DPP - Daily Practice Problems

Chapter-wise Sheets

Date : | **Start Time :** | **End Time :**

PHYSICS

CP02

SYLLABUS : Motion in a Straight Line

Max. Marks : 180 **Marking Scheme :** (+4) for correct & (–1) for incorrect answer **Time : 60 min.**

INSTRUCTIONS : This Daily Practice Problem Sheet contains 45 MCQs. For each question only one option is correct. Darken the correct circle/ bubble in the Response Grid provided on each page.

1. A particle starts moving rectilinearly at time t = 0 such that its velocity v changes with time t according to the equation $v = t^2 - t$ where t is in seconds and v is in m/s. Find the time interval for which the particle retards.

(a) $\frac{1}{2} < t < 1$ (b) $\frac{1}{2} > t > 1$

(c) $\frac{1}{4} < t < 1$ (d) $\frac{1}{2} < t < \frac{3}{4}$

2. The co-ordinates of a moving particle at any time 't' are given by $x = \alpha t^3$ and $y = \beta t^3$. The speed of the particle at time 't' is given by

(a) $3t\sqrt{\alpha^2 + \beta^2}$ (b) $3t^2\sqrt{\alpha^2 + \beta^2}$

(c) $t^2\sqrt{\alpha^2 + \beta^2}$ (d) $\sqrt{\alpha^2 + \beta^2}$

3. If a car covers $2/5^{th}$ of the total distance with v_1 speed and $3/5^{th}$ distance with v_2 then average speed is

(a) $\frac{1}{2}\sqrt{v_1 v_2}$ (b) $\frac{v_1 + v_2}{2}$ (c) $\frac{2v_1 v_2}{v_1 + v_2}$ (d) $\frac{5v_1 v_2}{3v_1 + 2v_2}$

4. Choose the correct statements from the following.

(a) The magnitude of instantaneous velocity of a particle is equal to its instantaneous speed

(b) The magnitude of the average velocity in an interval is equal to its average speed in that interval.

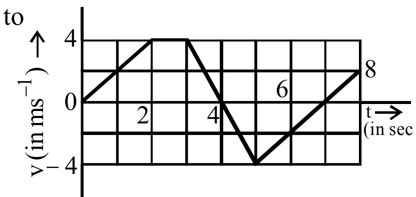
(c) It is possible to have a situation in which the speed of the particle is never zero but the average speed in an interval is zero.

(d) It is possible to have a situation in which the speed of particle is zero but the average speed is not zero.

5. A particle located at $x = 0$ at time $t = 0$, starts moving along with the positive x-direction with a velocity 'v' that varies as $v = \alpha\sqrt{x}$. The displacement of the particle varies with time as

(a) t^2 (b) t (c) $t^{1/2}$ (d) t^3

6. Figure here gives the speed-time graph for a body. The displacement travelled between t = 1.0 second and t = 7.0 second is nearest to



(a) 1.5 m

(b) 2 m

(c) 3 m

(d) 4 m

7. A particle is moving in a straight line with initial velocity and uniform acceleration a. If the sum of the distance travelled in t^{th} and $(t + 1)^{th}$ seconds is 100 cm, then its velocity after t seconds, in cm/s, is

(a) 80 (b) 50 (c) 20 (d) 30

RESPONSE GRID					
	1. ⓐⓑⓒⓓ	2. ⓐⓑⓒⓓ	3. ⓐⓑⓒⓓ	4. ⓐⓑⓒⓓ	5. ⓐⓑⓒⓓ
	6. ⓐⓑⓒⓓ	7. ⓐⓑⓒⓓ			

Space for Rough Work

8. A thief is running away on a straight road on a jeep moving with a speed of 9 m/s. A police man chases him on a motor cycle moving at a speed of 10 m/s. If the instantaneous separation of jeep from the motor cycle is 100 m, how long will it take for the police man to catch the thief?

(a) 1 second (b) 19 second
(c) 90 second (d) 100 second

9. The displacement x of a particle varies with time according to the relation $x = \frac{a}{b}(1 - e^{-bt})$. Then select the false alternative.

(a) At $t = \frac{1}{b}$, the displacement of the particle is nearly $\frac{2}{3}\left(\frac{a}{b}\right)$
(b) The velocity and acceleration of the particle at t = 0 are a and –ab respectively
(c) The particle cannot go beyond $x = \frac{a}{b}$
(d) The particle will not come back to its starting point at $t \to \infty$

10. A metro train starts from rest and in five seconds achieves a speed 108 km/h. After that it moves with constant velocity and comes to rest after travelling 45m with uniform retardation. If total distance travelled is 395 m, find total time of travelling.

(a) 12.2 s (b) 15.3 s (c) 9 s (d) 17.2 s

11. The deceleration experienced by a moving motor boat after its engine is cut off, is given by $dv/dt = -kv^3$ where k is a constant. If v_0 is the magnitude of the velocity at cut-off, the magnitude of the velocity at a time *t* after the cut-off is

(a) $\frac{v_0}{\sqrt{(2v_0{}^2kt+1)}}$ (b) $v_0\, e^{-kt}$
(c) $v_0 / 2$ (d) v_0

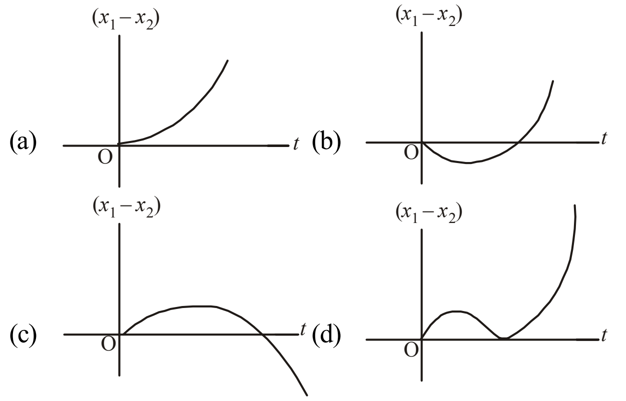
12. The velocity of a particle is $v = v_0 + gt + ft^2$. If its position is $x = 0$ at $t = 0$, then its displacement after unit time ($t = 1$) is

(a) $v_0 + g/2 + f$ (b) $v_0 + 2g + 3f$
(c) $v_0 + g/2 + f/3$ (d) $v_0 + g + f$

13. A man is 45 m behind the bus when the bus starts accelerating from rest with acceleration 2.5 m/s^2. With what minimum velocity should the man start running to catch the bus?

(a) 12 m/s (b) 14 m/s (c) 15 m/s (d) 16 m/s

14. A body is at rest at $x = 0$. At $t = 0$, it starts moving in the positive x-direction with a constant acceleration. At the same instant another body passes through $x = 0$ moving in the positive x-direction with a constant speed. The position of the first body is given by $x_1(t)$ after time '*t*'; and that of the second body by $x_2(t)$ after the same time interval. Which of the following graphs correctly describes $(x_1 - x_2)$ as a function of time '*t*'?



15. From the top of a building 40 m tall, a boy projects a stone vertically upwards with an initial velocity 10 m/s such that it eventually falls to the ground. After how long will the stone strike the ground ? Take g = 10 m/s^2.

(a) 1 s (b) 2 s (c) 3 s (d) 4 s

16. Two bodies begin to fall freely from the same height but the second falls T second after the first. The time (after which the first body begins to fall) when the distance between the bodies equals L is

(a) $\frac{1}{2}T$ (b) $\frac{T}{2}+\frac{L}{gT}$ (c) $\frac{L}{gT}$ (d) $T+\frac{2L}{gT}$

17. Let A, B, C, D be points on a vertical line such that AB = BC = CD. If a body is released from position A, the times of descent through AB, BC and CD are in the ratio.

(a) $1:\sqrt{3}-\sqrt{2}:\sqrt{3}+\sqrt{2}$ (b) $1:\sqrt{2}-1:\sqrt{3}-\sqrt{2}$
(c) $1:\sqrt{2}-1:\sqrt{3}$ (d) $1:\sqrt{2}:\sqrt{3}-1$

18. The water drops fall at regular intervals from a tap 5 m above the ground. The third drop is leaving the tap at an instant when the first drop touches the ground. How far above the ground is the second drop at that instant? (Take g = 10 m/s^2)

(a) 1.25m (b) 2.50m (c) 3.75m (d) 5.00m

19. The displacement '*x*' (in meter) of a particle of mass '*m*' (in kg) moving in one dimension under the action of a force, is related to time '*t*' (in sec) by $t = \sqrt{x} + 3$. The displacement of the particle when its velocity is zero, will be

(a) 2m (b) 4m (c) zero (d) 6m

20. A body moving with a uniform acceleration crosses a distance of 65 m in the 5 th second and 105 m in 9th second. How far will it go in 20 s?

(a) 2040m (b) 240m (c) 2400m (d) 2004m

21. An automobile travelling with a speed of 60 km/h, can brake to stop within a distance of 20m. If the car is going twice as fast i.e., 120 km/h, the stopping distance will be

(a) 60m (b) 40m (c) 20m (d) 80m

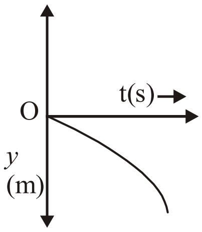
RESPONSE GRID	8. ⓐⓑⓒⓓ	9. ⓐⓑⓒⓓ	10. ⓐⓑⓒⓓ	11. ⓐⓑⓒⓓ	12. ⓐⓑⓒⓓ
	13. ⓐⓑⓒⓓ	14. ⓐⓑⓒⓓ	15. ⓐⓑⓒⓓ	16. ⓐⓑⓒⓓ	17. ⓐⓑⓒⓓ
	18. ⓐⓑⓒⓓ	19. ⓐⓑⓒⓓ	20. ⓐⓑⓒⓓ	21. ⓐⓑⓒⓓ	

Space for Rough Work

22. A particle accelerates from rest at a constant rate for some time and attains a velocity of 8 m/sec. Afterwards it decelerates with the constant rate and comes to rest. If the total time taken is 4 sec, the distance travelled is

(a) 32m (b) 16m
(c) 4m (d) None of the above

23. The equation represented by the graph below is :



(a) $y = \frac{1}{2}gt$

(b) $y = \frac{-1}{2}gt$

(c) $y = \frac{1}{2}gt^2$

(d) $y = \frac{-1}{2}gt^2$

24. A particle moves a distance x in time t according to equation $x = (t + 5)^{-1}$. The acceleration of particle is proportional to:

(a) $(\text{velocity})^{3/2}$ (b) $(\text{distance})^2$
(c) $(\text{distance})^{-2}$ (d) $(\text{velocity})^{2/3}$

25. A particle when thrown, moves such that it passes from same height at 2 and 10 seconds, then this height h is :

(a) 5g (b) g (c) 8g (d) 10g

26. The distance through which a body falls in the nth second is h. The distance through which it falls in the next second is

(a) h (b) $h + \frac{g}{2}$ (c) $h - g$ (d) $h + g$

27. A stone thrown upward with a speed u from the top of the tower reaches the ground with a velocity 3u. The height of the tower is

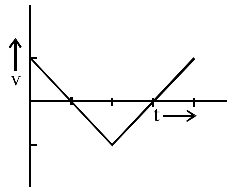
(a) $3u^2/g$ (b) $4u^2/g$ (c) $6u^2/g$ (d) $9u^2/g$

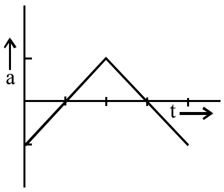
28. A particle moves along a straight line OX. At a time t (in seconds) the distance x (in metres) of the particle from O is given by $x = 40 + 12t - t^3$. How long would the particle travel before coming to rest?

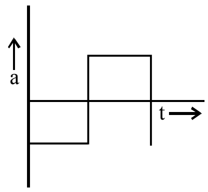
(a) 40m (b) 56m (c) 16m (d) 24m

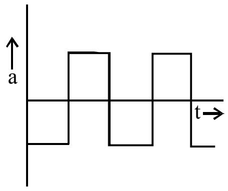
29. The graph shown in figure shows the velocity v versus time t for a body.

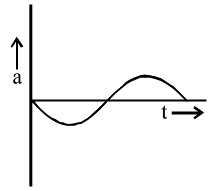
Which of the graphs represents the corresponding acceleration versus time graphs?



(a)


(b)


(c)


(d)


30. A particle moving along x-axis has acceleration f, at time t, given by $f = f_0\left(1 - \frac{t}{T}\right)$, where f_0 and T are constants. The particle at t = 0 has zero velocity. In the time interval between $t = 0$ and the instant when f = 0, the particle's velocity (v_x) is

(a) $\frac{1}{2}f_0T^2$ (b) f_0T^2 (c) $\frac{1}{2}f_0T$ (d) f_0T

31. A body is thrown vertically up with a velocity u. It passes three points A, B and C in its upward journey with velocities $\frac{u}{2}, \frac{u}{3}$ and $\frac{u}{4}$ respectively. The ratio of AB and BC is

(a) 20 : 7 (b) 2 (c) 10 : 7 (d) 1

32. A boat takes 2 hours to travel 8 km and back in still water lake. With water velocity of 4 km h^{-1}, the time taken for going upstream of 8 km and coming back is

(a) 160 minutes (b) 80 minutes
(c) 100 minutes (d) 120 minutes

33. A body starts from rest and travels a distance x with uniform acceleration, then it travels a distance 2x with uniform speed, finally it travels a distance 3x with uniform retardation and comes to rest. If the complete motion of the particle is along a straight line, then the ratio of its average velocity to maximum velocity is

(a) 2/5 (b) 3/5 (c) 4/5 (d) 6/7

34. A man of 50 kg mass is standing in a gravity free space at a height of 10 m above the floor. He throws a stone of 0.5 kg mass downwards with a speed 2 m/s. When the stone reaches the floor, the distance of the man above the floor will be:

(a) 9.9m (b) 10.1m (c) 10m (d) 20m

35. A boy moving with a velocity of 20 km h^{-1} along a straight line joining two stationary objects. According to him both objects

(a) move in the same direction with the same speed of 20 km h^{-1}
(b) move in different direction with the same speed of 20 km h^{-1}
(c) move towards him
(d) remain stationary

RESPONSE GRID					
	22. (a)(b)(c)(d)	23. (a)(b)(c)(d)	24. (a)(b)(c)(d)	25. (a)(b)(c)(d)	26. (a)(b)(c)(d)
	27. (a)(b)(c)(d)	28. (a)(b)(c)(d)	29. (a)(b)(c)(d)	30. (a)(b)(c)(d)	31. (a)(b)(c)(d)
	32. (a)(b)(c)(d)	33. (a)(b)(c)(d)	34. (a)(b)(c)(d)	35. (a)(b)(c)(d)	

Space for Rough Work

36. A rubber ball is dropped from a height of 5 metre on a plane where the acceleration due to gravity is same as that onto the surface of the earth. On bouncing, it rises to a height of 1.8 m. On bouncing, the ball loses its velocity by a factor of

(a) $\frac{3}{5}$ (b) $\frac{9}{25}$ (c) $\frac{2}{5}$ (d) $\frac{16}{25}$

37. A stone falls freely from rest from a height h and it travels a distance $\frac{9h}{25}$ in the last second. The value of h is

(a) 145 m (b) 100 m (c) 122.5 m (d) 200 m

38. Which one of the following equations represents the motion of a body with finite constant acceleration ? In these equations, y denotes the displacement of the body at time t and a, b and c are constants of motion.

(a) $y = at$ (b) $y = at + bt^2$

(b) $y = at + bt^2 + ct^3$ (d) $y = \frac{a}{t} + bt$

39. A particle travels half the distance with a velocity of 6 ms^{-1}. The remaining half distance is covered with a velocity of 4 ms^{-1} for half the time and with a velocity of 8 ms^{-1} for the rest of the half time. What is the velocity of the particle averaged over the whole time of motion ?

(a) 9 ms^{-1} (b) 6 ms^{-1} (c) 5.35 ms^{-1} (d) 5 ms^{-1}

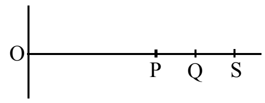
40. A bullet is fired with a speed of 1000 m/sec in order to penetrate a target situated at 100 m away. If $g = 10\ m/s^2$, the gun should be aimed

(a) directly towards the target
(b) 5 cm above the target
(c) 10 cm above the target
(d) 15 cm above the target

41. A body covers 26, 28, 30, 32 meters in 10^{th}, 11^{th}, 12^{th} and 13^{th} seconds respectively. The body starts

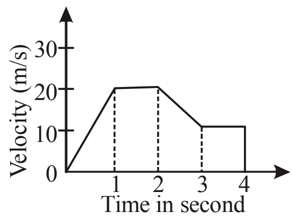
(a) from rest and moves with uniform velocity
(b) from rest and moves with uniform acceleration
(c) with an initial velocity and moves with uniform acceleration
(d) with an initial velocity and moves with uniform velocity

42. A particle is moving with uniform acceleration along a straight line. The average velocity of the particle from P to Q is 8ms^{-1} and that Q to S is 12ms^{-1}. If QS = PQ, then the average velocity from P to S is



(a) 9.6 ms^{-1} (b) 12.87 ms^{-1}
(c) 64 ms^{-1} (d) 327 ms^{-1}

43. The variation of velocity of a particle with time moving along a straight line is illustrated in the figure. The distance travelled by the particle in four seconds is



(a) 60 m
(b) 55 m
(c) 25 m
(d) 30 m

44. A stone falls freely under gravity. It covers distances h_1, h_2 and h_3 in the first 5 seconds, the next 5 seconds and the next 5 seconds respectively. The relation between h_1, h_2 and h_3 is

(a) $h_1 = \frac{h_2}{3} = \frac{h_3}{5}$ (b) $h_2 = 3h_1$ and $h_3 = 3h_2$

(c) $h_1 = h_2 = h_3$ (d) $h_1 = 2h_2 = 3h_3$

45. A car, starting from rest, accelerates at the rate f through a distance S, then continues at constant speed for time t and then decelerates at the rate $\frac{f}{2}$ to come to rest. If the total distance traversed is 15 S, then

(a) $S = \frac{1}{6}ft^2$ (b) $S = ft$

(c) $S = \frac{1}{4}ft^2$ (d) $S = \frac{1}{72}ft^2$

RESPONSE GRID	36. ⓐⓑⓒⓓ	37. ⓐⓑⓒⓓ	38. ⓐⓑⓒⓓ	39. ⓐⓑⓒⓓ	40. ⓐⓑⓒⓓ
	41. ⓐⓑⓒⓓ	42. ⓐⓑⓒⓓ	43. ⓐⓑⓒⓓ	44. ⓐⓑⓒⓓ	45. ⓐⓑⓒⓓ

DAILY PRACTICE PROBLEM DPP CHAPTERWISE CP02 - PHYSICS			
Total Questions	45	Total Marks	180
Attempted		Correct	
Incorrect		Net Score	
Cut-off Score	50	Qualifying Score	70
Success Gap = Net Score – Qualifying Score			
Net Score = (Correct × 4) – (Incorrect × 1)			

Space for Rough Work

1. **(a)** Acceleration of the particle a = 2t – 1
The particle retards when acceleration is opposite to velocity.
$\Rightarrow a \cdot v < 0 \Rightarrow (2t-1)(t^2-t) < 0 \Rightarrow t(2t-1)(t-1) < 0$
Now t is always positive
$\therefore\ (2t-1)(t-1) < 0$

or $2t-1<0$ and $t-1>0 \Rightarrow t < \frac{1}{2}$ and $t > 1$.

This is not possible
or $2t-1>0$ & $t-1<0 \Rightarrow 1/2 < t < 1$

2. **(b)** $x = \alpha t^3$ and $y = \beta t^3$

$$v_x = \frac{dx}{dt} = 3\alpha t^2 \text{ and } v_y = \frac{dy}{dt} = 3\beta t^2$$

$$\therefore\ v = \sqrt{v_x^2 + v_y^2} = \sqrt{9\alpha^2 t^4 + 9\beta^2 t^4}$$

$$= 3t^2\sqrt{\alpha^2 + \beta^2}$$

3. **(d)** Average speed $= \dfrac{\text{Total distance travelled}}{\text{Total time taken}}$

$$= \frac{x}{\dfrac{2x/5}{v_1} + \dfrac{3x/5}{v_2}} = \frac{5v_1v_2}{3v_1 + 2v_2}$$

4. **(a)** Instantaneous speed is the distance being covered by the particle per unit time at the given instant. It is equal to the magnitude of the instantaneous velocity at the given instant.

5. **(a)** $v = \alpha\sqrt{x}$, $\dfrac{dx}{dt} = \alpha\sqrt{x} \Rightarrow \dfrac{dx}{\sqrt{x}} = \alpha\, dt$

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

$$\left[\frac{2\sqrt{x}}{1}\right]_0^x = \alpha[t]_0^t$$

$$\Rightarrow 2\sqrt{x} = \alpha t \ \Rightarrow x = \frac{\alpha^2}{4}t^2$$

6. **(c)** $\frac{1}{2}(1+4)\times 4 - \frac{1}{2}\times 1\times 2 - \frac{1}{2}\times 3\times 4 = 3\text{ m}$

7. **(b)** The distance travel in n^{th} second is
$S_n = u + ½(2n–1)a$ ....(1)
so distance travel in t^{th} & $(t+1)^{th}$ second are
$S_t = u + ½(2t–1)a$ ....(2)
$S_{t+1} = u + ½(2t+1)a$ ....(3)
As per question,
$S_t + S_{t+1} = 100 = 2(u + at)$ ....(4)
Now from first equation of motion the velocity, of particle after time t, if it moves with an accleration a is
$v = u + a t$ ....(5)
where u is initial velocity
So from eq(4) and (5), we get v = 50 cm/sec.

8. **(d)** Relative speed of police with respect to thief
= 10 – 9 = 1 m/s
Instantaneous separation = 100 m

$$\text{Time} = \frac{\text{Distance}}{\text{Velocity}} = \frac{100}{1} = 100\,\text{sec}.$$

9. **(d)** $x = \dfrac{a}{b}(1 - e^{-b\times\frac{1}{b}}) = \dfrac{a}{b}(1 - e^{-1}) = \dfrac{a}{b}(1 - \dfrac{1}{e})$

$$= \frac{a}{b}\frac{(e-1)}{e} = \frac{a}{b}\frac{(2.718-1)}{2.718} = \frac{a}{b}\frac{(1.718)}{2.718} = 0.637\frac{a}{b} \simeq \frac{2}{3}a/b$$

velocity $v = \dfrac{dx}{dt} = ae^{-bt}$, $v_0 = a$

accleration $a = \dfrac{dv}{dt} = -abe^{-bt}$ & $a_0 = -ab$

At t = 0, $x = \dfrac{a}{b}(1-1) = 0$ and

At $t = \dfrac{1}{b}$, $x = \dfrac{a}{b}(1 - e^{-1}) = \dfrac{a}{b}(1 - \dfrac{1}{e}) = \dfrac{2}{3}a/b$

At $t = \infty$, $x = \dfrac{a}{b}$

It cannot go beyond this, so point $x > \dfrac{a}{b}$ is not reached by the particle.

At t = 0, x = 0, at $t = \infty$, $x = \dfrac{a}{b}$, therefore the particle does not come back to its starting point at $t = \infty$.

10. **(d)** Ist part: u = 0, t = 5s, v = 108 km/hr = 30 m/s
$v = u + at \Rightarrow 30 = 0 + a \times 5 \Rightarrow a = 6\text{ m/s}^2$

$$s = ut + \frac{1}{2}at^2 = 0\times 5 + \frac{1}{2}\times 6\times 5^2 = 75\text{ m}$$

IIIrd part: s = 45m, u = 30m/s, v = 0

$$a = \frac{v^2 - u^2}{2s} = \frac{-30\times 30}{2\times 45} = -10\text{m/s}^2$$

$v = u + at \Rightarrow 0 = 30 - 10\times t \Rightarrow t = 3s$
IInd part :
$s = s_1 + s_2 + s_3$
$395 = 75 + s_2 + 45 \Rightarrow s_2 = 275$ m

$$t = \frac{275}{30} = 9.16 = 9.2s.$$

Total time taken = (5 + 9.2 + 3) sec = 17.2 sec

11. **(a)** $\dfrac{dv}{dt} = -kv^3$ or $\dfrac{dv}{v^3} = -k\ dt$

Integrating we get, $-\dfrac{1}{2v^2} = -kt + c$ ...(1)

At t = 0, $v = v_0$ $\therefore\ -\dfrac{1}{2v_0^2} = c$

Putting in (1)

$$-\frac{1}{2v^2}=-kt-\frac{1}{2{v_0}^2} \text{ or } \frac{1}{2v_0^2}-\frac{1}{2v^2}=-kt$$

$$\text{or } \left[\frac{1}{2v_0^2}+kt\right]=\frac{1}{2v^2} \text{ or } \left[1+2v_0^2\ kt\right]=\frac{v_0^2}{v^2}$$

$$\text{or } v^2=\frac{v_0^2}{1+2v_0^2\,kt} \text{ or } v=\frac{v_0}{\sqrt{1+2v_0^2\,kt}}$$

12. **(c)** We know that, $v=\frac{dx}{dt} \Rightarrow dx = v\,dt$

Integrating, $\int_0^x dx=\int_0^t v\,dt$

or $x=\int_0^t (v_0+gt+ft^2)\,dt$

$$=\left[v_0t+\frac{gt^2}{2}+\frac{ft^3}{3}\right]_0^t$$

or, $x=v_0t+\frac{gt^2}{2}+\frac{ft^3}{3}$

At $t=1$, $x=v_0+\frac{g}{2}+\frac{f}{3}$.

13. **(c)** Let man will catch the bus after 't' sec. So he will cover distance ut.

Similarly, distance travelled by the bus will be $\frac{1}{2}at^2$

For the given condition

$ut=45+\frac{1}{2}at^2=45+1.25t^2$ [As $a = 2.5\ m/s^2$]

$\Rightarrow u=\frac{45}{t}+1.25t$

To find the minimum value of u $\frac{du}{dt}=0$

so we get t = 6 sec then,

$u=\frac{45}{6}+1.25\times 6=7.5+7.5=15\,m/s$

14. **(b)** **For the body starting from rest**

$x_1=0+\frac{1}{2}at^2$

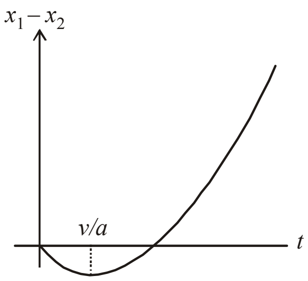
$\Rightarrow x_1=\frac{1}{2}at^2$

For the body moving with constant speed

$x_2=vt$

$\therefore\ x_1-x_2=\frac{1}{2}at^2-vt$

at $t=0, x_1-x_2=0$



For $t<\frac{v}{a}$; the slope is negative

For $t=\frac{v}{a}$; the slope is zero

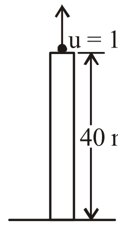
For $t>\frac{v}{a}$; the slope is positive

These characteristics are represented by graph (b).

15. **(d)** The stone reaches its maximum height after time t_1 given by

$t_1=\frac{u}{g}$ ($\because v=u-gt$)

$=\frac{10}{10}=1$ sec



Again it reaches to its initial position in 1 sec and falls with same initial speed of 10 m/s.

Let t_2 be the time taken to reach the ground, then

$v_{ground}=u+gt_2$

But $v_{ground}^2=u^2+2gh$

$=(10)^2+2\times 10\times 40=900$

$\Rightarrow v_{ground}=\sqrt{900}=30\,m/s$

$\therefore\ t_2=\frac{v_{ground}-u}{g}=\frac{30-10}{10}=2$ sec.

$\therefore$ Total required time $=(1+1+2)$ sec $=4$ sec

16. **(b)** $L=\frac{1}{2}gt^2-\frac{1}{2}g(t-T)^2$

$\Rightarrow\ t=\frac{T}{2}+\frac{L}{gt}$.

17. **(b)** $S=AB=\frac{1}{2}g\,t_1^{\ 2}\Rightarrow 2S=AC=\frac{1}{2}g\,(t_1+t_2)^2$

and $3S=AD=\frac{1}{2}g\,(t_1+t_2+t_3)^2$

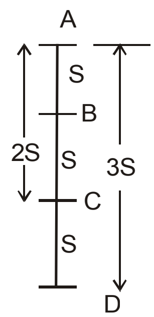
$t_1=\sqrt{\frac{2S}{g}}$

$t_1+t_2=\sqrt{\frac{4S}{g}},\ t_2=\sqrt{\frac{4S}{g}}-\sqrt{\frac{2S}{g}}$

$t_1+t_2+t_3=\sqrt{\frac{6S}{g}}$

$t_3=\sqrt{\frac{6S}{g}}-\sqrt{\frac{4S}{g}}$

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



18. **(c)** Height of tap = 5m and (g) = 10 m/sec^2.

For the first drop,

$5=ut+\frac{1}{2}gt^2=(0\times t)+\frac{1}{2}\times 10t^2=5t^2$ or $t^2=1$ or $t=1$.

It means that the third drop leaves after one second of the first drop. Or, each drop leaves after every 0.5 sec. Distance covered by the second drop in 0.5 sec

$= ut + \frac{1}{2}gt^2 = (0 \times 0.5) + \frac{1}{2} \times 10 = (0.5)^2 = 1.25\text{m}$.

Therefore, distance of the second drop above the ground = 5 – 1.25 = 3.75 m.

19. **(c)** $\because t = \sqrt{x} + 3$

$\Rightarrow \sqrt{x} = t - 3 \Rightarrow x = (t-3)^2$

$v = \frac{dx}{dt} = 2(t-3) = 0$

$\Rightarrow t = 3$

$\therefore x = (3-3)^2$

$\Rightarrow x = 0.$

20. **(c)** We have, $S_n = u + \frac{a}{2}(2n-1)$

or $65 = u + \frac{a}{2}(2 \times 5 - 1)$

or $65 = u + \frac{9}{2}a$ ..... (1)

Also, $105 = u + \frac{a}{2}(2 \times 9 - 1)$

or $105 = u + \frac{17}{2}a$ ..... (2)

Equation (2) – (1) gives,

$40 = \frac{17}{2}a - \frac{9}{2}a = 4a$ or $a = 10\ \text{m/s}^2$.

Substitute this value in (1) we get,

$u = 65 - \frac{9}{2} \times 10 = 65 - 45 = 20\ \text{m/s}$

$\therefore$ The distance travelled by the body in 20 s is,

$s = ut + \frac{1}{2}at^2 = 20 \times 20 + \frac{1}{2} \times 10 \times (20)^2$

$= 400 + 2000 = 2400$ m.

21. **(d)** Speed, $u = 60 \times \frac{5}{18}\text{m/s} = \frac{50}{3}\text{m/s}$

$d = 20\text{m},\ u' = 120 \times \frac{5}{18} = \frac{100}{3}\text{m/s}$

Let declaration be a then $(0)^2 - u^2 = -2ad$

or $u^2 = 2ad$ …(1)

and $(0)^2 - u'^2 = -2ad'$

or $u'^2 = 2ad'$ …(2)

(2) divided by (1) gives,

$4 = \frac{d'}{d} \Rightarrow d' = 4 \times 20 = 80\text{m}$

22. **(b)** $8 = a\,t_1$ and $0 = 8 - a\,(4 - t_1)$

or $t_1 = \frac{8}{a}$ $\therefore 8 = a\left(4 - \frac{8}{a}\right)$

$8 = 4a - 8$ or $a = 4$ and $t_1 = 8/4 = 2$ sec

Now, $s_1 = 0 \times 2 + \frac{1}{2} \times 4(2)^2$ or $s_1 = 8\text{ m}$

$s_2 = 8 \times 2 - \frac{1}{2} \times 4 \times (2)^2$ or $s_2 = 8\text{ m}$

$\therefore s_1 + s_2 = 16$ m

23. **(d)**

24. **(a)** $x = \frac{1}{t+5}$

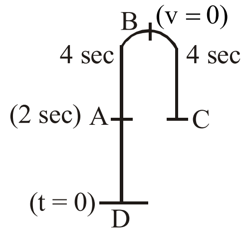
$\therefore v = \frac{dx}{dt} = \frac{-1}{(t+5)^2}$

$\therefore a = \frac{d^2x}{dt^2} = \frac{2}{(t+5)^3} = 2x^3$

Now $\frac{1}{(t+5)} \propto v^{\frac{1}{2}}$

$\therefore \frac{1}{(t+5)^3} \propto v^{\frac{3}{2}} \propto a$

25. **(d)**



As the time taken from D to A = 2 sec.
and D → A → B → C = 10 sec (given).
As ball goes from B → C (u = 0, t = 4 sec)
$v_c = 0 + 4g$.

As it moves from C to D, $s = ut + \frac{1}{2}gt^2$

$s = 4g \times 2 + \frac{1}{2}g \times 4 = 10\text{ g}.$

26. **(d)** $y = \frac{1}{2}g(n+1)^2 - \frac{1}{2}gn^2$

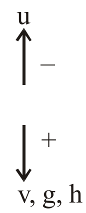
$= \frac{g}{2}[(n+1)^2 - n^2] = \frac{g}{2}(2n+1)$ ......(i)

Also, $h = \frac{g}{2}(2n-1)$ ......(ii)

From (i) and (ii)

$y = h + g$

27. **(b)** The stone rises up till its vertical velocity is zero and again reached the top of the tower with a speed u (downward). The speed of the stone at the base is 3u.



Hence $(3u)^2 = (-u)^2 + 2gh$ or $h = \frac{4u^2}{g}$

28. **(b)** $x = 40 + 12t - t^3$

$$v = \frac{dx}{dt} = 12 - 3t^2$$

For $v = 0$; $t = \sqrt{\frac{12}{3}} = 2$ sec

So, after 2 seconds velocity becomes zero.
Value of x in 2 secs $= 40 + 12 \times 2 - 2^3$
$= 40 + 24 - 8 = 56$ m

29. **(b)** The slope of v-t graph is constant and velocity decreasing for first half. It is positive and constant over next half.

30. **(c)** Here, $f = f_0\left(1 - \frac{t}{T}\right)$ or, $\frac{dv}{dt} = f_0\left(1 - \frac{t}{T}\right)$

or, $dv = f_0\left(1 - \frac{t}{T}\right)dt$

$$\therefore v = \int dv = \int\left[f_0\left(1 - \frac{t}{T}\right)\right]dt$$

or, $v = f_0\left(t - \frac{t^2}{2T}\right) + C$

where C is the constant of integration.
At $t = 0$, $v = 0$.

$$\therefore 0 = f_0\left(0 - \frac{0}{2T}\right) + C \quad \Rightarrow C = 0$$

$$\therefore v = f_0\left(t - \frac{t^2}{2T}\right)$$

If $f = 0$, then

$$0 = f_0\left(1 - \frac{t}{T}\right) \Rightarrow t = T$$

Hence, particle's velocity in the time interval $t = 0$ and $t = T$ is given by

$$v_x = \int_{t=0}^{t=T} dv = \int_{t=0}^{T}\left[f_0\left(1 - \frac{t}{T}\right)\right]dt$$

$$= f_0\left[\left(t - \frac{t^2}{2T}\right)\right]_0^T$$

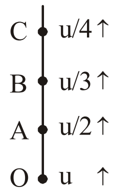
$$= f_0\left(T - \frac{T^2}{2T}\right) = f_0\left(T - \frac{T}{2}\right)$$

$$= \frac{1}{2}f_0T.$$

31. **(a)** Using $v^2 = u^2 - 2gh$ i.e., $h = \frac{u^2 - v^2}{2g}$,

$$AB = \frac{\left(\frac{u}{2}\right)^2 - \left(\frac{u}{3}\right)^2}{2g}$$

and $BC = \frac{\left(\frac{u}{3}\right)^2 - \left(\frac{u}{4}\right)^2}{2g}$



$$\therefore \frac{AB}{BC} = \frac{\left(\frac{u}{2}\right)^2 - \left(\frac{u}{3}\right)^2}{\left(\frac{u}{3}\right)^2 - \left(\frac{u}{4}\right)^2} = \frac{\left(\frac{1}{2}\right)^2 - \left(\frac{1}{3}\right)^2}{\left(\frac{1}{3}\right)^2 - \left(\frac{1}{4}\right)^2} = \frac{20}{7}$$

32. **(a)** Velocity of boat $= \frac{8 + 8}{2} = 8\,\text{km h}^{-1}$

Velocity of water $= 4\,\text{km h}^{-1}$

$$t = \frac{8}{8-4} + \frac{8}{8+4} = \frac{8}{3}\text{h} = 160 \text{ minutes}$$

33. **(b)** $v_{av} = \frac{x + 2x + 3x}{t_1 + t_2 + t_3}$

$$t_1 = \frac{2x}{v_{max}},\ t_2 = \frac{2x}{v_{max}},\ t_3 = \frac{6x}{v_{max}}$$

$$v_{av} = \frac{6x\ v_{max}}{10x}$$

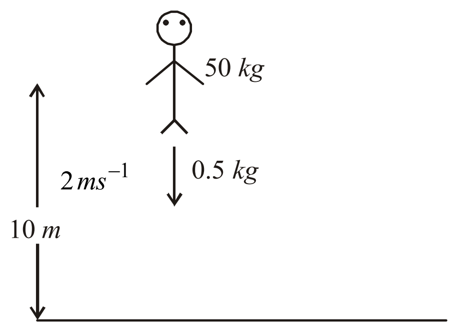
$$\frac{v_{av}}{v_{max}} = \frac{3}{5}$$

34. **(b)** No external force is acting, therefore,
$50u + 0.5 \times 2 = 0$
where u is the velocity of man.

$$u = -\frac{1}{50}\text{ms}^{-1}$$

Negative sign of u shows that man moves upward.
Time taken by the stone to reach the ground

$$= \frac{10}{2} = 5\text{S}$$



Distance moved by the man

$$= 5 \times \frac{1}{50} = 0.1\text{m}$$

$\therefore$ when the stone reaches the floor, the distance of the man above floor $= 10.1$ m

35. **(a)** Use $\vec{v}_{AB} = \vec{v}_A - \vec{v}_B$.

36. **(c)** Downward motion

$v^2 - 0^2 = 2 \times 9.8 \times 5$

$\Rightarrow \ v = \sqrt{98} = 9.9$

Also for upward motion

$0^2 - u^2 = 2 \times (-9.8) \times 1.8$

$\Rightarrow \ u = \sqrt{3528} = 5.94$

Fractional loss $= \dfrac{9.9 - 5.94}{9.9} = 0.4$

37. (c) Distance travelled by the stone in the last second is

$\dfrac{9h}{25} = \dfrac{g}{2}(2t-1) \quad (\because \ u = 0) \qquad \text{...(i)}$

Distance travelled by the stone in t s is

$h = \dfrac{1}{2} gt^2 \quad (\text{using } s = ut + \dfrac{1}{2} at^2) \qquad \text{...(ii)}$

Divide (i) by (ii), we get

$\dfrac{9}{25} = \dfrac{(2t-1)}{t^2}$

$9t^2 = 50t - 25, \ 9t^2 - 50t + 25 = 0$

Solving, we get

$t = 5s \ \text{ or } \ t = \dfrac{5}{9} s$

Substituting t = 5s in (ii), we get

$h = \dfrac{1}{2} \times 9.8 \times (5)^2 = 122.5 \text{ m}$

38. (b) $y \propto t^2 ; v\text{-} \propto t' ; a \propto t^{\circ}$

39. (b) Average velocity for the second half of the distance is

$= \dfrac{v_1 + v_2}{2} = \dfrac{4+8}{2} = 6 \, ms^{-1}$

Given that first half distance is covered with a velocity of $6 \, ms^{-1}$. Therefore, the average velocity for the whole time of motion is $6 \, ms^{-1}$

40. (b) Bullet will take $\dfrac{100}{1000} = 0.1$ sec to reach target.

During this period vertical distance (downward) travelled by the bullet

$= \dfrac{1}{2} gt^2 = \dfrac{1}{2} \times 10 \times (0.1)^2 = 0.05 \, m = 5 cm$

So the gun should be aimed 5 cm above the target.

41. (c) The distance covered in n^{th} second is

$S_n = u + \dfrac{1}{2}(2n-1)a$

where u is initial velocity & a is acceleration

then $26 = u + \dfrac{19a}{2} \qquad \text{....(1)}$

$28 = u + \dfrac{21a}{2} \qquad \text{....(2)}$

$30 = u + \dfrac{23a}{2} \qquad \text{....(3)}$

$32 = u + \dfrac{25a}{2} \qquad \text{....(4)}$

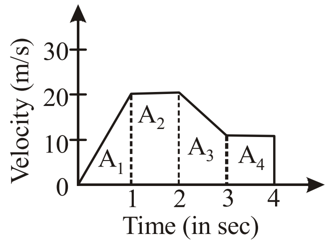
From eqs. (1) and (2) we get u = 7m/sec, a=2m/sec^2

$\therefore$ The body starts with initial velocity u =7m/sec and moves with uniform acceleration a = 2m/sec^2

42. (a) $8 = \dfrac{x}{t_1}, \ 12 = \dfrac{x}{t_2}$

$\bar{v} = \dfrac{2x}{t_1 + t_2} = \dfrac{2x}{\dfrac{x}{8} + \dfrac{x}{12}} = \dfrac{2 \times 8 \times 12}{12 + 8} = 9.6 \text{ ms}^{-1}$

43. (b) Distance = Area under v – t graph $= A_1 + A_2 + A_3 + A_4$



$= \dfrac{1}{2} \times 1 \times 20 + (20 \times 1) + \dfrac{1}{2}(20 + 10) \times 1 + (10 \times 1)$

$= 10 + 20 + 15 + 10 = 55 \text{ m}$

44. (a) $\because \ h = \dfrac{1}{2} gt^2$

$\therefore \ h_1 = \dfrac{1}{2} g(5)^2 = 125$

$h_1 + h_2 = \dfrac{1}{2} g(10)^2 = 500$

$\Rightarrow h_2 = 375$

$h_1 + h_2 + h_3 = \dfrac{1}{2} g(15)^2 = 1125$

$\Rightarrow h_3 = 625$

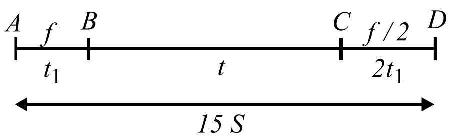
$h_2 = 3h_1, \ h_3 = 5h_1$

or $h_1 = \dfrac{h_2}{3} = \dfrac{h_3}{5}$

45. (d) Distance from A to $B = S = \dfrac{1}{2} f t_1^2$

Distance from B to $C = (f t_1) t$

Distance from C to $D = \dfrac{u^2}{2a} = \dfrac{(f t_1)^2}{2(f/2)} = f t_1^2 = 2S$



$\Rightarrow \ S + f t_1 t + 2S = 15 S$

$\Rightarrow \ f t_1 t = 12 S \qquad \text{............. (i)}$

$\dfrac{1}{2} f t_1^2 = S \qquad \text{............ (ii)}$

Dividing (i) by (ii), we get $t_1 = \dfrac{t}{6}$

$\Rightarrow \ S = \dfrac{1}{2} f \left(\dfrac{t}{6}\right)^2 = \dfrac{f t^2}{72}$