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Class : BCS-IE

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1. An automobile travels on a straight road for 40 km at 30 km/h. It then continues in the same direction for another 40 km at 60 km/h.
- What is the average velocity of the car during the full 80 km trip? (Assume that it moves in the positive  $x$  direction.)
  - What is the average speed?
  - Graph  $x$  versus  $t$  and indicate how the average velocity is found on the graph.

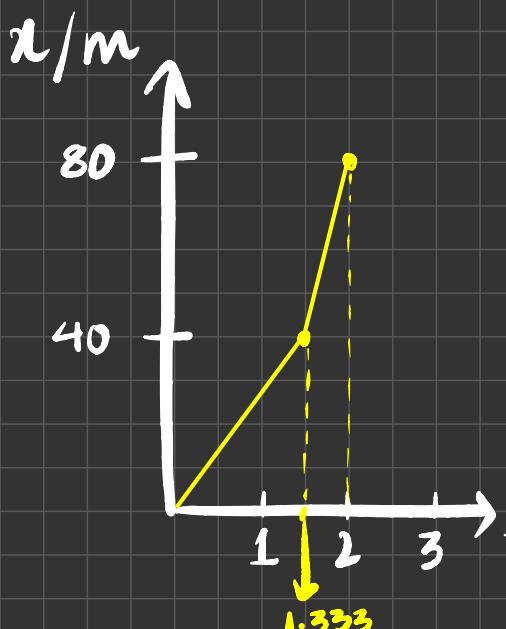
a. Avg velocity =  $\frac{\text{Total displacement}}{\text{Total time}}$

$$= \frac{40 + 40}{\frac{40}{30} + \frac{40}{60}} = \frac{80}{2} \Rightarrow 40 \text{ km/h}$$

b. Avg. speed =  $\frac{\text{Total distance}}{\text{Total time}}$

$$= \frac{40 + 40}{\frac{40}{30} + \frac{40}{60}} = \frac{80}{2} \Rightarrow 40 \text{ km/h}$$

c.



For average velocity from the graph, mark the final value of distance and time. Divide the distance value with time's value, you'll get average velocity.

2. A car starts from rest and accelerates uniformly to a speed of 25 m/s in 8 sec. (a)

What is the acceleration?

(b) How far did it travel in 8 sec?

$$a. \quad v_f = v_i + at$$

$$25 = 0 + a(8)$$

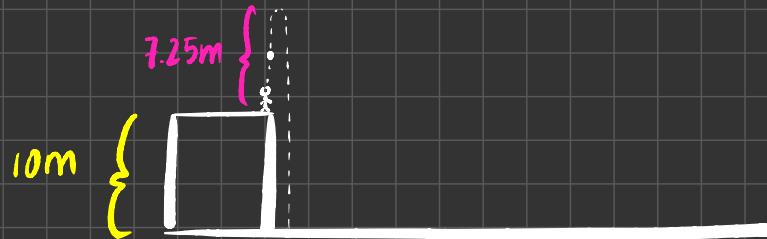
$$a = 3.125 \text{ ms}^{-2}$$

$$b. \quad s = v_i t + \frac{1}{2} a t^2$$

$$s = 0 + \frac{1}{2} (3.125) (8)^2$$

$$s = 100\text{m}$$

3. A boy stands on the edge of a building 10m above the ground and throws a ball upward with an initial velocity of 12 m/s. It misses the roof on the way down and falls to the ground. Find how long the ball was in the air and its velocity just before it strikes the ground.



$$v_f = v_i + at$$

$$0 = 12 + (-9.81)t$$

$$t_1 = 1.223 \text{ s}$$

$$s = v_i t + \frac{1}{2} a t^2$$

$$s = 12(1.223) + \frac{1}{2}(-9.81)(1.223)^2$$

$$s = 7.255 \text{ m}$$

$$v_f^2 - v_i^2 = 2as$$

$$v_f^2 - 0^2 = 2(9.81)(7.255 + 10)$$

$$v_f = 18.4 \text{ m/s}$$

$$v_f = v_i + at$$

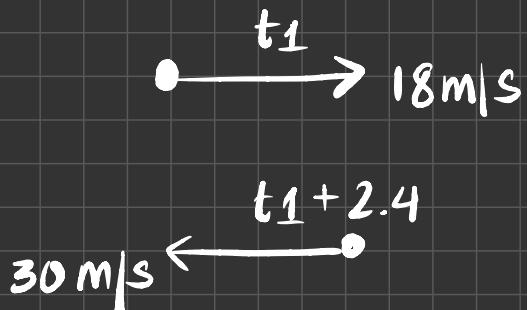
$$18.4 = 0 + 9.81 t$$

$$t_2 = 1.876 \text{ s}$$

$$t_1 + t_2 = 1.223 + 1.876 \Rightarrow 3.099 \approx 3.1 \text{ s}$$

Answer { The ball was in the air for 3.1 seconds.  
The ball hits the ground with 18.4 m/s

4. At a certain time a particle had a speed of 18 m/s in the positive x direction, and 2.4 s later its speed was 30 m/s in the opposite direction. What is the average acceleration of the particle during this 2.4 s interval?



Assuming  
right = positive  
left = negative

$$\text{acceleration} = \frac{\Delta v}{t} = \frac{v_f - v_i}{t}$$

$$= \frac{-30 - 18}{2.4} \Rightarrow -20 \text{ m/s}^2$$

The avg. accel of the particle is 20 m/s but on the left (negative) direction.

5. A car moving with constant acceleration covers a distance of 50m between two points in 5 sec. Its velocity as it passes the second point is 16m/sec.
- What is its acceleration?
  - What was its velocity as it passed the first point?

a.



$$v_f = v_i + at$$

$$16 = v_i + 5a$$

$$v_i = 16 - 5a$$

$$s = v_i t + \frac{1}{2} a t^2$$

$$50 = (16 - 5a)(5) + \frac{1}{2} a(5)^2$$

$$50 = 80 - 25a + \frac{25a}{2}$$

$$-30 = \frac{-25a}{2}$$

$$a = 60/25$$

$$a = 2.4 \text{ ms}^{-2}$$

b.  $v_f^2 - v_i^2 = 2as$

$$16^2 - v_i^2 = 2(2.4)(50)$$

$$-v_i^2 = -16$$

$$v_i = 4 \text{ m/s}$$

6. A ball thrown straight up takes 2.25 sec to reach a height of 36.8m
- What was its initial speed?
  - What is its speed at this height?
  - How much higher will the ball go?

$$a. s = v_i t + \frac{1}{2} a t^2$$

$$36.8 = v_i (2.25) + \frac{1}{2} (-9.81) (2.25)^2$$

$$v_i = 27.4 \text{ m/s}$$

$$b. v_f^2 - v_i^2 = 2as$$

$$v_f^2 - 27.4^2 = 2(-9.81)(36.8)$$

$$v_f = 5.32 \text{ m/s}$$

$$c. v_f^2 - v_i^2 = 2as$$

$$0 - 27.4^2 = 2(-9.81)s$$

$$s = 38.3 \text{ m}$$

7. A particle moves along the x axis according to the equation

$$x = 21t + 5t^2,$$

where x is in meters and t is in seconds. Calculate

- the average velocity of the particle during the first 3 sec of its motion,
- the instantaneous velocity of the particle at  $t = 3$  sec, and
- the instantaneous acceleration of the particle at  $t = 3$  sec.

$$x = 21t + 5t^2$$

a. Average velocity =  $\frac{\Delta x}{\Delta t}$

$$x_f = 21(3) + 5(3)^2$$

$$x_f = 108$$

$$V = \frac{108 - 0}{3 - 0}$$



$$V = 36 \text{ m/s}$$

$$v = \frac{dx}{dt} = 21 + 10t$$

b. Instantaneous

$$V = 21 + 10(3)$$

$$V = 21 + 30$$

$$V = 51 \text{ m/s}$$

c. Instantaneous accel. =  $\frac{dv}{dt} = 10$  ★ constant acceleration

accel at  $t = 3 \text{ sec}$  : acceleration =  $10 \text{ m/s}^2$

8. A particle rotates counterclockwise in a circle of radius 5 m with a constant angular speed of 12 rad/s. At t=0, the particle has an x coordinate of 1.5m and is moving to the right.

(a) Determine the x coordinate as a function of time. Find the x component of particle's velocity and acceleration at any time 't'.

$$(a) \therefore \text{Amplitude} = \text{radius} \quad \omega = 12 \text{ rad/s}$$

$$x = A \cos(\omega t + \theta)$$

$$x = 5 \cos(12t + \theta)$$

at  $x = 1.5, t = 0$

$$1.5 = 5 \cos(12(0) + \theta)$$

$$\cos \theta = \frac{1.5}{5}$$

$$\theta = 1.266$$

Because our particle is moving towards right:  $\theta = -1.266$

$$x = 5 \cos(12t - 1.266)$$

$$(b) v_x = \frac{dx}{dt} = -(12)(5) \sin(12t - 1.266)$$

$$= -60 \sin(12t - 1.266)$$

$$(c) a_x = \frac{d^2x}{dt^2} = -720 \cos(12t - 1.266)$$