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Class : BCS-1E

Roll No. : 21K-3278

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.
   (a) What is the average velocity of the car during the full 80 km trip? (Assume that it moves in the positive $x$ direction.)
   (b) What is the average speed?
   (c) Graph $x$ versus $t$ and indicate how the average velocity is found on the graph.

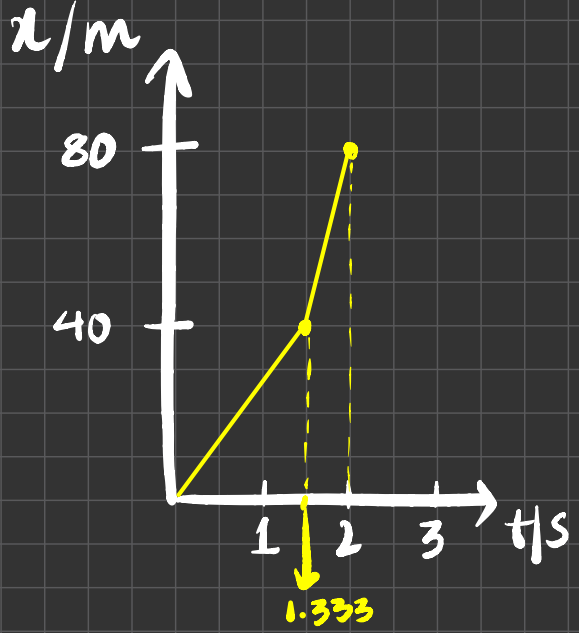
a. $\text{Avg velocity} = \dfrac{\text{Total displacement}}{\text{Total time}}$

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

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

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

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. $v_f = v_i + at$

$25 = 0 + a(8)$

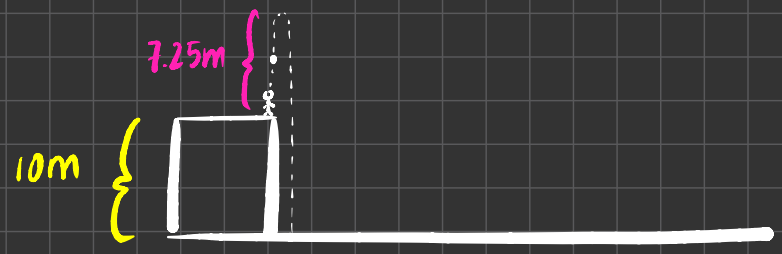
$a = 3.125\ ms^{-2}$

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

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

$s = 100m$

3. A boy stands on the edge of a building 10m above the ground and throws a ball upward with an intial 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.




$V_f = V_i + at$

$0 = 12 + (-9.81)t$

$t_1 = 1.223s$

$S = V_i t + \frac{1}{2}at^2$

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

$S = 7.255m$

$V_f^2 - V_i^2 = 2as$

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

$V_f = 18.4\ m/s$

$V_f = V_i + at$

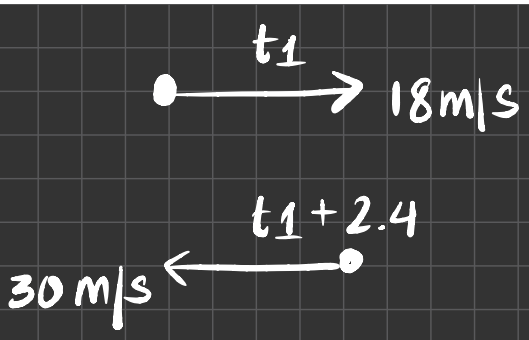
$18.4 = 0 + 9.81t$

$t_2 = 1.876s$

$t_1 + t_2 = 1.223 + 1.876 \Rightarrow 3.099 \simeq 3.1s$

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 t1 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?



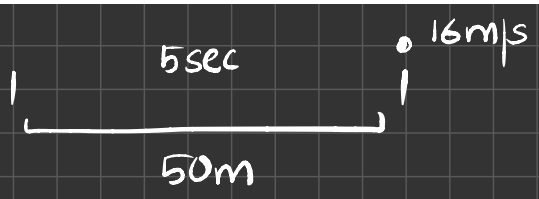

Assuming
right = positive
left = negative

$$\text{acceleration} = \frac{\Delta V}{t} = \frac{V_f - V_i}{t}$$

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

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.
(a) What is its acceleration?
(b) What was its velocity as it passed the first point?




a.

$v_f = v_i + at$

$16 = v_i + 5a$

$v_i = 16 - 5a$

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

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

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

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

$a = 60/25$

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

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

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

$-v_i^2 = -16$

$v_i = 4\ m/s$

6. A ball thrown straight up takes 2.25 sec to reach a height of 36.8m
   (a) What was its initial speed ?
   (b) What is its speed at this height?
   (c) 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

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

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

(a) the average velocity of the particle during the first 3 sec of its motion,

(b) the instantaneous velocity of the particle at t = 3 sec, and

(c) the instantaneous acceleration of the particle at t =3sec.

$x = 21t + 5t^2$

a. $V = \frac{dx}{dt}$

$V = 21 + 10t$

at $t = 0 \rightarrow V = 21$

at $t = 3 \rightarrow V = 51$

$V = 21 + 10(3)$

$V_{Avg} = \frac{51 - 21}{3} = \frac{30}{3} = 10\ m/s$

b. Instantaneous

$V = 10 + 21(3)$

$V = 43\ m/s$

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

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

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) ∴ Amplitude = radius $\omega = 12$ 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) $$A_x = \frac{d^2x}{dt^2} = -720\cos(12t - 1.266)$$