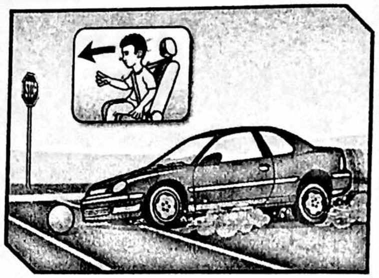
Name: (Station #1) **Date:**

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 F R I C T I O N.
2. Newton's law says that an object in motion will stay in M O T I O N.
3. Newton said that a moving object will travel at a steady S P E E D.
4. Objects stay at rest or in motion until an outside F O R C E interferes.
5. When an object is not moving, it is at R E S T.
6. A moving object will go in a S T R A I G H T line.
7. Isaac Newton described how objects behave with his L A W S of motion.

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

The law of I N E R T I A.

Station #2

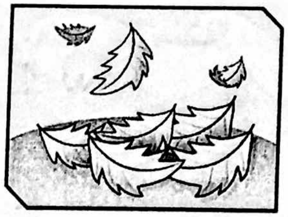
Review Newton's Laws

Identify the Law of Motion.

1. A magician pulls a tablecloth out from under dishes and glasses on a table without disturbing them. Law 1
2. A person◆s body is thrown outward as a car rounds a curve on a highway. Law 1
3. Rockets are launched into space using jet propulsion where exhaust accelerates out from the rocket and the rocket accelerates in an opposite direction. Law 3
4. A picture is hanging on a wall and does not move. Law 1
5. A person not wearing a seatbelt flies through a car window when someone slams on the breaks because the person◆s body wants to remain in continuous motion even when the car stops. Law 1
6. Pushing a child on a swing is easier than pushing an adult on the same swing, because the adult has more inertia. Law 2
7. A soccer ball accelerates more than a bowling ball when thrown with the same force. Law 2
8. A soccer player kicks a ball with their foot and their toes are left stinging. Law 3
9. A student leaves a pencil on a desk and the pencil stays in the same spot until another student picks it up. Law 1
10. Two students are in a baseball game. The first student hits a ball very hard and it has a greater acceleration than the second student who bunts the ball lightly. Law 2

Name: (Station #3) 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

U(1) N(2) B(3) A(4) L(5) A(6) N(7) C(8) E(9) D(10) forces cause an object to accelerate.

Acceleration depends on F(11) O(12) R(13) C(14) E(15) and M(16) A(17) S(18) S(19).

As the force increases, the A(20) C(21) C(22) E(23) L(24) E(25) R(26) A(27) T(28) I(29) O(30) N(31) increases, too.

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

He wanted to create a "M(16) A(4) S(18) S(19)" T(28) E(23) R(26) P I(29) E(9) C(8) E(25).

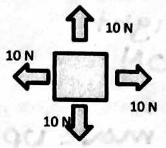
Station #4

Name ____________ Date ________ per ______

PRACTICE SHEET: Balanced / Unbalanced Forces

DIRECTIONS: Draw the NET FORCE ARROWS next to the drawings if the net force is greater than zero. Answer the questions

1. OBJECT IS AT REST ORIGINALLY



Total NET HORIZONTAL FORCE = ↔ ON

[✓ Balanced] / Unbalanced (circle one)

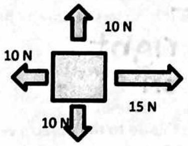
What, if anything, does this do to the objects horizontal motion? stay still

NET VERTICAL FORCE = ON

[✓ Balanced] / Unbalanced (circle one)

What, if anything, does this do to the objects vertical motion? Stay still

2. OBJECT IS AT REST ORIGINALLY ↔



NET HORIZONTAL FORCE = 5N

Balanced / [✓ Unbalanced] (circle one)

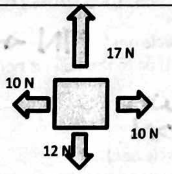
What, if anything, does this do to the objects horizontal motion? Accel to Right

NET VERTICAL FORCE = ON

[✓ Balanced] / Unbalanced (circle one)

What, if anything, does this do to the objects vertical motion? Stay Still

3. OBJECT IS AT REST ORIGINALLY



NET HORIZONTAL FORCE = ON

[✓ Balanced] / Unbalanced (circle one)

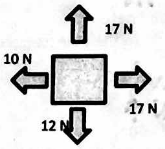
What, if anything, does this do to the objects horizontal motion? continue not to move

NET VERTICAL FORCE = 5N ↑

Balanced / [✓ Unbalanced] (circle one)

What, if anything, does this do to the objects vertical motion? accel up

4. OBJECT IS AT REST ORIGINALLY



NET HORIZONTAL FORCE = 7N →

Balanced / [✓ Unbalanced] (circle one)

What, if anything, does this do to the objects horizontal motion? accel right

NET VERTICAL FORCE = 5N ↑

Balanced / [✓ Unbalanced] (circle one)

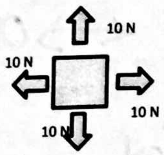
What, if anything, does this do to the objects vertical motion? accel up

What do you think the overall motion of this object would be like? (What would its path be?)

Station #4.

OBJECT IS ALREADY MOVING at a constant speed TO THE RIGHT BEFORE THESE FORCES ARE APPLIED

5.



NET HORIZONTAL FORCE = ON

[✓ Balanced] / Unbalanced (circle one)

What, if anything, does this do to the objects horizontal motion?

cont. to right

NET VERTICAL FORCE = ON

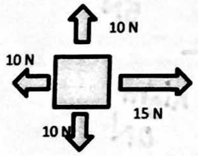
[✓ Balanced] / Unbalanced (circle one)

What, if anything, does this do to the objects vertical motion?

does not move up or down

OBJECT IS ALREADY MOVING at a constant speed TO THE RIGHT BEFORE THESE FORCES ARE APPLIED

6.



NET HORIZONTAL FORCE = 5N →

Balanced / [✓ Unbalanced] (circle one)

What, if anything, does this do to the objects horizontal motion?

accel to right

NET VERTICAL FORCE = ON

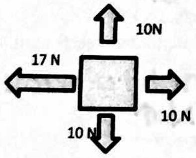
[✓ Balanced] / Unbalanced (circle one)

What, if anything, does this do to the objects vertical motion?

cont. not to move up or down

OBJECT IS ALREADY MOVING at a constant speed TO THE RIGHT BEFORE THESE FORCES ARE APPLIED

7.



NET HORIZONTAL FORCE =

Balanced / [✓ Unbalanced] (circle one) 7N ←

What, if anything, does this do to the objects horizontal motion?

Slows down

NET VERTICAL FORCE = ON

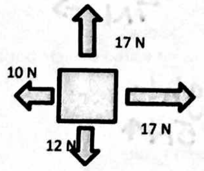
[✓ Balanced] / Unbalanced (circle one)

What, if anything, does this do to the objects vertical motion?

does not move

OBJECT IS ALREADY MOVING at a constant speed TO THE RIGHT BEFORE THESE FORCES ARE APPLIED

8.



NET HORIZONTAL FORCE = 7N

Balanced / [✓ Unbalanced] (circle one)

What, if anything, does this do to the objects horizontal motion?

Accel to Right

NET VERTICAL FORCE = 5N ↑

Balanced / [✓ Unbalanced] (circle one)

What, if anything, does this do to the objects vertical motion?

Accel up

MOTION

Station #5

Practice Problems for Newton's Second Law of Motion

You push an object, and it accelerates. You push harder on the same object, and it accelerates more quickly. Yet, when you push just as hard on a heavier object, it accelerates much more slowly. Why? It turns out that force, mass, and acceleration are related. The relationship is stated by Newton's second law of motion,

Force=Mass x Acceleration

-or-

F=ma

where F is the force, m is the mass, and a is the acceleration. The units are Newtons (N) for force, kilograms (kg) for mass, and meters per second squared (m/s^2) for acceleration. The other forms of the equation can be used to solve for mass or acceleration.

m=F/a and a=F/m **Example:**

Engineers at the Johnson Space Center must determine the net force needed for a rocket to achieve an acceleration of 70 m/s^2. If the mass of the rocket is 45,000 kg, how much net force must the rocket develop?

Using Newton's second law, F=ma

$F=(45{,}000\ kg)(70\ m/s^2) = 3{,}150{,}000\ kg\ m/s^2$ $F=3{,}150{,}000\ N$ Note that the units $kg\ m/s^2$ and newtons are equivalent; that is, $1\ kg\ m/s^2$

Now use Newton's second law to solve for force, mass, and acceleration.

Station #5

Give the equation used for each problem and show all work.

1. What net force is required to accelerate a car at a rate of 2 m/s^2 if the car has a mass of 3,000 kg?

F=____

m= 3,000Kg

a= $2 m/s^2$

$F = (3{,}000)(2)$

$\boxed{F = 6000N}$

2. A10 kg bowling ball would require what force to accelerate down an alleyway at a rate of 3 m/s^2?

F=____

m= 10Kg

a= $3 m/s^2$

$F = (10)(3)$

$\boxed{F = 30N}$

3. Sally has a car that accelerates at 5 m/s^2. If the car has a mass of 1000 kg, how much force does the car produce?

F= 5000N

m= 1000Kg

a= $5 m/s^2$

$F = ma$

$F = (1000)(5 m/s^2)$

$\boxed{F = 5000N}$

4. What is the mass of a falling rock if it produces a force of 147 N?

F=____

m=____

a=____

5. What is the mass of a truck if it produces a force of 14,000 N while accelerating at a rate of 5 m/s^2?

F= 14,000N

m= ?

a= $5 m/s^2$

$F = ma$

$\frac{14000}{5} = \frac{(m)(5)}{5}$

$\boxed{m = 2800kg}$

Station #5

6. What is the acceleration of softball if it has a mass of 0.5 kg and hits the catcher's glove with a force of 25 N?

F= 25N

m= 0.5kg

a= ?

$F = ma$

$\frac{25}{0.5} = \frac{0.5a}{0.5}$

$\boxed{a = 50 m/s^2}$

7. Your own car has a mass of 2000 kg. If your car produces a force of 5000 N, how fast will it accelerate? ~~F=~~

F= 5,000N

m= 2000kg

a= ?

$F = ma$

$\frac{5{,}000}{2000} = \frac{2{,}000a}{2{,}000}$

$\boxed{a = 2.5 m/s^2}$

8. Sally wants to accelerate even faster than in problem #3, so she removes 500 kg of mass from her car. How fast will her ~~1500~~ 1000 kg car accelerate if it produces 5000 N of force?

$1000 - 500 = 500kg$

F= 5000N

m= 500Kg

a= ?

$F = ma$

$\frac{5{,}000}{500} = \frac{500a}{500}$

$\boxed{a = 10 m/s^2}$

9. Sally challenges you to a race. On the first turn you run off the course and your car strikes a large bale of hay. Your car still produces 5000 N of force, but now it accelerates at only 2 m/s^2. What is the mass of your car now that the bale of hay is stuck to it?

F= 5000N

m= ?

a= $2 m/s^2$

$F = ma$

$\frac{5000}{2} = \frac{(m)(2)}{2}$

$\boxed{m = 2500kg}$

10. Even tough though she is way ahead of you, Sally switches her car to run on nitrous oxide fuel. The nitrous oxide allows her car to develop 10,000 N of force. What is Sally's acceleration if her car has a mass of 500 kg?

F= 10,000N

m= 500kg

a= ?

$F = ma$

$\frac{10{,}000}{500} = \frac{500a}{500}$

$\boxed{a = 20 m/s^2}$

Name: (Station #6) Date:

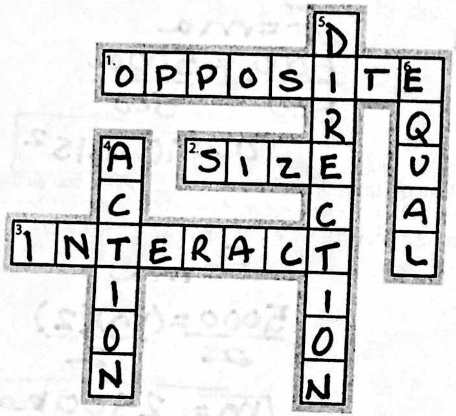
Newton's Third Law

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.

Name: (Station #7) Date:

Write an Article

Directions

Using the space provided below, write a newspaper article about why seat belts are important using Newton's laws to justify your opinon.

★ ★ ★ ★ ★

FORCE & MOTION GAZETTE

Sir Isaac Newton

Sir Isaac Newton would be in favor of seat belt laws because ________