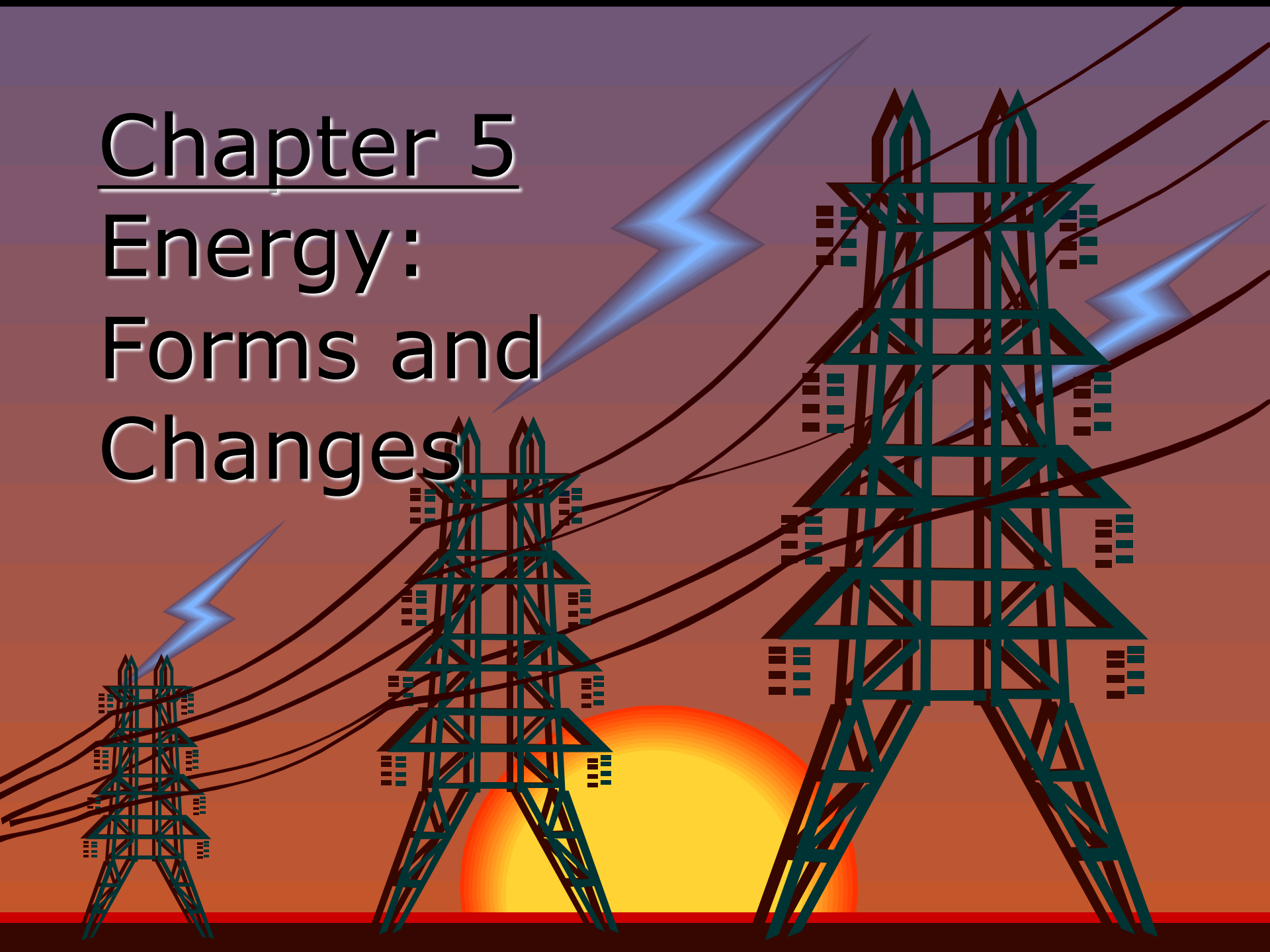


# Chapter 5

## Energy: Forms and Changes



# 5-1 Nature of Energy

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

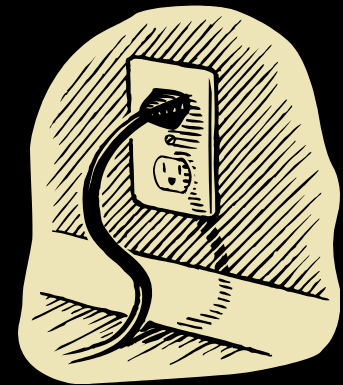


- You use energy when you:
  - hit a softball.
  - lift your bag.
  - compress a spring.
- You need energy for growth too!

# Energy- ability to do work

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- Energy can be defined as the ability to do work.
- An object or organism does work (exerts a force over a distance to move an object) the object or organism uses energy
  - Energy is involved when:
    - a bird flies.
    - a bomb explodes.
    - rain falls from the sky.
    - electricity flows in a wire.



# Forms of Energy

- Five main forms of energy
  - Heat
  - Chemical
  - Electromagnetic
  - Nuclear
  - Mechanical





# Heat Energy

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- Motion of the atoms produces heat
- Heat energy causes changes in temperature and phase of any form of matter
- Examples: friction, campfire, boiling water

# Chemical Energy

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- Energy due to atoms being bonded together
- When bonds are broken, energy is released!
- Examples: food & fuel



# Electromagnetic Energy

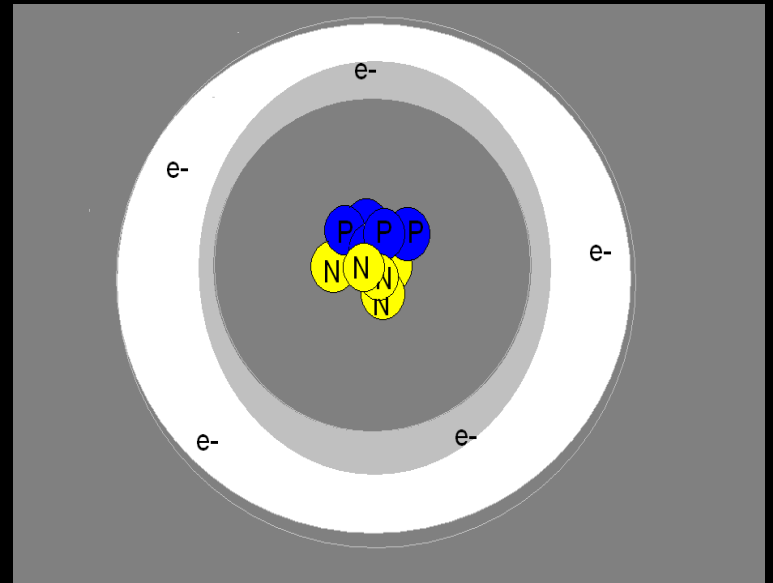
- Energy due to moving electrons
- Examples: electricity, X-rays, radio waves, laser beams, light



- Each color (ROY G BIV) represents a different amount of electromagnetic energy

# Nuclear Energy

- The nucleus of an atom is the source of nuclear energy.
- When the nucleus splits (fission), nuclear energy is released in the form of heat energy and light energy.





# Nuclear Energy

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Nuclear energy is also released when nuclei collide at high speeds and join (fuse).

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

# Mechanical Energy

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- Energy associated with motion
- Examples: running, waterfall, wind, automobile, jet plane



# Mechanical Energy

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



## 5-2 Kinetic and Potential Energy

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- All forms of energy classified according to their state
- Kinetic Energy- energy of motion
- Potential Energy- energy of position (stored energy)



# Kinetic Energy- energy of motion

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- 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

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

$$\text{K.E.} = \frac{1}{2} m \cdot v^2$$

- Mass in kg, velocity in m/s
- Unit is Joule!!
- *Direct connection between energy & work!*



# Potential Energy- energy due to position

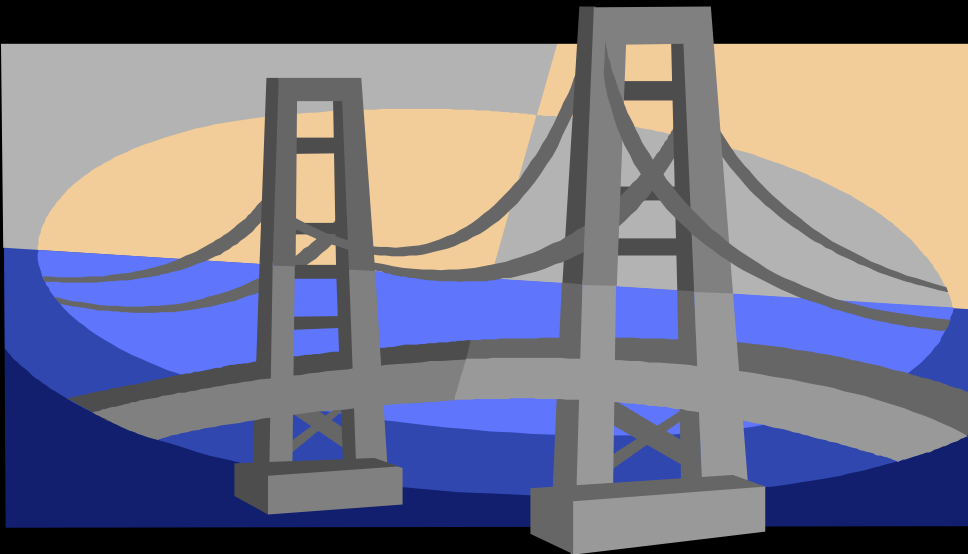
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- Potential Energy is stored energy.
  - Stored due to height (gravitational)
  - Stored because of the work done on it
    - Stretching a rubber band.
    - Winding a watch.
    - Pulling back on a bow's arrow.
    - Lifting a brick high in the air.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

# Gravitational Potential Energy

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- A waterfall, a bungee jumper, and a falling snowflake all have gravitational potential energy.





# Gravitational Potential Energy

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- G.P.E. = Weight X Height
- G.P.E. =  $m \cdot g \cdot h$
- *More mass? Affect on G.P.E.?*
- *More height? Affect on G.P.E.?*



“The bigger they are, the harder they fall” is not just a saying...

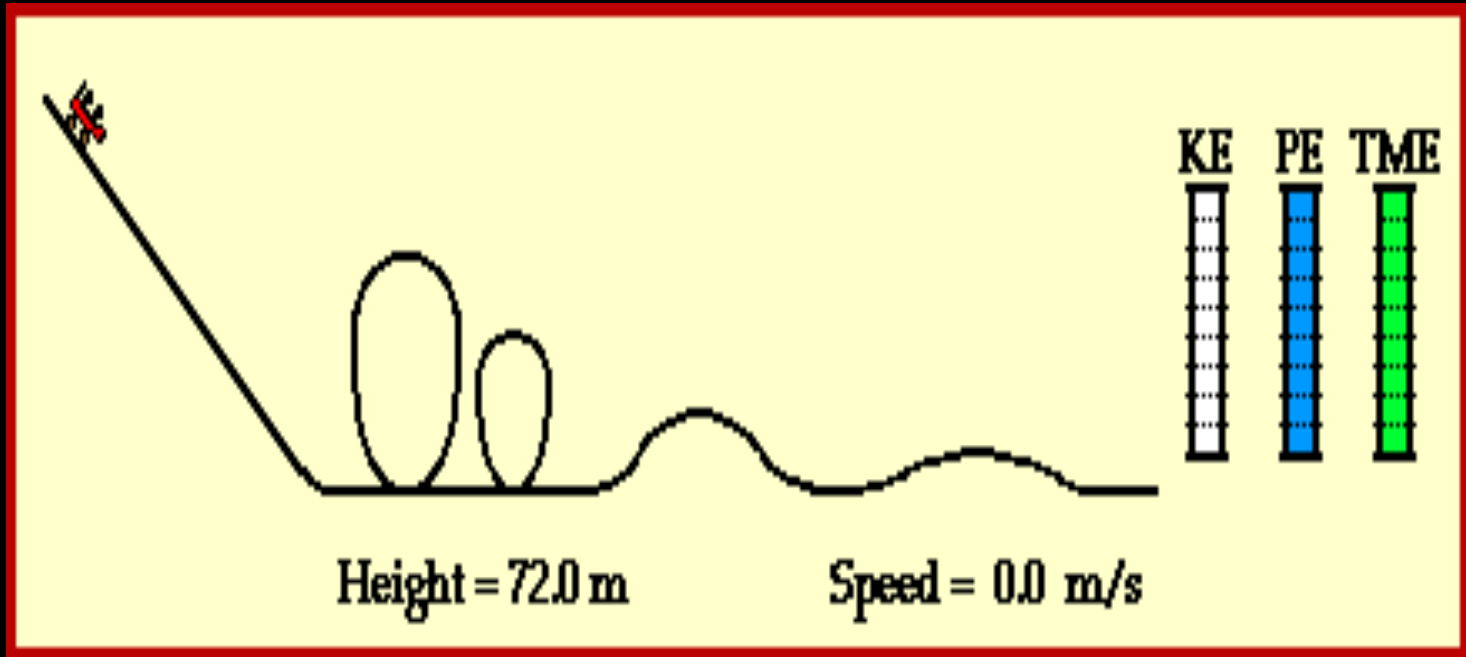
## 5-3 Kinetic-Potential Energy Conversion

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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

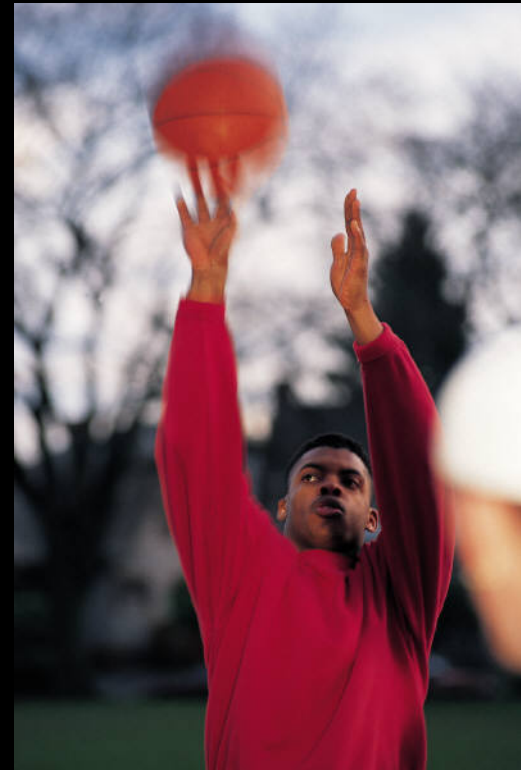


At the point of maximum potential energy, the car has minimum kinetic energy.

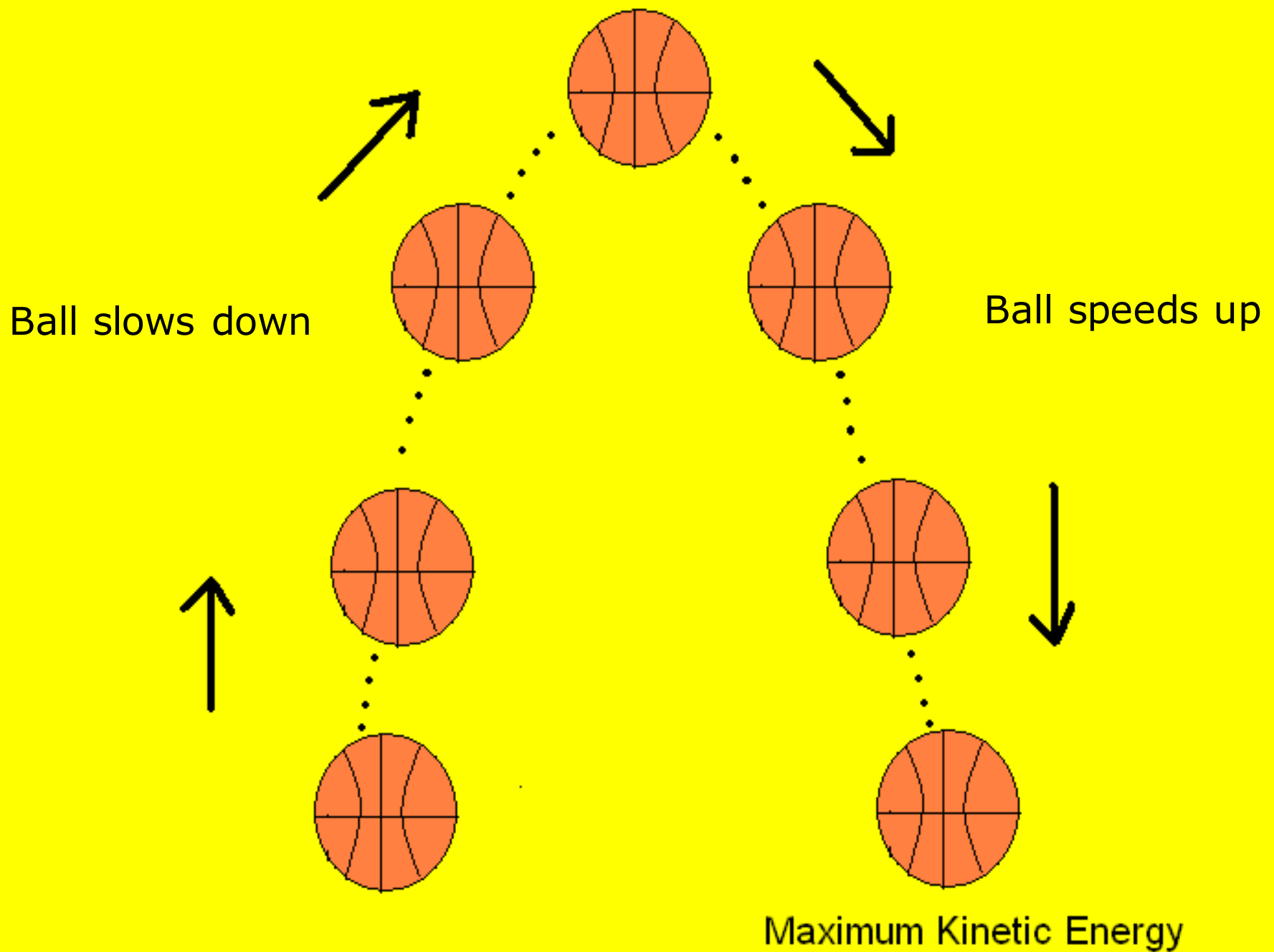
# Kinetic-Potential Energy Conversions

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

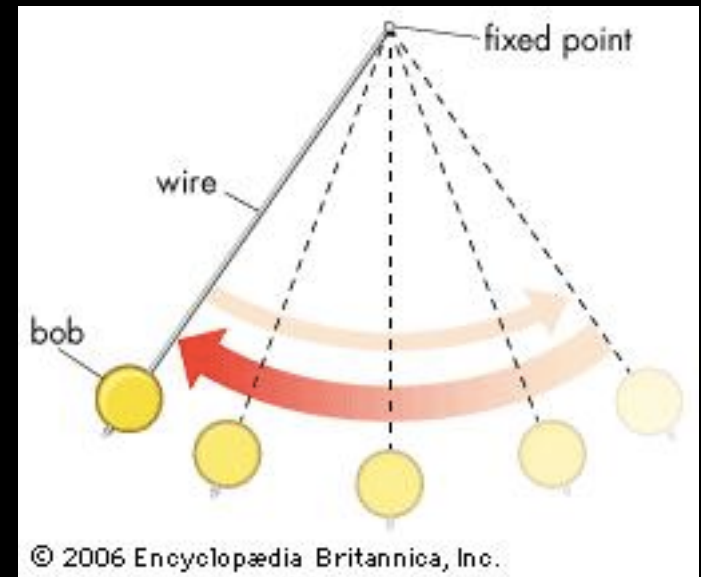


Maximum Potential Energy



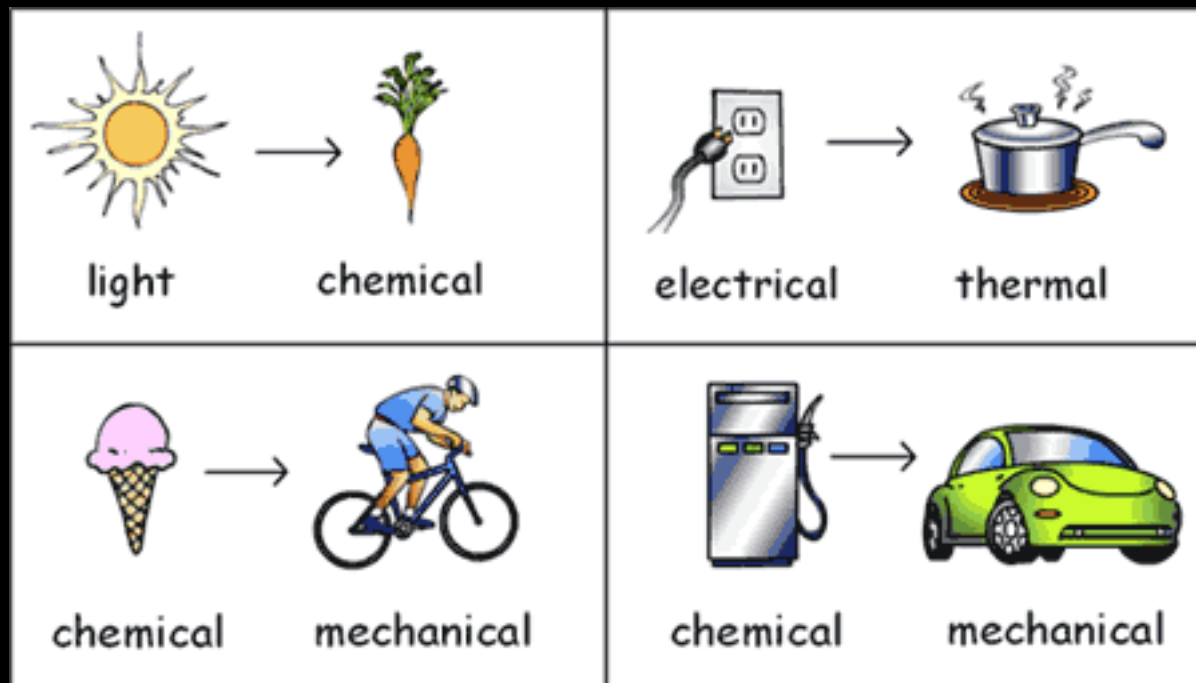
# Pendulum

- Continuous conversion between KE and PE
- Where is KE the greatest?
- Where is PE the greatest?
- $KE + PE = TE$



## 5- 3 Energy conversions

- ALL forms of energy can be converted into other forms!





# The Law of Conservation of Energy

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- Energy can be neither created nor destroyed.... it just changes forms!
  - Neither created nor destroyed by ordinary means ( like the creation of a star in our universe)
  - If energy seems to disappear, then scientists look for it – leading to many important discoveries.





## 5-4 Law of Conservation of Energy

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- 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.

$$○ E = MC^2$$



## 5-5 Physics and Energy

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- You have been learning about energy this whole semester!
  - Work
  - Power
  - Momentum
  - Forces
  - Velocity
  - Gravity
  - Acceleration



## 5-5 Relationships

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- Object in motion, has energy
  - What state?
- Force will change motion, energy changes
  - What conversion?
- Work requires energy
  - Power is rate of work, rate of energy "consumed"
  - Is energy "used up"?
- Acceleration- change in velocity
  - What change in state of energy?
- Momentum- has kinetic energy
- Gravity- potential energy