevant.

RULES

- All nonzero digits are significant. 58.43 [4]
- All zeros between two nonzero digits are significant. 340.009 [6]
- Zeros to the right of a nonzero digit, but to the left of an understood decimal point, are not significant unless specifically indicated to be significant by a bar. 154,000 [3] 154,000 [5]
- All zeros to the right of a decimal point but to the left of a nonzero digit are not significant. They are place holders. 0.00690 [3]
- All zeros to the right of a decimal point and to the right of a nonzero digit are significant. 60.00 [4] 0.5070 [4]
- For addition and subtraction keep the same decimal place as the LEAST precise number. $2.3 + 1.48 = 3.658 = 7.4$ [2]
- For multiplication and division, the answer may contain no more significant digits than the measurement with the fewest significant figures used in the calculation. $48.4398 \times 1.53 = 74.1$ [3]

PRACTICE PROBLEMS: State the number of significant figures in each of the following measurements. RULES # 1 - 5

- 27 cm _____
- 1.498 g _____
- 248.3 g _____
- 9.854 ml _____
- 78.565 kg _____
- 3.97 g _____
- 34.709 cm _____
- 103.768 km _____
- 0.0004765 mm _____
- 9000 cm _____
- 41.8 m _____
- 107 mm _____
- 0.238 km _____
- 80.67 cm _____
- 0.06468 m _____
- 802.13 kg _____
- 0.007846 cg _____
- 705.00 km _____
- 140,003.8 mm _____
- 19,280 m _____

Express the answer to each of the following calculations with the correct number of significant figures. See RULE # 6

- $3.42 \text{ cm} + 8.13 \text{ cm}$ _____
- $3.882 \text{ g} - 2.114 \text{ g}$ _____
- $4.939 \text{ g} + 3.822 \text{ g}$ _____
- $4.894 \text{ cm} - 2.33 \text{ cm}$ _____
- $17.8 \text{ cm} + 12.11 \text{ cm}$ _____
- $15.6674 \text{ m} - 1.838 \text{ m}$ _____
- $4.552 \text{ kg} + 3.14 \text{ kg}$ _____
- $11.22 \text{ g} - 8.8 \text{ g}$ _____
- $1.966 \text{ g} + 3.4422 \text{ g}$ _____
- $133 \text{ L} - 6.45 \text{ L}$ _____
- $82.5 \text{ cm} + 13.56 \text{ cm}$ _____
- $13.80 \text{ cm} - 6.0741 \text{ cm}$ _____
- $16.8892 \text{ m} + 3.5 \text{ m}$ _____
- $8.472 \text{ cg} - 1.440 \text{ cg}$ _____
- $30 \text{ m} - 1.442 \text{ m}$ _____
- $45.456 \text{ g} + 3.56 \text{ g}$ _____
- $54.00 \text{ g} - 30.2020 \text{ g}$ _____
- $106.22 \text{ mm} + 80.8 \text{ mm}$ _____
- $30.44 \text{ kg} + 3.9422 \text{ kg}$ _____
- $1.4505 \text{ g} - 0.00667 \text{ g}$ _____

Express the answer to each of the following calculations with the correct number of significant figures. See RULE # 7

- $1.2 \text{ cm} \times 1.3 \text{ cm}$ _____
- $32.88 \text{ m}^2 / 4.368 \text{ m}$ _____
- $2.1 \text{ cm} \times 1.8 \text{ cm}$ _____
- $16.5 \text{ km}^2 / 1.8 \text{ km}$ _____
- $1.45 \text{ m} \times 2.2 \text{ m}$ _____
- $84.99 \text{ m}^2 / 2.63 \text{ m}$ _____
- $2.5 \text{ mm} \times 1.33 \text{ mm}$ _____
- $9.9 \text{ m}^2 / 3.4484 \text{ m}$ _____
- $4.3324 \text{ m} \times 1.2 \text{ m}$ _____
- $3.085 \text{ m}^2 / 2.77448 \text{ m}$ _____
- $1.075 \text{ m} \times 2.0 \text{ m}$ _____
- $85.0869 \text{ m}^2 / 9.0049 \text{ m}$ _____
- $3.0899 \text{ m} \times 22.4 \text{ m}$ _____
- $0.00826 \text{ m}^2 / 0.00033 \text{ m}$ _____
- $0.00457 \text{ g} \times 0.18 \text{ g}$ _____
- $3.4500 \text{ cm}^2 / 450 \text{ cm}$ _____
- $10.00 \text{ m} \times 84.767 \text{ m}$ _____
- $0.005600 \text{ m}^2 / 0.200 \text{ m}$ _____
- $35.068 \text{ km}^2 / 5.7 \text{ km}$ _____

NAME _____ DATE _____

METRIC SYSTEM

DIRECTIONS: Convert each of the given measurements to the unit indicated.

1. 100 cm to _____ m
2. 500 g to _____ kg
3. 0.01 m to _____ cm
4. 250 mL to _____ L
5. 35 kg to _____ g
6. 0.89 L to _____ mL
7. 3.484 cm to _____ mm
8. 15.93 mg to _____ dg
9. 435.8 ms to _____ s
10. 89.05 mL to _____ dL
11. 0.00467 kg to _____ cg
12. 6.054 cm to _____ hm
13. 84.59 Å to _____ cm
14. 9.45 μm to _____ mm
15. 10.4 cm to _____ mm
16. 34.2 mm to _____ cm
17. 192.3 cg to _____ mg
18. 4.006 L to _____ mL
19. 70.5 cm^3 to _____ mL
20. 2.58 μg to _____ cg
21. 1.5×10^4 g to _____ cg
22. 3.2×10^{-3} cm to _____ mm
23. 0.5×10^{-9} Å to _____ mm
24. 8.22×10^{-5} μm to _____ Å
25. 14.8×10^{-8} cm to _____ Å
26. 5.552×10^{14} μm to _____ km
27. 3.680×10^{-9} cm to _____ μm
28. 9.92×10^7 mm to _____ m
29. 14.82×10^{-3} g to _____ cg
30. 4.82×10^5 mg to _____ kg

PHYSICS SKILL

Use with Chapter 2

Factor-Label Method for Converting Units

A very useful method of converting one unit to an equivalent unit is called the factor-label method of unit conversion. You may be given the speed of an object as 25 km/h and wish to express it in m/s. To make this conversion, you must change km to m and h to s. In algebra, you learned that if a quantity is multiplied by 1, its value does not change. But 1 is just a quantity divided by its equivalent. Since 1000 m = 1 km and 60 s = 1 min and 60 min = 1 h,

$$\frac{1000 \text{ m}}{1 \text{ km}} = 1 \quad \frac{1 \text{ min}}{60 \text{ s}} = 1 \quad \frac{1 \text{ h}}{60 \text{ min}} = 1$$

To change 25 km/h to m/s, you must multiply by a series of factors so that the units you do not want will cancel out and the units you want will remain.

$$\frac{25 \cancel{\text{ km}}}{1 \cancel{\text{ km}}} \times \frac{1000 \text{ m}}{1 \cancel{\text{ km}}} \times \frac{1 \cancel{\text{ h}}}{60 \cancel{\text{ min}}} \times \frac{1 \cancel{\text{ min}}}{60 \text{ s}} = 69 \text{ m/s}$$

To convert 80 milliliters to liters, first choose the factor. Since 1 L = 1000 mL,

$$\frac{1 \text{ L}}{1000 \text{ mL}} = 1$$

Use this factor for your conversion as follows.

$$\frac{80 \cancel{\text{ mL}}}{1 \cancel{\text{ mL}}} \times \frac{1 \text{ L}}{1000 \cancel{\text{ mL}}} = 0.08 \text{ L}$$

Problems

Carry out the following conversions using the factor-label method.

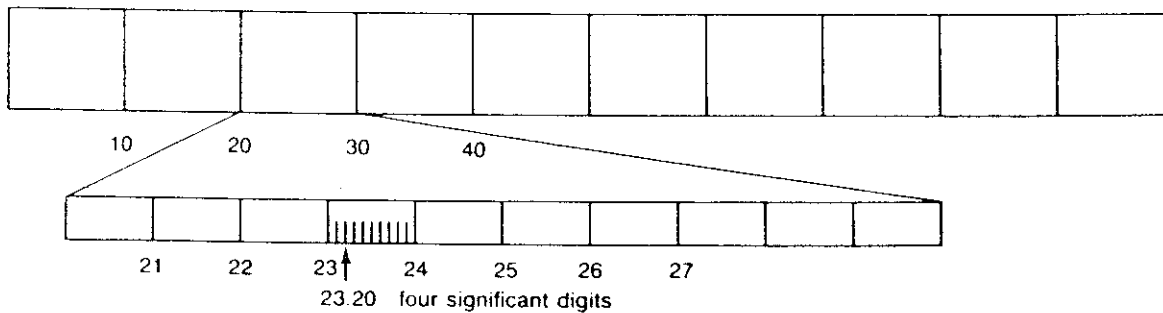
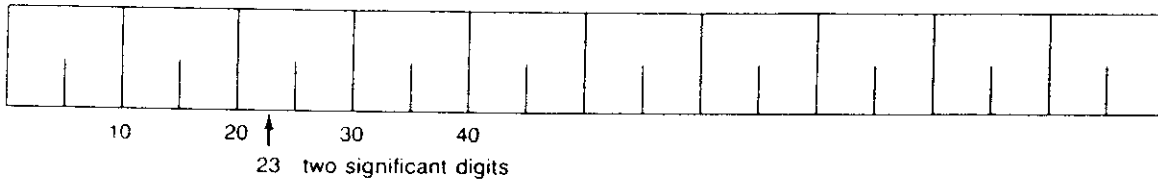
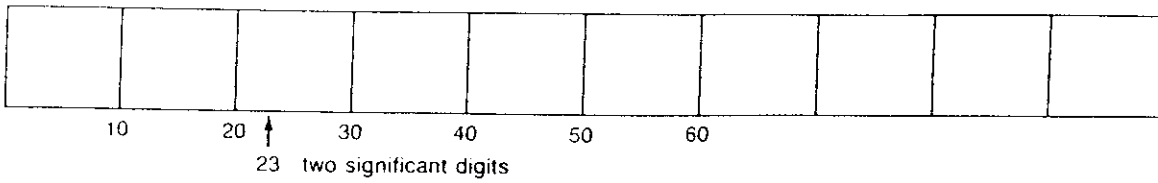
1. How many seconds are in a year?
2. Convert 28 km to cm.
3. Convert 50 g to kg.
4. Convert 45 kg to mg.
5. Convert 450 m/s to m/h.
6. Convert 50 liters to mL.
7. Convert 85 cm/min to m/s.
8. Convert the speed of light, $3.0 \times 10^8 \text{ m/s}$, to km/day.

2 Physics Skill

Use with Chapter 2.

RECORDING MEASUREMENTS

Look at the four meter sticks shown. As you proceed down the page, each meter stick has more divisions marked. When you read any scale, you always record the measurement by reading the smallest division on the scale and then "guessing at," or estimating, the tenth of the smallest division. As you proceed down the page you can see how your measurement becomes more precise, and you have more significant digits in your reading. A significant digit is a digit that has physical meaning.



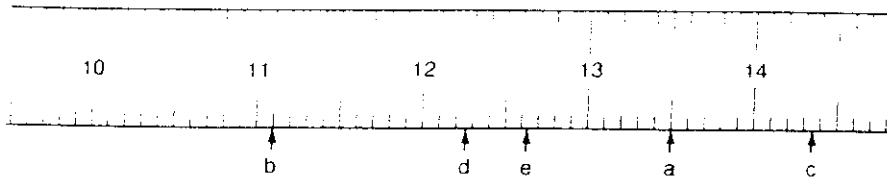
2 Physics Skill

NAME _____

For the instruments shown below, record the correct reading.

1.

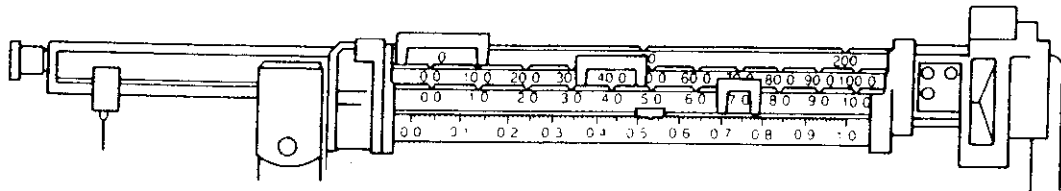
Metric Ruler



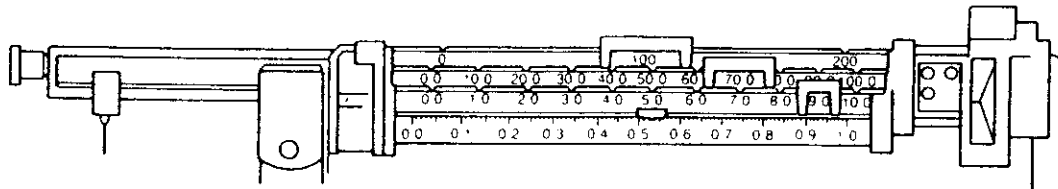
a. _____ b. _____ c. _____ d. _____ e. _____

2.

Balance

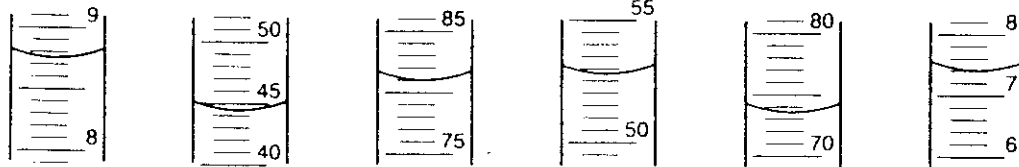


a. _____



3.

Graduated Cylinder



a. _____ b. _____ c. _____ d. _____ e. _____ f. _____

6 Physics Skill

Use with Chapter 2.

GRAPHING TECHNIQUES

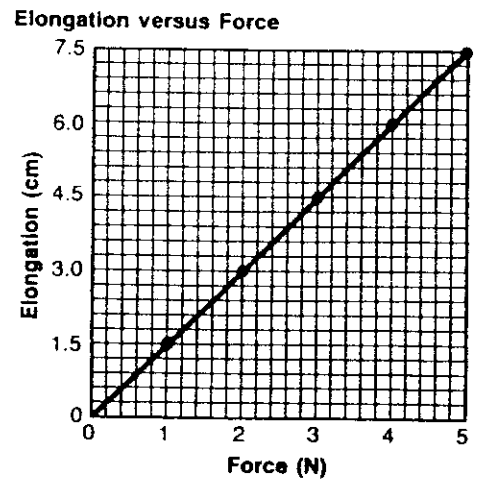
Frequently an investigation will involve finding out how changing one quantity affects the value of another. The quantity that is deliberately manipulated is called the *independent variable*. The quantity that changes as a result of the independent variable is called the *dependent variable*.

The relationship between the independent and dependent variable may not be obvious from simply looking at the written data. However, if one quantity is plotted against the other, the resulting graph gives evidence of what sort of relationship, if any, exists between the variables. When plotting a graph, take the following steps.

1. Identify the independent and dependent variables.
2. Choose your scale carefully. Make your graph as large as possible by spreading out the data on each axis. Let each space stand for a convenient amount. For example, choosing three spaces equal to ten is not convenient because each space does not divide evenly into ten. Choosing five spaces equal to ten would be better. To avoid a cluttered appearance, you do not need to number every space.
3. All graphs do not go through the origin (0,0). Think about your experiment and decide if the data would logically include a (0,0) point. For example, if a cart is at rest when you start the timer, then your graph of speed versus time would go through the origin. If the cart is already in motion when you start the timer, your graph will not go through the origin.
4. Plot the independent variable on the horizontal (x) axis and the dependent variable on the vertical (y) axis. Plot each data point.
5. Label each axis with the name of the variable and the unit. Using a ruler, darken the lines representing each axis.
6. If the data points appear to lie roughly in a straight line, draw the best straight line you can with a ruler and a sharp pencil. Have the line go through as many points as possible with approximately the same number of points above the line as below. Never "connect the dots." If the points do not form a straight line, draw the best smooth curve possible.
7. Title your graph. The title should clearly state the purpose of the graph and include the independent and dependent variables.

The graph shown was prepared using good graphing techniques. Go back and check each of the items mentioned above.

Force (N)	Elongation (cm)
0	0.0
1	1.5
2	3.0
3	4.5
4	6.0
5	7.5



6 Physics Skill

NAME _____

USE GRAPHICAL
ANALYSIS FIND CONSTANTS
TO GRAPH

Graph the following sets of data using proper graphing techniques.

1. Pressure (torr)	Volume (mL)
100	800
200	400
400	200
600	133
700	114
800	100
1000	80

2. Time (s)	Distance (m)
0	0
1	5
2	20
3	45
4	80
5	125

3. Time (s)	Speed (m/s)
0	0
1	20
2	45
3	60
4	84
5	105

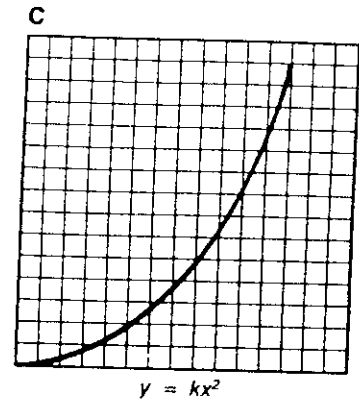
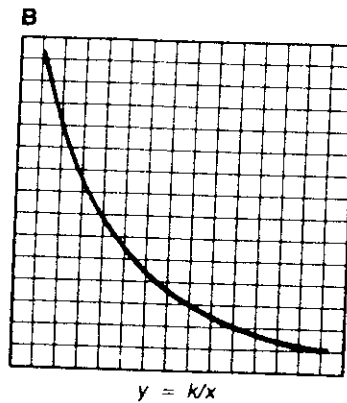
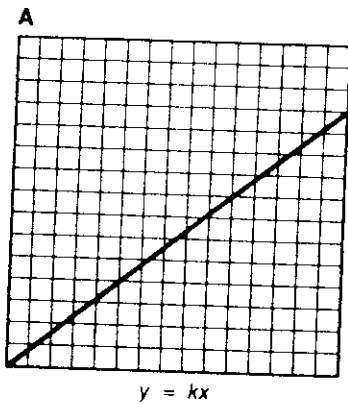
7 Physics Skill

Use with Chapter 2.

INTERPRETING GRAPHS

In laboratory investigations, you generally control one variable and measure the effect it has on another variable while you hold all other factors constant. For example, you might vary the force on a cart and measure its acceleration while you keep the mass of the cart constant. After the data are collected, you then make a graph of acceleration versus force using the techniques for good graphing. The graph gives you a better understanding of the relationship between the two variables.

There are three relationships that occur frequently in physics. If the dependent variable varies directly with the independent variable, the graph will be a straight line, as shown in graph A. If y varies inversely with x , the graph will be a hyperbola as shown in graph B. The third relationship, in which y varies directly with the square of x , gives a parabola (graph C).



Sometimes you need information about a value that you have not determined experimentally. Reading from the graph between data points is called *interpolation*. Reading from the graph beyond the limits of your experimentally determined data points is called *extrapolation*. Extrapolation must be used with caution because you cannot be sure that the relationship between the variables remains the same beyond the limits of your investigation.

- Suppose you recorded the following data during a study of the relationship of force and acceleration. Prepare a graph showing these data.

Force (N)	Acceleration (m/s ²)
10	6.0
20	12.5
30	19.0
40	25.0

- Describe the relationship between force and acceleration as shown by the graph.

7 Physics Skill

NAME _____

- b. What is the slope of the graph? Remember to include units with your slope. One newton equals $1 \text{ kg}\cdot\text{m}/\text{s}^2$.
- c. What physical quantity does the slope represent?
- d. Write an equation for the line.
- e. What is the value of the force for an acceleration of $15 \text{ m}/\text{s}^2$?
- f. What is the acceleration when the force is 50.0 N ?
2. The following data show the distance an object travels in certain time periods. Prepare a graph showing these data.

Time (s)	Distance (cm)
0	0
1	3
2	12
3	27
4	48

- a. Describe the relationship between x and y and write a general equation for the curve.
- b. Is the distance traveled greater between 0 s and 1 s or 3 s and 4 s ?
- c. Is the slope of the curve greater between 1 s and 2 s or 3 s and 4 s ?

7 Physics Skill

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3. Answer the questions about the sets of data below. First try answering the questions by simply looking at the data. Then prepare a graph of each set and see if the questions are easier to answer.

A.

x	y
1	3
2	6
3	9
4	12
5	15

B.

x	y
0	0
1	2
2	8
3	18
4	32

C.

x	y
1	80
2	40
3	27
4	20
5	16

D.

x	y
0	2
1	4
2	6
3	3
4	2

- In which graph is y directly proportional to x ?
- In which graph does y decrease as x increases?
- In which set of data is y inversely proportional to x ?
- Which graph does not seem to picture a simple relationship?
- Which graph has the general equation $y = kx^2$?

ENRICHMENT

Chapter 2

2-1 Determining Relationships from Graphs

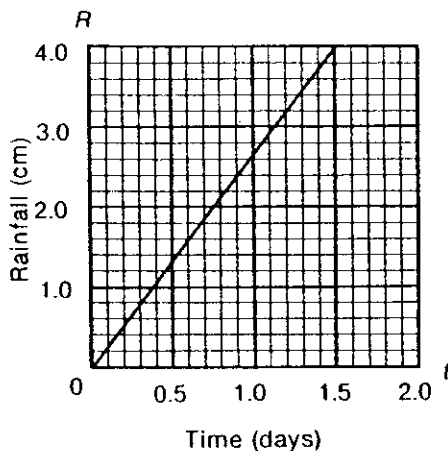
Data collected in the lab is often plotted and analyzed graphically. When the curve of the graph is a straight line, the equation for the relationship between the variables y and x is

$$y = mx + b$$

where m is the slope of the line and b is the y -intercept.

Determine the slope and equation for each graph given below. The first graph has been done as an example.

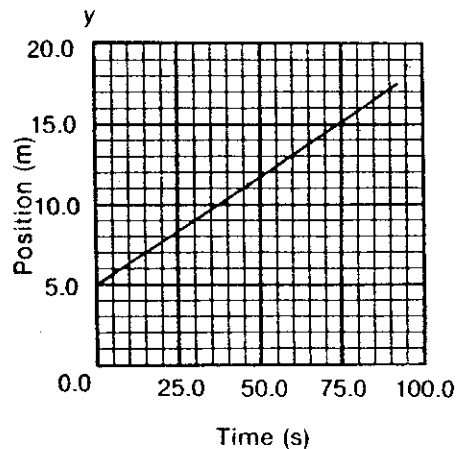
Rainfall versus Time



slope: 2.7 cm/d

equation: $R = (2.7 \text{ cm/d}) \cdot t$

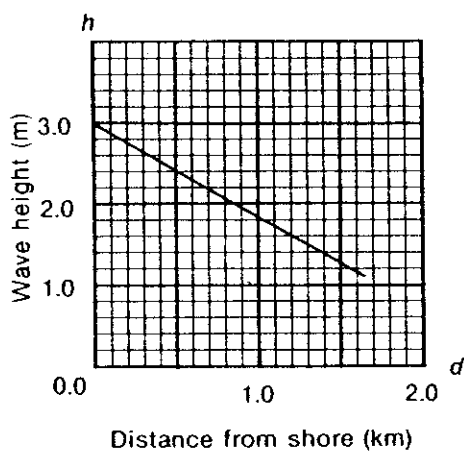
Position versus Time



slope: _____

equation: _____

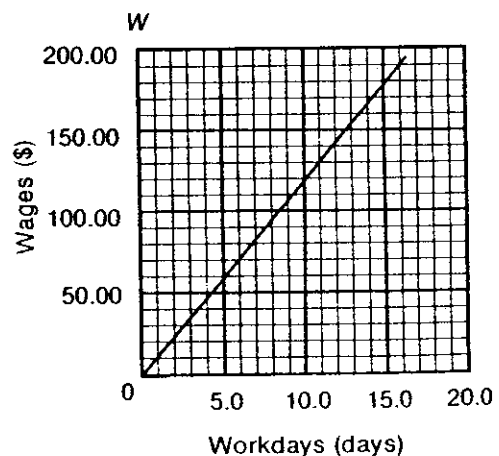
Wave Height versus Distance



slope: _____

equation: _____

Wages versus Workdays



slope: _____

equation: _____

REVIEW Chapter 2

Example

Rewriting Equations

Solve the following equation for r .

$$\frac{q}{m} = \frac{2V}{B^2 r^2}$$

Multiply both sides of the equation by $mB^2 r^2$.

$$qB^2 r^2 = 2Vm$$

Divide both sides by qB^2 .

$$r^2 = \frac{2Vm}{qB^2}$$

Take the square root of both sides.

$$r = \sqrt{\frac{2Vm}{qB^2}} = \frac{1}{B} \sqrt{\frac{2Vm}{q}}$$

Problems

Solve the following equations for the variable(s) requested.

1. $E = 1/2 mv^2$ for m and v .

5. $P = \frac{Fd}{t}$ for d

2. $E = mgh$ for h

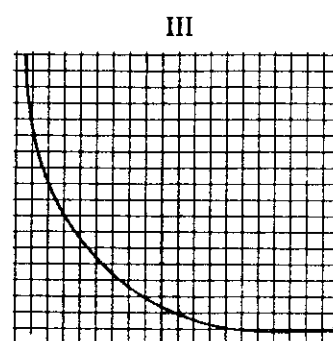
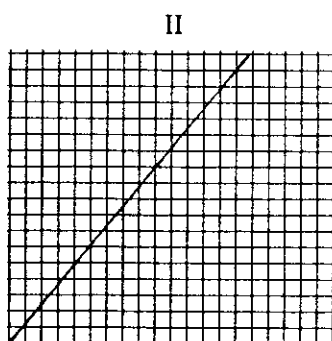
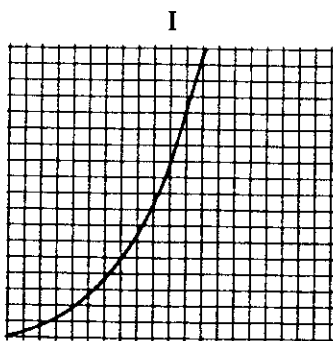
6. $E = hf - W_o$ for W_o and h

3. $\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$ for d_o

7. $\frac{r}{n^2} = \frac{h^2}{4\pi^2 kmq^2}$ for q

4. $\frac{s_o}{s_i} = \frac{d_o}{d_i}$ for s_i

8. Answer the questions on the next page about the graphs below.



Write the general equation for each graph.

I _____

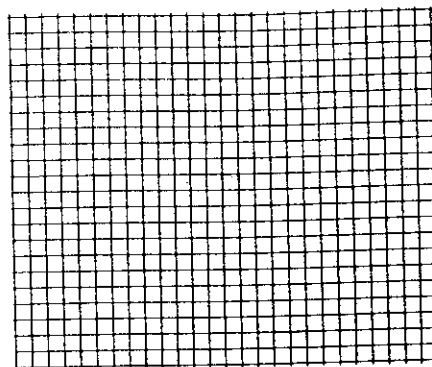
II _____

III _____

- _____ a. Which graph indicates y is directly proportional to x ?
- _____ b. Which graph indicates y is inversely proportional to x ?
- _____ c. Which graph indicates y is proportional to the square of x ?

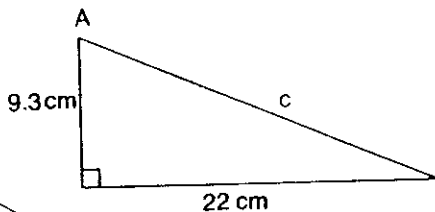
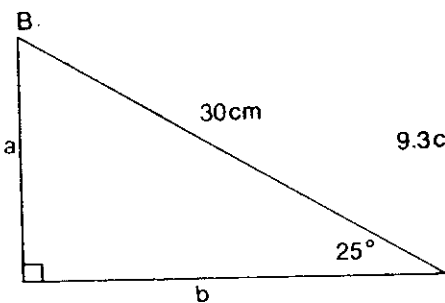
9. A car was designed so that each time one liter of gasoline was used, a light would flash on and the driver would then read the number of kilometers traveled. The data are given below. Make a graph and answer the questions about the graph.

Liters	Kilometers
1	6
2	12
3	18
4	24
5	30



- _____ a. Which is the independent variable?
- _____ b. What is the slope of the line?
- _____ c. What distance would be expected for 1.5 liters?
- _____ d. Reading between data points is called _____.
- _____ e. What distance would you expect for 6 liters?
- _____ f. Reading beyond the data points is called _____.

10. Solve the following triangles for the information requested.



- $B =$ _____
- $a =$ _____
- $b =$ _____
- $c =$ _____
- $A =$ _____