SRIGAYATRI EDUCATIONAL INSTITUTIONS
INDIA

MOTION IN STRAIGHT LINE UT-04 QB
PHYSICS

1. A car moving along a straight highway with speed of $252kmh^{-1}$ is brought to a stop with in a distance of 400m. What is the retardation of the car (assumed uniform). How long does it take for the car to stop ….

2. Two trains A & B of length 400m each are moving on two parallel takes with a uniform speed 72 km/h in the same direction, with A a head of B. The driver of B decides to overtake A and accelerates by 1 ms^{-2}. If after 50s, the guard of B just move past the diver of A. What was the original distance between them ?

3. A jet airplane travelling at the speed of 1500 kmh^{-1} ejects the products of combustion at the speed of 2500 kmh^{-1} relative to the jet plane. What is the speed of the latter with respect to an observer on the ground? (km/h)

4. The position of an object moving along x -axis is given by $x=p+Qt^2$ where p=8.5 m and Q=2.5m $/s^2$ & t is measured in seconds. The instantaneous velocity of the object at t=2 s is

5. A body starts from rest and travels a distance's' with uniform acceleration, then moves uniformly a distance 2 s and finally comes to rest after moving further 5 sunder uniform retardation. The ratio of average velocity to maximum velocity is

6. A balloon rises from rest on the ground with constant acceleration 1.25 m 5^{-2}. A stone is dropped when the balloon has risen to a height of 40 m. The time (ins) taken by the stone to reach the ground is

7. A juggler throws balls in to air. He throws one whenever the previous one is at it higher point. If he throws n balls each second, the height to which each ball will rise is

8. In a car race, car A takes 45 less than car B at the finish and parses the finishing point with a velocity v more than the Car B. Assuming that the car A\& B start form rest and travel with constant accelerations a_1=4m / s^2 respectively, the value of Vin m/s is ….

9. A boy standing on a stationary lift (open from above) throws a ball upwards with the maximum initial speed be can, equal to 49 m How much time does the ball take to return to his hands? If the lift starts moving up with a uniform speed of 5 m / s & the throws the ball up with the boy again throws the ball up with the maximum speed be can how long the ball take to return to his hand ?

10. A police van moving on a highway with a speed of 30 kmh^{-1} fires a bullet at a thief's car speeding away in a same direction with a speed of 192 km/h. If the muzzle speed of the buller 150 m/t. A with speed does the bullet hit the thief's car ?

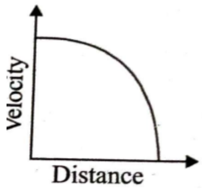
11. In a car race on straight road, car A takes a time t less than car B at the finish and passes finishing point with a speed v more than that of car B. Both the cars start from rest and travel with constant acceleration a_1 and a_2 respectively. Then v is equal to

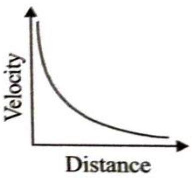
1) $\frac{a_1+a_2}{2}t$ 2) $\sqrt{a_1a_2}t$ 3) $\sqrt{2a_1a_2}t$ 4) $\frac{2a_1a_2}{a_1+a_2}t$

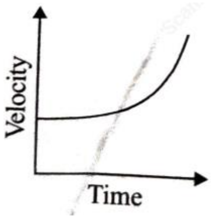
12. A passenger train of length 60 m travels at a speed of 80 km/ hr. Another freight train of length 120 m travels at a speed of 30 km / hr. The ratio of times taken by the passenger train to completely cross the freight train when: (i) they are moving in the same direction, and (ii) in the opposite direction is

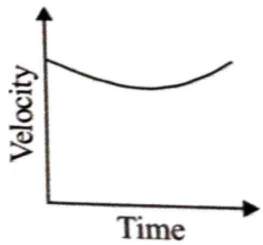
1) $\frac{25}{11}$ 2) $\frac{3}{2}$ 3) $\frac{5}{2}$ 4) $\frac{11}{5}$

13. Which graph corresponds to an object moving with a constant negative acceleration and a positive velocity?

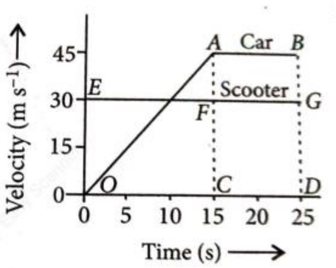
1) 

2) 

3) 

4) 

14. The velocity-time graphs of a car and a scooter are shown in the figure.
(i) The difference between the distance travelled by the car and the scooter in 15 s and ii) the time at which the car will catch up with the scooter are, respectively



1) 112.5m and 15s 2) 337.5m and 25s 3) 225.5m and 10s 4) 112.5m and 22.5s.

15. A particle is moving with speed $v=b\sqrt{x}$ along positive x -axis. Calculate the speed of the particle at time $t=\tau$ (assume that the particle is at origin at t=0)

1) $b^2\tau$ 2) $\frac{b^2\tau}{2}$ 3) $\frac{b^2\tau}{\sqrt{2}}$ 4) $\frac{b^2\tau}{4}$

16. The position of a particle as a function of time t, is given by $x(t)=at+bt^2-ct^3$ where a, b and c are constants. When the particle attains zero acceleration, then its velocity will be

1) $a+\frac{b^2}{4c}$ 2) $a+\frac{b^2}{3c}$ 3) $a+\frac{b^2}{c}$ 4) $a+\frac{b^2}{2c}$

17. A body moving with some initial velocity and having uniform acceleration attains a final velocity v m / s after travelling x m. If its final velocity is $v=\sqrt{180-7x}$, find the acceleration of the body.

1) $-3.5\,m/s^2$ 2) $-7\,m/s^2$ 3) $-15\,m/s^2$ 4) $-30\,m/s^2$

18. A body initially at rest is moving with uniform acceleration a. Its velocity after n seconds is v. The displacement of the body in last 2s is

1) $\frac{2v(n-1)}{n}$ 2) $\frac{v(n-1)}{n}$ 3) $\frac{v(n+1)}{n}$ 4) $\frac{2v(n+1)}{n}$

19. A ball A is thrown vertically upwards with speed u. At the same instant another ball B is released from rest at height h. At time t, the speed of A relative to B is

1) u 2) u – 2gt 3) $\sqrt{u^2-2gh}$ 4) u - gt

20. A bullet fired into a wooden block loses half of its velocity after penetrating 40 cm. It comes to rest after penetrating a further distance of

1) $\frac{22}{3}$cm 2) $\frac{40}{3}$cm 3) $\frac{20}{3}$cm 4) $\frac{22}{5}$cm

21. A particle is released from rest from a tower of height 3h. The ratio of the intervals of time to cover three equal heights h is

1) $t_1:t_2:t_3=3:2:1$ 2) $t_1:t_2:t_3=1:(\sqrt{2}-1):(\sqrt{3}-2)$

3) $t_1:t_2:t_3=\sqrt{3}:\sqrt{2}:1$ 4) $t_1:t_2:t_3=1:(\sqrt{2}-1):(\sqrt{3}-\sqrt{2})$

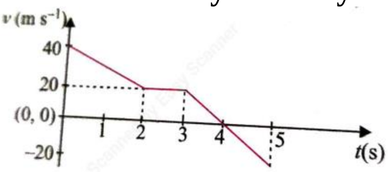
22. It is a common observation that rain clouds can be at about 1 km altitude above the ground. If a rain drop falls from such a height freely under gravity, then what will be its speed in kmh^{-1} ? (Take g=10 m s^{-2})

1) 510 2) 610 3) 710 4) 910

23. A stone is dropped from the top of a tall cliff and n seconds later another stone is thrown vertically downwards with a velocity u. Then the second stone overtakes the first, below the top of the cliff at a distance given by

1) $\frac{g}{2}\left[\frac{n\left(u-\frac{gn}{2}\right)}{(u-gn)}\right]^2$ 2) $\frac{g}{2}\left[\frac{n\left(\frac{u}{2}-gn\right)}{(u-gn)}\right]^2$ 3) $\frac{g}{2}\left[\frac{n\left(\frac{u}{2}-gn\right)}{\left(\frac{u}{2}-gn\right)}\right]^2$ 4) $\frac{g}{5}\left[\frac{(u-gn)}{\left(\frac{u}{2}-gn\right)}\right]^2$

24. In the given v-t graph the distance travelled by the body in 5 seconds will be



1)100 m 2)80 m 3) 40 m 4) 20 m

25. The motion of a body is given by the equation $\frac{dv}{dt}=6-3v$ where v is the speed in ms^{-1} and t is time in s. The body is at rest at t=0. The speed varies with time as

1) $v=\left(1-e^{-3t}\right)$ 2) $v=2\left(1-e^{-3t}\right)$ 3) $v=\left(1+e^{-2t}\right)$ 4) $v=2\left(1+e^{-2t}\right)$

26. A cyclist moving on a circular track of radius 40 m completes half a revolution in 40 s. Its average velocity is

1) Zero **2)** $4\pi ms^{-1}$ 3) 2s^{-1} 4) $8\pi ms^{-1}$

27. A particle moving with uniform acceleration has average velocities v_1, v_2 and v_3 over the successive intervals of time t_1, t_2 and t_3 respectively. The value of $\frac{(v_1-v_2)}{(v_2-v_3)}$ will be

1) $\frac{t_1-t_2}{t_2-t_3}$ 2) $\frac{t_1-t_2}{t_2+t_3}$ 3) $\frac{t_1+t_2}{t_2-t_3}$ 4) $\frac{t_1+t_2}{t_2+t_3}$.

28. A 175 m long train is traveling along a straight track with a velocity 72 km^{-1} h. A bird is flying parallel to the train in the opposite direction with a velocity 18 km^{-1}h. The time taken by the hird to cross the train is

1) 35 s 2) 27 s 3) 11.6 s 4) 7s

29. A bus is moving with a speed of 10 ms^{-1} on a straight road. A scooterist wishes to overtake the scooterist with what speed should the scooterist chase the bus?

1) 40 ms^{-1} 2) 25 ms^{-1} 3) 10 ms^{-1} 4) 20ms^{-1}

30. On a long horizontally 9 kmh^{-1} (with respect to the belt) an drown his father and mother located 50 m apart on the moving belt. The belt moves with a speed of 4 kmh^{-1}. For an observer on a stationary platform, the speed of the child running in the direction of motion of the belt is

1) 4kmh^{-1} 2) 5 kmh^{-1} 3) 9 kmh^{-1} 4) 13 kmh^{-1}

KEY

PHYSICS

1) **11.425**	2) **1250**	3) **–1000km/h**	4) **10m/ss**	5) **4/7**	6) **4s**	7) **g/2n^2**	8) **8**	9) **10s,10s**	10) **105m/s**
11) **2**	12) **4**	13) **1**	14) **4**	15) **2**	16) **1**	17) **1**	18) **1**	19) **1**	20) **2**
21) **4**	22) **1**	23) **1**	24) **1**	25) **2**	26) **3**	27) **4**	28) **4**	29) **4**	30) **4**

SOLUTION

1. $u = 252\text{kmln} = 252\times\frac{5}{18} = 70\text{mls}$

$s = 400\text{m\&v} = 0$

$v^2 - u^2 = 2as$

$a = \frac{-u^2}{2\times S} = \frac{-70\times 70}{2\times 400} = -6.125$

$v = u + at$

$t = \frac{-u}{a} = \frac{-10}{-6\cdot 125} = 11.42\text{s}$

2. $s = ut + \frac{1}{2}at^2$

Train A:

$u = 72\text{km/h} = 20\text{mls}$

$t = 50\text{s}$

$a_1 = 0$

$s_1 = ut + \frac{1}{2}at^2 = 1000\text{m}$

Train B:

$s = ut + \frac{1}{2}at^2$

$= 20\times 50 + \frac{1}{2}\times 1\times 50^2$

$= 2250$

original distance $2250 - 1000 = 1250\text{m}$

3. $v_{jet} = 1500\text{kmh}^{-1}$

$V = -2500\text{km/h}$

$V = V' - \text{v}_j\text{e}$

$\text{N}' = -1000\text{km/h.}$

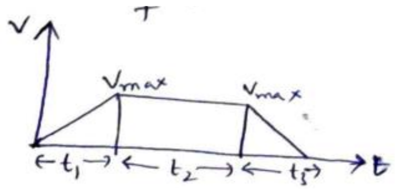
4.

$x = p + at^2$

$v = \frac{dx}{dt} = \frac{d}{dt}\left(p + Qt^2\right) = 2\theta t$

$t = 2s : v = 2(2.5)(2) = 10\text{m}ls$

5.



$$S=\frac{1}{2}V_{max}t_1 \qquad t_1=\frac{2s}{v_{max}}$$

$$2s=v_{max}t_2 \qquad t_2=\frac{2s}{v_{\max}}$$

$$3s=\frac{1}{2}V_{\max}\cdot t_3$$

$$t_3=\frac{10s}{v_{max}}$$

$$V_{av}=\frac{\text{Total dintance}}{\text{Total time}}=\frac{s+2s+5s}{\frac{2s}{V_{\max}}+\frac{2s}{V_{\max}}+\frac{10s}{V_{\max}}}$$

$$\frac{V_{avg}}{V_{\max}}=\frac{8\text{s}}{14\text{s}}=\frac{4}{7}$$

6. $h=\frac{1}{2}at^2$

$$t=\sqrt{\frac{2h}{a}}=\sqrt{\frac{2\times40\times8}{10}}=8$$

$$\text{velocity after } 8\text{s} \quad \text{V}=0+\frac{10}{8}\times8=10\text{m/S}$$

$$\text{For stone}-40=+10t-\frac{1}{2}\times10t^2$$

$$10t^2-2x10t-2\times40=0$$

$$t^2-2t-8=0$$

$$t^2-4t+2t-8=0 \quad t=45$$

7. Time taken by each ball to reach highest point t= 1/n second.
As the juggler theows the second ball, when the first ball is at is highest point so v=0

$$v=u+at$$

$$0=u+(-9)\frac{1}{n} \quad \Rightarrow u=9/n$$

$$v^2-u^2+2a \qquad s$$

$$\text{Aleo} \quad 0=9/n^2 \qquad +2(-g)h$$

$$h=\frac{9}{2n^2}$$

8.

$$t_1=t_2-t$$

$$v_1=v_2+v$$

$$s \quad =\frac{1}{2}a_1t_1^2$$

$$s \quad =\frac{1}{2}a_2t_2^2$$

$$v_1=a,t_1$$

$v_2 = a_2 t_2 \Rightarrow v_2 + v = a_1 t_1$

$a_2 t_2 + v = a, t, \Rightarrow t_2 = \frac{v + a_1 t}{a_1 - a_2}$

$\sqrt{\frac{ag}{a_1}} = \frac{t_1}{t_2} = 1 - \frac{t}{t_2} \Rightarrow \sqrt{\frac{a_2}{a_1}} = 1 - \frac{t(a_1 - a_2)}{v + a_1 t}$

$\frac{\sqrt{a}v}{\sqrt{a_1}} = \frac{v + a_2 t}{v + a_1 t}$

$v = \frac{\left(a, \sqrt{a}2 - a_2\sqrt{a}\right)t}{\left(\sqrt{a_1} - \sqrt{a_2}\right)} = 8m/s$

9.

1)

$s = 0 \qquad u = 4amls \quad a = -9$

$s = \qquad ut + \frac{1}{2}at^2$

$t = \frac{-2u}{a} = 10s$

2)

$s = ut + \frac{1}{2}at^2$

$5t = 54t + \frac{1}{2}(-9)t^2$

$t = \frac{2 \times 49}{9 \cdot 8} = 10s$

10. $v_v = 30\text{km/h} = \frac{25}{3}\text{m/s}$

$V_{BV} = V_{BG} - V_{VG}$

$V_{BG} = V_{BV} + V_{VG}$

$= \left(150 + \frac{25}{3}\right)m/s = \frac{475}{3}\text{m/s}$

$v_T = 195 \times \frac{5}{18} = \frac{160}{3}\text{m/s}$

$V_{BT} = V_{BG} - V_{TG}$

$= \left(\frac{475}{3} - \frac{160}{3}\right)\text{m/s}$

$= 105\text{m/s.}$

11. Both cars cover same distance.

$\frac{1}{2}a_1 t_1^2 = \frac{1}{2}a_2 t_2^2$

Also, $t_2 - t_1 = t$

$a_1 t_1 = v + a_2 t_2$

From eqn. (i) and (ii),

$\left(\frac{a_1}{a_2}\right) = \left(\frac{t + t_1}{t_1}\right)^2 = \left(\frac{t}{t_1} + 1\right)^2 \text{ or } \frac{t}{t_1} + 1 = \sqrt{\frac{a_1}{a_2}}; t_1 = \frac{\sqrt{a_2}}{\sqrt{a_1} - \sqrt{a_2}}t$

From eqn. (ii) and (iii),

$$a_1t_1 = v + a_2(t+t_1); v + a_2t = (a_1 - a_2)t_1$$

or $$v + a_2t = (a_1 - a_2)\times\frac{\sqrt{a_2t}}{(\sqrt{a_1}-\sqrt{a_2})}$$

$$v + a_2t = \sqrt{a_1a_2}t + a_2t \quad \therefore \quad v = \sqrt{a_1a_2}t$$

12. 60+120=180 m
60+120=
velocity is v_1-v_2=80-30=50 kmh^{-1}
So time taken to cross each other,

$$t_1 = \frac{180}{50\times\frac{10^3}{3600}} = \frac{18\times18}{25}\text{s}$$

when the trains are moving in opposite direction, relative velocity, $|v_1-(-v_2)| = 80+30 = 110\,\text{km h}^{-1}$

So, time taken to cross each other

$$t_2 = \frac{180}{110\times\frac{1000}{3600}} = \frac{18\times36}{110}\text{s}; \quad \text{Ratio}\,\frac{t_1}{t_2} = \frac{\frac{18\times18}{25}}{18\times36} = \frac{11}{5}$$

13. Here, acceleration is given by, a=-c

$$\frac{dv}{dt} = -c\,\text{or}\,\frac{dx}{dt}\cdot\frac{dv}{dx} = -c; vdv = -cdx$$

$$\frac{v^2}{2} = -cx + k\,\text{or}\,x = -\frac{v^2}{2c}+\frac{k}{c}$$

From this equation, we conclude option (a) is correct

14. Distance travelled by car in 15 s

$$= \frac{1}{2}\times AC\times OC = \frac{1}{2}(45)(15) = \frac{675}{\frac{2}{2}}\text{m}$$

Distance travelled by scooter in15s $= v\times t = 30\times15 = 450$,

Required difference in distance $= 450 - \frac{675}{2} = \frac{225}{2} = 112.5$c

Let car catches scooter in time$t$, $\frac{675}{2} + 45(t-15) = 30t$

$$337.5 + 45t - 675 = 30t \Rightarrow 15t = 337.5 \Rightarrow t = 22.5\text{s}$$

15. Given velocity as a function of x i.e., $v = b\sqrt{x}$ Differentiating w.r.t. time, we get

$$\frac{dv}{dt} = \frac{b}{2\sqrt{x}}\frac{dx}{dt} \Rightarrow a = \frac{bv}{2\sqrt{x}}$$

$$a = \frac{b(b\sqrt{x})}{2\sqrt{x}} \quad (\because v = b\sqrt{x})$$

$$a = \frac{b^2}{2}$$

Again,$a = \frac{dv}{dt} = \frac{b^2}{2} \quad \therefore \quad v = \frac{b^2}{2}t \Rightarrow (v)_{t=\tau} = \frac{b^2}{2}\tau$

16. Here$x(t) = at + bt^2 - ct^3$

$\therefore \quad v(t)=\frac{dx(t)}{dt}=a+2bt-3ct^2; a(t)=\frac{dv(t)}{dt}=2b-6ct$

$\because a(t)=0 \Rightarrow 2b-6ct=0 \Rightarrow t=2b/6c$

$\therefore \quad v=a+2b\left(\frac{2b}{6c}\right)-3c\left(\frac{2b}{6c}\right)^2=a+\frac{b^2}{3c}$

17. $v=\sqrt{180-7x}$ where x is the distance.

$\because \quad v^2=180-7x$

From the dimensions, 180 has dimensions of square of velocity. For a body travelling with uniform acceleration,

$v^2-u^2=2aS$ is valid. By inspection one can say

$u^2=180, 2aS=-7x$ (here $S=x$)

$-7x=2ax. \quad \therefore \quad a=-3.5\text{m}/\text{s}^2$

18. Here, $a=\frac{v-u}{t}=\frac{v-0}{n}=\frac{v}{n}$

Displacement in last $2s$

$S_n-S_{n-2}=\frac{1}{2}an^2-\frac{1}{2}a(n-2)^2$

$=2a(n-1)=2\frac{v}{n}(n-1)=\frac{2v(n-1)}{n}$

19. Taking upwards motion of ball A for time t, in velocity is V_A= u-gt
Taking downwards motion of ball B for time t, its velocity is V_B= gt
Relative velocity of A w.r.t B

$=v_{AB}=v_A-(-v_B)=(u-gt)-(-gt)=u$

20. For first part of penetration, by equation of motion

$\left(\frac{u}{2}\right)^2-(u)^2=2aS$ or $a=-\frac{3u^2}{8S}$

For later part of penetration

$(0)^2-\left(\frac{u}{2}\right)^2=2aS' \quad or \quad S'=-\frac{u^2}{8a}$

$S'=-\frac{u^2}{8}\left(\frac{8S}{-3u^2}\right)$ (Using (i))

$S'=\frac{S}{3}=\frac{40}{3}\text{cm}$ ($\because S=40\text{cm}$ \$given\$)

21. Let t_1, t_2, t_3 be the timings for three heights h covered during the free fall of the successive e

$h=\frac{1}{2}gt_1^2$ or $t_1=\sqrt{\frac{2h}{g}}$ ($\because u=0$) …(i)

$2h=\frac{1}{2}g(t_1+t_2)^2$ or $t_1+t_2=\sqrt{\frac{4h}{g}}$ …(ii)

$3h=\frac{1}{2}g(t_1+t_2+t_3)^2$ or $t_1+t_2+t_3=\sqrt{\frac{6h}{g}}$ …(iii)

Subtracting (i) from (ii), we get

$t_2=\sqrt{\frac{4h}{g}}-\sqrt{\frac{2h}{g}}=\sqrt{\frac{2h}{g}}(\sqrt{2}-1)$

Subtracting (ii) from (iii), we get

$t_3 = \sqrt{\frac{6h}{g}} - \sqrt{\frac{4h}{g}} = \sqrt{\frac{2h}{g}}(\sqrt{3} - \sqrt{2})$

From (i), (iv) and (v), we get

$t_1 : t_2 : t_3 = 1 : (\sqrt{2} - 1) : (\sqrt{3} - \sqrt{2})$

22. Here, $u = 0, g = 10\text{ms}^{-2}, h = 1\text{km} = 1000\text{m}$

As $v^2 - u^2 = 2gh \quad \therefore v^2 = 2gh$

or $v = \sqrt{2gh} = \sqrt{2 \times 10 \times 1000} = 100\sqrt{2}\text{ms}^{-1}$

$= 100\sqrt{2} \times \frac{18}{5}\text{kmh}^{-1} = 360\sqrt{2}\text{kmh}^{-1} \approx 510\text{kmh}^{-1}$

23. Let the two stones meet at time t For the first stone,

$S_1 = \frac{1}{2}gt^2 \quad (\because u = 0)$

For the second stone,

$S_2 = u(t-n) + \frac{1}{2}g(t-n)^2 \quad \ldots\text{(ii)}$

Displacement is same $\therefore \quad S_1 = S_2$

$\frac{1}{2}gt^2 = u(t-n) + \frac{1}{2}g(t-n)^2$ (Using (i) and (ii))

$\frac{1}{2}gt^2 = ut - nu + \frac{1}{2}gt^2 + \frac{1}{2}gn^2 - gtn$

$ut - gtn = nu - \frac{1}{2}gn^2$

$t = \frac{nu - \frac{1}{2}gn^2}{u - gn} = \frac{n\left(u - \frac{g}{2}n\right)}{u - gn}; \therefore S_1 = \frac{g}{2}\left[\frac{n\left(u - g\frac{n}{2}\right)}{(u - gn)}\right]^2$ [from (i)]

24. The distance is equal to total area under v -t graph

$= \frac{20 \times 2}{2} + 20 \times 2 + 20 \times 1 + \frac{20 \times 1}{2} + \frac{20 \times 1}{2} = 100\text{m}$

25. $\frac{dv}{dt} = 6 - 3v$ or $dt = \frac{dv}{6 - 3v}$

Integrating both sides, we get, $t = -\frac{1}{3}\ln(6 - 3v) + C$

where C is a constant of integration

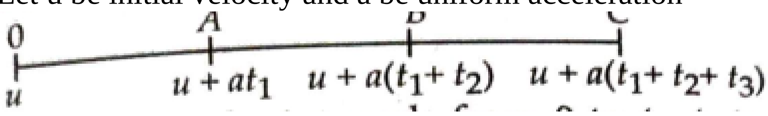
At $t = 0, v = 0 \quad \therefore \quad C = \frac{1}{3}\ln 6$

$\therefore t = -\frac{1}{3}\ln\left(\frac{6 - 3v}{6}\right)$ or $e^{-3t} = 1 - \frac{1}{2}v$ or $v = 2\left(1 - e^{-3t}\right)$

26. Average velocity

$= \frac{\text{Displacement}}{\text{Time taken}} = \frac{2\text{R}}{t} = \frac{2 \times 40}{40} = 2\text{ms}^{-1}$

27. Let u be initial velocity and a be uniform acceleration



Average velocities in the intervals from 0 to t_1, t_1 to t_2 and to t_3 are

$$v_1 = \frac{u+u+at_1}{2} = u + \frac{a}{2}t_1$$

$$v_2 = \frac{u+at_1+u+a(t_1+t_2)}{2} = u + at_1 + \frac{a}{2}t_2$$

$$v_3 = \frac{u+a(t_1+t_2)+u+a(t_1+t_2+t_3)}{2} = u + at_1 + at_2 + \frac{a}{2}t_3$$

Subtract (i) from (ii), we get

$$v_2 - v_1 = \frac{a}{2}(t_1+t_2)$$

Subtract (ii) from (iii), we get

$$v_3 - v_2 = \frac{a}{2}(t_2+t_3)$$

Divide (iv) by (v), we get

$$\frac{v_2-v_1}{v_3-v_2} = \frac{(t_1+t_2)}{(t_2+t_3)} \text{or} \frac{v_1-v_2}{v_2-v_3} = \frac{(t_1+2)}{(t_2+t_3)}$$

28. Velocity of train,

$$v_T = 72\text{km/h} = 72 \times \frac{5}{18}\text{m/s} = 20\text{m/s}$$

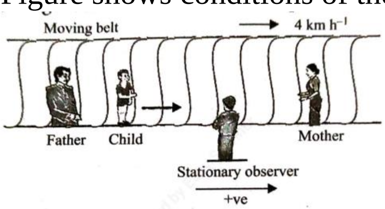
Velocity of bird, $v_B = 18\text{km/h} = 18 \times \frac{5}{18}\text{m/s} = 5\text{m/s}$

Since bird is flying parallel to train in opposite direction.
Relative velocity of bird w.r.t. train $= v_B + v_T = 25$ m / s
Train's length =175 m
Time taken by the bird to cross the train is = 175/5=7 s

29. Let v_s be the velocity of scooter. The distance between scooter and the bus = 1 km = 1000m
The velocity of bus, $v_b = 10\text{ m s}^{-1}$
Time taken to overtake the bus, t=100 s.
Relative velocity of the scooter w.r.t. the bus = $(v_s - 10)$

$$t = \frac{1000}{(v_s - 10)} = 100 \text{or} v_s = 20\text{ms}^{-1}$$

30. Figure shows conditions of the question.



In this case,
Speed of belt w.r.t. ground, $v_{BG} = 4\text{kmh}^{-1}$
Speed of child w.r.t. belt, $v_{CB} = 9\text{kmh}^{-1}$
∴For an observer on a stationary platform, speed of child running in the direction of motion of the belt

$$v_{CG} = v_{CB} + v_{BG} = 9\text{kmh}^{-1} + 4\text{kmh}^{-1} = 13\text{kmh}^{-1}$$