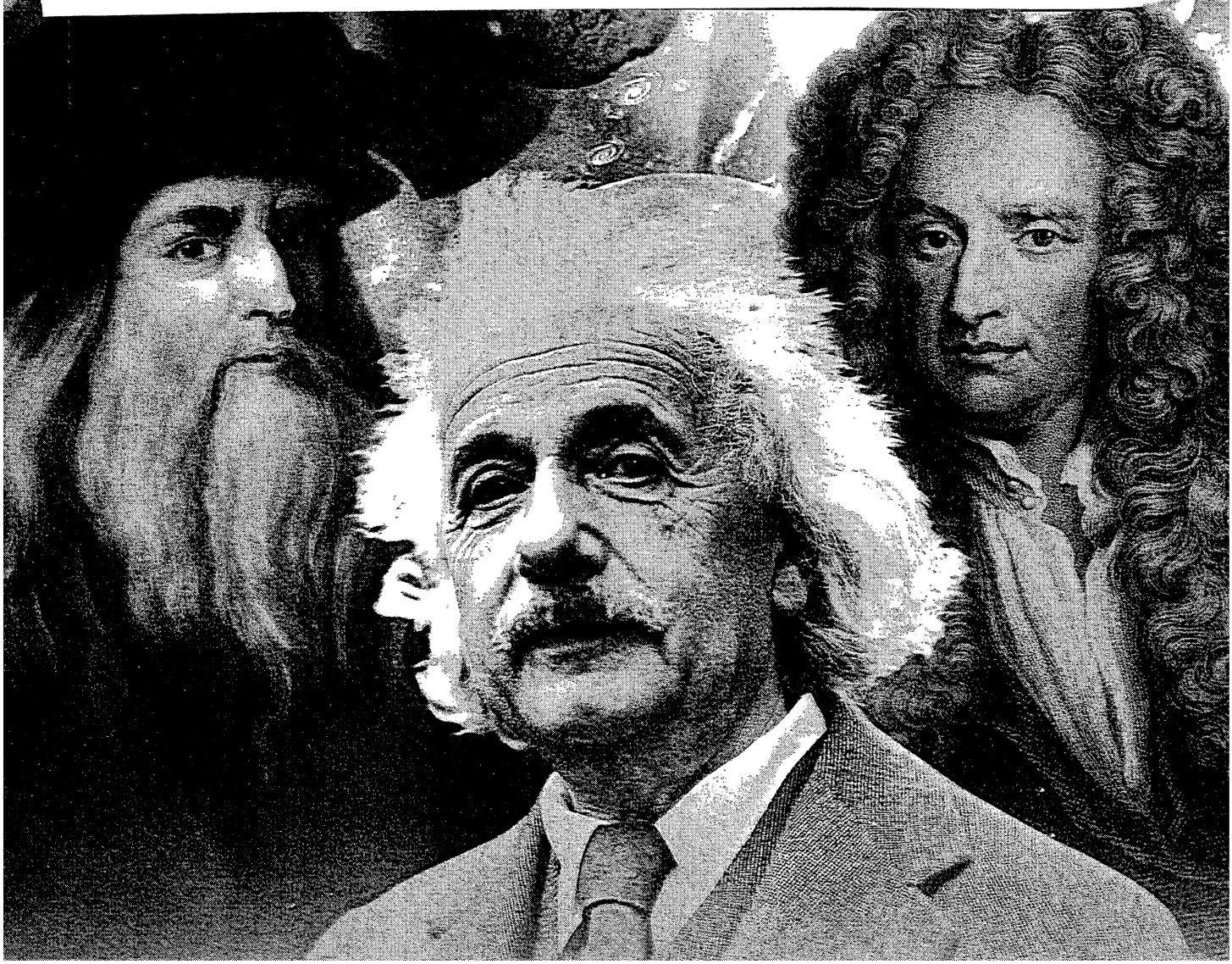
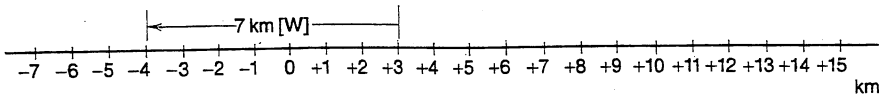
Grade 11 Physics Workbook



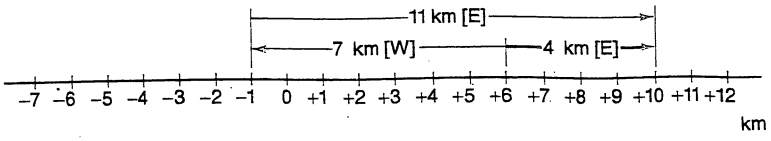
Sample problems 1.2

1. Find the displacement for a driver who started at marker +3 km and ended at marker −4 km.

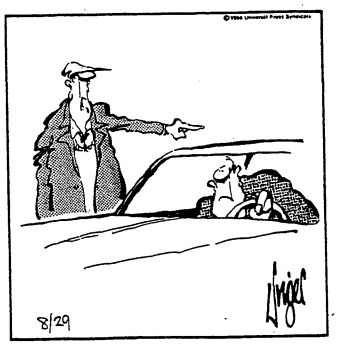


$$\begin{aligned}\overrightarrow{\Delta d} &= \vec{d}_2 - \vec{d}_1 \\ &= -4 \text{ km} - (+3 \text{ km}) \\ &= -4 \text{ km} - 3 \text{ km} \\ &= -7 \text{ km, or } 7 \text{ km[W]}\end{aligned}$$

2. Find the displacement for a cyclist who starts at marker +6 km, moves to −1 km, and then proceeds to marker +10 km.



Remember that the displacement for an interval is simply the difference between the final position and the initial position.



"Four blocks north. If it's not there, eight blocks south."

Therefore, the displacement can be found as follows:

$$\begin{aligned}\overrightarrow{\Delta d} &= \vec{d}_2 - \vec{d}_1 \\ &= +10 \text{ km} - (+6 \text{ km}) \\ &= +10 \text{ km} - 6 \text{ km} \\ &= +4 \text{ km, or } 4 \text{ km[E]}\end{aligned}$$

Practice 1.2 POSITION AND DISPLACEMENT

Use a number line to determine the displacements for the following changes in position:

1. −4 km to +5 km
2. −4 km to −9 km
3. +5 km to +11 km
4. +3 km to −5 km to +7 km
5. +8 km to −8 km
6. +2 km to −3 km to +3 km
7. 4 km[E] to 10 km[W]
8. 23 km[W] to 2 km[W]

1. +9 km
2. −5 km
3. +6 km
4. +4 km
5. −16 km
6. +1 km
7. 14 km[W]
8. 21 km[E]

Sample problems 1.4 UNIFORM MOTION

1. What is the velocity of a runner who runs 96 m[N] in 12 s?

$$\begin{aligned}\overrightarrow{\Delta d} &= 96 \text{ m[N]} \\ \Delta t &= 12 \text{ s} \\ \vec{v} &= ? \\ \vec{v} &= \frac{\overrightarrow{\Delta d}}{\Delta t} \\ &= \frac{96 \text{ m[N]}}{12 \text{ s}} \\ &= 8.0 \text{ m/s[N]}\end{aligned}$$

Therefore the runner has a velocity of 8.0 m/s[N].

2. An air traffic controller notices that a distant aircraft has a velocity of 360 km/h[SW]. What displacement will the plane experience in the 25 s period before the controller checks its position again?

$$\begin{aligned}\vec{v} &= 360 \text{ km/h[SW]} \\ \Delta t &= 25 \text{ s} \\ \overrightarrow{\Delta d} &= ?\end{aligned}$$

Before calculating the displacement, convert the time to hours or the velocity to metres per second. A positive sign is used to indicate the direction [SW].

$$\begin{aligned}\vec{v} &= \frac{+360 \text{ km}}{1.00 \text{ h}} \\ &= \frac{360\,000 \text{ m}}{3600 \text{ s}} \\ &= \frac{+100 \text{ m}}{1 \text{ s}}, \text{ or } 100 \text{ m/s[SW]}\end{aligned}$$

$$\begin{aligned}\overrightarrow{\Delta d} &= \vec{v}\,\Delta t \\ &= (+100 \text{ m/s})(25 \text{ s}) \\ &= +2500 \text{ m, or } 2.5 \text{ km[SW]}\end{aligned}$$

Therefore the plane's displacement is 2.5 km[SW].

1. 2.3×10^2 m/s[N]
2. 2.6×10^2 km[N]
3. 20 m/s[W], or 72 km/h[W]
4. 26 s

Practice

1. What is the velocity of an airplane that experiences a displacement of 580 m[N] in 2.5 s?
2. A car has a velocity of 105 km/h[N]. What is its displacement if it travels at this velocity for 2.5 h?
3. What velocity is required for a truck moving along the highway to experience a displacement of 400 m[W] in a time of 20 s? Express your answer in metres per second and in kilometres per hour.
4. How long would it take a dolphin swimming at 8.0 m/s[E] to travel 208 m[E]?

Sample problem 1.5 SPEED AND VELOCITY

Suppose a car travels with uniform motion from a position of 2.0 km[N] to a position of 20 km[S] in 0.50 h. Find the car's
(a) displacement,
(b) velocity,
(c) distance travelled, and
(d) speed.

In this case (+) will be used for north and (−) will be used for south.

(a) $\vec{d}_1 = +2.0$ km
$\vec{d}_2 = -20$ km
$\Delta t = 0.50$ h
$\overrightarrow{\Delta d} = \vec{d}_2 - \vec{d}_1$
$= -20$ km $-$ (+2.0 km)
$= -22$ km, or 22 km[S]

Therefore, the car's displacement was 22 km[S].

(b) $\vec{v} = \dfrac{\overrightarrow{\Delta d}}{\Delta t}$
$= \dfrac{-22 \text{ km}}{0.5 \text{ h}}$
$= -44$ km/h, or 44 km/h[S]

Therefore, the car's velocity was 44 km/h[S].

(c) The distance travelled by the car is 2.0 km + 20 km, or 22 km.

(d) $v = \dfrac{\Delta d}{\Delta t}$
$= \dfrac{22 \text{ km}}{0.5 \text{ h}}$
$= 44$ km/h

Therefore, the car's speed was 44 km/h .

Note that since the car does not change direction, the distance is the same as the magnitude of the displacement, and the speed is the same as the magnitude of the velocity.

Practice

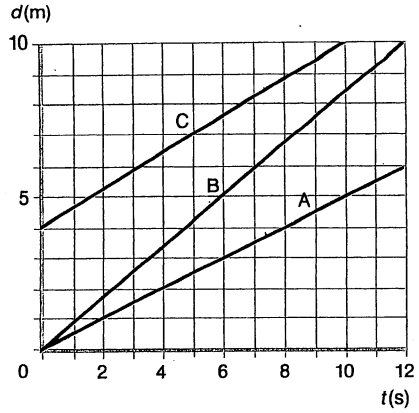
1. What is the speed of a train that travels a distance of 480 km in 8.0 h?
2. An ant moves a distance of 39.4 cm in 7.3 s. What is its speed?
3. A goalkeeper for a hockey team has a reaction time of 0.40 s. A puck travelling at 25 m/s bounces off an opposing player's pads without slowing down. How far away must this occur to give the goalkeeper a chance to make a save?

4. A tourist travelling along a straight section of the TransCanada Highway late at night has the car set on cruise control. At 11:30 p.m. he notices a sign which says "Calgary 250 km". At midnight he notices another sign which reads "Calgary 190 km". If the tourist is located directly east of Calgary on both occasions, find:
   (a) his displacement for the half hour interval stated,
   (b) his velocity, and
   (c) his speed.

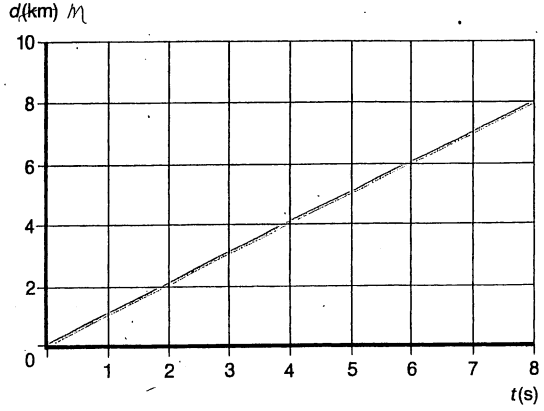
page 8
1. 60 km/h
2. 5.4 cm/s
3. 10 m
4. (a) 60 km[W]
   (b) 120 km/h[W]
   (c) 120 km/h

Practice 1.6 GRAPHING MOTION

1. This position-time graph shows the positions of several runners at various times. Determine the velocity of each of the runners.



2. This position-time graph represents the motion of a dog running along a railway track.



(a) What is the dog's position at 4.0 s?
(b) What is the dog's displacement between 2.0 s and 5.0 s?
(c) What is the velocity of the dog?

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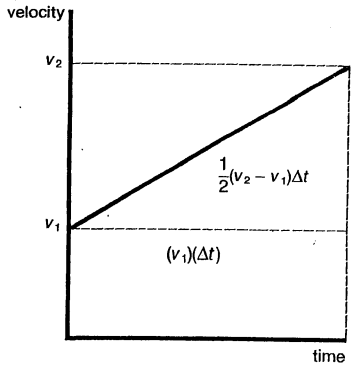


In Chapter 1 we found that the average velocity may be calculated by using the expression

$$\vec{v}_{av} = \frac{\overrightarrow{\Delta d}}{\Delta t}$$

Note also that

$$\overrightarrow{\Delta d} = \vec{v}_{av} \Delta t$$

If the acceleration is uniform, and only if it is uniform, the following expression is also valid.

$$\vec{v}_{av} = \frac{\vec{v}_1 + \vec{v}_2}{2}$$

A-2

Sample problems 2.1

1. A car accelerates at a constant rate from 40 km/h[E] to 90 km/h[E] in 5.0 s. What is its acceleration?

$$\vec{a} = \frac{\vec{v}_2 - \vec{v}_1}{\Delta t}$$
$$= \frac{90 \text{ km/h[E]} - 40 \text{ km/h[E]}}{5.0 \text{ s}}$$
$$= \frac{50 \text{ km/h[E]}}{5.0 \text{ s}}$$
$$= 10 \text{ (km/h)/s[E]}$$

The car is accelerating at a uniform rate of 10 (km/h)/s[E]. This means that its velocity increases by 10 km/h[E] each second.

Practice

1. A cyclist accelerates from 5.0 m/s[S] to 15 m/s[S] in 4.0 s. What is his acceleration?
2. A jet plane accelerates from rest to 750 km/h in 2.2 min. What is its average acceleration?
3. A runner accelerates from 0.52 m/s to 0.78 m/s in 0.50 s. What is her acceleration?
4. A driver entering the outskirts of a city takes her foot off the accelerator so that her car slows down from 90 km/h to 50 km/h in 10 s. Find the car's average acceleration.
5. A boy rolls a ball up a hill giving it a velocity of 4.5 m/s[N]. Five seconds later the ball is rolling down the hill with a velocity of 1.5 m/s[S]. What is the ball's acceleration?

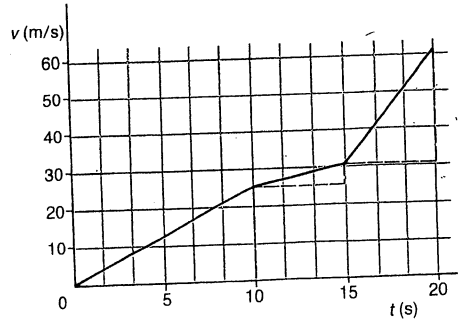
1. 2.5 m/s²[S]
2. 3.4×10^2 (km/h)/min
3. 0.52 m/s²
4. −4.0 (km/h)/s
5. 1.2 m/s²[S]

Sample problem 2.2 (v-t) GRAPHS AND $\vec{a}$

1. Use the velocity-time graph in the margin to determine this object's acceleration for
   (a) the first 10 s of its motion, and
   (b) the time interval of 10 s to 15 s.

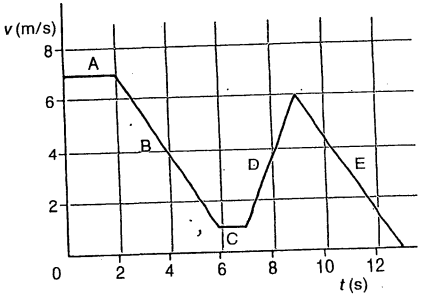
a)
$$\vec{\Delta v} = 25 \text{ m/s} - 0 \text{ m/s}$$
$$= 25 \text{ m/s}$$
$$\Delta t = 10 \text{ s}$$
$$\vec{a} = \frac{\vec{\Delta v}}{\Delta t}$$
$$= \frac{25 \text{ m/s}}{10 \text{ s}}$$
$$= 2.5 \text{ m/s}^2$$

(b)
$$\vec{a} = \frac{\vec{\Delta v}}{\Delta t}$$
$$= \frac{30 \text{ m/s} - 25 \text{ m/s}}{5.0 \text{ s}}$$
$$= 1.0 \text{ m/s}^2$$

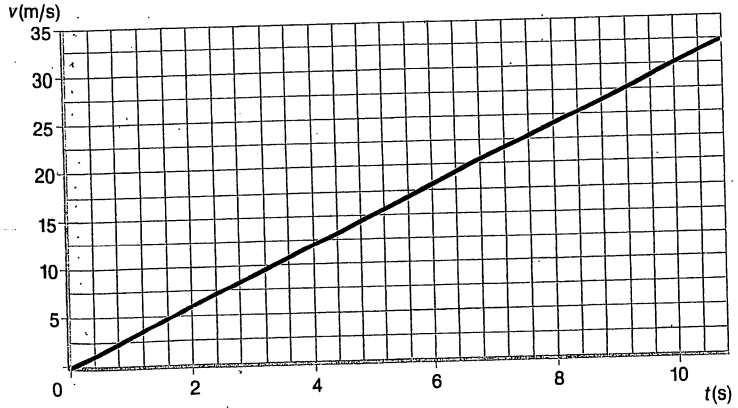


Practice 2.3

1. For each lettered section on the graph in the margin, calculate the acceleration of the object.
2. Construct a velocity-time graph for
   (a) a car that starts from rest and accelerates at 8 (km/h)/s for 10 s.
   (b) a runner who runs at a constant velocity of 8.0 m/s for 5.0 s, then slows down at a uniform rate and stops in 2.0 s.
3. Copy the graph below in your notebook. On the same axes, construct a line showing the motion of an object with an acceleration
   (a) two times that of the original line on the graph, and
   (b) half that of the original line on the graph.

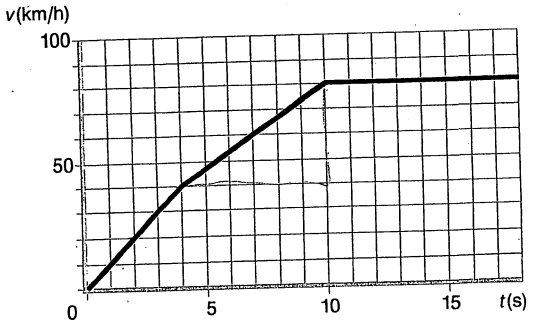


1. A 0, B −1.5 m/s², C 0, D 2.5 m/s², E −1.5 m/s²



Practice

1. Calculate the acceleration of the object in the sample problem for the time interval 15 s to 20 s.
2. The graph below shows the motion of a car accelerating from a stop at an intersection.
   (a) How fast was the car moving at the following times: 2.0 s, 4.0 s, 15.0 s?
   (b) Determine the acceleration during the following time intervals: 0 to 4.0 s, 4.0 s to 10.0 s, 10.0 s to 15.0 s.



1. 6 m/s²
2. (a) 20 km/h, 40 km/h, 80 km/h
(b) 10 (km/h)/s, 6.7 (km/h)/s, 0

Sample problems 2.5 EQUATIONS

1. A ball rolling down a hill at 4.0 m/s accelerates at 2.0 m/s². What is its velocity 5.0 s later?

To solve motion problems of this type, it helps to summarize the given information in algebraic form. This summary is shown below.

$$v_1 = 4.0 \text{ m/s}$$
$$a = 2.0 \text{ m/s}^2$$
$$\Delta t = 5.0 \text{ s}$$
$$v_2 = ?$$

To solve the problem we can use one of the equations developed for uniform acceleration. It must contain v_2 as the only variable for which the value is not known. The equation which will provide the solution is

$$v_2 = v_1 + a\Delta t$$

Substituting the values into this equation yields

$$\begin{aligned} v_2 &= 4.0 \text{ m/s} + (2.0 \text{ m/s}^2)(5.0 \text{ s}) \\ &= 4.0 \text{ m/s} + 10 \text{ m/s} \\ &= 14 \text{ m/s} \end{aligned}$$

The ball reaches a velocity of 14 m/s in 5.0 s.

The car had a velocity of 4.0 m/s when it started to accelerate.

4. A ball rolls at an initial velocity of 4.0 m/s up a hill. Five seconds later it is rolling down the hill at 6.0 m/s². Find the following:
   (a) its acceleration.
   (b) its displacement at 5.0 s.

(a) Assuming "up" the hill is positive and "down" the hill is negative, then:

$$v_1 = 4.0 \text{ m/s}$$
$$v_2 = -6.0 \text{ m/s}$$
$$\Delta t = 5.0 \text{ s}$$
$$a = ?$$
$$a = \frac{v_2 - v_1}{\Delta t}$$
$$= \frac{-6.0 \text{ m/s} - 4.0 \text{ m/s}}{5.0 \text{ s}}$$
$$= \frac{-10 \text{ m/s}}{5.0 \text{ s}}$$
$$= -2.0 \text{ m/s}^2, \text{ or } 2.0 \text{ m/s}^2\text{[down]}$$

The ball has an acceleration of 2.0 m/s² [down].

(b) We can use the information from (a) to solve this question.

$$\Delta d = \frac{(v_1 + v_2)\Delta t}{2}$$
$$= \frac{(4.0 \text{ m/s} + (-6.0 \text{ m/s}))}{2}(5.0 \text{ s})$$
$$= \frac{(-2.0 \text{ m/s})}{2}(5.0 \text{ s})$$
$$= -5.0 \text{ m, or } 5.0 \text{ m[down]}$$

The ball is 5.0 m down the hill from its starting point after 5.0 s.

Practice

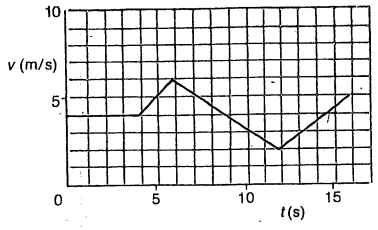
1. A horse running at 4.0 m/s accelerates uniformly to a velocity of 18 m/s in 4.0 s. What is its displacement during the 4.0 s time interval?
2. A car acquires a velocity of 32 m/s by accelerating at 4.0 m/s² for 5.0 s. What was its initial velocity?
3. A ball falling from rest is located 45 m below its starting point 3.0 s later. Assuming that its acceleration is uniform, what is its value?
4. The brakes are applied on a car travelling at 30 m/s. The car stops in 3.0 s.
   (a) What is its displacement during this time?
   (b) What is the car's average acceleration?
5. How long will it take a truck travelling at 35 m/s to stop if it accelerates at −5.0 m/s²?
6. A landing plane accelerates at −1.5 m/s² for 1.0 min until it stops. How fast was it going before it started to slow down?
7. A car hitting a tree loses 40.0 m/s in 0.100 s. What is its acceleration?
8. A skier accelerates at 1.20 m/s² down an icy slope, starting from 2.0 m/s. What is her displacement in
   (a) 5.0 s? (b) 10.0 s? (c) 15.0 s?
9. What is the acceleration of an object that accelerates steadily from rest, travelling 10 m in 10 s?
10. How long does it take an airplane, accelerating from rest at 5.0 m/s² to travel a distance of 360 m?
11. A rocket is moving forward at 120 m/s. When its retro rockets are fired it experiences an acceleration of −8.0 m/s². If these rockets are fired for 20 s, determine:
    (a) the final velocity of the rocket.
    (b) the displacement of the rocket.

1. 44 m
2. 12 m/s
3. 10 m/s²
4. (a) 45 m (b) −10 m/s²
5. 7.0 s
6. 90 m/s
7. −400 m/s²
8. (a) 25 m (b) 80 m (c) 165 m
9. 0.20 m/s²
10. 12 s
11. −40 m/s, 8.0 × 10² m

A-12

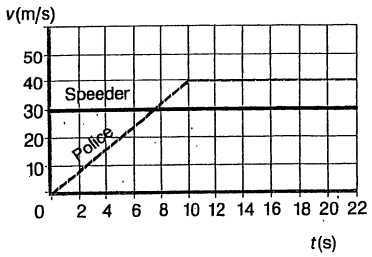
REVIEW

9. A dragster accelerates from 0 to 90 m/s in 6.0 s. What is its acceleration?
10. The driver of a truck moving at 18 m/s applies the brakes and stops it in 4.0 s. What is the truck's acceleration?
11. A car accelerates from rest to 8.8 m/s in 3.0 s in first gear, then changes into second gear. After 8.0 s from the start of the trip, the car reaches 22.0 m/s and is shifted into third gear. After 7.0 s in third gear, it reaches 41.8 m/s. Calculate the average acceleration in each gear.
12. Draw the velocity-time graph of the motion of a bus that accelerates from rest at 1.0 m/s² for 6.0 s, then continues on at a constant speed for 6.0 s, then accelerates at −2.0 m/s² for 3.0 s.
13. An arrow shot straight up into the air at 50 m/s accelerates at −10 m/s². Draw a velocity-time graph of this motion from the time the arrow leaves the bow until it reaches maximum height.
14. Here is the velocity-time graph of a trip on a bicycle.



(a) How fast is the bicycle moving at each of the following times?
(i) 4.0 s (ii) 6.0 s (iii) 10.0 s (iv) 12.0 s
(b) What is the acceleration of the bicycle at each of these times?
(i) 2.0 s (ii) 5.0 s (iii) 7.0 s (iv) 14.0 s
(c) What is the bicycle's displacement at the following times?
(i) 4.0 s (ii) 12.0 s (iii) 16.0 s

15. A speeder passes a stationary police cruiser. The police officer spots the speeder and pursues him. The graph in the margin shows the velocity of the two vehicles as a function of time. Assume that at time $t = 0$ s the speeder passes the stationary cruiser.



(a) What is the police cruiser's acceleration?
(b) What is the displacement for each of the two vehicles at 10 s?
(c) How far apart are the two vehicles at 10 s?
(d) At what time will the police cruiser pass the speeder?
16. A rocket accelerates at 40 m/s² for 3.0 min. What is its change in velocity?
17. How long will it take a falling rock, accelerating at 10 m/s², to reach 112 m/s, if it starts from rest?
18. A car enters a tunnel at 24 m/s and accelerates steadily at 2.0 m/s². At what velocity does it leave the tunnel, 8.0 s later?
19. A motorcycle stuntman accelerates from rest to a maximum velocity of 35.2 m/s at the top of the take-off ramp, then swoops up and over 20 cars. Calculate how long it takes him to accelerate, at an acceleration of 8.8 m/s².
20. Two runners accelerate uniformly from rest at 1.40 m/s² for 8.00 s.
(a) What is their final velocity?
(b) What is their average velocity?
(c) How far do they travel?

21. A ball accelerates steadily down a ramp, starting from rest. It goes 2.0 m in 4.0 s.
(a) What is its average velocity?
(b) What is its final velocity?
(c) What is its acceleration?
22. A car accelerates from rest at 6.00 m/s². What distance does it travel between 10.0 s and 15.0 s?
23. A skier accelerates steadily down a hill from 3.50 m/s to 11.40 m/s in 4.20 s.
(a) What is the average velocity for the interval?
(b) What is the displacement?
24. Runner A runs at 6.0 m/s for 10 s. Runner B accelerates from 4.0 m/s to 10.0 m/s, steadily, in 10 s.
(a) How far does runner A go?
(b) How far does runner B go?
(c) How much farther does runner B travel than runner A?
25. A motorcycle moving at 12 m/s[W] accelerates at 6.0 m/s²[W]. How long will it take to experience a displacement of 63 m[W]?

26. A baseball player catches a ball moving at 24 m/s. Upon striking the player's glove, the ball moves 12 cm as it comes to rest. Assume uniform acceleration in answering these questions:
(a) How long did it take the ball to come to rest after striking the glove?
(b) What was the ball's acceleration as it came to rest?
27. A ball pushed along a slope has an initial velocity of 10 m/s[up]. Its acceleration is 2.0 m/s²[down].
(a) After its release, what is the ball's velocity at: 2.0 s, 5.0 s, 8.0 s?
(b) What is the ball's displacement at: 2.0 s, 5.0 s, 8.0 s?
28. An astronaut on the moon throws a wrench straight up at 4.0 m/s. Three seconds later it falls downwards at a velocity of 0.8 m/s.
(a) What was the acceleration of the wrench after it left the astronaut's hand?
(b) How high above the point from which it was released was the wrench at 3.0 s?
(c) How long would it take the wrench to return to the position from which it was thrown?
29. At the Los Alamos National Laboratory in New Mexico protons are accelerated from rest to a velocity of 2.5×10^8 m/s in an accelerator that is 0.80 km long.
(a) What is the protons' average acceleration?
(b) How long do the protons take to travel the length of the accelerator?
30. Jack and Jill ran down the hill. Both started from rest and accelerated steadily. Jack accelerated at 0.25 m/s² and Jill at 0.30 m/s². After running for 20 s, Jill fell down.
(a) How far did Jill get before she fell?
(b) How far had Jack travelled when Jill fell?
(c) How fast was Jack running when Jill fell?
(d) How long (to the nearest second) was it after Jill fell that Jack ran into her and broke his crown?

Velocity and Acceleration

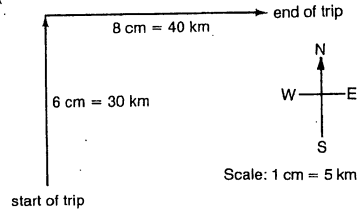
9. 15 m/s²
10. −4.5 m/s²
11. 2.9 m/s², 2.6 m/s², 2.8 m/s²
14. (a) (i) 4.0 m/s (ii) 6.0 m/s
(iii) 3.1 m/s (iv) 2.0 m/s
(b) (i) 0 (ii) 1.0 m/s²
(iii) −0.67 m/s² (iv) 0.75 m/s²
(c) (i) 16 m (ii) 50 m (iii) 64 m
15. (a) 4.0 m/s²
(b) 300 m, 200 m
(c) 100 m
(d) 20 s
16. 7.2×10^3 m/s
17. 11 s
18. 40 m/s
19. 4.0 s
20. (a) 11.2 m/s
(b) 5.60 m/s
(c) 44.8 m
21. (a) 0.50 m/s
(b) 1.0 m/s
(c) 0.25 m/s²
22. 475 m
23. (a) 7.45 m/s
(b) 31.3 m
24. (a) 60 m
(b) 70 m
(c) 10 m
25. 3.0
26. (a) 0.01 s
(b) -2.4×10^3 m/s
27. (a) 6.0 m/s, 0, −6.0 m/s
(b) 16 m, 25 m, 16 m
28. (a) 1.6 m/s²[down]
(b) 4.8 m
(c) 5.0 s
29. (a) 3.9×10^{13} m/s²
(b) 6.4×10^{-6} s
30. (a) 60 m
(b) 50 m
(c) 5.0 m/s
(d) 2 s
31. (a) 0.50 m/s²
(b) 22 s
(c) 1.7 m/s²
(d) 28 s, 50 s
(e) 0 s

3.2 Vector Addition

If you went on a trip of 30 km[N], followed by a trip of 40 km[E], the sum of the distances you travelled is 70 km.

However, you would not be 70 km from your starting point. Your displacement from that point may be obtained from a vector diagram by "adding" together the two displacement vectors. The first step is to set up a proper scale and a set of directions.

(a) To add vectors, draw both of them to the same scale and connect them tip to tail.



(b) Now, draw a vector from the tail of the first to the tip of the second displacement vector. This represents the total displacement. Measure the length and direction of this vector and calculate the displacement, using the scale. The total displacement is 50 km[N53°E].

The magnitude of this displacement may be written as $|\overrightarrow{\Delta d}| = 50$ km. Note that its value is different from the distance travelled.

If we have more than two vectors, the procedure for addition is the same. The vectors are drawn to scale and are added tip to tail, one after the other. The vector sum is the vector drawn from the tail of the first to the tip of the last vector.

Practice

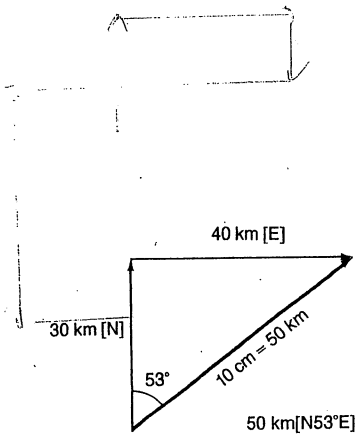
1. What is the total displacement of a trip in which a person travels 10 km[N] and then 24 km[E]?
2. What is the total displacement of a trip of 50 km[W] followed by a trip of ~~100~~ km[N30°E]?
3. What is the total displacement of a trip of 100 km[N30°E] followed by a trip of 50 km[W]? What is significant about the result? What is significant about the result when compared to the answer for question 2?
4. A small boy goes to a store 2 blocks[N], 3 blocks[E], 1 block[S], 5 blocks[W], 4 blocks[S], and then 2 blocks[E]. What is the total displacement of his trip?

Here $\overrightarrow{\Delta d}_1$ = 30 km[N]
$\overrightarrow{\Delta d}_2$ = 40 km[E]

The total displacement of these two, $\overrightarrow{\Delta d}_{total}$, is shown as:

$$\overrightarrow{\Delta d}_3 = \overrightarrow{\Delta d}_1 + \overrightarrow{\Delta d}_2$$

This equation tells you to add the two vectors together using a vector diagram, and not just to add their magnitudes together.



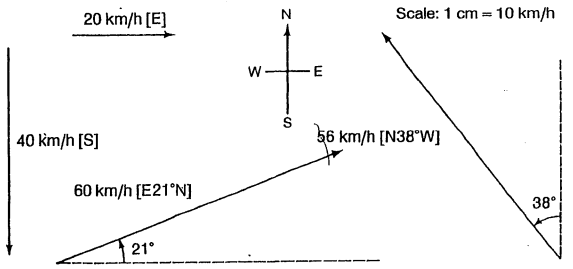
1. 26 km[N67°E]
2. 87 km[N]
4. 3 blocks[S]

	Speed	Velocity
Symbol	v	$\vec{v}$
Example	25 km/h	100 km/h[W]

3.3 Speed and Velocity

You know from our work in Chapter 1 that the speed of a car, measured on its speedometer, is a scalar quantity. The car could be going east or west, uphill or downhill. The speedometer does not indicate direction. You will also recall that the combination of speed and direction is called velocity, a vector quantity.

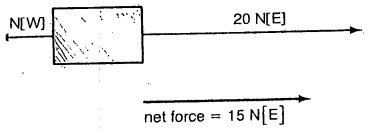
Velocity vectors can also be represented by arrows. Look at these vector diagrams. All that is needed is a proper scale and a north-pointing arrow to establish direction. Velocity vectors are added together in exactly the same way as displacement vectors. As you will see, the vector diagrams that are produced are useful in a wide variety of boat, balloon, and airplane navigation problems.



3.4 Velocity Vectors in One Dimension

Let's consider a situation that involves velocity vectors in one dimension.

A passenger walking inside a moving train has different velocities relative to the train and the ground. On a train moving at 20 km/h[E], seated passengers are at rest relative to the train, but are moving at 20 km/h[E] relative to the ground. If a passenger on this train walks towards the front of the train at a normal pace, say, 3 km/h, the passenger's velocity is 3 km/h[E] relative to the train and 23 km/h[E] relative to the ground. The passenger's velocity relative to the ground is found by adding his or her velocity relative to the train and the train's velocity relative to the ground.



As indicated earlier, you can solve vector addition problems in one of two ways:

1. **by using an accurately drawn scale diagram;**
2. **by using a sketch roughly to scale, and then using algebra and trigonometry.**

For Sample problem 3 we could determine the answer as follows:

$$(30\ \text{N})^2 + (40\ \text{N})^2 = (F_{net})^2$$
$$900\ \text{N}^2 + 1600\ \text{N}^2 = (F_{net})^2$$
$$2500\ \text{N}^2 = (F_{net})^2$$
$$F_{net} = 50\ \text{N}$$
$$\tan\theta = \frac{40\ \text{N}}{30\ \text{N}}$$
$$\tan\theta = 1.33$$
$$\theta = 53^\circ$$

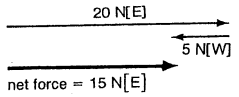
Therefore the resultant force is 50 N[N53°E].

2. Two children pull in opposite directions on a toy. One pulls with a force of 20 N[E] and the other pulls with a force of 5 N[W]. What is the net force acting on the toy?

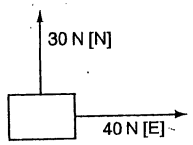
Since the forces again act along the same line, the resultant force may be calculated as follows:

$$\vec{F}_{net} = \vec{F}_1 + \vec{F}_2$$
$$= 20\ \text{N[E]} + 5\ \text{N[W]}$$
$$= 20\ \text{N[E]} - 5\ \text{N[E]} \quad \text{(where east is positive)}$$
$$= 15\ \text{N[E]}$$

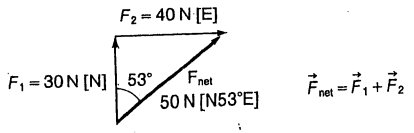
Again, however, the result may also be obtained by using a vector diagram.



3. Let's consider an example in which the forces do not act along the same line. A trunk is acted upon by forces of 30 N[N] and 40 N[E]. Find the unbalanced force acting on the trunk.



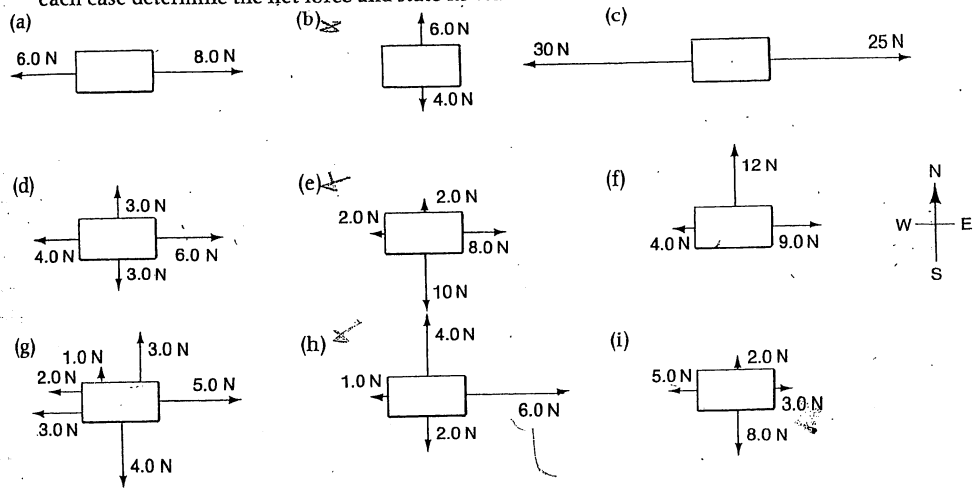
This time a mathematical solution obtained by inspecting the problem is much more difficult. The addition of the vectors, however, proceeds as before.



Using a scale diagram or the Pythagorean Theorem, the resultant force has a magnitude of 50 N. Its direction is determined by finding the angle at the tail of the net force vector. Since the value of this angle is 53°, a complete description of the resulting net force is 50 N[N53°E].

Practice

1. The diagrams below show forces acting on various objects. For each case determine the net force and state its value.



2. (a) A child is pulling a wagon along a sidewalk. At a particular instant the child is exerting a horizontal force of 10 N[W] on the wagon. Frictional resistance amounts to 8.0 N. Draw a diagram of the wagon showing both forces acting on it. Determine the unbalanced force acting on the wagon.
   (b) There are at least two additional forces acting on the wagon described in (a). Add them to your diagram and write a sentence describing each of them.
3. Two children playing on the beach are pulling on an inner tube. One exerts a force of 45 N[N]. The other exerts a force of 60 N[SW]. What is the net force acting on the tube?

1. (a) 2.0 N[E]
   (b) 2.0 N[N]
   (c) 5 N[W]
   (d) 2.0 N[E]
   (e) 10 N[S37°E]
   (f) 13 N[E67°N]
   (g) 0
   (h) 5.4 N[E22°N]
   (i) 6.3 N[W72°S]
3. 42.5 N[N87°W]

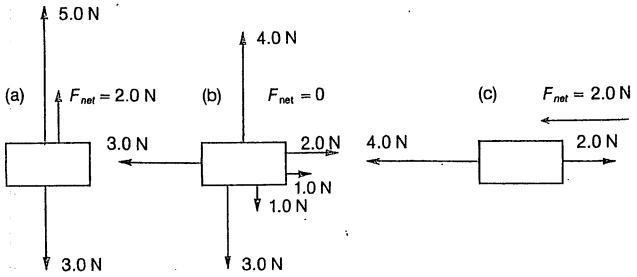
A-15

Free Body Diagrams 6.2

When analyzing many problems, it is frequently helpful to draw a diagram on which all the forces acting on an object are shown as force vectors. As we explained briefly in Chapter 5, such a diagram is called a free body diagram.

Sample problems

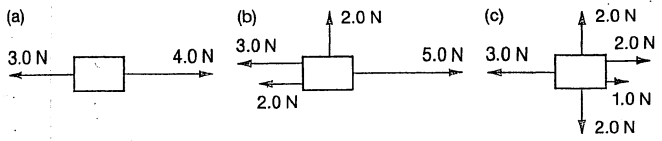
For each of the following, determine the net, or unbalanced, force. State which objects could be at rest or could be moving with a uniform velocity.



Only object (b) could be at rest or moving with uniform velocity because it is the only one in which the unbalanced force is 0.

Practice

1. Determine the net force for each of the following. State in which case the object could be at rest.



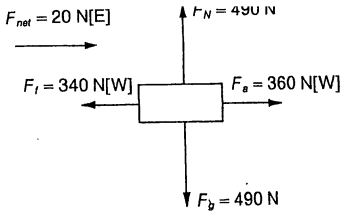
2. A jet plane is travelling at a constant speed in a straight line in level flight. What does this tell you about the forces acting on it? Draw a free body diagram of the plane, showing all the forces acting on it.
3. A woman pushes a refrigerator across the floor at a steady speed of 20 cm/s. If she has to push with a horizontal force of 400 N to keep it moving, is the force of friction on the refrigerator (a) more than 400 N? (b) less than 400 N? (c) 400 N? Explain your answer.
4. A 1200 kg boat accelerates steadily at 0.05 m/s² in a straight line. Are the forces on this boat balanced or unbalanced?

Sample problems

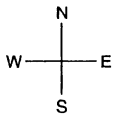
1. What is the acceleration of a 70 kg skater, acted upon by an unbalanced force of 161 N[W]?

$$\vec{a} = \frac{\vec{F}_{net}}{m}$$
$$= \frac{161 \text{ N[W]}}{70 \text{ kg}}$$
$$= 2.3 \text{ m/s}^2\text{[W]}$$

Therefore the skater accelerates at 2.3 m/s²[W].



The normal force, F_N, and the force of gravity, F_g, are also shown in this diagram. If you are certain that the forces acting on the object in a vertical direction balance each other, it is acceptable to omit them from the free body diagram.



Note that a wiggly arrow is used to denote the acceleration vector in the free body diagram. We have done this to avoid confusion when both a force vector and an acceleration vector are needed in a free body diagram. We will use this convention in this text. Also note that F_{net} is shown unattached to the wagon. This is because it represents the vector sum of all contact forces acting on the wagon.

1. (a) 1.0 N[E]
(b) 2.0 N[N]
(c) 0
3. 400 N

1. 4.0 m/s²
2. 0.25 kg
3. 7.5×10^4 N
4. 18 N
5. 5.0 m/s²

2. A worker applies a force of 360 N[E] on a trunk of mass 50 kg. If frictional resistance amounts to 340 N, what is the resulting acceleration of the trunk?

It's often useful to construct a free body diagram to solve problems of this type. We can draw a rectangle to represent the trunk. The 360 N applied force is shown as a vector acting on the trunk in an easterly direction. Since the frictional resistance opposes the motion, it acts as an applied force in the opposite direction. The information can then be summarized as follows:

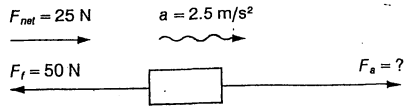
$$\vec{F}_{net} = 20 \text{ N[E]}$$
$$m = 50 \text{ kg}$$
$$\vec{a} = \frac{\vec{F}_{net}}{m}$$
$$= \frac{20 \text{ N[E]}}{50 \text{ kg}}$$
$$= 0.40 \text{ m/s}^2\text{[E]}$$

Therefore the trunk will accelerate at 0.40 m/s²[E].

3. A boy pushes horizontally on a 10 kg wagon and it accelerates at 2.5 m/s². If frictional forces total 50 N, what force must he be exerting on it? When no direction is specified for the acceleration or the net force, you can assume that they are in the positive direction.

$$m = 10 \text{ kg}$$
$$\vec{a} = 2.5 \text{ m/s}^2$$
$$\vec{F}_{net} = m\vec{a}$$
$$= (10 \text{ kg})\ (2.5 \text{ m/s}^2)$$
$$= 25 \text{ N}$$

The net force is 25 N. We can use a free body diagram to help determine the force that the boy applies.



or, expressed mathematically

$$\vec{F}_{net} = \vec{F}_a + \vec{F}_f \quad \text{where } \vec{F}_a \text{ is the applied force and}$$
$$25 \text{ N} = \vec{F}_a - 50 \text{ N} \quad \vec{F}_f \text{ is the force of friction}$$
$$\vec{F}_a = 75 \text{ N}$$

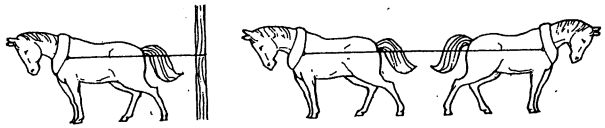
To produce the required unbalanced force of 25 N, the boy must exert a force of 75 N in the direction in which the wagon is accelerating.

Practice

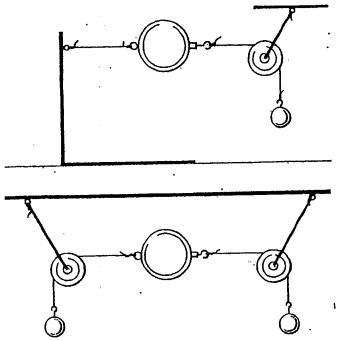
1. The net force on a 5.0 kg bowling ball is 20 N. What is its acceleration?
2. A baseball hit by a bat with an average force of 1000 N accelerates at 4.0×10^3 m/s². What is the ball's mass?
3. What unbalanced force is needed to accelerate a 3.0×10^4 kg spacecraft at 2.5 m/s²?
4. How much applied force is needed to accelerate a 2.0 kg block of wood at 4.0 m/s² along a rough table, against a 10 N force of friction?
5. A jet plane pilot decides to accelerate horizontally. If the thrust of the engines is increased to 50 000 N at a time when the air resistance (or drag) acting on the 4000 kg plane amounts to 30 000 N, what will be the plane's acceleration?

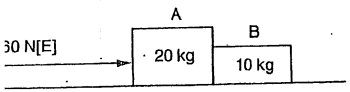
Practice

1. Write a description of the reaction force for each of the following forces.
   (a) When a football player kicks a football, his foot exerts a force of 500 N[N] on the ball.
   (b) A book pushes down on a desk with a force of 25 N.
   (c) A crane exerts a force of 6000 N[up] on a steel girder that it is lifting.
   (d) A gun exerts a force of 1000 N[E] on a bullet when the bullet is fired.
   (e) The Earth pulls down on an apple with a force of 5 N.
2. A skydiver of mass 60 kg attempting a publicity stunt jumps from the edge of the CN tower.
   (a) Draw a free body diagram for the skydiver in the instant after he jumps. (Assume that at this point his velocity is near zero so that air resistance is still negligible.)
   (b) Write a description for the force acting on him.
   (c) Describe the reaction force for the force described in (b).
3. An astronaut is stranded 10 m from a space station that is orbiting the Earth. Explain what she could do to return to the space station. Assume that the jet pack used to propel her is out of fuel, but that it can be removed without endangering her.
4. A man wants to test a rope. He ties one end to a telephone pole and the other to a horse. The horse pulls as hard as it can, but is not strong enough to break the rope. The man replaces the telephone pole with a second horse of identical strength. Assume the two horses pull in opposite directions as hard as they can. Will the rope break? Explain your answer.



The following demonstration may help you understand question 4. All the masses are identical. Before you set up the demonstration, predict what the reading on each spring scale will be.





An Action-Reaction Problem

In the following illustration of Newton's Third Law we can calculate the size of the action force and reaction force separately.

Consider the situation shown in the diagram in the margin. A force of 60 N[E] acts on a combination of two boxes that are next to each other on a frictionless surface.

Find:
(a) the acceleration of the boxes.
(b) the force exerted by box A on box B.
(c) the force exerted by box B on box A.

(a) To find the acceleration of the boxes, we can simply think of them as being one mass. The free body diagram in the margin shows all the information given in the question.

$$\vec{a} = \frac{\vec{F}_{net}}{m}$$
$$= \frac{60 \text{ N[E]}}{30 \text{ kg}}$$
$$= 2.0 \text{ m/s}^2\text{[E]}$$

Therefore, the system accelerates at 2.0 m/s²[E].

(b) To find the force exerted by A on B, we need to construct a free body diagram for B. (Remember that a free body diagram for an object shows all the forces acting on it.)

Since the force exerted by A on B is the only force acting in a horizontal direction, it must be the unbalanced force.

$$\vec{F}_{net} = m\vec{a}$$
$$= (10 \text{ kg})\ (2.0 \text{ m/s}^2\text{[E]})$$
$$= 20 \text{ N[E]}$$

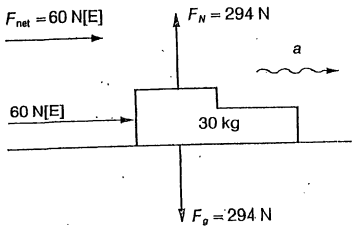
The force exerted by A on B is 20 N[E]. Are you surprised to see that the 60 N exerted on A is not all transferred to B? If you think about it you will realize that this is not possible. If it were, then B would accelerate at 6.0 m/s² instead of at 2.0 m/s².

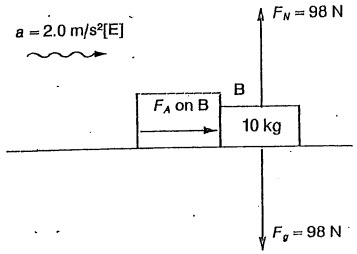
(c) To find the force exerted by B on A, construct a free body diagram for A. We find the net force acting on A first.

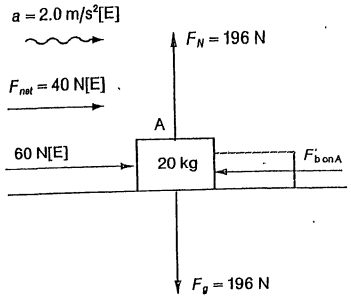
$$\vec{F}_{net} = m\vec{a}$$
$$= (20 \text{ kg})\ (2 \text{ m/s}^2\text{[E]})$$
$$= 40 \text{ N[E]}$$

Since the net force is 40 N[E] and the force being applied on A is 60 N[E], B must be pushing back on A with a force of 20 N[W].

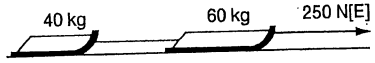
You can see that the answers obtained for (b) and (c) constitute an action-reaction pair. If we changed the masses of A and B and the applied force, we would get different values. We would always find, though, that the force exerted by B on A is *equal* and *opposite* to that exerted by A on B.







This example shows clearly that action and reaction forces act on different bodies.



"Tension" is a word that physicists and engineers use to describe the force exerted by a rope or rigid member that "pulls" on another object. It may also be referred to as a *tensile force*.

1. (a) 2.5 m/s²[E]
   (b) 1.0×10^2 N
2. (a) 2.0 m/s²[E]
   (b) 1.3×10^2 N[E]
   (c) 5.0×10^1 N[E]

Practice

1. Two toboggans are connected by a rope. The first toboggan has a mass of 60 kg and the second has a mass of 40 kg. The two toboggans are pulled by a rope connected to the first toboggan. If the force exerted on the rope is 250 N[E], and friction between the toboggans and the ice can be ignored, find:
   (a) the acceleration of the toboggans.
   (b) the tension in the rope connecting the toboggans.
2. Suppose a third toboggan of mass 25 kg is connected to the second toboggan in question 1. Find:
   (a) the acceleration of the system of three toboggans.
   (b) the force exerted by toboggan one on toboggan two.
   (c) the force exerted by the second toboggan on the last one.

3.5 Velocity Vectors in Two Dimensions

Practice

1. A swimmer jumps into a river and swims straight for the other side at 1.5 km/h[N] relative to the water. There is a current in the river of 2.0 km/h[W]. What is the swimmer's velocity relative to the shore?
2. A conductor in a train travelling at 12.0 km/h[N] walks across the aisle at 5.0 km/h[E] relative to the train. What is his velocity relative to the ground?
3. A mouse is crawling inside a cart which is being pushed across the deck of a moving boat. The mouse is moving at 0.5 m/s[E] relative to the cart. The cart is travelling at 1.2 m/s[E] relative to the surface of the boat, and the boat is moving at 4.0 m/s[N] relative to the water. What is the velocity of the mouse relative to the water?

3.6 Airplane Navigation Problems

Vector diagrams are useful in solving a wide variety of navigation problems. The principles that we established for swimmers and boats in the previous section are also valid for aircraft. Flying objects are affected by the wind in the same way that floating or swimming objects are carried downstream by the current.

An airplane that can fly at 250 km/h in still air will only travel over the ground at 200 km/h if flying into a 50 km/h wind. Flying in the same direction as this wind will increase the plane's ground velocity to 300 km/h.

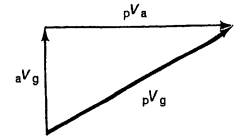
The plane's velocity relative to the ground is found by adding the plane's velocity relative to the air and the velocity of the air relative to the ground. Pilots have special names for each of these vectors, as shown in the table.

Symbol	Velocity vector	Speed	Direction
$\vec{p}\vec{v}_a$	plane's velocity relative to air	air speed	heading
$\vec{a}\vec{v}_g$	wind velocity (velocity of air relative to ground)	wind speed	wind direction
$\vec{p}\vec{v}_g$	plane's velocity relative to ground	ground speed	track

The relationship between the vectors is stated as:

$$\vec{p}\vec{v}_g = \vec{p}\vec{v}_a + \vec{a}\vec{v}_g$$

Air navigation problems are solved with vector diagrams in exactly the same way as river-crossing problems. The vectors in this section, however, will not always be at right angles to one another as they were in the previous examples.



$$\vec{a}\vec{V}_g + \vec{p}\vec{V}_a = \vec{p}\vec{V}_g$$

Use this vector relationship stated above to solve these sample problems.

Sample problems

1. An airplane has a velocity of 240 km/h[E] relative to the air. An 80 km/h wind is blowing towards the south. Calculate the velocity of the airplane relative to the ground.

We can state that:

$$\vec{p}\vec{v}_g = \vec{p}\vec{v}_a + \vec{a}\vec{v}_g$$
$$= 240 \text{ km/h[E]} + 80 \text{ km/h[S]}$$

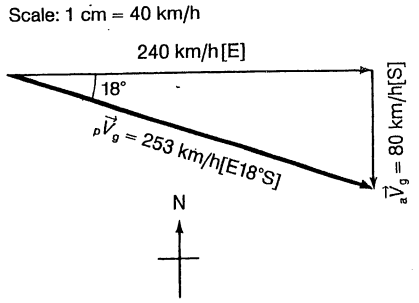
Since the vectors to be added do not both lie along the same straight line a vector diagram is required. The vector diagram in the margin shows the solution. The tail of the second vector is placed at the tip of the first. The resultant vector then goes from the tail of the first vector to the tip of the second. Measuring this vector gives the magnitude of the resultant velocity and the angle at its tail gives its direction.

The velocity of the plane relative to the ground is 253 km/h[E18°S].

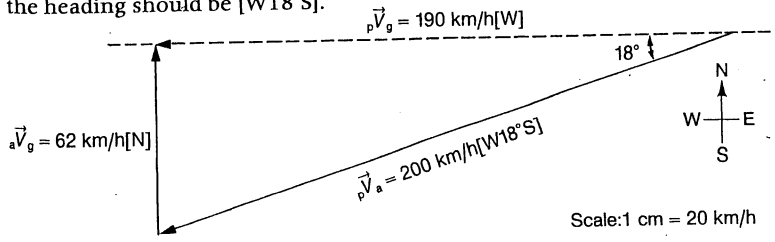
2. A pilot wants to fly due west. The airplane has a velocity of 200 km/h relative to the air. There is a 62 km/h wind blowing to the north. Determine the heading the pilot should use and the velocity of the plane relative to the ground.

Since the wind will tend to carry the plane northward the pilot must aim slightly towards the south to compensate for the wind. Draw a dotted line to represent the east→west direction. Draw the wind velocity vector $\vec{a}\vec{v}_g$ so that its tip is located on the dotted line. Then draw a second vector $\vec{p}\vec{v}_a$ 10 cm long (200 km/h) so that its tip is on the tail of the first vector and its tail is on the dotted line. The resultant vector, $\vec{p}\vec{v}_g$, goes from the tail of $\vec{p}\vec{v}_a$ to the tip of $\vec{a}\vec{v}_g$.

By measurement we see that the resultant velocity is 190 km/h and the heading should be [W18°S].



A wind of 20 km/h[N] is called a "south wind" because it blows from the south.



Practice

1. A plane has a velocity of 300 km/h relative to the air. If the pilot points the plane straight north, when there is a wind of 80 km/h blowing towards the west, what will the resultant velocity of the plane be?

Review Scientific Notation and Conversions

1. Write the following in scientific notation.

a) 604 b) 403 c) 710 000 d) 0.050 4
e) 0.003 8 f) 0.043 g) 0.000 031 h) 4.3

2. Write the following in standard notation

a) 8.1×10^{3} b) 6.1×10^{7} c) 7.6×10^{5} d) 9.3×10^{1}
e) 4.7×10^{-4} f) 2.3×10^{-2} g) 4.7×10^{-7} h) 4.03×10^{-1}

3. Convert these to S.I. units

a) 6700 g b) 45000 mm c) 8.9×10^{4} mm d) 5.3×10^{6} g
e) 2.7×10^{4} min f) 4.3×10^{3} h g) 34.5 cm h) 3.45 cm

4. Convert the following

a) The length of a car from 2.8 m to mm

b) The thickness of a textbook from 35 mm to m

c) The radius of the Earth from 6.37×10^{6} m to km

d) One day, 24 h to min.

e) One year, 3.156×10^{7} s to h

f) One day, 24 h to s

5. To convert km/s to m/s you must

_____

To convert m/s to km/s you must

_____

6. Calculate the following

a) 56 km/h = _____ m/s
b) 4.3×10^{3} m/s = _____ km/h
c) 7.3×10^{4} km/h = _____ m/s
d) 2.4×10^{2} m/s = _____ km/h

Activity Graphing

Rules

1. Make sure you put a title on the graph eg. Temperature vs. Time
2. Label the axis and include units eg. Time (s)
3. Mark points on the graph clearly
4. If the graph looks like a straight line draw a line of best fit with a ruler. If the graph looks like a curve draw a smooth curve freehand
5. Make the graph as large as possible, use the whole paper

Exercise: Late at night the Toronto airport detected an unidentified flying object (UFO) on its radar. This UFO is flying over the airport toward the CN Tower. The data given is its distance from the airport from the time of its first sighting.

Time (min.)	Distance (km)
0	0.0
5	2.7
11	7.6
22	16.9
27	17.8
37	22.4
42	27.7
53	32.0

a) Graph the data and draw a line of best fit. Put time on the x-axis.
b) Calculate the slope of this line with units.
c) How long will it take the UFO to reach the CN Tower if the tower is 35 km from the airport? Extrapolate to find this.
d) How far is it to Maple Leaf Gardens if the UFO takes 40 min. to reach it? Interpolate to find this

Kinematics Review of Motion

Scalars are quantities that have a magnitude but no direction. An example of a scalar is: Distance = 6km.
Other examples of scalars are: _____ = _____, and _____ = _____.

Vectors are quantities that have magnitude and direction. An example of a vector is: Displacement = 6km[East].
Other examples of vectors are: _____ = _____, and _____ = _____.

Distance is a scalar and has no direction. If you walk 6 m then 5m then 8m, you have walked a total of 19m. It does not matter which way you were walking. Example: You walk 3 m [East] then 5 m [South] then 4 m [North]. The total distance is 3 + 5 + 4 = 12m

Displacement is a vector and it really matters which way you were moving. Example: You walk 3 m [East] then 5 m [West] then 4 m [East]. If East is positive then your displacement is + 3 + (-5) + 4 = + 2m = 2m [East].

Questions: Fill in the missing information given the following displacements.

A	B	C	D	Distance (m)	Displacement (m)
6m [East]	8m [West]	3m [East]	4m [East]		
4m [East]	21m [West]	2m [East]	9m [West]		
2m [Forward]	5m [Backward]	8m [Backward]	6m [Forward]		
6m [Left]	9m [Left]	12m [Right]	17m [Left]		
15m [Up]	12m [Down]	21m [Down]	8m [Up]		

Speed is the rate at which things move and **uses distance in the calculation**. We say "sports cars move fast", "snails move slow" and sometimes "Albert is not too swift". Speed tells us the distance an object travels in an interval of time. To find speed, use the formula

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

where v stands for the speed of the object, d the ***distance*** it travels and t the time taken to do so.

Example

A truck travels 20 m in 15 s. Find its speed.

Solution

d = 20 m
t = 15 s

v = d / t
= 20 m / 15 s
= 1.3 m/s

The speed of the truck is 1.3 m/s.

Check Units

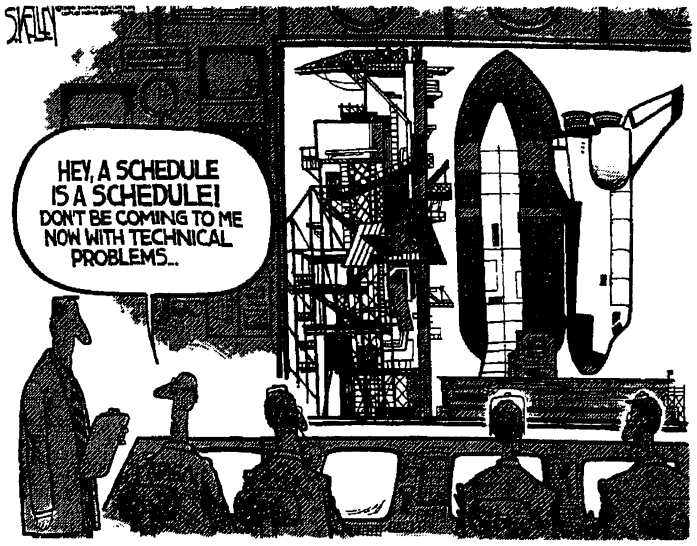
d =
t =
V =

Questions:

1. A hurricane blew a car a distance of 10 m in 2 s into the front window of a store. Find the car's average speed as it crashed through. (5 m/s)

2. An unidentified flying object travelled 15.5 km across the sky in 3 seconds. Find its speed in km/h and m/s. (5170 m/s, 18 600 km/h)

3. An eighteen-wheel Mac truck was thundering down the 401 at 130 km/h.
   a) In one hour, how far did it travel? (130 km/h)
   b) In one minute, how far did it travel? (2.2 km)
   c) In one second, how far did it travel? (36 m)



4. In his pod racer, young Aniken travels at 200 m/s. He made a complete lap of the racing course in 90 s. What is the distance around the course in metres? (18 000m)

5. If you were the 6 Million Dollar Man (an 80's TV show character) who could run at 145 km/h, how long would it take for you to run from Toronto to Montreal, a distance of 450 km? (3.1 h)

6. You camped out all night and scored some tickets to the latest Ricky Martin concert, but unfortunately your seat is high up in the stands, 400 m away from the stage. The sound from the stage travels through the air at 332 m/s. How long will it take the sound to reach your ears? (1.2 s)

7. Light travels at 3.0×10^8 m/s. A quasar, one of the most distant objects from us in the universe, is 1.2×10^{26} m away from earth. How long ago was the light that we see today emitted from the quasar? Give your answer in years. (1.27×10^5 years)

Velocity is similar to speed but has a direction. Velocity **uses displacement in the calculation**.

To find velocity, use the formula $\vec{v} = \frac{\vec{d}}{t}$

Where v stands for the velocity of the object, d the ***displacement*** and t the time taken to do so.

Example

A truck travels 20 m [East] then 40m [West] in 15 s. Find its velocity.

Solution

Displacement = + 20 – 40 = -20m = 20m [West]

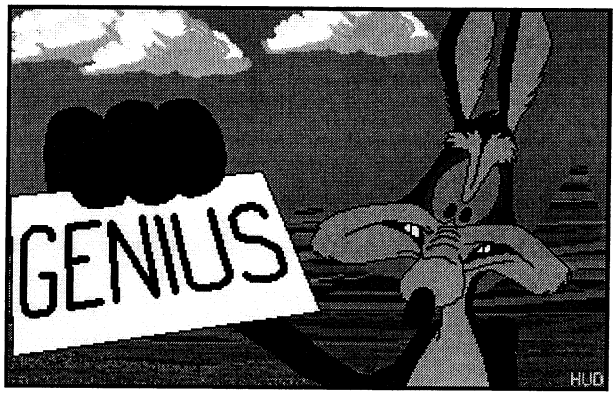
t = 15 s

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

= 20 m / 15 s

= 1.3 m/s [West]

The velocity of the truck is 1.3 m/s [West]



Questions: Fill in the missing information given the displacements and time.

A	B	C	Time (s)	Total Distance (m)	Total Displacement (m)	Speed (m/s)	Velocity (m/s)
8m [East]	10m [West]	12m [East]	5				
12m [East]	14m [West]	11m [East]	3				
7m [Forward]	12m [Backward]	14m [Backward]	4				
13m [Left]	9m [Left]	6m [Right]	8				
11m [Up]	21m [Down]	5m [Down]	3				

1) A jogger is out for her usual run. She travels north covering 3.0 km in 30 minutes. She then turns south for another 6.0 km in 50 minutes.

a. Calculate the average speed for her run in kilometres per hour. Answer: _____

b. Calculate the average velocity for her run in kilometre per hour. Answer: _____

2) A cross-country skier skis 150 m [E] in 40 s for the first part of his activity and then skis 500 m [W] in 350 s in the second part of his activity.

a. What is his velocity in the first part of his activity? Answer: _____

b. What is his velocity in the second part of his activity? Answer: _____

c. What is his average velocity for the whole activity? Answer: _____

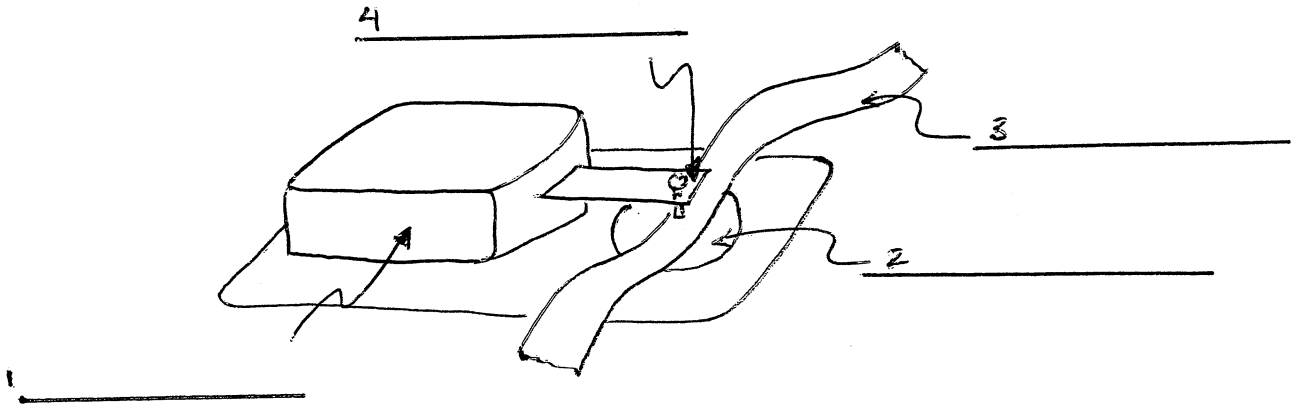
Graphing Uniform Motion

Name _____

Purpose: To learn how to use a dot timer and plot a distance time graph

Procedure:

1. Set up the apparatus as shown in the diagram and label the parts of the equipment in the diagram.



2. Cut a piece of the timer tape 1m long.
3. Pull the tape through the timer at a slow speed.
4. Make a second timer tape at a fast speed.
5. For both tapes, mark with a pencil the start at a place where the dots start to be uniformly spaced. Label it t=0s.
6. Mark every 6th dot on the tape and label them t=0.1s t=0.2s etc.
7. Fill in the chart below with the distance time information from the tapes. NOTE: always measure the distances from the start of the tape.

Time (s)	0.0	0.1	0.2	0.3	0.4	0.5	0.6
Distance SLOW (cm)							
Distance FAST (cm)							

8. On graph paper make a distance vs. time graph with the distance on the *y-axis* and time on the *x-axis*. Put both sets of data on the same graph.
9. Draw a line of best fit through the data and indicate which line is the slow speed and which is the fast speed.
10. Calculate the slope of each line. Slow speed = _____ (include units)
    Fast speed = _____

Questions:

1. What is the shape of a d-t graph for uniform motion?

2. What does the slope of a d-t graph give us?

3. How can you tell which line represents the faster object by looking at the d-t graph?

Graphing Accelerated Motion: Air Table Lab

Name _____

Purpose: To learn how to get information from d-t, v-t and a-t graphs

Procedure:

1. Set up the apparatus as shown by your teacher.
2. The timer makes a dot on the paper every _____ (include units) so 2 dots = _____ (s)
3. Mark the first dot on the paper and label it t=0s.
4. Using a ruler measure the distance to every second dot from dot t=0s and fill in the chart

Time (s)							
Distance (cm)							

5. On graph paper, draw a distance vs. time graph with the distance on the *y-axis* and time on the *x-axis*. Make sure you label the graph properly.

   Title of graph _____

6. Draw a curve of best fit through the data.
7. What is the shape of a d-t graph of acceleration. _____
8. Calculate the slope of the graph at each time period and enter it into the chart.

Time Units = ( )							
Velocity Units = ( )							

9. Plot a velocity- time graph below with the velocity on the *y-axis* and time on the *x-axis*. Make sure you label the graph properly.

   Title of graph _____

10. Draw a line of best fit on the graph.
11. What is the shape of a v-t graph for accelerated motion? _____
12. Calculate the slope of the graph at any point. (include units)

13. What does the slope represent? _____
14. Calculate the area under the velocity time graph. Include units.

15. Calculate the average velocity for the whole trip by using the area from your velocity-time graph and the total time form this graph.

16. Calculate the slope of the graph at 3 time periods and enter it into the chart. (Yes! they should all be the same number or very close)

Time Units = ( )			
Acceleration Units = ( )			

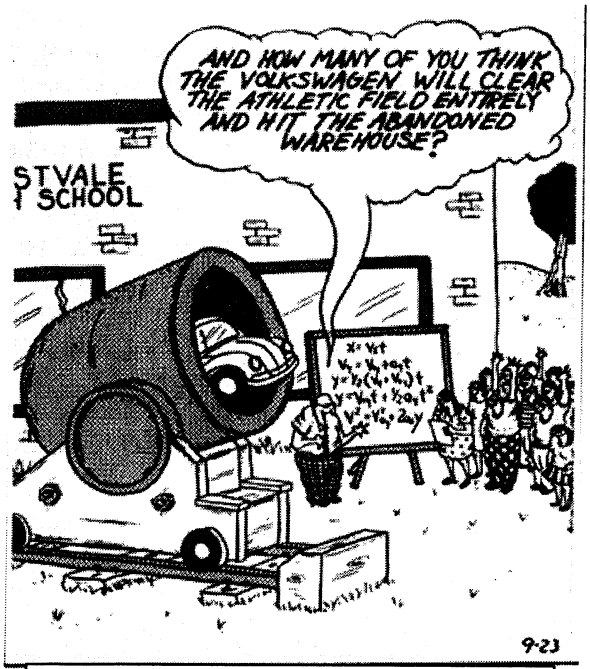
17. Plot an acceleration- time graph below with the acceleration on the *y-axis* and time on the *x-axis*. Make sure you label the graph properly.

Title of graph _____

18. Draw a line of best fit through the graph.
19. What is the shape of an a-t graph for accelerated motion? _____

20. Calculate the area under the acceleration-time graph for the whole time interval for the experiment. Include units.

21. What does the area represent? _____



Thanks to the innovative labs of Mr. Caruana, Physics quickly became Earl Haig's most popular course.

Formula Worksheet

Name _____

The five equations for acceleration are:

1 O'Brian takes his brother's car out for a test drive. The car accelerates at 1.2 m/s^2 from rest position. How far away is he when his brother notices the cars is gone 40 s later? Calculation:

Given:
Find:

Answer =

2 J.R. borrows his dad's plane and starts down the runway at 2 m/s accelerating at 1.5 m/s^2. He accelerates for 1 minute before the plane takes off. How long must the runway be in order for him to take off?

Calculation:

Given:
Find:

Answer =

3 Mitra decides to take up track and field. For her first run she starts at rest and in the first 30 s she manages to get to a speed of 10.8 km/h. How far was her first run?

Calculation:

Given:
Find:

Answer =

4 Shruti also can't bear the thought of being late for her favorite class so she sprints the last 12m. Her acceleration is 2 m/s^2 and she starts at a velocity of 1.5 m/s. What is her velocity when she arrives at class.

Calculation:

Given:
Find:

Answer =

5 Mr. Caruana can't wait to get home from class so when the bell rings he runs out the door at a velocity of 3 m/s. He is so excited about getting out of school he manages to sprint for 5s to a final velocity of 23 m/s!! What was his acceleration?

Calculation:

Given:
Find:

Answer =

6 Omran was walking down the hall at 2 m/s when he decides to sprint to class in order to be on time. He runs the last 22 m. to class accelerating all the way and reaches the class at a final speed of 8 m/s. How long did it take him to get to class?

Calculation:

Given:
Find:

Answer =

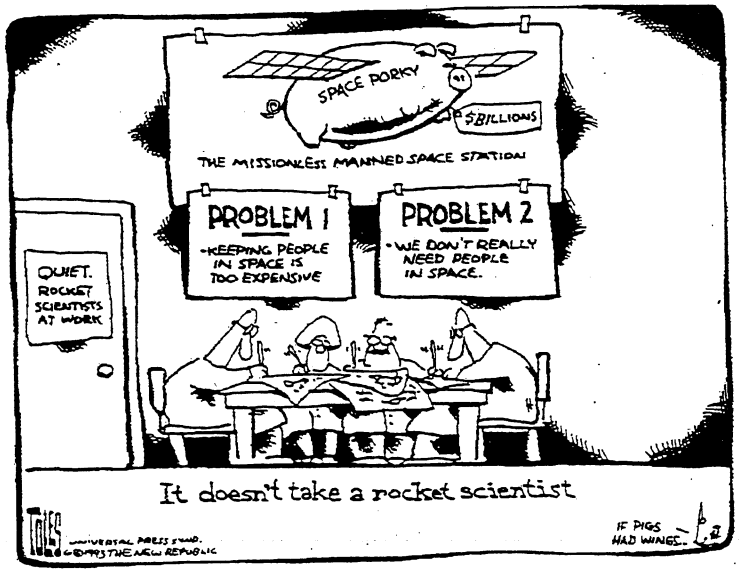
7 ***Bonus Question:***

While driving his car home that night, Mr. Caruana sees a $100 dollar bill on the road ahead. He continues driving at 40 km/h for 4 seconds as he decides if he wants it. He decides it is worth stopping and begins to decelerate to a stop. If it takes him 20 s to slow down and stop, how far did he travel in total? Try solving it in two parts. First how far did he travel before he decided to stop, then how far did he travel to stop.

Problems The Big 5 Kinematic Equations

1. The Porsche 917/30 Can-Am car (the fastest production model built as of January 1987) can accelerate from zero to 320 km/h [forward] in 12.6 s and has a recorded top speed of 411 km/h. What is its acceleration in m/s^2?
2. A snow avalanche moving with a velocity of 8.0 m/s undergoes an acceleration of 1.5 m/s^2 for 6.0 s. What is the final velocity of the avalanche?
3. Jennifer is driving her Honda Civic above the speed limit on a straight level highway when she receives a warning that a police car is ahead. She decelerates at 5.0 (km/h)/s for 6.0 s to reach a velocity of 100 km/h. How fast is Jennifer going when she receives the warning?
4. Henry drives his tank initially at 14 m/s in a 50 km/h zone. He accelerates at 2.0 m/s^2 to a final velocity of 28 m/s. How long does it take the tank to reach the final velocity?
5. The burning of the second engine of a two-stage toy rocket accelerates the rocket from 60 km/h [up] to 145 km/h [up] in 5.0 s. Calculate the average acceleration of the rocket in (km/h)/s.
6. In the 74 s after lift-off, the shuttle Challenger travels 36 km. Assuming constant acceleration, calculate
   a) the acceleration of the shuttle in m/s^2.
   b) the speed of the shuttle in km/h.
7. Bill takes his brother's car out for a joy ride and steps on the gas; the car accelerates at 0.8 m/s^2 from a rest position. How far away is he when his brother notices the car gone 30s later?
8. Bill borrows his Dad's plane and starts down the runway at 2 m/s accelerating at 1.5 m/s^2. He accelerates for 1 min before the plane takes off. Can Bill take off if the runway is only 2500 m or does he crash?
9. Later that day when Bill returns his brother's car, he drives up the driveway at 20 m/s and slams on the brakes, decelerating at 1.2 m/s^2 for ½ a minute. If the garage is 59 m away, does he hit or stop in time?

Answers: 1) 7.05m/s^2, 2) 17m/s, 3) 130km/h, 4) 7s, 5) 17km/h/s, 6) a) 13m/s^2, b) 3.5 x 10^3 km/h, 7) 360m



Motion Up and Down

Name _____

1 If you drop a ball at rest off the CN Tower, how far will it fall in the first 6 seconds?

Given:
Find

Answer =

2 A car drives off a cliff at 18 km/h down. It falls to the bottom of the cliff, which is 25 m down below. How fast did it crash into the ground?

Given:
Find:

Answer =

3 If you shoot an arrow up at 72 km/h, how high will it go in the first 3 seconds?

Given
Find:

Answer =

4 If a super frog jumps straight up at an incredible speed of 32 m/s, How fast would it be going up after 2 seconds?

Given:
Find:

Answer =

When an object is thrown up you can calculate its maximum height by knowing that it **stops at the maximum height** ***(v_f is 0 m/s)***

5 A rocket is shot up at 24 m/s. If it takes 2.5 seconds to reach its maximum height, how high did it go?

Given:
Find:

Answer =

6 A ball is thrown up at 4 m/s. How high does it go until it stops.

FALLING OBJECTS

Remember; Draw a sketch and label up as positive

1 Bill borrows his Dad's gun and when he gets outside he fires it straight up into the air. If the bullet left the gun at 400 m/s
a) How far had it moved up after 4 s? 1522m [UP]
b) How fast was it going at this time? 361 m/s [UP]

2 How long does it take for a the bullet ~~to reach~~ to reach its highest point? ~~(this takes longer than 3 s.)~~ 41s
IF V_i IS 400 m/s [UP] NOTE: AT ITS HIGHEST POINT $V_f = 0$ m/s

3 Bill fires a rocket up from the ground at 200 m/s.
a) How long does it take to reach its maximum height? 20s
b) How high does it go? 2041 m [UP]

4 To get rid of the gun, Bill throws it off a cliff at 3 m/s down.
If he hears the gun hit the ground 8 s. later
a) What speed was it going when it hit the ground? 81 m/s [DOWN]
b) How far down is the bottom of the cliff? 338 m [DOWN]

Activity Drawing Vector Diagrams

1 Draw the following vectors to the scale1 cm = 1 m.

a) 3 m [E]

b) 4 m [N 45° E]

c) 5 m [S 30° W]

d) 3.5 m [S 70° E]

2. Draw a vector diagram of my walk in the park 8 m [E] and then 4 m [S 15° E].

a) Find the total **distance** walked.

b) Find the total **displacement** with direction.

Vector Addition

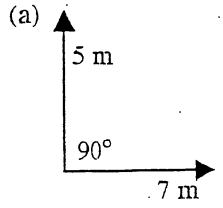
$\vec{A}$ = 50 km [N] $\vec{B}$ = 30 km [S 50° E]

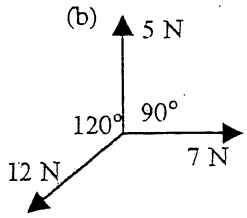
$\vec{C}$ = 70 km [W 20° N] $\vec{D}$ = 10 km [N 70° E]

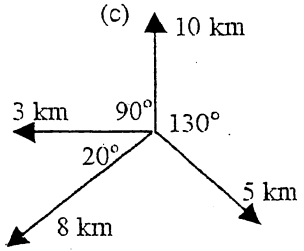
1. Use a scale diagram to find the resultant of the following equations:
   a) $\vec{R} = \vec{A} + \vec{B} + \vec{C}$
   b) $\vec{R} = \vec{B} + \vec{C} + \vec{D}$
   c) $\vec{R} = \vec{A} + \vec{B} + \vec{C} + \vec{D}$

   (approximately 70 km [N 40° W], 34 km [W 14° N], 63 km [N 30° W])

2. For the following diagrams:
   - Write out the vector equation used to find the resultant.
     Example: $\vec{R}$ = 2 km [N] + 5 km [N 30 W]
   - Use a scale diagram to find the resultant.







(approximately 8.6 m [54° cw from 5m], 3.8 N [100° ccw from 5m], 7.6 km [55° ccw from 10 km])

3. Two forces of 100 units each, and making an angle of 120° relative to each other, pull on an object. Find the single force that (a) could replace these two forces (b) could balance these two forces.

Vector Subtraction

$\vec{A}$ = 50 km [N] $\vec{B}$ = 30 km [S 50° E]

$\vec{C}$ = 70 km [W 20° N] $\vec{D}$ = 10 km [N 70° E]

1. For the following diagrams:
   - Write out the vector equation used to find the resultant as demonstrated below.
     Example: $\vec{R}$ = 2 km [N] - 5 km [N 30 W]
     Therefore $\vec{R}$ = 2 km [N] + 5 km [S 30 E]
   - Use a scale diagram to find the resultant.

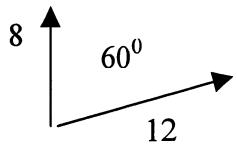
   a) $\vec{R} = \vec{A} - \vec{B} - \vec{C}$
   b) $\vec{R} = \vec{B} - \vec{C} - \vec{D}$
   c) $\vec{R} = \vec{A} + \vec{B} - \vec{C} + \vec{D}$

Grade 11 Physics Vector Addition Assignment

Name _____

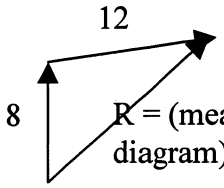
1 Label each of the following vectors with bearings
2 Write out an equation to add the vectors
3 Draw a diagram to scale to find the resultant of your equation

Sample

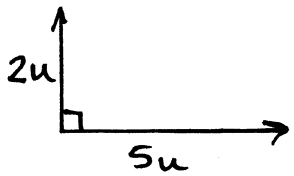


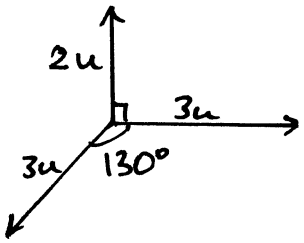
Answer

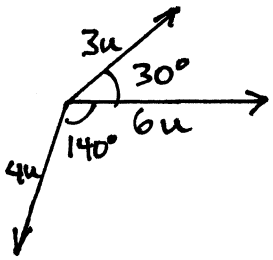
1. 8 [N], 12[N60E]
2. R = 8 [N] + 12[N60E]

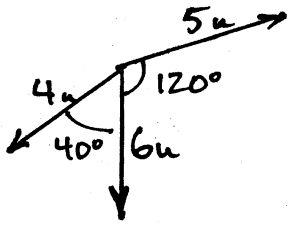


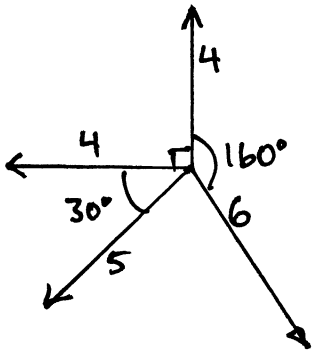
1











3 On the way home one night I got lost and walked the following steps to my house.
a) Draw a diagram to scale to find the resultant of your equation. This will be the displacement of my walk.
b) Calculate the distance I walked

a) = _____

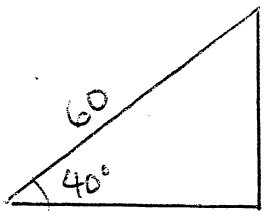
b) = _____

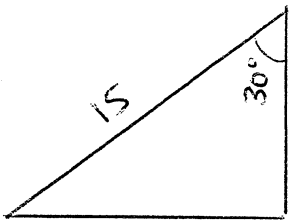
$\vec{R}$ = 2 [E 40 N] + 4 [N 40 W] + 4 [W 40 S]
+ 6 [E 15 S] + 5 [W 60 S] + 2 [N]

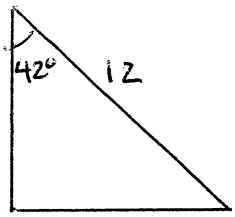
TRIG REVIEW

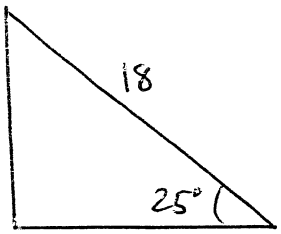
NAME: _____

1) FIND THE LENGTH OF THE MISSING SIDES.

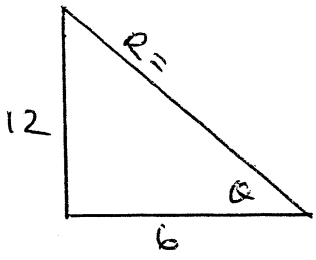


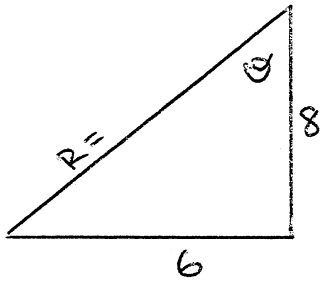


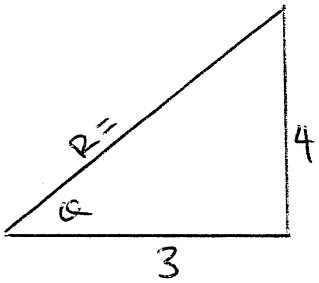


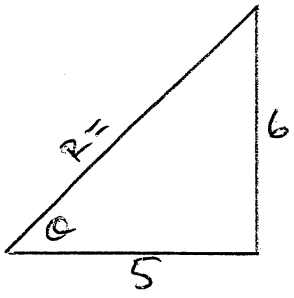


2) FIND THE ANGLE AND R

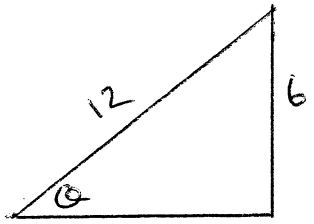


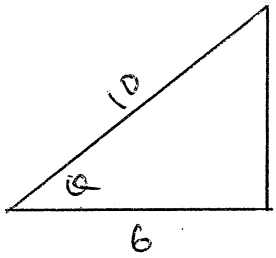


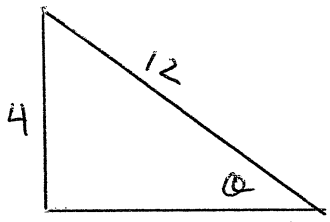


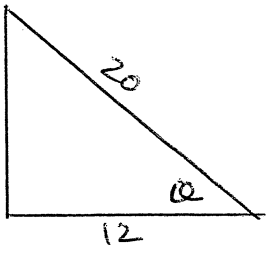


3) FIND THE MISSING ANGLE





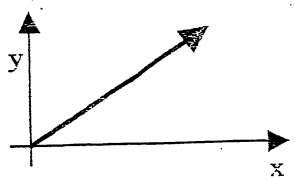




Vectors and Components SPH 4AU

1. Find the components of each vector with respect to the given coordinate system. Be sure to use a sign convention.

a)

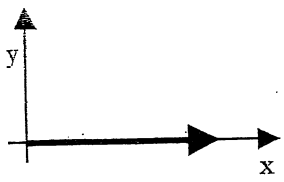


$\vec{A}$ = 30 m [N 40° E]

A_x =

A_y =

b)

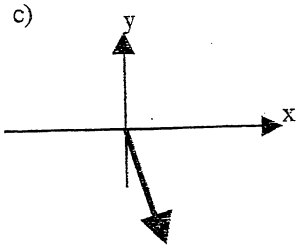


$\Delta\vec{d}$ = 20 km [E]

Δd_x =

Δd_y =

c)

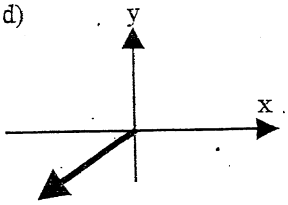


$\vec{F}$ = 45 N [S 20° E]

F_x =

F_y =

d)



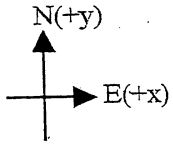
$\vec{v}$ = 7.8 m/s [S 50° W]

v_x =

v_y =

Answers: (19.3 m, 22.3 m), (20 km, 0), (15.4 N, -42.3 N), (-6.0 m/s, -5.0 m/s)

2. Given the following components and sign convention, reconstruct the original vectors. Sketch the vector diagram showing the addition of the components into the resultant vector.



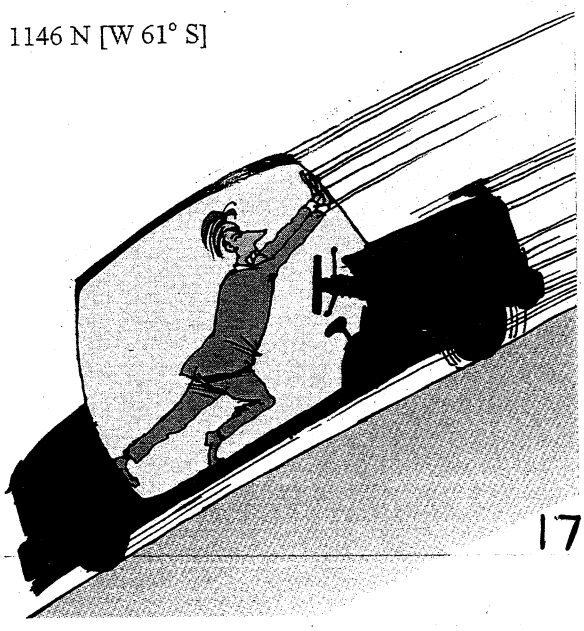
a) Δd_x = 300 m, Δd_y = 400 m, $\Delta\vec{d}$ =

b) v_x = -12.4 m/s, v_y = 10 m/s, $\vec{v}$ =

c) a_x = 3.5 m/s^2, a_y = - 1.0 m/s^2, $\vec{a}$ =

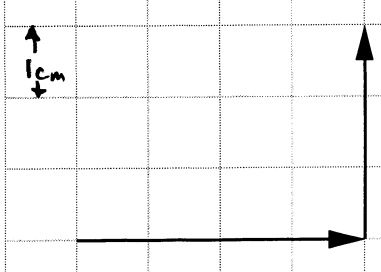
d) F_x = -549 N, F_y = -1007 N, $\vec{F}$ =

Answers: 500 m [E 53° N], 15.9 m/s [W 39° N], 3.6 m/s^2 [E 16° S], 1146 N [W 61° S]

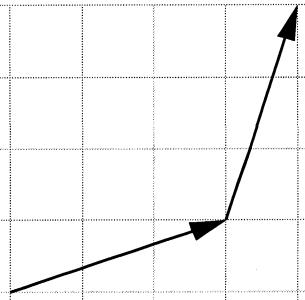


Calculate the magnitude (in centimeters) and direction of the resultant vector for each diagram using the method of components. A ruler and protractor are not needed for this exercise. EACH BOX = 1 cm x 1 cm

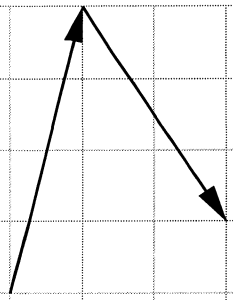
1.



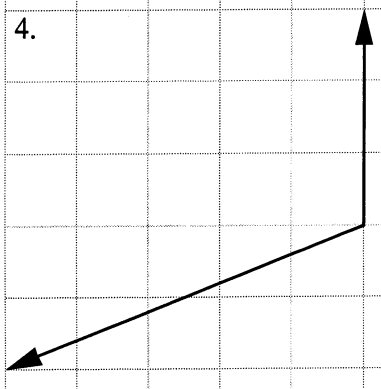
2.



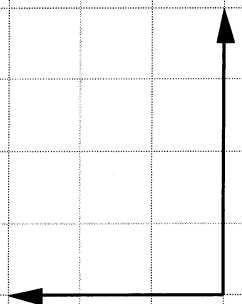
3.



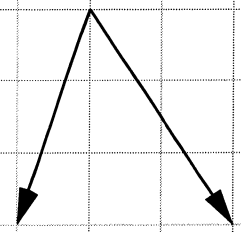
4.



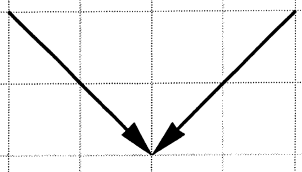
5.



6.

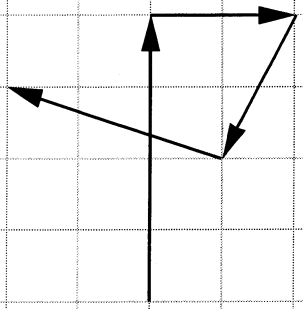


7.

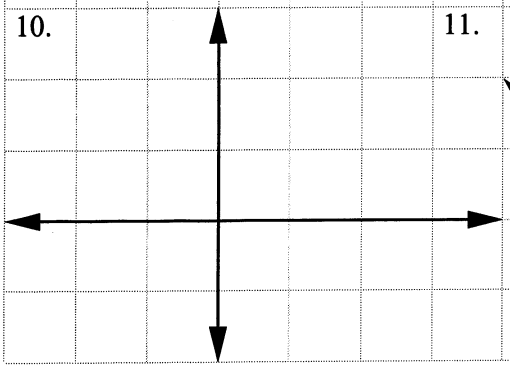


8.

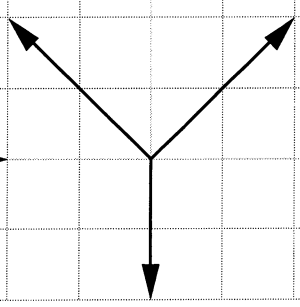
9.



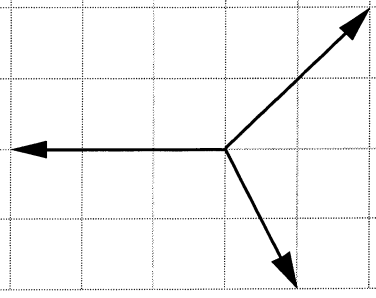
10.



11.

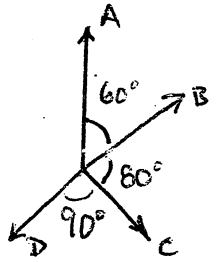


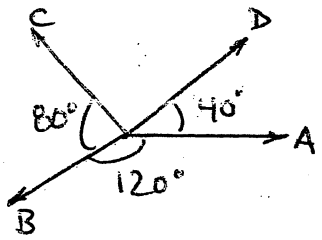
12.



GRADE 11 PHYSICS REVIEW SHEET

NAME _____

① 



A = _____

B = _____

C = _____

D = _____

WRITE BEARINGS FOR

A= _____ B= _____ C= _____ D= _____

② ON THE BACK OF THIS, PAPER FIND THE RESULT OF

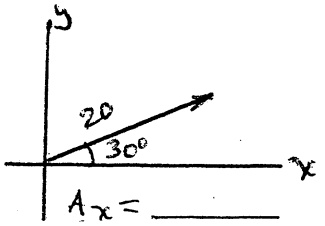
$\vec{R}$ = 10 km [N] + 8 km [E] + 6 km [S 30W] − 9 km [W 20N]

$\vec{R}$ = _____

③ REWRITE THE FOLLOWING EQUATION TO MAKE THE NEGATIVES (−) INTO POSITIVES (+) $\vec{R}$ = 6 km [E 30S] − 8 km [W] − 4 km [N 30W] − 5 km [S 45 E]

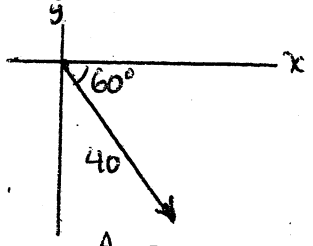
$\vec{R}$ = _____ + _____ + _____ + _____

④ DRAW AND CALCULATE THE COMPONENTS OF THESE VECTORS



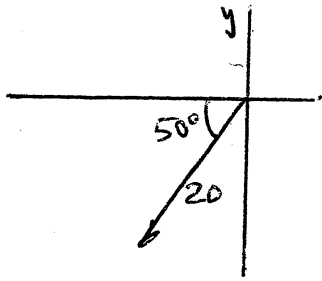
A_x = _____

A_y = _____



A_x = _____

A_y = _____



A_x = _____

A_y = _____

⑤ USE THE FOLLOWING COMPONENTS TO CONSTRUCT THE ORIGINAL VECTORS (DRAW THEM IN THE SPACE BELOW)

a) d_x = 200 m d_y = 300 m

Δd = _____

b) V_x = −12 m/s V_y = 15 m/s

V = _____

Relative Velocity Problems Assignment

Due Date _____

Name _____

1. An airplane has a velocity of 240 km/h [E] and is flying in a storm where a wind is blowing at 80 km/h to the south. What is the planes resultant velocity (relative to the ground)?

   Answer _____

2. A plane has a velocity of 300 km/h in the air and the pilot points the plane north in an area where the wind is 80 km/h [W]. What is the planes resultant velocity (relative to the ground)?

   Answer _____

3. A canoe is paddled 8 m/s north in a river that is flowing 5 m/s east. The river is 160 m wide.
   a) What is the canoe's resultant velocity?
   b) How long will it take to cross the river?
   c) How far downstream will the canoe land on the shore?
   d) What direction should the canoe travel in to go directly across the river?

   Answers
   a) _____
   b) _____
   c) _____
   d) _____

4. A blimp (airship) is trying to travel north. The pilot can fly the blimp at a speed of 26 km/h in the air. The wind is 10 km/h [E].
   a) What direction should the blimp pilot point the blimp for it to travel north?
   b) What is the resultant speed of the blimp?
   c) How long will it take to travel 200km?

   Answers
   a) _____
   b) _____
   c) _____

5. A canoe is paddled 3 m/s ... in a river that is flowing 2 m/s south. The river is 500 m wide.
   a) What direction should the canoe travel in order to cross directly across the river?
   b) What is the resulting velocity across the river?
   c) How long will it take to travel directly across the river?

   Answers
   a) _____
   b) _____
   c) _____

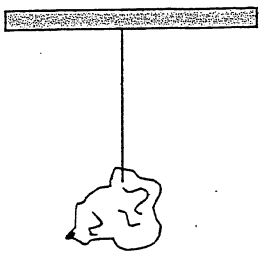
Free Body Diagrams

WORKSHEET

Name _____

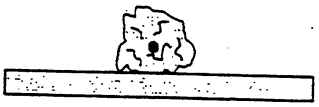
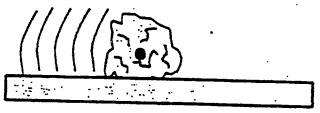
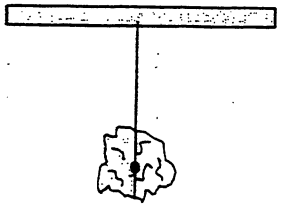
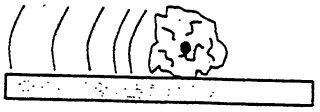
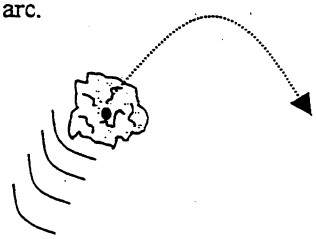
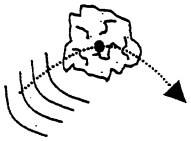
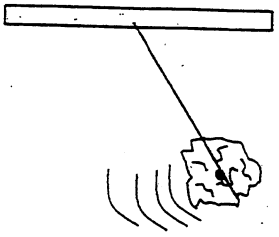
Draw the Free Body Diagrams and label the forces. **Force of gravity = F_g** **Force of friction = F_f**
Force applied = F_a **Normal force = F_n**

1)

1) A car is at rest on the road	2) A ball is rolling at uniform speed (no friction)	3) A ball is rolling and slowing down (friction)	4) A ball is falling
5) A ball is falling at terminal (constant) velocity due to air resistance (friction)	6) A person is pushing a box along the floor at uniform speed. (friction)	7) A car is accelerating along the road (friction)	8) A car is slowing down on the road (friction)
9) A rock is tied to a rope and is at rest 		10) A rock is tied to a rope and accelerated up. 	

Work Sheet Forces and Free Body Diagrams

In each example below, one or more forces act on the rock. Assume there is no friction or air resistance unless mentioned. Draw a free body showing all forces acting on the rock. Estimate the size of the force vectors relative to one another. You may draw all forces acting at the centre of the rock. Please use a ruler and pencil so that you can correct your mistakes. Label the forces using the following symbols: F_g = the force due to gravity, F_T = the force of tension, F_n = the normal force, F_f = the force of friction, F_a = the force of air resistance.

① The rock is falling. 		⑥ The rock is at rest. 	
② The rock is falling at constant (terminal) velocity due to air resistance. 		⑦ The rock is sliding at constant speed. 	
③ The rock tied to a rope is at rest. 		⑧The rock is slowing down due to friction. 	
④ The rock is rising in an arc. 		⑨ The rock is at the top of its arc. 	
⑤ The rock is tied to a rope and is pulled upward such that it is accelerating up 		⑩The rock tied to a rope is swinging. 	

Worksheet Forces and Newton's Second Law

When solving force problems, follow the guidelines given below. This will help you organize your work and reduce the mistakes you may make.

1. List everything you know (the givens) about the problem.
2. State what you are trying to find.
3. Draw a Free Body Diagram and perhaps a picture for the problem.
4. Find the approach you will use. This is almost always Newton's 2nd Law. Sometimes you also have to solve a kinematics problem, which means you will use one of the Big Five Equations.
5. Solve the problem.
6. State the final result in a sentence.

Problems

Mandatory

1. You have to push with a force of 200 N to slide a refrigerator across a floor at constant velocity. What is the force of friction acting on the fridge? (200 N)
2. Suppose a photograph showed a body moving with constant velocity from left to right. In what direction is the net force? ($F_{net} = 0$)

Easy

1. A frog with a mass of 0.5 kg is accelerated at 4 m/s^2. What is the net force acting on it? (2 N)
2. What is the net force required to give an automobile of mass 1600 kg an acceleration of 4.5 m/s^2 ? (7.2×10^3 N)
3. What is the acceleration of a wagon of mass 20 kg if a horizontal force of 64 N is applied to it (ignore friction)? (3.2 m/s^2)
4. What is the mass of a block of iron if a net force of 240 N causes it to accelerate across a smooth horizontal surface at 2.5 m/s^2? (96 kg)

Medium

1. A net force of 8.0 N gives a mass m_1 an acceleration of 2.0 m/s^2 and a mass m_2 an acceleration of 4.0 m/s^2. What acceleration would the force give the two masses if they were fastened together? (1.3 m/s^2)
2. A 1.0 kg toy car is moving across a smooth floor with a velocity of 5.0 m/s. An unbalanced force of 2.0 N acts on the car for 4.0 s. Determine the velocity of the car at the end of the interval in each of the following cases.
   a) if the force acts in the direction of motion of the car? (13 m/s)
   b) if the force acts in the opposite direction to the motion of the car? (-3 m/s)
3. A toy rabbit is balanced by two identical masses on a balance scale. A certain force accelerates the toy rabbit by 2 m/s^2. At what rate will the same force accelerate **one** of the weights? (4 m/s)
4. A car can accelerate at 3 m/s^2. What would its acceleration be if it was towing another car like itself? (1.5 m/s^2)
5. A block of mass 8.0 kg, starting from rest, is pulled along a rough horizontal tabletop by a constant force of 2.0 N. It is found that this body moves a distance of 3.0 m in 6.0 s.
   a) What is the acceleration of the body? (0.17 m/s^2)
   b) What is the net force acting on the body? (1.3 N)
   c) What other force is involved in this problem? Find its magnitude. (0.7 N)
6. An electron has a mass of 9.1×10^{-31} kg. Between the electrodes of a cathode-ray tube, it moves a distance of 4.0 mm, accelerated by a net electrical force of 5.6×10^{-15} N. Assuming that it started from rest, find its acceleration and its final velocity. (6.2×10^{15} m/s^2, 7.0×10^6 m/s)
7. A child's wagon experiences a frictional force of 73 N whenever it is in motion, regardless of the load it is carrying. An applied horizontal force of 128 N causes the wagon to accelerate at 5.0 m/s^2. The same applied force, with a child on a wagon causes it to accelerate at 1.0 m/s^2. What is the mass of the child? (44 kg)

Hard

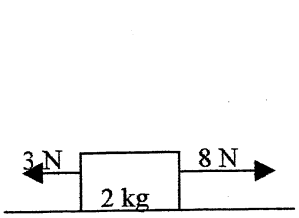
1. A sled of 6.0 kg mass is moving along a smooth, horizontal ice surface with a velocity of v_0. A force of 36 N is applied to the sled in its direction of motion, increasing its velocity to $2v_0$ while it moves 10 m. Find
   a) the sled's original velocity, v_0 (6.3 m/s)
   b) the length of time that the force acted (1.1 s)
2. A 0.50 kg skateboard is at rest on a rough, level floor on which two lines have been drawn 1.0 m apart. A constant horizontal force is applied to the skateboard at the beginning of the interval and is removed at the end. The skateboard takes 8.5 s to travel the 1.0 m distance, and it coasts for another 1.25 m before coming to rest. Calculate the force applied to the skateboard, and also the constant frictional force opposing its motion. (2.6×10^{-2} N, 1.2×10^{-2} N)
3. An arrow, starting form rest, leaves the bow with a speed of 25.0 m/s. If the average force exerted on the arrow by the bow were doubled, all else remaining the same, with what speed would the arrow leave to bow? (35.4 m/s)

Vectors and Newton's Second Law

1. A 70 kg person in an elevator is accelerating up at 4 m/s^2. Draw a FBD and find the tension in the cable.

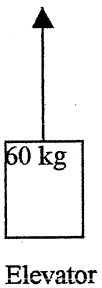
2. A 45 kg person is in an elevator that is accelerating down at 5 m/s^2. Draw a FBD and find the tension in the cable.

3. Draw FBS's for the following and calculate the accelerations of the object



FBD

a =



FBD

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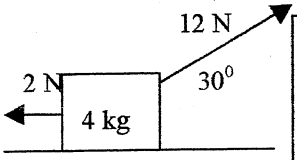
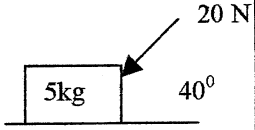


FBD

a =



FBD

a =

Activity Student Power!

Purpose

To determine your power.

Procedure

1. Measure the height of the stairs from floor to floor and enter this in your chart.
2. Find the time to run up the stairs one step at a time (no skipping!). Do this twice and take the average.
3. Find the time to climb the stairs at maximum speed (this may be two or three steps at a time).
4. Calculate your potential energy and your power.

Observations

Height of the stairs	
Your mass	
Calculate the force of gravity on you	
Time to run up one step at a time	
Time to run up fast	

Potential Energy

One step at a time	W = mgh =
Fast	W = mgh =
With extra mass (imagine you double your mass)	W_2 = (2m)gh =

Power

One step at a time	P = W/t =
Fast	P = W/t =
With extra mass	P = W_2/t =

Questions

1 My maximum power is _____

2 My horse power is _____ (750 W = 1 HP)

Grade 11 Work, Energy and Power Review Assignment (V07)

1. Calculate the amount of work done to stop a bullet traveling through a tree trunk a distance of 60 cm with a force of 300 N. (180J)

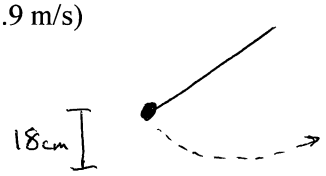
2. Bruno is giving his baby sister a ride on a wagon. He pulls with a force of 150 N. If 364 J of work is done, how far did he pull it? (2.4m)

3. A construction worker does 550 J of work in lifting a load of bricks from the ground to a support stand 2.50 m from the ground. What was the mass of the bricks she lifted? (22.4 kg)

4. A 45 kg girl rides her 0.5 kg skateboard. She starts from rest and at a constant acceleration reaches 4 m/s in 12 s on a horizontal surface. How much power did she use? (0.33W)

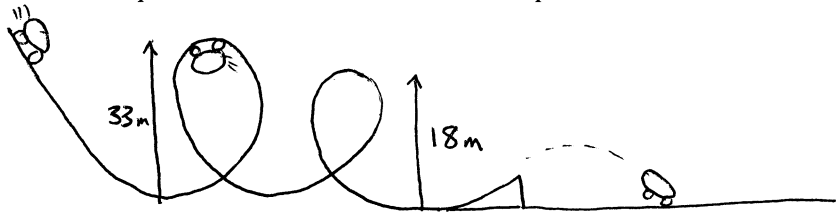
5. An electric hoist provides 3.5×10^3 W of power to lift a 180-kg sack vertically upwards in 2.5 seconds. To what height has the sack been lifted? (5m)

6. A ball is tied to a string and pulled up to the side 18 cm from its lowest position. What will be its speed when it reaches the bottom. (1.9 m/s)



7. An elevator motor lifts a load of 2500 kg a height of 15 m in 5 seconds. The energy required by the motor to accomplish this task is 735 000 J. What is the efficiency of the elevator? (50%)

8. A roller coaster has two vertical loops one after the other. The roller coaster has a speed of 7 m/s at the top of the first loop with a height of 33 m. It then proceeds around the second vertical loop with a height of 18 m. What is the speed of the roller coaster at the top of the second vertical loop? (18.5 m/s)



9. A person throws a 0.14 kg ball at a speed of 90 km/h from a standing height of 2.2 m.
   a) What is the kinetic energy of the ball when it leaves the persons hand? (48.3J)
   b) What is the total energy of the ball when it leaves the persons hand? (46.8J)
   c) What is the kinetic energy of the ball when it hits the ground? (after it falls the 2.2m) (46.8J)
   d) How fast is the ball moving when it hits the ground?

10. The world record for high jump is 2.39m.
    a) What was the kinetic energy of the 60 kg jumper just as he left the ground if he had to be traveling 0.4 m/s as he went over the bar? (1400J)
    b) What was the speed he need to be traveling when he left the ground? (6.8 m/s)

11. A 75 kg passenger in a van is wearing a seat belt when the van crashes into a wall at 15 m/s. The front end of the van collapses 0.5 m as it comes to rest.
    a) What was the kinetic energy of the person before the crash? (8.4J)
    b) What force was applied to the passenger by the seat belt in order to stop them? (17 kN)

12. a) If you lift a 12 kg mass up 2 m and do this 500 times, how much work have you done? (118 kJ)
    b) One kg of fat has 30 MJ of energy and you can convert fat with an efficiency of 20%. If the energy you used in part a) is from your fat. What is the mass of the fat that you converted to energy? (20 g)

V06

Work, Energy, Power Review

True/False

____ 1. Gravitational potential energy is always measured in relation to an object's position above the Earth.
____ 2. The energy of a moving object is called kinetic energy.
____ 3. Work is done when a net force is applied to an object over a certain distance.
____ 4. Positive work means that the work done is greater than the force of friction.
____ 5. Negative work means the force applied is opposite to the direction of the displacement.
____ 6. If a Mary Ann is holding a 100-kg barbell above her head for 5 s and Kavitha holds the same 100-kg barbell over her head for 10 s, then Kavitha has done twice the amount of work as Mary Ann.
____ 7. To compare the kinetic energy of two objects moving horizontally, you only need to know the work required to stop each object.
____ 8. If the speed of a person triples, the person's kinetic energy triples.

1 Sharon works as a carpenter for a furniture company. If she applies a force of 60 N horizontally to shove a plane 40 cm along a piece of wood, how much work does she do? 24 J

2 Bruno is giving his baby sister a ride on a wagon. He exerts a constant horizontal force of 150 N to move the wagon. If 364 J of work are done, how far does he move it? 2.43 m

3 A 90 kW motor exerts an average force of 4.0 kN to move a speedboat at a constant speed through the water. How fast, in km/h, is the boat moving? 81 km/h

4 One kilogram of fat is equivalent to about 30 MJ of energy. The efficiency of converting fat to mechanical energy is about 20%.
a) Suppose you lift a 12 kg mass 2.0 m vertically 500 times, how much work do you do? (Assume that the work done by the mass on you is dissipated as heat to the surroundings.) 120 kJ
b) If all the energy used to do the work comes from "burning" fat, how much fat is used up by the exercise? 20 g

5 A pitcher throws a fast ball, off target, at a speed of 90 km/h and hits home plate. The ball, which has a mass of 0.14 kg, is 2.2 m above the ground when it leaves the pitcher's hand.
a) What is the total gravitational and kinetic energy of the ball at the time of release? 47 J
b) What is the ball's kinetic energy when it reaches home plate? 47 J
c) How fast is the ball moving when it collides with home plate? 26 m/s

6 A waterfall is 25 m high and the conversion from gravitational energy at the top to electricity from the generators is 95% efficient. If 1 m^3 of water has a mass of 1000 kg, how many cubic metres of water have to pass over the falls to produce 1 kW·h of electricity? 15 m^3

7 The Horseshoe Falls on the Niagara River in Ontario are about 48 m high and 780 m wide. The water at the top of the falls is moving at 9.0 m/s and has a depth of about 0.80 m as it goes over the falls. 5.6×10^6 kg
a) If the density of water is 1000 kg/m^3, what mass of water goes over the falls every second?
b) What is the change in gravitational energy of this mass of water? 2.6×10^9 J
c) If the efficiency of a hydro-electric generator is 95%, and it is able to use 25% of the water, how many kilowatts of electricity could be produced from this water? 620 kW

8 The world record for the high jump is 2.39 m and was set in 1984 by Zhu Jianhua of China. What was his kinetic energy when he left the ground if his mass was 60.0 kg and he had to cross the bar with a speed of 0.400 m/s? 1400 J

9 Bruce, a 75 kg passenger in a van, is wearing a seat belt when the van moving at 15 m/s collides with a concrete wall. The front end of the van collapses 0.50 m in coming to rest.
a) What was Bruce's kinetic energy before the crash? 8.4 kJ
b) What average force did the seat belt exert on Bruce during the crash? 17 kN

Refraction of Light

Group Members _____ _____ _____ _____

Materials: Semi-circular prism, ray-box, slit, paper, ruler, protractor.
Follow the procedure as outlined below.

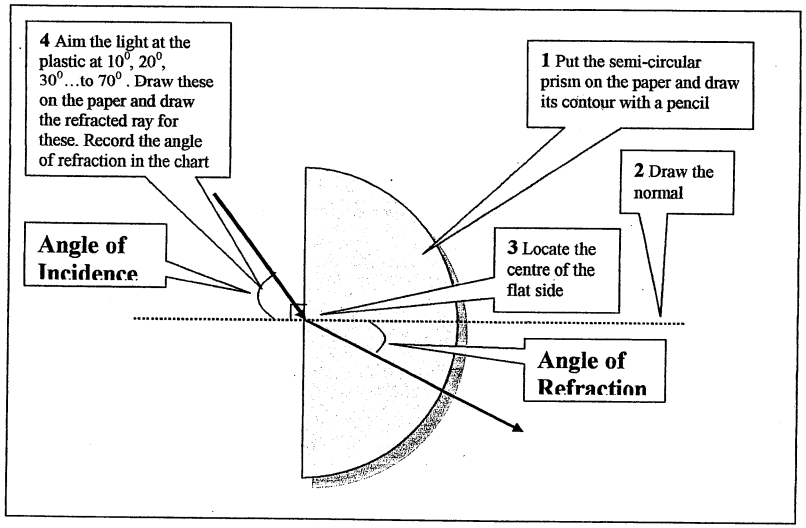


Chart:

Angle of incidence	Angle of refraction	Sin (i)	Sin(R)	Sin (i) / Sin (R)
10^0				
20^0				
30^0				
40^0				
50^0				
60^0				
70^0				

Questions:

1. Is the ratio of Sin(i)/Sin(R) constant?

2. Use n_{air} sin (i) = n_p sin (R) for the any angle of incident above to solve for n_p

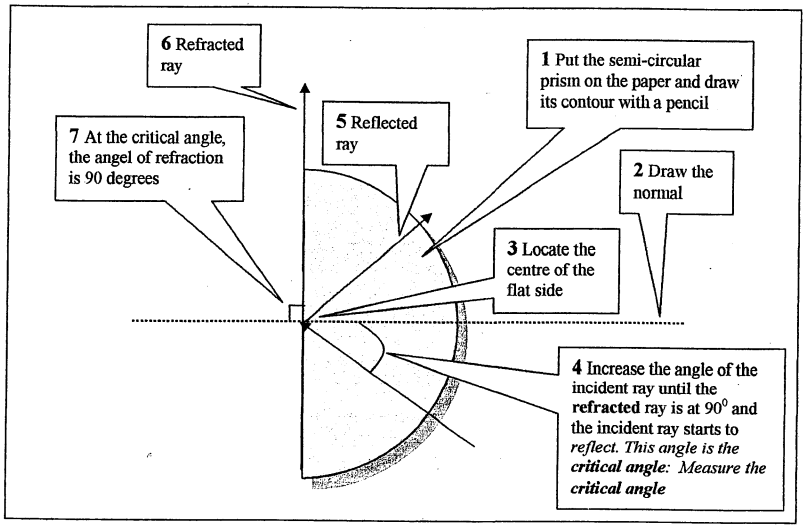
3. Find the speed of light in Plexiglas using $n_p = V_{air}/V_{Plexiglas}$)

Total Internal Reflection

Group Members _____ _____ _____ _____

Materials: Semi-circular prism, ray-box, slit, paper, ruler, protractor.

Follow the procedure as outlined below.



Questions:

1. The critical angle from Plexiglas to air is _____

2. Use Snell's law, the index of refraction of air (1.0) and the angles above to calculate the index of refraction of Plexiglas.

3. Light travels from diamond (index = 2.42) to air (index = 1.0). Calculate the critical angle (Note: at the critical angle, the angle of refraction is 90 degrees, see #7 above)

Problems Snell's Law and Total Internal Reflection

1. Solve the following

a) sin 50 = b) sin 20 = c) sin 40 =

d) sin 0 = e) sin 45 = f) sin 90 =

2. Find the angle, θ, for the following

a) $\sin\theta = 0.50$ b) $\sin\theta = 0.7071$

c) $\sin\theta = 0.8339$ d) $\sin\theta = 0.9863$

3. For light passing from air to brownite ($n_b = 1.75$) determine the angle of refraction, θ_2, for each angle of incidence θ_1.

$\theta_1 = 50°$, θ_2 = $\theta_1 = 40°$, θ_2 =

$\theta_1 = 30°$, θ_2 = $\theta_1 = 22°$, θ_2 =

4. For light passing from Jacksonite ($n_j = 2.6$) into air determine the angle of refraction

$\theta_1 = 20°$, θ_2 = $\theta_1 = 10°$, θ_2 =

5. Find the index of refraction for light traveling from air into

a) benzene, $\theta_1 = 70°$, $\theta_2 = 39°$, n_b = a) diamond, $\theta_1 = 30°$, $\theta_2 = 12°$, n_d =

6. In an experiment Professor Snell found that $\theta_1 = 31°$ and $\theta_2 = 18°$ when he passed light into a substance from air. What was the substance? (see pg. 334 of your text)

7. Determine if there is a refracted ray for the given angles of incidence.

a) Light passing from diamond into air. ($n_d = 2.42$)

$\theta_1 = 35°$ $\theta_1 = 28°$ $\theta_1 = 20°$

b) Light passing from water into air. ($n_w = 1.33$)

$\theta_1 = 65°$ $\theta_1 = 52°$ $\theta_1 = 44°$

8. Calculate the critical angle for

a) diamond $n_d = 2.42$ b) water $n_w = 1.33$

c) ruby $n_r = 1.76$ d) zircon $n_z = 1.92$

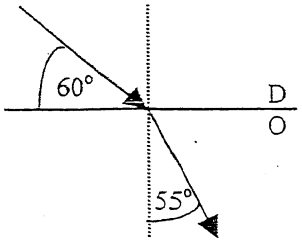
9. Find the index of refraction for light traveling from

a) glass to diamond, $n_g = 1.3$ and $n_d = 2.42$

b) ice to benzene, $n_i = 1.3$ and $n_b = 1.5$

10. What is the critical angle for light traveling from CS_2 ($n_{CS2} = 1.63$) into glass ($n_g = 1.5$)?

11. Given the diagram to the right, find: a) $n_{d\text{-}o}$ b) $n_{o\text{-}d}$ c) if $n_d = 2.42$ find $n_{o\text{-}air}$



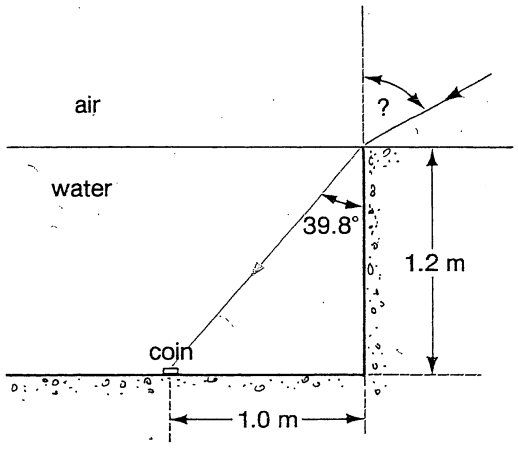
SPH 3U1- CLASS ASSIGNMENT NAME:

SOLVE THE FOLLOWING QUESTIONS AND HAND IN

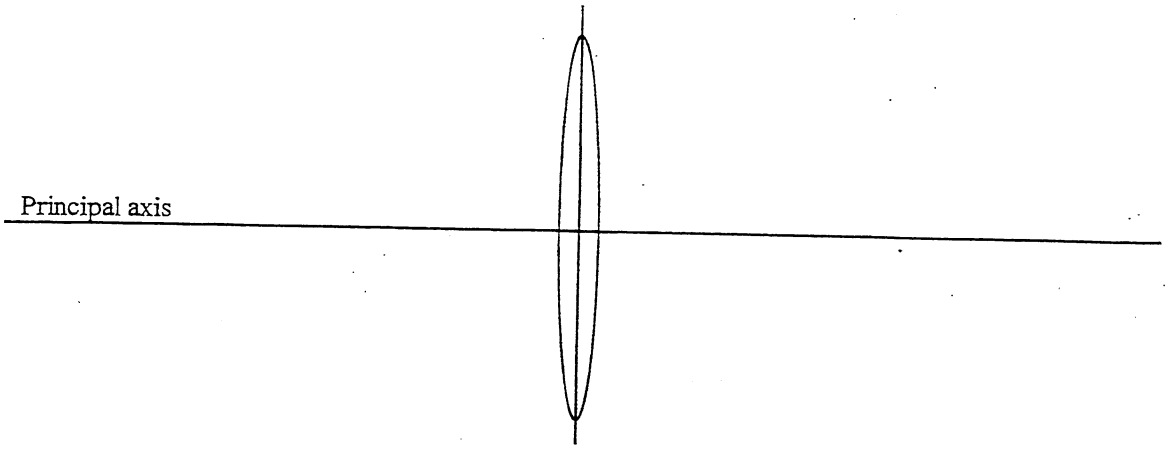
/5

20. The index of refraction of crown glass for violet light is 1.53, and for red light it is 1.51. Assuming that the velocity of light in a vacuum is 3.00×10^8 m/s, what are the speeds of violet light and red light in crown glass?
21. Using Snell's Law, determine the constant when the angle of incidence and the angle of refraction are:
    (a) 50° and 30° (b) 30° and 18° (c) 60° and 38°
22. (a) What is the index of refraction of a medium if the angle of incidence in air is 63° and the angle of refraction is 30°?
    (b) What is the angle of refraction in a medium if the angle of incidence in air is 48° and the index of refraction of the medium is 1.58?
    (c) What is the angle of incidence in a medium in the case where the angle of refraction in air is 40° and the index of refraction of the medium is 1.58?
23. A ray of light passes from air into water ($n_w = 1.33$) at an angle of incidence of 50°. What is the angle of refraction?
24. Light travels from air into water. If the angle of refraction is 30°, what is the angle of incidence?
25. A ray of light in air strikes a block of quartz at an angle of incidence of 30°. The angle of refraction is 20°. What is the index of refraction of the quartz?
26. Prove, geometrically, that a ray of light entering a plate of glass always emerges in a direction parallel to the incident ray.
27. One ray of light in air strikes a diamond ($n_d = 2.42$) and another strikes a piece of fused quartz ($n_q = 1.46$), in each case at an angle of incidence of 40°. What is the difference between the angles of refraction?
28. A ray of light strikes a block of polyethylene ($n_p = 1.50$) with angles of incidence of (a) 0°, (b) 30°, (c) 60°. Determine the angle of refraction in each case.
29. An underwater swimmer looks up towards the surface of the water on a line of sight that makes an angle of 25° with a normal to the surface of the water. What is the angle of incidence in air for the light rays that enter the swimmer's eye?
30. A beam of light is directed on the flat surface of a block of fused quartz. Part of the beam is refracted with an angle of refraction of 30°. What is the angle of reflection?
31. A coin lies on the bottom of a swimming pool under 1.2 m of water and 1.0 m from the edge of the pool, as illustrated. A flashlight beam is directed over the edge of the pool to illuminate the coin. At what angle relative to the pool wall must the flashlight be aimed?

20. 1.96×10^8 m/s, 1.97×10^8 m/s
21. (a) 1.53
(b) 1.62
(c) 1.41
22. (a) 1.78
(b) 28°
(c) 24°
23. 35°
24. 42°
25. 1.46
27. 11°
28. (a) 0°
(b) 19°
(c) 35°
29. 34°
30. 47°
31. 58°



Activity Converging Lenses



PART A – Finding the Focus

1. Using the three slit comb on the ray box aim the rays at the lens and draw the path of the rays on the diagram. This will locate the primary focus. Label this point PF.
2. Repeat this from the other side to locate the secondary focus. Label this point SF.

PART B – Examining the Rays

1. Using the single slit comb aim a ray parallel to the principal axis (but not on it) at the lens.
2. Draw its path and label this ray, PARALLEL RAY
3. Aim a ray at an angle to the principal axis so that it travels through the center of the lens.
4. Draw its path and label this ray, CENTRE RAY.
5. Aim a ray such that it travels through the secondary focus before reaching the lens.
6. Draw its path and label this ray, FOCAL RAY.

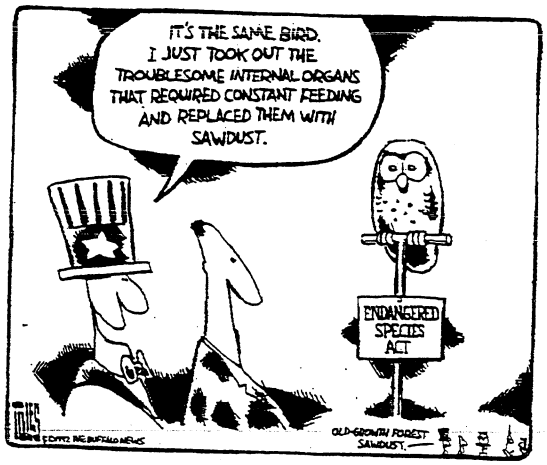
RULES – Converging Lens

1. A parallel ray passing through a convex lens will travel _____
2. A centre ray passing through a convex lens will travel _____
3. A focal ray passing through a convex lens will travel _____

Repeat this lab for a concave lens.

RULES – Diverging Lens

4. A parallel ray passing through a concave lens will travel _____
5. A centre ray passing through a concave lens will travel _____
6. A focal ray passing through a concave lens will travel _____



Activity Using Lenses

INSTRUCTIONS
For this lab you will need a convex and concave lens.

1) Hold the convex lens close to your eye and look at an object close to the lens. Describe the image. (Attitude, Type, Size)

2) Describe the background image.

3) Name two uses for this lens.

4) Hold the convex lens away from your eye and describe the image you see.

5) Name a use for this lens when used this way.

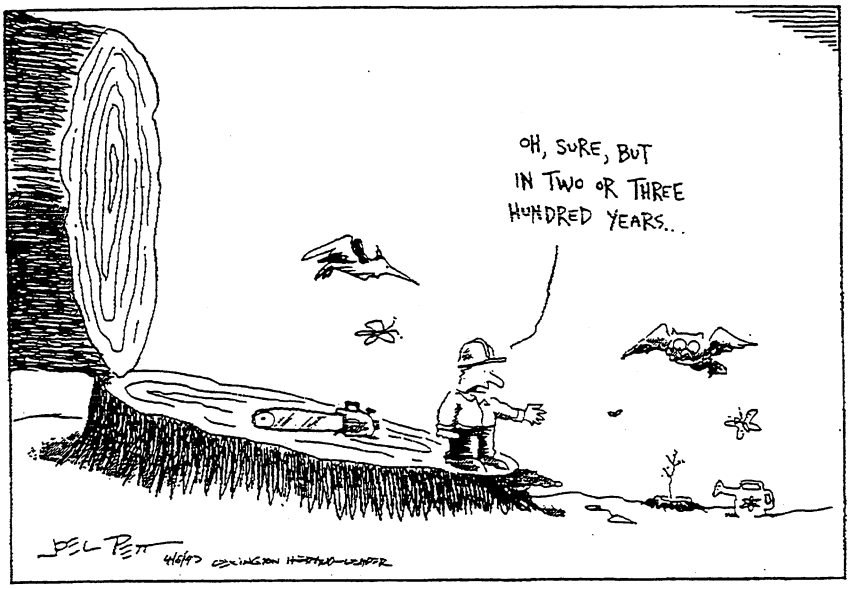
6) Describe the image when you hold the lens at a point where the image changes from what you saw in (1) to what you saw in (4)

7) Hold the convex lens over a piece of paper (about 10 cm) and move it back and forth until an image appears. Describe this image and measure its distance from the lens.

8) Hold the concave lens close to your eye and describe the image that you see.

9) Hold the concave lens away from your eye and describe the image that you see.

10) Name a use for this kind of lens.



Activity Ray Diagrams for Convex Lenses

Locate the images of these objects and describe the images' attitude, position, magnification and type.

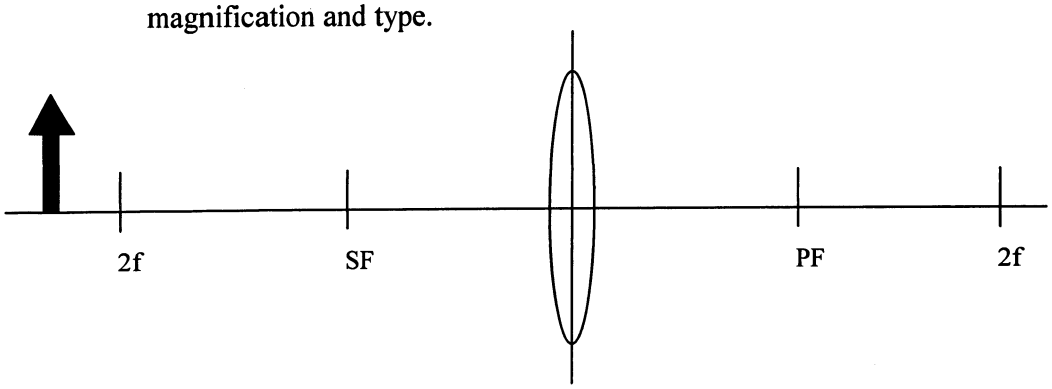


Image Characteristics
Attitude:

Position:

Magnification:

Type:

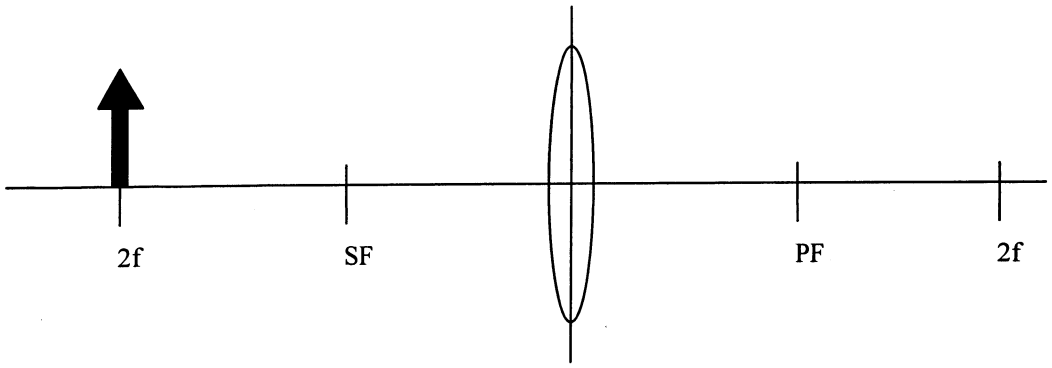


Image Characteristics
Attitude:

Position:

Magnification:

Type:

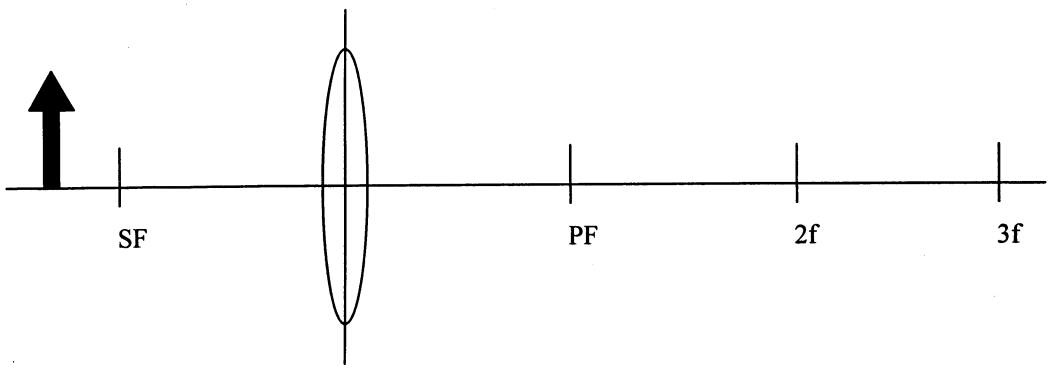


Image Characteristics
Attitude:

Position:

Magnification:

Type:

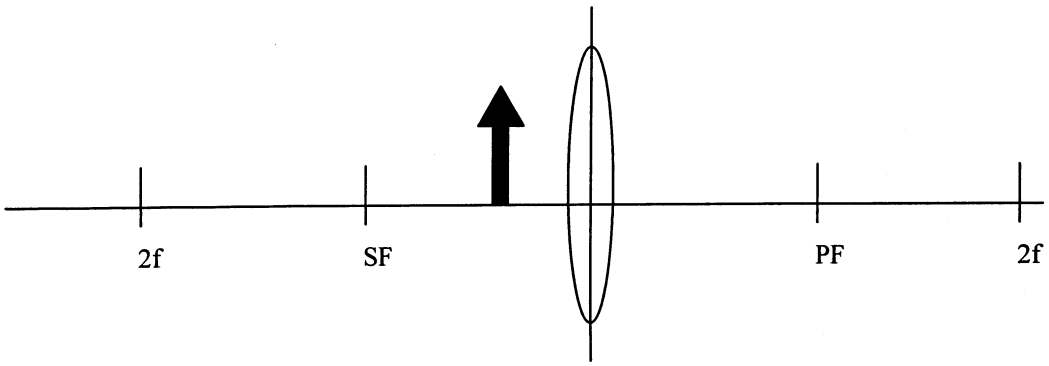


Image Characteristics
Attitude:

Position:

Magnification:

Type:

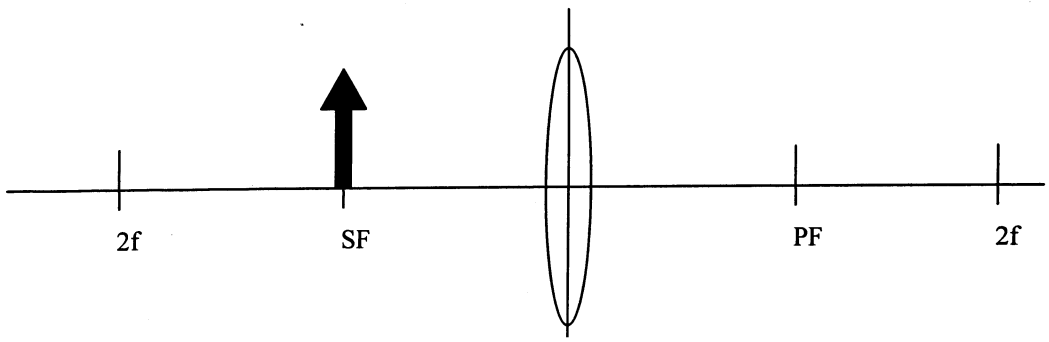


Image Characteristics
Attitude:

Position:

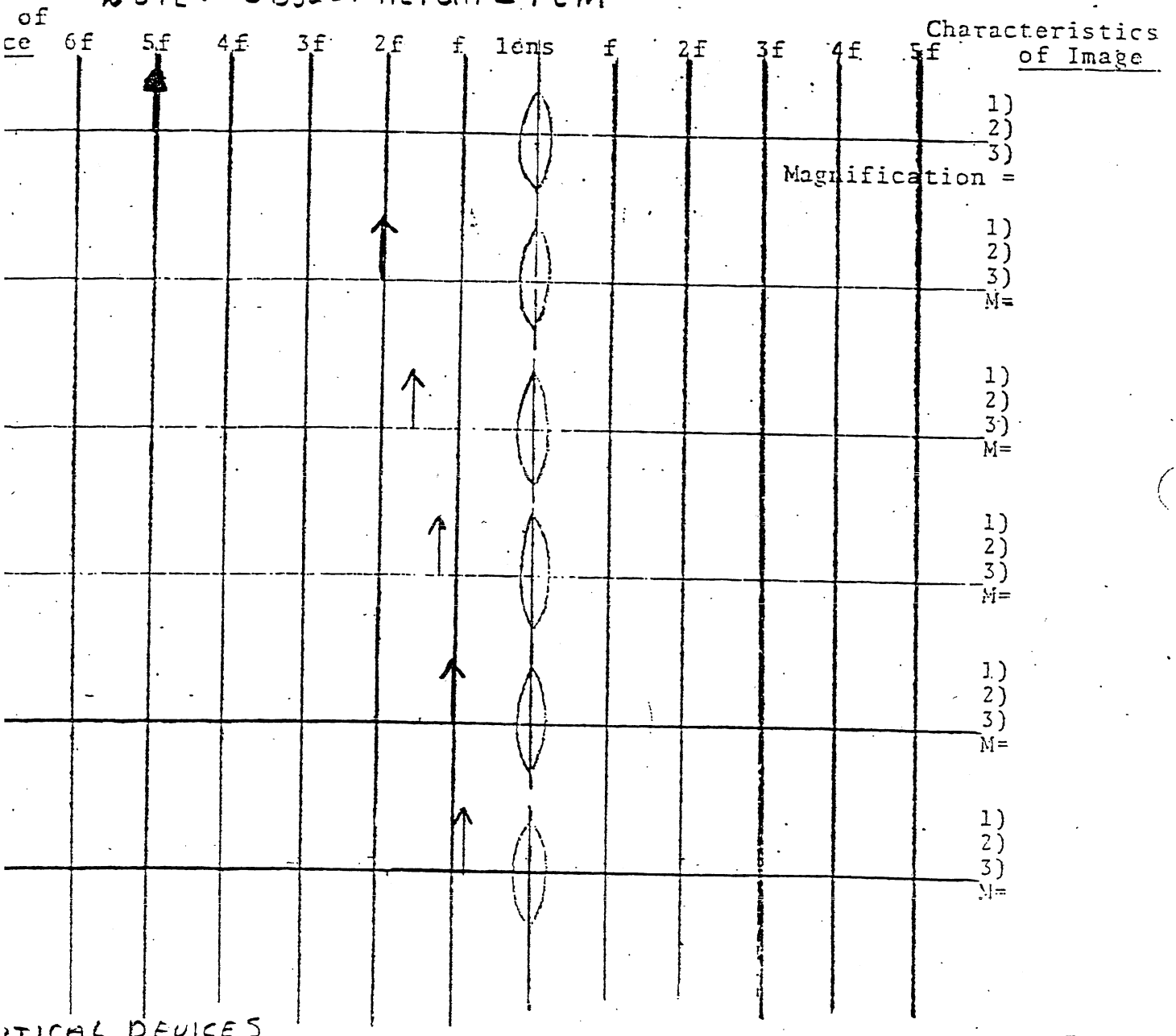
Magnification:

Type:

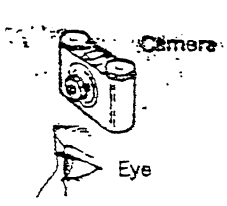
A convex lens can be used in many ways depending on where the object is located with respect to the lens.

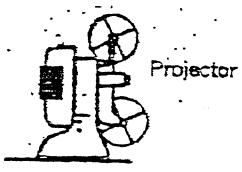
In the following chart: (a) Locate the image by using at least two finder rays; (b) State the three characteristics of each image; (c) Give the name of the optical device that each diagram represents.

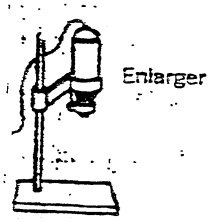
NOTE: OBJECT HEIGHT = 1 CM

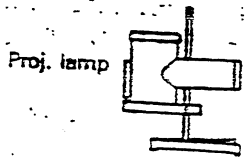


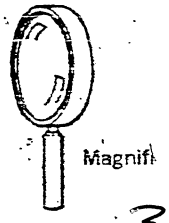
TICAL DEVICES



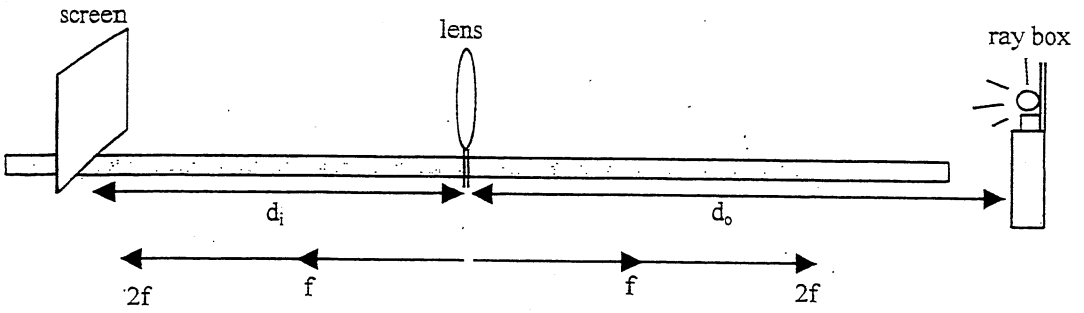








Activity Images Formed by a Converging Lens



METHOD

1. Find the focal length of the lens by focusing light from a distant (much more than 2 m away!) object onto your screen. The distance from the lens to the image is approximately f.
2. Place the lens in the middle of the metre stick and label a point on each side of the lens at a distance, f, from the lens.
3. Measure of a distance of 2f from the lens on each side and label these 2f.
4. Place the light source at the position from the lens indicated in the chart below. Record this distance on your chart.
5. Locate the image on your screen and fill in the chart with your observations. Repeat this for the other locations in the chart.

Position of light source	d_o	d_i	h_o	h_i	attitude	type	d_i / d_o	h_i / h_o	$1/d_i + 1/d_o$
beyond 2f									
at 2f									
between 2f and f									
between f and the lens									
at f									

Questions

1. Calculate h_i/h_o from your lab and compare these to d_i/d_o
2. Find a new formula for magnification?
3. Calculate $1/d_i + 1/d_o$. Is this constant? Compare this with 1/f.
4. Using a suitable scale, draw a ray diagram for each position you tested. Use only f, d_o and h_o for this diagram, and solve for d_i, h_i and the images' size, attitude and type.
5. Compare the results from the diagram with those from the lab.

Activity Ray Diagrams for Concave Lenses

Locate the images of these objects and describe the images' attitude, position, magnification and type.

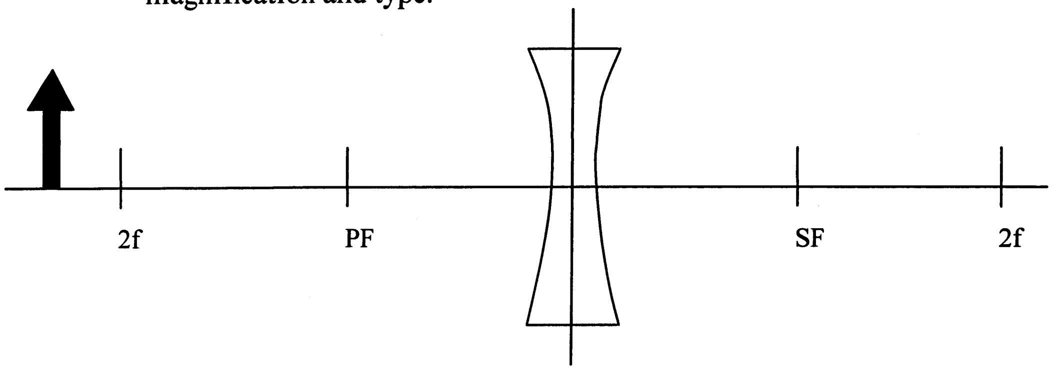


Image Characteristics

Attitude:

Position:

Magnification:

Type:

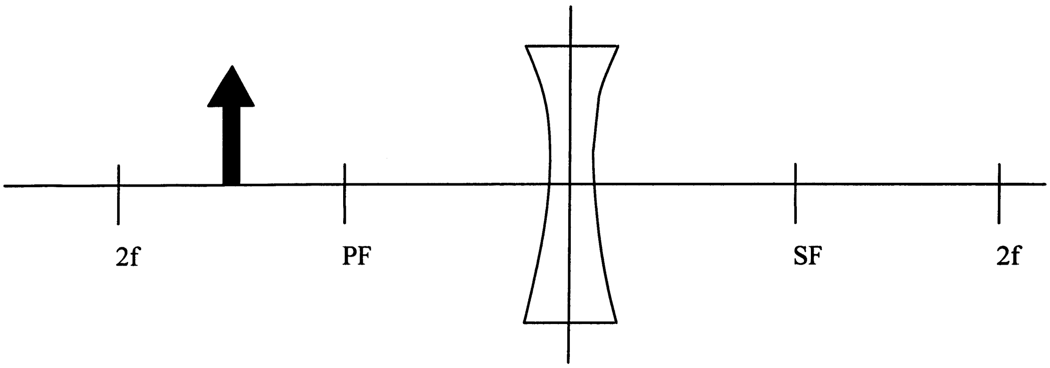


Image Characteristics

Attitude:

Position:

Magnification:

Type:

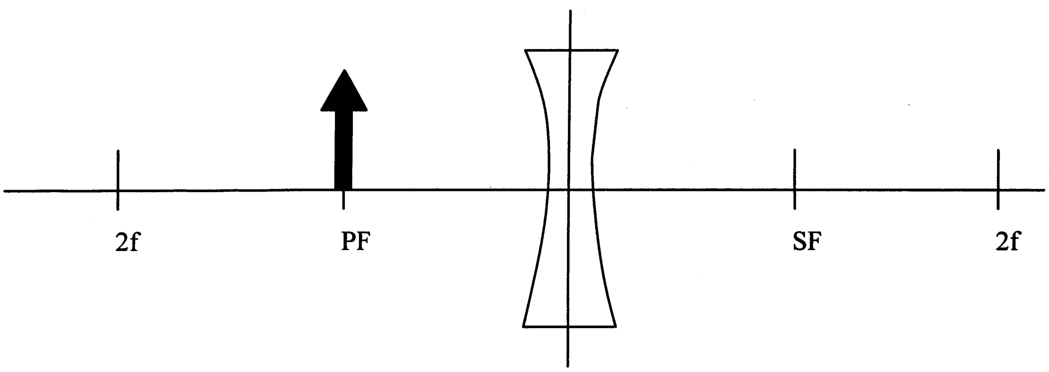


Image Characteristics

Attitude:

Position:

Magnification:

Type:

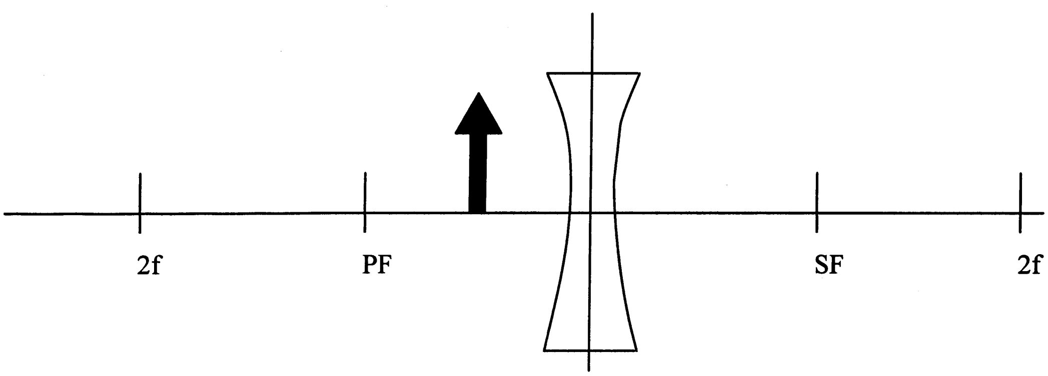


Image Characteristics

Attitude:

Position:

Magnification:

Type:

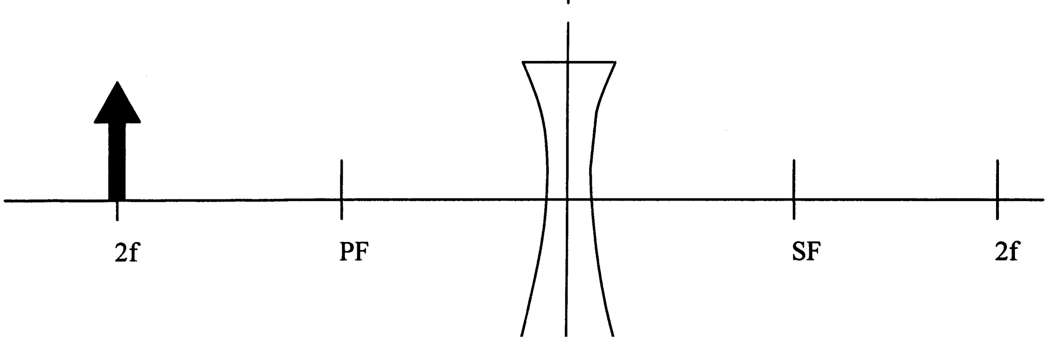


Image Characteristics

Attitude:

Position:

Magnification:

Type:

Problems The Thin Lens Equation

1. A tree 20 m high is located 40 m from the secondary focus of a convex lens of local length 8 cm. Calculate the height of the image of the tree. (4 cm)

2. A normal human eye has a focal length of about 2.3 cm. If you look at the tip of a pencil, 55.3 cm from your eye, how far is the image from the principle focus of the eye? (0.1 cm)

3. A converging lens in a photocopying machine makes images the same size as the original. If the items to be copied are placed at a fixed distance of 40 cm from the lens, what is the focal length of the lens? (20 cm)

4. The **image** of a newspaper is focused by a convex lens with a focal length of 50 cm onto a film that is 1 cm from the primary focus of the lens. The distance between adjacent grains on the film (the image height) is about 10^{-4} cm. What is the distance between these two dots on the newspaper (the object height)? ($5x10^{-3}$ cm)

5. If the focal length of the lens in your camera is 2 cm, at what distance will objects clearly be in focus if the film is set at 3 cm from the lens? (6 cm)

6. What is the focal length of the lens in your eye if you wish to look at an object 100 cm away from your eye, and the distance from your lens to the retina is 1.44 cm? (1.42 cm)

7. What is the maximum size of an object that is 100 cm from your eye if you want to see all of it? The focal length of the lens in your eye is 2 cm and the maximum size of an image that can be perceived on your retina is 5 cm. (2.45 cm)

8. A camera lens has a focal length of 3 cm
   a) When photographing a very close up object (30 cm from the lens) how far from the film should the lens be set so that the image is clear? (3.34 cm)
   b) How far should the lens be set from the film when photographing an object that is 30.03 m from the lens? (3 cm)
   c) How tall will the film image of a man who is 1.8 m tall, standing 15.03 m from the lens be? (0.36 cm)

LENS PROBLEMS

NAME _____

Practice

1. An object 8.0 cm high is placed 80 cm in front of a converging lens of focal length 25 cm.
   (a) By means of a scale ray diagram, locate the image and determine its height.
   (b) Using the lens and magnification equations, determine the image position and its height.
2. A lamp 10 cm high is placed 60 cm in front of a diverging lens of focal length −20 cm.
   (a) By means of a scale ray diagram, locate the image and determine its height.
   (b) Using the appropriate equations, calculate the image position and the height of the image.
3. A typical single lens reflex (SLR) camera has a converging lens with a focal length of 50.0 mm. What is the position and size of the image of a 25 cm candle located 1.0 m from the lens?
4. A converging lens with a focal length of 20 cm is used to create an image of the sun on a paper screen. How far from the lens must the paper be placed to produce a clear image?
5. The focal length of a slide projector's converging lens is 10.0 cm.
   (a) If a 35 mm slide is positioned 10.2 cm from the lens, how far away must the screen be placed to create a clear image?
   (b) If the height of a dog on the slide film is 12.5 mm, how tall will the dog's image on the screen be?
   (c) If the screen is then removed to a point 15 m from the lens, by how much will the separation between film and lens have to change from part (a)?

6. A copy machine has a converging lens with a focal length of 40 cm. How far from the lens must documents be placed if the copies are to be exactly the same size as the original?

7. A candle is placed 36 cm from a screen. Where between the candle and the screen should a converging lens with a focal length of 8.0 cm be placed to produce a sharp image on the screen?
8. An object 5.0 cm high is placed at the 20 cm mark on a metre stick optical bench. A converging lens with a focal length of 20 cm is mounted at the 50 cm mark. What are the position and size of the image?
9. A camera lens has a focal length of 6.0 cm and is located 7.0 cm from the film. How far from the lens is the object positioned if a clear image has been produced on the film?
10. A lens with a focal length of 20 cm is held 12 cm from a grasshopper 7.0 mm high. What is the size of the image of the grasshopper? State its position and type.
11. A projector is required to make a real image, 0.5 m tall, of a 5.0 cm object placed on a slide. Within the projector, the object is to be placed 10.0 cm from the lens. What must be the focal length of the lens?

12. A 3.0 cm flower is placed 40 cm from a lens with a focal length of 10 cm. What is the position, size, and type of image?
13. An amateur photographer takes a series of photographs of a lunar eclipse using a camera with a focal length of 6.0 cm. What will be the size of the moon's image on the film? (diameter of moon = 3.5×10^6 m, distance to the moon = 3.7×10^8 m)

1 $d_i = 36.4\text{cm}$ $h_i = -3.6\text{cm}$
2 $d_i = -15\text{cm}$ $h_i = 2.5\text{cm}$
3 $d_i = 5.3\text{cm}$ $h_i = -1.3\text{cm}$
4 $d_i = 20\text{cm}$
5 $d_i = 510\text{cm}$ $h_i = -62.5\text{cm}$
6 $d_o = 10.1\text{cm}$ $f = 40\text{cm}$
8 $d_i = 60\text{cm}$ $h_i = -10\text{cm}$
9 $d_o = 42\text{cm}$
10 $h_i = 1.75\text{cm}$ $d_i = -30\text{cm}$
11 $f = 9.1\text{cm}$
12 $d_i = 13.3\text{cm}$ $h_i = -1\text{cm}$

Independent Study The Human Eye

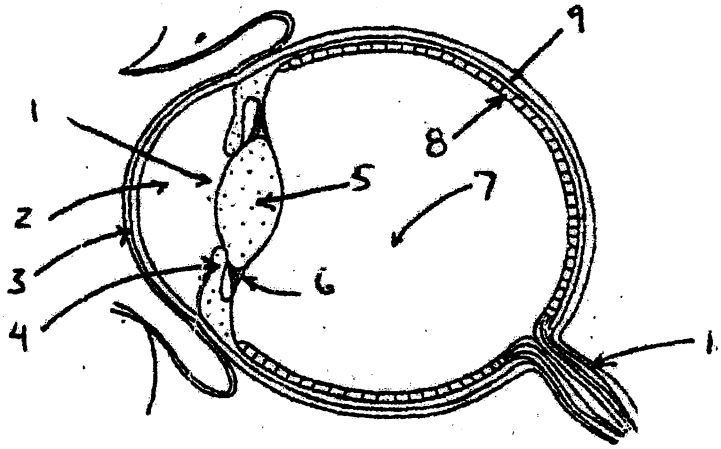
Station 1

THE STRUCTURES OF THE EYE (Hirsch: 367-8, MHR 585-588)

1. In chart form describe the function of the following parts of the human eye.

sclera	cornea	lens	ciliary muscles
pupil	iris	retina	aqueous humour
rods	cones	optic nerve	vitreous humour

2. Label the following diagram with these parts.



DOMINANT EYE TEST

3. Which is your dominant eye?
4. Are both eyes of equal strength?
5. How could having a dominant eye present a problem?

Station 2

BLIND SPOT TEST (Hirsch 368)

6. What do you see filling your blind spot when you looked at the pattern?
7. How does the blind spot get its name?
8. What causes your blind spot?
9. Why do you not have a blind spot when both eyes are open?
10. Why can't you notice your blind spot?
11. Where is the place of sharpest vision on your retina?

Station 3

ACCOMMODATION (Hirsch: 367, MHR 585)

12. What is the distance to your near point for your left and right eye?

	Near point (cm)
Left eye	
Right eye	

13. What is the near point and far point for a normal person's vision.
14. What is accommodation?
15. What problem do you get if you view close objects for too long?
16. Name several occupations that might cause this problem

VISUAL ACUITY (Hirsch: 369)

Test your visual acuity using the eye chart. This will give you an indication of your eyesight.

17. What is the visual acuity of each of your eyes?
18. Explain what the numbers mean.
19. What does 6/6 vision mean?
20. Which eye has better vision, one with 6/8 vision or 6/16 vision? Explain why.

Station 4

ASTIGMATISM (Hirsch: 369-371, MHR 588)

21. What is astigmatism?

22. What part of the eye causes this?

23. What can be used to correct this problem? (2 methods)

24. Take the test for astigmatism in Hirsch pg 369-370. In the test, what indicates that a person has astigmatism?

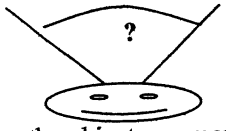
FIELD OF VIEW AND PERIPHERAL VISION (Labsheets)

Some animals have their eyes on the front of their heads (such as wolves and tigers) and some have them on the sides of their heads (such as deer and rabbits).

25. Why do some animals have their eyes on the front of their heads?

26. Where are the eyes placed on animals that have a wide field of vision?

27. Fill in the diagram of your field of vision.



28. Was your peripheral vision better or worse when-the object was moving?

29. Describe what happened when you tested for your peripheral colour vision.

30. Explain why your peripheral colour vision is so poor.

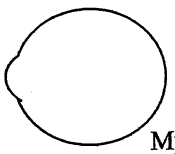
Station 5

VISION DEFECTS (Hirsch: 369-71)

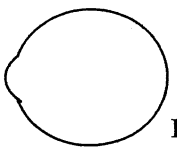
31. In chart form (a) describe the following vision defects (b) there cause and (c) ways of correcting these problems.

Defect	Description	Cause	Correction
myopia			
hyperopia			
astigmatism			
presbyopia			

32. Fill in the following diagrams with light rays to show these defects



Myopia



Hyperopia

33. A person has a near point of 13 cm and a far point of 65 cm.
    a) What type of vision defect does this person have?

    b) Can this person see an object clearly at 5 cm _____, 25 cm _____, 80 cm _____.

    c) What type of lens would correct this problem?

COLOURS FROM WHITE LIGHT

34. List the colours of the spectrum in order

35. Why do you see leaves as green?

COLOUR VISION AT A DISTANCE

36. Name the colours that where hardest to see at a distance.

37. What colour would you suggest, be the best to make a life raft if it needs to be seen at a great distance on a blue ocean?

Station 6

COLOUR VISION (Hirsch: 371, 393)

To test your vision, use the 4 lshihara colour plates printed on the lab sheet provided by your teacher

38. Describe what you saw on the 4 colour plates.

39. What part of the retina is responsible for colour vision?

40. What proportion of those likely to be colour blind are male _____ female_____

41. Many occupations are not available to people who are colour blind. Name 5 occupations that you think would require proper colour vision.

42. Many people who are partially or completely colour blind cope satisfactorily. Explain how they do this?

43. What colours are emitted by a colour TV to produce all the colours?

44. What causes these colour bars to emit light?

45. What parts of the retina are sensitive to light?

46. What colours are detected by the retina?

Worksheet The Additive Theory of Colour

There are two main applications of mixing colours additively. Colour television hues are produced in this manner and lighting effects on stage are produced by shining coloured lights together. This mixes colours additively.

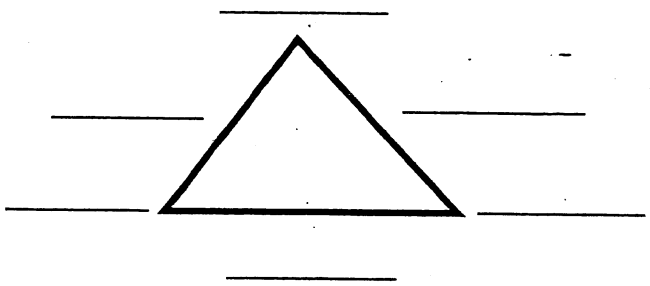
There are three colours that we call the additive primary colours. These colours are _____, _____, and _____

Why were these colours chosen as the primary light colours?

Fill in the following chart

Red + Green =	Red + Cyan =
Green + Blue =	Blue + Yellow =
Red + Blue =	Green + Magenta =
Red + Green + Blue =	

You can now summarize this information from the chart by the use of a colour triangle. Write the additive primaries at the vertices of the triangle and the colour which results from their mixing along the sides.



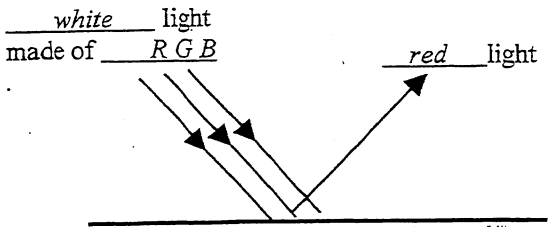
What name do we give to the colours that result from the mixing of the primary colours.

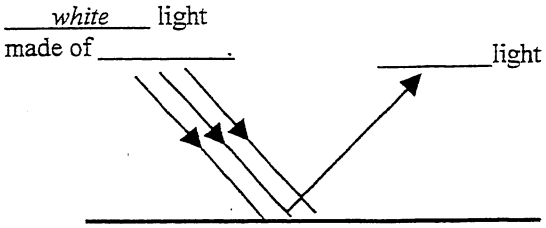
Two colours are said to be complimentary if when they mix they produce white light. Name the pairs of complimentary colours

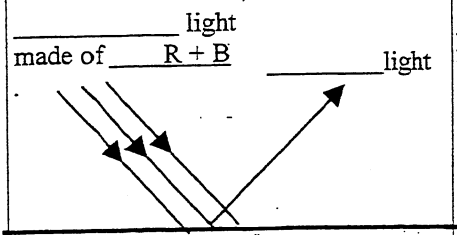
_____ and _____, _____ and _____, _____ and _____

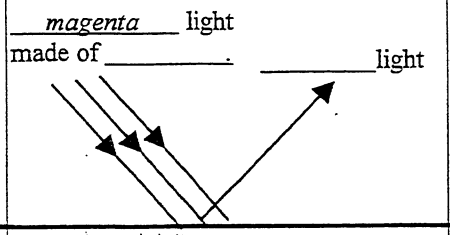
Activity Subtractive Colours

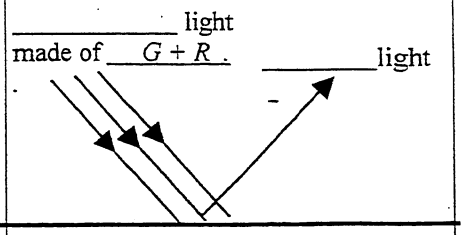
Fill in the missing information. Consider the colour of the incident light, the colours absorbed and reflected from the paint and the perceived colour of the reflected light.

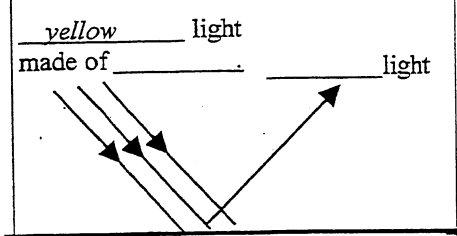


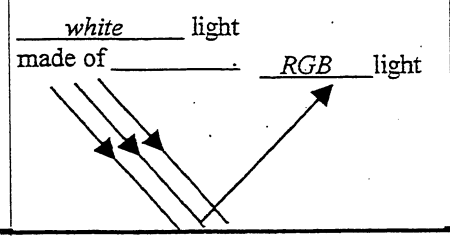


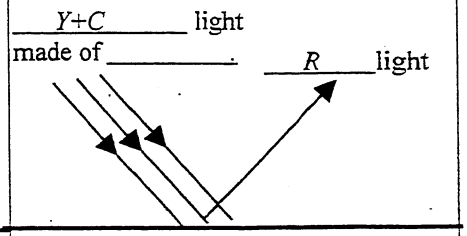












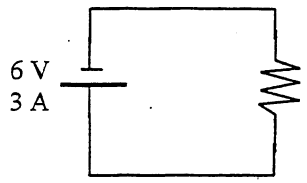
The Canadian flag is seen under the given coloured lights. What colour would it appear to the human eye?

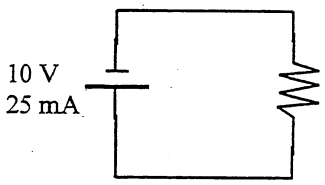
In white light the flag appears	_____	and	_____
In red light the flag appears	_____	and	_____
In magenta light the flag appears	_____	and	_____
In cyan light the flag appears	_____	and	_____
In blue light the flag appears	_____	and	_____

Problems Ohm's Law

1. A solution of sodium chloride creates a potential difference of 15 volts allowing a current of 2 amperes to flow. Find its resistance. (7.5 ohms)

2. Find the resistance of the resistors in each of the following circuits. (2 Ω, 400Ω)

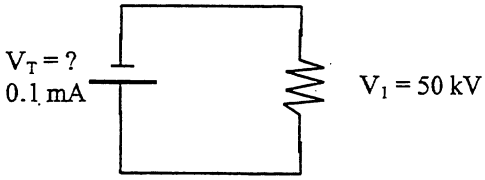




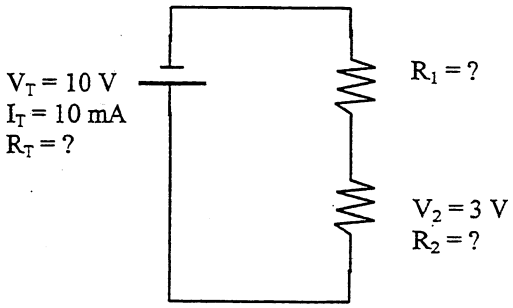
3. An electric motor operating on a 120 V supply has a resistance of 16 Ω. Find the current in the motor (7.5 A)

4. A single lamp connected to a battery of 4.5 V draws a charge of 20 C every 4 s. Find the lamp's resistance. (0.9Ω)

5. Find V_T.



6. Find R, V and I for the resistors and the cell.



Superconductivity Heats Up

Breakthroughs in transmitting electricity without energy loss

At the University of Alabama in Huntsville, physicists last month placed a chip of a green, brittle compound inside a thermos-like container, doused it with frigid liquid nitrogen and sent an electric current through it. As the temperature dropped, they took careful measurements of the compound's electrical resistance—its opposition to the passage of current.*

Suddenly, at 93 Kelvin (−292° F), the resistance dropped precipitously. The substance had become a superconductor, able to transmit current with virtually no loss of energy. "We were so excited and so nervous that our hands were shaking," says Physicist Maw-kuen Wu. "At first we were suspicious that it was an error."

Not so. Wu's group, under the direction of University of Houston Physicist Paul C.W. Chu, had achieved the phenomenon of superconductivity at a higher temperature than ever before. And the National Science Foundation announced last week that Chu's Houston lab had pushed that temperature 5° higher—to 98 K. Under such conditions—far less extreme than those required only a few years ago—superconducting technology might eventually become inexpensive and even commonplace. Possible applications: superconducting cables that could transmit electricity from a power plant to a distant city with essentially no energy loss; practical versions of trains that "fly" just above their tracks at hundreds of miles an hour, cushioned on magnetic fields; more widespread use of magnetic resonance imaging machines, which take sharp pictures of the soft tissues of the body. Says Northwestern University Physicist Arthur Freeman: "A barrier has been broken. It's exciting for the physics community and for mankind as a whole."

Superconductivity was discovered in 1911, when Dutch Physicist Heike Onnes cooled the element mercury to near absolute zero (0 Kelvin, or −460° F) and discovered that it had lost its resistance to electric current. Since then more than two dozen chemical elements and hundreds of compounds have been found to be superconductors near that temperature extreme. The only practical way to make something that cold is to bathe it in liquid helium, which exists only at temperatures below 4 K. But helium is rare, and expensive to liquefy. Even so, the efficiency of electromagnets wound with superconducting wires is so great that in certain situations the expense is justified.

For example, giant particle accelerators require extremely powerful magnets to keep the particles confined to a circular track as they move at nearly the speed of light. At Fermilab, near Chicago, the world's most powerful accelerator, known as Tevatron, uses more than 1,000 superconducting magnets cooled with liquid helium at a cost of $5 million a year. But the efficiency of the magnets saves Fermilab an estimated $185 million annually in electric energy costs. The superconducting super collider, a mammoth accelerator 52 miles in circumference, endorsed last month by President Reagan for completion in the 1990s at a projected cost of between $4 billion and $6 billion, will use 10,000 superconducting magnets and save nearly $600 million annually.

In most uses, however, the cost of liquid helium outweighs the benefits of superconducting technology. For that reason, scientists have long searched for a compound that would become a superconductor at less extreme temperatures—particularly above 77 K (−320° F), the point at which nitrogen gas liquefies. Reason: nitrogen is a common gas and costs no more than a tenth as much in liquid form as helium. In fact, says Iowa State University Physicist Douglas Finnemore, liquid nitrogen, priced as low as a nickel a liter, is a "heck of a lot cheaper than beer."

The much sought-after goal proved to be elusive. In the early 1970s scientists found an alloy of niobium and germanium that lost all resistance at 23 K. Then, last April, a group at the IBM Zurich Research Laboratory in Switzerland announced development of a compound of barium, lanthanum, copper and oxygen that appeared to begin the transition to superconductivity at 35 K.

In October the Zurichers confirmed their result, which other researchers duplicated and then tried to beat. A slow-moving branch of physics became a horse race as laboratories around the world attempted to push temperatures higher. Last week's announcement does not end the competition. Says Paul Fleury, director of AT&T Bell Laboratories' Physical Research Laboratory: "It took physicists 75 years to raise superconductivity temperatures by 19°. We have more than doubled that in the last 75 days. We're now dealing with new science, and we don't know what the upper limits are."

Chu foresees a balmy 120 K within a few months, and does not rule out superconductors that could operate at 300 K (room temperature). University of Illinois Physicist John Bardeen, who shared the Nobel Prize in 1972 for his part in explaining the quantum-mechanical basis of superconductivity, agrees that there is no theoretical reason precluding higher temperature superconductors. But, he says, "finding materials with the right combination of properties is tricky." Admits Chu: "There was a bit of serendipity involved."

Chu will describe the new material and details of how it was developed in an upcoming issue of *Physical Review Letters*, but the University of Houston has already applied for a patent on both product and process. If it is granted, Chu stands to share in the profits, which could be large. "It's phenomenal—we're excited," says Robert Jake of American Magnetics, a manufacturer of superconducting magnets. "But it will take several years of research and development to make it feasible for commercial application." When such applications come, says Chu, they will make clear the significance of his discovery: "I think it could almost be like the discovery of electricity."

—By Michael D. Lemonick. Reported by J. Madeleine Nash/Chicago and Richard Woodbury/Houston

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Physicist Chu holds a tweezerful of the world's warmest superconductor

"It could almost be like the discovery of electricity."

*It is resistance that converts electric energy into heat, as in the coils of an electric heater.

Worksheet Superconductivity

1 What is superconductivity?

2 Who discovered superconductivity?

3 At what temperature was superconductivity first achieved?

4 What is the highest temperature superconductivity achieved so far and who did this (in °C)?

5 What are the applications of superconductors?

6 Discuss some of the problems with using the superconductors we have now?

7 Why do we need a superconductor that works at temperatures above 77 °K ?

8 What elements are used to make a superconductor?

Ohm's Law and Resistivity

Group Names _____, _____, _____, _____

Materials: Pencil, connectors, voltmeter, ammeter, power supply.

The resistance of a material depends on the length, the cross-sectional area and the resistivity of the material.

Combining all this we get $\mathbf{R = \rho L/A}$ where **R** is the resistance in Ω, ρ is the resistivity in Ωm, **L** is the Length in metres (m) and **A** is the area in m^2.

1) Using a carbon rod (pencil lead) sharpen both ends and then measure the length and diameter.
L = _____cm = _____m. Measure the diameter of the pencil lead D = _____mm = _____m

2) Draw a circuit with that shows the power supply, connecting wire, load, ammeter in series, voltmeter in parallel to read voltage across the pencil. **Have your diagram checked by the teacher before moving on to the next step.**

3) Set up the circuit you drew and measure the voltage and current through the circuit with the power supply set at 1.5 v, 3 v, 4.5 v and 6 v. Calculate the resistance for the chart.

Power supply voltage setting (V)	Actual Voltage (V)	Current (A)	Resistance (Ω)
1.5			
3			
4.5			
6			

4) From your results what is the most likely value for the resistance?

5) Calculate the area of the carbon rod.

6) Rearrange the equation to solve for the resistivity.

7) Calculate the resistivity of the carbon rod.

8) Compare this to the value of the resistivity of carbon given in the book

9) Find the resistivity of 15m of copper wire that has a radius of 2.5×10^{-4} m.

ELECTRICITY REVIEW

(A) Practice

1. How much electric current is there when 12 C of charge pass a point in a conductor in 4.0 s?
2. What is the current through a light bulb when it takes 24 s for 18 C of charge to pass through its filament?
3. How much charge passes through the starting motor, if it takes 4.0 s to start a car and there is a current of 225 A during that time?
4. A small electric motor draws a current of 0.40 A. How long will it take for 8.0 C of charge to pass through it?
5. How many electrons pass through a light bulb in each second if the bulb has a current of 0.50 A through it?

(B)

1. What amount of energy does a kettle use to boil water if it has 800 C of charge passing through it with a potential difference of 120 V?
2. What is the potential difference across a refrigerator if 75 C of charge transfer 9.0×10^3 J of energy to the compressor motor?
3. An electric baseboard heater draws a current of 6.0 A and has a potential difference of 240 V. For how long must it remain on to use 2.2×10^5 J of electrical energy?
4. A flash of lightning transfers 1.5×10^9 J of electrical energy through a potential difference of 5.0×10^7 V between a cloud and the ground. Calculate the quantity of charge transferred in the lightning bolt.
5. Calculate the energy stored in a 9.0 V battery that can deliver a continuous current of 5.0 mA for 2.0×10^3 s.
6. If a charge of 0.30 C moves from one point to another in a conductor and, in doing so, releases 5.4 J of electrical energy, what is the potential difference between the two points?
7. How much charge is transferred by a current of 0.40 A in 15 min?
8. How long does it take for a current of 7.5 mA to transfer a charge of 15 C?
9. What is the potential difference between two points if 1 kJ of work is required to move 1 C of charge between the two points?
10. What is the energy of an electron accelerated through a potential difference of 1.0 MV?
11. What is the potential difference between two points when a charge of 80 C has 4.0×10^2 J of energy supplied to it as it moves between the points?
12. There is a current of 0.50 A through an incandescent lamp for 2.0 min, with a potential difference of 120 V. How much energy does the current transfer to the lamp?

Problems More Current and Voltage Problems!

For each circuit, find all the missing quantities.

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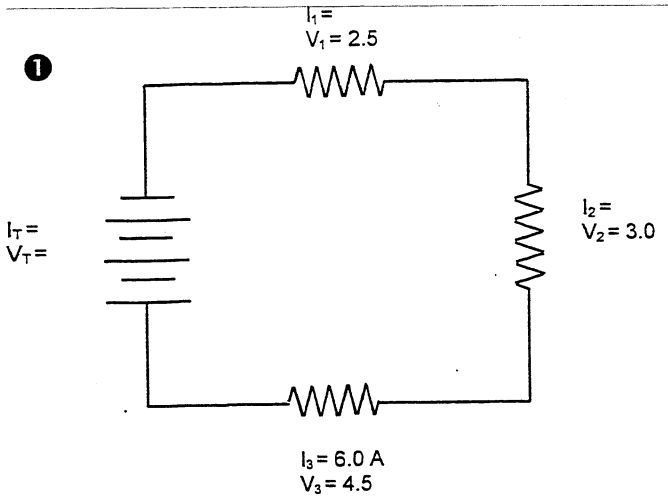

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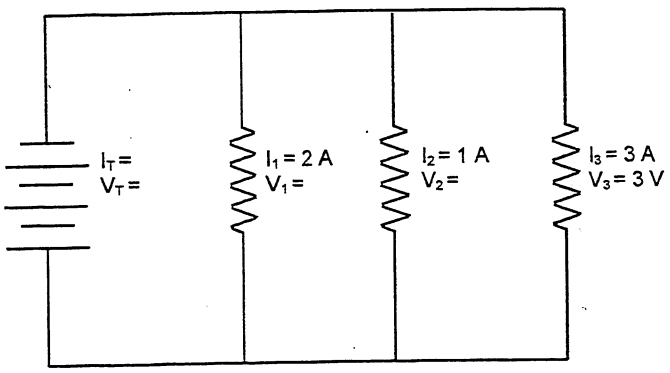

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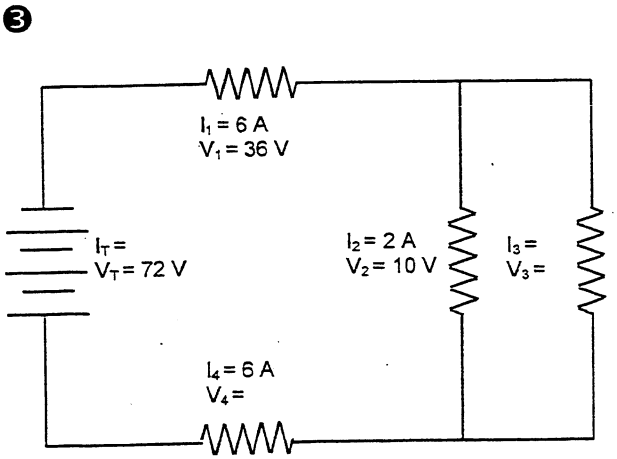

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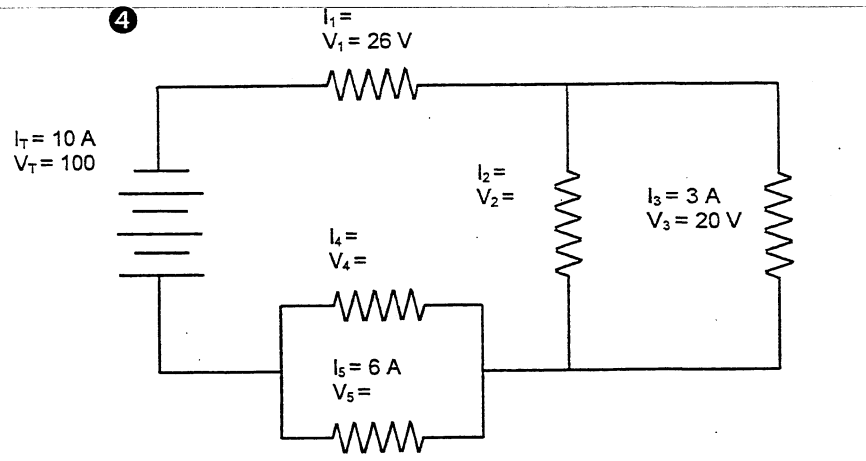

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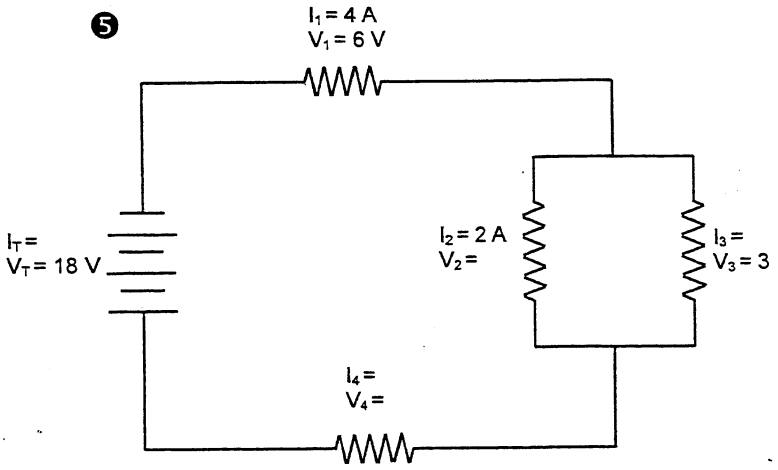

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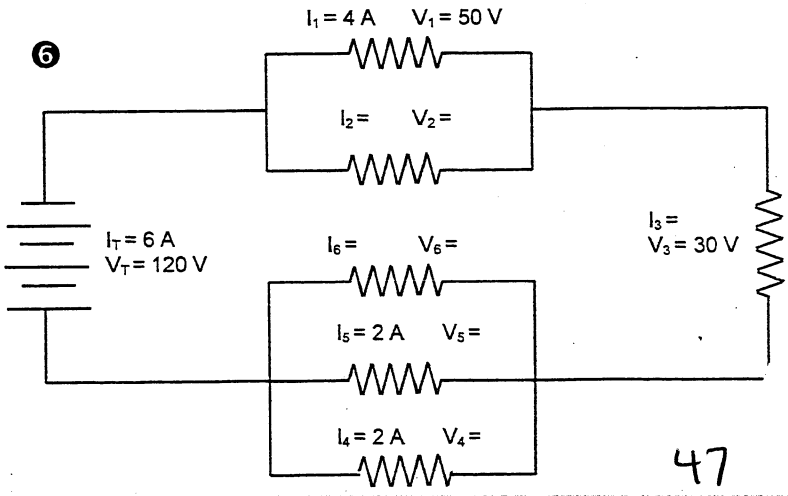

Problems Equivalent Resistance

Determine the total resistance of each circuit.

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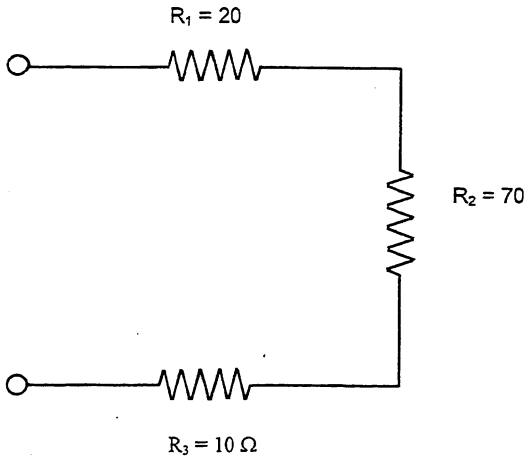

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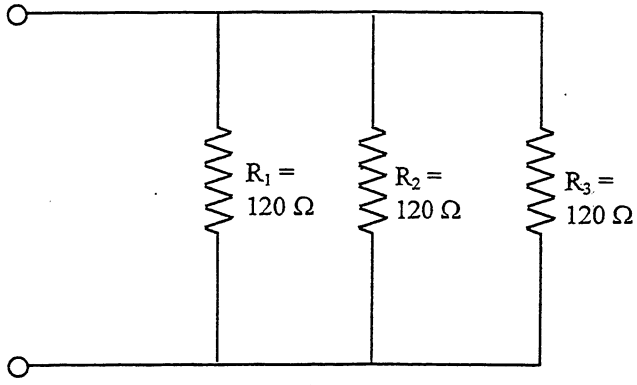

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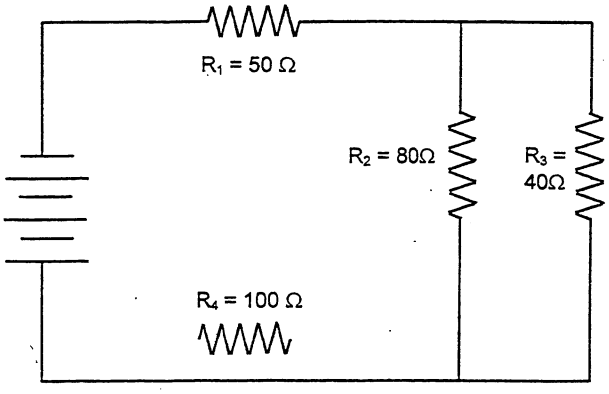

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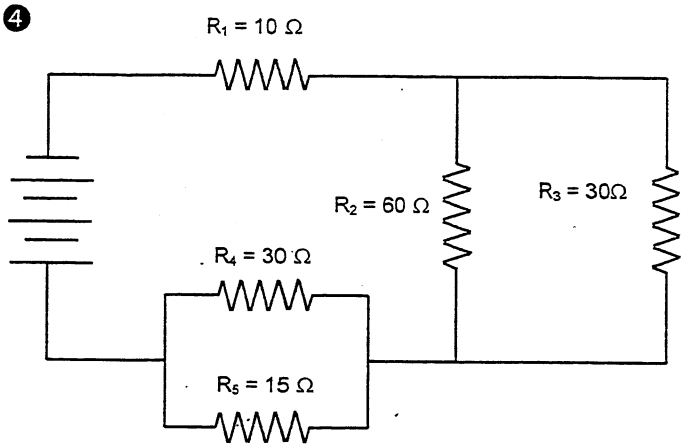

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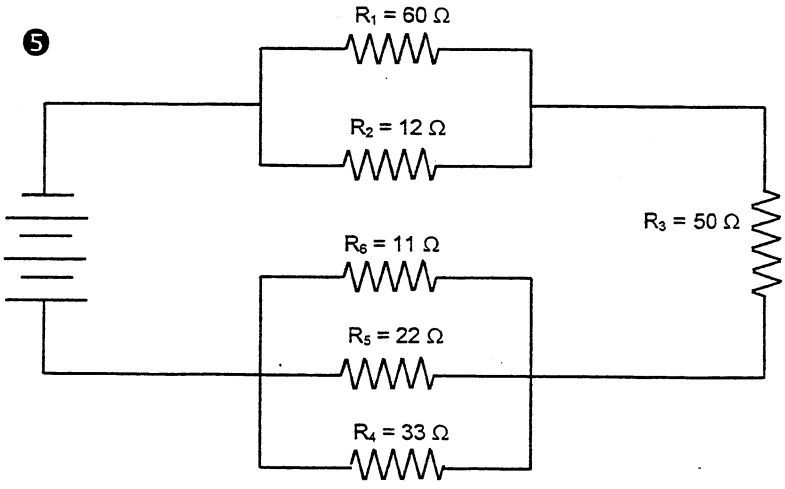

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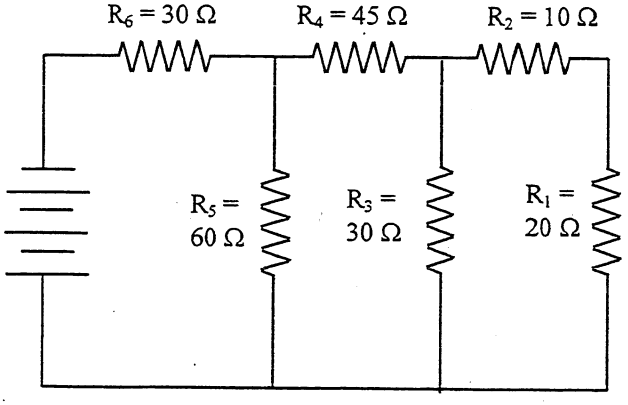
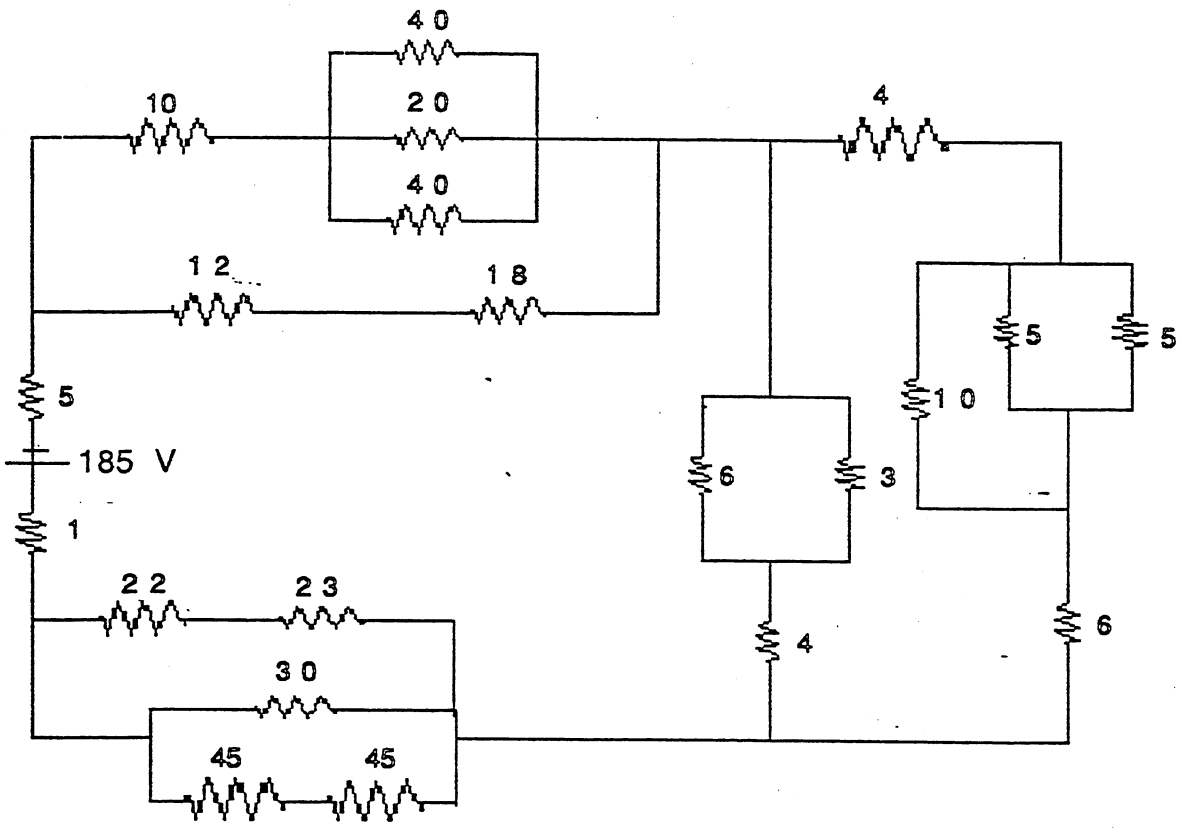
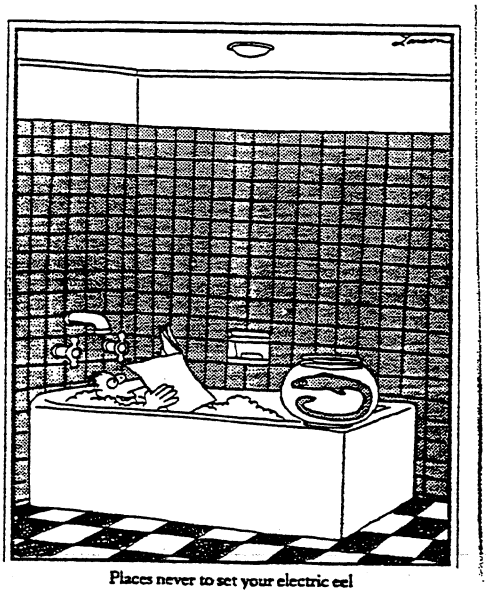


DO YOUR OHMWORK!



Find the total resistance and the total current



Places never to set your electric eel

Drawing Circuits

Name _____

One cell, one switch, two resisters in series	Two cells, one switch, three bulbs in series	Two cells, one switch, three bulbs in series and an ammeter.
Two cells, one switch, two bulbs in series and a voltmeter to measure the voltage of the second bulb.	Two cells, one switch, three bulbs in series and a voltmeter to measure the voltage of the second bulb and an ammeter.	Two cells in series, three bulbs in parallel and a switch to turn the bulbs all off at once.
Two cells in parallel, two bulbs in parallel and switches to turn each bulb on separately.	Two cells in parallel, two resisters in parallel and ammeters and voltmeters to measure each resister.	Two cells in series, two bulbs in parallel, one in series and switches to turn each bulb on separately.

Conceptual Questions

5. One electrical appliance operates with a voltage of 120 V, while another operates with 240 V. Based on this information one, is it correct to say that the second appliance uses more power than the first? Give your reasoning.

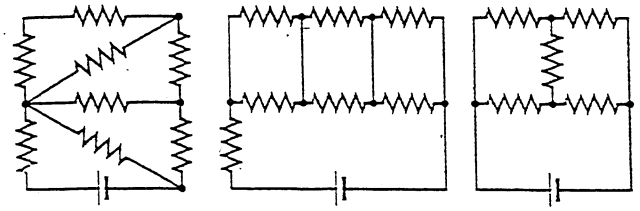
6. Two light bulbs are designed for use at 120 V and are rated at 75 W and 150 W. Which light bulb has the greater filament resistance? Why?

7. Often, the instructions for an electrical appliance do not state how many watts of power the appliance uses. Instead, a statement such as "10 A, 120 V" is given. Explain why this statement is equivalent to telling you the power consumption.

10. A number of light bulbs are to be connected to a single electrical outlet. Will the bulbs provide more brightness if they are connected in series or in parallel? Why?

11. A car has two headlights. The filament of one burns out. However, the other headlight stays on. Draw a circuit diagram that shows how the lights are connected to the battery. Give your reasoning.

* 12. In one of the circuits in the drawing, none of the resistors is in series or in parallel. Which is it? Explain.



13. You have four identical resistors, each with a resistance of R. You are asked to connect these four together so that the equivalent resistance of the resulting combination is R. How many ways can you do it? There is more than one way. Justify your answers.

Problems

1. **ssm** A portable compact disc player is designed to play for 2.0 h on a fully charged battery pack. If the battery pack provides a total of 180 C of charge, how much current does the player use in operating? 0.025 A

2. A CD-ROM drive in a laptop computer uses a current of 0.27 A. In one minute, how many electrons pass through the device?

3. A toaster has a resistance of 14 Ω and is plugged into a 120-V outlet. What is the current in the toaster? 8.6 A

4. The filament of a light bulb has a resistance of 580 Ω. A voltage of 120 V is connected across the filament. How much current is in the filament?

5. **ssm** In the arctic, electric socks are useful. A pair of socks uses a 9.0-V battery pack for each sock. A current of 0.11 A is drawn from each battery pack by wire woven into the socks. Find the resistance of the wire in one sock. 82 Ω

6. A battery charger is connected to a dead battery and delivers a current of 6.0 A for 5.0 hours, keeping the voltage across the battery terminals at 12 V in the process. How much energy is delivered to the battery?

* = Tricky Question

Power

22. An automobile battery is being charged at a voltage of 12.0 V and a current of 19.0 A. How much power is being produced by the charger?

23. The heating element in an iron has a resistance of 24 Ω. The toaster is plugged into a 120-V outlet. What is the power dissipated by the iron? 6.0×10^2 W

24. An electric blanket is connected to a 120-V outlet and consumes 140 W of power. What is the current in the wire in the blanket?

26. An electric alarm clock uses a 5.0-W motor and runs all day, every day. If electricity costs $0.10/kWh, determine the yearly cost of running the clock.

Series Circuits

40. The current in a 47-Ω resistor is 0.12 A. This resistor is in series with a 28-Ω resistor, and the series combination is connected across a battery. What is the battery voltage?

41. **ssm** Three resistors, 25, 45, and 75 Ω, are connected in series, and a 0.51-A current passes through them. What is (a) the equivalent resistance and (b) the potential difference across the three resistors? a) 145 Ω b) 74 V

42. A 36.0-Ω resistor and an 18.0-Ω resistor are connected in series across a 15.0-V battery. What is the voltage across (a) the 36.0-Ω resistor and (b) the 18.0-Ω resistor?

43. A battery dissipates 2.50 W of power in each of two 47.0-Ω resistors connected in series. What is the voltage of the battery? 21.7 V

44. Three resistors, 9.0, 5.0, and 1.0 Ω, are connected in series across a 24-V battery. Find (a) the current in, (b) the voltage across, and (c) the power dissipated in each resistor.

45. **ssm** The current in a series circuit is 15.0 A. When an additional 8.00-Ω resistor is inserted in series, the current drops to 12.0 A. What is the resistance in the original circuit? 32 Ω

Parallel Circuits

49. **ssm** A 16-Ω loudspeaker and an 8.0-Ω loudspeaker are connected in parallel across the terminals of an amplifier. Assuming the speakers behave as resistors, determine the equivalent resistance of the two speakers. 5.3 Ω

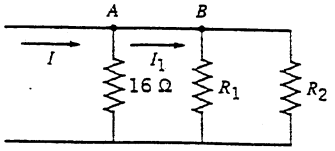
50. What resistance must be placed in parallel with a 155-Ω resistor to make the equivalent resistance 115 Ω?

51. How many 4.0-Ω resistors must be connected in parallel to create an equivalent resistance of one-sixteenth of an ohm? 64

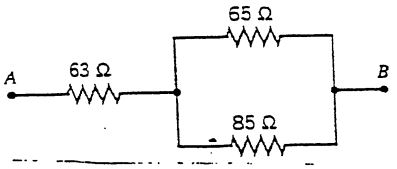
52. A wire whose resistance is R is cut into three equally long pieces, which are then connected in parallel. In terms of R, what is the resistance of the parallel combination?

53. **ssm** Two resistors, 42.0 and 64.0 Ω, are connected in parallel. The current through the 64.0-Ω resistor is 3.00 A. (a) Determine the current in the other resistor. (b) What is the total power consumed by the two resistors? a) 4.57 A b) 1450 W

* 56. The drawing shows three resistors connected in parallel. At junction A the current I divides equally. At junction B the current I_1 also divides equally. Find the values of (a) R_1 and (b) R_2.

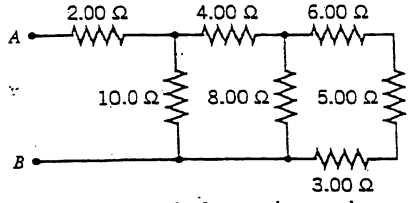


61. **ssm** For the combination of resistors shown in the drawing, determine the equivalent resistance between points *A* and *B*.



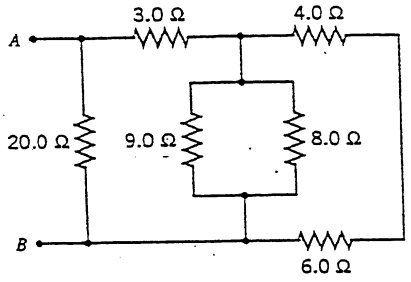
1.0x10²Ω

63. Find the equivalent resistance between points *A* and *B* in the drawing.



6.76Ω

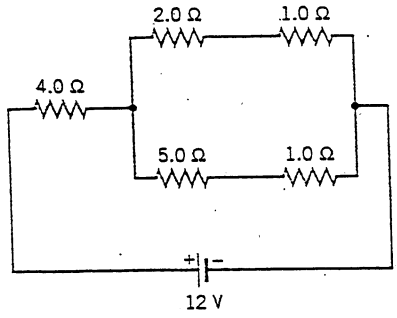
65. **ssm** Determine the equivalent resistance between the points *A* and *B* for the group of resistors in the drawing.



4.6Ω

*66. You have a number of identical 450.0-Ω resistors. (a) There is one way in which three of these resistors can be wired to give an equivalent resistance of 300.0 Ω. What is it? (b) There are two ways in which six of these resistors can be wired to give an equivalent resistance of 300.0 Ω. What are they? In both parts (a) and (b), show calculations to support your answers.

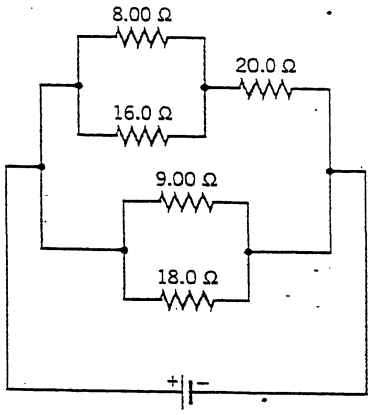
*67. Determine the power dissipated in the 5.0-Ω resistor in the circuit shown in the drawing.



2.2W

*68. Three identical resistors are connected in parallel. The equivalent resistance increases by 700 Ω when one resistor is removed and connected in series with the remaining two, which are still in parallel. Find the resistance of each resistor.

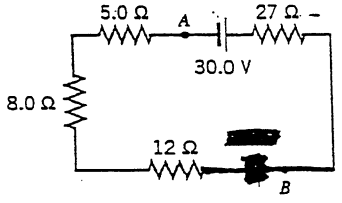
69. **ssm www The current in the 8.00-Ω resistor in the drawing is 0.500 A. Find the current in (a) the 20.0-Ω resistor and in (b) the 9.00-Ω resistor.



a) 0.750 A b) 2.11 A

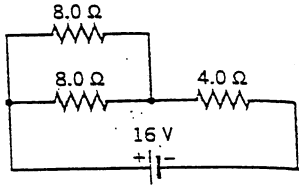
VOLTAGE/CURRENT LAWS

77. **ssm** Consider the circuit in the drawing. Determine (a) the magnitude of the current in the circuit and (b) the magnitude of the voltage between the points labeled *A* and *B*. (c) State which point, *A* or *B*, is at the higher potential.

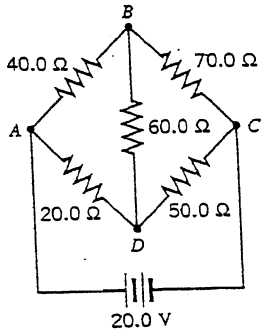


a)
b)
c)

78. The drawing shows resistors that are partly in series and partly in parallel. (a) Find the current in the 4.0-Ω resistor.



**83. The circuit in the drawing is known as a Wheatstone bridge circuit. Find the voltage between points *B* and *D*.

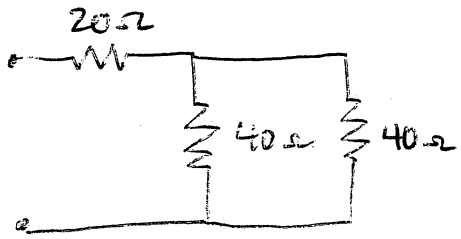


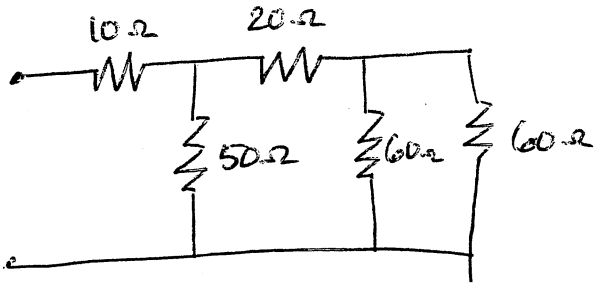
0.94V

Electricity Review

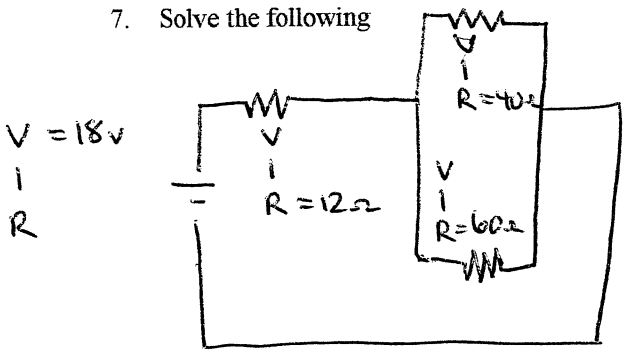
Name _____

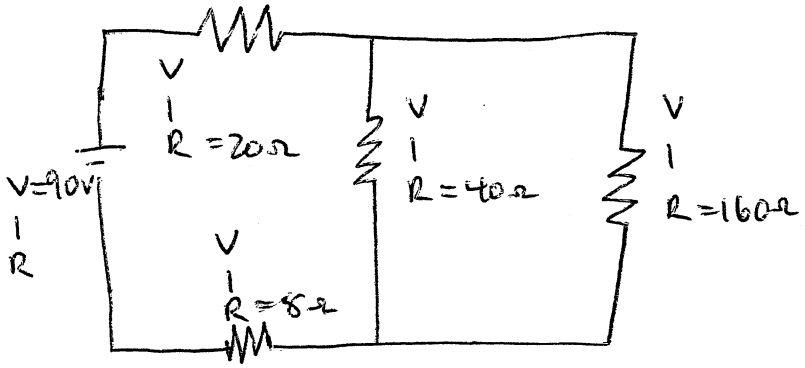
1. Draw a voltaic cell and label its parts.
2. A charge of 6C moves through a bulb in 2 seconds. Find the amount of current.
3. How much energy is given by a battery that is 1.5V if 6C of charge passes through it.
4. How much energy is used by a heater that draws 14 A of current from a 120 V plug in 8 minutes.
5. Find the total resistance.





6. A hair dryer draws 25 A from a 120 V circuit. Find its resistance.
7. Solve the following





8. Find the cost to run a 120V television if it draws 4A of current in 20 minutes at an electrical rate of 4.5 cents/kWh.
9. Find the cost to run a washer for 2 hours if it has a resistance of 2 ohms and draws 30 A of current at a rate of 5 cents/kWh.
10. What is the electric potential of a 30 W stereo that draws 2.5A
11. A 20-ohm razor requires an electric potential of 5V. What is the razor's power?
12. A 24-ohm curling iron draws a current of 5.5A. What is the power of the curling iron and how long will it take to use 1 mega-Joule of energy?
13. A 1.1 kW electric lawnmower is used in a 120 volt circuit. What is the resistance?
14. A 2.2 kW stove is used for 24 minutes. The cost of electricity is 2.5 cents/kWh. How much did it cost to run it?
15. A light bulb has a life of 3000 hours. If a 60 W light bulb is left on for the 3000 hours, at a cost of 5.2 cents/kWh, how much did it cost to run it?

Video Magnetism

1 Without magnetism there can be no _____, _____ or _____

2 When did the Greeks discover magnetite?

3 When did Europeans first use lodestone as a compass?

4 The way iron fillings are attracted to Lodestone suggest the idea of _____

5 Draw the magnetic lines around the magnet.

N	S

6 The North magnetic pole of the Earth is actually this kind of pole _____

7 The south magnetic pole turns out to be a _____

8 What happens to the magnetic properties of iron at high temperature?

9 What is believed to be the cause of the Earth's magnetic field?

10 At Eureka, NWT what is the magnetic declination _____

11 At Toronto, what is the declination _____

12 At Churchill Manitoba, what is the declination _____

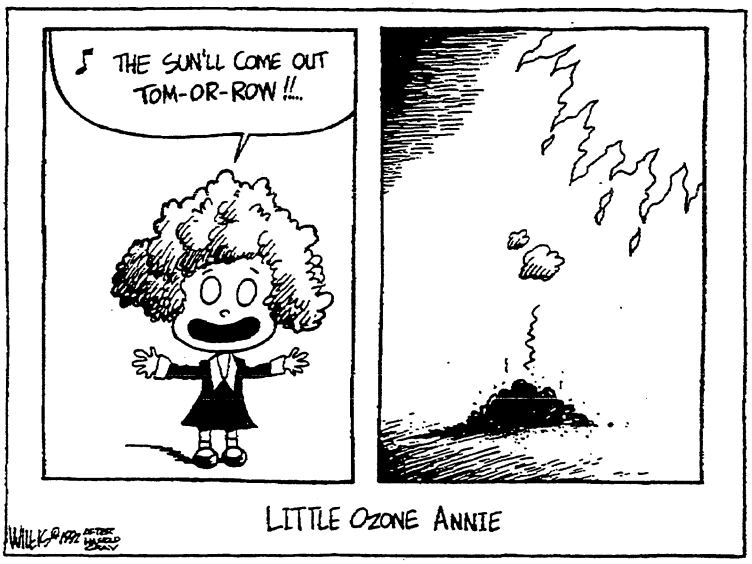
13 Where are the magnetic field lines of the Earth parallel to the surface _____

14 What is the name of the instrument used to measure inclination _____

After the video

15 Define magnetic declination.

16 Define magnetic inclination.



Video Magnetism Part II

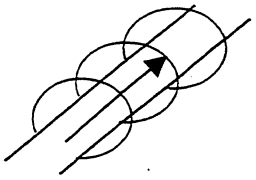
1 Do magnetic fields travel through space? _____

2 What do they compare magnetism with? _____

3 In 1800 what did Alessandro Volta make? _____

4 In 1819 what did Oersted use to make a magnetic field? _____

5 Show on the diagram how Henri Ampere showed the magnetic field



6 Name the rule for predicting the magnetic field direction_____

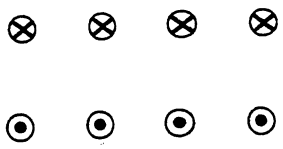
7 What shows the electron flow or current direction _____

8 What shows the magnetic field direction _____

9 The loop evolves into a helix or _____

10 Show the direction of the current at both ends of the wire

11 Show with arrows the direction of the magnetic field lines. Remember the field lines do not overlap



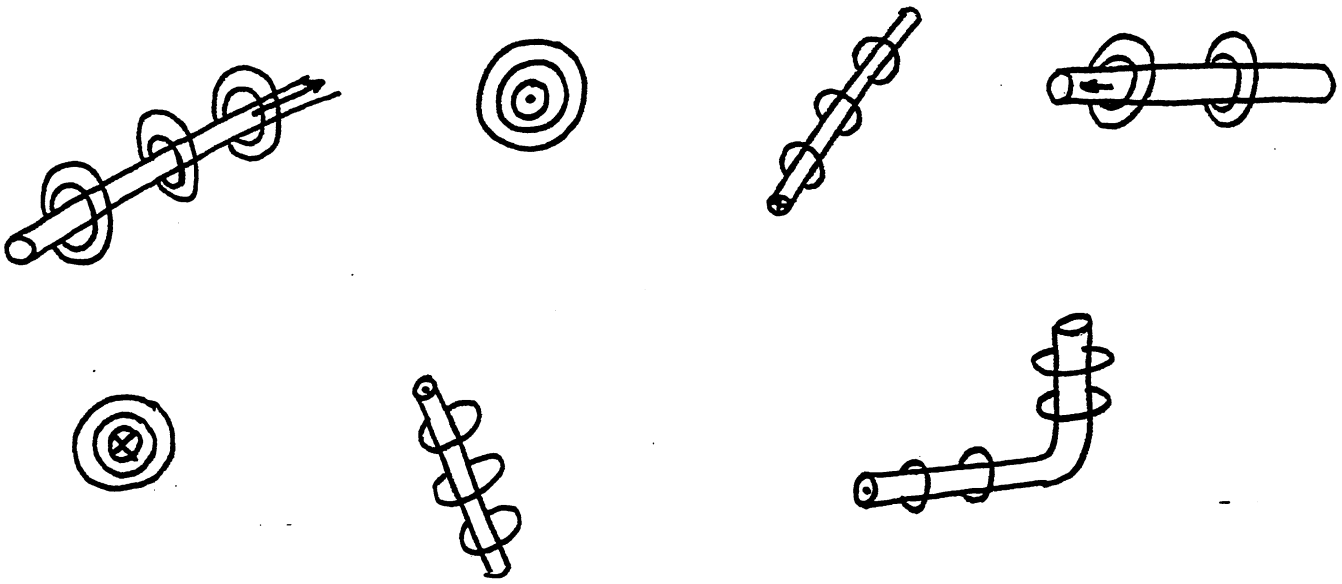
13 Where the lines are close together the field is (stronger, weaker)

14 Where the lines are far apart the field is _____

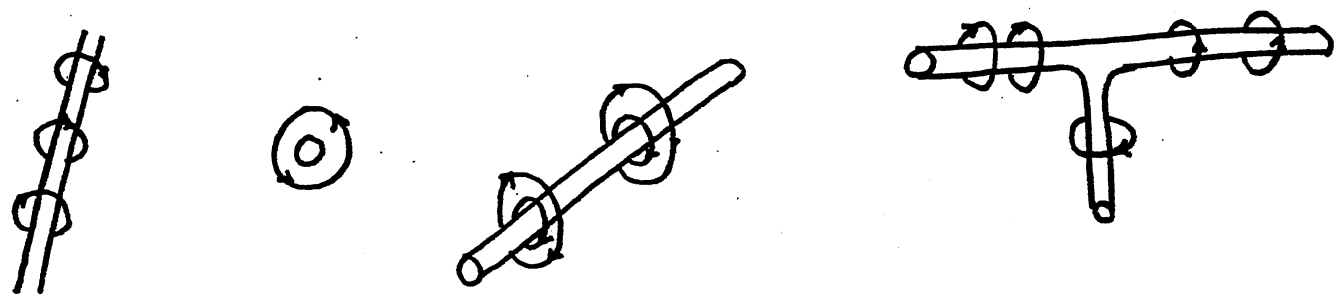
15 In the left hand rule for coils, the _____ shows the current direction and the _____ shows the end where the North pole is.

THE RIGHT HAND RULE

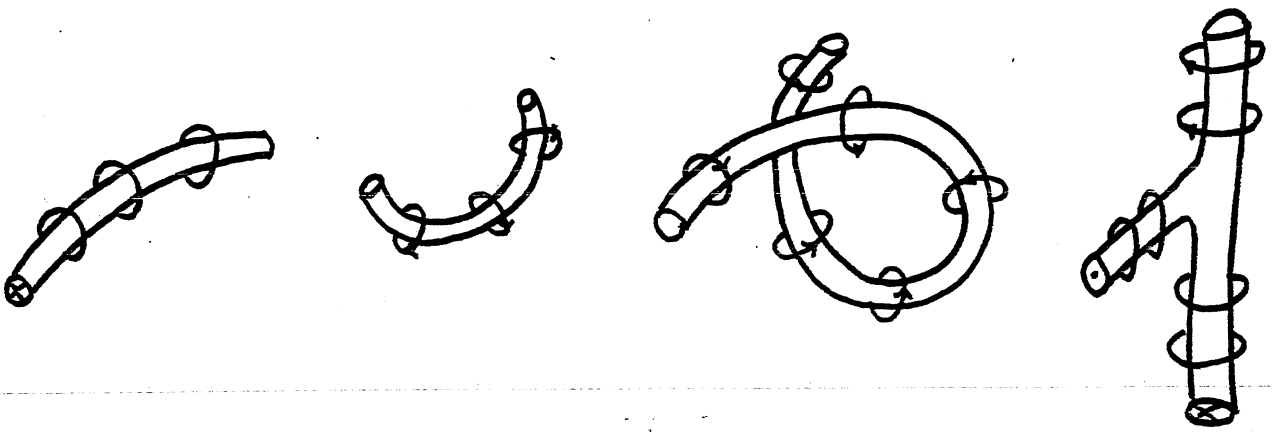
1 Add arrow heads to the following diagrams to show the direction of the magnetic field created by the flow of electrons.



2 Show the directions that electricity should flow to give the following magnetic fields.



3 Complete whatever is missing

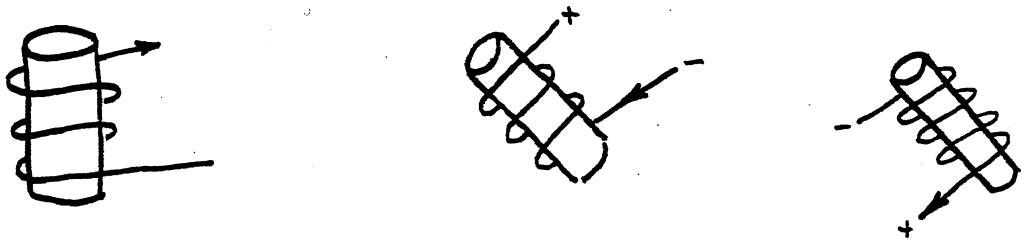


RIGHT HAND AND HELIX RULES

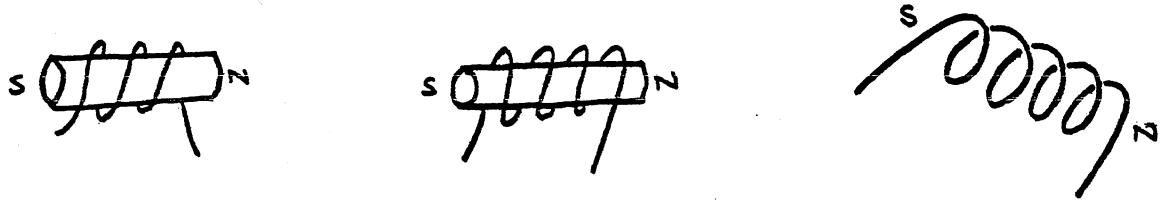
1 Draw the direction of the electricity flow using dots and crosses

2 Draw the magnetic field around these conductors and show the direction of the field

3 Label the north and south poles of these electromagnets

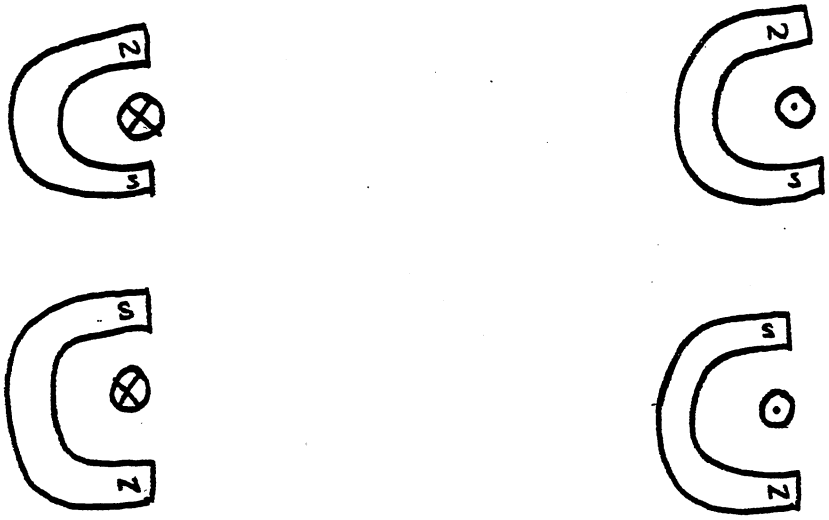


4 Show the direction of the electricity flow in these electromagnets

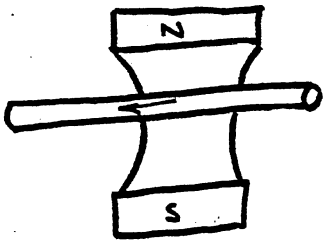


THE MOTOR PRINCIPLE

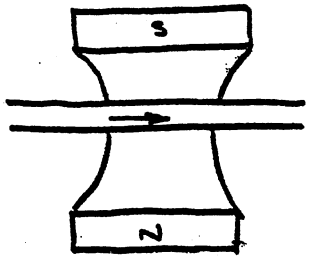
1 Show the direction of the force on the wire



2 Describe the direction that the wire will move

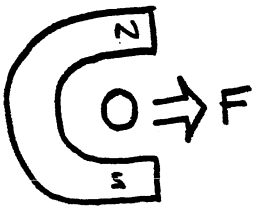


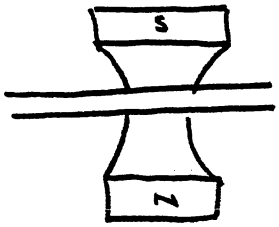
wire will move _____



wire will move _____

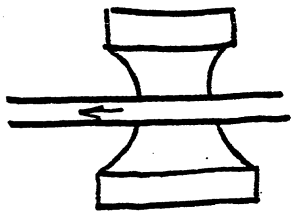
3 Use dots and arrows to show the direction that the electricity is flowing





wire is pushed into the page

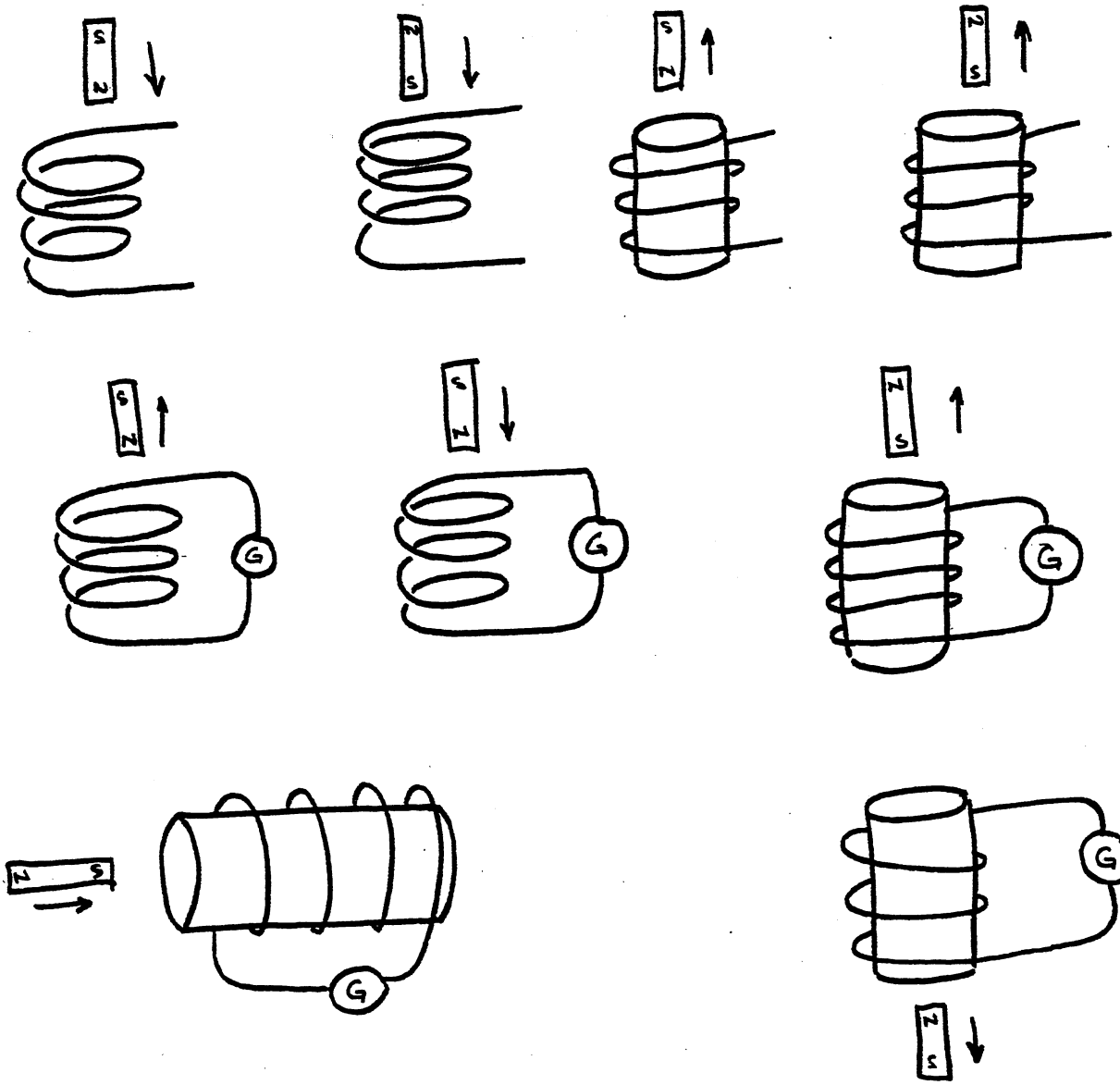
4 Label the poles on this magnet and show the direction of the lines of force of the magnet



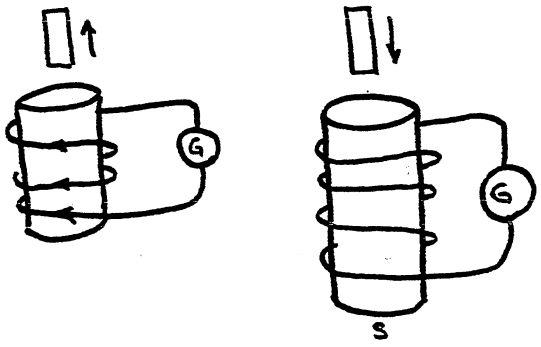
wire is pushed out of page

INDUCED CURRENT

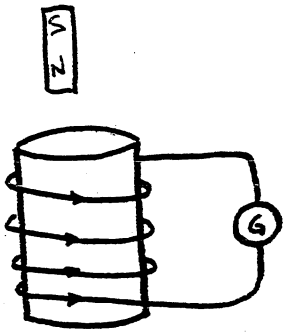
Label the direction of the electricity flow and the polarity of the coils



Label the poles of the permanent magnet

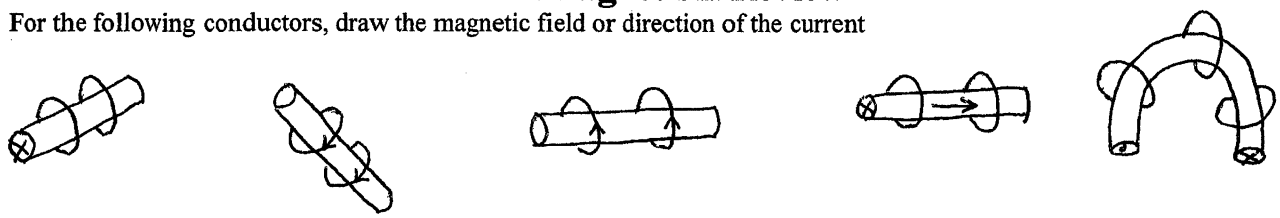


Show the direction of the magnets motion

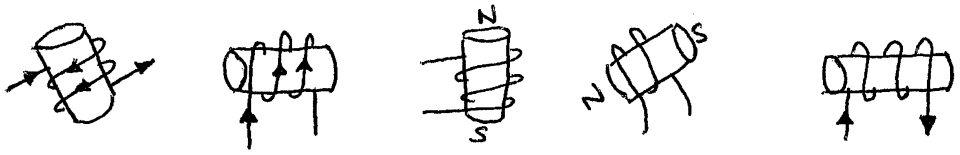


Electromagnetism Review

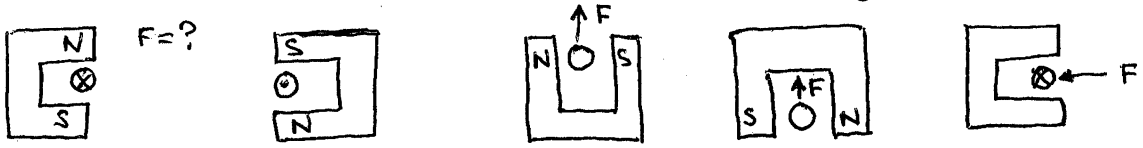
1. For the following conductors, draw the magnetic field or direction of the current



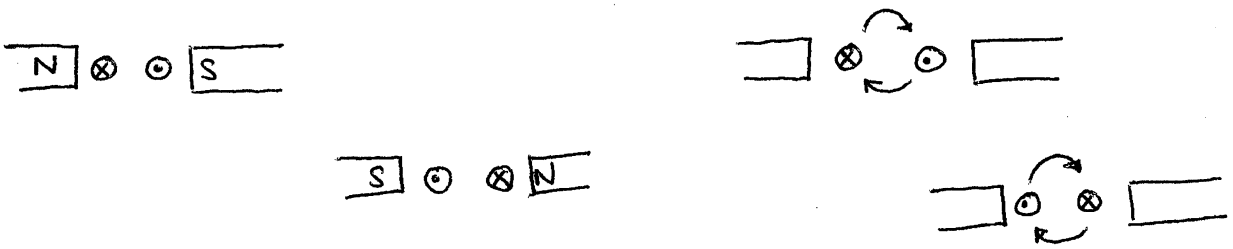
2. For the following coils, label the poles or direction of the current.



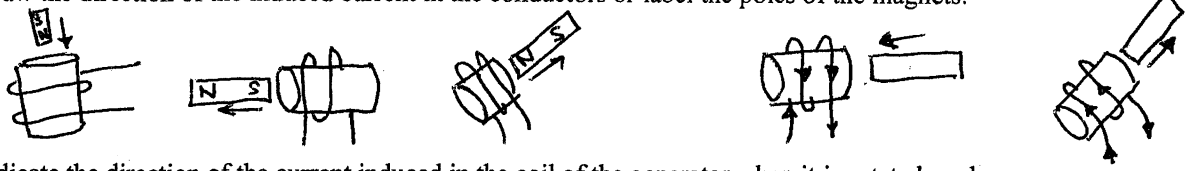
3. For the following diagrams, use the right hand rule for motors to fill in the missing information.



4. Determine the direction that these motors will rotate. Determine the poles for the magnets for the motor.



5. Draw the direction of the induced current in the conductors or label the poles of the magnets.



6. Indicate the direction of the current induced in the coil of the generator when it is rotated as shown.

7. Calculate the magnetic field strength when a conductor has 6 A of current passing through it. The length of the conductor in the magnetic field is 40cm and it is pushed with a force of 0.8N

8. A coil with a diameter of 4 cm has 200 turns of wire on it. 1.8 A of current pass through it when it is in a magnetic field of 0.14 T. Calculate the force on the conductor.

9. An appliance has a resistance of 15.0 Ω. It uses 30.0 V, supplied by the secondary coil of a transformer. The transformer has 200 turns in its primary coil and is plugged into a 120-V source. Calculate
   (a) The current in the secondary coil (b) The current in the primary coil
   (c) The power rating of the transformer (d) The amount of energy used in one minute

10. In Spain, the standard electric current has a potential difference of 220 V. Canadian appliances, designed for a 120-V current, can be made to work safely if they are first connected to a transformer. If a 1750-W Canadian hair dryer is brought to Spain,
    (a) What ratio of loops is needed in the primary and secondary coils of the transformer for the hair dryer to work properly?
    (b) How much current will the hair dryer use if it is connected to the transformer?
    (c) How much current would the dryer use if it is plugged directly into the wall outlet in Spain?

Waves and Sound Chapter 7

Vibrations | **The Cause of Waves page 326**

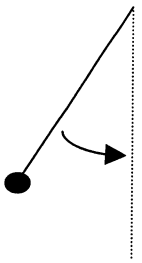
1. Define the following terms:
   a) Vibration

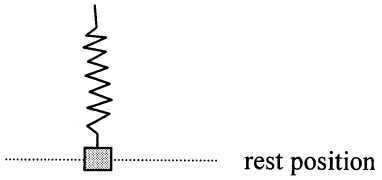
   b) Transverse vibration

   c) Longitudinal vibration

   d) Torsional vibration

2. Label the following diagrams with the amplitude and length. Draw the path taken for one cycle





Frequency and Period of Vibration:

Write the formula for period, frequency and the formula that relates these two variables. Include the units for period and frequency.

Period = __ = _____ Units = _____	Frequency = ___ = _____ Units = _____

__ = _____

1) A pendulum swings back and forth 120 times in 1 minute. What is its frequency and period?

2) The lowest sound a human ear can detect vibrates 750 times in 30 s. What is its frequency?

page 331 #1-3

Activity The Period of the Pendulum

Design and conduct an experiment that will test how three factors affect the period of a pendulum. You must think carefully about how you can help reduce errors in your measurements. You are responsible for a lab report describing your experiment and its results. Remember, the purpose of writing up an experiment is to allow other scientists to reproduce your experiment and get the exact same results. You should include enough detail to allow this. You must also use care when you make your conclusions. What change in your results represents the physics and what change is just error in measurement? How can you convince someone of this?

Resonance Page 332

1. Define resonance.

2. What does natural frequency mean?

2. Why did the Tacoma Narrows Bridge collapse?

3. Why must engineers consider resonance when they design large structures?

4. Give three examples of resonance.

Demonstration Resonance in a Wine Glass

1. How does the wine glass create sound? Use the definition of natural frequency to help you.

2. How does the pitch of the note created by the glass change when you add water?

Wave Equation Page 337

Write the universal wave equation. State what each variable is and its units.

1) A sound wave has a wavelength of 78 cm and a frequency of 440Hz. Find the speed of the wave.

2) A water wave has a speed of 2 m/s and is 3.5 m long. What is its frequency?

3) The highest sound a human ear can hear is about 20 kHz. If the speed of sound in air is 345 m/s, How long is this sound wave?

page 339 #5-7

Research Periodic Waves page 334

The two main types of waves are the _____ and the _____

Draw these waves and label the parts

1) _____ wave.

_____

2) _____ wave.

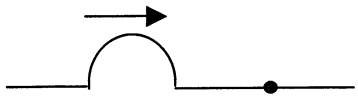
Draw a periodic transverse wave that is 2 wavelengths long with amplitude of 3 cm and a wavelength of 8 cm in the space below. Label: 3 differentλ's, a crest, a trough and the amplitude.

_____

Activity Pulses in a Coiled Spring

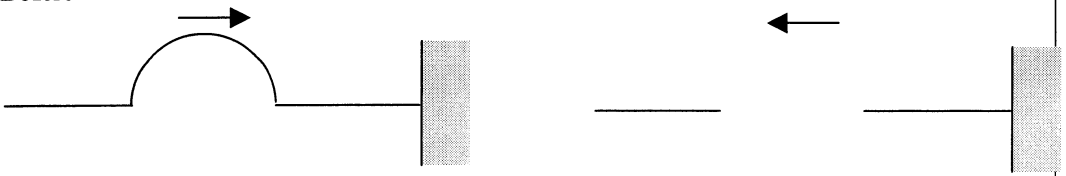
Questions

1 Draw the path of the indicated particle as the wave passes it



2 Draw the path of the indicated particle as the wave passes it

3 Before After



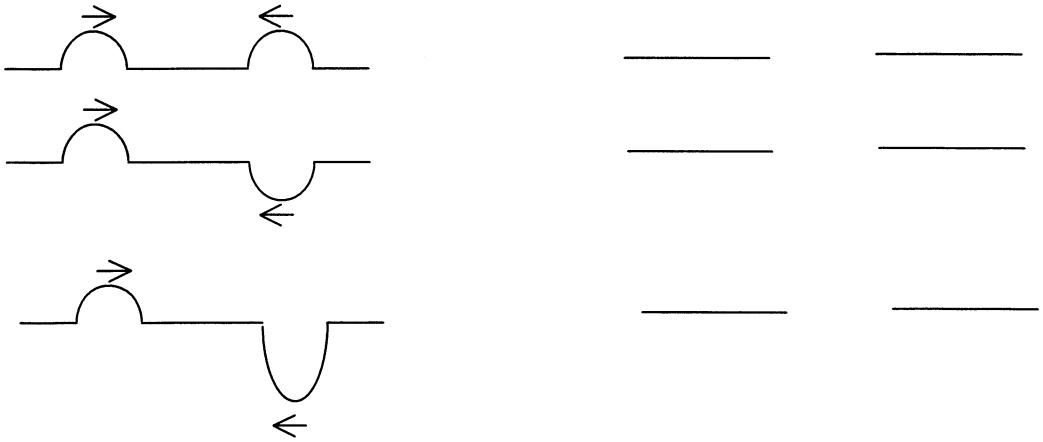
4 Before After

5 a) Send a large amplitude wave and a small amplitude wave along the spring. Which one is faster?

b) Send a high frequency wave and a low frequency wave along the spring. Which one is faster?

6. Interference: Draw what happens when the waves meet.

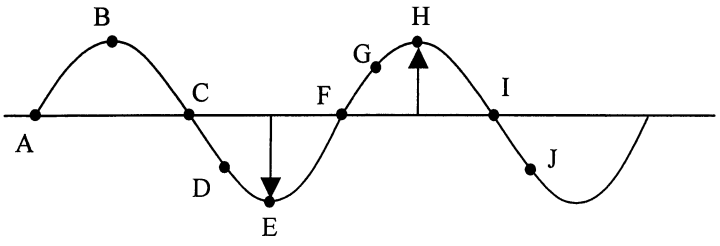
Result



Review Wave review questions

1) When a sounding of a lake is taken to measure the depth, the time lapse between the sound production and the echo is 0.75 s. The velocity of sound in water is 1410 m/s. Find the depth of the lake.

2) Identify as many examples of each of the following.
A negative displacement _____ 2 points in phase _____ 2 points out of phase _____ one wavelength _____



3) The number of cycles, oscillations, or vibrations an object makes in one second is called the object's _____.

4) The _____ of a vibration is the amount of time taken to make one complete oscillation.

5) A(n) _____ is the part of a longitudinal wave in which the particles are closer together than when they are at rest.

6) The _____ of a transverse wave can be measured as the distance from crest to crest or as the distance from trough to trough.

7) The _____ of a wave is measured from the medium's rest position to its maximum displacement on either side.

8) State the type of vibration that occurs in each of the following:
(a) the spring in a pogo stick as a child bounces up and down on it. _____
(b) a tree swaying in the wind. _____
(c) the rotating masses on an anniversary clock. _____

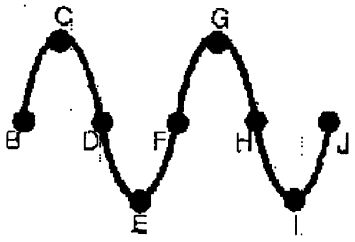
9) For each of the following, calculate the frequency, in hertz, and the period, in seconds:
(a) A bee beating its wings 3000 times in 30 s.

(b) A tuning fork completing 2048 oscillations in 8.0 s.

10) For each of the following, calculate the frequency, in hertz, and the period, in seconds:
(a) a pendulum swinging 20 times per minute.

(b) a car engine rotating at 8000 rpm's (revolutions per minute).

11) For the wave shown below, measure the wavelength _____ and amplitude _____ using a ruler.



12) Calculate the period and frequency of a pendulum that completes 150 vibrations in 1.5 min.

13) The distance between two successive crests in a wave is 1.5 m, and the source generates 25 crests and 25 troughs in 5.0 s. What is the speed of the waves?

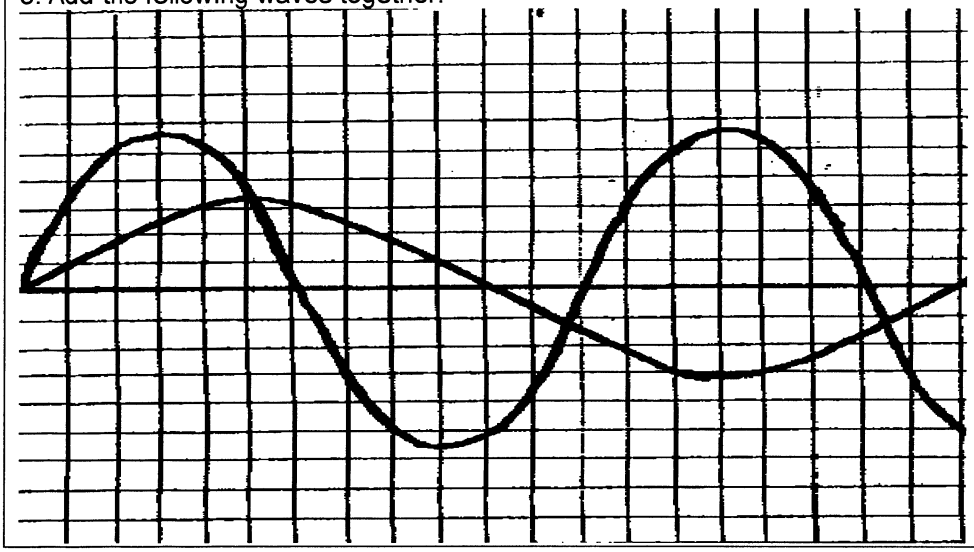
14) A sound wave with a frequency of 1.25×10^4 Hz travels at 344 m/s. What is its wavelength?

Superposition Adding waves page 345

1. Define in your own words what superposition means.

2. What are the 2 types of interference?

3. Add the following waves together.



Demonstration Standing waves page 346

Stretch the thin, coiled spring in the air to a distance of about 5 m. Measure the length of the spring.

1. Low frequency standing wave. Draw this pattern and label the nodes, antinodes and the wavelength on this diagram.

2. High frequency standing wave. Draw this pattern and label the nodes, antinodes and the wavelength on this diagram.

3. Draw a standing wave with a length of 4 ½ λ. Label the nodes and antinodes.

Waves and Sound Chapter 8

Sound Sound wave characteristics page 366

1. What kind of wave is sound transmitted as?

2. Draw a sound wave and label its two parts

3.What is an oscilloscope?

4. What type of wave is sound shown as on an oscilloscope?

5. Why do we show sound as this type of wave on an oscilloscope?

6.

Sound Property	Wave Property	Diagram
Loudness		Large
		Small
Pitch		High
		Low
Quality		Pure
		Complex

Frequency Meter

1. Test the frequency of a few tuning forks to see that the meter is working.
2. Write down the frequencies of the following:
   A low note _____a high note _____
   The lowest note you can make _____
   The highest note that you can make _____

Hearing Range Page 372

What is the range of frequencies that a normal human ear can hear?

Define with an example:

(a) Infrasonic

(b) Ultrasonic

Activity Hearing Range

Testing your hearing range (class activity)

My hearing range is _____ to _____

The normal human range is _____to _____

Speed of Sound — page 378

1. Write the formula for the speed of sound in air.

2. Name five materials that sound can travel faster in than air.

3. Name two materials that sound travels slower in than air.

4. Calculate the speed of sound at the following temperatures.
   a) 22 ^{0}C _____ b) 34 ^{0}C _____
   c) -12 ^{0}C _____ c) 15 ^{0}C _____

Page 382 #2-4

Beats — Beat Frequency page 386

How are beat frequencies created?

1. A tuning fork having a frequency of 256 Hz is sounded together with a note produced by an acoustic guitar. If the beat frequency heard is 3 Hz, what are the possible frequencies produced by the guitar? (253 Hz, 259 Hz)

2. Two tuning forks having frequencies of 256 Hz and 254 Hz are sounded at the same time. What beat frequency will be heard? (2 Hz)

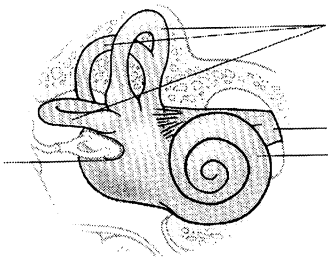
3. A third fork of unknown frequency is sounded in turn with each of the forks in the question above. What is the frequency of this fork if (a) 8 beats are heard in 8 s with each fork, (b) 8 beats are heard in 8 s with the 254 Hz fork and 24 beats are heard in 8 s with the 256 Hz fork? (a) 255 Hz, b) 253 Hz)

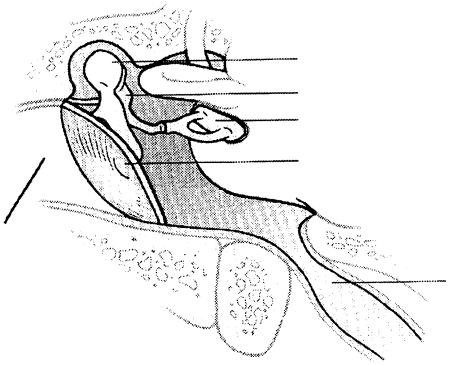
Page 388 #7-9

The Human Ear — Page 408

Part	Function
Outer ear	
Middle ear	
Inner ear	
Eardrum	
Ossicles	
Oval window	
Cochlea	
Auditory nerve	

1. Label the following diagrams of the middle and inner ear with the following parts: ear drum, cochlea, auditory nerve, Eustachian tube, hammer (malleus), anvil (incus), stirrup (stapes), oval window.





2. Define Conductive hearing loss.

3. Define sensorineural hearing loss.

Motion and Sound Page 418

Describe in simple terms what the Doppler effect is

2. Give an example of the Doppler effect

3. Describe what happens as an ambulance travels past you at a fast speed.

4. What is a sonic boom?

Grade 11 Review Sheet A

Name _____

Kinematics

1 Write the formula for uniform motion

2 An impatient motorist considers speeding as he travels between two cities. If the trip normally takes 2.8 h at an average speed of 100.0 km/h, how much time will be saved if he exceeds the speed limit by 10.0 km/h? (15 min)

3 A person walks 2 km [N] then 8 km [E] then 8 km [S]. The trip takes 6 hours.
(a) Find the displacement of the person.
(b) Calculate the velocity of the person.

4 Write the 5 formulas for acceleration.

5 A car that starts from rest and accelerates at 3 m/s^2 to a speed of 12 m/s?
a) Calculate the distance traveled in this time.
b) Calculate the time it takes to travel this distance.

6 a) What is the acceleration of a ball after it is thrown up at 2 m/s?
b) What is the acceleration of the ball as it falls back down to the ground?

7 A ball is thrown up off a 3.6 m high building at 2.8 m/s.
a) What is the velocity of the ball when it hits the ground?
b) What is the maximum height the ball will reach? (Remember, at max h, V=0)

Dynamics

8 Write Newton's second law

9 List the 4 forces that we draw on a Free Body Diagram.

10 Draw a FBD for a car that is accelerating forward. There is friction on the car.

11 An elevator and its contents have a combined mass of 6000 kg. It is suspended by a single cable.
(a) Draw a free-body diagram of the elevator at rest.
(b) Draw a FBD of the elevator accelerating up.
(c) What force must the cable exert on the elevator when it is at rest? (5.9 □ 10^4 N [up])
(d) What force must the cable exert on the elevator when it is moving upward at 2.0 m/s^2? (7.1 □ 10^4 N [up])

12 If a 7.2 N force is required to accelerate a 3.4-kg object along a horizontal surface at a rate of 1.6 m/s^2, what is the frictional resistance that is acting? (1.8 N [bkwd])

13 A soap box derby is about to start and Marisa pushes her 15.0-kg car to the start line 10.0 m up the hill. Calculate the work done by Marisa on the soap box car over the 10.0 m if friction is ignored. (1470 J)

14 A large electromagnet is lifting a 2000-kg minivan by doing 3.0 □ 10^4 J of work. How high is the minivan being lifted? (1.5m)

15 A air-hockey paddle hits a 48.0 g stationary puck with a force of 12.0 N. The puck travels 50 cm on the frictionless surface while the force is applied to the puck. Calculate the final speed of the mass at the end of the 50 cm. (15.8 m/s)

Grade 11 Review Sheet B

Name _____

Optics

16 a) Write the formula for refraction
b) Write the 2 formulas for lenses.

17 Draw a chart which shows the sign convention for the lens formulas.

18 Light passes from alcohol (n = 1.36) into glass (n = 1.52). If the incident angle is 32□, calculate the angle of refraction.

19 Light passes from alcohol (n = 1.36) into glass (n = 1.52). If the angle of refraction is 32□, calculate the angle of incidence.

20 Calculate the critical angle for diamond (n = 2.42) in air.

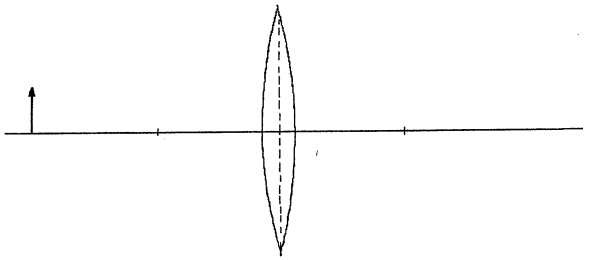
21. A frog is placed 15 cm from a converging lens of focal length 12 cm. Where is the image located? (d image = 60cm)

22. A slide projector with a lens that has a focal length of 8.3 cm produces a clear image on a screen 2.3 m away. How far from the lens is the slide? (d object = 8.6 cm)

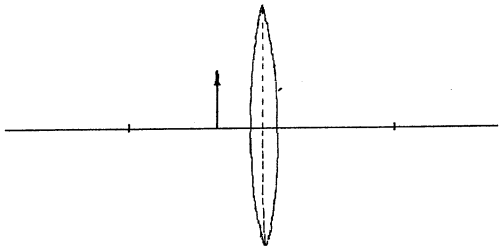
23. A diverging lens is placed 14 cm from an object that is 15 mm high. The image is located 7.7 cm from the lens. Calculate the focal length of the lens. (-17 cm)

24. A converging lens is placed 18 cm away from an object. The virtual image is located 25 cm from the lens. Calculate the focal length of the lens. (64 cm)

25. Complete the ray diagram below to locate the image and list the four image characteristics.



26. Complete the ray diagram below to locate the image and list the four image characteristics.



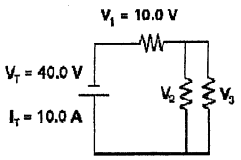
Grade 11 Review Sheet C

Name _____

Electricity

List all the equations for electricity. How many are there?

28. Examine the following circuit diagram and state the value of
(a) V_2 (b) I_2 (c) R_1 (d) R_2 (e) R_T



(a) 30.0 V
(b) 5.0 A
(c) 1.0 Ω
(d) 6.0 Ω
(e) 4.0 Ω

29. How long could you leave 60-W light bulb on, for the same cost as leaving a 100-W light bulb on for 24 h? (40 h)

30. An oven operates on a 15.0-A current from a 120-V source. How much energy will it consume in 3.0 h of operation? (1.9×10^7 J)

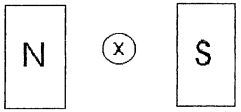
31. What is the potential difference when 3.45×10^3 J of work is done on a 12.0-C charge? (288v)

32. A 10.0-A circuit has a potential difference of 120 V. Calculate the resistance in the circuit. (12 ohms)

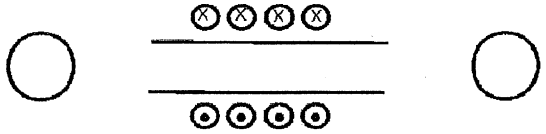
33. A 120-V circuit contains a 20.0-Ω resistor and a 40.0-Ω resistor connected in parallel.
(a) What is the current through the 40.0-Ω resistor? (3.0 A)
(b) What is the total current in the circuit? (9A)

Electromagnetism

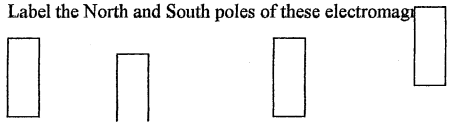
The diagram below shows a straight conductor between the poles of a permanent magnet. The direction of the magnetic force on the wire will be (left)



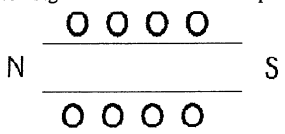
35. The open circles represent compasses. Show the directions of the compass needles.



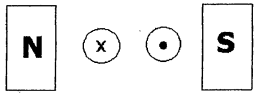
36 Label the North and South poles of these electromagn



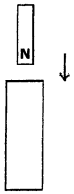
37 . The open circles represent cross-sections of the loops in a coil. Show the current direction in each coil segment so that the indicated poles are produced.



38. The diagram below shows a cross-section of a current-carrying loop between the poles of a permanent magnet. In which direction will the coil turn?



39 The diagram shows a bar magnet moving down into a coil. Label all N- and S-poles on the inducing and induced magnet.



40. An appliance has a resistance of 20.0 Ω. It uses 30.0 V, supplied by the secondary coil of a transformer. The transformer has 200 turns in its primary coil and is plugged into a 120-V source. Calculate
(a) the number of turns in the secondary coil. (50)
(b) the current in the secondary coil. (1.5v)

41. An appliance has a resistance of 15.0 Ω. It uses 30.0 V, supplied by the secondary coil of a transformer. The transformer has 200 turns in its primary coil and is plugged into a 120-V source. Calculate
(a) the current in the secondary coil (2A)
(b) the current in the primary coil (0.5A)
(c) the power rating of the transformer (60 W)
(d) the amount of energy the appliance uses in one minute (3.60×10^3 J)