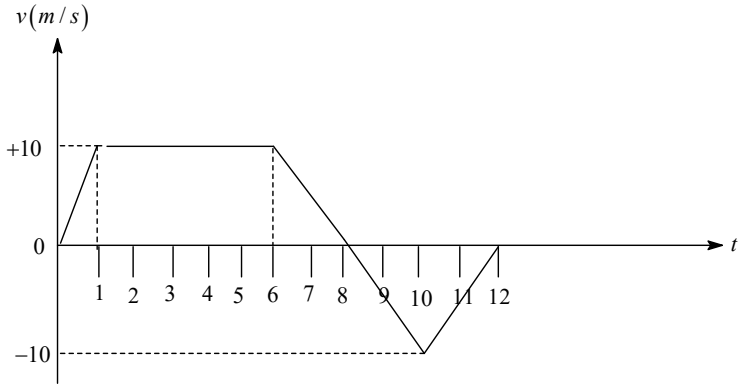
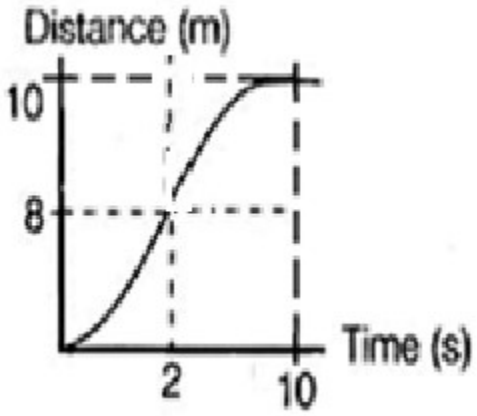
DPP : MOTION IN A STRAIGHT LINE

1. From metro station 'A', a metro train starts at regular interval of 10 min and runs towards 'B' metro station with constant speed of 80 kmh^{-1} without any stoppage. At some point of time, all the trains simultaneously have to reduce their speed 50 kmh^{-1} due to defect in rails. What will become the time intervals between arrivals of the trains at the metro station 'B' during the defect in rails?
   A) $\frac{8}{3}$ min B) $\frac{4}{15}$ min C) 16 min D) 4 min
2. The relation between time and distance is $t = \alpha x^2 + \beta x$, where α and β are constants. The retardation is
   A) $2\alpha v^3$ B) $2\beta v^3$ C) $2\alpha\beta v^3$ D) $2\beta^2 v^3$
3. The velocity-time graph of a body moving along a straight line is given below. The average velocity in whole motion is



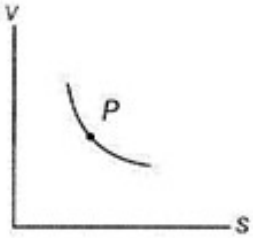
   A) 60 ms^{-1} B) 20 ms^{-1} C) 6.67 ms^{-1} D) 3.33 ms^{-1}
4. An engine of a train, moving with uniform acceleration passes the signal-post with velocity u and the last compartment with velocity v.The velocity with which middle point of the train passes the signal post is
   A) $\sqrt{\frac{v^2+u^2}{2}}$ B) $\frac{v-u}{2}$ C) $\frac{u+v}{2}$ D) $\sqrt{\frac{v^2-u^2}{2}}$
5. A balloon is at a height of 40 m and is ascending with a velocity of 10 ms^{-1}. A bag of 5 kg weight is dropped from it. The body reach the surface of the earth after_____
   A) 2 s B) 4 s C) 0.25 s D) 1 s
6. A car is moving towards check post with velocity 54 kmh^{-1}. When car is at 400 m from the check post, driver applied brakes which is caused of retardation of 0.3 ms^{-2}. The distance of the car from the check post for 2 min after applying the brakes
   A) 375 m B) 25 m C) 400 m D) 775 m
7. An automobile travelling with a speed of 60 kmh^{-1}, can brake to stop within a distance of 20 m. If the car is going twice as fast i.e., 120 kmh^{-1}. The stopping distance is
   A) 20 m B) 40 m C) 60 m D) 80 m
8. A 200 m long train starts from rest at t = 0 with constant acceleration 4 cms^{-2}. The head light of its engine is switched ON at t=60 s and its tail light is switched ON at t =120 s. the distance between these two events for an observer standing on platform
   A) 72 m B) 288 m C) 266 m D) 16 m

9. The average speed in time interval t=2s to t=10 s



A) 0.25 ms^{-1} B) 0.50 ms^{-1} C) 4 ms^{-1} D) 25 ms^{-1}

10. A particle is moving on straight line whose velocity-displacement graph is shown in figure. At point P of graph $v = \sqrt{3} ms^{-1}$ and slope is $-\sqrt{3}$. The magnitude of acceleration at point P is



A) -3 ms^{-2} B) 3 ms^{-2} C) $-\sqrt{3}\, ms^{-2}$ D) $\sqrt{3}\, ms^{-2}$

11. A car moves for half of its time 80 km/h and for rest half of time at 40 km/h. The total distance covered is 60 km. The average speed of the car is
A) 180 km/h B) 120 km/h C) 80 km/h D) 60 km/h

12. A body covered a distance of 5 m along a semicircular path. The ratio of distance to displacement is
A) 5 : 10 B) 10 : 5 C) 11 : 7 D) 7 : 11

13. The displacement is given by $x = 2t^2 + t + 5$, the acceleration at $t = 2s$ is
A) $4\,m/s^2$ B) $8\,m/s^2$ C) $10\,m/s^2$ D) $15\,m/s^2$

14. A particle is moving in a straight line and passes through a point O with a velocity of 6 ms^{-1}. The particle moves with a constant retardation of 2 ms^{-2} for 4s and there after moves with constant velocity. How long after leaving O does the particle return to O?
A) 3s B) 8s C) never D) 4s

15. A body falls freely from the top of a tower. It covers 36 % of the total height in the last second before striking the ground level. The height of the tower is
A) 50 m B) 75 m C) 100 m D) 125 m

16. A ball is projected upwards from a height 'h' above the surface of the earth with velocity 'v'. The time at which the ball strikes the ground is
A) $\frac{v}{g} + \frac{2hg}{\sqrt{2}}$ B) $\frac{v}{g}\left[1 - \sqrt{1 + \frac{2h}{g}}\right]$ C) $\frac{v}{g}\left[1 + \sqrt{1 + \frac{2gh}{v^2}}\right]$ D) $\frac{v}{g}\left[1 + \sqrt{v^2 + \frac{2g}{h}}\right]$

17. A player throws a ball upwards with an initial speed of 29.4 m/s. The velocity and acceleration of the ball at the highest point of its motion are (take g=9.8 m/s^2)
A) zero,zero B) 9.8 m/s,zero C) zero, 9.8 m/s^2 D) 9.8 m/s, 9.8 m/s^2

18. If the velocity of a body related to displacement 'x' is given by $v = \sqrt{5000 + 24x}$ m/s then the acceleration of the body is _____ m/s^2
A) 6 B) 12 C) 18 D) 24

19. A particle starts from rest with an acceleration 2ms^{-2}. The acceleration of the particle decreases down to zero uniformly during time interval of 4s. the velocity of particle (in ms^{-1}) after 2s
A) 1 B) 2 C) 3 D) 4

20. A train travels from city A to city B with constant speed of $10ms^{-1}$ and return back to city A with a constant speed of 20 ms^{-1}. The average speed during its entire journey

A) $\frac{20}{3} m/s$ B) $\frac{40}{3} m/s$ C) $20\ m/s$ D) $40\ m/s$

21. A car takes 20 s to move around a roundabout of radius 14m.The magnitude of average velocity is

A) 4.4 m/s B) 8.8 m/s C) 2.2 m/s D) zero

22. Consider a particle initially moving with a velocity of 5 m/s starts retardation at a constant rate of 2 m/s^2. The distance travelled in the 2^{nd} second is

A) 14 m B) 7 m C) 4.5 m D) 2 m

23. Consider a particle initially moving with a velocity of 5 m/s starts retardation at a constant rate of 2 m/s^2. Determine the time at which the particle becomes stationary

A) 2.5 s B) 2.8 s C) 4.35 s D) 4.6 s

24. A balloon starts rising upward with constant acceleration 'a' and after 't_0' second, a packet is dropped from it which reaches the ground after 't' second. The value of 't' is

A) $\frac{a}{g}\left[t_0+\sqrt{1+\frac{g}{a}}\right]$ B) $\frac{at_0}{g}\left[t_0+\sqrt{1+\frac{g}{a}}\right]$ C) $\frac{t_0}{g}\left[a+\sqrt{1+\frac{g}{a}}\right]$ D) t_0

25. Two balls of different masses m_1 and m_2 are dropped from two different heights h_1 and h_2 respectively. The ration of time taken by the two balls to drop through these distances is

A) $\frac{t_1}{t_2}=\sqrt{h_1h_2}$ B) $\frac{t_1}{t_2}=h_1.h_2$ C) $\frac{t_1}{t_2}=\sqrt{\frac{h_1}{h_2}}$ D) $\frac{t_1}{t_2}=\sqrt{\frac{h_2}{h_1}}$

26. A swimmer capable of swimming with velocity 'v' relative to water jumps in a flowing river having velocity 'u'. The man swims a distance 'd' downstream and returns back to the original position. The tine taken in complete motion is

A) $\frac{d}{v+u}$ B) $\frac{d}{v-u}$ C) $\frac{2d}{v^2-u^2}$ D) $\frac{2d}{v^2+u^2}$

27. Two buses of equal 5 m lengths are moving with the same velocity in the same direction on a highway. The first bus is 40 m ahead of the second bus. The driver of the second bus thinks to overtake the first bus and gives an acceleration of $1ms^{-2}$ to the bus. After what time the second bus just passes the first bus?

A) 4.75 sec B) 9.48 sec C) 12.35 sec D) 10.5 sec

28. A summer moving upstream passes a float at point P. After two hours, he returns and at this instant he meets the float again at a distance 15 km from the point P. If the swimmer velocity in water remains constant, then the speed of river flow is

A) 7.5 km/h B) 4.5 km/h C) 4.75 km/h D) 3.75 km/h

29. The distance travelled by a particle is related to time t as $x=4t^2$. The velocity of the particle at $t=5s$ is

A) $40ms^{-1}$ B) $25ms^{-1}$ C) $20ms^{-1}$ D) $8ms^{-1}$

30. For a train engine moving with speed of 20 ms^{-1} the driver must apply brakes at a distance of 500 m before the station for the train to come to rest at the station. If the brakes were applied at half of this distance, the train engine would cross the station with speed $\sqrt{x}$ ms^{-1}. The value of x is_____

A) 200 B) 250 C) 400 D) 450

KEY

PHYSICS

	1	2	3	4	5	6	7	8	9	10
1-10	C	A	D	A	B	B	D	D	A	A
11-20	D	C	A	B	D	C	C	B	C	B
21-30	D	D	A	B	C	C	B	D	A	A

HINTS

1. $v_1 = 80 kmh^{-1},\ t_1 = 10\,\text{min} = \frac{10}{60} hr$

Distance between the successive trains on the track is $s = v_1 t = 80 \times \frac{10}{60} = \frac{40}{3} km$

$v_2 = 50 kmh^{-1}$

When speed of all trains is reduced to $50 kmh^{-1}$, then the distance covered in

$t_2 = \frac{s}{v_2} = \frac{40/3}{50} = \frac{4}{15} hr = \frac{4}{15} \times 60\,\text{min} = 16\,\text{min}$

2. $t = \alpha x^2 + \beta x$

$\Rightarrow \frac{dt}{dx} = 2\alpha x + \beta$

$\Rightarrow \frac{1}{v} = 2\alpha x + \beta$

$v = \frac{1}{2\alpha x + \beta} \rightarrow (1)$

$a = \frac{dv}{dt}$

$\Rightarrow a = \frac{dv}{dx} . \frac{dx}{dt} \left(\because \frac{dx}{dt} = v \right)$

$\Rightarrow a = \frac{d}{dx} \left(\frac{1}{2\alpha x + \beta} \right)$

$\Rightarrow a = v. \left[\frac{-2\alpha}{(2\alpha x + \beta)^2} \right] (\because (1))$

$\Rightarrow a = -\frac{2\alpha}{(2\alpha x + \beta)^3} \Rightarrow a = -2\alpha v^3$

$\therefore$ Retardation = $2\alpha v^3$

3. Area of graph above time axis is $A_1 = \frac{1}{2} \times (8-4) \times 10 = 60m$

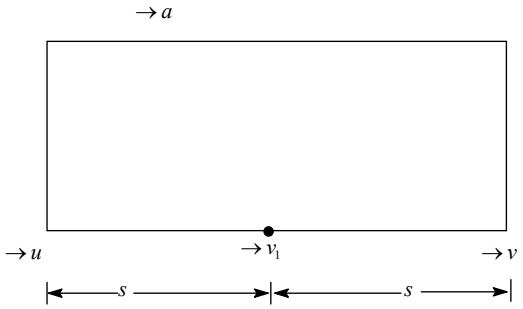
Area of graph below time axis is $A_2 = \frac{1}{2} \times 4 \times 10 = 20m$

Average velocity in whole time of motion is

$v_{avg} = \frac{displacement}{total\ time} = \frac{A_1 - A_2}{t} = \frac{60-20}{12} = 3.33 ms^{-1}$

4. Let the velocity of middle point of train is v_1

$(i) v_1^2 - u^2 = 2as$



$v_1^2 = u^2 + 2as \rightarrow (1)$

$(ii) v^2 - v_1^2 = 2as$

$v_1^2 = v^2 - 2as \rightarrow (2)$

From eq (1) & (2)

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

$4as = v^2 - u^2$

$as = \frac{v^2 - u^2}{4} \rightarrow (3)$

Sub eq (3) in eqn (1)

$$v_1^2 = u^2 + 2.\left(\frac{v^2 - u^2}{4}\right)$$

$$v_1^2 = u^2 + \frac{v^2}{2} - \frac{u^2}{2}$$

$$v_1^2 = \frac{u^2 + v^2}{2}$$

$$v_1 = \sqrt{\frac{u^2 + v^2}{2}}$$

5. h =40 m, u=10ms^{-1}, a=g=10ms^{-2}

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

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

$$-40 = 10t - \frac{1}{2}.10t^2$$

$$-4 = t - \frac{1}{2}.t^2$$

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

$$t = \frac{2 \pm \sqrt{4 + (4 \times 1 \times 8)}}{2}$$

$$t = \frac{2 \pm \sqrt{36}}{2}$$

$$t = \frac{2 \pm 6}{2}$$

$$t = \frac{2+6}{2} \ (or) \ \ t = \frac{2-6}{2}$$

$$t = 4\,\text{sec} \ \ or \ \ t = -2\,\text{sec}$$

$$t = 4\,\text{sec}$$

6. $v = 0; u = 54kmh^{-1} = 15ms^{-1}; d = 400m$

$a = -0.3ms^{-2}; t = 2\,\text{min}; d^1 = ?$

From $v^2 - u^2 = 2as \Rightarrow s = 375m$

$d^1 = d - s \Rightarrow d^1 = 400 - 375 \Rightarrow d^1 = 25m$

7. $u_1 = 60kmh^{-1}, u_2 = 120kmh^{-1}; s_1 = 20m, s_2 = ?$

$v = 0$; from $v^2 - u^2 = 2as \Rightarrow s \propto u^2 \Rightarrow \frac{s_1}{s_2} = \left(\frac{u_1}{u_2}\right)^2 \Rightarrow s_2 = 80m$

8. $u = 0; a = 0.04ms^{-2}; t_1 = 60\,\text{sec}, t_2 = 120\,\text{sec}$

$l = 200m$

$$s_1 = ut_1 + \frac{1}{2}at_1^2 = 72m$$

$$s_2 = ut_2 + \frac{1}{2}at_2^2 = 288m$$

Thus, the distance b/w these tow events is $d = s_2 - (l + s_1) = 16m$

9. $x_1 = 8m, x_2 = 10m, t_1 = 2\,\text{sec}, t_2 = 10\,\text{sec}$

$$v_{avg} = \frac{\Delta x}{\Delta t} = \frac{x_2 - x_1}{t_2 - t_1} = \frac{2}{8} = 0.25ms^{-1}$$

10. slope $= \frac{v}{s} = -\sqrt{3}; v = \frac{s}{t} = \sqrt{3} ms^{-1}$

$\Rightarrow \frac{v/t}{s/t} = -\sqrt{3} \Rightarrow \frac{a}{\sqrt{3}} \Rightarrow a = -3ms^{-2}$

11. $t_1 = t_2 = t; v_1 = 80km/h, v_2 = 40km/h$, d=60km

Since $t_1 = t_2 \Rightarrow \frac{d_1}{v_1} = \frac{d_2}{v_2} \Rightarrow d_1 = 2d_2$

$d_1 + d_2 = 60 \Rightarrow d_1 = 40km, d_2 = 20km$

$\therefore v_{avg} = \frac{d}{t_1 + t_2} = \frac{d}{\frac{d_1}{v_1} + \frac{d_2}{v_2}} = 60km/h$

12. $d = \pi r = 5m \Rightarrow r = \frac{5}{\pi} m$

$s = 2r = \frac{10}{\pi} m$

$d : s = 5 : \frac{10}{\pi} = 11 : 7$

13. $x = 2t^2 + t + 5; t = 2\sec$

$v = \frac{dx}{dt} = 4t + 1; a = \frac{dv}{dt} = 4m/s^2$

14. $u = 6m/s; a = -2m/s^2; t = 4\sec$

$v = u + at \Rightarrow v = -2m/s$

v is -ve means it returns after 4 sec

Now distance travelled in $t = 4\sec$ is

$s = ut + \frac{1}{2}at^2 \Rightarrow s = 8m$

Now after returning, body moves with constant velocity $v = \frac{s}{t^1}$

$\Rightarrow t^1 = \frac{s}{v} = \frac{8}{2} = 4\sec$

Total time $T = t + t^1 = 4 + 4 = 8\sec$

15. A body is falling freely from height h and let that body strikes the ground after t seconds

$u = 0; s = h; t = t, a = g$

From $s = ut + \frac{1}{2}at^2 \Rightarrow h = \frac{1}{2}gt^2 \rightarrow (1)$

It has covered 36 % of h in the time last 1 second

So, we get $t_1 = (t-1)$ second for descending through 64 % of h

$\therefore 64\%\ of\ h = \frac{1}{2}g(t-1)^2$

$\Rightarrow \frac{64}{100} \times h = \frac{1}{2}g(t-1)^2 \rightarrow (2)$

$\frac{(1)}{(2)} \Rightarrow \frac{100}{64} = \frac{t^2}{(t-1)^2} \Rightarrow \frac{10}{8} = \frac{t}{t-1}$

$\Rightarrow t = 5\sec$

$(1) \Rightarrow h = \frac{1}{2} \times 10 \times 25 \Rightarrow h = 125m$

16. given $u = v$

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

$$\Rightarrow -h = vt - \frac{1}{2}gt^2$$

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

$$gt^2 - 2vt - 2h = 0$$

$$t = \frac{2v \pm \sqrt{4v^2 + 8gh}}{2g}$$

$$t = \frac{2v \pm \sqrt{1 + \frac{8gh}{4v^2}}}{2g}$$

$$t = \frac{v}{g}\left(1 + \sqrt{1 + \frac{2gh}{v^2}}\right)$$

17. At maximum, velocity of the ball becomes zero. $\therefore v = 0$
At highest point of the ball acceleration due to gravity "g" acts vertically downwards.
$a = g = 9.8m/s^2$

18. $v = \sqrt{5000 + 24x}$

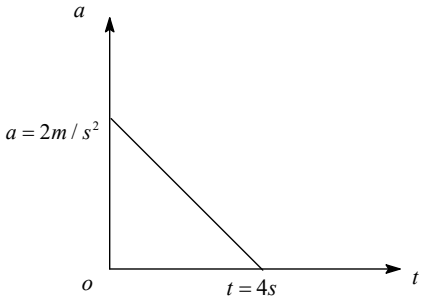
$$\frac{dv}{dx} = \frac{1}{2\sqrt{5000 + 24x}} \times 24 = \frac{12}{\sqrt{5000 + 24x}}$$

And $\frac{dv}{dx} = \frac{dv}{dt}.\frac{dt}{dx} \Rightarrow \frac{dv}{dx} = \frac{a}{v} \Rightarrow a = v.\frac{dv}{dx}$

$\Rightarrow a = 12m/s^2$

19. $\frac{a}{2} + \frac{t}{4} = 1$

$2a + t = 4$



$$2a = 4 - t \Rightarrow a = 2 - \frac{t}{2}$$

But $a = \frac{dv}{dt} \Rightarrow \frac{dv}{dt} = 2 - \frac{t}{2}$

$$\Rightarrow dv = \left(2 - \frac{t}{2}\right)dt \Rightarrow \int_0^v dv = \int_0^2 \left(2 - \frac{t}{2}\right)dt$$

$$\Rightarrow (v)_0^v = \left(2t - \frac{t^2}{4}\right)_0^2 \Rightarrow v = 4 - \frac{4}{4}$$

$\Rightarrow v = 4 - 1 \Rightarrow v = 3m/s$

20. $v_A = 10ms^{-1}, v_B = 20ms^{-1}$

Distance between A & B = x (say)

Time taken by the train to travel from A to B is $t_1 = \frac{x}{v_A}$

$\Rightarrow t_1 = \frac{x}{10}$

Time taken to come back from B to A is $t_2 = \frac{x}{v_B}$

$\Rightarrow t_2 = \frac{x}{20}, v_{avg} = \frac{x+x}{t_1+t_2} = \frac{2x}{\frac{x}{10}+\frac{x}{20}} \Rightarrow v_{avg} = \frac{40}{3} m/s$

21. In one complete revolution, displacement of car is zero i.e, $s = 0$

$\left|\vec{v}_{avg}\right| = \frac{displacement}{time} = \frac{s}{t} = 0$

22. $u = 5m/s, a = -2m/s^2, n = 2$

$s_n = u + a\left(n - \frac{1}{2}\right)$

$\Rightarrow s_2 = 5 - 2\left(2 - \frac{1}{2}\right) = 5 - 3 = 2m$

23. $u = 5m/s, a = -2m/s^2, v = 0, t = ?$

From $v = u + at, t = 2.5\sec$

24. At $t = t_0, h = \frac{1}{2}at_0^2$

$u = at_0$

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

$\Rightarrow -\frac{1}{2}at_0^2 = (at_0)t - \frac{1}{2}gt^2$

$\Rightarrow t^2 - \frac{2at_0}{g}.t - \frac{a}{g}.t_0^2 = 0$

$\Rightarrow t = \frac{at_0}{g}\left(1 + \sqrt{1 + \frac{g}{a}}\right)$

25. for ball-1 : u=0;a=g,t=t_1;s=h_1

From $s = ut + \frac{1}{2}at^2 \Rightarrow h_1 = \frac{1}{2}gt_1^2$

$\Rightarrow t_1 = \sqrt{\frac{2h_1}{g}} \rightarrow (1)$

For ball-2 ; u=0,a=g; t=t_2;s=h_2

$\Rightarrow h_2 = \frac{1}{2}gt_2^2 \Rightarrow t_2 = \sqrt{\frac{2h_2}{g}} \rightarrow (2)$

$\frac{(1)}{(2)} \Rightarrow \frac{t_1}{t_2} = \sqrt{\frac{h_1}{h_2}}$

26. $v_{downstream} = v + u$

$v_{upstream} = v - u$

Total time t = $t_{downstream} + t_{upstream}$

$t = \frac{d}{v+u} + \frac{d}{v-u}$

$t = \frac{2dv}{v^2 - u^2}$

27. $d = 40m, a = 1m/s^2, l = 5m, s = d + l$

$s = 45m, u = 0$

From $s = ut + \frac{1}{2}at^2 \Rightarrow 45 = 0 + \frac{1}{2} \times 1 \times t^2$

$\Rightarrow t = \sqrt{90} \Rightarrow t = 9.48\,\text{sec}$

28. In the frame of river, the float remains stationary, the speed of swimmer w.r.to river is v_{re}

Time taken by the swimmer to return the float position is $t = 2 + 2 = 4hr$

In this time, the float moves 15 km in the frame of ground (d=15km)

$\therefore$ the river flow velocity of float in the frame of ground $v_r = \frac{d}{t} = \frac{15}{4} = 3.75km/h$

29. $x = 4t^2$

$v = \frac{dx}{dt} = 8t$

At $t = 5\,\text{sec}$

$v = 8 \times 5 = 40m/s$

30. $(i)\, u_1 = 20m/a, s_1 = 500m, v_1 = 0$

$v_1^2 - u_1^2 = 2as_1 \Rightarrow a = \frac{4}{10} m/s^2$

$(ii)\, u_2 = 20m/s, s_2 = 250m, v_2 = ?$

$a = \frac{4}{10} m/s^2$

$v_2^2 - u_2^2 = 2as_2 \Rightarrow v_2\sqrt{200}m/s$

$x = 200$