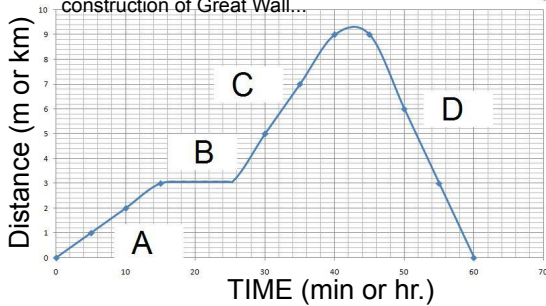
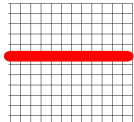
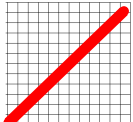
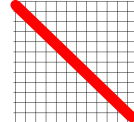





**Warm Up:** Create a story using the graph. Describe what will be happening at each point during the day (A-D). Example: Trump has a busy day. He is currently at Trump Tower in NY. A- Trump jumps on his "yuge" jet and flies to China. B- Trump admires the construction of Great Wall...



### Graphing HW:

1. Albert.
2. He finished the race in less time.
3. Charlie.
4. Horizontal line
5. 6 seconds.
6. Between 7s and 13s.
7. 14 seconds.
8. The end of his line stops at 100 m and 14 s.
9. Albert: 8.33 m/s  
Bob: 7.14 m/s  
Charlie: 5.56 m/s

a. 	b. 
c. 	d. 
e. 	f. 

### Forces



Why science teachers should not be given playground duty.

### Video Demos

- Coin Drop Trick
- Egg Drop Trick
- Tablecloth Trick



### Video Demos

- What happened in each of the videos?
- How does it work?
- The objects (coins, eggs, dishes) are sitting at rest and will remain at rest until another force acts on them. When the card/pan was removed from under the coins/eggs, gravity acted upon them, causing them to fall straight down. When the cloth was pulled, the dishes stayed in place because there was no other force to make them move.
- Why didn't friction pull the objects? There was some friction present, but not enough to cause the objects to move in the same direction as the card/pan/cloth were pushed/pulled.

## Force Key Terms- RT side

**Balanced:** When the net force on an object is zero. There will be no change in the motion of an object; object is either motionless or maintaining a constant speed.

**Force:** A push or pull acting on an object

**Friction:** A force that opposes motion between two surfaces that are touching

**Gravity:** The force of attraction between two masses

**Inertia:** Tendency of an object to resist a change in its motion

**Magnetic Force:** Force of attraction or repulsion exerted by a magnet

**Unbalanced:** When the net force of an object is greater than zero; there will be a change in the motion of the object; a motionless object will begin to move, while an already moving object will change its speed or direction

## Left Side Output

Use the **Key Terms & Underlined words** from your notes to fill in your vocabulary chart. This should be on the LEFT side of your ISN.

Term	Definition	Your Words	Drawing

## Warm Up

- What kind of force, balanced or unbalanced, changes an object's motion?
  - unbalanced forces
- What happens to an object when all forces are balanced?
  - it will either remain stationary or remain in constant motion
- Who wrote the book Philosophiae Naturalis Principia Mathematica, which described universal gravitation and the 3 laws of motion?
  - Sir Isaac Newton

**Force**

Force: a push or pull

- Force is described by 2 characteristics
  - Strength of the force
  - Direction that the force is acting towards
- The unit for force is the Newton (N).
  - Newton is equal to the force required to accelerate 1 kilogram of mass at 1 m/s<sup>2</sup>.
- A force can be represented by an arrow.
  - A resultant is an → that points in the direction of the net force.
  - The size of the resultant depends on the size of the net force; the larger the force the larger the arrow, the smaller the force the smaller the arrow.

**Combining Forces**

- Net force: the combination of all forces acting on an object.
  - Net forces determine whether an object moves as well as the direction of movement.
- Unbalanced forces
  - Forces acting in same direction
    - Add the forces and take the direction of the forces.
  - Forces acting in different directions
    - Subtract the smaller from the larger & take the direction of the larger.
- Balanced forces
  - ...are equal forces acting in opposite directions.
  - The net force is always equal to zero (0).
  - Balanced forces do not change the motion of an object as each force is balanced by the other.

**Force is a vector**

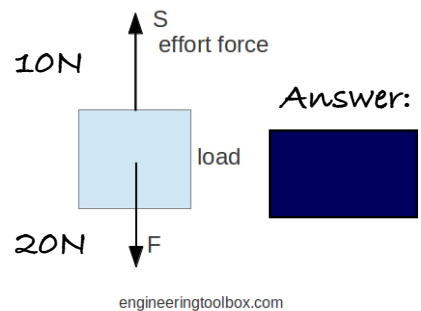
The direction (arrow) shows the direction of the force. The length (size) of the arrow shows the strength of the force.

## Adding Forces Practice

Move the Blocks to reveal the answer!

- $5 \rightarrow + 5 \rightarrow =$  Net Force
- $5 \rightarrow + \leftarrow 5 =$
- $5 \rightarrow + \rightarrow 10 =$
- $5 \rightarrow + \leftarrow 10 =$
- $5 \rightarrow + \leftarrow 15 =$
- $10 \uparrow + \downarrow 5 =$

## Adding Forces Worksheet



# Warm Up

1.) What does "conservation" mean?

• to begin and end with the same amount

2.) What is the net force of balanced objects?

• 0

3.) Find the net force:

13N  $\Rightarrow$  + 3N  $\Leftarrow$  + 12N  $\Leftarrow$  + 2N  $\Rightarrow$  • ON

### Friction

- **Friction**
  - > The force that 2 surfaces exert on each other when they rub against each other.
  - > Friction acts in a direction opposite to the direction of the object's motion.
- Smooth surfaces produce less friction than rough surfaces.
- The strength of the force of friction depends on 2 factors:
  - > How hard the surfaces push together.
  - > The types of surfaces involved.
- **Types of Friction**
  - > **Static friction**
    - Friction that acts on objects that are not moving.
    - Friction acts in the opposite direction of the intended motion.
      - Ex.) Trying to push furniture across the floor.
  - > **Sliding friction**
    - Friction that occurs when one solid surface slides over another.
    - Friction acts in the opposite direction of the intended motion.
      - Ex.) Edge of the furniture begins to move there is friction acting against its continued movement.
  - > **Rolling friction**
    - Friction that occurs when an object rolls over another surface.
    - Rolling friction is easier to overcome than sliding friction.
      - Ex.) Skateboard rolling across the sidewalk.
      - Ex.) Cars rolling on a track.
  - > **Fluid friction**
    - Friction that occurs when a solid object moves through a fluid.
    - Fluid: anything that flows & fills its container; air, water, oil, etc.
      - Ex.) Oil inside of an engine.

### Gravity

- **Gravity**
  - > Naturally occurring force within the universe that draws or attracts objects to each other.
  - > Sir Isaac Newton is credited as the discoverer of the scientific concept of gravity.
- **Law of Universal Gravitation:**
  - > The force of gravity acts between all objects in the universe.
  - > The gravity of each individual object is different and can negate the attraction of the other.
 
$$F_g = G \frac{m_1 m_2}{r^2}$$
    - $m_1, m_2$  = mass of the 2 objects.
    - $r$  = distance between the objects.
    - $G$  = the Universal Gravitational constant.
- **Gravity & Motion**
  - > **Free fall**
    - The state in which the only force acting upon a falling object is gravity.
      - Acceleration due to gravity is  $9.8 \text{ m/s}^2$ .
      - Vacuum: a volume of space that is empty of matter, including air.
  - > **Air resistance**
    - Upward force extended on falling objects.
    - Air resistance is proportional to the surface area of an object.
    - The greater the surface area the greater the air resistance.
  - > **Terminal velocity**
    - Greatest velocity an object can reach.
    - Upward force of air resistance is equal to the downward force of gravity.
 
$$F_t = \sqrt{\frac{2mg}{\rho C_d A}}$$
      - Where  $V_t$  is the terminal velocity
      - $m$  is the mass of the falling object
      - $\rho$  is the **density of the fluid** (air)
      - $C_d$  is the **drag coefficient**
      - $A$  is the **area of the fluid** the object is falling through
      - $A$  is the object's cross-sectional area.
- **Projectile motion**
  - > An object thrown or shot will fall at the same speed (g: acceleration due to gravity) as an object dropped from a certain height.
  - > "What goes up, must come down."

### Momentum

- **Momentum**
  - > "The quantity of motion."
  - > A product of an object's mass and its velocity.
  - > Described by both the strength & direction.
  - > The greater the momentum, the harder to stop a moving object.
- **There are 2 main types**
  - Linear momentum
    - Momentum in a straight line.
  - Angular momentum
    - Momentum in an instant or at a specific point.
- **Mass & velocity have a direct relationship to momentum.**
  - Increase mass, increases momentum
  - Increase velocity, increases momentum
  - Decrease mass, decrease momentum
  - Decrease velocity, decrease momentum
- **Can be found using the formula**

$$\text{Momentum} = \text{Mass} \cdot \text{Velocity}$$
- **Variations on the momentum formula**

$$\text{Mass} = \frac{\text{Momentum}}{\text{Velocity}} \quad \text{Velocity} = \frac{\text{Momentum}}{\text{Mass}}$$
- **Units for momentum**
  - > Momentum is a **derived unit** meaning its unit is a combination of other units.
    - (kg • m/s): kilogram times meter per second
    - (N • s): Newton times a second
- **Conservation of momentum**
  - > **Conservation** in "everyday" language means to save.
  - > **Conservation** in Science means to begin & end with the same amount.
    - Momentum may be transferred from one object to another but none is lost.
    - Ex.) Newton's Cradle

## Warm Up

1.) Which type of friction, sliding or rolling, is the easiest to overcome? -rolling

2.) Which type of friction occurs between objects that are stationary? -static

3.) Combine these forces: -3N  $\Rightarrow$

12N  $\Rightarrow$  + 15N  $\Leftarrow$  + 5N  $\Rightarrow$

## FORCES STATION LAB:

1. **Drop it like it's Hot:** Learn about gravity while dropping a variety of objects.

2. **Mo' Friction:** Race cars over different types of surfaces.

3. **House of Cards:** Look at balanced and unbalanced forces while building a house of cards.

### Warm Up- Lab Summary

- 1.) Describe your findings in "Drop like it's Hot".
- 2.) Describe your findings in "House of Cards."
- 3.) Describe your findings for "Mo Friction".



What Does Newton's Laws Say?

(Click the picture for video)

### Newton's 1st Law of Motion

- Law of Inertia: An object at rest tends to stay at rest unless acted upon by an unbalanced force.
  - > Ex: If you have ever left your roller skate lying in the hallway, it will stay there until someone or something moves it. If you are riding your skateboard and you hit a rock, the board will stop but you will keep moving until something stops you.
  - > Gravity & friction are 2 common unbalanced forces that often change an object's motion.



### 2nd Law of Motion

- The smaller the mass of an object, the greater its acceleration when a force is applied to the object.
  - > Ex: If you apply the same force to an object with a small mass, like a tennis ball, and an object with a large mass, like a bowling ball, the object with the small mass will accelerate more than the object with the large mass.
  - > The greater the force applied to an object, the greater the object's acceleration.
  - > Ex: If you drop a heavy object and a light object at the same height, they will accelerate at the same rate and hit the ground at the same time because the force of gravity is acting on the objects.
- Can be determined by the formula
 
$$\text{Acceleration} = \frac{\text{Force}}{\text{Mass}}$$

**F=ma**

THE GREATER FORCE... THE MORE ACCELERATION

  - Variations on acceleration formula
 
$$\text{Force} = \text{Acceleration} \times \text{Mass}$$

$$\text{Mass} = \frac{\text{Force}}{\text{Acceleration}}$$
  - Units...
    - Acceleration: m/s<sup>2</sup>
    - Mass: kg
    - Force: Newton (N) or (kg x m/s<sup>2</sup>)
- Acceleration & force have a direct relationship, what you do to one... you do to the other.
- Acceleration & mass have an inverse relationship, what you do to one... you do the opposite to the other.
- In order to change the acceleration of an object you can either...
  - Decrease the mass of the object.
  - Increase the force being applied to the object.

### 3rd Law of Motion

FOR EVERY ACTION  
THERE IS AN EQUAL AND  
OPPOSITE REACTION



- When one object exerts a force on a second object, the second object exerts a force back that is equal, but in the opposite direction.
  - > Ex: If you stand on a skateboard and push against a wall, you will roll backwards. The wall pushes back on you with the same force.
  - > Action/Reaction Pairs
    - Motion of each object can't always be detected.
    - Even though they are equal & opposite, they don't cancel each other out because they don't act on the same object.

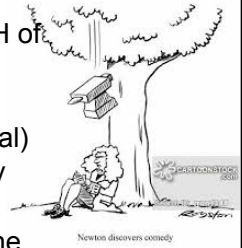


### Warm Up

- 1.) What is the tendency for an object to remain in motion? -inertia
- 2.) What is the force of attraction between two masses? -gravity
- 3.) What is the force that opposes motion between two surfaces? -friction

### Newton's Laws Comic:

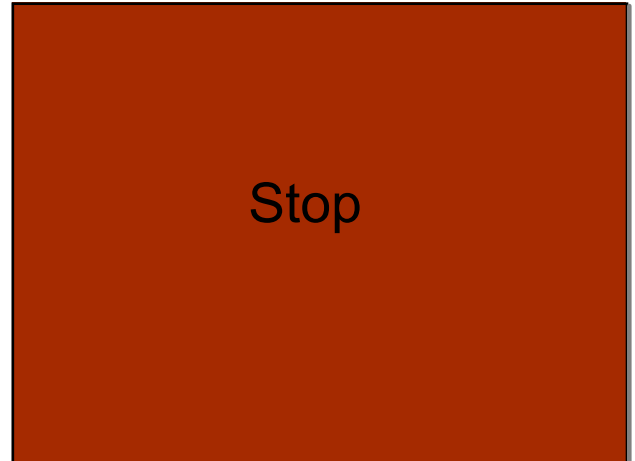
- Create 1 comic for EACH of the 3 laws. Each comic should be on a separate sheet of paper.(3 pgs total)
- Use Included Vocabulary
- How to:
  - > 1st- Create a story line.
  - > 2nd- Sketch out ideas
  - > 3rd- Final drawing



### Good Example:



### Bad Example:



### Warm Up

- 1.) If an object slows down from 15 meters a second to 5 meters a second, over a period of 45 seconds, what is the car's acceleration? -0.22 m/s<sup>2</sup>
- 2.) Using the formula  $v_2 = v_1 + (a \times t)$ , calculate the final speed for an object that accelerates from 62 m/s at a rate of 3 m/s<sup>2</sup> over a period of 30 seconds. 152 m/s