1. A ship moves along the equator to the east with a speed 30 km/h. Southeastern wind blows 60° to the east with 15 kmh^{-1}. Find the wind velocity relative to the ship.
(a) 39.7 kmh^{-1}, $\tan^{-1}1/5$ N of W
(b) 23.7 kmh^{-1}, $\tan^{-1}1/3$ N of W
(c) 37.5 $klmh^{-1}$, $\tan^{-1} 1/5$ N of E
(b) None of these

2. A person is standing on a truck moving with 14.7 ms^{-1} on a horizontal road. He throws a ball so that it returns to him when the truck has moved 58.8 m. Find the speed of the ball and angle of projection as seen by a man standing on the road.
(a) 22.5 ms^{-1}, 53^0 (b) 24.5 ms^{-1}, 53^0
(c) 19.6 ms^{-1}, vertical (d) None of these

3. Six person are situated at the corners of a hexagon of side l. They move at a constant speed v. Each person maintains a direction towards the person at the next corner. When will the person meet?
(a) l/v (b) 2l/3v (c) 3l/2v (d) 2l/v.

4. The compass needle of the airplane shows it is heading due North and speedmeter indicates a velocity 240 kmh^{-1}. Wind is blowing 100 kmh^{-1} due east. Find the velocity of airplane with respect to earth.
(a) 260 ms^{-1}, 23^0 E of N (b) 260 ms^{-1}, 23^0 W of N
(c) 260 ms^{-1}, 32^0 E of N (d) None

5. A car accelerates from rest at a constant rate a for some time after which it decelerates at a constant rate β to come to rest. If the total time elapsed is t, the maximum velocity acquired by the car is given by
(a) $\left(\frac{\alpha^2+\beta^2}{\alpha\beta}\right)t$ (b) $\left(\frac{\alpha^2-\beta^2}{\alpha\beta}\right)t$
(c) $\left(\frac{\alpha+\beta}{\alpha\beta}\right)t$ (d) $\left(\frac{\alpha\beta}{\alpha+\beta}\right)t$

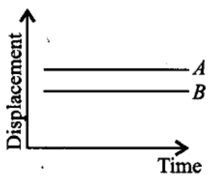
6. In question number 9, the average velocity of the object between t = 2 s and t = 4 s is
(a) 5 m s^{-1} (b) 10 m s^{-1} (c) 15 m s^{-1} (d) 20 m s^{-1}

7. A cyclist moving on a circular track of radius 40 m completes half a revolution in 40 s. Its average velocity is
(a) Zero (b) $4\pi \, m\,s^{-1}$ (c) 2 m s^{-1} (d) $8\pi \, m\,s^{-1}$

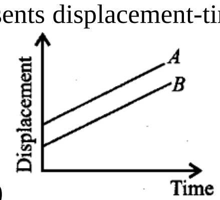
8. For the one-dimensional motion, described by $X = t - \sin t$
(a) x(t) > 0 for all t > 0 (b) v(t) > 0 for all t > 0
(c) a(t) > 0 for all t > 0 (d) All of these

9. Stopping distance of a moving vehicle is directly proportional to
(a) Square of the initial velocity
(b) Square of the initial acceleration
(c) The initial velocity
(d) The initial acceleration

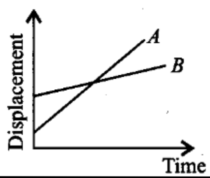
10. Which one of the following represents displacement-time graph of two objects A and B moving with zero relative velocity?



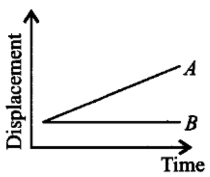
(a)



(b)



(c)



(d)

11. A man is standing on top of a building 100 m high. He throws two balls vertically, one at t = 0 and other after a time interval (less than 2 s). The later ball is thrown at a velocity of half the first. The vertical gap between first and second ball is 15 m at t = 2 s. The gap is found to remain constant. The velocities with which the balls were thrown are (Take g = 10 m s^{-2})
(a) 20 m s^{-1}, 10 m s^{-1} (b) 10 m s^{-1}, 5 m s^{-1}
(c) 16 m s^{-1}, 8 m s^{-1} (d) 30 m s^{-1}, 15 m s^{-1}

12. A bird is tossing (flying to and fro) between two cars moving towards each other on a straight road. One car has speed of 27 km h^{-1} while the other has the speed of 18 km h^{-1}. The bird starts moving from first car towards the other and is moving with the speed of 36 km h^{-1} when the two cars separated by 36 km. The total distance covered by the bird is
(a) 28.8 km (b) 38.8 km (c) 48.8 km (d) 58.8 km

13. Two towns A and B are connected by a regular bus service with a bus leaving in either direction every T minutes. A man cycling with a speed of 20 km h^{-1} in the direction A to B notices that a bus goes post him every 18 min in the direction of his motion, and every 6 min in the opposite direction. The period T of the bus service is
(a) 4.5 min (b) 9 min (c) 12 min (d) 24 min

14. A jet airplane travelling at the speed of 500 km h^{-1} ejects its products of combustion at the speed of 1500 km h^{-1} relative to the jet plane. The speed of the products of combustion with respect to an observer on the ground is
(a) 500 km h^{-1} (b) 1000 km h^{-1}
(c) 1500 km h^{-1} (d) 2000 km h^{-1}

15. A police van moving on a highway with a speed of 30 km h^{-1} fires a bullet at a thief's car speeding away in the same direction with a speed of 192 km h^{-1}. If the muzzle speed of the bullet is 150 km h^{-1}, with what speed does the bullet hit the thief's car?
(a) 95 m s^{-1} (b) 105 m s^{-1} (c) 115 m s^{-1} (d) 125 m s^{-1}

16. Two cars A and B are running at velocities of 60 km h^{-1} and 45 km h^{-1}. What is the relative velocity of car A with respect to car B, if both are moving eastward?
(a) 15 km h^{-1} (b) 45 km h^{-1}
(c) 60 km h^{-1} (d) 105 km h^{-1}

17. In the above que., what is the relative velocity of a car A with respect to car B, if car A is moving eastward and car B is moving westward?
(a) 15 km h^{-1} (b) 45 km h^{-1}
(c) 60 km h^{-1} (d) 105 km h^{-1}

18. On a two-lane road, car A is travelling with a speed of 36 km h^{-1}. Two cars B and c approach car A in opposite directions with a speed of 54 km h^{-1} each. At a certain instant, when the distance AB is equal to AC, both being 1 km, B decides to overtake A before C does. The minimum required acceleration of car B to avoid an accident is
(a) 1 m s^{-2} (b) 1.5 m s^{-2} (c) 2 m s^{-2} (d) 3 m s^{-2}

19. A bus is moving with a speed of 10 m s^{-1} on a straight road. A scooterist wishes to overtake the bus in 100 s. If the bus is at a distance of 1 km from the scooterist with what speed should the scooterist chase the bus?
(a) 40 m s^{-1} (b) 25 m s^{-1} (c) 10 m s^{-1} (d) 20 m s^{-1}

20. 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
(a) u (b) $u-2gt$ (c) $\sqrt{u^2-2gh}$ (d) $u-gt$

21. A student is standing at a distance of 50metres from the bus. As soon as the bus starts its motion with an acceleration of $1ms^{-2}$, the student starts running towards the bus with a uniform velocity u. Assuming the motion to be along a straight road, the minimum value of u, so that the students is able to catch the bus is
(a) 5 ms^{-1} (b) 8 ms^{-1} (c) 10 ms^{-1} (d) 12 ms^{-1}

22. A car, moving with a speed of 50 km/hr, can be stopped by brakes after at least 6m. If the same car is moving at a speed of 100 km/hr, the minimum stopping distance is
(a) 6m (b) 12m (c) 18m (d) 24m

23. A 120 *m* long train is moving in a direction with speed 20 *m/s*. A train *B* moving with 30 *m/s* in the opposite direction and 130 *m* long crosses the first train in a time

(a) 6 *s* (b) 36 *s*
(c) 38 *s* (d) None of these

24. A 210 meter long train is moving due North at a of 25*m/s*. A small bird is flying due South a little above the train with speed 5*m/s*. The time taken by the bird to cross the train is

(a) 6*s* (b) 7*s*
(c) 9*s* (d) 10 *s*

25. A police jeep is chasing with, velocity of 45 *km/h* a thief in another jeep moving with velocity 153 *km/h*. Police fires a bullet with muzzle velocity of 180 *m/s*. The velocity it will strike the car of the thief is

(a) 150 *m/s* (b) 27 *m/s*
(c) 450 *m/s* (d) 250 *m/s*

26. A train of 150 *meter* length is going towards north direction at a speed of $10 m/\sec$. A parrot flies at the speed of $5\ m/\sec$ towards south direction parallel to the railway track. The time taken by the parrot to cross the train is

(a) 12 *sec* (b) 8 *sec*
(c) 15 *sec* (d) 10 *sec*

27. The distance between two particles is decreasing at the rate of 6 *m/sec*. If these particles travel with same speeds and in the same direction, then the separation increase at the rate of 4 *m/sec*. The particles have speeds as

(a) 5 *m/sec* ; 1 *m/sec* (b) 4 *m/sec* ; 1 *m/sec*
(c) 4 *m/sec* ; 2 *m/sec* (d) 5 *m/sec* ; 2 *m/sec*

28. A boat moves with a speed of 5 *km/h* relative to water in a river flowing with a speed of 3 *km/h* and having a width of 1 *km*. The minimum time taken around a round trip is

(a) 5 min (b) 60 min
(c) 20 min (d) 30 min

29. A river is flowing from W to E with a speed of 5 *m/min*. A man can swim in still water with a velocity 10 *m/min*. In which direction should the man swim so as to take the shortest possible path to go to the south.

(a) 30° with downstream (b) 60° with downstream
(c) 120° with downstream (d) South

30. A train is moving towards east and a car is along north, both with same speed. The observed direction of car to the passenger in the train is

(a) East-north direction (b) West-north direction
(c) South-east direction (d) None of these

1. (a)

$v_{ws} = v_w - v_s$

$= (15 \cos 60\hat{i} + 15 \sin 60\hat{j}) - 30\hat{i}$

$|v| = \sqrt{(39.5)^2 + (7.5)^2} = 39.7 \text{ kmh}^{-1}$

$\tan\beta = 7.5/37.8 = 1/5$

$\beta = \tan^{-1} 1/5$ North of West.

2. (b)

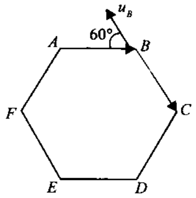
$T = \frac{58.8}{14.7} = 4s$

$T = \frac{2u_y}{g} = 4 \therefore u_y = 19.6 \text{ ms}^{-1}$

$v = \sqrt{14.7^2 + 19.6^2} = 24.5 \text{ ms}^{-1}$

$\tan\beta = \frac{v_y}{v_x} = \frac{19.6}{14.7} = \frac{4}{3}$ or $\beta = 53^0$ wrt horizontal.

3. (d)



$t = \frac{1}{v_{AB}} = \frac{1}{v_A - v_B \text{ in the direction of A}}$

$= \frac{1}{v - v\cos 60} = \frac{2l}{v}$

4. (a)

$v_{AE} = 100\hat{i} + 240\hat{j}$

$v_{AE} = \sqrt{(240)^2 + 100^2} = 260\text{ms}^{-1};$

$\phi = \tan^{-1}(100/240) = 23^0$ E of N.

5. (d)

Using, $v = u + at_1$, we get,

$t_1 = \frac{v}{\alpha}$ ($\because u = 0$)

for retarded motion,

$0 = v - \beta/2$ or $t_2 = v/\beta$

Total time $t = t_1 + t_2 = \frac{v}{\alpha} + \frac{v}{\beta}$

$= v\left(\frac{\alpha+\beta}{\alpha\beta}\right)$ or $u = \left(\frac{\alpha\beta}{\alpha+\beta}\right)t$

6. (c) Average velocity, $\bar{v} = \frac{(x)_{t=4} - (x)_{t=2}}{4-2}$

$\bar{v} = \frac{(a + b(4)^2) - (a + b(2)^2)}{4-2} = \frac{(a+16b)-(a+4b)}{4-2} = 6b = 6(2.5)\text{ms}^{-1} = 15\text{ms}^{-1}$

7. (c) Average velocity

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

8. (a) x = t – sin t

$$v = \frac{dx}{dt} = 1 - \cos t$$

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

$\therefore$ x (t) > 0 for all values of t > 0 and v (t) can be zero for one value of t. a (t) can zero for one value of t.

9. (a) Let d, is the distance travelled by the vehicle before it stops.

Here, final velocity v = 0, initial velocity = u, S = d, Using equations of motions

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

$$\therefore (0)^2 = u^2 + 2ad,$$

$$d_s = \frac{u^2}{2a}$$

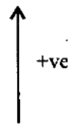
$$d_s \propto u^2$$

10. (b) When velocity of A = velocity o B, then, relative velocity is zero.

$\therefore$ Displacement – time graphs of A and B must have same slope (other than zero)

11. (a) For first stone. Taking the vertical upwards motions of the first stone up to highest point

Here , $u = u_1, v = 0$ (At highest point velocity is zero)



$$a = -g, S = h_1$$

$$\therefore (0)^2 - u_1^2 = 2(-g)h_1$$

$$h_1 = \frac{u_1^2}{2g}$$

Or …… (1)

For second stone. Taking the vertical upwards motions of the second stone up to highest point

Here, $u = u_2, v = 0, a = -g, S = h_2$

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

$$\therefore (0)^2 - u_2^2 2(-g)h_2$$

$$h_2 = \frac{u_2^2}{2g} \quad \text{……… (ii)}$$

As per questions

$$h_1 - h_2 = 15m, u_2 = \frac{u_1}{2}$$

Subtract (i) From (ii), we get

$$h_1 - h_2 = \frac{u_1^2}{2g} - \frac{u_2^2}{2g}$$

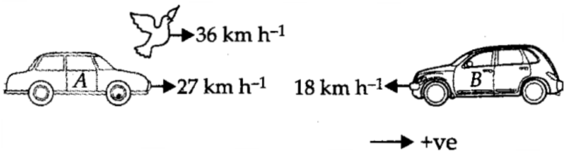
On substituting the given information, we get

$$15 = \frac{u_1^2}{2g} - \frac{u_1^2}{8g} = \frac{3u_1^2}{8g}$$

Or $u_1^2 = \frac{15 \times 8g}{3} = \frac{15 \times 8 \times 10}{3} = 400$

Or $u_1 = 20ms^{-1}$ and $u_2 = \frac{u_1}{2} = 10ms^{-1}$

12. (a)



Velocity of car A, $V_A = +27km\,h^{-1}$

Velocity of car B $V_B = -18km\,h^{-1}$

Relative velocity of car A with respect to car B

$= V_A - V_B = +27km\,h^{-1} - (-18km\,h - 1)$

$= 45km\,h^{-1}$

Time taken by the two cars to meat

$= \frac{36km}{45km\,h^{-1}} 0.8h$

Thus, distance covered by the bird

$= 36km\,h^{-1} \times 0.8h = 28.8km$

13. (b) Let v $km\,h^{-1}$ be the constant speed with which the buses ply between the towns A and B.

Relative velocity of the bus from A to B with respect to the cyclist

= (v – 20) km h^{-1}

Relative velocity of the bust form B to A with respect to the cyclist

= (v + 20) km h^{-1}

Distance travel by the bus in time T (minutes) = Vt

As per questions

$\frac{vT}{v-20} = 18$

Or vT = 18v - 18 × 20 …….(i)

And $\frac{vT}{v+20} = 6$

Or vT = 6v+ 20 × 6 ……..(ii)

Equating (i) and (ii), we get

18v – 18 × 20 = 6v + 20 × 6

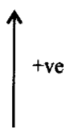
Or 12v = 20 × 6 + 18 × 20 = 480 or v = 40 km h^{-1}

Putting this value of v in (i), we get

40T = 18 × 40 – 18 × 20 = 18 × 20

Or $T = \frac{18 \times 20}{40} = 9\,min$

14. (b) Velocity of jet plane w.r.t. ground $V_{JG} = 500km\,h^{-1}$



Velocity of products of combustions w.r.t. jet plane $V_{CJ} = -1500km\,h^{-1}$

$\therefore$ Velocity of products of combustions w.r.t. ground is $V_{CG} = V_{CJ} + V_{JG} = 1500km\,h^{-1} + 500km\,h^{-1} = -1000km\,h^{-1}$

- ve sing shows that the direction of products of combustion is opposite to that of the plane.

$\therefore$ Speed of the products of combustions w.r.t. ground = $1000km\,h^{-1}$.

15. (b) Speed of police van w.r.t. ground $V_{PG} = 30 km h^{-1}$ Speed of thief's Car w.r.t. ground $V_{TG} = 192 km h^{-1}$ Speed of bullet w.r.t. police van

$$V_{BP} = 150 ms^{-1} = 150 \times \frac{18}{5} km h^{-1} = 540 km h^{-1}$$

Speed with which the bullet will hit the thier's car will be

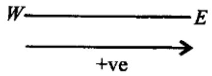
$$V_{BT} = V_{BG} + V_{GT} = V_{BP} + V_{PG} + V_{GT} = 540 km h^{-1} + 30 km h^{-1} - 192 km h^{-1}$$

$$(\because V_{GT} = -V_{TG})$$

$$378 km h^{-1} = 378 \times \frac{5}{18} ms^{-1}$$

$$= 105 ms^{-1}$$

16. (a)



Velocity of car A w.r.t. ground $V_{AG} = 60 km h^{-1}$

Velocity of car B w.r.t. ground $V_{BG} = 45 km h^{-1}$

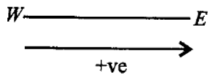
Relative velocity of car A w.r.t. B

$$V_{AB} = V_{AG} + V_{GB}$$

$$= V_{AG} - V_{BG} \qquad (\because V_{GB} = -V_{BG})$$

$$= 60 km h^{-1} - 45 km h^{-1} = 15 km h^{-1}$$

17. (d)



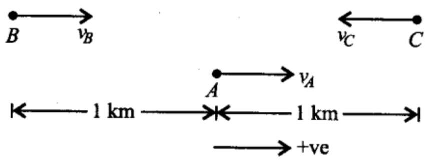
Velocity of car A w.r.t. ground $V_{AG} = 60 km h^{-1}$

Velocity of car B w.r.t. ground $V_{AG} = -45 km h^{-1}$

Relative velocity of car A w.r.t. car B is

$$V_{AB} = V_{AG} + V_{GB} = V_{AG} - V_{BG} \qquad (\because V_{GB} = -V_{BG}) = 60 km h^{-1} - (-45 km h^{-1}) = 150 km h^{-1}$$

18.



Velocity of car A,

$$V_A = 36 km h^{-1} = 36 \times \frac{5}{18} m s^{-1} = 10 ms^{-1}$$

Velocity of car B,

$$V_B = 54 km h^{-1} = 54 \times \frac{5}{18} m s^{-1} = 15 m s^{-1}$$

Velocity of car C,

$$V_C = -54 km h^{-1} = -54 \times \frac{5}{18} m s^{-1} = -15 m s^{-1}$$

Relative velocity of car B w.r.t. car A

$$V_{BA} = V_B - V_A = 15 ms^{-1} - 10 ms^{-1} = 5 ms^{-1}$$

Relative velocity of car C w.r.t. car A is

$$V_{CA} = V_C - V_A = -15 ms^{-1} - 10 ms^{-1} = -25 ms^{-1}$$

At a certain instant, both cars B and C are at the same distance form car A
i.e., AB = BC = 1 lm = 1000m

The taken by car C to cover 1 km to reach car a $= \frac{1000m}{25ms^{-1}} = 40s$

In order to avoid an accident, the car B accelerates such that it overtakes car A in less than 40s. Let the minimum required accelerations be a. Then,

$u = 5ms^{-1}$, t = 40s, S = 1000 m, a = ?

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

$\therefore 1000 = 5 \times 40 + \frac{1}{2} \times a \times 40^2$

800a = 1000 – 200 = 800 or a = 1 ms^{-2}

19. (d) Let v_s be the velocity of scooter. The distance between the scooter and the bus = 1 km = 1000 m.

The velocity of bus, $v_b = 10ms^{-1}$

Time taken to overtake the bust, t = 100s.

Relative velocity of the scooter w.r.t. the bus =

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

20. (a) Taking upwards motions of ball A for time t, its velocity is $v_A = u - gt$.

Taking downwards motions of ball B for time t, its velocity is $v_B = gt$.

$\therefore$ Relative velocity of A w.r.t. B

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

21. **(c)**

Let student will catch the bus after t *sec*. So it will cover distance *ut*. Similarly distance travelled by the bus will be $\frac{1}{2}at^2$ for the given condition

$ut = 50 + \frac{1}{2}at^2 = 50 + \frac{t^2}{2}$

$\Rightarrow u = \frac{50}{t} + \frac{t}{2}$ (As $a = 1 m/s^2$)

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

so we get $t = 10$ *sec* then $u = 10$ *m/s.*

22. **(d)**

$v^2 = u^2 - 2as \Rightarrow 0 = u^2 - 2as \Rightarrow s = \frac{u^2}{2a} \Rightarrow s \propto u^2$

(As a = constant)

$\frac{s_2}{s_1} = \left(\frac{u_2}{u_1}\right)^2 = \left(\frac{100}{50}\right)^2 \Rightarrow s_2 = 4s_1 = 4 \times 12 = 24\ m.$

23. (d) Total distance $= 130 + 120 = 250\ m$

Relative velocity $= 30 - (-20) = 50\ m/s$

Hence $t = 250/50 = 5s$

24. (b) Relative velocity of bird *w.r.t* train $= 25 + 5 = 30\ m/s$

time taken by the bird to cross the train $t = \frac{210}{30} = 7\ sec$

25. (a) Effective speed of the bullet
= speed of bullet + speed of police jeep
$= 180\ m/s + 45\ km/h = (180 + 12.5)\,m/s = 192.5\ m/s$

Speed of thief 's jeep $= 153\,km/h = 42.5\,m/s$

Velocity of bullet *w.r.t* thief 's car $= 192.5 - 42.5$ $= 150\,m/s$

26. (d) Relative velocity
$= 10 + 5 = 15\ m/sec$

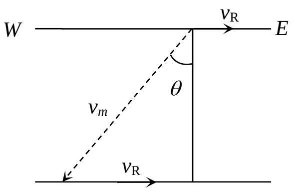
$\therefore\ t = \frac{150}{15} = 10\ sec$

27. (a) When two particles moves towards each other then $v_1 + v_2 = 6$ ...(i)
When these particles moves in the same direction then $v_1 - v_2 = 4$ ...(ii)
By solving $v_1 = 5$ and $v_2 = 1\ m/s$

28. (d) For the round trip he should cross perpendicular to the river $\therefore$ Time for trip to that side $= \frac{1km}{4km/hr} = 0.25\,hr$

To come back, again he take 0.25 *hr* to cross the river.
Total time is 30 min, he goes to the other bank and come back at the same point.

29. (c) For shortest possible path man should swim with an angle (90+θ) with downstream.



From the fig,

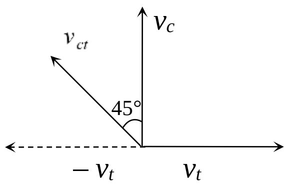
$\sin\theta = \frac{v_r}{v_m} = \frac{5}{10} = \frac{1}{2}$

$\Rightarrow\ \therefore\ \theta = 30°$

So angle with downstream = $90° + 30° = 120°$

30. (b) $\vec{v}_{ct} = \vec{v}_c - \vec{v}_t$

$\vec{v}_{ct} = \vec{v}_c + (-\vec{v}_t)$



Velocity of car *w.r.t.* train (v_{ct}) is towards West – North