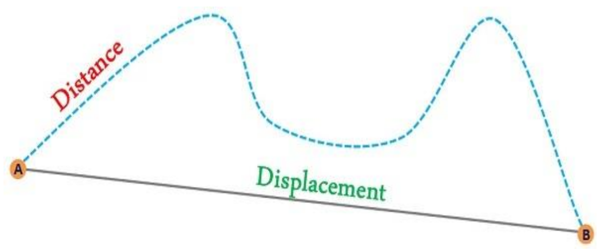
LA IMMACULADA CONCEPCION SCHOOL
SENIOR HIGH SCHOOL
GRADE 11 – CORE: PHYSICAL SCIENCE

APRIL 20-24, 2020
TOPIC: HOW DO OBJECTS MOVE?

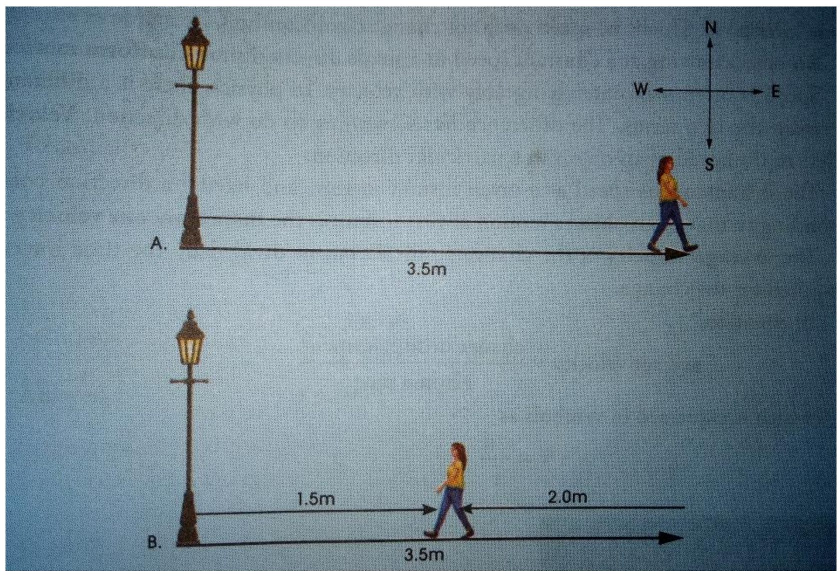
Distance and Displacement

- Distance
  - Total path length traveled between two points.
  - It is a scalar quantity that has magnitude but with no direction.
- Displacement
  - Refers to the change in position of a body relative to some reference point.
  - It is a vector quantity that has both magnitude and direction.



In figure A, a girl walks 3.5 m away from a lamp post.
✓ The total distance traveled by the girl is 3.5 m and the total displacement is 3.5 m to the east.

In figure B, the girl returns and moves 2.0 m to the west.
✓ The total distance traveled is now 5.5 m which is the sum of 3.5 and 2.0
✓ The total displacement is 1.5 m east which is the vector sum of 3.5 m east and 2.0 m west. This is the shortest straight-line distance between two points.



SPEED AND VELOCITY

- Speed
  - Rate of motion
  - Often used interchangeably with velocity.

Average speed
- When an object is in motion, the average speed is the total distance an object travels divided by the time it takes to travel that distance.
- In equation,

$$\text{Average speed} = \frac{\text{Distance traveled}}{\text{Time of travel}}$$

Which is expressed in symbols as

$$\bar{v} = d/t$$

✓ If a car travels a distance of 420 km in 5 hours, the entire trip takes place at a speed of 84 km/h.
✓ The average speed of 84 km/h tells us how long the trip took place but does not say very little about the variation of speed during the trip.

Instantaneous speed
- Tells how fast the car is moving at a given instant.
- The instantaneous speed is determined by computing the average speed for a very short time interval in which the speed does not change significantly.

Speedometer

- A device that measures instantaneous speed.

Uniform motion

- An object moving at a constant speed in a single direction.

- Velocity

- Refers to the speed of an object in a particular direction.

Instantaneous velocity

- The instantaneous speed at a given instant in time and having a direction corresponding to that of an objects' motion at that instant.

Average velocity

- The change in displacement divided by the time interval required for the change.

In equation,

$$\text{Average velocity} = \frac{\text{Change in displacement}}{\text{elapsed time}}$$

Which is expressed in symbols as:

$$\mathbf{\overline{v} = d/t}$$

Sample problem 1. A traveler covers a distance of 1.5 km in 20 minutes. What is the average speed of the traveler in km/h?

Given:

d= 1.5 km

$t = 20\ \cancel{min} \times \frac{1h}{60\ \cancel{min}} = 0.33\ h$

Required:

$\overline{v}$= ?

Equation:

$\overline{v} = d/t$

Solution:

$\overline{v} = \frac{1.5\ km}{0.33\ h} = \mathbf{4.55\ km/h}$

Sample problem 2. A girl walks a distance of 300 m with an average speed of 1.5 m/s. What time is the required to walk the distance?

Given:

d= 300m

$\overline{v}$= 1.5 m/s

Required:

t= ?

Equation:

t= d/v

Solution:

$t = \frac{300\cancel{m}}{1.5\ \cancel{m}/s} = \mathbf{200\ s}$

ACCELERATION

- Refers to the change in velocity of a moving object per unit of time.
- Does not only refer to speeding up but also slowing down.

The changes in velocity can be achieved in three ways:

a. By increasing its speed while travelling in a straight line
b. By decreasing its speed while travelling in a straight line; and
c. By changing its direction even while travelling at a constant speed.

In equation:

$$\text{Acceleration} = \frac{\text{Change in velocity}}{\text{Elapsed time}}$$

Which is expressed in symbols as:

$a = \Delta v / t$

$\mathbf{a = v_f - v_i / t}$

where v_f is the final velocity

v_i is the initial velocity

Deceleration – negative acceleration

✓ Since the velocity is increasing or decreasing uniformly with time, we can express the average velocity as the arithmetic average velocity as the arithmetic average of the initial and final velocity.

$$\bar{v} = \frac{Vi + vf}{2}$$

we can obtain an expression for the displacement of an object using following equations:

- Equation 1:

$$d = \bar{v}t$$

- Equation 2:

$$\bar{v} = \frac{Vi + vf}{2}$$

substitute equation 2 in equation 1,

$$d = \bar{v}t$$

$$d = \left[\frac{Vi + vf}{2}\right] t$$

- Equation 3:

$$d = ½ (vi + vf)\ t$$

we can obtain another equation for displacement by substituting the equation for final velocity (vf = vi + at) in equation 3

$$d = ½ (vi + vf)t$$

$$= ½ [vi + (vi + at)t$$

- Equation 4:

$$d = vi\ t + ½ at^2$$

finally an equation for displacement that does not contain time can be obtained by substituting the equation for time ($t = \frac{vf - vi}{a}$) in

equation 3: $d = \frac{1}{2} (vi + vf)t$

$$= \frac{1}{2} (vi + vf) \left(\frac{vf - vi}{a}\right)$$

- Equation 5:

$$d = \frac{vf2 - vi2}{2a}$$

Sample problem 1. A car starts from rest and accelerates at a constant rate of 2.5m/s^2 for 5 s. what is the velocity of the car after 5s?

Given:

Vi = 0 a = 2.5 m/s^2

T = 5s

Required:

vf = ?

equation:

from $a = \frac{vf - vi}{t}$

vf = vi + at

Solution:

Vf = 0 + (2.5 m/s^2)(5s)

Vf= 12.5 m/s

Sample problem 2. A roller coaster is moving up at 25 m/s^2 from the bottom of the hill. It decelerates at the rate of 6 m/s^2 until it reaches a velocity of 10 m/s^2 at the top of the hill. How long did the roller coaster decelerate?

Given:

$V_i = 25 m/s$

$V_f = 10 m/s$

$a = -6 m/s^2$

Required:

t= ?

Equation:

$$t = \frac{vf - vi}{a}$$

solution:

$$t = \frac{10\frac{m}{s} - 25\frac{m}{s}}{-6\ m/s2} = \frac{-15\ m/s}{-6\ m/s2} = \mathbf{2.5s}$$