5. Energy Concepts
2. Force, Energy, and Power

Prepared for EGY 105

Energy in Our World

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Recap from Lecture 4:

- Velocity = Δ distance / Δ time

- Acceleration = Δ Velocity / Δ time
- = Δ Distance / Δ time^2

- When an object is accelerating:
- Velocity = Acceleration x time

Momentum and Force

- Momentum = mass x velocity
- Force = mass x acceleration
- Common unit of measure for force:
  - Newton ($N = kg \times m / s^2$)
- Other relationships
  - Mass = Force / acceleration (kg=F/a)
  - Acceleration = Force / mass (A=F/kg)

Sample problem

- A rock having a mass of 2 kg falls into the water from a cliff. What is the force that it exerts?
  - $F = Kg \times A$
  - $F = 2\ Kg \times 9.8\ m / s^2$
  - $F = 19.6\ Kg \times m / s^2$
  - Does that force vary if the cliff is 50' high, as opposed to being 100' high?

Mass and Weight are sometimes confused.

- Mass is a property of a body (measure of inertia).
  - Irrespective of its position relative to gravity.
  - Often expressed as Kg.
- Weight depends on gravity. An object will weigh more on earth than on moon because gravitational force greater on earth.
  - Weight often considered to be unit of force, expressed as Kg x A_{grav}
    - Where Kg is mass and A_{grav} is acceleration due to gravity.

Newton's Laws of Motion

- 1. A body will continue to remain at rest or in motion with a constant velocity unless it is acted upon by an outside force.
- 2. The acceleration of an object is directly proportional to the net force acting on it, and is inversely proportional to its mass (A = F/Kg).
- 3. For every action force, there is an equal and opposite reaction force.
- (see pp. 41-44 of text for more complete explanation)

Energy (work)

- Energy = Force x Distance
  - Joule (J) = Newton x meter
    - Energy of an apple 1 m from the floor
  - Some additional measures of energy
    - Foot pound = 1.4 J
    - 1 calorie = 4.187 J
    - 1 BTU = 1054 J
  - (See Chapter 3 of your text)

Energy can be potential or kinetic

- Potential energy
  - Stored energy, able to do work if released. Examples include:
    - Objects placed at an elevation
      - Water behind dam
      - Release energy if they fall
    - Objects placed at mechanical tension
      - Wound up spring
      - Release energy if tension is relieved
    - Chemical bond energy
      - Organic molecules
      - Energy released if combusted
  - Potential energy due to elevation
    - PE_G = weight x height = Kg x A_{grav} x h

Energy can be potential or kinetic

- Kinetic energy
  - Energy of motion
    Examples include:
    - Moving water
    - Moving catapult
  - Can be expressed mathematically as
    - $1/2\ Kg \times v^2$

Power

- Rate at which energy is produced, used, or transferred.
  - Expressed as energy per time
  - Common units include
    - Watt (J / s)
    - Ft-lb / sec
    - Horsepower
      - 1 hp = 550 ft-lbs / sec
      - 1 hp = 746 Watts

Common unit is kilowatt hour

- Question: A kilowatt hour is a measure of:
  - Power
  - Energy
  - Force
  - Acceleration
  - None of the above

Energy and power

- Power = energy / time
- Energy = power x time

Work is one way of transferring energy to an object

- $W = \Delta (KE + PE + TE)$