UNIT CONVERSIONS AND FACTOR-LABEL METHOD

Name ____________________

Another method of going from one unit to another involves multiplying by a conversion factor. A conversion factor is a fraction that is equal to the number 1. For example, 60 seconds = 1 hour. Therefore, 60 sec/1 hr or 1 hr/60 sec = 1. When you multiply by the number 1, the value of the number is not changed, although the units may be different.

Example: How many milligrams in 20 kilograms?

Solution: Use the following relationships:

1000 mg = 1 g

1000 g = 1 kg

1. Start with the original number and unit.
2. Multiply by a unit factor with the unit to be discarded on the bottom and the desired unit on top.
3. Cancel units.
4. Perform numerical calculations.

$$20\text{ kg} \times \frac{1000\text{ g}}{1\text{ kg}} \times \frac{1000\text{ mg}}{1\text{ g}} = 20{,}000{,}000 \text{ or } 2 \times 10^7\text{ mg}$$

Perform the following conversions using unit factoring.

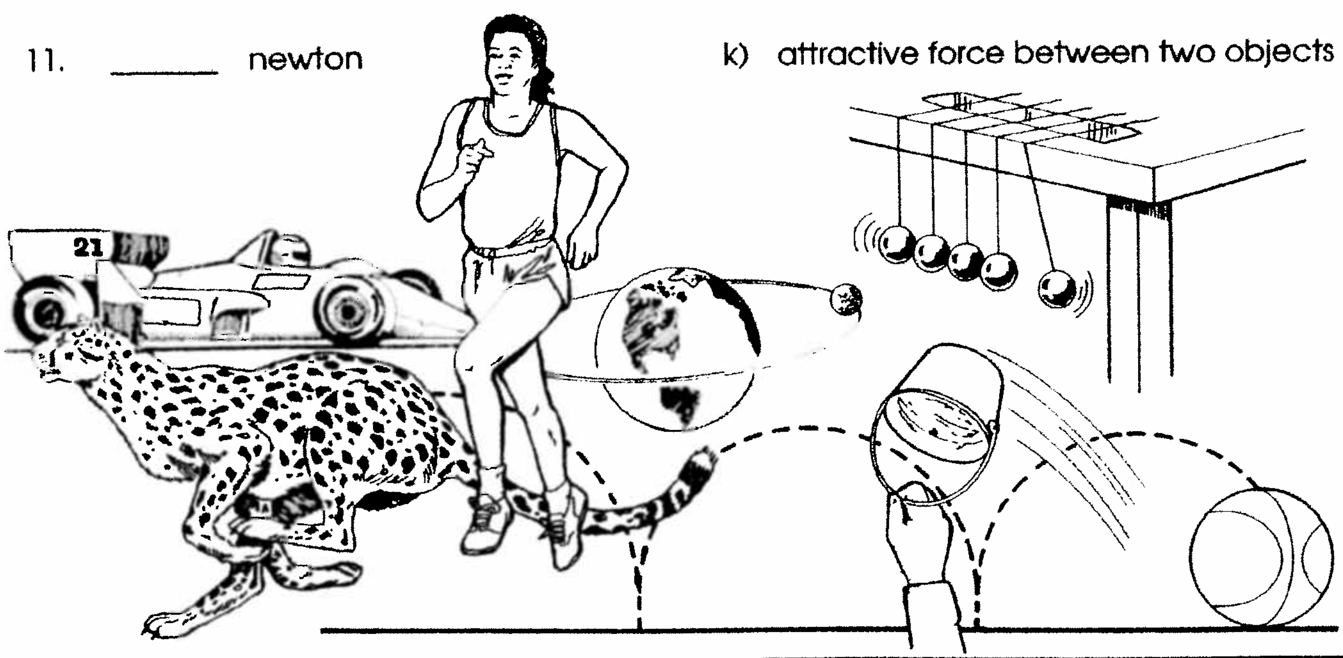
1. 500 mL = __________ L
2. 25 cg = __________ g
3. 400 mg = __________ kg
4. 30 cm = __________ mm
5. 3500 secs = __________ hr
6. 2 yrs = __________ secs (Assume 1 year = 365 days)
7. 15 m = __________ mm
8. 0.75 L = __________ mL
9. 6.4 kg = __________ g
10. 7200 m = __________ km
11. 4.2 L = __________ cm^3
12. 0.35 km = __________ m
13. 2.3 L = __________ mL
14. 4.5 yds = __________ in
15. 50 mm = __________ km
16. 150 mg = __________ g
17. 150 kg = __________ g
18. 23 mL = __________ L
19. 0.156 g = __________ mg
20. 1.25 L = __________ mL

MOTION MATCHING

Name ____________________

Match the correct term in Column I with its definition in Column II.

I		II
1. _______ kinetic		a) amount of matter in an object
2. _______ centripetal		b) amount of force exerted on an object due to gravity
3. _______ mass		c) distance covered per unit of time
4. _______ acceleration		d) rate at which velocity changes over time
5. _______ velocity		e) speed in a given direction
6. _______ weight		f) unit of measurement for force
7. _______ gravity		g) energy of motion
8. _______ inertia		h) tendency of a moving object to keep moving
9. _______ speed		i) depends on the mass and velocity of an object
10. _______ momentum		j) type of force that keeps objects moving in a circle
11. _______ newton		k) attractive force between two objects



NOTIONS ABOUT MOTIONS

Skydivers leaping out of an airplane, kids doing tricks on skateboards, rollercoasters circling in upside-down loops, commuters riding on subways, people dancing—motion is all around us. In order to describe a motion, you have to know where the object begins. The beginning position (the skydiver in the airplane) is the reference point from which you can describe the distance moved (200 feet into a freefall). Many other terms are used to describe aspects of motion. Many of them are scrambled below. Find the scrambled term that matches each clue. Then unscramble it, and write it next to the clue.

yolevict deeps tear talicecerona

trainie noctrifi ster smas snotnew

tommemun nertlaim ira traicnesse

tridenioc spira noholzatir clatrive

lateptricne crofe

vragyti sperruse

______________ 1. the rate of change in velocity

______________ 2. describes the speed and direction of an object

______________ 3. the amount of an object

______________ 4. the greatest velocity a falling object reaches

______________ 5. velocity parallel to Earth's surface

______________ 6. the force on an object pulling toward the center of a circular path

______________ 7. the rate of change in position (or rate of motion)

______________ 8. ratio between two different quantities

______________ 9. property of a body that resists any change in velocity

______________ 10. zero velocity

______________ 11. mass of an object multiplied by its velocity

______________ 12. upward force of air against a moving object

______________ 13. velocity in an up or down direction

______________ 14. unit of measurement for force

______________ 15. a push or pull exerted on one body by another

______________ 16. Forces always come in ________ .

______________ 17. Two objects with the same velocity must be moving in the same ________ .

______________ 18. a force that acts on all objects on Earth

______________ 19. the force that opposes the motion of two touching surfaces

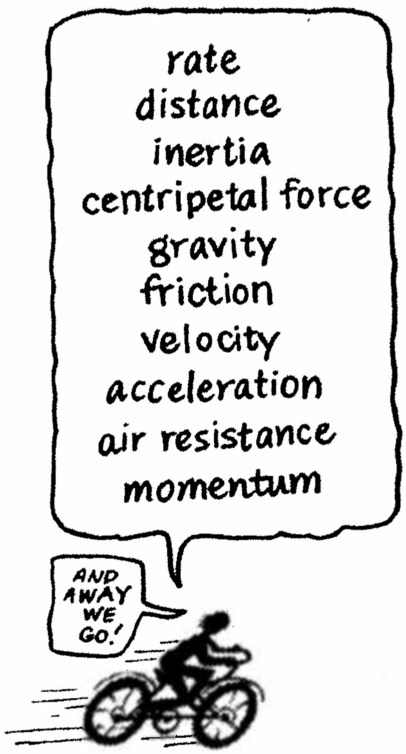
______________ 20. amount of force per unit area

Name ____

WHAT'S YOUR MOTION IQ?

Do you know the difference between velocity and inertia? . . . acceleration and rate? . . . speed and velocity? . . . gravity and centripetal force? . . . momentum and inertia? . . . friction and air resistance? If you have those all straight, you'll be able to tell which is operating in each of these examples. Choose from the list of terms. A term may be used more than once.

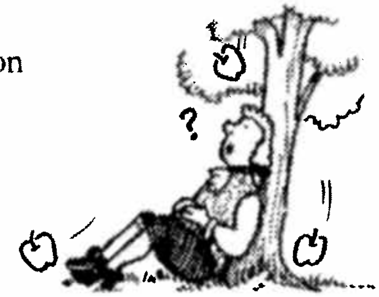
1. A car hits a tree and doesn't stop, but keeps going until it's severely damaged. Why? ________
2. When a space capsule returns to Earth after a mission, it glows red-hot as it enters the atmosphere because of ________ .
3. Mark and his friends love the Terminator roller coaster because of its two 360° loops. Nobody falls out when the cars are upside-down because of ________ .



4. Josh and Ramon head toward each other on their rollerblades at the same, breakneck speed. But, because they are going opposite directions, they do not share the same ________ .
5. The blade of an ice skate melts the ice beneath it and reduces ________ .
6. Joleen shoots an arrow at a target many feet away, but the arrow curves toward the ground before it gets to the target, due to the force of ________ .
7. The sleek shape of a bobsled reduces ________ and allows greater speeds.
8. A pool player hits the eight ball which slams into a second ball. The eight ball stops, but the second ball goes forward, because of ________ .
9. Michael waxes his skis so they'll go faster. He's reducing the force of ________ .
10. Scott falls off his skateboard. He comes to a crashing stop against the sidewalk, but his skateboard rolls on because of ________ .
11. Showing off, Megan swings a bucket of water around in circles, upside-down. No water spills out. Why? ________
12. The snowboard sits at the bottom of the hill, unmoving, until Andrea gets on it and pushes it along. ________ kept it from moving.
13. Jim's little sister isn't swinging very high, so he gives her a huge push to get her higher. This shows an increase in ________ .
14. Kate drops her math paper out of her second floor bedroom window to share with her friend, Evan, who is waiting below. It takes a really long time for the paper to get down to him because of ________ .
15. Tom bragged to Tara that he watched a centipede crawl the whole length of his room in the time he did his homework. His room is 16 feet long and his homework took 2.5 hours, so he's saying the centipede traveled at 6.4 feet per hour. What characteristic of motion has he calculated? ________

Name ________________________________

WHICH LAW?



We're told that Sir Isaac Newton discovered some things about motion when an apple dropped on his head. Whatever "force" was behind his discoveries, we have benefited from his discoveries.
Here are his three laws of motion. You should be familiar with them. Fill in the missing words in each of the three laws. Then tell which law fits each example below.

Which law? First, Second, or Third?

_____ 1. A frog leaping upward off his lily pad is pulled downward by gravity and lands on another lily pad instead of continuing on in a straight line.

_____ 2. As the fuel in a rocket ignites, the force of the gas expansion and explosion pushes out the back of the rocket and pushes the rocket forward.

_____ 3. When you are standing up in a subway train, and the train suddenly stops, your body continues to go forward.

_____ 4. After you start up your motorbike, as you give it more gas, it goes faster.

_____ 5. A pitched baseball goes faster than one that is gently thrown.

_____ 6. A swimmer pushes water back with her arms, but her body moves forward.

_____ 7. As an ice skater pushes harder with his leg muscles, he begins to move faster.

_____ 8. When Bobby, age 5, and his dad are skipping pebbles on the pond, the pebbles that Bobby's dad throws go farther and faster than his.

_____ 9. When you paddle a canoe, the canoe goes forward.

_____ 10. A little girl who has been pulling a sled behind her in the snow is crying because when she stopped to tie her hat on, the sled kept moving and hit her in the back of her legs.

NEWTON'S FIRST LAW OF MOTION:

An object at ________ stays at ________ or an object that is ________ at a ________ in a straight ________ keeps moving at that ________ unless another ________ acts on it.

NEWTON'S SECOND LAW OF MOTION:

The amount of ________ needed to make an object change its ________ depends on the ________ of the object and the ________ required.

NEWTON'S THIRD LAW OF MOTION:

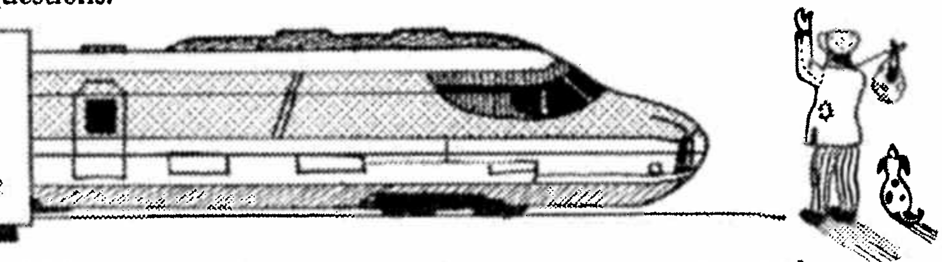
For every ________ (or force), there is an ________ and ________ action (or force).

Name ____________________

PROBLEMS WITH TRAINS

What is it about trains that makes them so popular in problems about motion? Well, probably it's the fact that it's usually speeding along or chugging along in a steady motion—going somewhere beyond wherever you are. In keeping with the tradition of train problems, practice your calculations with rate of motion by solving these questions.

REMEMBER:
Distance = rate x time
SO: Time = distance ÷ rate
AND: Rate = distance ÷ time



1. The *Midnight Express* heading west from Chicago to Albuquerque travels at 100 mph for 160 miles. How much time does this take?
2. A train that's heading west leaves a station at the same time that an east-bound train 840 miles away leaves its station. They both travel at an average speed of 120 mph. How long will it take before they meet?
3. If the *West Coast Skyliner* is traveling north at 120 mph and the *Skyliner II* is traveling south at 120 mph, do these trains have the same speed?
   Do they have the same velocity?
4. The *Black Giant* heads west for 16 hours traveling at an average speed of 120 mph. The *Speed Demon* leaves the same station and heads west on a parallel track, traveling at 95 mph for 20 hours. After these amounts of time, which train will have covered more distance?
5. Two trains leave their stations, which are 2860 miles apart, at the same time—8:00 A.M. central time. They both travel at 110 mph toward each other on the same track. At what time (central time) will they meet?
6. The *Rocky Mountain Cruiser* covers 3105 miles in 27 hours. What is its rate?
7. You are on a train that is going east at 95 mph. You are walking at 5 mph toward the front of the train. In relation to the passengers seated on the train, how fast are you moving?
8. In the same situation above, how fast are you moving in relation to the kid standing beside the railroad track, watching the train go by?
9. The *Appalachian Express* and the *Mississippi Streamer,* starting 2184 miles apart, leave at the same time, heading toward each other. They meet in 12 hours. The *Appalachian Express* has traveled at a rate of 85 mph, and the *Mississippi Streamer* has traveled at a rate of 97 mph. How far has the *Mississippi Streamer* traveled when they meet?
10. The *Quebec Racer* travels for 6 hours at 105 mph. The *Chicago Skyscraper* travels for 8.5 hours at 92 mph. Which train covers more distance?
    How much more?

Name

ACCELERATION CALCULATIONS

Name ______________

Acceleration means a change in speed or direction. It can also be defined as a change in velocity per unit of time.

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

where a = velocity
v_f = final velocity
v_i = initial velocity
t = time

Calculate the acceleration for the following data.

	Initial Velocity	Final Velocity	Time	Acceleration
1.	0 km/hr	24 km/hr	3 s	______
2.	0 m/s	35 m/s	5 s	______
3.	20 km/hr	60 km/hr	10 s	______
4.	50 m/s	150 m/s	5 s	______
5.	25 km/hr	1200 km/hr	2 min	______

6. A car accelerates from a standstill to 60 km/hr in 10.0 seconds.
   What is its acceleration? ______

7. A car accelerates from 25 km/hr to 55 km/hr in 30 seconds.
   What is its acceleration? ______

8. A train is accelerating at a rate of 2.0 km/hr/s.
   If its initial velocity is 20 km/hr, what is its velocity after 30 seconds? ______

9. A runner achieves a velocity of 11.1 m/s 9 s after he begins.
   What is his acceleration? ______
   What distance did he cover? ______

POTENTIAL AND KINETIC ENERGY

Name ____________________

Potential energy is stored energy due to position. Kinetic energy is energy that depends on mass and velocity (movement).

Potential Energy = Weight x Height (P.E. = w x h)	
Kinetic Energy = $^1/_2$ Mass x Velocity^2 (K.E. = $^1/_2mv^2$)	
The units used are:	Energy = joules
	Weight = newtons
	Height = meters
	Mass = kilograms
	Velocity = m/s

For a closed system, the sum of the potential energy and the kinetic energy is a constant. As the potential energy decreases, the kinetic energy increases.

Solve the following problems.

1. What is the potential energy of a rock that weighs 100 newtons that is sitting on top of a hill 300 meters high?

   Answer: __________

2. What is the kinetic energy of a bicycle with a mass of 14 kg traveling at a velocity of 3 m/s?

   Answer: __________

3. A flower pot weighing 3 newtons is sitting on a windowsill 30 meters from the ground. Is the energy of the flower pot potential or kinetic? How many joules is this?

   Answers: __________ __________

4. When the flower pot in Problem 3 is only 10 meters from the ground, what is its potential energy?

   Answer: __________

5. How much of the total energy in Problems 3 and 4 has been transformed to kinetic energy?

   Answer: __________

6. A 1200 kg automobile is traveling at a velocity of 100 m/s. Is its energy potential or kinetic? How much energy does it possess?

   Answers: __________ __________