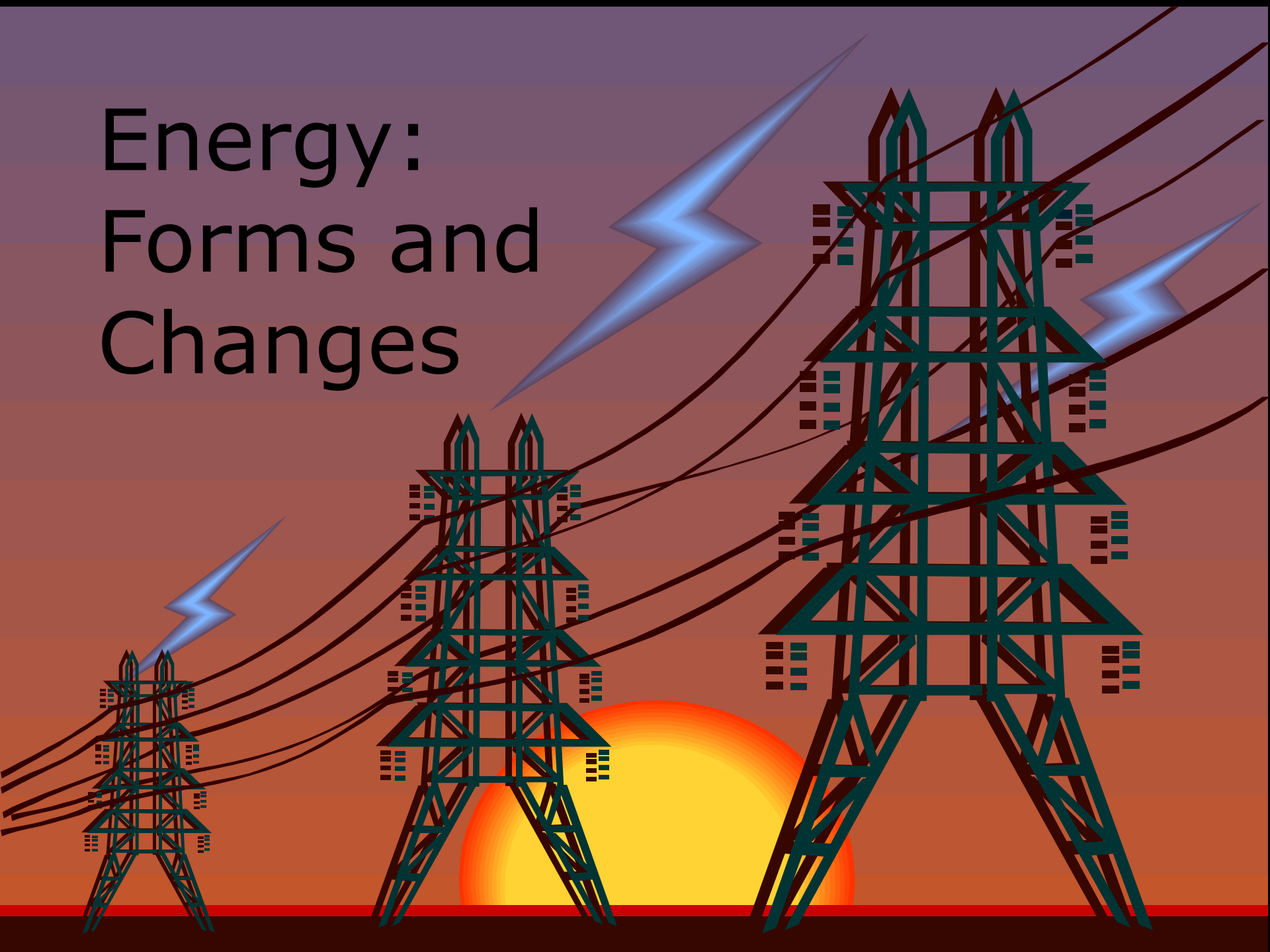
Energy: Forms and Changes



Nature of Energy

- Energy is all around you!
  - You can hear energy as sound.
  - You can see energy as light.
  - And you can feel it as wind.

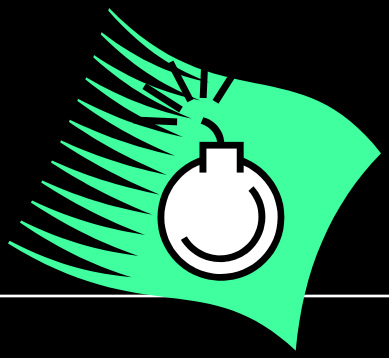
Nature of Energy

- You use energy when you:
  - hit a softball.
  - lift your book bag.
  - compress a spring.

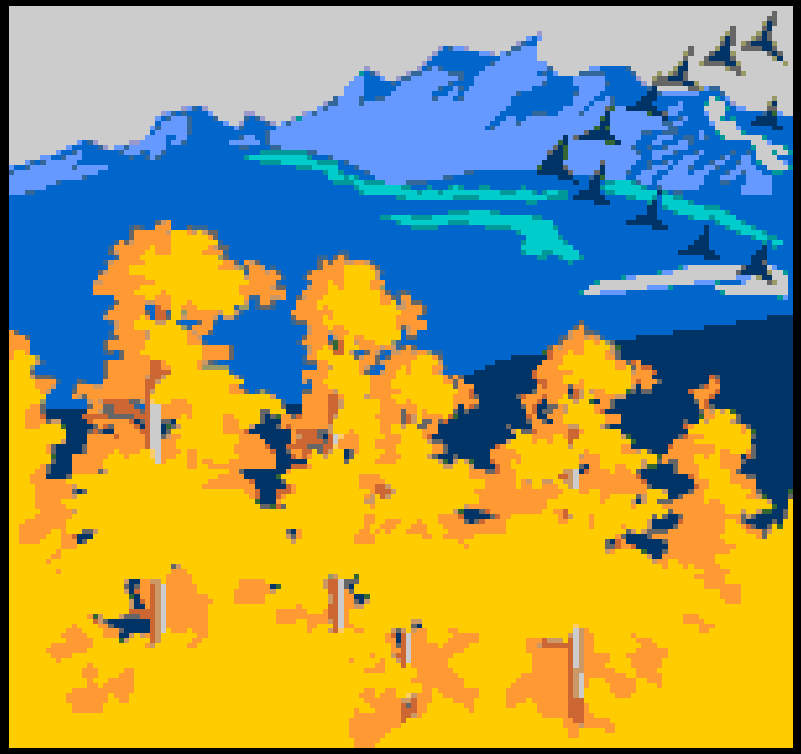
Nature of Energy

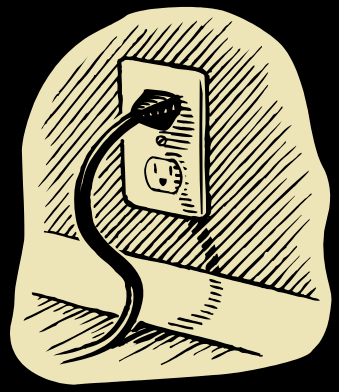
Living organisms need energy for growth and movement.

Nature of Energy



- Energy is involved when:
  - a bird flies.
  - a bomb explodes.
  - rain falls from the sky.
  - electricity flows in a wire.





Nature of Energy

- What is energy that it can be involved in so many different activities?
  - Energy can be defined as the ability to do work.
  - If an object or organism does work (exerts a force over a distance to move an object) the object or organism uses energy.

Nature of Energy

- Because of the direct connection between energy and work, energy is measured in the same unit as work: joules (J).
- In addition to using energy to do work, objects gain energy because work is being done on them.

Forms of Energy

- The five main forms of energy are:
  - Heat
  - Chemical
  - Electromagnetic
  - Nuclear
  - Mechanical

Heat Energy

- The internal motion of the atoms is called heat energy, because moving particles produce heat.
- Heat energy can be produced by friction.
- Heat energy causes changes in temperature and phase of any form of matter.

Chemical Energy

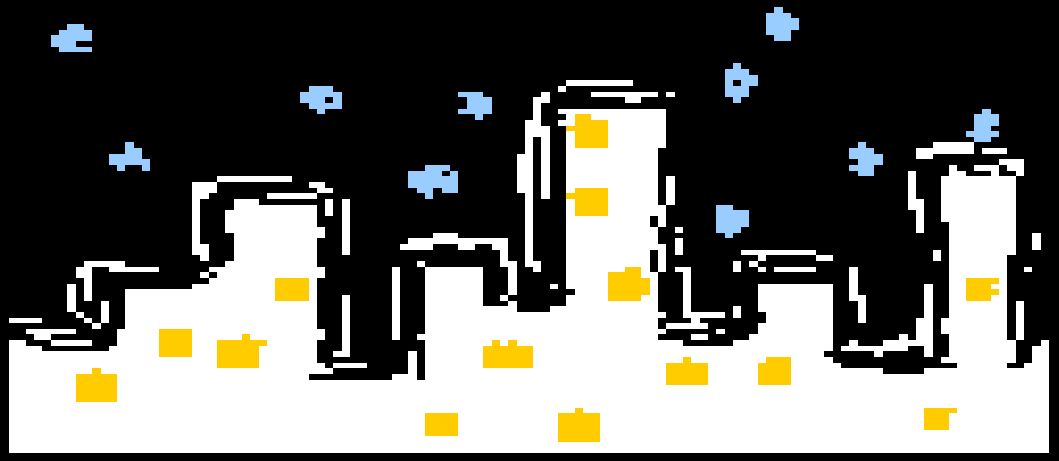
- Chemical Energy is required to bond atoms together.
- And when bonds are broken, energy is released.

Chemical Energy

- Fuel and food are forms of stored chemical energy.

Electromagnetic Energy

- Power lines carry electromagnetic energy into your home in the form of electricity.

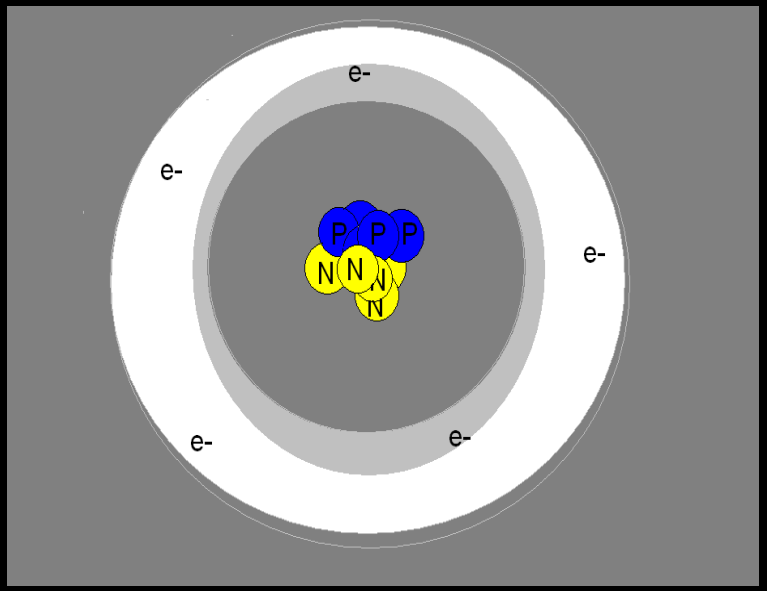


Electromagnetic Energy

- Light is a form of electromagnetic energy.
- Each color of light (Roy G Bv) represents a different amount of electromagnetic energy.
- Electromagnetic Energy is also carried by X-rays, radio waves, and laser light.

Nuclear Energy

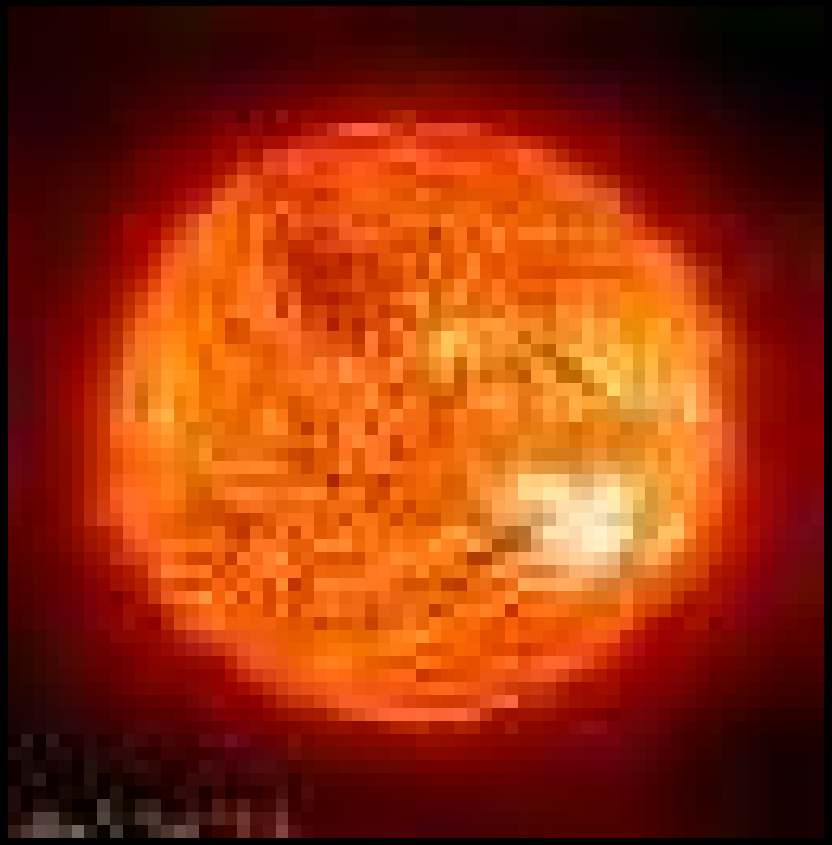
- The nucleus of an atom is the source of nuclear energy.



Nuclear Energy

- When the nucleus splits (fission), nuclear energy is released in the form of heat energy and light energy.
- Nuclear energy is also released when nuclei collide at high speeds and join (fuse).

Nuclear Energy



The sun’s energy is produced from a nuclear fusion reaction in which hydrogen nuclei fuse to form helium nuclei.

Nuclear Energy

- Nuclear energy is the most concentrated form of energy.

Mechanical Energy

- When work is done to an object, it acquires energy. The energy it acquires is known as mechanical energy.

Mechanical Energy

- When you kick a football, you give mechancal energy to the football to make it move.

Mechanical Energy

When you throw a balling ball, you give it energy. When that bowling ball hits the pins, some of the energy is transferred to the pins (transfer of momentum).

Energy Conversion

- Energy can be changed from one form to another. Changes in the form of energy are called energy conversions.

Energy conversions

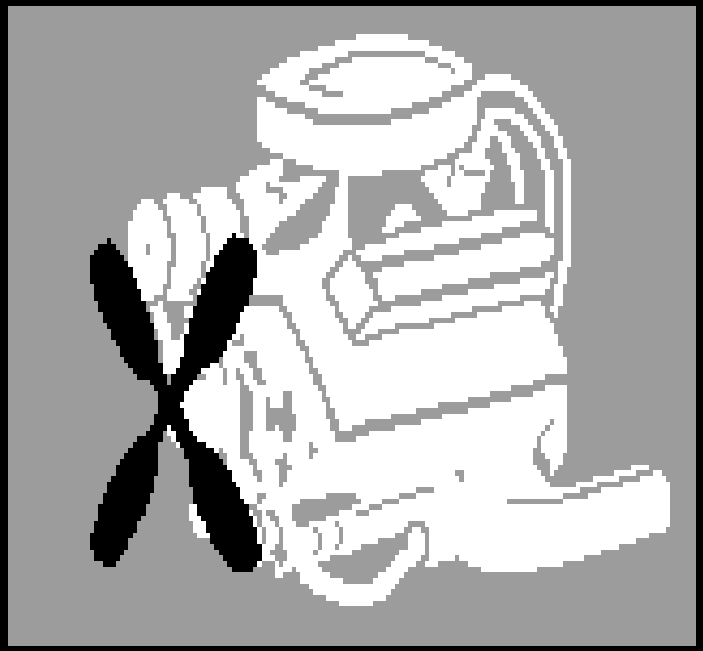
- All forms of energy can be converted into other forms.
  - The sun's energy through solar cells can be converted directly into electricity.
  - Green plants convert the sun's energy (electromagnetic) into starches and sugars (chemical energy).

Other energy conversions

- In an electric motor, electromagnetic energy is converted to mechanical energy.
- In a battery, chemical energy is converted into electromagnetic energy.
- The mechanical energy of a waterfall is converted to electrical energy in a generator.

Energy Conversions

- In an automobile engine, fuel is burned to convert chemical energy into heat energy. The heat energy is then changed into mechanical energy.



Chemical → Heat →Mechanical

States of Energy

- The most common energy conversion is the conversion between potential and kinetic energy.
- All forms of energy can be in either of two states:
  - Potential
  - Kinetic

States of Energy: Kinetic and Potential Energy

- Kinetic Energy is the energy of motion.
- Potential Energy is stored energy.

Kinetic Energy

- The energy of motion is called kinetic energy.
- The faster an object moves, the more kinetic energy it has.
- The greater the mass of a moving object, the more kinetic energy it has.
- Kinetic energy depends on both mass and velocity.

Kinetic Energy

$$K.E. = \frac{\text{mass} \times \text{velocity}^2}{2}$$

What has a greater affect of kinetic energy, mass or velocity? Why?

Potential Energy

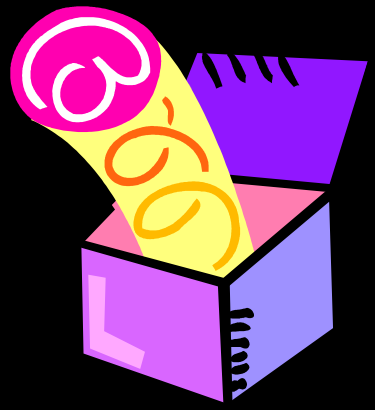
- Potential Energy is stored energy.
  - Stored chemically in fuel, the nucleus of atom, and in foods.
  - Or stored because of the work done on it:
    - Stretching a rubber band.
    - Winding a watch.
    - Pulling back on a bow's arrow.
    - Lifting a brick high in the air.

Gravitational Potential Energy

- Potential energy that is dependent on height is called gravitational potential energy.

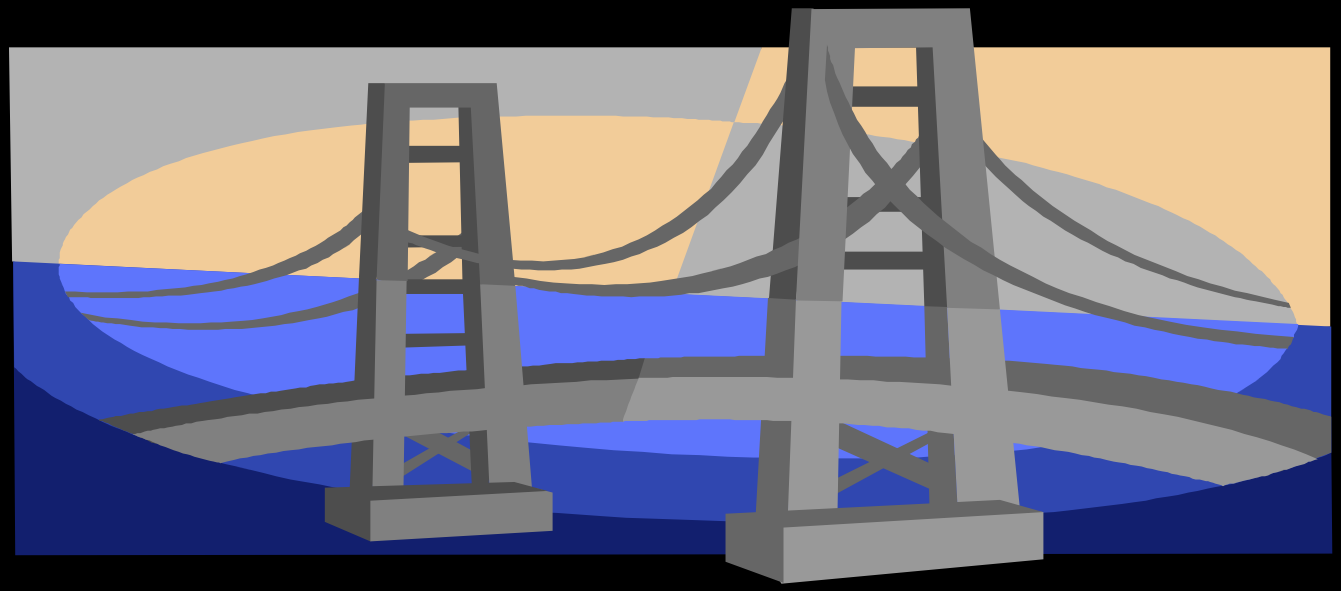
Potential Energy

- Energy that is stored due to being stretched or compressed is called elastic potential energy.



Gravitational Potential Energy

- A waterfall, a suspension bridge, and a falling snowflake all have gravitational potential energy.



Gravitational Potential Energy

- If you stand on a 3-meter diving board, you have 3 times the G.P.E, than you had on a 1-meter diving board.

Gravitational Potential Energy

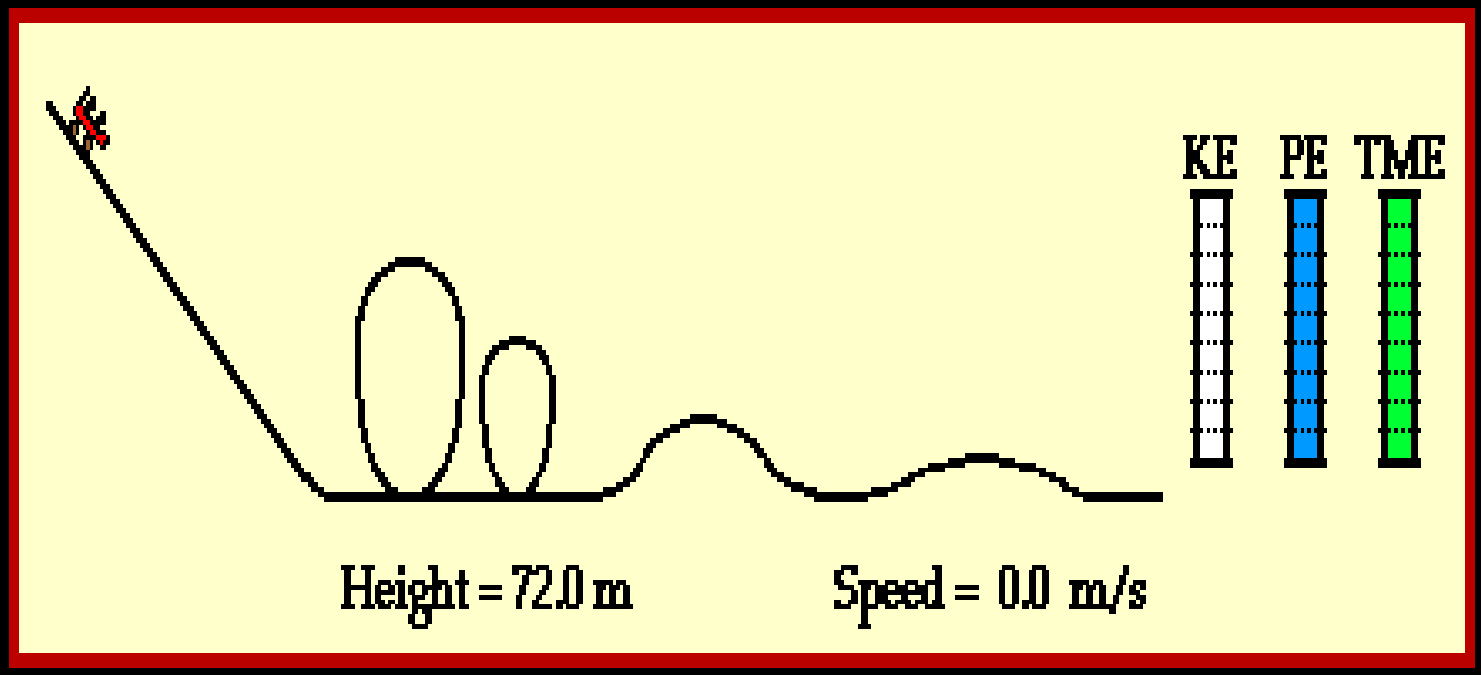
- "The bigger they are the harder they fall" is not just a saying. It's true. Objects with more mass have greater G.P.E.
- The formula to find G.P.E. is

G.P.E. = Weight X Height.

Kinetic-Potential Energy Conversion

Roller coasters work because of the energy that is built into the system. Initially, the cars are pulled mechanically up the tallest hill, giving them a great deal of potential energy. From that point, the conversion between potential and kinetic energy powers the cars throughout the entire ride.

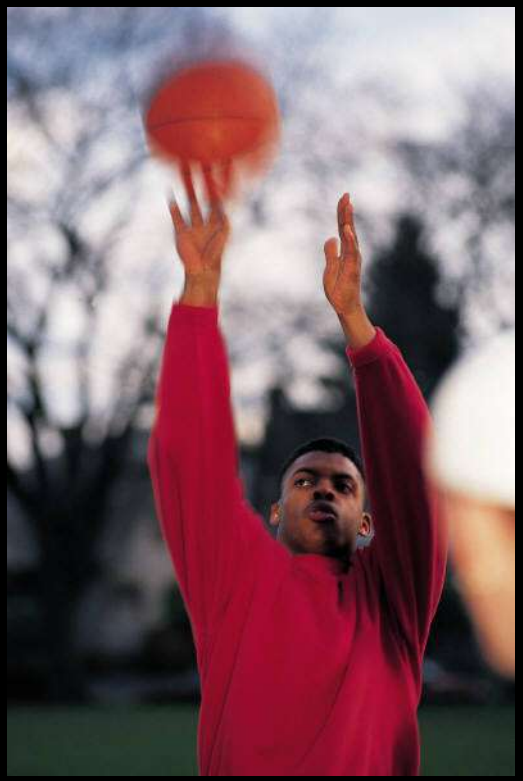
Kinetic vs. Potential Energy

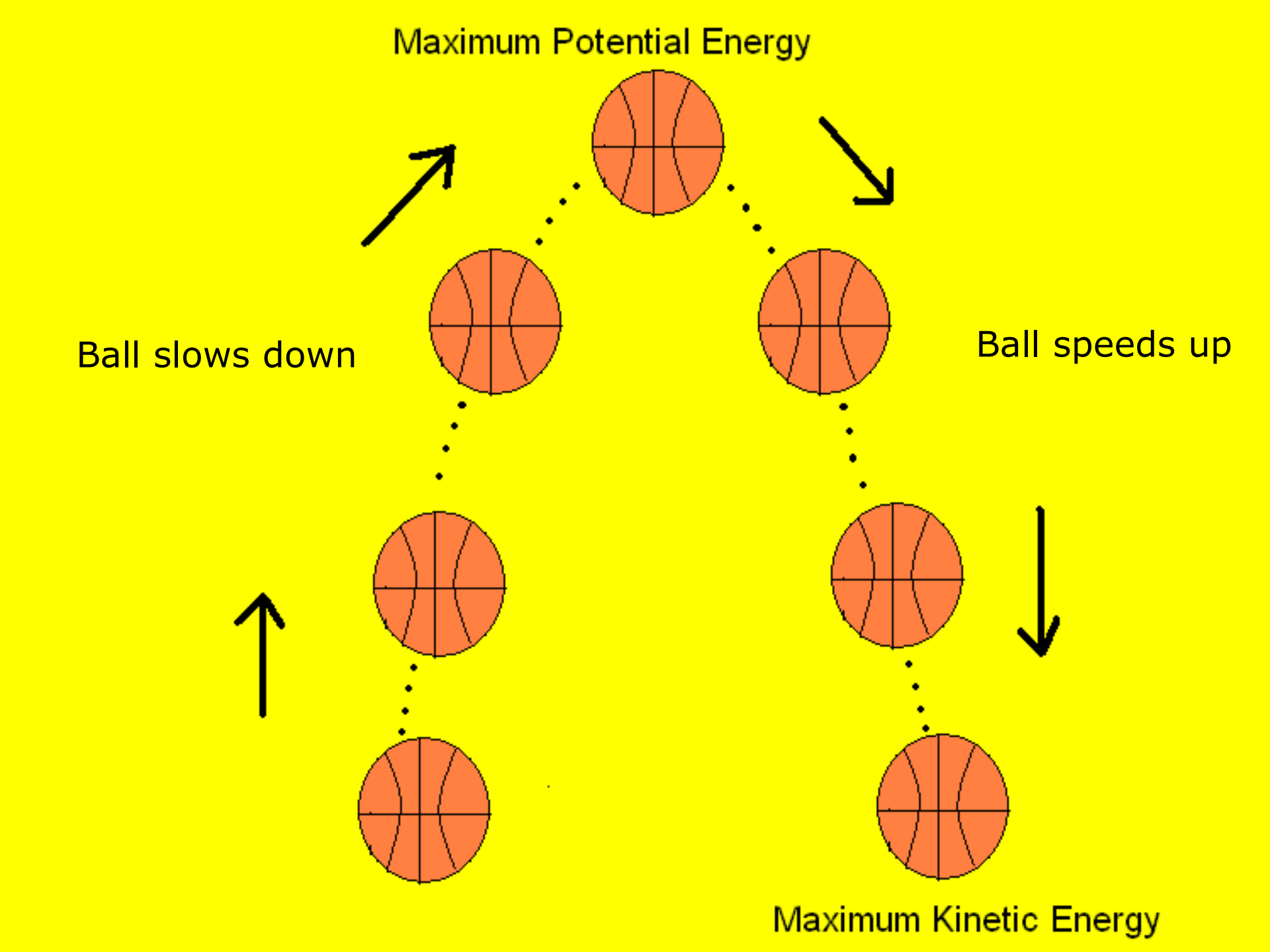


At the point of maximum potential energy, the car has minimum kinetic energy.

Kinetic-Potential Energy Conversions

- As a basketball player throws the ball into the air, various energy conversions take place.




Maximum Potential Energy
Ball slows down
Ball speeds up
Maximum Kinetic Energy

The Law of Conservation of Energy

- Energy can be neither created nor destroyed by ordinary means.
  - It can only be converted from one form to another.
  - If energy seems to disappear, then scientists look for it – leading to many important discoveries.

Law of Conservation of Energy

- In 1905, Albert Einstein said that mass and energy can be converted into each other.
- He showed that if matter is destroyed, energy is created, and if energy is destroyed mass is created.
  - $E = MC^2$

Vocabulary Words

energy
mechanical energy
heat energy
chemical energy
electromagnetic energy
nuclear energy
kinetic energy
potential energy
gravitational potential energy
energy conversion
Law of Conservation of Energy