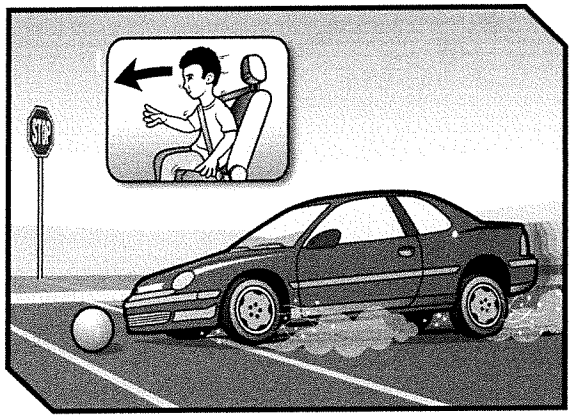
Name: Date:

Newton's First Law

Imagine that you're riding in a car and the driver suddenly puts on the brakes. The car stops, but your body seems to keep going! You slide forward in your seat...until your seatbelt catches you and holds you back. You've just experienced Newton's First Law of Motion.



Newton's First Law of Motion is this:

- **An object at rest tends to stay at rest, and an object in motion tends to stay in motion, unless acted upon by an outside force.**

Newton's law has two parts. The first part says that if an object is "at rest," or still, it will continue to be still unless something moves it. If your car is parked in the driveway, it will stay right there until someone, or something, comes along and starts it or pushes it.

But what about objects that are moving? According to Newton's First Law, a moving object stays in motion in a straight line and at a steady speed. Think about sitting in that moving car again. Your body is in motion at the same speed as the car. The car has brakes to slow it down, but your body wants to stay in motion at the same, steady speed. That's why you slide forward in your seat, and that's why seatbelts are so important!

Outside forces, like air resistance and friction, slow things down and make them stop. Sometimes a moving object bumps into another object, and the impact makes it stop or change direction. If it weren't for these outside forces, then objects actually would stay in motion forever!

Fill in the missing words to complete the sentences about Newton's First Law of Motion. Then, copy the boxed letters on the lines below to solve the puzzle.

1. One example of an outside force that slows down moving objects is _____ _____ _____ _____ _____ _____ _____ _____.
2. Newton's law says that an object in motion will stay in _____ _____ _____ _____ _____ _____.
3. Newton said that a moving object will travel at a steady _____ _____ _____ _____ _____.
4. Objects stay at rest or in motion until an outside _____ _____ _____ _____ _____ interferes.
5. When an object is not moving, it is at _____ _____ _____ _____.
6. A moving object will go in a _____ _____ _____ _____ _____ _____ _____ _____ line.
7. Isaac Newton described how objects behave with his _____ _____ _____ _____ of motion.

Another name for Newton's First Law of Motion is:

The law of _____ _____ _____ _____ _____ _____ _____.

LESSON 63

Motion

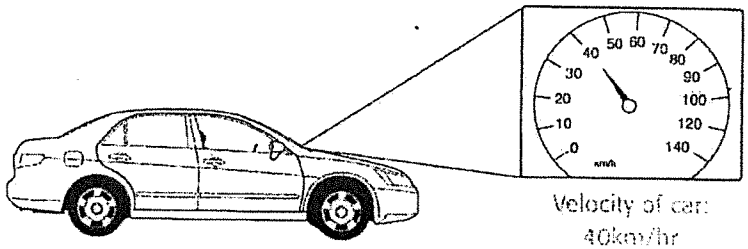
How do we describe motion?

Motion is a change in position. Forces cause motion. Gravity can cause a book to fall off your desk and onto the floor. Friction between a car's tires and the road can cause a car to slow down.

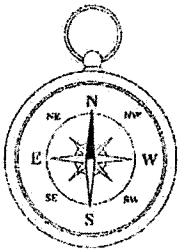
Motion is described in terms of distance, direction, speed, and velocity. **Distance** can be measured with a meterstick. **Direction** is measured with a compass. The points on a compass are N for North, S for South, E for East, and W for West.

Speed is the distance an object travels in a certain amount of time. You can use a stopwatch and a meterstick to measure speed. **Velocity** is an object's speed in a particular direction. To describe an object's velocity, you must include both its speed and the direction it is moving. So to measure velocity, you use a stopwatch, a meterstick, and a compass.

Acceleration occurs when an object speeds up, slows down, or changes direction. That means acceleration is a change in velocity. So, it can be measured with a stopwatch, a meterstick, and a compass.



Velocity of car: 40km/hr



Direction of car: North (N)

Velocity includes speed and direction.

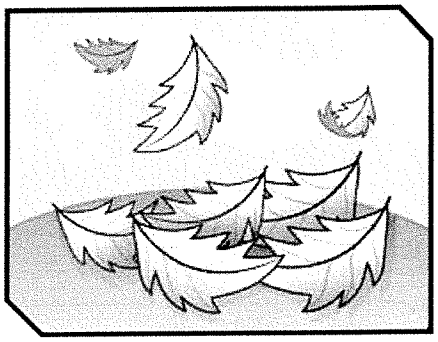
Show What You Know

Match the following terms and definitions.

_____ 1. motion	a. a change in velocity
_____ 2. velocity	b. which way an object is going
_____ 3. direction	c. a change in position
_____ 4. speed	d. speed in a particular direction
_____ 5. acceleration	e. distance traveled in a certain amount of time

Name: Date:

Newton's Second Law



Have you watched what happens to a pile of leaves on a windy day? A light breeze might gently scatter the leaves across the lawn, but a huge gust of wind would send the leaves whirling into the air. If the wind got stronger, the leaves would soar through the air even faster—and your bike might even tip over, too!

Remember, Newton's First Law tells us that an object will stay at rest or in motion unless a force changes it. In his second law, he explains how unbalanced forces cause objects to accelerate, or move faster.

Newton's Second Law says that an object's acceleration depends on two things: force and mass. As the force exerted on an object increases, the acceleration will increase. That's why when the gentle breeze turns into a strong gust, the leaves move faster and farther. As the force of the wind increases, the acceleration of the moving leaves increases, too.

The relationship between acceleration and mass is just the opposite. The more mass something has, the less it will accelerate. Leaves are light and have very little mass, so they will accelerate quickly. Your bicycle, on the other hand, has much more mass than the leaves. The same gust of wind that blew the leaves into your neighbor's yard might have scooted your parked bicycle only a few inches.

Below is a summary of Newton's Second Law. Fill in the missing words to complete the sentences. Then, complete the riddle below by finding the matching number and writing the letter.

Newton's Second Law

___ ___ ___ ___ ___ ___ ___ ___ ___ ___ forces cause an object to accelerate.
1 2 3 4 5 6 7 8 9 10

Acceleration depends on ___ ___ ___ ___ ___ and ___ ___ ___ ___ .
11 12 13 14 15 16 17 18 19

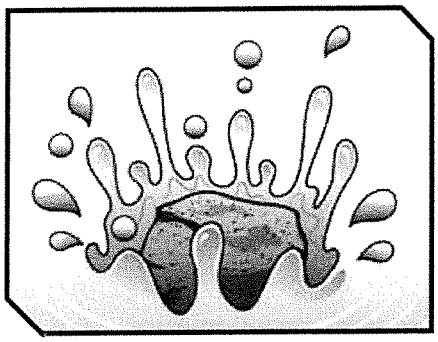
As the force increases, the ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___
20 21 22 23 24 25 26 27 28 29 30 31
increases, too.

Why did the artist paint on cement blocks instead of paper?

" "
He wanted to create a ___ ___ ___ ___ ___ ___ ___ **P** ___ ___ ___ ___ .
16 4 18 19 28 23 26 29 9 8 25

Name: Date:

Newton's Third Law

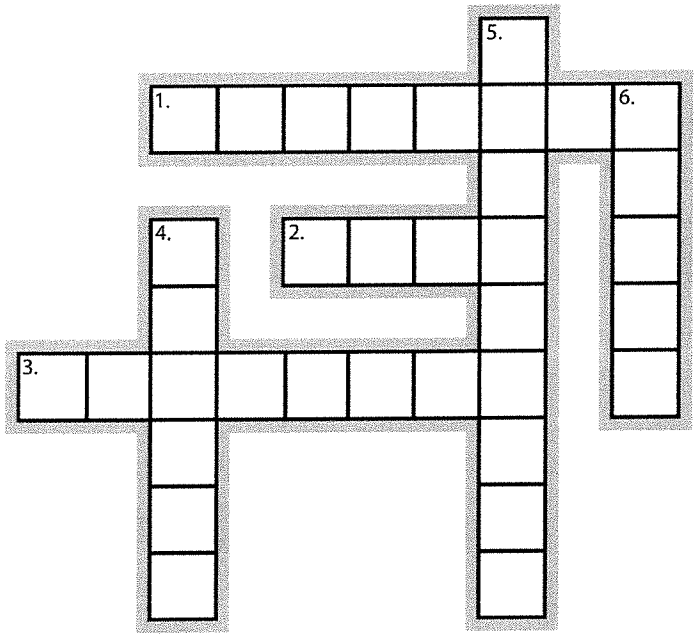


Newton's Third Law helps us understand what happens when two objects come in contact, or interact with each other. If you throw a rock down into the water, what happens? There's a reaction—a splash of water goes up. As Newton explained, **every action has an equal and opposite reaction.**

For every action, there is a reaction that is equal in size. If you throw a small pebble into the water, it's going to make a pretty small splash. But if you throw a giant boulder, the splash will be big enough to soak you! If you tested different sizes of rocks, you'd generally find that the size of the rock will match the size of the splash. In other words, the action—the rock hitting the water—causes an equal reaction with its splash.

Newton tells us that the size of the action and reaction are the same, but the direction of these two forces are not the same! In fact, the reaction is always in the opposite direction. That's why the rock falling downward sends a splash going upward!

Solve the crossword puzzle by completing the sentences with the correct word.



Across

1. Reactions always go in the _____ direction of the action.
2. An action and its reaction are equal in _____.
3. Newton's Third Law explains what happens when two objects _____.

Down

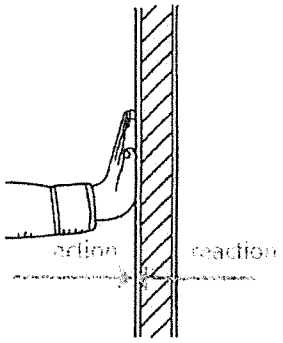
4. Forces always come in pairs—so each _____ has a reaction.
5. The force of an action sends a reaction in the opposite _____.
6. Every action and its reaction are _____ in size.

..LESSON..
66

Action and Reaction

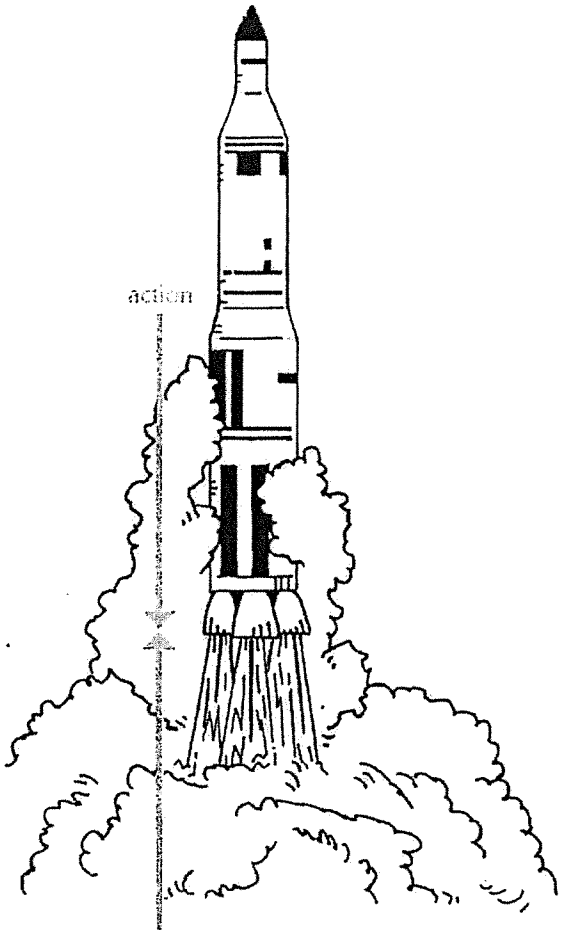
How do forces work in pairs?

Forces work in pairs. When one object pushes on a second object, the second object pushes back with equal force. For every **action** there is an equal and opposite **reaction.** When you push on a wall, the wall pushes back with equal force. If it did not, the wall would collapse.



Forces work in pairs.

Paired forces help explain how rockets are launched into space. A rocket's engine pushes exhaust gases out the back end of the rocket. The exhaust gases push back on the rocket with an equal and opposite force. This push moves the rocket upward. The rocket engine provides the action force. The exhaust gases provide the reaction force. The two forces are equal and opposite in direction.



How a rocket works

Show What You Know

Think about stubbing your toe on the ground. Explain why it hurts in terms of action and reaction forces.

_____

_____

_____

Name: Date:

Where's That Word?

Read each sentence clue and figure out what force and motion concept is being described. Find each word in the word search. Words are written across and down.

A	M	O	M	E	N	T	U	M	T	I	U
C	O	F	R	I	C	T	I	O	N	G	N
C	M	O	V	E	L	O	C	I	T	Y	B
E	Q	U	I	L	I	B	R	I	U	M	A
L	M	A	S	F	N	E	V	N	F	A	L
E	U	S	V	O	E	Q	E	E	O	S	A
R	N	T	G	R	R	U	L	W	R	S	N
A	C	O	N	S	T	A	N	T	C	P	C
T	G	R	A	V	I	T	Y	O	E	O	E
I	B	E	E	B	A	L	A	N	C	E	D
O	A	D	K	I	N	E	T	I	C	K	I
N	L	Y	P	O	T	E	N	T	I	A	L

1. When two objects rub against each other it creates this. _____
2. An object tends to keep moving because it has this quality. _____
3. Newton's First Law of Motion is also called the law of _____.
4. The more of this an object has, the more force it takes to move it. _____
5. The speed and direction of a moving object. _____
6. Everything gets pulled down toward the earth's center because of this force. _____
7. This is the result of unbalanced forces making an object speed up. _____
8. What you get when you multiply an object's mass times the acceleration. _____
9. The scientist who came up with the three laws of motion. _____
10. A skier at the top of a hill has more _____ energy than a skier at the bottom.
11. Another word for potential energy. _____
12. A skier traveling downhill has this type of energy. _____
13. When two forces acting on an object are equal, they are _____.
14. When two forces are _____, there is a change in position or motion.
15. When two balanced forces cancel each other out, they are in _____.
16. When the velocity of a moving object stays the same, it has a _____ speed.

Name: Date:

Force & Motion Assessment

Match each vocabulary word with its definition.

1. acceleration _____
2. equilibrium _____
3. force _____
4. friction _____
5. gravity _____
6. inertia _____
7. kinetic energy _____
8. momentum _____
9. potential energy _____
10. velocity _____

A An object at rest will stay at rest, and an object in motion will stay in motion unless a force is introduced.

B How fast and in what direction an object is traveling.

C A force that pulls anything on the Earth's surface toward the center of the Earth.

D Something that changes an object's state of rest or motion.

E An increase in an object's velocity.

F Energy that is stored up on an object because of its position.

G A tendency of an object to keep moving when it's in motion.

H The energy an object has because it is moving.

I The force that results from two surfaces rubbing against one another.

J A state of balance where opposing forces on an object simply cancel each other out, and the object remains stable and unchanged.

Choose the correct answer:

11. Which law of motion states that, for every action, there is an equal and opposite reaction?
    a. Newton's First Law of Motion.
    b. Newton's Second Law of Motion.
    c. Newton's Third Law of Motion.
    d. The law of reaction.

12. What is an example of how friction can be helpful?
    a. A skateboard ramp.
    b. A seatbelt in a car.
    c. The brakes on a car.
    d. The wheels on a bicycle.

13. If you kick a bowling ball and a tennis ball with the same amount of force, according to Newton's Second Law of Motion, what will happen?
    a. The tennis ball will travel farther than the bowling ball.
    b. The bowling ball will travel farther than the tennis ball.
    c. The bowling ball will travel faster, but cover a shorter distance.
    d. The balls will travel the same distance.

Name _____ Date _____

Balanced and Unbalanced Forces

By Cindy Grigg

A **force** is a push or a pull on an object. Forces are at work all around you all the time. More than one force can-and usually does- act on an object at the same time. Sometimes two forces act in the same direction. An example is when two people work together to push a heavy object. Sometimes the forces act in different directions.

Imagine a tug-of-war between you and one friend. If you are stronger, you apply more force to the rope. You pull your friend across the line, and you are the winner! If your friend is stronger, he might pull you across the line. Sometimes the forces are equal. Neither you nor your friend moves across the line. The two forces are balanced.

We say that the **net force** on an object is the combination of all the forces acting on it. To find the net force of forces that are acting in the same direction, add them together. For example, if you pull on a box with a force of 25 newtons (N) while your friend pushes the box (in the same direction you are pulling) with a force of 30 N, the net force applied to the box in that direction is 55 newtons.

To find the net force of forces that are acting in opposite directions, subtract the smaller force from the larger one. If you are pulling on a tug-of-war rope with a force of 40 N, and your friend is pulling with a force of 35 N in the opposite direction, the net force on the rope is 5 newtons in your direction. You win!

When the net force on an object is zero, the two forces are balanced. **Balanced forces** don't cause any change in the motion of an object. Balanced forces are equal and in opposite directions. If the object is not moving and two forces are applied to it that equal zero when combined, then the object will not move. If the object is already moving and two balanced forces are applied to it, the object will continue moving at the same speed and in the same direction that it was before the forces were applied.

That doesn't mean that balanced forces have no effect on an object, however. Think about what would happen to an empty soda can if you pushed against it in one direction, and a friend pushed against it in the opposite direction with an equal amount of force. If the amount of force was equal, the can wouldn't move. But the two opposing forces would probably crush the can.

When the net force on an object is greater than zero, the forces are unbalanced. **Unbalanced forces** cause the object to move. An object that is not already moving will begin to move in the direction of the larger force. An object that is already moving will change its speed and/or its direction.

Remember that two forces applied to an object in the same direction will combine by adding the two together. Two forces applied to an object in opposite directions will be subtracted. The net force is the combination of the two forces, whether by addition or subtraction. If the net force is zero, no change will happen to the object's motion. If the forces are unbalanced, meaning there is some amount of net force, then the object will move in the direction of the force.

Name _____ Date _____

Balanced and Unbalanced Forces

Questions

1. What is a force?

_____

_____

_____ 2. A combination of all the forces acting on an object is called:

A. balanced force
B. gross force
C. unbalanced force
D. net force

_____ 3. To find the net force on an object:

A. always subtract the amounts of the forces
B. divide the larger force by the smaller one
C. combine the amounts of the forces acting on the object
D. multiply the forces together

_____ 4. When the net force on an object is zero, we say that the two forces are:

A. unbalanced
B. gross
C. balanced
D. cancelled out

_____ 5. When the net force on an object is zero, the object's motion will:

A. stop
B. change
C. not change

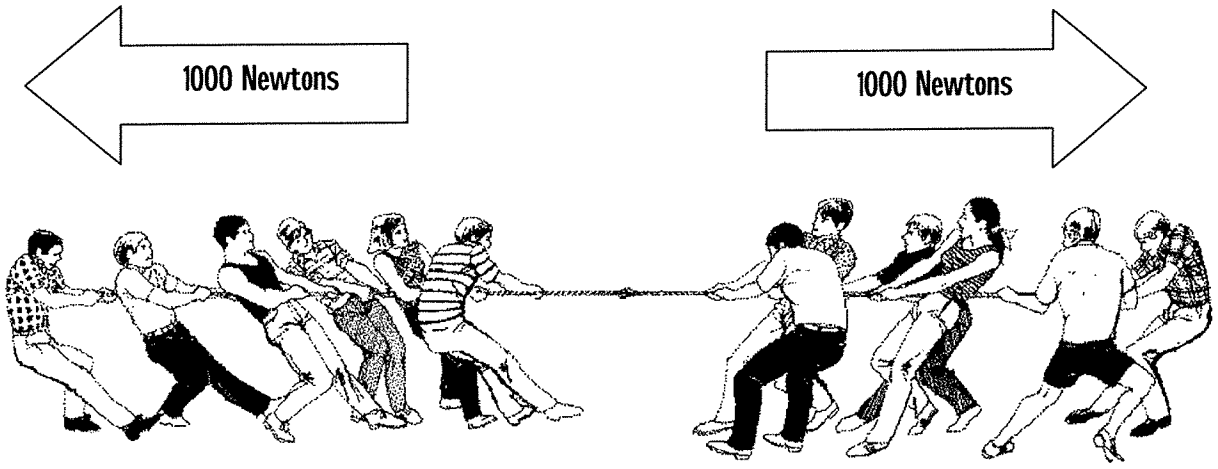
_____ 6. When forces are balanced, they:

A. have no effect on the object
B. don't cause any change in the motion of an object
C. might crush the object
D. both b and c are correct

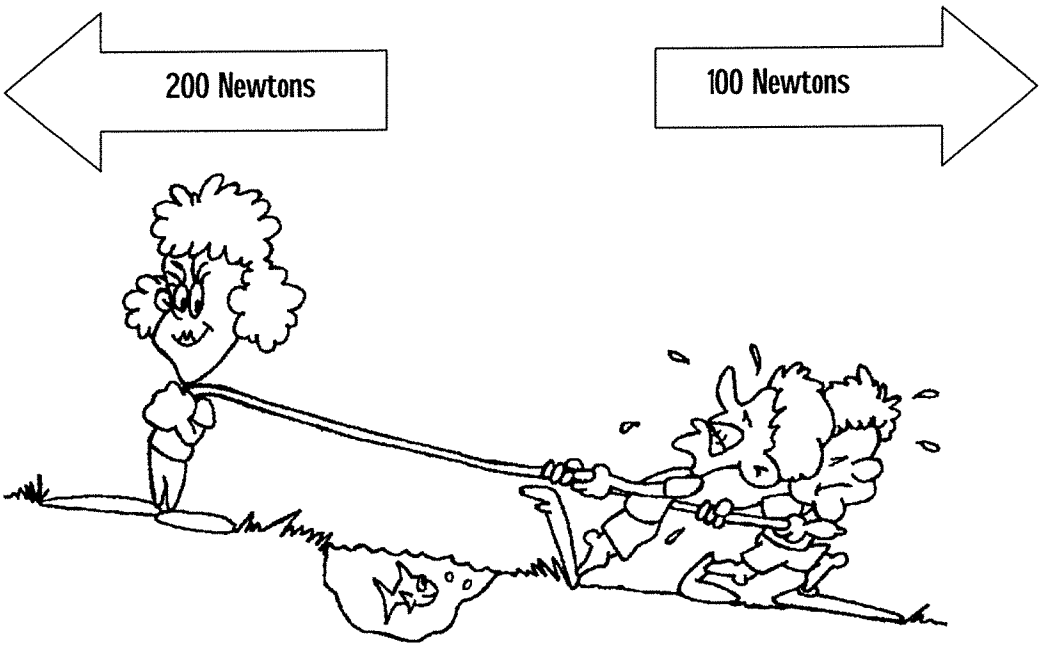
_____ 7. If you are pushing a box toward your friend with a force of 20 N, and your friend is pushing the box toward you with a force of 30 N, what will happen to the box?

A. The box will move toward your friend with a force of 50 N.
B. The box will move toward you with a force of 10 N.
C. The box will move toward your friend with a force of 10 N.
D. The box will move toward you with a force of 50 N.

Circle the best answer:



1. The forces shown above are PUSHING / PULLING forces.
2. The forces shown above are WORKING TOGETHER / OPPOSITE FORCES.
3. The forces are EQUAL / NOT EQUAL.
4. The forces DO / DO NOT balance each other.
5. The resultant force is 1000 N TO THE RIGHT / 1000 N TO THE LEFT / ZERO.
6. There IS / IS NO motion.



7. The forces shown above are PUSHING / PULLING forces.

8. The forces shown above are WORKING TOGETHER / OPPOSITE FORCES.

9. The forces are EQUAL / NOT EQUAL.

10. The forces DO / DO NOT balance each other.

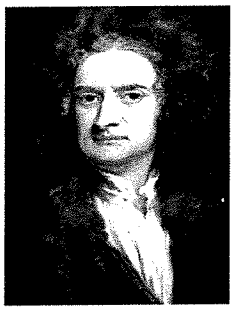
11. The stronger force is pulling to the RIGHT / LEFT.

12. The weaker force is pulling to the RIGHT / LEFT.

13. Motion is to the RIGHT / LEFT.

READING COMPREHENSION I

SIR ISAAC NEWTON



Sir Isaac Newton (1642 - 1727) was an English scientist who made great contributions to physics, optics, maths and astronomy. He is known for his Three Laws of Motion and the Universal Law of Gravitation.

When Sir Isaac Newton was a boy, he was more interested in making mechanical devices than in studying. He made a windmill which could grind wheat and corn, and he made a water clock and a sundial. His teachers thought he was not a very intelligent student because he didn't do very well.

He wanted to go to college, but he didn't have the money to go, so at university, he had to serve the other students by doing chores for them. He even ate the leftovers of their meals, but he would do anything to get an opportunity to learn. Even when he was in college, he was not outstanding and received no awards.

When the university shut down because of the plague, an illness where people caught diseases and died suddenly, he went home and continued to study on his own.

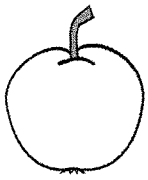
He had a notebook with blank pages and he began to fill them with notes as he read and experimented about different things around him.

One day when he was drinking tea in the garden, he saw an apple fall to the ground. He started thinking about why it fell. Why did the apple fall out of the tree? Does everything fall? What makes things fall? Can anything stop things from falling? Are the sun, moon, and stars falling? Why don't they ever fall to the ground? He finally decided that a force called gravity, which caused the apple to fall also kept the moon in the sky around the earth. This same force called gravity, also kept the planets in the sky around the sun.

The apple incident led to his three basic laws of motion:

- A moving object keeps moving unless an outside force stops it.
- An object moves in a straight line unless some force makes it change direction; and
- For every action, there is an equal and opposite reaction.

Isaac Newton is well known as one of the greatest scientists who ever lived.



Comprehension Questions:

1. What are the *Laws* Newton is famous for?

2. What was Isaac Newton interested in when he was a young boy?

3. Can you name three things he made when he was young?

4. What did Newton have to do at university so he could study?

5. Why did Isaac Newton's university close?

6. What did Newton do when his university closed?

7. What did Newton do with his blank notebook?

8. What did Isaac Newton discover when he observed the falling apple?

9. Can you name the three Laws of Motion?

10. Can you give an example to explain one of Newton's law of motion?

Name: _____ Date: _____

1. The story of the falling apple describes how Newton might have discovered

   a. the moon.
   b. apples.
   c. gravity.
   d. the earth.

2. Why does the author mention the story of the apple?

   a. to show how silly old stories are
   b. it describes Newton's famous discovery
   c. it is the only thing Newton ever published
   d. without it, we wouldn't understand gravity

3. Based on the passage, it is likely that Newton's ideas

   a. were very popular while he was alive
   b. are believed more today than when he was alive
   c. have been proven wrong by today's scientists
   d. are all made up stories

4. Read the following sentences: "An apple fell from the tree and hit Newton on the head. He realized gravity was the force that kept us on the ground."

The word **realized** means

   a. became bruised
   b. listened carefully to something
   c. completely forgot something
   d. started to think something is true

5. This passage is mainly about

   a. how different scientists think of gravity.
   b. Sir Isaac Newton and his discovery of gravity.
   c. myths that people tell about scientific discoveries.
   d. Sir Isaac Newton's fame and riches during his life.

6. Based on information in the passage, describe two things that gravity does.

_____

_____

_____

7. Based on the passage, why is Newton's work considered some of the greatest work in the history of science even though people of his time had problems with his ideas?

_____

_____

_____

8. The question below is an incomplete sentence. Choose the answer that best completes the sentence.

People of the time were critical of his discoveries, _____ Newton was afraid to publish his findings.

a. despite
b. therefore
c. because
d. even though

9. Read the following sentence.

In 1687, Newton published his first book because he wanted to share his discoveries.

Answer the questions below based on the information provided in the sentence you just read. One of the questions has already been answered for you.

1. Who? Newton
2. What? _____
3. When? _____
4. Why? _____

10. **Vocabulary Word**: publish: share ideas by printing.

Use the vocabulary word in a sentence: _____

_____

Name_____

Write the definitions to the science words related to the force and motion unit. Write a sentence for each vocabulary word. Make sure to use the science word correctly.

Gravity- *Sentence:*	*Force-* *Sentence:*	*Friction-* *Sentence:*
Mass- *Sentence:*	*Speed-* *Sentence:*	