SAPTARSHI CLASSES PVT. LTD.

NEET-2020 **Time : 60 Min** **PHYSICS** **Marks :** 180

Topic wise Test 1 Motion In One Dimensions

: ANSWER KEY :

1)	c	2)	b	3)	b	4)	d
5)	b	6)	a	7)	b	8)	a
9)	d	10)	b	11)	a	12)	c
13)	d	14)	a	15)	c	16)	b
17)	b	18)	d	19)	b	20)	d
21)	c	22)	c	23)	b	24)	d
25)	d	26)	c	27)	c	28)	d
29)	c	30)	a	31)	c	32)	d
33)	d	34)	d	35)	c	36)	d
37)	b	38)	a	39)	b	40)	c
41)	c	42)	a	43)	b	44)	b
45)	a						

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: HINTS AND SOLUTIONS :

1 **(c)**
Slope is negative at the point E.

2 **(b)**
$h = vt - \frac{1}{2}gt^2$ or $\frac{1}{2}gt^2 - vt + h = 0$
or $gt^2 - 2vt + 2h = 0 \Rightarrow t_1t_2 = \frac{2h}{g}$
$1 \times 3 = \frac{2h}{10}$ or $2h$ =30m or $h = 15$m

3 **(b)**
Area between $v - t$ graph and time-axis
$= \frac{1}{2} \times 3 \times 20 + 1 \times 10 + \frac{1}{2} \times 1 \times 10$
$= 45m$ m.

4 **(d)**
$x = 2t^3 + 21t^2 + 60t + 6$
$\therefore v = \frac{dx}{dt} = 6t^2 + 42t + 60$
But , $v = 0$ (given)
$t^2 + 7t + 10 = 0$
$\Rightarrow t = -5$s
or $t = -2$s
$a = \frac{dv}{dt} = 12t + 42$
$a\,|_{t=5s} = -60 + 42 = -18\text{ms}^{-2}$
$a\,|_{t=-2s} = -24 + 42 = 18\text{ms}^{-2}$

5 **(b)**
Between time interval 20s the 4s, there is non-zero acceleration and retardation. Hence, distance travelled during this interval = Area between time interval 20 s to 40 s

$$= \frac{1}{2} \times 20 \times 3 + 20 \times 1 = 30 + 20$$
$$= 50 \text{ m}$$

6 **(a)**
Slope of displacement time-graph is velocity

$$\frac{v_1}{v_2} = \frac{\tan\theta_1}{\tan\theta_2} = \frac{\tan 30°}{\tan 45°} = \frac{1}{\sqrt{3}}$$

$$v_1 : v_2 = 1 : \sqrt{3}$$

7 **(b)**
Area under acceleration-time graph gives the change in velocity. Hence,

$$v_{\max} = \frac{1}{2} \times 10 \times 11 = 55 \text{ ms}^{-1}$$

Therefore, the correct option is (b).

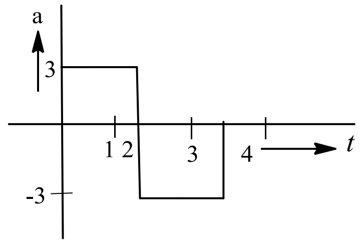
8 **(a)**
A particle starts from rest at $t = 0$

The equation of motion

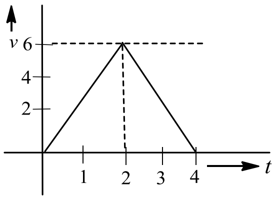
$$v = u + at = 0 + 3 \times 2 = 6 \text{ ms}^{-1}$$

The velocity for next 2 s

$$v''''''' = v + at$$
$$= 6 - 3 \times 2 = 0$$
$$v''''''' = 0$$

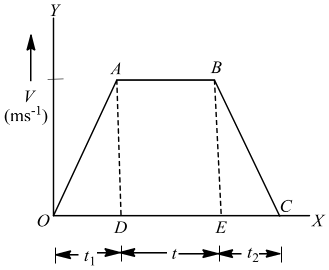


Hence, $v - t$ graph will be as shown.



9 **(d)**

The velocity-time graph for the given situation can be drawn as below. Magnitudes of slope of $OA = f$



And slope of $BC = \frac{f}{2}$

$$v = f\,t_1 = \frac{f}{2}t_2$$

$$t_2 = 2t_1$$

In graph area of ΔOAD gives

Distance, $S = \frac{1}{2}\,f\,t_1^2$ $\quad\quad$ .... (i)

Area of rectangle $ABED$ gives distance travelled in time t.

$$S_2 = (f\,t_1)t$$

Distance travelled in time t_2 =

$$S_3 = \frac{1}{2}\frac{f}{2}(2t_1)^2$$

Thus, $S_1 + S_2 + S_3 = 15\,S$

$$S + (ft_1)t + ft_1^2 = 15\,S$$

$$S + (ft_1)t + 2S = 15\,S \qquad \left(S = \frac{1}{2}\,ft_1^2\right)$$

$$(ft_1)t = 12\,S \qquad \text{... (ii)}$$

From Eqs. (i) and (ii), we have

$$\frac{12\,S}{S} = \frac{(ft_1)t}{\frac{1}{2}(ft_1)t_1}$$

$$\therefore t_1 = \frac{t}{6}$$

From Eq. (i), we get

$$\therefore S = \frac{1}{2}\,f(t_1)^2$$

$$\therefore S = \frac{1}{2}\,f\left(\frac{t}{6}\right)^2 = \frac{1}{72}\,ft^2$$

10 **(b)**

Given, $\quad x = 4\,(t-2) + a(t-2)^2$

$$v = \frac{dx}{dt} = 4 + 2a(t-2)$$

At $t = 0$, $\quad v = 4(1-a)$

Acceleration $a = \frac{d^2x}{dt^2} = 2a$

11 **(a)**

Let t_1 and t_2 be times taken by the car to go from X to Y and then from Y to X respectively.

Then, $t_1 + t_2 = \frac{XY}{v_u} + \frac{XY}{v_d} = XY\left(\frac{v_u + u_d}{v_u v_d}\right)$

Total distance travelled

$$= XY + XY = 2\,XY$$

Therefore, average speed of the car for this round trip is

$$\text{Average speed} = \frac{\text{distance travelled}}{\text{time taken}}$$

$$v_{\text{av}} = \frac{2\,XY}{XY\left(\frac{v_u + v_d}{v_u v_d}\right)} \text{ or } v_{\text{av}} = \frac{2v_u v_d}{v_u + v_d}$$

12 **(c)**

Time taken by the body to reach the point A is t_1 (During upward journey).

The body crosses this point again (during downward journey) after t_2, *ie*, the body takes the time $(t_2 - t_1)$ to come again at point A.

So, the time taken by the body to reach at point B (a maximum height).

$$t = t_1\left(\frac{t_2 - t_1}{2}\right)$$

[$\because$ Time pf ascending = Time of descending]

$$t = \frac{t_1 + t_2}{2}$$

So, maximum height $H = \frac{1}{2}\,gt^2$

$$= \frac{1}{2} g \left(\frac{t_1 + t_2}{2}\right)^2$$

$$= 2g \left(\frac{t_1 + t_2}{4}\right)^2$$

13 **(d)**
The distance covered by a body moving with uniform acceleration is given by

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

As body starts from rest, therefore initial velocity $u = 0$

∴ Distance covered by the body

$$s = \frac{1}{2}\, at^2$$

Or $\quad s \propto t^2$

14 **(a)**
Velocity $v = \alpha\sqrt{x}$

$$\frac{dx}{dt} = \alpha\sqrt{x} \qquad \left(\because v = \frac{dx}{dt}\right)$$

Or $\quad \frac{dx}{\sqrt{x}} = \alpha\, dt$

Integrating

$$\int_0^x \frac{dx}{\sqrt{x}} = \int_0^t \alpha\, dt$$

[∵ at $t = 0, x = 0$ ad let at any time t, paricle is at x]

Or $\quad \frac{x^{1/2}}{1/2} = \alpha t$

Or $\quad x^{1/2} = \frac{\alpha}{2} t$

Or $\quad x = \frac{\alpha^2}{4} \times t^2 \Rightarrow x \propto t^2$

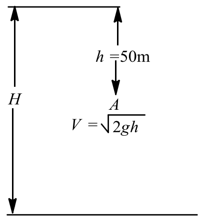
15 **(c)**
Parachute bails out at height H from ground. Velocity at A

$$v = \sqrt{2\,gh}$$

$$= \sqrt{2 \times 9.8 \times 50} = \sqrt{980}\text{ms}^{-1}$$

The velocity at ground $v_1 = 3\text{ ms}^{-1}$ (given)

Acceleration $= -2\text{ ms}^{-2}$ (given_



$$\therefore H - h = \frac{v^2 - v_1^2}{2 \times 2}$$

$$= \frac{980 - 9}{4} = \frac{971}{4} = 242.75$$

$$\therefore \quad H = 242.75 + h$$

$$= 242.75 + 50 = 293\text{ m}$$

16 **(b)**
Given, $a = \alpha t + \beta$

$$\frac{dv}{dt} = \alpha t + \beta$$

$$\int_0^t dv = \int_0^t \alpha t\, dt + \int_0^t \beta\, dt$$

$$v = \frac{\alpha t^2}{2} + \beta t$$

17 **(b)**
The displacement equation is given by

$$x = a_0 + \frac{a_1 t}{2} - \frac{a_2 t^2}{3}$$

Velocity = rate of change of displacement

$$ie, \quad v = \frac{dx}{dt}$$

$$= \frac{d}{dt}\left(a_0 + \frac{a_1 t}{2} - \frac{a_2 t^2}{3}\right)$$

$$= 0 + \frac{a_1}{2} - \frac{2a_2 t}{3}$$

$$= \frac{a_1}{2} - \frac{2a_2 t}{3}$$

Acceleration = rate of change of velocity

$$ie, \quad a = \frac{dv}{dt}$$

$$= \frac{d}{dt}\left(\frac{a_1}{2} - \frac{2a_2}{3}\, t\right)$$

$$= 0 - \frac{2a_2}{3}$$

$$= -\frac{2a_2}{3}$$

18 **(d)**
From first equation of motion, we have

$$v = u + at$$

Given, $u = 0, a_1 = 2\ \text{ms}^{-2}$

$$t = 10\ \text{s},$$

$\therefore \quad v_1 = 2 \times 10 = 20\ \text{ms}^{-1}$

In the next 30 s, the constant velocity becomes

$$v_2 = v_1 + a_2 t_2$$

Given, $v_1 = 20\ \text{ms}^{-1}, a_2 = 2\ \text{ms}^{-2}, t_2 = 30\ \text{s}$

$\therefore \quad v_2 = 20 + 2 \times 30 = 80\ \text{ms}^{-1}.$

When it decelerates, then

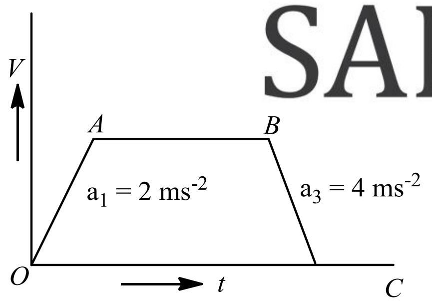
$$v_3^2 = u^2 - 2a_3 s$$

Here, $v_3 = 0$ (train stops), $v_2 = 80\ \text{ms}^{-1}$,

$$a_3 = 4\ \text{ms}^{-2}$$

$$0 = (80)^2 - 2 \times 4 \times s$$

Or $\quad s = \frac{80 \times 80}{8} = 800\ \text{m}.$



19 **(b)**
Given, $\quad a = \frac{dv}{dt} = 6t + 5$

Or $\quad dv = (6t + 5)\ dt$

Integrating, we get

$$\int_0^v dv = \int_0^t (6t + 5)\ dt$$

Or $\quad v = \left(\frac{6t^2}{2} + 5t\right)$

Again $\quad v = \frac{ds}{dt}$

$\therefore \quad ds = \left(\frac{6t^2}{2} + 5t\right) dt$

Integrating again, we get

$$\int_0^s ds = \int_0^t \left(\frac{6t^2}{2} + 5t\right) dt$$

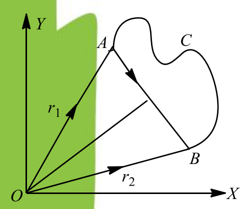
$\therefore \quad s = \frac{3t^3}{3} + \frac{5t^2}{2}$

When, $t = 2\ \text{s}, s = 3 \times \frac{2^3}{3} + \frac{5 \times 2^2}{2} = 3 \times \frac{8}{3} + \frac{5 \times 4}{2}$

$$= 8 + 10 = 18\ \text{m}$$

20 **(d)**
The average speed

$$v_{av} = \frac{\text{length of path } ACB}{\text{time interval } (t_2 - t_1)} \quad \text{... (i)}$$



And average velocity,

$$\mathbf{v}_{av} = \frac{\text{displacement}}{\text{time interval}} = \frac{\mathbf{r}_2 - \mathbf{r}_1}{t_2 - t_1} \quad \text{... (ii)}$$

But we know that distance is always be greater than or equal to magnitude of displacement. So the average speed will always be greater than or equal to the magnitude of average velocity.

From Eqs. (i) and (ii)

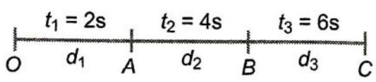
$$\frac{\mathbf{v}_{av}}{v_{av}} = \frac{\text{displacement}}{\text{length of path (distance)}} \leq 1$$

21 **(c)**
Let particle start from O and travels distance

$d_1(OA), d_2(AB), d_3(BC)$

From equation of motion, we have

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



For OA : $\quad t = 2\ \text{s}, u = 0$

$$d_1 = \frac{1}{2}\,a(2)^2 = 2a$$

For OB : $t = 4\text{ s}, u = 0$

$$\therefore \qquad s_2 = \frac{1}{2}\,a(4)^2 = 8a$$

$$d_2 = 8a - 2a = 6a$$

For OC : $t = 6\text{ s}, u = 0$

$$\therefore \qquad S = \frac{1}{2}\,a(6)^2 = 18a$$

Distance in last 2 s $= 18a - 8a = 10a$

$$\therefore \qquad d_1 : d_2 : d_3 = 2a : 6a : 10a$$

$$d_1 : d_2 : d_3 = 1 : 3 : 5$$

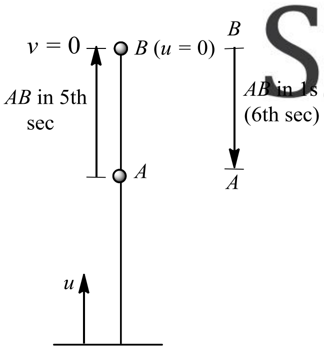
22 **(c)**

$h = 0 + \frac{1}{2}gt^2 \Rightarrow t^2 \propto h$

$$\therefore \frac{t_1}{t_2} = \sqrt{\frac{h_1}{h_2}} = \sqrt{\frac{16}{25}} = \frac{4}{5}$$

23 **(b)**

The distance travelled in t sec in upward motion is



$$s = u - \frac{1}{2}\,\mathrm{g}(2\mathrm{t} - 1)$$

$$\therefore \qquad AB = u - \frac{1}{2}\mathrm{g}(2 \times 5 - 1)$$

$$AB = u - \frac{1}{2}\,9\mathrm{g}$$

Distance travelled in 1 s in the downward direction is

$$BA = 0 + \frac{1}{2}\,\mathrm{g}(1)^2$$

It is given that these distance are equal. Therefore,

$$u - \frac{9\mathrm{g}}{2} = \frac{1}{2}\mathrm{g}$$

$$\Rightarrow \qquad u = 5 \times 9.8 = 49\text{ ms}^{-1}$$

24 **(d)**

The student is able to catch the bus if in time t the distance travelled by him is equal to the distance travelled by bus in time t

ie, $\qquad s_1 = s_2 \qquad$ ... (i)

From Eq. (i)

$$0 + \frac{1}{2}\,at^2 = ut - d$$

Or $at^2 - 2ut + 2d = 0$

It is quadratic equation

So, $t = \frac{+2u \pm \sqrt{4u^2 - 8ad}}{2} = \frac{+2u \pm 2\sqrt{u^2 - 2ad}}{2}$

For t to be real

$$u \geq \sqrt{2ad} \geq \sqrt{2 \times 1 \times 50} = 10\text{ ms}^{-1}$$

26 **(c)**

Let body reaches the ground in t sec.

$\therefore$ Velocity of body after $(t-2)$ sec from equation of motion.

$v = u + \mathrm{g}t'$

And $t' = t - 2$

$\therefore v = \mathrm{g}(t - 2)$

Distance covered in last two sec

$$h' = \mathrm{g}(t-2) \times 2 + \frac{1}{2}\mathrm{g}(2)^2$$

$60 = 20(t - 2) + 20$

Or $t = 4$ s

Hence, height of tower is given buy

$$h = ut + \frac{1}{2}\mathrm{g}t^2$$

$$h = \frac{1}{2}\mathrm{g}t^2 [\because u = 0]$$

$$= \frac{1}{2} \times 10 \times (4)^2 = 80\text{ m.}$$

27 **(c)**

Given, $s = t^3 - 6t^2 + 3t + 4$

Velocity $v = \frac{ds}{dt} = 3t^2 - 12t + 3$ ... (i)

Acceleration $a = \frac{dv}{dt} = 6t - 12$ ... (ii)

Since, acceleration is zero, so, $6t - 12 = 0$, or $t = 2$ s

So, velocity v at

$t = 2$ s, is $= 3 \times 2^2 - 12 \times 2 + 3 = -9\ \text{ms}^{-1}$

29 **(c)**
Given, $v = (180 - 16x)^{1/2}$

Or $v^2 = 180 - 16x$

Differentiating with respect to t, we get

$$2v\frac{dv}{dt} = 0 - 16\frac{dx}{dt}$$

$$2v\frac{dv}{dt} = -16v$$

$$\Rightarrow \frac{dv}{dt} = -8$$

Hence, particle decelerates at the rate of 8 ms^{-2}.

30 **(a)**
$\frac{dv}{dt} = -2.5\sqrt{v}$

$$\Rightarrow \frac{dv}{\sqrt{v}} = -2.5dt$$

$$\Rightarrow \int_{6.25}^{0} v^{-1/2}\ dv = -2.5\int_0^t dt$$

$$\Rightarrow -2.5[t]_0^t = \left[2v^{1/2}\right]_{6.25}^0$$

$$\Rightarrow t = 2\ \text{s}$$

31 **(c)**
Given, $s = 2$ m, $u = 80\ \text{ms}^{-1}, v = 0$

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

$\therefore (0)^2 = (80)^2 - 2 \times a \times 2$

Or $a = \frac{80 \times 80}{4} = 1600\ \text{ms}^{-2}$

32 **(d)**
From equation of motion

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

$$x = 0 + \frac{1}{2} \times 10t^2 = 5t^2 \quad \text{... (i)}$$

$$x + 3 = 0 + \frac{1}{2} \times 10(t + 0.5)^2$$

$$x + 3 = 5\left(t^2 + \frac{1}{4} + t\right) \quad \text{... (ii)}$$

Subtract Eq. (i) from Eq. (ii)

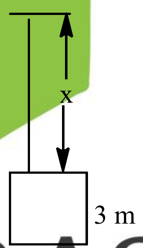
$$3 = 5\left(\frac{1}{4} + t\right) = \frac{5}{4} + 5t$$

$$3 - \frac{5}{4} = 5t$$

$$\frac{7}{4} = 5t \Rightarrow t = \frac{7}{20}\ \text{s}$$

Now, $v = u + at$

$$v = 0 + 10 \times \frac{7}{20} = 3.5\ \text{ms}^{-1}$$



33 **(d)**
Given, $x = 6t^2 - t^3$

$$\frac{dx}{dt} = 12t - 3t^2 \quad \text{.... (i)}$$

$$\frac{dx}{dt} = 0 \Rightarrow t = 4\ \text{s}$$

Now, again differentiating Eq. (i), we get

$$\frac{d^2x}{dt^2} = 12 - 6t = 12 - 6(4) = -12$$

Since, $\frac{d^2x}{dt^2}$ is negative, hence $t = 4$ s gives the maximum value for $x - t$ curve.

Moreover, acceleration $a = \frac{d^2x}{xt^2}$, at $t = 0, \frac{d^2x}{dt^2} = 12\ \text{ms}^{-2}$

34 **(d)**
Since, the initial position of cyclist coincides with final position, so his net displacement is zero.

$$\text{Average speed} = \frac{\text{total distance travelled}}{\text{total time taken}}$$

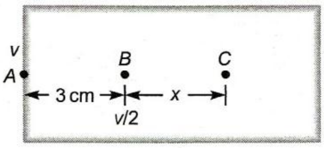
$$= \frac{OP + PQ + QO}{10}\ \text{km min}^{-1}$$

$$= \frac{1 + \frac{\pi}{2} \times 1 + 1}{10}\ \text{km min}^{-1}$$

$$= \frac{\pi + 4}{20} \times 60\ \text{kmh}^{-1} = 21.4\ \text{kmh}^{-1}$$

35 **(c)**

Let initial velocity of body at point A is v, AB is 3 cm.



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

$$\left(\frac{v}{2}\right)^2 = v^2 - 2a \times 3$$

$$a = \frac{v^2}{8}$$

Let on penetrating 3 cm in a wooden block, the body moves x distance form B to C.

So, for B to C

$$u = \frac{v}{2}, v = 0,$$

$$s = x, a = \frac{v^2}{8} \qquad \text{(deceleration)}$$

$$\therefore (0)^2 = \left(\frac{v}{2}\right)^2 - 2 . \frac{v^2}{8} . x$$

$$x = 1$$

36 **(d)**

Let acceleration is a and retardation is $-2a$. Then for accelerating motion

$$t_1 = \frac{v}{a} \qquad \text{....(i)}$$

For retarding motion, $t_2 = \frac{v}{2a}$ ....(ii)

Given,

$$t_1 + t_2 = 9 \Rightarrow \frac{v}{a} + \frac{v}{2a} = 9 \Rightarrow \frac{3v}{2a} = 9 \Rightarrow \frac{v}{a} = 6$$

Hence, duration of acceleration, $t_1 = 6$ s

37 **(b)**

The ball is thrown vertically upwards, then according to equation of motion.

$$(0)^2 - u^2 = -2gh \qquad \text{... (i)}$$

And $$0 = u - gt \qquad \text{... (ii)}$$

From Eqs. (i) and (ii),

$$h = \frac{gt^2}{2}$$

When the ball is falling downwards after reaching the maximum height

$$s = ut' + \frac{1}{2}g(t')^2$$

$$\frac{h}{2} = (0)t' + \frac{1}{2}g(t')^2$$

$$\Rightarrow \qquad t' = \sqrt{\frac{h}{g}}$$

$$t' = \frac{t}{\sqrt{2}}$$

Hence, the total time from the time of projection of reach a point at half of its maximum height while returning $= t + t'$

$$= t + \frac{t}{\sqrt{2}} = \left(1 + \frac{1}{\sqrt{2}}\right)t$$

38 **(a)**

From equation of motion, we have

$$h = ut + \frac{1}{2}gt^2$$

taking upward direction as negative and downward direction as positive, we have

$$h = 65\ \text{m},$$

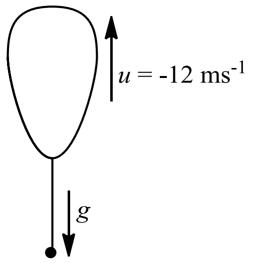
$$u = -12\ \text{ms}^{-1} \text{and } g = 10\ \text{ms}^{-2}$$

$$\therefore \quad 65 = -12t + \frac{1}{2} \times 10 \times t^2$$

$$\therefore \quad 5t^2 - 12t - 65 = 0$$

$$\Rightarrow \quad (t - 5)(5t + 13) = 0$$

$$\therefore \quad t = 5\ \text{s}$$



39 **(b)**
Average velocity is that uniform velocity with which the object will cover the same displacement in same interval of time as it does with its actual variable velocity during that time interval.

Here, total distance covered

$$= (3\ \text{ms}^{-1} \times 20\ \text{s}) + (4\ \text{ms}^{-1} \times 20\ \text{s}) + (5\ ms^{-1} \times 20\ \text{s})$$

$$= (60 + 80 + 100) = 240\ \text{m}$$

Total time taken $= 20 + 20 + 20 = 60$ s

$\therefore$ Average velocity $= \frac{240}{60} = 4\ \text{ms}^{-1}$

40 **(c)**
Here, $s_1 = 40$ m, $s_2 = 65$ m,

$t_1 = 5$ s, $a = ?$

$$a = \frac{s_2 - s_1}{t^2} = \frac{(65 - 40) \times 2}{(5)^2}$$

$$= \frac{50}{25} = 2\ \text{ms}^{-2}$$

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

$$40 = 5u + \frac{1}{2} \times 2 \times 25$$

Or $5u = 15$ or $u = 3\ \text{ms}^{-1}$

41 **(c)**
$v = \frac{dx}{dt} = 0 + 12t - 3t^2 = 0$

$\Rightarrow$ $t = 2$ s

Hence, distance travelled by the particle before coming to rest is given by

$$x = 40 + 12(2) - (2)^3$$

$$= 40 + 24 - 8 = 64 - 8$$

$$= 56\ \text{m}$$

42 **(a)**
Distance covered in 5 s

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

$$= \frac{1}{2}a(5)^2 = \frac{25a}{2}$$

Distance covered in 5th second

$$s_2 = \frac{1}{2} \times a(2 \times 5 - 1) = \frac{9}{2}a$$

$$\therefore \frac{s_2}{s_1} = \frac{9}{25}$$

43 **(b)**
$E = KF^aA^bT^c$
$[ML^2T^{-2}] = [MLT^{-2}]^a[LT^{-2}]^b[T]^c$
$[ML^2T^{-2}] = [M^aL^{a+b}T^{-2a-2b+c}]$
$\therefore a = 1, a + b = 2 \Rightarrow b = 1$
And $-2a - 2b + c = -2 \Rightarrow c = 2$
$\therefore E = KFAT^2$

44 **(b)**
We know that kinetic energy $= \frac{1}{2}mv^2$
Required percentage error is 2%+2× 3% *ie*, 8%

45 **(a)**
Bxt is unitless. $\therefore$ Unit of B is $m^{-1}s^{-1}$