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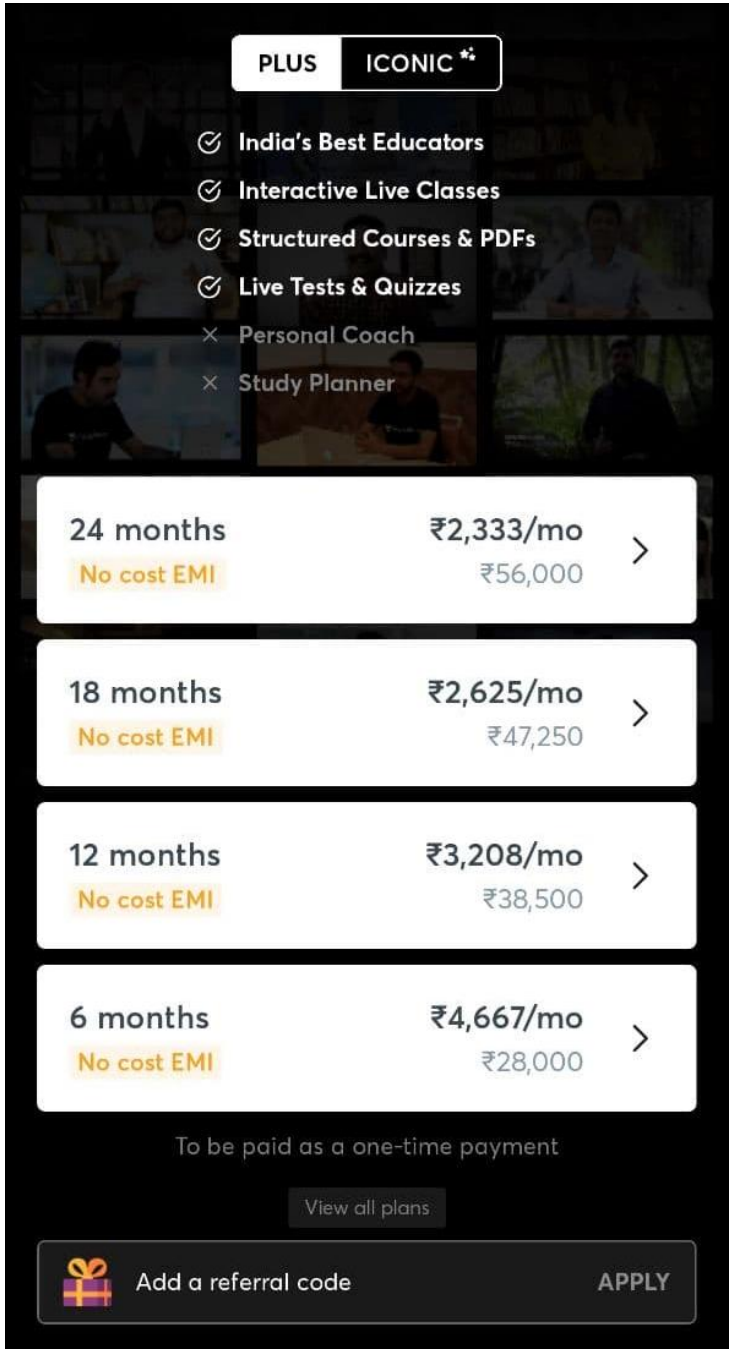

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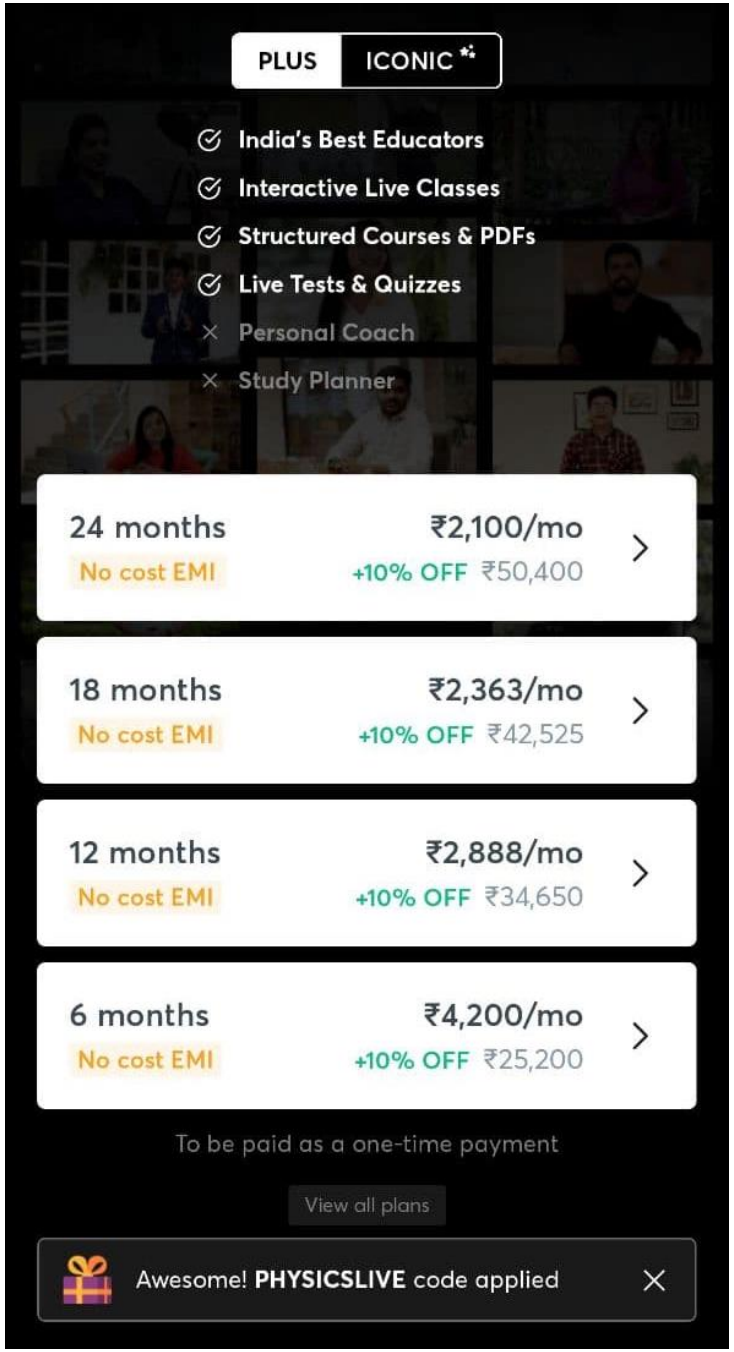

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Physics DPP

DPP-2 Equation of kinematics

By Physicsaholics Team

Q) A dog walking to the right with a velocity of 1.5 m/s sees a cat and speeds up with a constant rightward acceleration of magnitude 12 m/s^2. What is the velocity of the dog after speeding up for 3.0 m?

(a) 4 m/s (b) 8.6 m/s (c) 12.6 m/s (d) 16.6 m/s

Ans. b

$u = 1.5 \text{ m/s}$

$a = 12 \text{ m/s}^2$

$s = 3 \text{ m}$

$v = ?$

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

$v^2 - (1.5)^2 = 2(12)(3)$

$v^2 = (1.5)^2 + 72$

$v^2 = 2.25 + 72$

$v^2 = 74.25$

$\boxed{v = 8.61 \text{ m/s}}$

Q) A particle moving in straight line experience constant acceleration for 20 second after starting from rest. If it travel a distance S_1 in the first 10 seconds and distance S_2 in the next 10 seconds then find the relation between S_1 and S_2:

(a) $S_1 = 3S_2$

(b) $S_1 = \frac{3}{2}S_2$

(c) $S_2 = 3S_1$

(d) $S_2 = \frac{3}{2}S_1$

Ans. c

Let acceleration = a

$u = 0$

for first 10 seconds

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

$s_1 = 0 + \frac{1}{2}a(10)^2 = 50a$

$\boxed{s_1 = (50a)\,m}$

Velocity after $t = 10$ sec

$v_1 = u + at = 0 + a(10)$

$\boxed{v_1 = (10a)\ m/s}$

Distance covered in next 10 seconds!

$s_2 = ut + \frac{1}{2}at^2$

Now $u = v_1$

$s_2 = (10a)(10) + \frac{1}{2}a(10)^2$

$s_2 = 100a + 50a$

$\boxed{s_2 = (150a)\,m}$

$\frac{s_1}{s_2} = \frac{50a}{150a}$

$\frac{s_1}{s_2} = \frac{1}{3}$

$\boxed{s_2 = 3s_1}$

Q) A car travels a distance 100m with a constant acceleration and average velocity of 20 m/s. The final velocity acquired by the car is 25 m/s. Find the initial velocity.

(a) 15 m/s

(b) 30 m/s

(c) 10 m/s

(d) zero

Ans. a

$u = ?$

$V = 25 \text{ m/s}$

for constant acceleration

$$V_{avg} = \frac{V+u}{2}$$

$$20 = \frac{25+u}{2}$$

$$u = 40 - 25$$

$$\boxed{u = 15 \text{ m/s}}$$

Q) A body starting from rest is travelling on a straight road with constant non-zero acceleration. If the speeds after covering distances S_1 and S_2 be V_1 and V_2 respectively. If $\frac{V_2}{V_1} = 2$, then $\frac{S_2}{S_1} = N$. Find N?

(a) 1

(b) 2

(c) 1/2

(d) 3

Ans. d

Let acceleration = a

& given; $\frac{v_2}{v_1} = 2$

$u = 0$

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

for $v = v_1$

given; $s = s_1$

$\therefore \quad v_1^2 - (0)^2 = 2as_1$

$v_1^2 = 2as_1 \quad -(1)$

Now $u = v_1$

& $s = s_2$ & $v = v_2$

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

$\Rightarrow \quad v_2^2 - v_1^2 = 2as_2 \quad -(2)$

Put value of v_1^2 in eq^n (2)

$v_2^2 - 2as_1 = 2as_2$

$v_2^2 = 2a(s_1 + s_2) \quad -(3)$

$\frac{(3)}{(1)} \Rightarrow \left(\frac{v_2}{v_1}\right)^2 = \frac{2a(s_1 + s_2)}{2as_1}$

$(2)^2 = \frac{s_1 + s_2}{s_1} \Rightarrow 4 = \frac{s_1 + s_2}{s_1}$

$4s_1 = s_1 + s_2 \Rightarrow 3s_1 = s_2$

$\Rightarrow \boxed{\frac{s_2}{s_1} = 3} \Rightarrow \boxed{N = 3}$

Q) A bike moving along a straight road covers 35 m in the 4th second and 40 m in the 5th second. What is its initial velocity: (if the acceleration is assumed to be uniform)?

(a) 5 m/s

(b) 10 m/s

(c) 17.5 m/s

(d) 15.5 m/s

Ans. c

distance covered in n^{th} sec.

$$d_n = S_n - S_{n-1}$$

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

when $t = n$ sec.

Now ~~let~~ acceleration = 'a'

$\therefore$ in ~~4~~ th sec.

$$d_4 = S_4 - S_3$$

$$d_4 = \left[u(4) + \frac{1}{2}a(4)^2\right] - \left[u(3) + \frac{1}{2}a(3)^2\right]$$

$$d_4 = u + \frac{7}{2}a = 35 \text{ m} \quad \text{—(1)}$$

in 5^{th} sec.

$$d_5 = S_5 - S_4$$

$$= \left[u(5) + \frac{1}{2}a(5)^2\right] - \left[u(4) + \frac{1}{2}a(4)^2\right]$$

$$= u + \frac{9}{2}a(9)$$

$$d_5 = u + \frac{9}{2}a = 40 \text{ m} \quad \text{—(2)}$$

from eq^n (1) & (2)

$$a = 5 \text{ m/s}^2$$

and $u = 17.5$ m/s

Q) A truck moving on a straight road with constant acceleration covers the distance between two points 180 m apart in 6 seconds. Its speed as it passes the second points 45 m/s. Find its speed when it was at the first point:

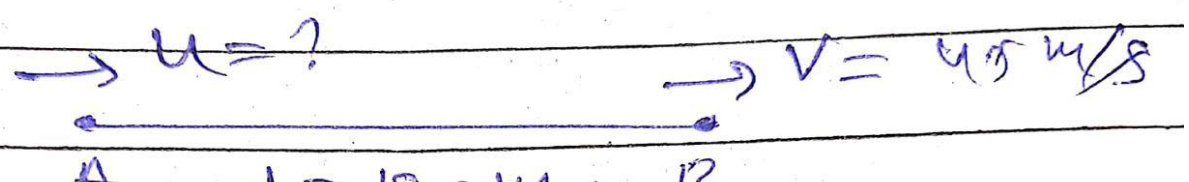
(a) 5 m/s

(b) 10 m/s

(c) 15 m/s

(d) 20 m/s

Ans. c



Let acceleration = 'a'

$t = 6$ Sec (given)

$V = u + at$

$45 = u + 6a$ — ①

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

$180 = 6u + \frac{1}{2}a(6)^2$

$180 = 6u + 18a$ — ②

eq^n ① & ②

$(45 = u + 6a) \times 3$ — ①

$180 = 6u + 18a$ — ②

eq^n ② − (eq^n ① × 3) $\Rightarrow 45 = 3u$

$$\boxed{u = 15 \text{ m/s}}$$

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Q) A car accelerates uniformly from 18 km/h to 36 km/h in 5 seconds. Calculate the acceleration of truck:

(a) $1\ m/s^2$

(b) $1\ km/h^2$

(c) $3\ m/s^2$

(d) $2.5\ m/s^2$

Ans. a

$u = 18 \text{ km/h} = 18 \times \frac{5}{18} = 5 \text{ m/s}$

$v = 36 \text{ km/h} = 10 \text{ m/s}$

$a = \frac{v-u}{t}$ $\quad (\because v = u + at)$

$t = 5 \text{ sec}$

$a = \frac{10-5}{5}$

$\boxed{a = 1 \text{ m/s}^2}$

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Q) A body starts from rest and travels with a uniform acceleration of 3 m/s^2 and then decelerates at a uniform rate of 2 m/s^2 again to come to rest. Total time of travel is 10 sec. find the maximum velocity during the journey:

(a) 10 m/s

(b) 12 m/s

(c) 15 m/s

(d) 27 m/s

Ans. b

$u = 0$

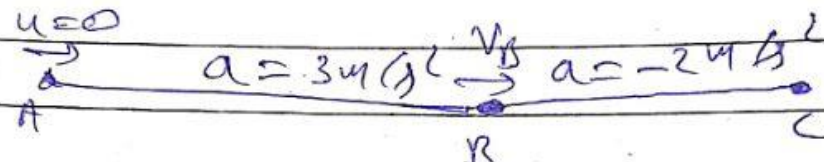
$a = 3\,m/s^2$

for $t = t_1$

and $a = 2\,m/s^2$

for $t = t_1$ to $t = t_2$

$t_1 + t_2 = 10$ sec



for A → B [max speed will be at point B]

$u = 0$

$a = 3\,m/s^2$

$t = t_1$

$\therefore V$ at B

$V_B = u + at$

$= 0 + 3 \times t_1$

$V_B = 3t_1$

in net $t_2 = 10 - t_1$ time

it's final velocity $= 0$

$V = u + at$

$V_C = V_B + (-2)(10 - t_1)$

$0 = 3t_1 - 20 + 2t_1$

$20 = 5t_1 \Rightarrow \boxed{t_1 = 4 \text{ sec}}$

$\boxed{V_B = 3 \times 4 = 12\,m/s}$

& $\boxed{V_B = \text{max speed} = 12\,m/s}$

Q) Consider a train which can accelerate with an acceleration of 20 cm/s^2 and slow down with deceleration of 100 cm/s^2. Find the minimum time for the train to travel between the stations 2.7km apart:

(a) 90 s

(b) 180 s

(c) 160 s

(d) 240 s

Ans. b

acceleration = 20 cm/s²

$= 20 \times 10^{-2}$ m/s²

$= 0.2$ m/s²

deceleration = 100 cm/s²

$= 1$ m/s²

Let it accelerates for time t_1 and decelerates for time t_2

then; at $t = t_1$

$v = u + at$

$v_1 = 0 + (0.2)t_1$

$\boxed{v_1 = 0.2t_1}$ — (1)

Deceleration $v = u + at$

$v = 0$; $u = v_1$

$0 = 0.2t_1 - 1(t_2)$

$0.2t_1 = t_2$

$t_1 = \frac{t_2}{0.2} = 5t_2$

$t_1 = 5t_2$ or $\frac{t_1}{t_2} = \frac{5}{1}$

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

total time $= t_1 + t_2 = t$

$t_1 = \frac{5}{6}t$ & $t_2 = \frac{1}{6}t$

it accelerates for $t = t_1 = \frac{5}{6}t$

decelerates for $t = t_2 = \frac{1}{6}t$

$s_1 = 0 + \frac{1}{2}(0.2)t_1^2$

$s_1 = (0.1)\left(\frac{5t}{6}\right)^2 = 0.1 \times 25\left(\frac{t}{6}\right)^2$

$s_1 = 2.5\left(\frac{t}{6}\right)^2$ — (1)

Now $s_2 = v_1 t_2 + \frac{1}{2}a_2 t_2^2$

$s_2 = (0.2t_1)t_2 + \frac{1}{2}(-1)t_2^2$

$s_2 = (0.2)\left(\frac{5t}{6}\right)\left(\frac{t}{6}\right) - \frac{1}{2}(1)\left(\frac{t}{6}\right)^2$

$s_2 = \left(\frac{t}{6}\right)^2 - \frac{1}{2}\left(\frac{t}{6}\right)^2$

$s_2 = \frac{1}{2}\left(\frac{t}{6}\right)^2$ — (2)

(1) + (2) $s_1 + s_2 = 2.5\left(\frac{t}{6}\right)^2 + 0.5\left(\frac{t}{6}\right)^2$

$2700 = 3\left(\frac{t}{6}\right)^2$

$900 = \left(\frac{t}{6}\right)^2$

$\frac{t}{6} = 30$

$\boxed{t = 180 \text{ sec}}$

Q) An automobile travelling with the speed of 72 km/h, can be stopped within a distance of 20m, by applying brakes. Determine the distance travelled in the first second:

(a) 10 m

(b) 25 m

(c) 15 m

(d) 35 m

Ans. c

$u = 72 \text{ km/h} = 72 \times \frac{5}{18}$

$u = 20 \text{ m/s}$

$d = 20 \text{ m}$

$v = 0$

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

$0 - (20)^2 = 2a(-20)$

$\boxed{a = -10 \text{ m/s}^2}$

∴ distance traveled in 1st sec is

$S_1 = ut + \frac{1}{2}at^2$

$S_1 = 20(1) - \frac{1}{2}(10)(1)^2$

$S_1 = 20 - \frac{1}{2}(10)$

$S_1 = 20 - 5$

$\boxed{S_1 = 15 \text{ m}}$

Q) A body starting from rest is moving with a uniform acceleration of 8 m/s^2. Then the distance travelled by it in 5th second will be:

(a) 40 m

(b) 36 m

(c) 100 m

(d) zero

Ans. b

distance traveled in 5^{th} sec.

$$d = S_5 - S_4$$

$$= \left[u(5) + \frac{1}{2}(a)(5)^2\right] - \left[u \times 4 + \frac{1}{2} a (4)^2\right]$$

$$d = 4 + \frac{9}{2} a$$

$$d = 0 + \frac{9}{2}(8)$$

$$\boxed{d = 36\ m}$$

Q) A motor cycle moving with speed of 15m/s is subject to an acceleration of 0.2 m/s^2 in the direction of motion. Calculate the speed of motorcycle after 10 second,

(a) 7 m/s

(b) 10 m/s

(c) 13 m/s

(d) 17 m/s

Ans. d

$u = 15 \text{ m/s}$

$a = 0.2 \text{ m/sec}$

$t = 10 \text{ sec}$

$v = u + at$

$v = 15 + (0.2)(10)$

$v = 15 + 2$

$\boxed{v = 17 \text{ m/s}}$

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