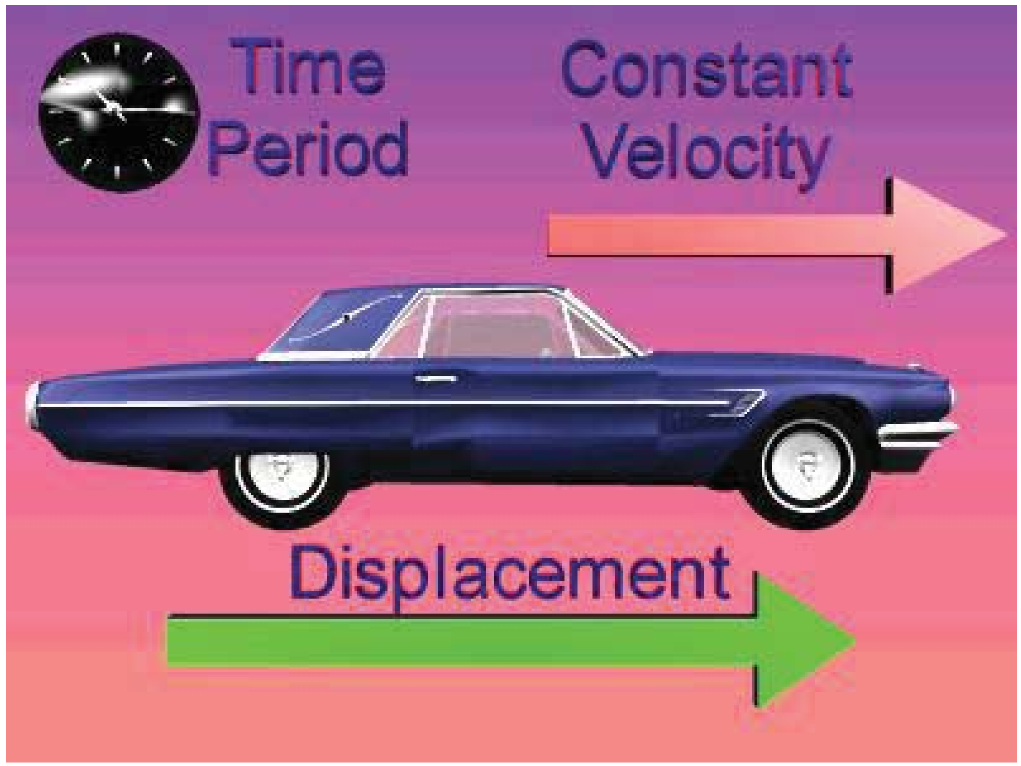

Time
Period
Constant
Velocity
Displacement

Physics 11 Formula Sheet

(EQUATIONS USED IN THIS BOOK- SNaP)

Wave Motion and Geometrical Optics

$$v = \frac{d}{t}$$

$$v = \lambda f$$

$$T = \frac{1}{f}$$

$$M = \frac{h_i}{h_o} \quad \text{or} \quad M = \frac{d_i}{d_o}$$

$$\frac{h_i}{h_o} = \frac{d_i}{d_o}$$

$$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$$

$$\frac{\sin\theta_1}{\sin\theta_2} = \frac{v_1}{v_2} = \frac{\lambda_1}{\lambda_2} = \frac{n_2}{n_1}$$

Kinematics

$$a = \frac{v_f - v_0}{t}$$

$$d = v_0 t + \frac{1}{2}at^2$$

$$d = \left(\frac{v_f + v_0}{2}\right)t$$

$$v_f^2 = v_0^2 + 2ad$$

Dynamics

$$F_{net} = ma$$

$$F_g = \frac{Gm_1m_2}{r^2}$$

$$g = \frac{F_g}{m} \quad \text{or} \quad F_g = mg$$

$$F_N = F_g = mg$$

$$F_f = \mu F_N$$

$$F_g = -kx$$

$$p = mv$$

$$F_{net}t = m\Delta v$$

Energy

$$W = Fd$$

$$E_p = mgh$$

$$E_k = \frac{1}{2}mv^2$$

$$\Delta E_h = m\Delta tc$$

$$P = \frac{W}{t} \quad \text{or} \quad P = \frac{\Delta E}{t}$$

$$P = Fv$$

$$\text{Efficiency} = \frac{\text{work out}}{\text{work in}} \times 100$$

$$\text{Efficiency} = \frac{\text{power out}}{\text{power in}} \times 100$$

Modern Physics

$$t = \frac{t_o}{\sqrt{1-\left(\frac{v}{c}\right)^2}}$$

$$L = L_o\sqrt{1-\left(\frac{v}{c}\right)^2}$$

$$m = \frac{m_o}{\sqrt{1-\left(\frac{v}{c}\right)^2}}$$

$$E = mc^2$$

$$u = \frac{v + u'}{1 + \frac{vu'}{c^2}}$$

Trigonometry

$$\text{slope} = \frac{\text{rise}}{\text{run}} \quad \text{or} \quad \text{slope} = \frac{y_2 - y_1}{x_2 - x_1}$$

$$\sin\theta = \frac{\text{opposite}}{\text{hypotenuse}}$$

$$\cos\theta = \frac{\text{adjacent}}{\text{hypotenuse}}$$

$$\tan\theta = \frac{\text{opposite}}{\text{adjacent}}$$

$$R = \sqrt{R_x^2 + R_y^2}$$

Data

Speed of light in air or vacuum	$= 3.00 \times 10^8$ m/s
Index of refraction for air or vacuum	$= 1.00$
Acceleration due to gravity near the Earth's surface (or Gravitational Field Strength near the Earth's surface)	$= 9.80$ m/s^2 or N/kg
Gravitational Constant	$= 6.67 \times 10^{-11}$ N•m^2/kg^2
Mass of Earth	$= 5.98 \times 10^{24}$ kg
Radius of Earth	$= 6.37 \times 10^6$ m

Lesson 1-intro

Significant Digits and Rounding

There are four summary rules for determining the number of significant digits (SD) in your text (p 23).
We are modifying them slightly and will use the following rules for determining what numbers are significant:

All numbers 0-9 are significant **except zeros** to the **left** of other numbers

eg. 0.00003 - 1 SD
0.0030 - 2 SD
30.00030 - 7 SD

Rules for Rounding off

a) **Addition or subtraction rule**:
Add or subtract first, then round to the least **decimal places**

eg. 10.0	10
1 dec. place (dp)	0 dec. places

5.01 m + 10 m + 2.98 m = 17.99 = 18 m
(2 dp) (0 dp) (2 dp)

b) **Multiplication or division rule**:
multiply or divide first then round to the least **significant digits**
(Note - you may have to put your answer in scientific notation.)

eg. 10 m/s x 18.64s = 186.4 m = 1.9×10^2 m
(2 sd) (4sd) (2sd)

Lesson 1 (HW)

A) Review and Reinforcement

Working With Numbers

Complete the following statements by inserting either "are" or "are not" in the blanks provided.

1. Zeros between two significant digits ________ significant.
2. Zeros to the right of a decimal point that precede all nonzero digits __________ significant.
3. All nonzero digits ________ significant.
4. One or more final zeros used after the decimal point ________ significant.
5. Zeros used solely for spacing the decimal point ________ significant.

Count the number of significant digits in each of the measurements listed below. Write your answer in the space provided.

	Significant Digits
6. 230.005 m	____________
7. 109,000 kg	____________
8. 328.46 mm	____________
9. 0.00607 cm^3	____________
10. 5.017 L	____________
11. 8000 km	____________
12. 0.057 g	____________
13. 610.0 kPa	____________

Name ______________________ Date __________ Class __________

B) Practice Problems

Identify the number of significant digits in each of the following measurements. Write the number in the space provided.

1. 520 mL __________
2. 0.0102 ms __________
3. 0.230 kg __________
4. 25,600 L __________
5. 10.002 ns __________
6. 0.451 Pa __________
7. 0.001 cm __________

Physics 11 Introduction - Lesson 1

1 Physics Skill

Use with Chapter 2.

MATHEMATICS ASSESSMENT

Write the following numbers in scientific notation.

1. 156.90 ____
2. 12 000 ____
3. 0.0345 ____
4. 0.008 90 ____

Expand the following numbers.

5. 1.23×10^{6} ____
6. 2.5×10^{-3} ____
7. 1.54×10^{4} ____
8. 5.67×10^{-1} ____

Solve the following and put your answer in scientific notation.

9. $\frac{6.6 \times 10^{-8}}{3.3 \times 10^{-4}} =$ ____
10. $\frac{7.4 \times 10^{10}}{3.7 \times 10^{3}} =$ ____
11. $\frac{2.5 \times 10^{8}}{7.5 \times 10^{2}} =$ ____
12. $(2.67 \times 10^{-3}) - (9.5 \times 10^{-4}) =$ ____
13. $(1.56 \times 10^{-7}) + (2.43 \times 10^{-8}) =$ ____
14. $(2.5 \times 10^{-6}) \times (3.0 \times 10^{-7}) =$ ____
15. $(1.2 \times 10^{-9}) \times (1.2 \times 10^{7}) =$ ____
16. $(2.3 \times 10^{4}) + (2.0 \times 10^{-3}) =$ ____

Give the number of significant digits in the following measurements.

17. 2.9910 m ____
18. 5600 km ____
19. 0.006 70 kg ____
20. 809 g ____

Solve the following problems and give the answer in the correct number of significant digits.

21. $\frac{2.674 \text{ m}}{2.0 \text{ m}} =$ ____
22. 5.25 L × 1.3 L = ____
23. 9.0 cm + 7.66 cm + 5.44 cm = ____
24. 10.07 g − 3.1 g = ____

Lesson 1

E.) **SIGNIFICANT DIGITS - EXTRA PROBLEMS**

Perform the following operations obeying the rules on significant digits.

ADD:

A. 4.13
   2.6

B. 8.04
   .1

C. .00631
   .0068

D. .00360
   .003914

SUBTRACT:

A. 2.63×10^2
   $- \ 2.89 \times 10^1$

B. 43.61×10^4
   $- \ 4.38 \times 10^3$

MULTIPLY:

A. (894) (260)

B. (.00630) (894)

C. $(863 \times 10^2)\ (2.31 \times 10^{-2})$

D. $(.0084 \times 10^{-2})\ (6.86 \times 10^3)$

DIVIDE:

A. $(894) \div (260)$

B. $(.00630 \div (894)$

C. $(863 \times 10^2) \div (2.31 \times 10^{-2})$

D. $(.0084 \times 10^{-2}) \div (6.86 \times 10^3)$

Lesson 2 - intro

CONVERSIONS & UNITS

1. **Convert to a new unit**:
eg. 60 km/h = ___ m/s

$60\ \frac{km}{h} \times \frac{1000m}{1\ Km} \times \frac{1\ h}{3600s} = 16.67\ \frac{m}{s} = 17\ \frac{m}{s}$ (keep the **same** number of **significant digits**)

2. **Change to a different size unit**:
make a ratio: let the largest unit have a value of 1, the other unit is 10 to some positive power

eg. 3 sd
100μg to ___g

$100\mu g \times \frac{1\ g}{1 \times 10^6 \mu g} = 1.00 \times 10^{-4} g$

eg 454 mg = _____ kg

$454\ mg \times \frac{1\ g}{1 \times 10^3 mg} \times \frac{1\ kg}{1 \times 10^3 g} = 4.54 \times 10^{-4} kg$

2 DIFFERENT UNITS

convert to same unit and then perform required calculation

eg. 1.0μm + 6.0 mm
10^{-6} 10^{-3}

$1.0 \times 10^{-6} m + 6.0 \times 10^{-3} m = 6.0 \times 10^{-3} m$

- 3 fundamental units in physics: length (m), time (s), mass (kg)

- accuracy - how correct the measurement is
- precision - how often the measurement is repeated the same.

- note SI prefix table 2.1 p 17
(memorize n, μ, m, c, k, M

n	μ	m	c	k	M
nano	micro	milli	centi	kilo	Mega
10^{-9}	10^{-6}	10^{-3}	10^{-2}	10^{3}	10^{6}

Lesson 2-intro (HW)

Physics 11 Formula Sheet

* SOLVE FOR THE INDICATED VARIABLES

▼ *Wave Motion and Geometrical Optics*

$T = \frac{1}{f}$; $f = ?$

$n = \frac{c}{v}$; $c = ?$

$v = f\lambda$; $f = ?$

$n_1 \sin\theta_1 = n_2 \sin\theta_2$; $n_1 = ?$; $\sin\theta_1 = ?$; $\theta_1 = ?$

▼ *Kinematics*

$d = \bar{v}t$; $t = ?$

$a = \frac{\Delta v}{\Delta t}$; $\Delta t = ?$

$v = v_0 + at$; $v_0 = ?$; $a = ?$

$\bar{v} = \frac{v + v_0}{2}$; $v = ?$

$d = v_0 t + \frac{1}{2}at^2$; $a = ?$; $v_0 = ?$

$v^2 = v_0^2 + 2ad$; $d = ?$; $a = ?$

▼ *Dynamics in One Dimension*

$F_g = mg$; $g = ?$

$F_g = G\frac{m_1 m_2}{r^2}$; $r = ?$; $m_1 = ?$

$F_{fr} = \mu F_N$; $\mu = ?$

$F = kx$; $x = ?$

$F_{net} = ma$; $a = ?$

$p = mv$; $v = ?$

12 Physics Skill

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. If a quantity is multiplied by 1, its value does not change. Any quantity divided by its equivalent is equal to 1. Since 1000 m = 1 km and 60 s = 1 min and 60 min = 1 h,

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

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.

$$\frac{25\ \cancel{\text{km}}}{1\ \cancel{\text{h}}}\cdot\frac{1000\text{ m}}{1\ \cancel{\text{km}}}\cdot\frac{1\ \cancel{\text{h}}}{60\ \cancel{\text{min}}}\cdot\frac{1\ \cancel{\text{min}}}{60\text{ s}} = 6.9\text{ m/s}$$

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.

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

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 45 kg to mg.

4. Convert 450 m/s to m/h.

5. Convert 85 cm/min to m/s.

6. Convert the speed of light, 3.0×10^8 m/s, to km/day.

Lesson 3 – intro

6 Physics Skill

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*.

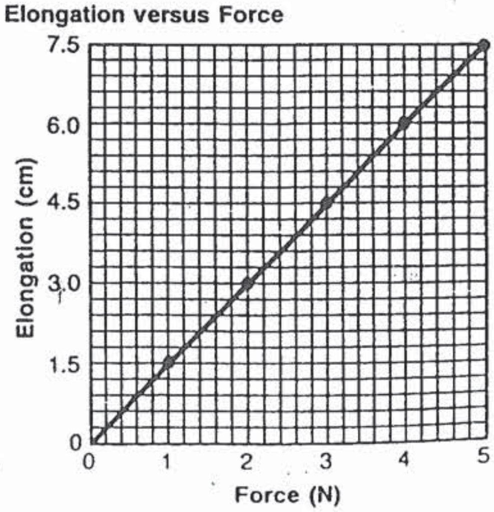
The relationship between the independent and dependent variable may not be obvious from simply looking at the written data. However, if one quantity is plotted against the other, the resulting graph gives evidence of what sort of relationship, if any, exists between the variables. When plotting a graph,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

Elongation versus Force



Lesson 3 (HW)

6 Physics Skill

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

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

Lesson 3

Lesson 3 (HW)
(Continued)

7 Physics Skill

INTERPRETING GRAPHS

1. 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

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

b. What is the slope of the graph? Remember to include units with your slope. One newton equals 1 $kg \cdot m/s^2$.

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 m/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?

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

a. In which graph is y directly proportional to x?

b. In which graph does y decrease as x increases?

c. In which set of data is y inversely proportional to x?

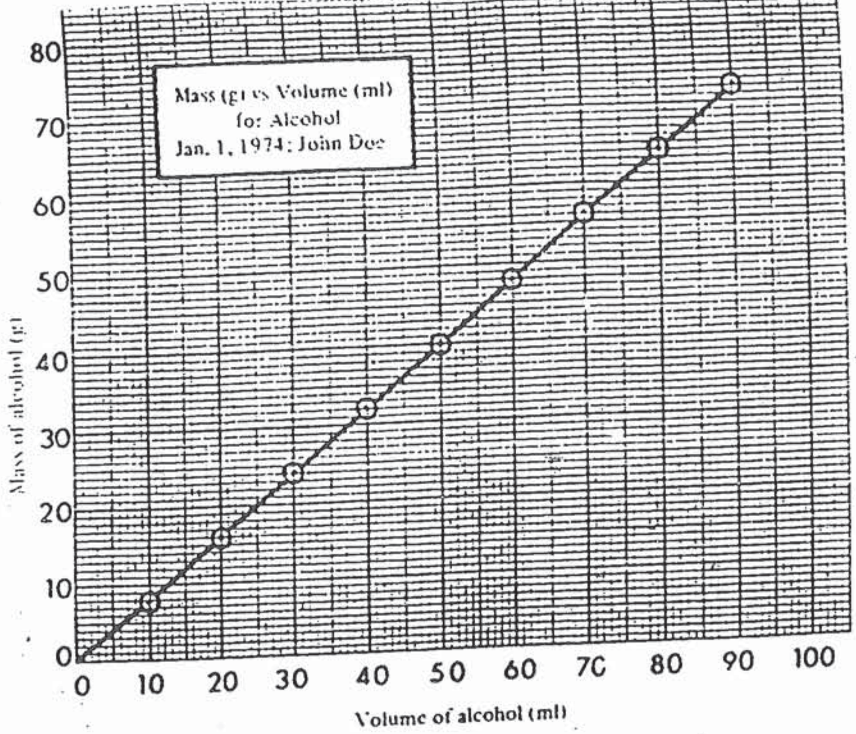
d. Which graph does not seem to picture a simple relationship?

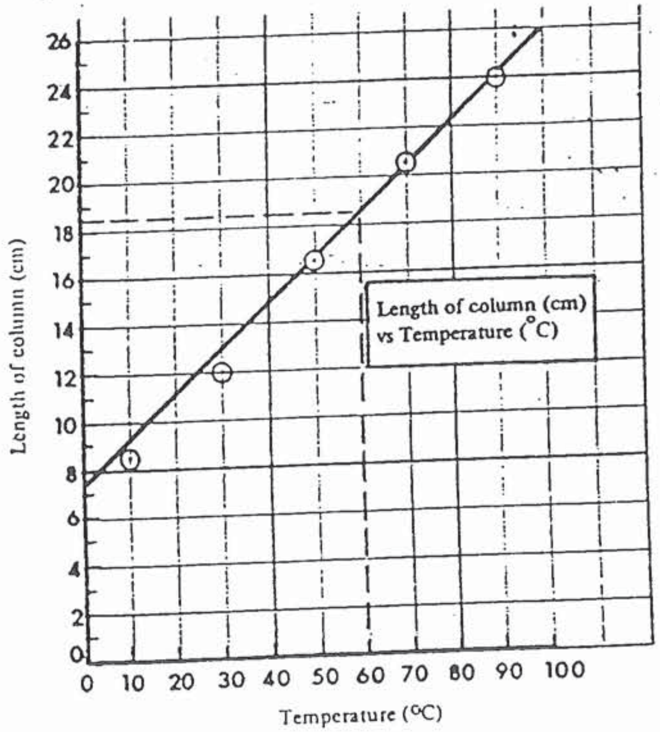
e. Which graph has the general equation $y = kx^2$?

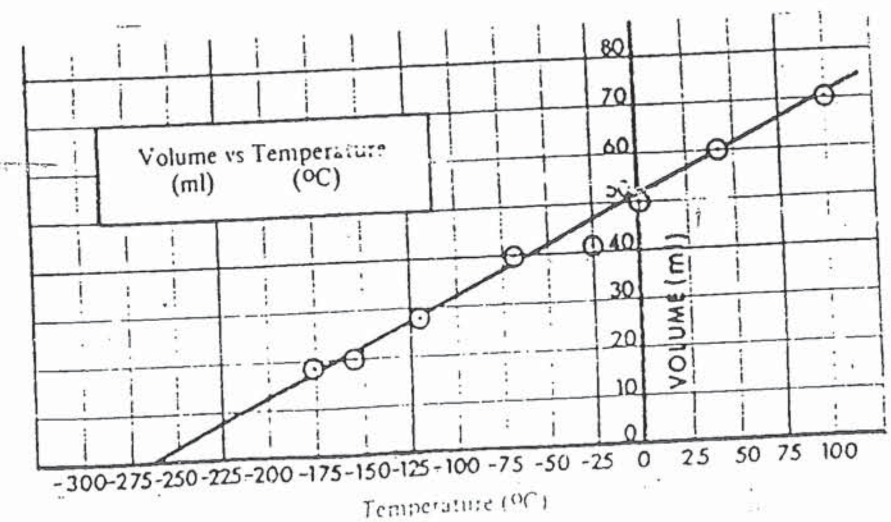
Lesson 4 - intro

Calculate Slopes:

ysics-11





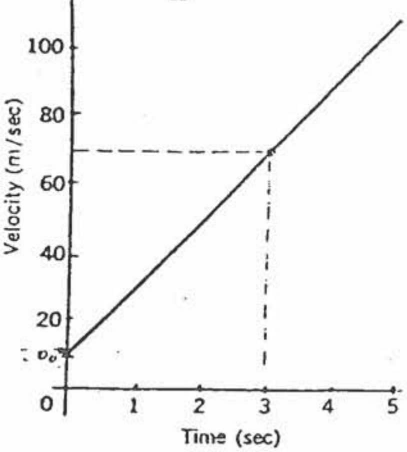


Lesson 4

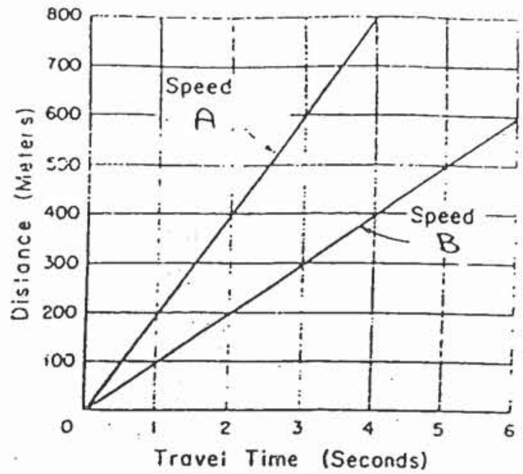
Slopes:

Find the multiple slopes of graphs #2-#4:

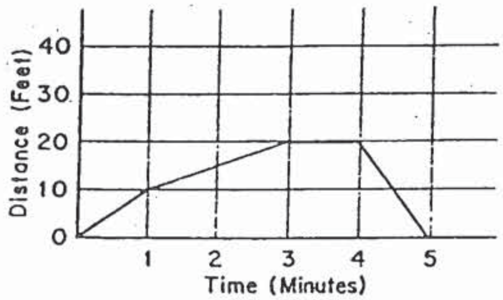
#1



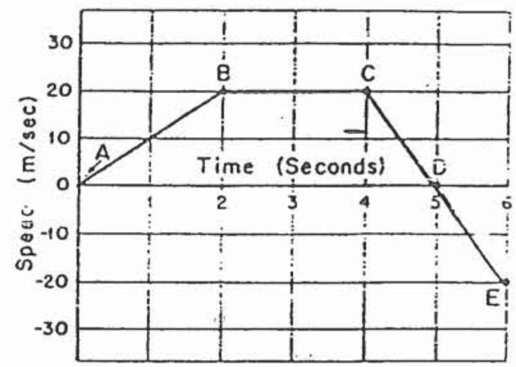
#2



#3

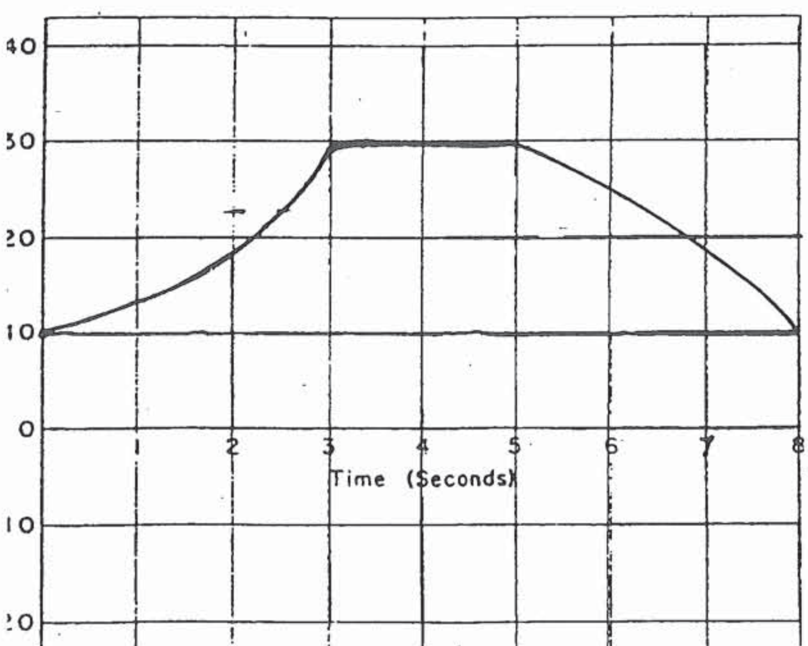


#4



Lesson 5:

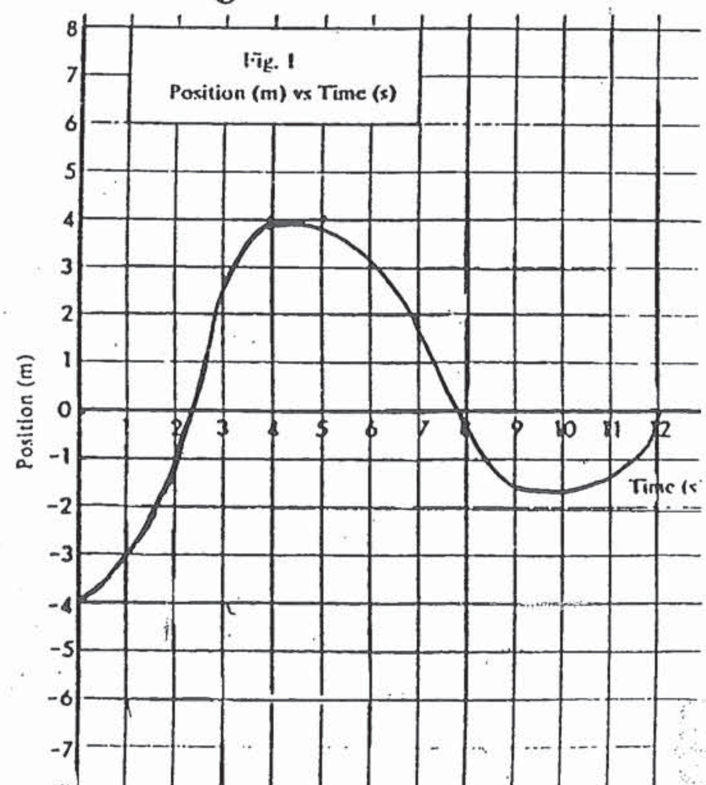
#5



Slope at 2 seconds =

Slope at 7 seconds =

#6



Slope at 3 seconds =

Slope at 11 seconds =

Problems: Graphing

1. A student collects the following data. She is attempting to find how *A* changes as she manipulates *B*.

B (tz/s)	*A* (eb)
3.00	0.151
6.00	0.310
9.00	0.448
12.0	0.600
15.0	0.750

a) Draw a graph showing the relationship between variable *A* and variable *B*.

b) Find the slope of the graph.

c) What is the mathematical relationship between *A* and *B*?

2. A student collects the following data. He is attempting to find how *A* changes as he manipulates *B*.

B ($\times 10^{-2}$ tz/s)	*A* (eb)	$\frac{1}{B}$ (s/tz)
2.1	4.0	
1.4	6.0	
1.1	8.0	
0.7	12.0	
0.35	24.0	

a) Draw a graph showing the relationship between variable *A* and variable *B*.

b) Complete the $\frac{1}{B}$ column in the above table, and draw the graph showing the relationship between variable *A* and $\frac{1}{B}$.

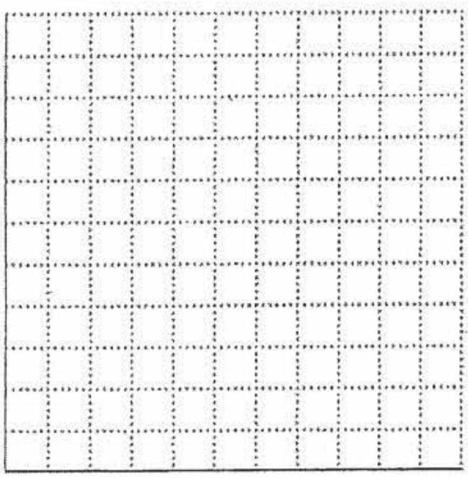
c) Find the slope of the graph you just drew.

d) What is the mathematical relationship between *A* and *B*?

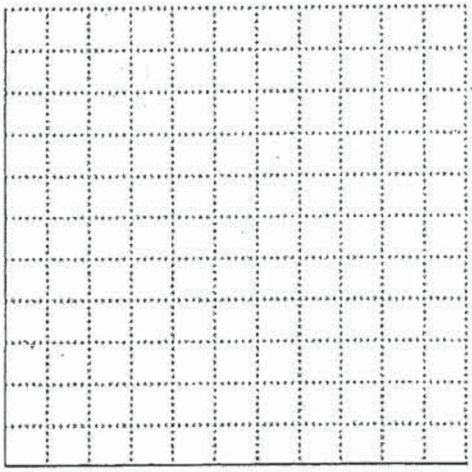
3. A student collects the following data. She is attempting to find how *A* changes as she manipulates *B*.

B (tz/s)	*A* (eb)	B^2 (tz^2/s^2)
1.5	2.25	
3.0	9.00	
4.5	20.25	
6.0	36.00	
7.5	56.25	
9.0	81.00	

a) Draw a graph showing the relationship between variable *A* and variable *B*.



b) Complete the B^2 column in the above table, and draw the graph showing the relationship between variable *A* and B^2.



c) Find the slope of the graph that you just drew.

d) What is the mathematical relationship between *A* and *B*?

* * * * * * * * * * *

Introduction

Lesson 1 to 5

Key

A) Review and Reinforcement

Working With Numbers

Complete the following statements by inserting either "are" or "are not" in the blanks provided.

1. Zeros between two significant digits __are__ significant.
2. Zeros to the right of a decimal point that precede all nonzero digits __are NOT__ significant.
3. All nonzero digits __are__ significant.
4. One or more final zeros used after the decimal point __are__ significant.
5. Zeros used solely for spacing the decimal point __are NOT__ significant.

Count the number of significant digits in each of the measurements listed below. Write your answer in the space provided.

	Significant Digits
6. 230.005 m	6
7. 109,000 kg	6
8. 328.46 mm	5
9. 0.00607 cm^3	3
10. 5.017 L	4
11. 8000 km	4
12. 0.057 g	2
13. 610.0 kPa	4

Name ______________________ Date ____________ Class ____________

B) Practice Problems

Identify the number of significant digits in each of the following measurements. Write the number in the space provided.

1. 520 mL __3__
2. 0.0102 ms __3__
3. 0.230 kg __3__ 4 ≥ 3
4. 25,600 L __5__
5. 10.002 ns __5__
6. 0.451 Pa __3__
7. 0.001 cm __1__

1 Skill

DATE: Use with Chapter 2.

MATHEMATICS ASSESSMENT

Write the following numbers in scientific notation.

1. 156.90 1.5690×10^2
2. 12 000 1.2000×10^4
3. 0.0345 3.45×10^{-2}
4. 0.008 90 8.90×10^{-3}

Expand the following numbers.

5. 1.23×10^6 1230000
6. 2.5×10^{-3} 0.0025
7. 1.54×10^4 15400
8. 5.67×10^{-1} 0.567

Solve the following and put your answer in scientific notation.

9. $\frac{6.6 \times 10^{-8}}{3.3 \times 10^{-4}} =$ 2.0×10^{-4}
10. $\frac{7.4 \times 10^{10}}{3.7 \times 10^{3}} =$ 2.0×10^{7}
11. $\frac{2.5 \times 10^{8}}{7.5 \times 10^{2}} =$ 3.3×10^{5}

12. $(2.67 \times 10^{-3}) - (9.5 \times 10^{-4}) =$ $1.72 \times 10^{-3} = 1.7 \times 10^{-3}$
13. $(1.56 \times 10^{-7}) + (2.43 \times 10^{-8}) =$ 1.803×10^{-7} 1.80×10^{-7}
14. $(2.5 \times 10^{-6}) \times (3.0 \times 10^{-7}) =$ 7.5×10^{-13}
15. $(1.2 \times 10^{-9}) \times (1.2 \times 10^{7}) =$ $1.44 \times 10^{-2} = 1.4 \times 10^{-2}$
16. $(2.3 \times 10^{4}) + (2.0 \times 10^{-3}) =$ $2.30000002 \times 10^{4} = 2.3 \times 10^{4}$

Give the number of significant digits in the following measurements.

17. 2.9910 m 5
18. 5600 km 4
19. 0.006 70 kg 3
20. 809 g 3

Solve the following problems and give the answer in the correct number of significant digits.

21. $\frac{2.674 \text{ m}}{2.0 \text{ m}} =$ 1.337 = 1.3
22. 5.25 L × 1.3 L = $6.825 L^2 = 6.8 L^2$
23. 9.0 cm + 7.66 cm + 5.44 cm = 22.1 cm
24. 10.07 g − 3.1 g = 6.97 g = 7.0 g

SIGNIFICANT DIGITS

Perform the following operations obeying the rules on significant digits.

ADD:

A. 4.13 + 2.6 = 6.73

B. 8.04 + .1 = 8.14

C. .00631 + .0068 = 0.01311

D. .00360 + .003914 = 0.007514

SUBTRACT:

* MAKE EXP.'S SAME
* ADD
* ROUND TO APPRO. SIG. DIGITS/DECIMALS

A. $2.63 \times 10^2 - 2.89 \times 10^1$ = 2.341×10^2

B. $43.61 \times 10^4 - 4.38 \times 10^3$ = $43.17 \times 10^4 \rightarrow 4.32 \times 10^5$ (431.7×10^3)

MULTIPLY:

A. (894) (260) = 232440 = 2.32×10^5

B. (.00630) (894) = 5.6322 = 5.63×10^0

C. $(863 \times 10^2)(2.31 \times 10^{-2})$ = 1993.53×10^0 = 1.99×10^3

D. $(.0084 \times 10^{-2})(6.86 \times 10^3)$ = 0.057624×10^1 = 0.058×10^1 = 5.8×10^{-1}

DIVIDE:

A. (894) ÷ (260) = 3.44

B. (.00630 ÷ (894) = 7.05×10^{-6}

C. $(863 \times 10^2) \div (2.31 \times 10^{-2})$ = 374×10^4 = 3.74×10^6

D. $(.0084 \times 10^{-2}) \div (6.86 \times 10^3)$ = 0.0012×10^{-5} = 1.2×10^{-8}

Physics 11 Formula Sheet

* SOLVE FOR THE INDICATED VARIABLES

▼ *Wave Motion and Geometrical Optics*

$T = \frac{1}{f}$: $f = ?$ $f = \frac{1}{t}$

$n = \frac{c}{v}$: $c = ?$ $nv = c$

$v = f\lambda$: $f = ?$ $\frac{v}{\lambda} = f$

$n_1 \sin\theta_1 = n_2 \sin\theta_2$: $n_1 = ?$; $\sin\theta_1 = ?$; ~~$\theta_1 = ?$~~

$n_1 = \frac{n_2 \sin\theta_2}{\sin\theta_1}$ $\sin\theta_1 = \frac{n_2 \sin\theta_2}{n}$ $\theta_1 = \frac{n_2\theta_2}{n}$

▼ *Kinematics*

$d = \bar{v}t$: $t = ?$ $\frac{d}{\bar{v}} = t$

$a = \frac{\Delta v}{\Delta t}$: $\Delta t = ?$

$v = v_0 + at$: $v_0 = ?$; $a = ?$ $v - at = v_0$ $\frac{v - v_0}{t} = a$

$\bar{v} = \frac{(v + v_0)}{2}$: $v = ?$ $v + v_0 = 2\bar{v}$ $v = 2\bar{v} - v_0$

$d = v_0 t + \frac{1}{2}at^2$: $a = ?$; $v_0 = ?$ $d - v_0 t = \frac{1}{2}at^2$ $\frac{2(d - v_0 t)}{t^2} = a$ $\frac{d - \frac{1}{2}at^2}{t} = v_0$

$v^2 = v_0^2 + 2ad$: $d = ?$; $a = ?$ $\frac{v^2 - v_0^2}{2a}$ $\frac{v^2 - v_0^2}{2d}$

▼ *Dynamics in One Dimension*

$F_g = mg$: $g = ?$ $\frac{F_g}{m}$

$F_g = G\frac{m_1 m_2}{r^2}$: $r = ?$; $m_1 = ?$ $r = \sqrt{\frac{Gm_1m_2}{F_g}}$ $F_g r^2 = Gm_1m$ $\frac{F_g r^2}{Gm_2} = m_1$

$F_{fr} = \mu F_N$: $\mu = ?$ $\frac{F_{fr}}{F_N}$

$F = kx$: $x = ?$ $\frac{F}{k} = x$

$F_{net} = ma$: $a = ?$ $\frac{F_{net}}{m}$

$p = mv$: $v = ?$ $v = \frac{p}{m}$

DATE ______ PERIOD ______ NAME ______________________

11 Physics Skill

Use with Chapter 2.

ESTIMATING ORDERS OF MAGNITUDE

How can you determine how many leaves are on a tree? If you do not need to know an exact number, you can estimate the value by making several assumptions about the tree. For example, assume the tree is a cube, perhaps 10 m on its side. The tree will then have a volume of about 10^3 m^3. Now suppose that the leaves are symmetrical and uniformly distributed and that ten leaves lying end to end equal one meter. The tree will have roughly 10^3 leaves per cubic meter. Therefore, we estimate that the tree has 10^6 leaves. The power of ten is often referred to as the "order of magnitude." We could say the order of magnitude of leaves on the tree is 10^6.

Estimate answers for the following problems using the method described above. Summarize your assumptions.

1. How many hairs are on your head? Hint: Estimate the number of hairs per square centimeter and the area of your scalp.

   (20 hairs/cm^2)(30 cm)(30 cm) = 2×10^4 hairs

2. How many blades of grass are on a football field?

   (10 blades/cm^2)(1.0×10^4 cm^2/m^2)(100 m)(50 m) = 5×10^8 blades

3. How many times does a person's heart beat in a lifetime?

   (70 beats/min)(60 min/h)(24 h/day)(365 day/yr)(70 yr) = 3×10^9 beats

4. How many cans of soda pop does the student body at your school drink in a school year?

   (0.5 cans/student/day)(1000 students)(5 days/wk)(36 wk/yr) = 9×10^4 cans

5. Using convenient units such as minutes, hours, days, or years, estimate the lifetime of each of the objects below. Then find the order of magnitude in seconds for each lifetime.

   a. human being
   70 yr = 2×10^9 s

   b. dog
   10 yr = 3×10^8 s

   c. sea turtle
   100 yr = 3×10^9 s

   d. flea
   10 wk = 6×10^6 s

   e. baseball game
   3 h = 1×10^4 s

   f. lightning bolt
   1 s = 1 s

   g. firefly flash
   3 s = 3 s

   h. white line in middle of a road
   2 yr = 6×10^7 s

DATE ______ PERIOD ______ NAME ______________________

12 Physics Skill

Use with Chapter 3.

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. If a quantity is multiplied by 1, its value does not change. Any quantity divided by its equivalent is equal to 1. Since 1000 m = 1 km and 60 s = 1 min and 60 min = 1 h,

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

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.

$$\frac{25\ km}{1\ h}\cdot\frac{1000\ m}{1\ km}\cdot\frac{1\ h}{60\ min}\cdot\frac{1\ min}{60\ s} = 6.9\ m/s$$

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

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

Use this factor for your conversion as follows.

$$80\ mL \cdot \frac{1\ L}{1000\ mL} = 0.08\ L$$

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

1. How many seconds are in a year?

   $$\frac{365\ days}{1\ year}\cdot\frac{24\ h}{1\ day}\cdot\frac{60\ min}{1\ h}\cdot\frac{60\ s}{1\ min} = 3.15 \times 10^7\ s/year$$

2. Convert 28 km to cm.

   $$\frac{28\ km}{}\cdot\frac{1000\ m}{1\ km}\cdot\frac{100\ cm}{1\ m} = 2.8 \times 10^6\ cm$$

3. Convert 45 kg to mg.

   $$\frac{45\ kg}{}\cdot\frac{1000\ g}{1\ kg}\cdot\frac{1000\ mg}{1\ g} = 4.5 \times 10^7\ mg$$

5 4. Convert 450 m/s to m/h.

   $$\frac{450\ m}{1\ s}\cdot\frac{60\ s}{1\ min}\cdot\frac{60\ min}{1\ h} = 1.62 \times 10^6\ m/h$$

6 5. Convert 85 cm/min to m/s.

   $$\frac{85\ cm}{1\ min}\cdot\frac{1\ m}{100\ cm}\cdot\frac{1\ min}{60\ s} = 1.4 \times 10^{-2}\ m/s$$

7 6. Convert the speed of light, 3.0×10^8 m/s, to km/day.

   $$\frac{3.0 \times 10^8\ m}{1\ s}\cdot\frac{1\ km}{1000\ m}\cdot\frac{60\ s}{1\ min}\cdot\frac{60\ min}{1\ h}\cdot\frac{24\ h}{1\ day} = 2.6 \times 10^{10}\ km/day$$

added to SNAP p7

SNAP

6 Physics Skill

NAME ____________________

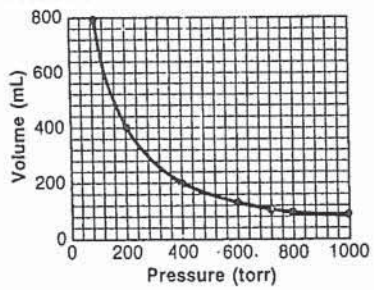
Graph the following sets of data using proper graphing techniques.

$y = \frac{k}{x}$

1\.

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

Pressure versus Volume

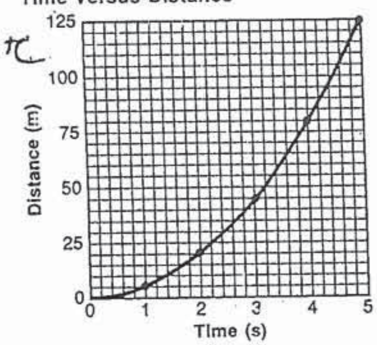


2\.

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

$y = ax^2 + bx + c$

Time versus Distance



3\.

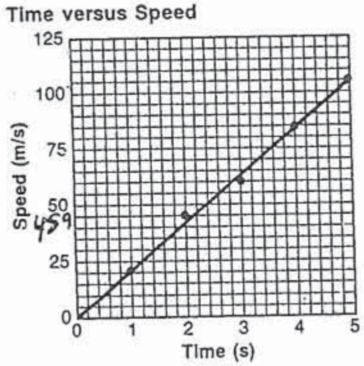
Time (s)	Speed (m/s)
0	0
1	20
2	45
3	60
4	84
5	105

$y = mx + b$

22.5 0

$y = 22.5x$

Time versus Speed



DATE ________ PERIOD ________ NAME ____________________

7 Physics Skill

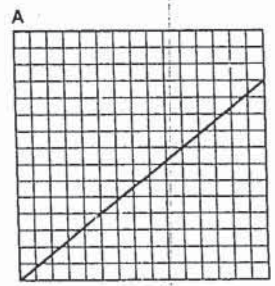
Use with Chapter 2.

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.

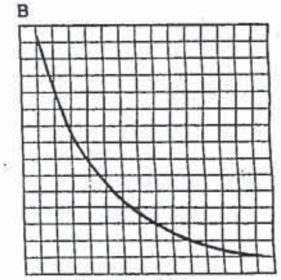
There are three relationships that occur frequently in physics. If the dependent variable varies directly with the independent variable, the graph will be a straight line, as shown in graph A. If y varies inversely with x, the graph will be a hyperbola as shown in graph B. The third relationship, in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

A



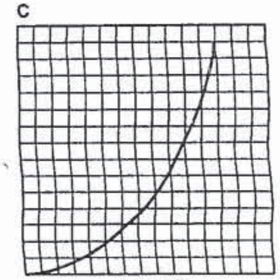
$y = kx$

B



$y = k/x$

C



$y = kx^2$

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.

1. 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

a. Describe the relationship between force and acceleration as shown by the graph.
Acceleration is directly proportional to force.

7 Physics Skill

NAME ______________________

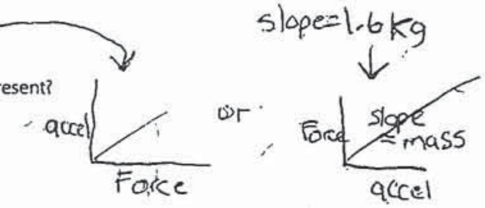
b. What is the slope of the graph? Remember to include units with your slope. One newton equals 1 kg•m/s².

$$\text{slope} = \frac{\Delta y}{\Delta x}$$
$$= \frac{(25 - 0)\ \text{m/s}^2}{(40 - 0)\ \text{N}}$$
$$= 0.625\ \text{m/s}^2\text{/N} = 0.63/\text{kg}$$

slope=1.6 kg

c. What physical quantity does the slope represent?

The slope is the reciprocal of the mass.



d. Write an equation for the line.

$a = kF$

$a = \frac{\Delta y}{\Delta x} F + 0$

$y = mx + b$

e. What is the value of the force for an acceleration of 15 m/s²?

$$F = \frac{a}{0.63\ \text{kg}}$$
$$= \frac{15\ \text{m/s}^2}{0.63\ \text{kg}}$$
$$= 24\ \text{N}$$

f. What is the acceleration when the force is 50.0 N?

$$a = (0.63\ \text{kg})F$$
$$= (0.63\ \text{kg})(50.0\ \text{N})$$
$$= 32\ \text{m/s}^2$$

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.

y is proportional to x^2.
$y = kx^2$

$y = mx^2 + (bx + c)$ (0)

b. Is the distance traveled greater between 0 s and 1 s or 3 s and 4 s?

The distance is greater between 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?

The slope is greater between 3 s and 4 s.

7 Physics Skill

NAME ______________________

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

a. In which graph is y directly proportional to x?

A

b. In which graph does y decrease as x increases?

C

c. In which set of data is y inversely proportional to x?

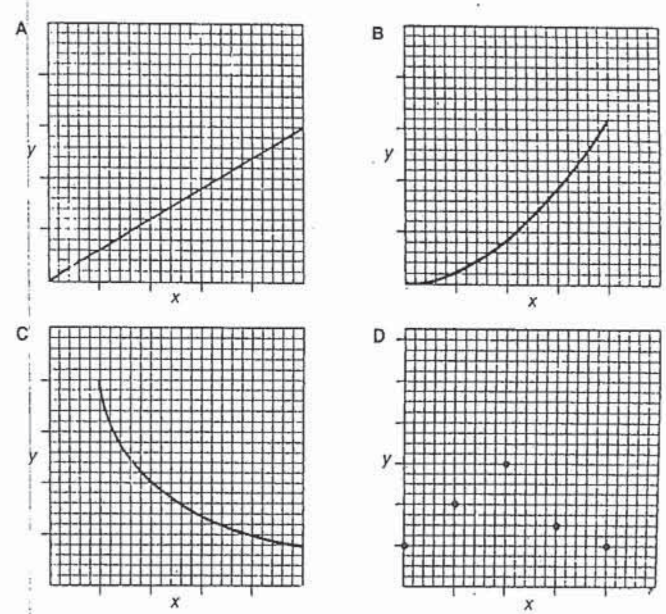
C

d. Which graph does not seem to picture a simple relationship?

D

e. Which graph has the general equation $y = kx^2$?

B



Slopes Sheet (lesson 4)

p1.

1. $m = 0.8 \, g/mL$
2. $m = 0.2 \, cm/°C$
3. $m = 0.18 \, mL/°C$

p2.

1. $m = 20 \, m/s^2$

2. $m_A = 200 \, m/s$

   $m_B = 100 \, m/s$

3. $m_1 = 10 \, ft/min$

   $m_2 = 5 \, ft/min$

   $m_3 = 0 \, ft/min$

   $m_4 = -20 \, ft/min$

4. $m_1 = 10 \, m/s^2$

   $m_2 = 0 \, m/s^2$

   $m_3 = -20 \, m/s^2$

5. $m_2 = 8 \, m/s^2$

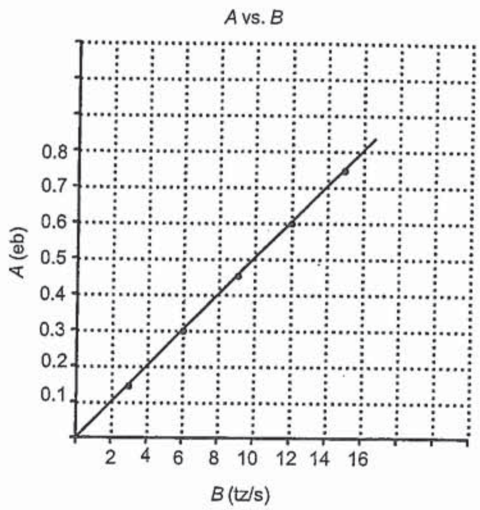
   $m_7 = -7 \, m/s^2$

6. $m_3 = 2.5 \, m/s$

   $m_{11} = 0.7 \, m/s$

Lesson 5–Graphing

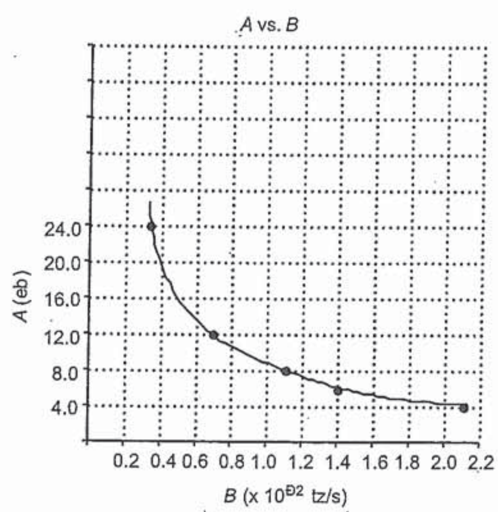
1.



b)
$$\text{slope} = \frac{\text{rise}}{\text{run}} = \frac{y_2 - y_1}{x_2 - x_1}$$
$$= \frac{0.750 \text{ eb} - 0}{15.0 \text{ tz/s} - 0}$$
$$= 5.00 \times 10^{-2} \text{ eb•s/tz}$$

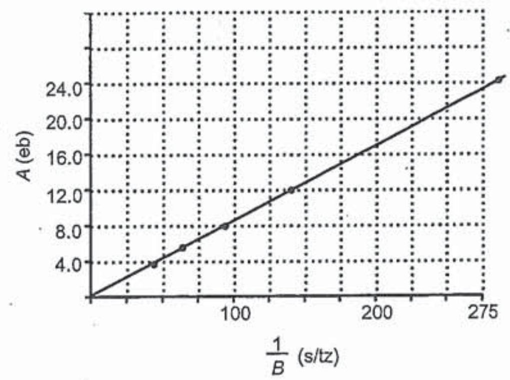
c) $A \Delta B$ or $A = kB$

2. a)



b)

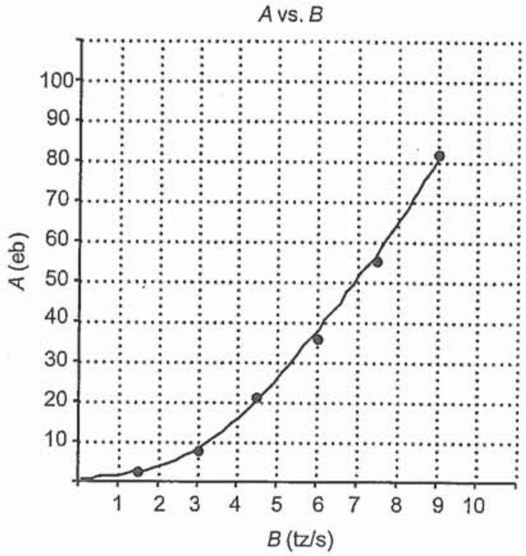
B ($\times 10^{-2}$ tz/s)	A (eb)	$\frac{1}{B}$ (s/tz)
2.1	4.0	47.6
1.4	6.0	71.4
1.1	8.0	90.9
0.7	12.0	143
0.35	24.0	286



c)
$$\text{slope} = \frac{\text{rise}}{\text{run}} = \frac{y_2 - y_1}{x_2 - x_1}$$
$$= \frac{23 \text{ eb} - 0}{275 \text{ s/tz} - 0}$$
$$= 8.36 \times 10^{-2} \text{ eb•tz/s}$$

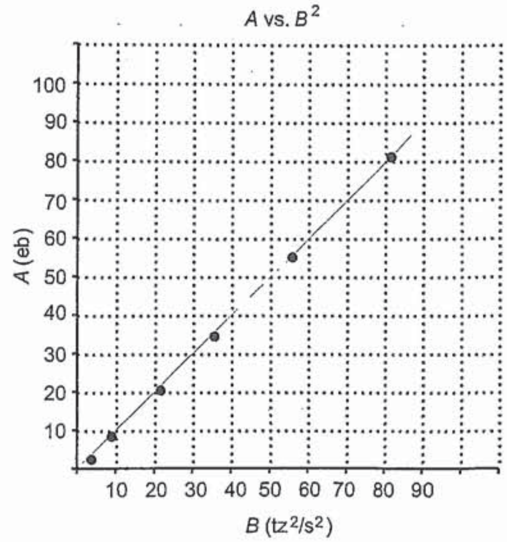
d) $A \Delta \frac{1}{B}$ or $A = \frac{k}{B}$

3. a)



b)

B (tz/s)	A (eb)	B^2 (tz^2/s^2)
1.5	2.25	2.25
3.0	9.00	9.00
4.5	20.25	20.25
6.0	36.00	36.00
7.5	56.25	56.25
9.0	81.00	81.00



c) $$\text{slope} = \frac{\text{rise}}{\text{run}} = \frac{y_2 - y_1}{x_2 - x_1}$$

$$= \frac{70 \text{ eb} - 0}{70 \text{ tz}^2/\text{s}^2 - 0}$$

$$= 1.00 \text{ eb}\cdot\text{s}^2/\text{tz}^2$$

d) $A \Delta B^2$ or $A = kB^2$

Kinematics Lesson 1

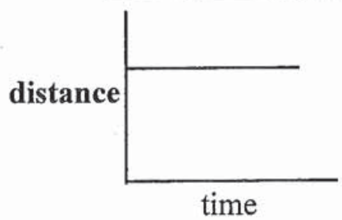
GRAPHS

Study these graphs until you are sure how to interpret what is happening. Note that the **variable** on the **vertical axis** a **key** to the solution.

Uniform Motion (graphs b & c)

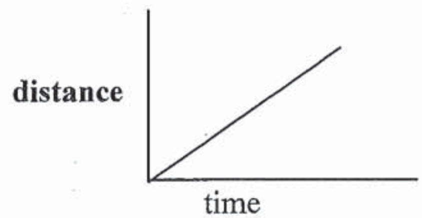
No Motion (graph a)

a.



No Motion

b.



Uniform Motion

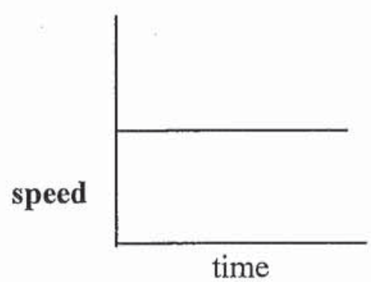
For **d/t** graphs: **SLOPE = VELOCITY**

$$\vec{v} = \frac{\Delta \vec{d}}{\Delta t} \qquad \text{slope} = \frac{\Delta y}{\Delta x}$$

slope = velocity (when the **vertical axis** is **distance** because of the **parallel** between the **slope** and **velocity formulae**)

$$\frac{d_2 - d_1}{t_2 - t_1} \quad \Big| \quad \frac{y_2 - y_1 \ (\text{rise})}{x_2 - x_1 \ (\text{run})}$$

c.



Uniform Motion

For **v/t** graphs**: SLOPE=ACCELERATION**
(again, due to the **parallel** between the **slope formula** and **acceleration)**
formula: $a = \frac{\Delta v}{\Delta t}$

4b

PHYSICS 11 - KINEMATICS Lesson 1

In Physics, **direction is very important and we use vectors to represent direction**. Arrows are used to represent vectors and diagrams are always drawn to indicate the motion and direction of the object.

Displacement: Sometimes, the motion is **in one plane only**:

3.0 m **south** and 4.0 m **south**

3.0 m **south** and 4.0 m **north**

Sometimes, the motion **is in two planes**:

3.0 m **south** and 4.0 m **east**

8.0 m **west** and 5.0 m **north**

An object is travelling at a **constant** velocity of 5.6 m/s east. How long will this object take to travel 32.6 m? **Draw a vector diagram and then solve.**

A man runs at an average velocity of 1.40 m/s north for 54.0 s, and then jogs at an average velocity of 0.85 m/s in the same direction for 70.0 s. What is the average velocity for his total time of travel? **Draw a vector diagram and then solve.**

A car leaves home and travels 8.9 km west, turns left and travels 2.3 km south, then turns right and travels 13.0 km west and stops. **Draw a vector diagram.**

a) What distance did the car travel?

b) What is the displacement of the car?

Assignment: Lesson 1

1. A man walks 275 m east and then turns around and walks 425 m west. **Draw a vector diagram.**

   a) What is the distance traveled by the man?

   b) What is the displacement of the man?

2. If a car is traveling at a speed of 31.0 m/s, it is exceeding the speed limit of 75 km/h?

3. While Nicki is driving down the highway, she notices a km marker which says 145 km. She then drives 45 km past the mark. After visiting some friends, she turns around and travels 20 km in the opposite direction. What is her displacement? **Draw a vector diagram.**

4. An athlete swims the length of a 50.0 m pool in 18.0 s and makes the return trip to the starting position in 19.0 s. Determine the average velocities in:

a) the first half of the trip

b) the second half of the swim

c) the round trip

5. An object travels 11 m north and then turns around and travels 25 m south. **Draw a vector diagram and then solve.** If the total time of travel is 52 s, what is...

   a) the average speed of the object?

   b) the average velocity of the object?

6. An object travels at a constant velocity of 6.2 m/s south for 24 min, and then 4.5 m/s north for 12 min. Calculate the average velocity. **Draw a vector diagram.**

7. Solve the following displacement vectors by finding the net displacement and direction. **You <u>must</u> draw a vector diagram with each.**

a) 5.0 m east and 2.5 m east

b) 7.2 m east and 3.0 m west

c) 5.0 m south and 8.0 m west

d) 6.5 m west and 2.4 m north

e) 7.0 m north and 11.0 m east

f) 20.0 m east and 15.0 m south

g) 7.0 m south, 6.0 m east and 8.0 m north (**hint**: add the vectors that are along the same plane first)

h) 15 m west, 12 m north, and 20 m east

8. A car leaves home and travels 12.3 km east, turns left and travels 5.2 km north, then turns right and travels 8.9 km east and stops. **Draw a vector diagram.**

a) What distance did the car travel?

b) What is the displacement of the car?

Kinematics Lesson 1

Solutions:

1. a) 700m b) 150m [W]

2. Yes-111.6 km/h

3. 25km [W]

4. a) 2.78 m/s [f] b) 2.63 m/s [b] c) 0 m/s

5. a) 0.69 m/s b) 0.27 m/s [S]

6. 2.6 m/s [S]

7. a) 7.5 m [E] b) 4.2 m [E] c) 9.4 m [SW] d) 6.9 m [NW]

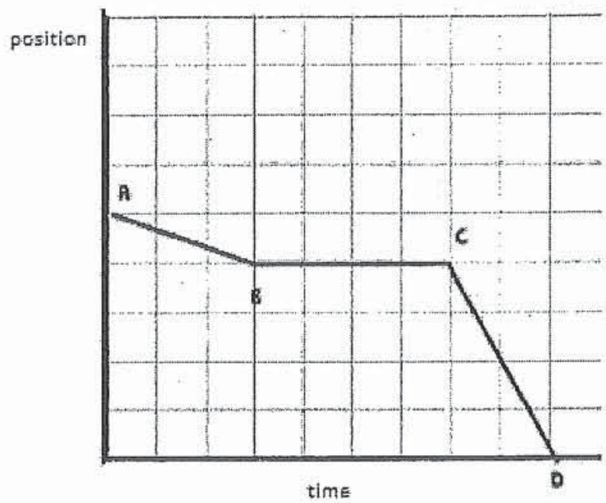
e) 13 m [NE] f) 25.0 m [SE] g) 6.1 m [NE] h) 13 m [NE]

8. 22 km [NE]

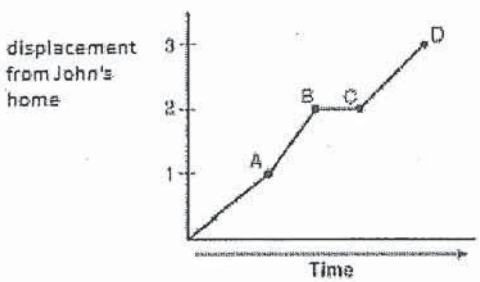
Position-Time Graphs Lesson 1 continued

An Airplane is descending to land at the airport. During its descent it had to fly in circles until the landing was cleared of other planes. Explain what is occurring during each of the segments.

1)



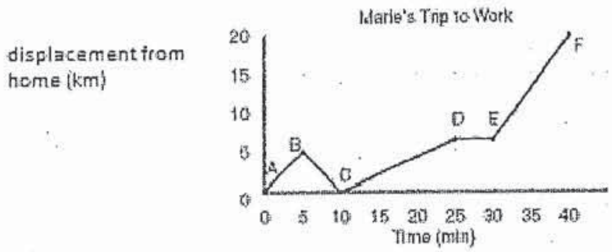
2) John left his home and walked 3 blocks to his school, as shown in the accompanying graph.



What is one possible interpretation of the section of the graph from point *B* to point *C*?

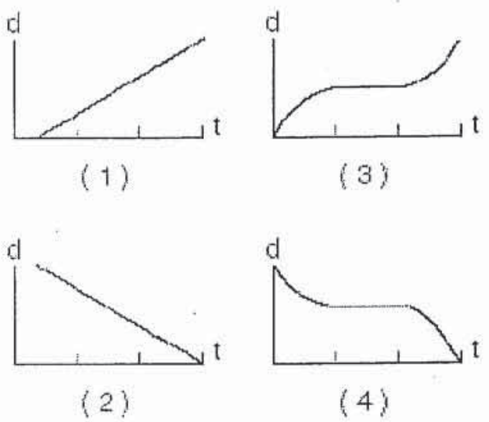
(1) John arrived at school and stayed throughout the day.
(2) John waited before crossing a busy street.
(3) John returned home to get his mathematics homework.
(4) John reached the top of a hill and began walking on level ground.

3. The accompanying graph shows Marie's distance from home (*A*) to work (*F*) at various times during her drive.



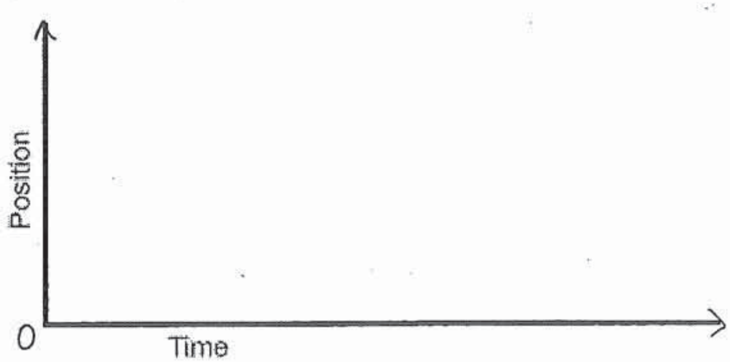
a Marie left her briefcase at home and had to return to get it. State which point represents when she turned back around to go home and explain how you arrived at that conclusion.

4.)A bug travels up a tree, from the ground, over a 30-second interval. It travels fast at first and then slows down. It stops for 10 seconds, then proceeds slowly, speeding up as it goes. Which sketch best illustrates the bug's distance (*d*) from the ground over the 30-second interval (*t*)?



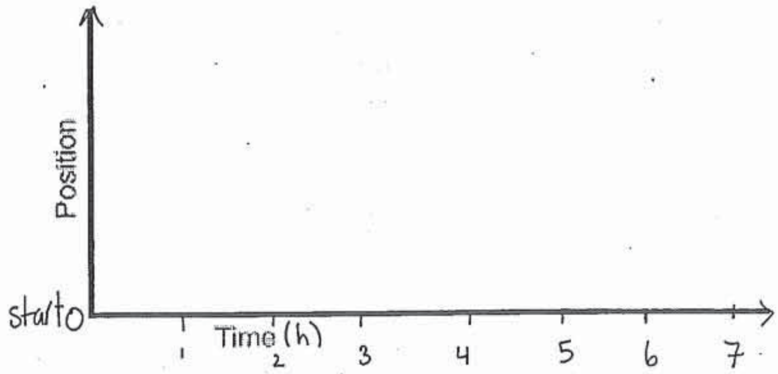
5. Graph Red Riding Hood's movements according the following events listed in the order they occurred:

- Little Red Riding Hood set out for Grandmother's cottage at a good walking pace.
- She stopped briefly to talk to the wolf.
- She walked a bit slower because they were talking as they walked to the wild flowers.
- She stopped to pick flowers for quite a while.
- Realizing she was late, Red Riding Hood ran the rest of the way to Grandmother's cottage.



6. Graph the movements of the Tortoise and the Hare. Use two lines to show the movements of each animal on each graph. The movements of each animals are listed in the order they occurred.

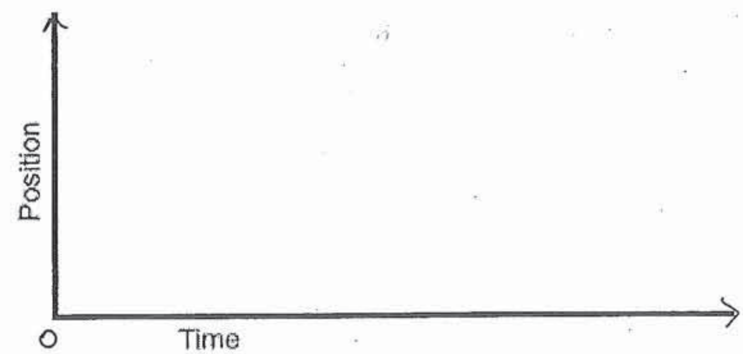
- The tortoise and the hare began their race from the combined start-finish line. By the end of the race, the two will be at the same position at which they started.
- Quickly outdistancing the tortoise, the hare ran off at a moderate speed.
- The tortoise took off at a slow but steady speed.
- The hare, with an enormous lead, stopped for a short nap.



- With a start, the hare awoke and realized that he had been sleeping for a long time.
- The hare raced off toward the finish at top speed.
- Before the hare could catch up, the tortoise's steady pace won the race with an hour to spare.

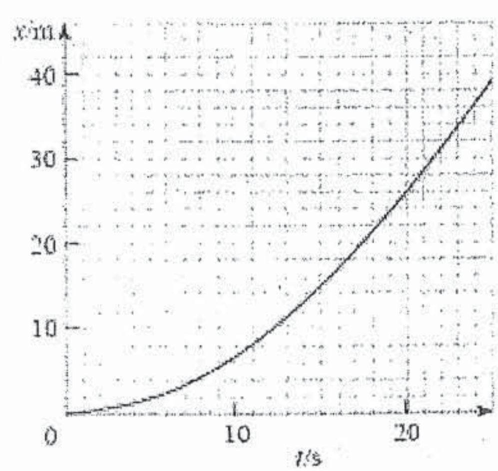
7. Graph the altitude of the sky rocket on its flight according to the following sequence of events listed in order.

- The skyrocket was placed on the launcher.
- As the rocket motor burned, the rocket flew faster and faster into the sky.
- The motor burned out; although the rocket began to slow, it continued to coast ever higher.
- Eventually, the rocket stopped for a split second before it began to fall back to Earth.



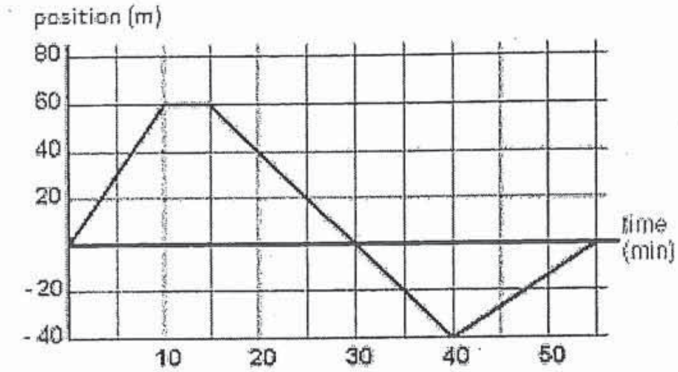
- Gravity pulled the rocket faster and faster toward Earth until a parachute popped out, slowing its descent.
- The descent ended as the rocket landed gently on the ground.

8.



1. Find the instantaneous velocity at 15.s [+1.8m/s]
2. Find the average velocity between 0 and 20s. [+1.3m/s]

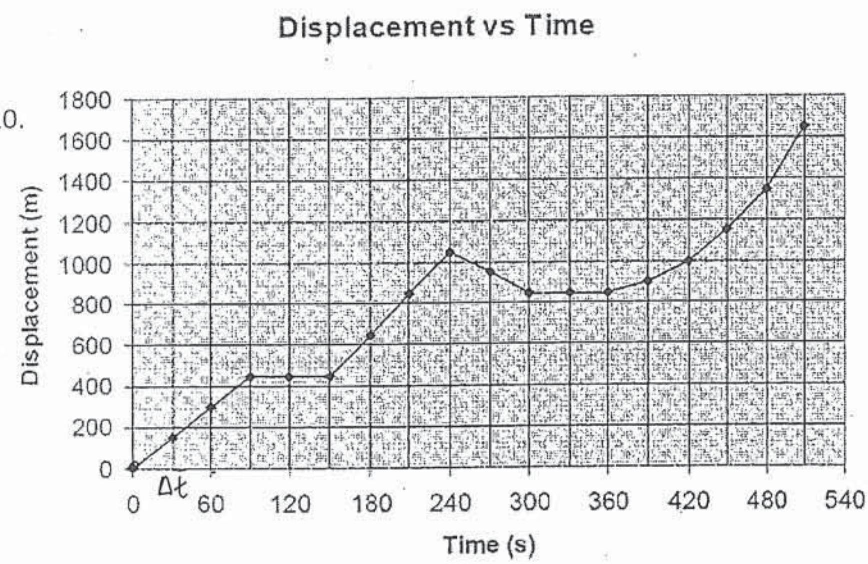
9.



1. How much distance did the object travel in 50min?
2. What is the displacement of the object at 30min?
3. What is the displacement of the object at 50min?
4. What is the average velocity at 25min?

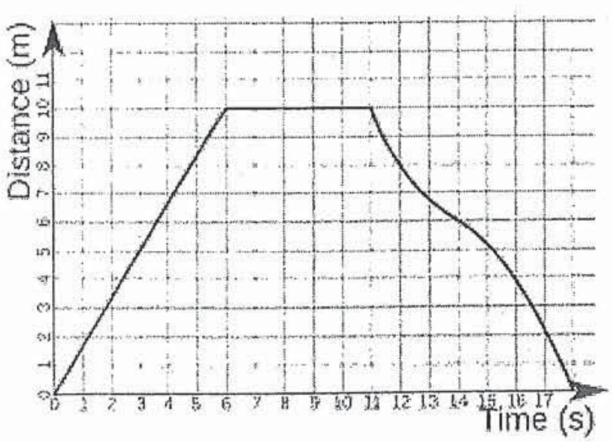
[190m] [0m] [-10m] [-4.0m/min]

10.



1. What is the instantaneous velocity at 420s?[+3.7m/s]
2. What is the average velocity at 60s?[+5.0m/s]
3. What is the average velocity between 0 and 180s? [+3.3m/s]

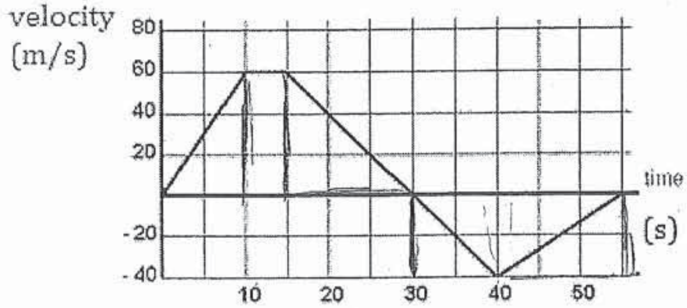
11.



1. What distance did the object travel after 18 s?
2. What is the displacement of the object at 14s?
3. What is the average velocity between 0 and 14s?
4. What is the instantaneous velocity at 15s?

[20m] [+6m] [+0.43m/s] [-1.1m/s]

15.



1. How much distance did the object travel in 40s?

$\frac{10\times60}{2}=300$ $5\times60=300$ $\frac{15\times60}{2}=450$ $\frac{10\times(40)}{2}=200$ $=1.3\times10^3m$

2. What is the displacement of the object at 30s?

$300+300+450=1.1\times10^3m$

3. What is the displacement of the object at 55s?

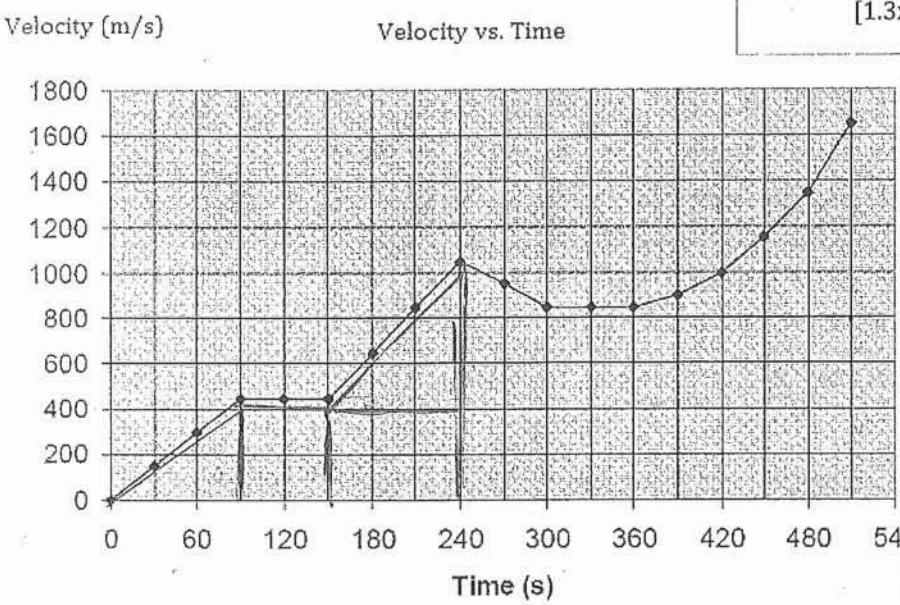
$\frac{-40\times15}{2}=-300$ $300+300+450+(-200)+(-300)=5.5\times10^2m$

4. What is the average acceleration between 10 and 40s?

$\frac{-40-60}{40-10}=3.3m/s^2$

[1.3×10^3m] [[1.1×10^3m] [5.5×10^2m] [-3.3m/s^2]]

16.



1. What is the displacement after 240s?

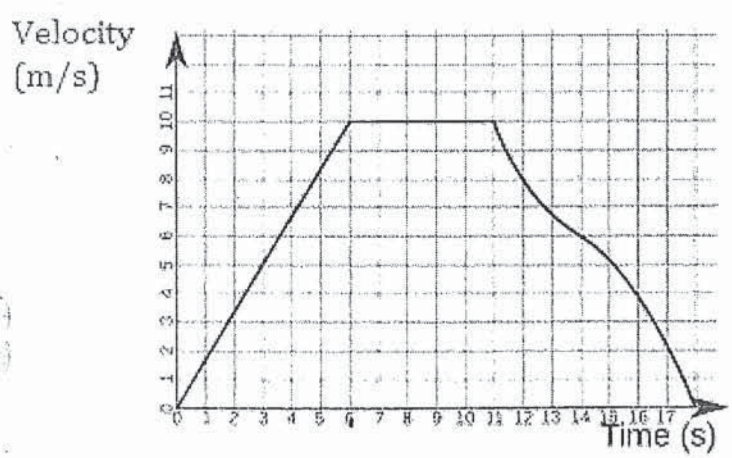
$\frac{90\times400}{2}=18000$ $60\times400=24000$ $90\times400=36000$ $\frac{90\times600}{2}=27000$ $=9.5\times10^4m$

2. What is the average acceleration between 180 and 360s?

$\frac{800-600}{360-180}=1.1m/s^2$

[1.1×10^5m] [+1.1m/s^2]

17.



1. What distance did the object travel after 6 s?[30m]

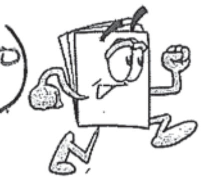
$\frac{6\times10}{2}=30m$

2. What is the average acceleration between 3 and 12 s?[+0.3m/s^2]

$\frac{8-5}{12-3}=\frac{3}{9}=\frac{1}{3}=+0.3m/s^2$

Lesson 2 Uniform Motion lab

UNIFORM ACCELERATED MOTION Lesson 3 (+ accel due to gravity)



PHYSICS 11

SUMMARY OF FORMULAS

	$\vec{v}_o$	$\vec{v}_f$	$\vec{a}$	$\vec{d}$	t
$\vec{a} = \dfrac{\vec{v}_f - \vec{v}_o}{t}$	√	√	√		√
$\vec{d} = \left(\dfrac{\vec{v}_f + \vec{v}_o}{2}\right)t$	√	√		√	√
$\vec{d} = \vec{v}_o t + \dfrac{1}{2}\vec{a}t^2$	√		√	√	√
$\vec{v}_f^{\,2} = \vec{v}_o^{\,2} + 2\vec{a}\vec{d}$	√	√	√	√	

We know that the formula for <u>average velocity</u> is when dealing with uniform motion (<u>constant velocity</u>):

$$\vec{V}_{av} = \frac{\vec{d}}{t}$$

We can also find the <u>average velocity</u> when dealing with uniform <u>accelerated</u> motion with:

$$\vec{V}_{av} = \frac{\vec{V}_o + \vec{V}_F}{t}$$

Example Problems:

1. An object that is initially travelling at a velocity of 7.0 m/s east accelerates uniformly to a velocity of 22.0 m/s east in a time of 1.7 s. Calculate the acceleration of the object. Draw the diagram and then solve the problem.

2. An object accelerates north uniformly from rest in a time of 2.70s. In this time, it travelled 20.0 m. What was the final velocity? Draw the diagram and then solve the problem.

3. An object accelerates uniformly from rest. If the acceleration was 2.00 m/s^2 west, what was the displacement when it reached a velocity of 1.00 x 10^2 km/hr? Draw the diagram and then solve the problem.

4. An object accelerates uniformly at a rate of 0.750 m/s^2 north. This object reaches a velocity of 14.0 m/s north while its displacement was 22.0 m north. What was the initial velocity? Draw the diagram and then solve the problem.

5. A motorcyclist traveling at 14.0 m/s collides with a haystack and is brought to rest in a distance of 4.5 m. What is the acceleration of the motorcycle and rider while being brought to a stop? Draw the diagram and then solve the problem.

6. A bullet penetrates 7.0 cm into wood when fired at a speed of 33 m/s. Draw the diagram and then solve the problem.

a) Calculate the acceleration.

b) Calculate the time taken to stop.

7. An object that is initially travelling at a velocity of 4.0 m/s east accelerates uniformly to a velocity of 16.0 m/s east in a time of 3.7 s. Calculate the acceleration of the object. Draw the diagram and then solve the problem.

ACCELERATION DUE TO GRAVITY

EXAMPLE PROBLEMS:

1. A large steel ball is dropped from a height of 7.00 m above the floor. What is the velocity at which the object will strike the floor?

2. If you drop your pen from a height of 2.50 m above the floor, how long will it take to fall?

3. A beach ball is thrown vertically upward from the ground with a speed of 16 m/s.

   a) How high does it rise (maximum height)?

   b) How long will it be airborne?

   c) What is the velocity at the highest point?

   d) What should the initial upward velocity of a ball if it just reaches the roof of a house 14 m high?

4. A paratrooper, descending at a constant speed of 3.0 m/s, accidentally drops his flashlight 150 m above the ground.

a) How much time does it take the paratrooper to reach the ground?

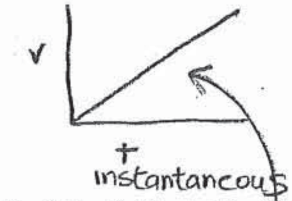
b) How much time does it take the flashlight to reach the ground?

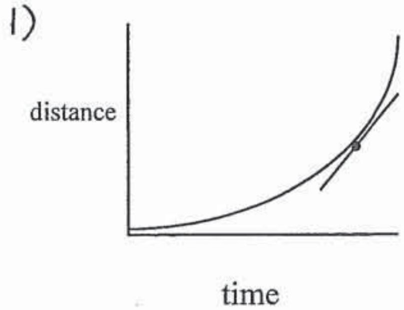
Lesson 4 notes:

Nonuniform Motion (not constant speed) but Uniform Acceleration (graphs d & e)

- The **velocity** at any given point in time on a **d/t graph** showing **acceleration** (i.e. a d/t graph with a curve) is called the **instantaneous velocity**.
- **Instantaneous velocity** is **calculated** by finding the **slope** of the **tangent to the curve**, at a specific time.

d. speeding up (acceleration is positive):

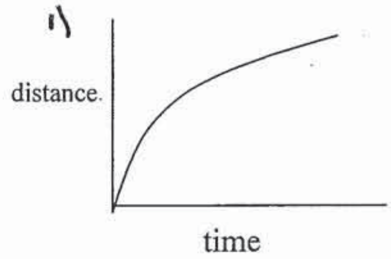
2) 

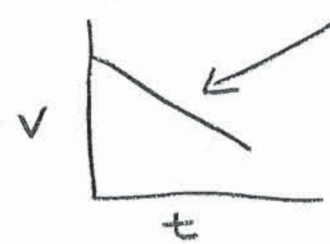
1) 

Tangent (find the slope of this line to find the "v" at this "t")

Slope of a v/t graph is acceleration

slowing down (acceleration is negative):

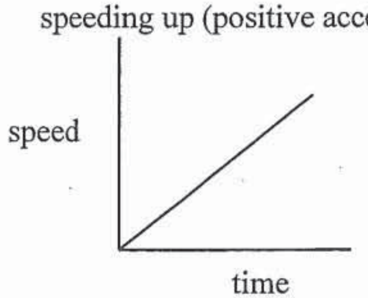
1) 

2) 

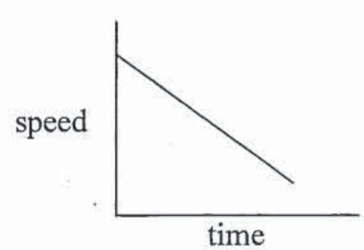
For nonuniform motion with **uniform acceleration, instantaneous velocity is:**

instantaneous velocity = slope of TANGENT at a given point in time

e. speeding up (positive accel)

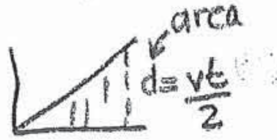


slowing down (negative accel)



for v/t graphs: i.) slope = acceleration

or

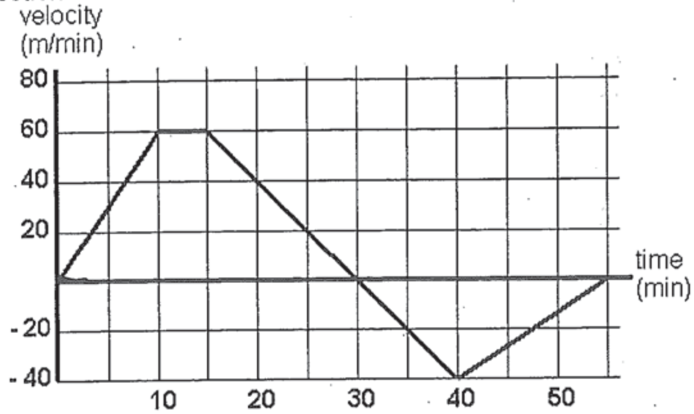


ii.) area under the graph = displacement $d = v \times t$ or

VELOCITY AND ACCELERATION ASSIGNMENT

NAME:

1. The graph below represents an objects motion for 55 minutes. The object is moving to the right Use the graph to answer the following questions.



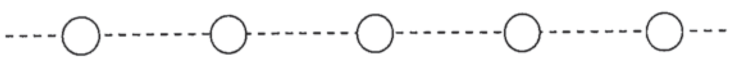
a) Calculate the acceleration of the object at 5 minutes and at 30 minutes.

b) The velocity of the object at 12 minutes = ____________________

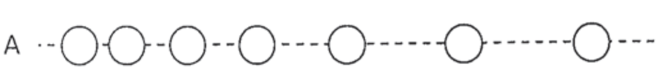
c) The velocity of the object at 35 minutes = ____________________

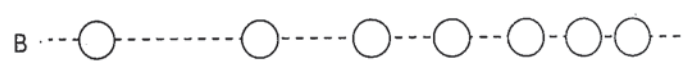
d) In "physics language", describe (in words) the motion of the object for the entire 55 minute trip.

2. The diagram below shows the positions of a ball moving from left to right at 10 second intervals. Is the ball accelerated? Explain.



3. The diagrams below show the position of two balls moving from left to right 0.10 sec intervals. Indicate if the ball is accelerated and explain how you know.





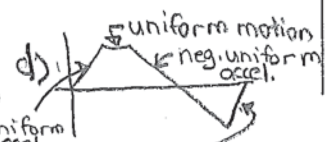
Ball A

Ball B

Slope

1a) $\frac{60-0}{10-0} = 6.0 \frac{m}{min^2}$ b) $60 \frac{m}{min}$ c) $-20 \frac{m}{min}$ d)

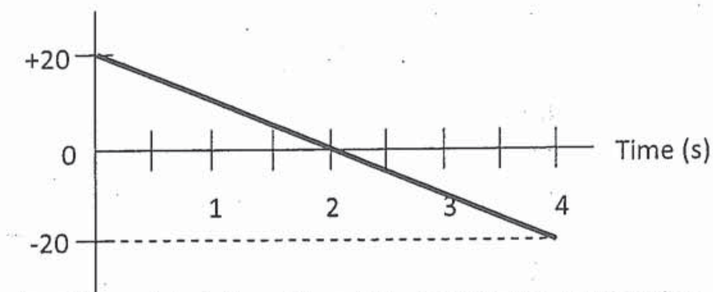
$\frac{-40-60}{40-15} = \frac{-100}{25} = -4.0 \frac{m}{min^2}$



2. no, distance intervals uniform (constant

3. A accelerated as distance interval ↑'s
B negative accel (decelerated) as distance interval ↓'s.

4. Joey throws his baseball glove straight upward into the air with a velocity of 20 m/s, upward. The velocity-time plot is shown below.



a) The glove travels upwards, reaches its peak height and then falls downwards. At what time does the glove reach its highest point in the air? Explain how you determined your answer.

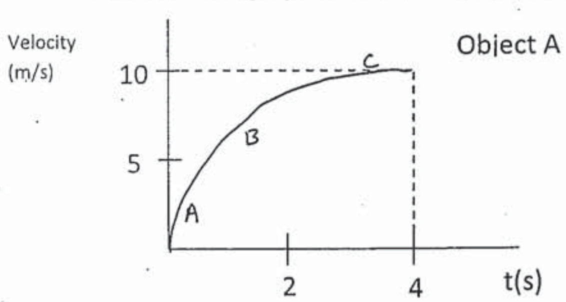
b) As the glove is moving upwards, it is slowing down. Therefore, its acceleration is __________ (up or down)

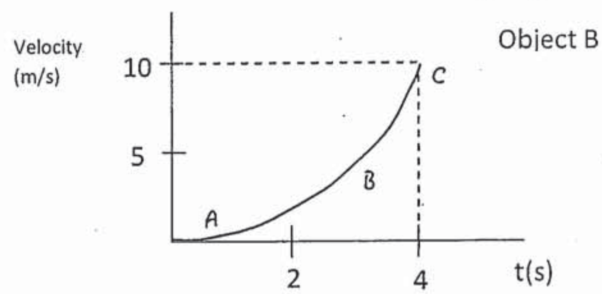
c) As the glove it moving downwards, it is speeding up. Therefore, its acceleration is __________ (up or down)

d) Use the velocity-time graph to determine the acceleration of the glove.

e) What is causing the acceleration of the glove?

5. In the two graphs below, velocity has been plotted as a function of time for two different moving objects.





a) At which point in the motion of object A is the acceleration the greatest? Explain.

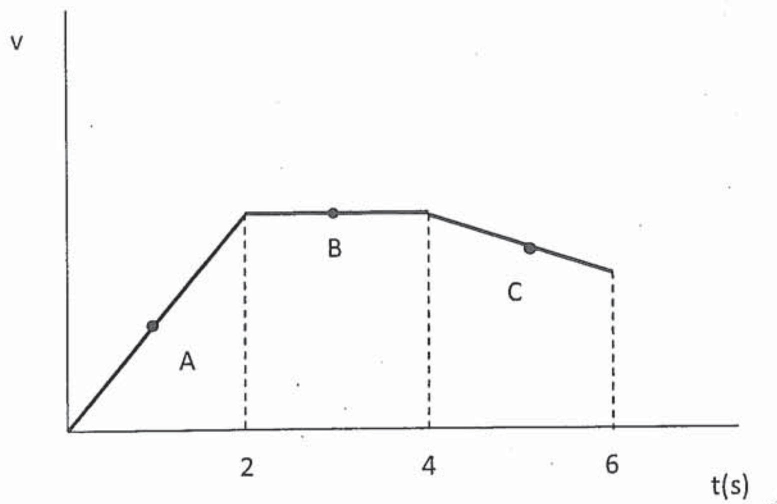
b) At which point is object B undergoing constant acceleration? Explain.

c) Which of the objects (A or B) covers the greatest distance in equal times shown? Explain.

4) a) 2s; "v" becomes negative b) down c) down d) -10 m/s² e) gravity
5 a) A, steepest slope b) never c) object A; area between graph + x axis is greatest for object A.

6. The driver of a car steps on the brakes, causing the velocity of the car to decrease. According to the definition of acceleration, is the car accelerated during this process? Explain.

7. A car moves along a straight section of road so that its velocity as a function of time is described by the graph.



a) At which of the labelled points (A, B, or C) is the acceleration the greatest? Explain.

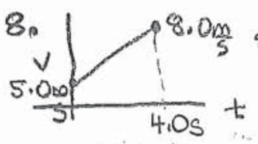
b) Does the car ever go backwards during the time interval shown on the graph? Explain.

c) In which of the equal time segments, 0-2s, 2-4s, or 4-6s, is the distance traveled by the car the greatest? Explain.

8. A car traveling in a straight line has a velocity of 5.0 m/s [E] at some instant. After 4.0 s, its velocity is 8.0 m/s [E]. What is its acceleration in this time interval? Draw the diagram and then solve the problem.

6) yes, negative accel 7) a) A steepest slope b) no because "area" is positive/above x axis c) B-biggest area

8.



slope $= \frac{8.0-5.0}{4.0-0.0} = \frac{3}{4} = 0.75 \frac{m}{s^2}$

9. A car is travelling at 85.0 km/h on a highway. The driver then notices a deer crossing the road ahead and sharply applies the brakes to slow the car at an acceleration of -15.0 m/s^2 for a time period of 1.50 seconds. How fast (in km/h) is the car travelling after 2.50 s braking period. Draw the diagram and then solve the problem.

10. A certain car is capable of accelerating at a rate of +0.60 m/s^2. How long does it take for this car from a speed of 55 km/h to a speed of 70 km/h? Draw the diagram and then solve the problem.

11. An object travels 210 m north and then turns around and travels 430 m south. **Draw a vector diagram and then solve**. If the total time of travel is 300 s, what is...

a) the average speed of the object?

b) the average velocity of the object?

12. An object travels at a constant velocity of 11 m/s south for 403 s, and then 4.5 m/s north for 3 min. Calculate the average velocity. **Draw a vector diagram and solve.**

13. A car leaves home and travels 15 km east, turns left and travels 2.2 km north, then turns right and travels a further 2.0 km east and stops. **Draw a vector diagram solve.**

a) What distance did the car travel?

b) What is the displacement of the car?

9) 4.00 $\frac{km}{h}$ 10) 6.9 s 11a) 2.13 $\frac{m}{s}$ b) 0.733 $\frac{m}{s}$ 12) 6.21 $\frac{m}{s}$, S 13) a) 19.2 km b)

17.14 km
→ 17 km

Lesson 5

- Rolling Object acceleration lab
- Vernier Motion detector lab

Lesson 6

PHYSICS
KINEMATICS

PRACTICE PROBLEMS

1. A motorist travels a distance of 406 km during a 7.0 h period. What was the average speed in (a) km/h and (b) m/s? a) 58 km/h b) 16 m/s

2. During a canoe race, a camper paddles a distance of 406 m in 70 s. What is the average speed in (a) m/s and (b) km/h? a) 5.8 m/s b) 21 km/h

3. A rocket launched into outer space travels a distance of 240,000 km during the first 6.0 h after the launching. What is the average speed of the rocket in (a) km/h and (b) m/s? a) 4.0×10^4 km/h b) 1.1×10^4 m/s

4. An electron traverses a vacuum tube with a length of 2.0 m in 2.0×10^{-3} s. What is the average speed of the electron during this time in (a) m/s and (b) cm/s? a) 1.0×10^3 m/s b) 1.0×10^5 cm/s

5. Light from the sun requires 8.3 minutes to reach the earth. The speed of light is 3.0×10^8 m/s. In kilometers, how far is the earth from the sun? (1.5×10^8 km)

6. A bullet leaves the muzzle of a rifle and 5.0 s later becomes embedded in the trunk of a tree 3000 m away. What is the average speed of the bullet in (a) m/s and (b) km/h?
a) 6.0×10^2 m/s b) 2.2×10^3 km/h

7. What is the acceleration of a racing car if its speed is increased uniformly from 44 m/s to 66 m/s over an 11-s period? (2.0 m/s²)

8. What is the acceleration of a racing car if its speed is decreased uniformly from 66 m/s to 44 m/s over an 11-s period? (−2.0 m/s²)

9. A train moving at a speed of 15 m/s is accelerated uniformly to 45 m/s over a 12-s period. What is its acceleration? (2.5 m/s²)

10. A plane starting from rest ($v_o = 0$) is accelerated uniformly to its take off speed of 72 m/s during a 5.0-s period. What is the plane's acceleration? (14 m/s²)

11. A bullet leaves the muzzle of a rifle in a direction straight up with a speed of 700 m/s. Ten seconds later its speed straight up is only 602 m/s. At what rate does the earth's gravitational field decelerate the bullet?
(−9.8 m/s²)

12. An arrow is shot straight up with an initial speed of 98 m/s. Nine seconds later its speed straight up is only 9.8 m/s. At what rate is the arrow decelerated by the pull of the earth's gravitational field?
(−9.8 m/s²)

13. In a vacuum tube, an electron is accelerated uniformly from rest to a speed of 2.6×10^5 m/s during a time period of 6.5×10^{-2} s. Calculate the acceleration of the electron. 4.0×10^6 m/s²

* 14. A car is uniformly accelerated at the rate of 2.0 m/s² for 12 seconds. If the original speed of the car is 36 m/s, what is its final speed? 60 m/s

15. An airplane flying at 90 m/s is accelerated uniformly at the rate of 0.5 m/s² for 10 seconds. What is its final speed? v_f = 95 m/s

16. A race car travelling at 45 m/s is slowed uniformly at the rate of -1.5 m/s² for 10 seconds. What is its final speed in (a) m/s and (b) km/h?
a) $v_f = 30 m/s$ b) $1.1 \times 10^2 km/h$

17. A spacecraft travelling at 1200 m/s is uniformly accelerated at the rate of 150 m/s² by burning its second stage rocket. If the rocket burns for 18 seconds, what is the final speed of the craft?
$v_f = 3.9 \times 10^3 m/s$

18. A car travelling at 44 m/s is uniformly decelerated to a speed of 22 m/s over an 11-s period. What distance does it travel during this time? ($3.6 \times 10^2 m$)

19. A racing car starts from rest ($v_o = 0$) and is accelerated uniformly to 40 m/s in 80 s. What distance does the car travel? ($1.6 \times 10^3 m$)

20. A plane flying at the speed of 150 m/s is accelerated uniformly at a rate of 5.0 m/s². (a) What is the plane's speed at the end of 10 s? (b) What distance has it travelled?
a) $2.0 \times 10^2 m/s$ b) $1.8 \times 10^3 m$

21. A rocket travelling at 88 m/s is accelerated uniformly to 132 m/s over a 15-s period. What distance in meters does the rocket travel during this time? $d = 1.7 \times 10^3 m$

22. An engineer is to design a runway to accommodate airplanes that must gain a ground speed of 60 m/s before they can take off. If these planes are capable of being accelerated uniformly at the rate of 1.5 m/s², (a) how long will it take them to achieve take-off speed? (b) What must be the minimum length of the runway?
a) $t = 40 s$ b) $d = 1.2 \times 10^3 m$

23. An airplane starts from rest and undergoes a uniform acceleration of 3.0 m/s² for 30 s before leaving the ground. What distance does it travel during the 30 s? ($d = 1.4 \times 10^3 m$)

24. A jet plane lands on a runway travelling at 88 m/s and is decelerated uniformly to rest in 11 s. Calculate (a) its deceleration in m/s², and (b) the distance it travels. a) $a = -8.0 m/s^2$ b) $d = 4.8 \times 10^2 m$

25. The Tokyo express is accelerated from rest at a constant rate of 1.0 m/s² for one minute. How far does it travel during this time? $d = 1.8 \times 10^3 m$

26. Starting from rest, a racing car travels a distance of 200 m in the first 5.0 s of uniform acceleration. At what rate is it being accelerated? ($a = 16 m/s^2$)

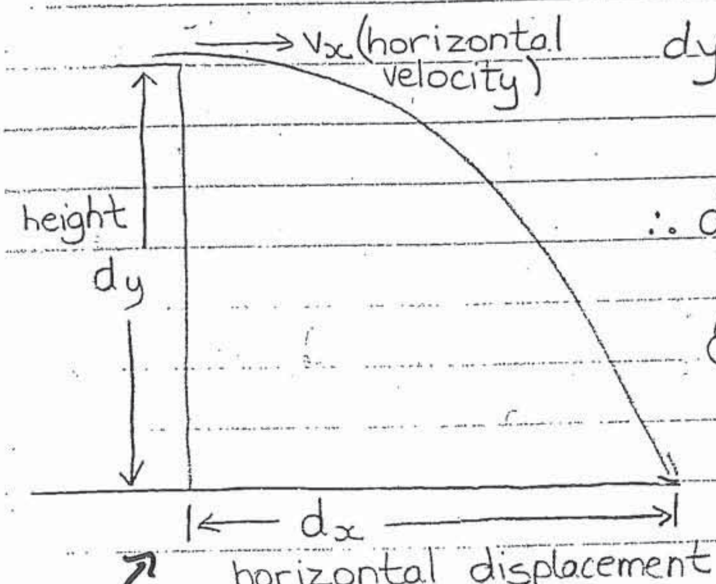
27. In an emergency, a driver brings a car to a full stop in 5.0 s. The car is travelling at a rate of 38 m/s when braking begins. (a) At what rate is the car decelerated? (b) How far does it travel before stopping?
a) $a = -7.6 m/s^2$ b) 95m

Lesson 7
Uniform acceleration dropping lab

Lesson 8

Motion in 2-Dimensions:

_nd:



always draw + label a diagram

vertical	horizontal
$d_y = v_{y_0}t + \frac{1}{2}a_g t^2$	$d_x = v_x t$
$v_{y_0} = 0$ (dropping)	
$\therefore d_y = \frac{1}{2}a_g t^2$	

1ST Find time from:

$t = \sqrt{\frac{2d_y}{a_g}}$ OR $t = \frac{d_x}{v_x}$

and Use time to find:

$d_y = \frac{1}{2}a_g t^2$ OR $d_x = v_x t$

$v_x = \frac{d_x}{t}$

1St:

Horizontally: uniform motion $v = \frac{d}{t}$ $v_x = \frac{d_x}{t}$

Vertically: falling or dropping $\therefore$ there is acceleration due to gravity (a_g)

AND $v_{y_0} = 0.0$ m/s

$d_y = \cancel{v_{y_0}t} + \frac{1}{2}at^2$

$d_y = \frac{1}{2}at^2$

Horizontal + vertical motion - INDEPENDENT of each other

Physics 11 - **Projectile Motion** Lesson 8

Assignment –

1. A baseball is thrown horizontally with a velocity of 13.6 m/s from a height of 35.0 m above the ground.

a) Calculate the time of flight of the projectile. [2.67s]

b) How far does the object land from the base of the building? [36.4m]

2. A marble, rolling with a speed of 20.0 cm/s, rolls off the edge of a table that is 80.0 cm high.

a) How long does it take to drop to the floor? [0.404s]

b) How far, horizontally, from the table edge does the marble strike the floor? [8.08cm]

3. A stunt car rolls off the side of a cliff at 17.0 m/s (horizontal velocity). The height of the cliff is 102 m.

a) Calculate the time it takes the car to reach the ground. [4.56s]

b) How far, horizontally, from the edge of the cliff does the car hit the ground? [77.5m]

c) Calculate the vertical speed of the car just before it hits the ground. [44.7m/s[down]]

d) Calculate the resultant speed of the car just before it hits the ground. [47.8m/s[down]]

4. A ball rolls horizontally off a track with a speed of 7.00 m/s. It has a range of 2.90m.

a) Calculate the time of flight of the ball. [0.410s]

b) Calculate the height of the track. [0.841m]

5. A ball rolls horizontally off the top of a building with a speed of 4.8 m/s. It has a range of 19.5 m.

a) Calculate the time of flight of the ball. [4.1s]

b) Calculate the height of the building. [82m tall]

6. A shopping basket rolls off the side of a cliff at 12 m/s (horizontal velocity). It has a range of 41 m.

a) Calculate the time it takes the cart to reach the ground.[3.4s]

b) Calculate the height of the cliff. [57m]

c) Calculate the vertical speed of the cart just before it hits the ground. [33m/s[down]]

d) Calculate the resultant velocity of the cart.[35m/s[down]]

7. An arrow is fired horizontally from a height of 6.20 m. It has a range of 52.4 m.

a) Calculate the time of flight of the arrow. [1.13s]

b) Calculate the initial horizontal velocity of the arrow. [46.4m/s]

8. A plane is travelling at 87.4 m/s north at an altitude of 0.760 km. It is dropping an object onto a target.

a) Calculate the time it takes for the object to reach the target. [12.5s]

b) At what position relative to the target should the drop be made?[1092m[S]]

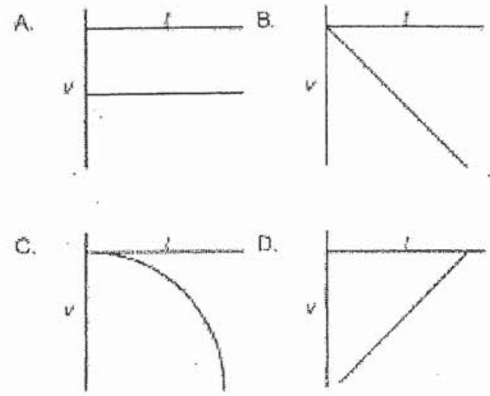
9. Jenny is standing on the edge of a 135 m tall cliff. She throws a ball horizontally at a velocity of 11.4 m/s to see how far it will go. Unfortunately, she hits the tail feather of an eagle (but does not hurt it!) which is 24.0 m away from the cliff.

a) How high above the ground is the eagle flying? [113m high]

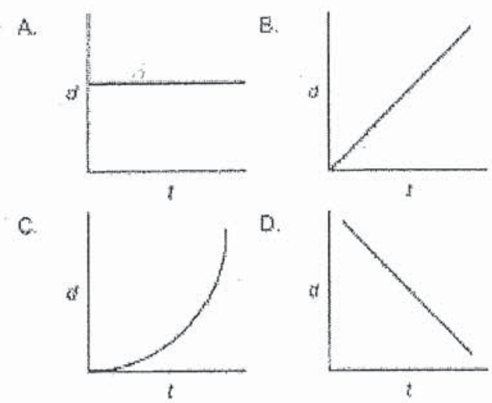
Physics 11 – Kinematics Test Review

Topics- Scalar vs. Vector, v=d/t, P-T graphs, V-T graphs, Acceleration (horizontal and vertical)

1. Which of these graphs best represents a velocity-time graph for an object travelling south and slowing down?



2. Which of the graphs best represents a displacement-time graph for a car travelling north at a constant velocity?

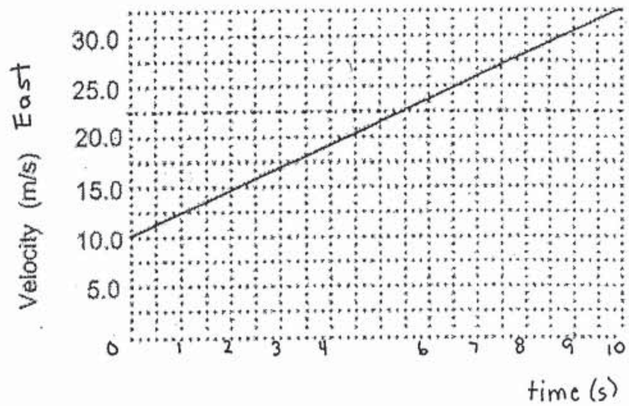


3. A lion runs across the savannah at an average velocity of 2.20 m/s north for 2.0 min, and then runs at an average velocity of 3.40 m/s south for 45 s when it spots a gazelle. What is the average velocity of the lion during its total time of travel?

4. What is the velocity of the object at 4.5 s?

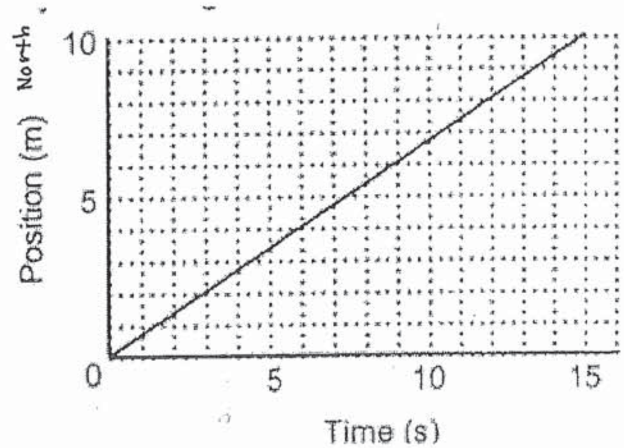
What is the acceleration of the object at 4.5 s?

What is the displacement of the object at 4.5 s?



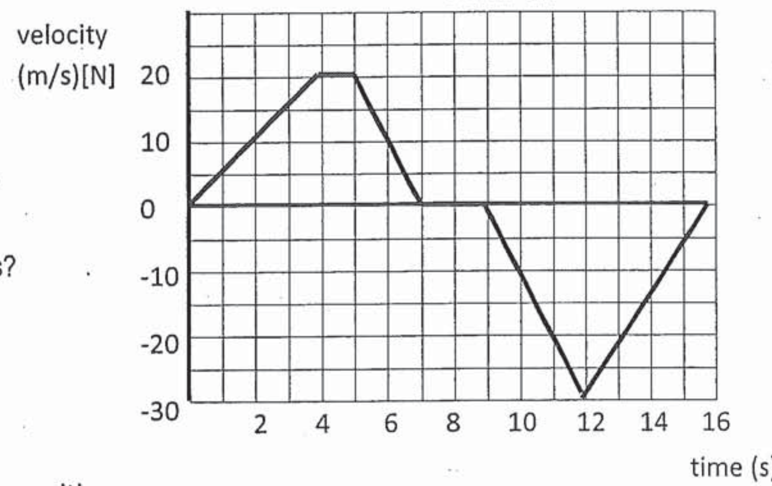
5. What direction is this object travelling?

What is the velocity of this object at 10 s?



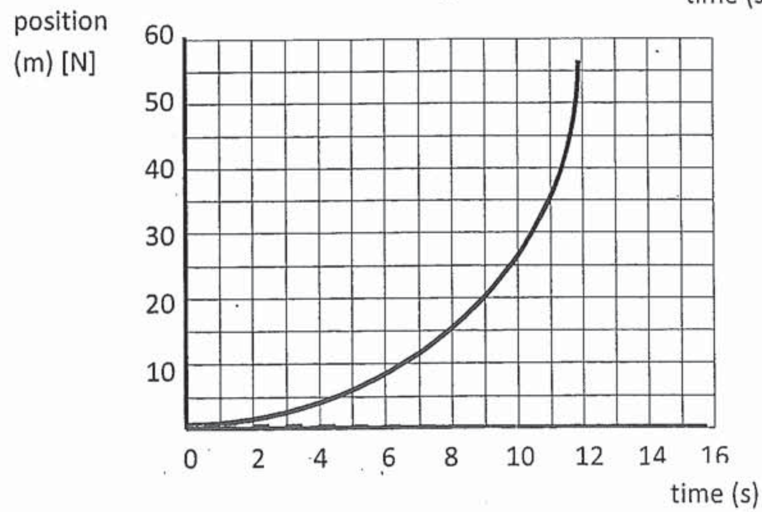
6. What is the distance travelled by the object between 0s and 16s?

What is the displacement of the object between 0s and 16s?



7. What is the instantaneous velocity at 10 s?

What is the average velocity between 0 and 10s?



8. An object accelerates uniformly from rest at a rate of 3.55 m/s^2 east. How long (time) was the object travelling for when a velocity of 14.5 m/s was reached? *Draw the correct diagram and show all work.*

9. An object uniformly accelerates from 14.0 m/s north to 22.0 m/s north. What is the rate of acceleration if the displacement during this time was 55.0 m? *Draw the correct diagram and show all work.*

10. A rock is dropped from the window of the school. If the rock takes 3.25 s to reach the ground, what was the velocity of the rock when it reached the ground? *Draw the correct diagram and show all work.*

11. An object is thrown vertically downward. If the object hits the ground with a velocity of 14.0 m/s and it fell for 0.650 s, at what velocity was the object released? *Draw the correct diagram and show all work.*

12. An object accelerates uniformly from rest for 8.7 s. What was the velocity of the object at 8.7 s if the displacement was 27.0 m west? *Draw the correct diagram and show all work.*

13. A penny is thrown vertically downward and takes 1.2 s to reach the ground. If it travels 6.5 m before reaching the ground, what is its velocity when it strikes the ground? *Draw the correct diagram and show all work.*

14. On a straight track, a cart travels with a constant velocity of 3.5 m/s for 8.0 s. It then uniformly accelerates to a final velocity of 14.6 m/s in 5.5 s. Calculate the total distance travelled by the cart. *Draw the correct diagram and show all work.*

15. An car travels 220 m east and, turns and travels 120 m south. Finally it turns east again and travels another 220m east. What is the total displacement of the car? *Draw the correct diagram and show all work.*

16. A parachute, descending at a constant speed of 2.2 m/s, releases an attached crate 195 m above the ground. *Draw the correct diagram and show all work.*

a) How much time does it take the parachute to reach the ground?

b) How much time does it take the crate to reach the ground?

1) D 2) B **3) 0.67 m/s [N] 4) 20 m/s [E], 2.2 m/s² [E], 68 m [E] 5) north, 0.67 m/s [N] 6) 185m, 25m [S]**

7) 7.0 m/s [N], 2.5 m/s [S] 8) 4.08 s 9) 2.62 m/s² [N] 10) 31.9 m/s[down] 11) -7.63 m/s [W] 12) 6.2 m/s [W]

13) 12 m/s [down] 14) 78 m 15) 456 m [SE] 16) 89 s, 6.1 s

Two Directional Motion (1-D Kinematics)

Problems:

1. A stone is thrown vertically upward with an initial velocity of 25.2 m/s. Calculate the displacement (height) of this stone when it is at a velocity of 17.0 m/s down.

2. A stone is thrown upward off a 230m high cliff at a velocity of 15.0 m/s. Calculate the velocity of this object when it reaches the ground.

3. A stone is thrown vertically upward with an initial velocity of 11 m/s. Calculate the time the stone is in the air.

4. A ball is rolled up a constant slope with an initial velocity of 12.0 m/s. If the ball's displacement is 0.500 m up the slope after 3.60 s, what is the velocity of the ball at this time?

5. A baseball is thrown upward into the air with an initial velocity of 20 m/s.

a) Find the height and time elapsed as the ball reaches the maximum height.

b) How long is the ball in the air before it returns to the thrower's hand?

c) What is the velocity of the ball when it returns to the thrower's hand?

d) At what time does the ball pass a point 8.0m above the thrower's hand?

Kinematics
Lessons
Key

UNIFORM ACCELERATED MOTION

Lesson 3

PHYSICS 11

SUMMARY OF FORMULAS

	$\vec{v}_o$	$\vec{v}_f$	$\vec{a}$	$\vec{d}$	t
$\vec{a} = \dfrac{\vec{v}_f - \vec{v}_o}{t}$	√	√	√		√
$\vec{d} = \left(\dfrac{\vec{v}_f + \vec{v}_o}{2}\right)t$	√	√		√	√
$\vec{d} = \vec{v}_o t + \dfrac{1}{2}\vec{a}t^2$	√		√	√	√
$\vec{v}_f^{\,2} = \vec{v}_o^{\,2} + 2\vec{a}\vec{d}$	√	√	√	√	

We know that the formula for <u>average velocity</u> is when dealing with uniform motion (<u>constant velocity</u>):

$$\vec{V}_{av} = \frac{\vec{d}}{t}$$

We can also find the <u>average velocity</u> when dealing with uniform <u>accelerated</u> motion with:

$$\vec{V}_{av} = \frac{\vec{V}_o + \vec{V}_F}{t}$$

<u>Example Problems</u>:

1. An object that is initially travelling at a velocity of 7.0 m/s east accelerates uniformly to a velocity of 22.0 m/s east in a time of 1.7 s. Calculate the acceleration of the object. Draw the diagram and then solve the problem.

$\vec{a} = \dfrac{v_f - v_o}{t} = \dfrac{22-7}{1.7} = 8.8\ m/s^2$ east

2. An object accelerates north uniformly from rest in a time of 2.70s. In this time, it travelled 20.0 m. What was the final velocity? Draw the diagram and then solve the problem.

$$d = \left(\frac{v_f + v_o}{2}\right)t = 20m = \left(\frac{v_f + 0}{2}\right)2.70s = \frac{20}{2.70} = \frac{v_f + 0}{2} \quad \therefore v_f = 14.8 m/s$$

3. An object accelerates uniformly from rest. If the acceleration was 2.00 m/s² west, what was the displacement when it reached a velocity of 1.00 x 10² km/hr? Draw the diagram and then solve the problem.

$$100 \frac{km}{hr} \times \frac{1hr}{3600s} \times \frac{1000m}{1km} = 27.\bar{7} m/s = v_f \quad v_o = 0 m/s$$

$$v_f^2 = v_i^2 + 2ad \quad = (27.\bar{7} m/s)^2 = 0 + 2(-2.00)d \quad d = -193 m$$

4. An object accelerates uniformly at a rate of 0.750 m/s² north. This object reaches a velocity of 14.0 m/s north while its displacement was 22.0 m north. What was the initial velocity? Draw the diagram and then solve the problem.

$$v_2^2 = v_1^2 + 2ad$$

$$14^2 = v_1^2 + 2(0.750)22m$$

$$v_1 = \pm\sqrt{163} = 12.8 m/s$$ b/c north. or $-12.8 m/s$

5. A motorcyclist traveling at 14.0 m/s collides with a haystack and is brought to rest in a distance of 4.5 m. What is the acceleration of the motorcycle and rider while being brought to a stop? Draw the diagram and then solve the problem.

$$v_f^2 = v_o^2 + 2ad$$

$$0 = 14^2 + 2(a)(4.5m)$$

$$-196 = 9(a)$$

$$a = -22 m/s^2$$

6. A bullet penetrates 7.0 cm into wood when fired at a speed of 33 m/s. Draw the diagram and then solve the problem.

a) Calculate the acceleration.

$$v_2^2 = v_1^2 + 2ad$$

$$0 = 33^2 + 2(a)(0.07)$$

$$-1089 = 2(a)(0.07)$$

$$a = -7.8 \times 10^3 m/s^2$$

b) Calculate the time taken to stop.

$$d = \left(\frac{v_f + v_o}{2}\right)t \qquad 0.07m = \left(\frac{0 + 33}{2}\right)t$$

$$t = 4.2 \times 10^{-3} s$$

7. An object that is initially travelling at a velocity of 4.0 m/s east accelerates uniformly to a velocity of 16.0 m/s east in a time of 3.7 s. Calculate the acceleration of the object. Draw the diagram and then solve the problem.

$$a = \frac{v_f - v_o}{t} \qquad a = \frac{16 - 4}{3.7} = 3.2 m/s^2$$

ACCELERATION DUE TO GRAVITY

EXAMPLE PROBLEMS:

1. A large steel ball is dropped from a height of 7.00 m above the floor. What is the velocity at which the object will strike the floor?

$v_0 : 0$ $\qquad$ $v_f^2 = v_0^2 + 2ad$

$v_f : x$ $\qquad$ $v_f^2 = 0 + 2(-9.81)(-7.00)$

$a : -9.81 m/s^2$ $\qquad$ $v_f = 11.7 m/s$ down

$d : -7.00$

$\therefore -11.7 m/s$ or $11.7 m/s$ down

2. If you drop your pen from a height of 2.50 m above the floor, how long will it take to fall?

$v_0 : 0$ $\qquad$ $d = v_0 t + \frac{1}{2}at^2$ $\qquad$ $= \sqrt{\frac{2(-2.50)}{(-9.81)}}$

$a : -9.81$ $\qquad$ $d = 0 + \frac{1}{2}at^2$ $\qquad$ $= 0.714 s$

$d : -2.50$

$t = \sqrt{\frac{2d}{a}}$

3. A beach ball is thrown vertically upward from the ground with a speed of 16 m/s.

a) How high does it rise (maximum height)?

$v_0 : 16$ $\qquad$ $v_f^2 = v_0^2 + 2ad$

$v_f : 0$ $\qquad$ $0 = 16^2 + 2(-9.81)d$

$a : -9.81$ $\qquad$ $\therefore d = 13m$

$d : ?$

b) How long will it be airborne?

When it touches the ground, $v = -16 m/s$

$a : -9.81 m/s^2$ $\qquad$ $\therefore a = \frac{v_f - v_0}{t}$ $\qquad$ $-9.81 = \frac{-16 - 16}{t}$

$\therefore t = 3.2619$

c) What is the velocity at the highest point? 0 $\qquad$ $\therefore t = 3.3 s$

d) What should the initial upward velocity of a ball if it just reaches the roof of a house 14 m high?

$v_0 : ?$ $\qquad$ $v_f^2 = v_0^2 + 2ad$

$v_f : 0$ $\qquad$ $0 = v_0^2 + 2(-9.81)(14)$

$a : -9.81$ $\qquad$ $v_0 = 17 m/s$

$d : 14$

$\therefore v_0 = 17 m/s$

4. A paratrooper, descending at a constant speed of 3.0 m/s, accidentally drops his flashlight 150 m above the ground.

a) How much time does it take the paratrooper to reach the ground?

$v = -3.0 \text{ m/s}$

$d = -150 \text{ m}$

$d = vt$

$-150 = -3.0t$

$\therefore t = 50 \text{ s}$

b) How much time does it take the flashlight to reach the ground?

$v_0 = -3.0 \text{ m/s}$

$a = -9.80 \text{ m/s}^2$

$d = -150 \text{ m}$

$t = ?$

$d = v_0 t + \frac{1}{2}at^2$

$-150 = -3t + \frac{1}{2}(-9.80)t^2$

$-150 = -3t - 4.90t^2$

$4.90t^2 + 3t - 150 = 0$

$$t = \frac{-b \pm \sqrt{b^2 - 4ac}}{2(4.90)}$$

$$= \frac{-3 \pm \sqrt{3^2 - 4(4.900)(-150)}}{9.80}$$

$= 5.2 \text{ s}$ or -5.8 s (reject)

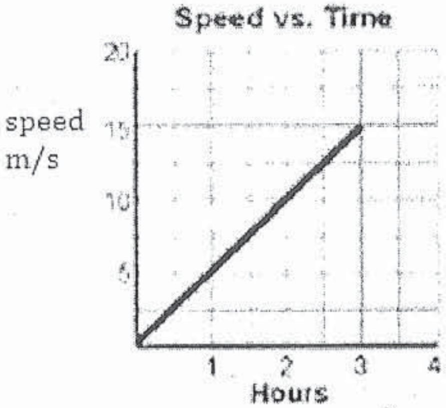
$\therefore t = 5.2 \text{ s}$

extra practice.

Velocity-Time Graphs

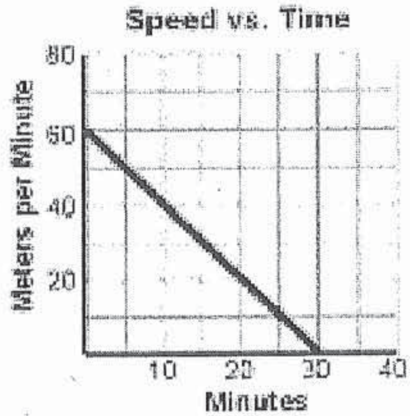
Calculate acceleration from each of these graphs.

1. Graph 1:



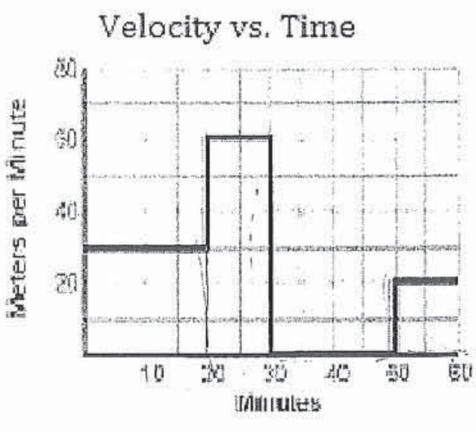
$\frac{v}{t} = a$ $\frac{15\,m/s}{10800\,s} = 1.4 \times 10^{-3}\,m/s^2$

2. Graph 2:



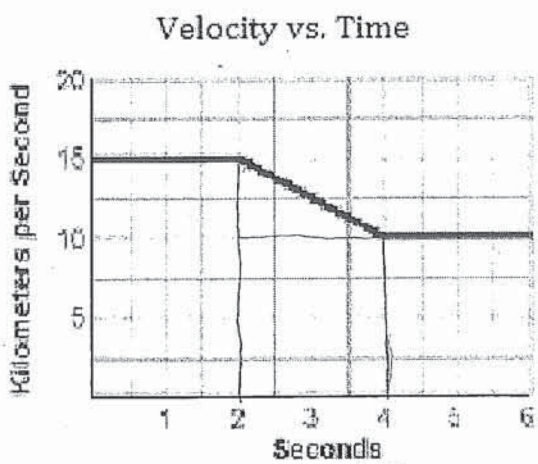
$\frac{v}{t} = a$ $90\,\frac{m}{min} \times \frac{1\,min}{60\,secs} = 0.6\bar{6}\,m/s$ $\therefore \frac{0.6\bar{6}\,m/s}{1800\,s} = 3.7 \times 10^{-4}\,m/s^2$

3. Calculate the displacement at 60 minutes.



30 × 20 = 600
60 × 10 = 600
20 × 10 = 200
1400 m

4. Find the displacement at 6 seconds.



15 × 2 = 30 2 × 10 = 20 ∴ 30 + 20 + 20 + 10 = 80 km
$\frac{4 \times 5}{2} = 10$ 2 × 10 = 20

5. A school bus takes 0.53 hours to reach the school from your house. If the average speed of the bus is 19km/h, what is the displacement of the bus during the trip?

t = 0.53 h v = 19 km/h

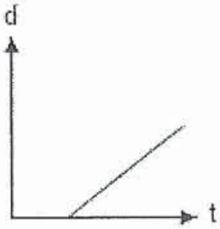
$v = \frac{d}{t} \therefore v \cdot t = d = 19\,km/h \times 0.53 = 10\,km$

6. A girl participating in cross-country spends the afternoon practicing, and ends the practice completely tired from her hard work, despite the fact that her average velocity during the practice was 0.0m/s. Explain how this situation is possible.

Because velocity is a vector, when the girl arrives back to her original position after the run, the overall velocity will end up cancelling out to 0.0 m/s.

Questions #7-12 all have to do with position-time graphs of different riders in a bicycle race. Match each graph with the explanation that makes the most sense, and write the letter of the explanation next to the appropriate number. (Some explanations will not be used.)

B 7.



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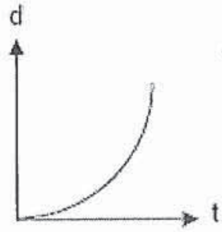
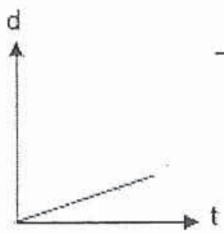
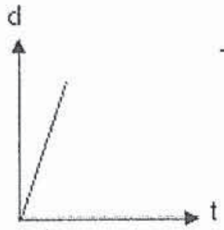


D 9.

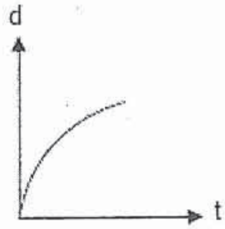
A 10.



E 11.

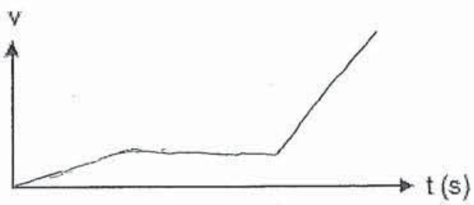


G 12.

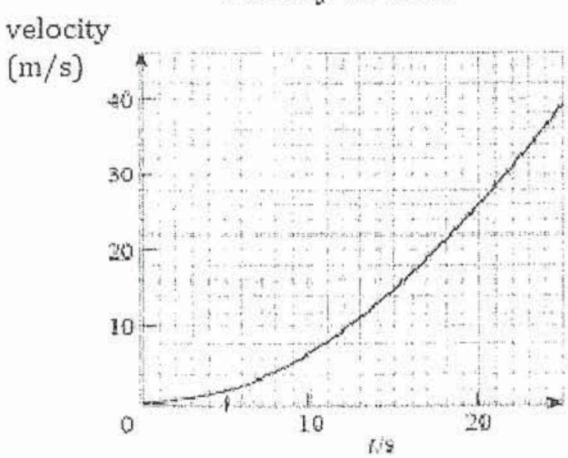


A. slow, constant rate	E. fast constant rate
B. started late	F. gradually increasing speed
C. went back to take a picture	G. gradually decreasing speed
D. spectator standing still	H. leg cramp causes sudden drop in speed

13. An object moves at a slow, constant speed, then sits at rest for a moment, then moves at a new faster, constant speed. Sketch a velocity-time graph of this motion on the given axes.



14. Velocity vs. Time



1. Find the average acceleration between 5 and 20s.[+1.6m/s²]

$a_{ve} = \frac{\Delta V}{\Delta t} = \frac{26-2}{20-5} = \frac{24 m/s}{15 t} = 1.6 \, m/s^2$

PROBLEMS:

1. A stone is thrown vertically upward with an initial velocity of 25.2 m/s. Calculate the displacement (height) of this stone when it is at a velocity of 17.0 m/s down.

v	v_0	t	d	a
−17.0	+25.2		?	−9.80

$v^2 = v_0^2 + 2ad$

$(-17.0)^2 = (25.2)^2 + 2(-9.80)(d)$

$289 = 642.6 + -19.6d$

$-642.6 \quad -642.6$

$-353.6 = -19.6d$

$d = 18.0\text{m}$

2. A stone is thrown upward off a 230m high cliff at a velocity of 15.0 m/s. Calculate the velocity of this object when it reaches the ground.

v	v_0	t	d	a
?	+15.0		−230	−9.80

$v^2 = v_0^2 + 2ad$

$v = \sqrt{(15.0)^2 + 2(-230)(-9.80)}$

225 4508

$= \sqrt{4733} = 68.796 \text{ m/s}$

add this as its down: → (−) 68.8 m/s

3. A stone is thrown vertically upward with an initial velocity of 11 m/s. Calculate the time the stone is in the air.

v	v_0	t	d	a
	11	?	0.0	−9.80

$d = v_0 t + \frac{1}{2}at^2$

$0.0 = 11(t) + \frac{1}{2}(-9.80)t^2$

$-11t = -4.90t^2$

$t = 2.24\text{ s}$

$= 2.2\text{s}$

4. A ball is rolled up a constant slope with an initial velocity of 12.0 m/s. If the ball's displacement is 0.500 m up the slope after 3.60 s, what is the velocity of the ball at this time?

v	v_o	d	t	a
?	12.0	0.500	3.60	

$$d = \left(\frac{v_1 + v_2}{2}\right) t$$

$$2 \times \frac{0.500}{3.60} = \frac{(12.0 + v)}{2}(3.60) \times \frac{2}{3.60}$$

$$0.2777 = 12.0 + v$$

$$\boxed{v = -11.7 \text{ m/s}}$$

5. A baseball is thrown upward into the air with an initial velocity of 20 m/s.

a) Find the height and time elapsed as the ball reaches the maximum height. $\rightarrow v_2 = 0$

v	v_o	a	d	t
0.0	+20	-9.80	a) ?	b) ?

a) $v^2 = v_o^2 + 2ad$

$0^2 = (20)^2 + 2(-9.80)d$

$-400 = -19.6d \quad \therefore \boxed{d = 20.4 \text{ m} = 20 \text{ m}}$

b) $t \times a = \frac{v_2 - v_1}{t} \times \frac{t}{a}$

$t = \frac{v_2 - v_1}{a}$

$= \frac{0.0 - 20.0}{-9.80}$

$\boxed{t = 2.1 \text{ s}}$

b) How long is the ball in the air before it returns to the thrower's hand?

$\boxed{4.2 \text{ s}}$

c) What is the velocity of the ball when it returns to the thrower's hand?

$v_o = +20 \text{ m/s} \quad \therefore v = -20 \text{ m/s}$

d) At what time does the ball pass a point 8.0m above the thrower's hand?

v	v_o	a	d	t
	+20	-9.80	8.0m	?

either use quadratic $d = v_o t + \frac{1}{2}at^2$

OR $v^2 = v_o^2 + 2ad$

$v = \sqrt{20^2 + 2(-9.80)(8.0)}$

$= \sqrt{400 - 156.8} = 15.6 \text{ m/s}$

$\rightarrow a = \frac{v_2 - v_1}{t} \quad t = \frac{v_2 - v_1}{a}$

$t = \frac{16.0 - 20}{-9.80} = \boxed{0.41 \text{ s}}$