Introduction to Applied Physics

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What is Physics?

- Physics is the study of matter and energy

Physics has many subcategories:

Mechanics- the study of motion

Dynamics- the study of causes of motion

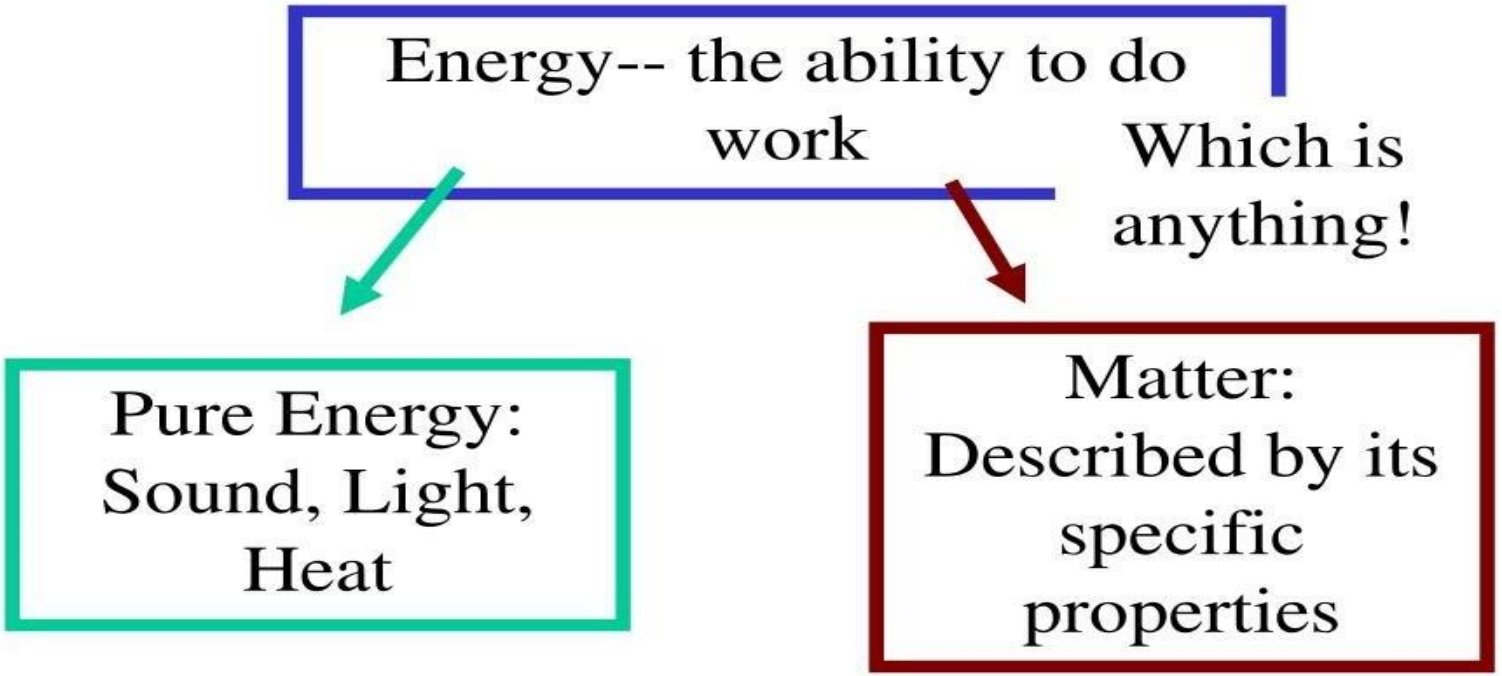
Thermodynamics- heat behaviors

Waves, Sound, Light, Optics

Modern Physics- nuclear physics, relativity, astrophysics, etc.

Physics is a science → an exploration into how things work and why

Physics--> the study of matter and energy



- Matter is anything that takes up space and can be weighed. In other words, matter has volume and mass.

Energy-the capacity to do work

- Potential Energy
- -gravitational
- -elastic
- -chemical
- -etc.

- Kinetic Energy
- the energy contained by any object that is in "motion"
- unless otherwise specified, the surface of the earth is considered stationary

- **In physics, the kinetic energy of an object is the form of energy that it possesses due to its motion.**

Kinetic Energy

Kinetic energy is the energy that objects possess due to their motion.

$$KE = \frac{1}{2}mv^2$$

m = mass (kg)
v = velocity (m/s)
KE = Kinetic energy (J)

Examples:

1. A car with a mass of 700 kg is moving with a speed of 20m/s. Calculate the kinetic energy of the car.
2. A cyclist and bike have a total mass of 100 kg and a speed of 15 m/s. Calculate the kinetic energy.
3. A tennis ball is traveling at 50 m/s and has a kinetic energy of 75 J. Calculate the mass of the tennis ball.

Gravitational Potential Energy

Gravitational potential energy is the energy stored in an object due to its position above the Earth's surface.

$$E_p = mgh$$

m = mass (kg)
g = gravitational field strength (N/kg)
h = height (m)
E_p = gravitational potential energy (J)

Examples:

1. A crane lifts a 75kg mass a height of 8 m. Calculate the gravitational potential energy gained by the mass (g = 9.8 N/kg).
2. A ball with a mass of 500g is lifted onto a shelf which is 1.5m above the ground. Calculate the gravitational potential energy gained by the ball (g = 9.8 N/kg).

(Some) Properties of Matter

Mass: How much stuff - quantity of matter

Inertia: A resistance to a change in motion

Volume: How much space the matter takes up

Mass Density: the ratio of mass to volume

$$D = \frac{m}{V}$$

units:

g/cm^3

$$D = \frac{m}{V}$$

This is one physical concept represented mathematically, but it is three equations:

$$m = D \bullet V$$

$$V = \frac{m}{D}$$

For our purposes, these are all the same base relationship for use in problem solving.

What is the density of a rectangular object that has a mass of 63.2 g and is 3.42 cm long, 1.09 cm wide and 2.56 cm in height?

D = ?

m = 63.2 g

l = 3.42 cm

w = 1.09 cm

h = 2.56 cm

$$D = \frac{m}{V}$$

$$V = l \bullet w \bullet h$$

$$D = \frac{m}{l \bullet w \bullet h}$$

$$= \frac{63.2\ g}{(3.42\ cm)(1.09\ cm)(2.56\ cm)}$$

$$= 6.62\ g/cm^3$$

The mass of a block of wood is measured to be 125.25 g. The length of the block is measured as 5.25 cm, the width is measured as 6.80 cm and the height is measured as 8.35 cm. Find the mass density of this wood block. .420 g/cm^3

The density of a sample of lead is found to be 11.6 g/cm^3. If the mass of the lead is measured to be 125.0 g, what must be the volume of the sample?

A block of wood with dimensions of 5.35 cm, 3.45 cm and 2.45 cm has a mass density of .876 g/cm^3. What must the mass of that block be?

39.6 g

Mechanics

- Newton's Laws of Motion
- Kinematics
- Statics
- Dynamics

Kinematics

- Branch of physics concerned with describing the motion of objects
- Velocity, time, distance, acceleration

Velocity

- Distance covered in a certain amount of time
- $V = d/t$
- Units will be in meters per second (m/s), miles per hour (mph), or other combinations of distance and time

Examples

- A baseball is thrown 60 meters in 2 seconds. What was the baseball's velocity?

- Your car covers 10 miles in 15 minutes. How fast is your car going in miles per hour?

Distance

- Distance can be calculated by taking velocity x time

- $d = vt$

Examples

- A car is traveling 65 miles per hour. How far can the car travel in 6 hours?

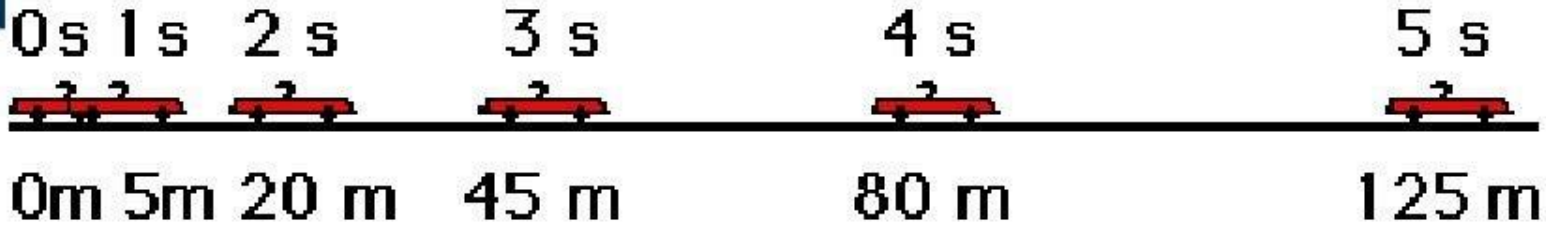
- You are riding your bike at a constant rate of 3 m/s. How far will you travel in 1 minute?

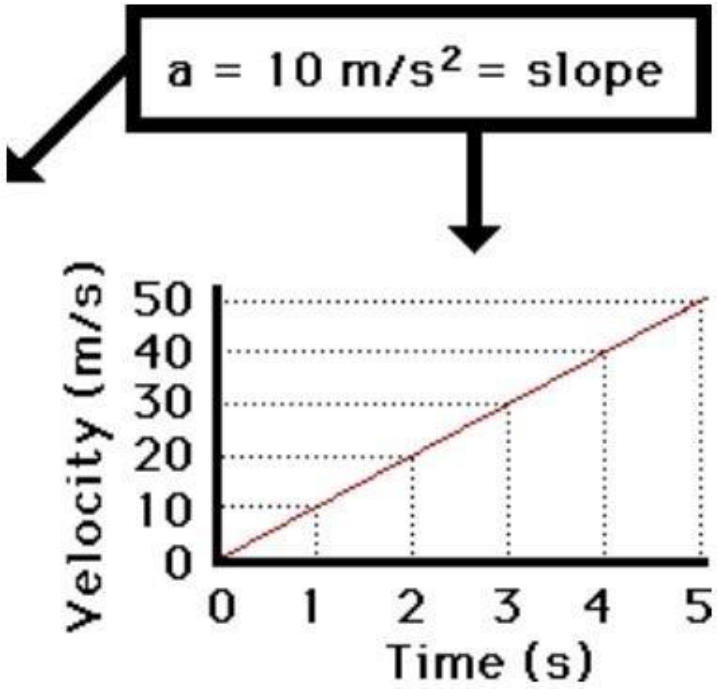
Acceleration

- The rate of change of velocity divided by time change
- Usually m/s/s…..or m/s^2

$$\text{Ave. acceleration} = \frac{\Delta \text{velocity}}{\text{time}} = \frac{v_f - v_i}{t}$$

Is the velocity constant?





Force

- How do forces influence motion?
- **Force**– a push or pull exerted on an object having magnitude and direction
- **System**—object that experiences the force
- **Environment**—world around the system that exerts the force

Two Categories of Forces…

- Contact Force
  - Acts on an object only by touching it
- Long-Range Force
  - Exerted without contact
    - Magnets
    - Gravity

Agent: a specific, identifiable, immediate cause of a force

Types of Forces

- F_f - - Friction (opposes sliding)
- F_N - - Normal (surface)
- F_{sp} - - Spring (push or pull of a spring)
- F_T - - Tension (spring, rope, cable)
- F_{thrust} - - Thrust (rockets, planes, cars)
- F_g - - Weight (force due to gravity)

Newton's Second Law

- $F = ma$
- $a = F_{net} / m$

- Expressed in Newtons (N)
  - Force required to give 1kg mass a $1 m/s^2$ acceleration

$$1\ \text{Newton} = 1\ \text{kg} * \frac{\text{m}}{\text{s}^2}$$

Example

- A race car has a mass of 710 kg. It has a acceleration of 5 m/s^2. What net force is exerted on it?