4. Energy Concepts
1. Speed, Velocity, and Acceleration

Prepared for EGY 105

Energy in Our World

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Overview of topics

- Overview
  - Energy defined
  - Forms of energy
- The physical nature of energy
  - Energy and Newtonian Laws of Motion
  - Units of measure
  - Conversions
- Terminology pertaining to energy

What is energy?

- Ability to do work
- Physicists distinguish between kinetic and potential energy
- Energy comes in different forms
  - Radiation
  - Mechanical energy
  - Chemical energy
  - Atomic energy
  - Electrical energy
  - Heat energy

Energy relates to Newtonian motion

Sir Isaac Newton
1642 - 1727

What is energy? – Physics definition

- Energy = Force x distance
- Force = Acceleration x mass
- Acceleration = Speed / time
- Speed = Distance / time

Speed – Velocity

- Speed = distance / time
- Ways of expressing
  - Miles / hour
  - Km / hour
  - Feet / second
  - Meters / second
- Other relationships
  - Distance = Speed x time
  - Time = Distance / speed
- Velocity is a vector: implies speed and direction

Speed: Conversions

- 1 ft/s = 0.305 m/s
- 1 mi/h = 0.447 m/s
- 1 km/hr = 0.28 m/s

Some quick problems

- 1. A car drives 72 miles in 120 minutes. What is its speed in miles per hour?
- 2. A person runs at 6 miles per hour. How far can that person run in 10 minutes?
  - Expressed in miles:
  - Expressed in feet:
- 3. How long does it take for that person to run 528 feet?

Solution to problem 1

- 1. A car drives 72 miles in 120 minutes. What is its speed in miles per hour.

  - Speed = distance / time
  - Speed = 72 miles / 120 minutes
  - Speed = 72 miles / 120 minutes

    1 hour = 60 minutes
  - Speed = 72 miles / 2 hours
  - Speed = 36 miles / hour

Solution to problem 2

- 2. A person runs at 6 miles per hour. How far can that person run in 10 minutes?
  - Expressed in miles:
    - Speed = distance / time
    - Speed x time = distance
    - Distance = Speed x time
    - Distance = 6 miles per hour x 10 minutes
    - 1 hour = 60 minutes
    - Distance = 6 mph x 10 min x 1 h / 60 min.
    - Distance = 6 (10/60)
    - Distance = 60 / 60
    - Distance = 1 mile

Solution to problem 2

- 2. A person runs at 6 miles per hour. How far can that person run in 10 minutes?
  - Expressed in feet:
    - Distance = 1 mile
    - 5280 feet = 1 mile
    - Distance = 1 mile x (5280 feet / 1 mile)
    - Distance = 5280 feet

Solution to problem 2

- 2. A person runs at 6 miles per hour. How far can that person run in 10 minutes?
  - Expressed in feet:
    - Distance = 1 mile
    - 5280 feet = 1 mile
    - Distance = 1 mile x (5280 feet / 1 mile)
    - Distance = 5280 feet
    - Thus, 5280 feet in ten minutes

Solution to problem 3

- 3. How long does it take for that person to run 528 feet?
  - Time = Distance / speed
  - Time = 528 feet /
    - 528 feet / 5280 feet per mile = 0.1 mile
  - Time = 0.1 mile / 6 miles per hour
  - Time = 1/60 hours
  - Time = 1 minute

Another problem

- A car is traveling 60 miles per hour. How many feet can it travel in one second?

Another problem

- A car is traveling 60 miles per hour. How many feet can it travel in one second?
- 60 mi /hr x (5280 ft/mi) x (1/3600 sec/hr)
- = 88 ft/sec
- See p. 38 in your text for more examples.

Acceleration

- Acceleration = Change in velocity / time
  - Expressed as distance / time X time
  - Or distance / time^2
- Occurs when an object is speeding up or slowing down
- Units include
  - Miles / hour^2
  - Km / hour^2
  - Feet / second^2
  - Meters / second^2

Helpful conversions

- $1\ ft/s^2 = 0.305\ m/s^2$
- $1\ m/s^2 = 3.28\ ft/s^2$

A quick problem

- A Dodge Hornet can accelerate to 30 km / hour in 6 seconds. What is its acceleration?
  - Express in terms of m / second^2
    - (see Example 2.6 on p. 39)

A quick problem

- A Dodge Hornet can accelerate to 30 km / hour in 6 seconds. What is its acceleration?
  - Express in terms of m / second^2
    - (see Example 2.6 on p. 39)
    - A = (30 km/hr) / 6 sec.
    - A = 5 km /hr / sec
      - 1 km/hr = 0.28 m/s

    A = 5 km/hr/sec x 0.28 m/s / km/hr

    A = 1.4 m/s^2

Can calculate velocity by knowing acceleration and time

- Velocity = Acceleration X Time

- Problem:
  - Return to the Hornet
    - What is velocity after 1 second? =
    - After 3 seconds?
    - After 6 seconds?
    - After 9 seconds?
    - After 12 seconds?

Can calculate velocity by knowing acceleration and time

- Velocity = Acceleration X Time

- Problem:
  - Return to the Hornet
    - What is velocity after 1 second? = 1.4 m/s
    - After 3 seconds? = 4.2 m/s
    - After 6 seconds? = 8.4 m/s
    - After 9 seconds? = 12.6 m/s
    - After 12 seconds? = 16.8 m/s

Gravity

- Gravity has an acceleration (A_{grav})
  - Metric: 9.8 m/s^2
  - English: 32 ft/s^2

Can calculate distance moved as a function of acceleration and time

- $X = (1/2) \times A \times T^2$ (see p. 39–40 of text for derivation)

Problem: Imagine you drop a stone from a cliff, and it takes three seconds to hit the water below.

How high was the cliff above the water?

How fast was the stone moving when it hit the water?

Can calculate distance moved as a function of acceleration and time

- $X = (1/2) \times A \times T^2$ (see p. 40 of text for derivation)

Problem: Imagine you drop a stone from a cliff, and it takes three seconds to hit the water below.

How high was the cliff above the water?

$X = (1/2) \times 9.8\ m/s^2 \times 3\ s \times 3\ s.$

$X = 4.9\ m/s^2 \times 9\ s^2$

$X = 44.1\ m$

How fast was the stone moving when it hit the water?

$V = A \times T$

$V = 9.8\ m/s^2 \times 3\ s = 29.4\ m/s$

Next up:

Lecture 5 – Energy Principles 2: Force, Energy, and Power.

Next up:

- Lecture #5 – Force, Energy, and Power