Sir Isaac Newton

1. Mathematician
2. Scientist
3. Born in England on December 25, 1643.
4. His grandmother raised him and he lived for 85 years.
5. He became interested in new ideas about motion and gravity when he was at college.
6. Published his observations and theories about force and motion in 1687.
7. Newton's ideas were so good that Queen Anne knighted him in 1705.
8. His accomplishments laid the foundations for modern science and revolutionized the world.
9. Sir Isaac Newton died in 1727.

Describing Motion

- **Motion**
  - If an objects distance from another object is changing. (Speed and direction)
    - Ex: Sitting at your desk, are you in motion?
    - Ex: Sitting in a car, are you in motion?

Reference Point

- **A place or object used for comparison to determine if something is in motion.**
  - An object is in motion if it changes position relative to a reference point.
    - Ex: Stationary Objects; Tree, Building, Sign.

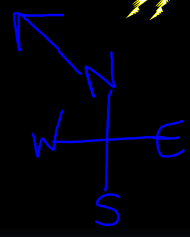
https://www.youtube.com/watch?v=sA2zYD2A45c

Speed

- **The distance the object travels per unit of time.**
- If you know the distance an object travels in a certain amount of time, you can calculate the speed of the object.
- Speed = $\frac{\text{Distance}}{\text{Time}}$

Velocity

- **The rate of change in the position of an object as it moves in a particular direction (straight line).**



- **Vector (direction of travel)**
  - North, South,
  - East (direction of sunrise), and West (direction of sunset)
  - Ex: A storm/hurricane
    - You know the velocity of the storm when you know that it is moving 25 km/h in an eastward direction.

- Displacement
  - Change in position in a given direction.
    - To figure out Displacement you take the change in placement divided by the change in time.

Acceleration

- A measure of the rate of change in the velocity of something per unit of time.
- Referred to as:
  - **Increasing speed; Acceleration**
    - Ex: Coasting down a hill on your bike
  - **Decreasing** speed; Deceleration
    - Ex: Going uphill on your bike or hitting the brakes.
  - **Changing Direction**
  - Ex: Runner going around a turn on a track.

Acceleration

- Acceleration = $\frac{\text{Final Speed} - \text{Initial Speed}}{\text{Time}}$

To determine the acceleration of an object moving in a straight line, you must calculate the change in speed per unit of time.

Acceleration is measured by m/s^2

Nature of Force

Force

- A push or pull
- The strength of a force is measured in the SI unit called the Newton.
  - You exert about one Newton of force when you lift a small lemon.
  - Represented by an arrow
- Net Force
  - Combination of all forces acting on an object

Force Examples

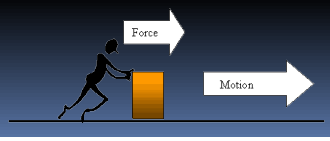
- 5 N 5 N = 10 N
- 5 N 10 N = 5 N
- 5 N 5 N = 0

Unbalanced Forces

- Can cause an object to:
  - Start Moving
  - Stop Moving
  - Change direction
- Unbalanced forces acting on an object result in a net force and cause a change in the object's motion.

Unbalanced Force

- Same Direction
  - When 2 forces act in the same direction the net force is the sum of the 2 individual forces.



Unbalanced Forces

- Opposite Direction
  - * When 2 forces act in opposite directions, the net force is the difference between the two individual forces.

Balanced Force

- Balanced Force
  - Equal forces acting on one object in opposite directions .
  - Balanced forces acting on an object do not change the objects motion. They cancel each other out.

Friction

- The force that two surfaces exert on each other when they rub against each other.
- Depends on 2 factors
  - How hard the surfaces push together
  - Types of surfaces involved
    - Ex. Your hands
- 4 types of Friction
  - Static
  - Sliding
  - Rolling
  - Fluid

Friction

- Static Friction
  - Acts on objects that are <u>not</u> moving
    - Ex: Car tires not sliding.
- Sliding Friction
  - Occurs when 2 solid surfaces slide over each other.
    - Ex: Rubbing hands together.

Friction

- Rolling Friction
  - When an object rolls across a surface
    - Ex: Bowling Ball
- Fluid Friction
  - When a solid object moves through a fluid(liquid or air)
    - Ex. Skim Boarding, Surfing, Air Resistance

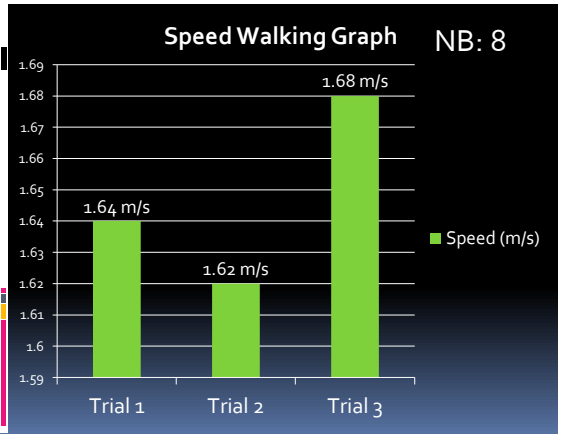
Measurement Review

Common SI Prefixes		
Prefix	Symbol	Meaning
kilo-	k	
hecto-	h	
deka-	da	
deci-	d	
centi-	c	
milli-	m	

Meter measures distance/length

Speed Walking Data (NB:8)

Walking Trial	Meters	Seconds	Speed (m/s)	AVG speed (add your three times together and divide by three)
Trial #1	20	12.22 sec	1.64 m/s	1.65 m/s
Trial #2	20	12.37 sec	1.62 m/s	
Trial 3	20	11.87	1.68 m/s	



Analysis:

- What formula did you use to compute your average walking speed?_____
- What is your average walking speed? _____
- How does your average walking speed compare with that of the other members of your group? (faster, slower, same)
- At your average walking speed, estimate how far you could walk in one minute _____, one hour _____.

Gravity

- Force that pulls objects toward each other.

- Rumor- Newton discovers gravity sitting underneath a apple tree, only a grain of truth to that, about the size of an apple seed.

Gravity and Motion

- The force of gravity is an unbalanced force that causes an object to accelerate.
  - With no air resistance objects with 2 different masses will fall at exactly the same time.

Demonstration

http://www.youtube.com/watch?v=1whMAlGNq7E

Newton's 1st Law of Motion

An object at rest will stay at rest and an object in motion will stay in motion, unless it is acted upon by an unbalanced force.

- Basically what it is saying is that:
  - something will not move unless an unbalanced (stronger) force moves it.
  - something will not stop unless an unbalanced (stronger) force stops it.
  - http://archive.ncsa.illinois.edu/Cyberia/VideoTestbed/Projects/NewPhysics/newtons_1.html
  - http://www.youtube.com/watch?v=4CWINoNpXCc
  - http://www.youtube.com/watch?v=8zsE3mpZ6Hw

1st Law; Law of Inertia

- Inertia
  - Tendency of an object to resist a change in motion.

Ex: Hockey Puck

https://www.youtube.com/watch?v=7lx-eywqUOg&list=PLE5B069B747E16B20

Demonstration

Newton's 2nd Law of Motion

Acceleration depends on the object's <u>mass</u> and on the <u>net force</u> acting on the object.

Force= Mass X Acceleration

OR

$$\text{Acceleration} = \frac{\text{Net Force}}{\text{Mass}}$$

- By increasing the force you will <u>increase</u> acceleration
- By increasing the mass you will <u>decrease</u> acceleration

https://www.youtube.com/watch?v=UVdqxYyFRKY&list=PLE5B069B747E16B20 1:12 – 2:33

Acceleration

- Acceleration is the measure of the change in what?
- A: density
- B: motion
- C: velocity
- D: mass

Acceleration Problem

If a car accelerates from 3 m/s to 12 m/s in 3 seconds, what is the car's average acceleration? (final-initial speed/time)

- A: 1 m/s^2
- B: 2 m/s^2
- C: 3 m/s^2
- D: 4 m/s^2

Ex: Baseball

Pitcher – "force in motion"

Catcher – "force to stop the ball"

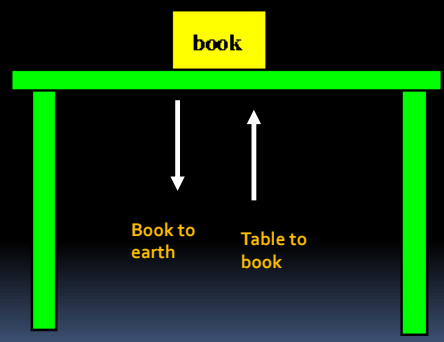
Newton's 3rd Law of Motion

- For every action there is an equal and opposite reaction.

Ex: Blowing Up a Balloon

Action Force?

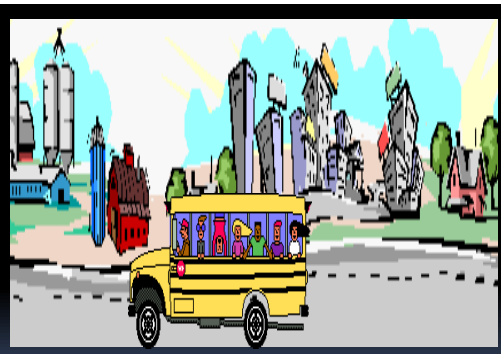
Reaction Force?



Think about it . . .

- What happens if you are standing on a skateboard or a slippery floor and push against a wall?

Why does it hurt so much when you stub your toe?



Reaction: road pushes on tire

Action: tire pushes on road

Consider hitting a baseball with a bat. If we call the force applied to the ball by the bat the *action force*, identify the *reaction force*.

(a) the force applied to the bat by the hands
(b) the force applied to the bat by the ball
(c) the force the ball carries with it in flight

Review

https://www.youtube.com/watch?v=iH48Lc7wq0U&list=PLE5B069B747E16B20&index=36

Newton's First Law:

Objects in motion tend to stay in motion and objects at rest tend to stay at rest unless acted upon by an unbalanced force.

Newton's Second Law:

Force equals mass times acceleration (F = ma).

Newton's Third Law:

For every action there is an equal and opposite reaction.

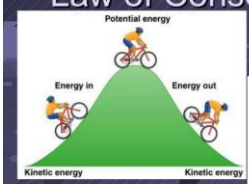
Why would you need to learn about the laws of motion?

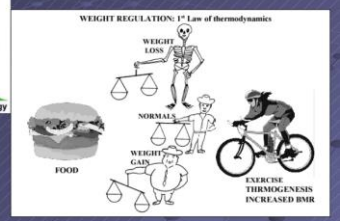
POTENTIAL AND KINETIC ENERGY

Law of Conservation of Energy

- *The Law of Conservation of Energy states:
  - *Energy is never created or destroyed
  - *Energy is simply converted from one form to another
  - (also called the First Law of Thermodynamics)

Law of Conservation of Energy





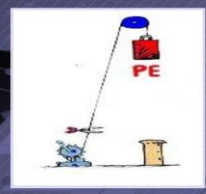
How is all energy divided?

All Energy

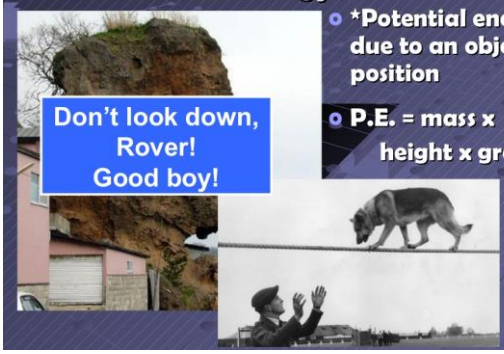
- Potential Energy
  - Gravitation Potential Energy
  - Elastic Potential Energy
  - Chemical Potential Energy
- Kinetic Energy

What is *Potential Energy?

- *Energy that is stored and waiting to be used later



What is *Gravitational Potential Energy?



- *Potential energy due to an object's position
- P.E. = mass x height x gravity

What is *Elastic Potential Energy?

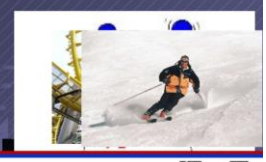
- *Potential energy due compression or expansion of an elastic object.

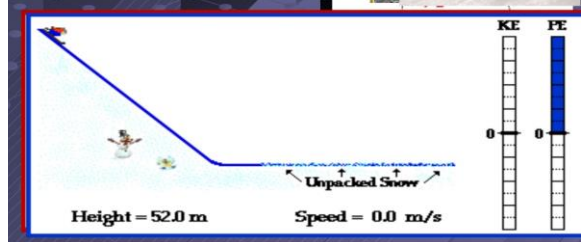
What is *Chemical Potential Energy?

- *Potential energy stored within the chemical bonds of an object

What is *Kinetic Energy?

- *Energy an object has due to its motion
- K.E. = .5(mass x speed²)



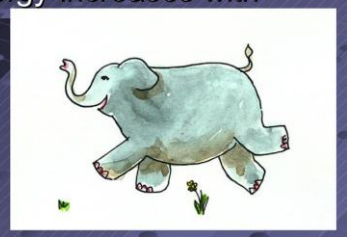


*Kinetic Energy

- *Kinetic Energy increases with speed.

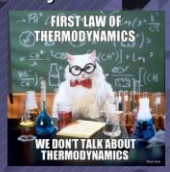
Kinetic Energy

- *Kinetic Energy increases with mass.



Your turn…

- List on your notes:
- Six examples of potential energy
- Six examples of kinetic energy
- Thank you for your attention today!!!



Energy Transformation and Electrical Circuits

Vocabulary

Word	Definition
Energy	The ability to do work. Anything that makes matter move or change.
Energy transformation	When energy is changed from one form to another. For example, electrical energy into light energy.
Force	A push or a pull.
Electrical Force	The pushing and pulling by moving electrons.
Electricity	The presence or movement of charged particles called electrons.
Electrical Energy	Energy from interactions between charged particles (electrons).
Current	A steady flow of electrons.
Circuit	The complete loop through which an electrical current can pass.
Green energy	Energy that comes from sources that do not pollute the Earth.
Primary Energy	Energy sources found in nature that have not been subjected to any conversion or transformation process.
Secondary Energy	Energy which has been transformed from another source.

What is Energy?

- **Energy** can mean lots of things. It's everywhere!
- In physics, **energy** refers to the ability to do **work** (and usually has something to do with movement or action).
- **Energy** is anything that can make matter **move** or **change**.

What is Energy?

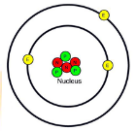
Energy comes in a number of forms including:

*potential energy, which is energy that's stored in a system and waiting to come out;

*kinetic energy, which is the energy in a moving system;

*chemical energy, which is energy that's stored in chemical bonds between atoms;

*electrical energy, which is energy from interactions between charged particles;



What is Energy?

* thermal energy, which relates to heat energy of molecules;

*nuclear energy, which is energy that's stored between the particles within atoms.

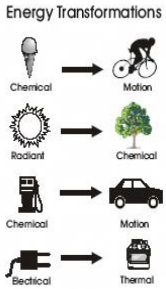
*Light and other forms of electromagnetic radiation such as gamma rays or X-rays are also thought of as a form of energy.

*The physicist Albert Einstein showed that in fact, pretty much all mass is a form of energy too!"

$E=mc^2$

Energy Transformation

- The Law of Conservation of Energy states that energy cannot be created or destroyed in a system. Instead, it must be converted, or transformed, into another type of energy.
- Energy transformation is when energy is changed from one form to another.



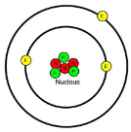
Energy Transformation

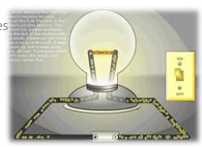
*You can see the idea of energy transformation when you think about lighting a match. What happens is that the chemical energy stored in the match is converted into heat energy and light energy.

*When electrical energy passes through a light bulb, electrical energy is transformed into light energy.

Electric Circuits

- Electricity is the presence or movement of electrons, which are tiny, negatively charged particles that orbit an atom's nucleus. Electricity is what we get when electrons move from one place to another.
- Energy can be transferred from one system to another when two objects push or pull on each other over a distance. In the case of electricity, electrons are pushed and pulled through a circuit.
- A force is a push or a pull. There are many types of forces. The pushing and pulling of moving electrons is an electrical force.





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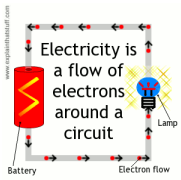
Electric Circuits

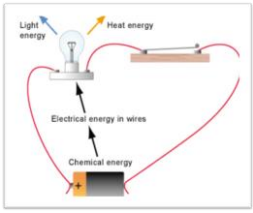
- Electricity is naturally present in lightning and static electricity, but the flow of the electrons in lightning and static electricity are not controlled or steady.

- In order for electricity to be useful in our homes and devices, there needs to be a steady flow of electrons called a current.
- There also needs to be a complete circuit or a complete loop through which the electrical current can pass.



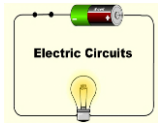
Electric Circuits

- In a complete circuit, energy starts at a power source (for example a battery), moves through a **conductor** (for example, a metal wire), passes through a load (a device that uses electricity such as a light bulb or toaster) and returns back to the power source.
- It starts out in one place, travels around the circuit, and ends up back at the place where it originated. The electrons are pushed and pulled through the circuit.



Batteries and Circuits

- Batteries are devices that use "**energy transformation**" to produce electricity. They work by changing stored chemical energy into electrical energy.
- A **chemical** reaction inside a battery creates electrons. These electrons are stored in the negative terminal (-) of the battery. When a battery is part of a complete circuit, the negative terminal pushes the electrons out.
- The electrons travel from the negative terminal, through the circuit to the positive terminal (+). The positive side of the battery pulls the electrons in.
- Batteries create an **electrical force** by pushing and pulling electrons through a complete circuit.



Generating Electricity

- Power plants use generators to produce electricity. The electricity produced through these generators are secondary energy sources.
  - **Primary energy** sources are found in nature and have not been subjected to any conversion or transformation process such as sunlight, wood, oil, coal and natural gas.
  - **Secondary energy** sources have been transformed from another source.
  - To produce electricity through a **generator**, a heat source is needed to create the conditions in which electrical currents form. This heat can come from a variety of different primary energy sources including coal, hydro power, wind power, nuclear and solar energy.

Generating Electricity

Water, wind and solar are some sources of **green energy**—meaning they do not **pollute** the environment.

You need a complete circuit for electrons to flow and have an electrical current. Electricity is important because we can use it to make so many things work. When electrons are pushed or pulled through a circuit (electrical force), the electrical energy can be converted through energy transformation into many other types of energy including light, heat, and sound.

Simple Machines

Work

- In science, the word work has a different meaning than you may be familiar with.
- The scientific definition of work is: using a force to move an object a distance (when both the force and the motion of the object are in the same direction.)

Work or Not?

- According to the scientific definition, what is work and what is not?
  - a teacher lecturing to her class
  - a mouse pushing a piece of cheese with its nose across the floor

What's work?

- A scientist delivers a speech to an audience of his peers.
- A body builder lifts 350 pounds above his head.
- A mother carries her baby from room to room.
- A father pushes a baby in a carriage.
- A woman carries a 20 km grocery bag to her car?

Formula for work

Work = Force x Distance

- The unit of force is newtons
- The unit of distance is meters
- The unit of work is newton-meters
- One newton-meter is equal to one joule
- So, the unit of work is a **joule**

W=FD

Work = Force x Distance

Calculate: If a man pushes a concrete block 10 meters with a force of 20 N, how much work has he done?

History of Work

Before engines and motors were invented, people had to do things like lifting or pushing heavy loads by hand. Using an animal could help, but what they really needed were some clever ways to either make work easier or faster.

What is a Simple Machine?

- A simple machine has few or no moving parts.
- Simple machines make work easier

Wheels and Axles

- The wheel and axle are a simple machine
- The axle is a rod that goes through the wheel which allows the wheel to turn
- Gears are a form of wheels and axles

Pulleys

- Pulleys are wheels and axles with a groove around the outside
- A pulley needs a rope, chain or belt around the groove to make it do work

Inclined Planes

- An inclined plane is a flat surface that is higher on one end
- Inclined planes make the work of moving things easier

Wedges

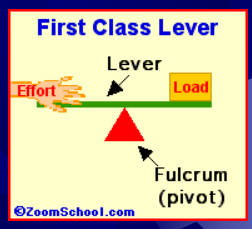
- Two inclined planes joined back to back.
- Wedges are used to split things.

Screws

- A screw is an inclined plane wrapped around a shaft or cylinder.
- The inclined plane allows the screw to move itself when rotated.

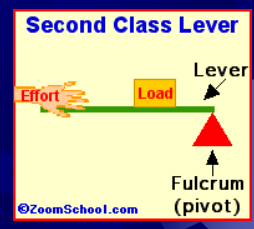
Levers-First Class

- In a first class lever the fulcrum is in the middle and the load and effort is on either side
- Think of a see-saw



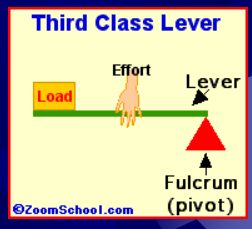
Levers-Second Class

- In a second class lever the fulcrum is at the end, with the load in the middle
- Think of a wheelbarrow



Levers-Third Class

- In a third class lever the fulcrum is again at the end, but the effort is in the middle
- Think of a pair of tweezers



Simple Machines

- Simple Machines can be put together in different ways to make complex machinery