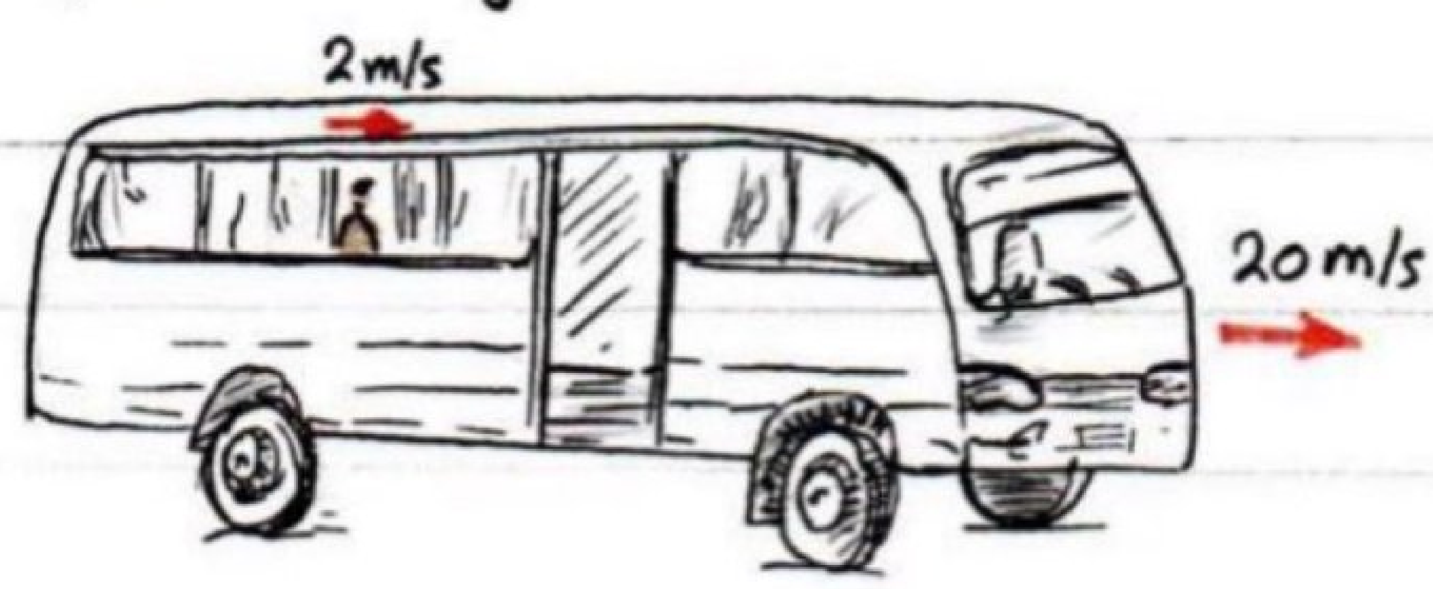
11 october 2022 week .05.

Chapter 2

2-1 Reference Frames and Displacement:

In this chapter we will be concerned with describing an object that moves along a strait-line path (one dimensional translational motion). In order to study Kinematics we shall take measurement of position, distance, or speed, and this must be made with respect to a **reference frame**. (see Figure 2-1).

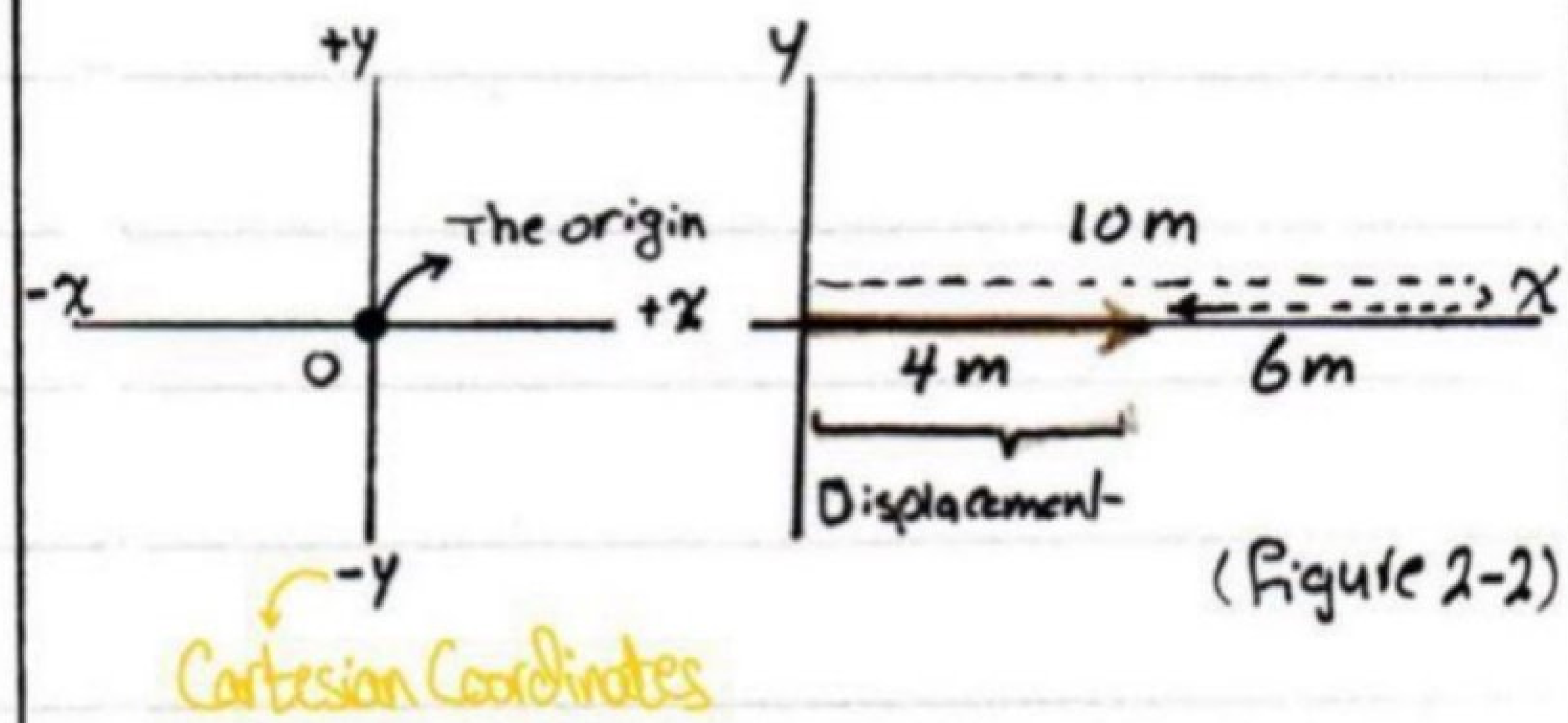
A person walks toward the front of a bus at 2 m/s. The bus is moving 20 m/s with respect to the ground.



The walking person's speed relative to the ground is: 22 m/s

The waking person's speed relative to the driver is: 2 m/s

*When describing the motion it is important to specify the direction too. And the act of using the words: up, down, right, or left is not enough, in physics we draw a set of **coordinate axes** to represent a frame of reference.



(Figure 2-2)

* We shall make a distinction between the distance and the displacement. To see this, imagine a person walking 10 m to the east and then turning around and walking back (west) a distance of 6m. The total distance is 16m.

But the displacement is only 4 m (since the person is only 4 m from the starting point.

We call the displacement **Vector** which has both magnitude and direction, and is represented by arrows in diagrams (Fig. 2-2).

Example (1)

An ant starts at $x = 20$ cm and walks along the x axis to $x = -20$ cm. It then turns around and walks back to $x = 10$ cm. Determine (a) The ant's displacement. (b) The ant's total distance.

Sol. (a) -30 cm.

(b) 50 cm.

2-2 Average Velocity

The term "Speed" refers to how far an object travels in a given time interval, regardless of direction. The average speed ($\overline{S}$) is the total distance traveled along its path divided by the time.

$$\overline{S} = \frac{d}{\Delta t} \quad \dots 1$$

But "Velocity" refers to how fast an object is moving plus the direction, therefor it's a vector.

$$\overline{v} = \frac{\Delta x}{\Delta t} \quad \dots 2$$

→ displacement = x

*When does the average speed and average velocity have the same magnitude?
Sol. when the object doesn't change its direction (motion in one direction).

*Note :- The direction of the average velocity is always the same as the direction of the displacement.

*Note :- If the velocity is constant, then the speed and the direction is also a constant => $\overline{v}$ = instantaneous velocity

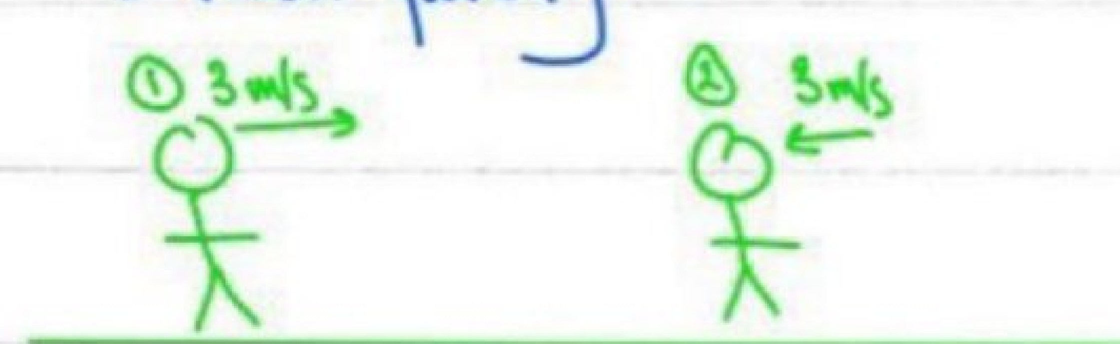
2-4 Acceleration

An object whose velocity is changing is said to be accelerating.

$$\overline{a} = \frac{\Delta v}{\Delta t} \quad \dots 3$$

*Speed :- has magnitude only
- scalar quantity (like temperature, mass)

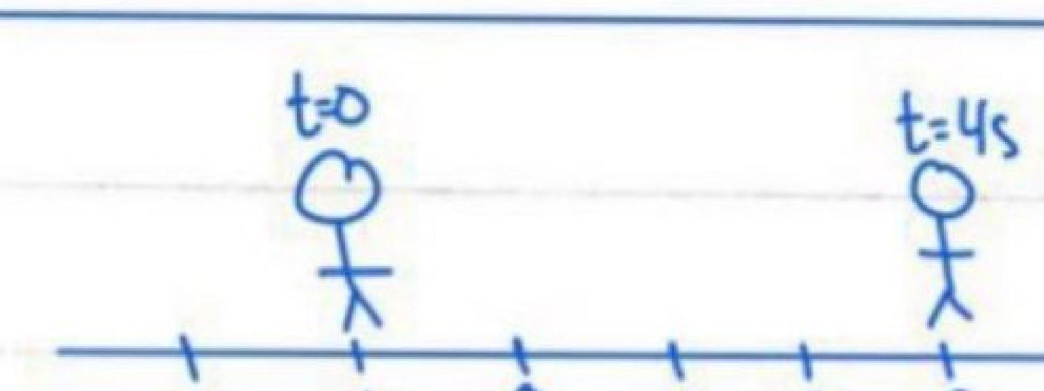
*Velocity: - has magnitude and direction
- vector quantity



We can say:

* ① and ② have the same speed 3 m/s
* $\vec{V_1}$ = 3 m/s to the right ($v_1 = +3$ m/s)
  $\vec{V_2}$ = 3 m/s to the left ($v_2 = -3$ m/s)
  (+) and (-) refer to directions

*



Find $\overline{S}$:

$$\overline{S} = \frac{d}{\Delta t} = \frac{4\,m}{4.0\,s} = 1\,m/s$$

* A car covered a distance of 40 Km in 0.5 hours, find its average speed

$$\overline{S} = \frac{d}{\Delta t} = \frac{40\,Km}{0.5\,h} = 80\,Km/h$$

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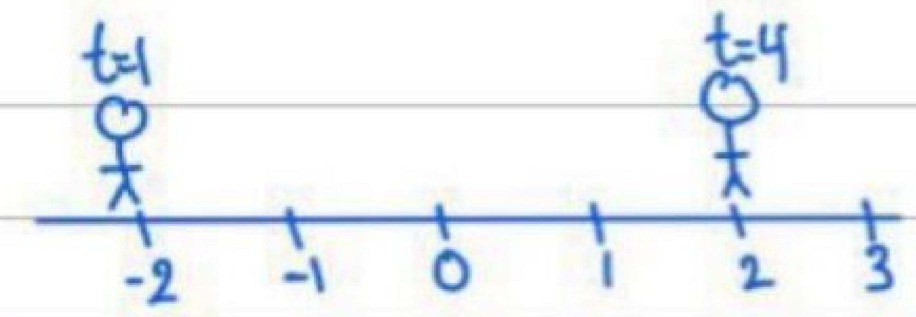

Find $\bar{V}$:

$$\bar{V} = \frac{\Delta x}{\Delta t} = \frac{x_f - x_i}{t_f - t_i}$$

$$\bar{V}_{1-4} = \frac{2-(-2)}{4-1} = \frac{4}{3} \approx \oplus 1.3 \text{ m/s}$$

positive x-axis (direction)
motion to the right

*

Find $\bar{V}$:

$$\bar{V}_{2-6} = \frac{-3-3}{6-2} = \frac{-6}{4} = \ominus 1.5 \text{ m/s}$$

negative x-axis (direction)
motion to the left

* NOTE: If the velocity = 0 it's not necessary for a to be 0, because a depends on the change of velocity