TOPIC: MOTION IN A PLANE

1. Three vectors each of $\bar{a}$ acting at a point simultaneously are represented by the closed triangle in the same order. If one of the vectors is reversed in order, the magnitude of their resultant vector is
   1) a 2) 2a 3) 3a 4) zero
2. Three vectors are given as $\bar{P}=3\hat{i}-4\hat{j}, \bar{Q}=6\hat{i}-8\hat{j}$ and $\hat{R}=\frac{3}{4}\hat{i}-\hat{j},$ the correct statement is
   1) $\bar{P},\bar{Q}$ and $\bar{R}$ are equal vectors
   2) $\bar{P}$ and $\bar{Q}$ are parallel but R is not parallel
   3) $\bar{P},\bar{Q}$ and $\bar{R}$ are parallel
   4) R is the resultant of $\bar{P}$ and $\bar{Q}$
3. Two vectors $\bar{A}$ and $\bar{B}$ have equal magnitudes. The magnitude of $(\bar{A}+\bar{B})$ is 'n' times the magnitude of $(\bar{A}-\bar{B})$. The angle between $\bar{A}$ and $\bar{B}$ is
   1) $\sin^{-1}\left[\frac{n^2-1}{n^2+1}\right]$ 2) $\sin^{-1}\left[\frac{n-1}{n+1}\right]$ 3) $\cos^{-1}\left[\frac{n^2-1}{n^2+1}\right]$ 4) $\cos^{-1}\left[\frac{n-1}{n+1}\right]$
4. If the magnitudes of $\bar{A},\bar{B}$ and $\bar{C}$ are 12,5 and 13 units respectively and $\bar{A}+\bar{B}=\bar{C},$ then the angle between $\bar{A}$ and $\bar{B}$ is
   1) 0 2) $\pi/2$ 3) π 4) $\pi/4$
5. Two vectors $\bar{A}$ and $\bar{B}$ are inclined at an angle 'θ' and $\bar{R}$ is their resultant keeping the magnitudes and angle between the vectors same, if the direction of $\bar{A}$ and $\bar{B}$ is inter changed, then there is a change with regard R in
   1) Magnitude
   2) Direction
   3) Both magnitude and direction
   4) None of the above
6. Rain is falling vertically with a speed of $35ms^{-1}$. A woman rides a bicycle with a speed of $12ms^{-1}$ in east to west direction. The direction in which she would hold her umbrella is
   1) at $\cos^{-1}(0.343)$ with vertical towards east
   2) at $\tan^{-1}(0.343)$ with vertical towards west
   3) at $\cos^{-1}(0.343)$ with vertical towards west
   4) at $\tan^{-1}(0.343)$ with vertical towards east
7. Buses A and B are moving with velocities $20\hat{i}\ m/s$ and $15\hat{i}\ m/s$ respectively. Then, relative velocity of A w.r.t. B is
   1) $5\hat{i}\ m/s$ 2) $5\hat{j}\ m/s$ 3) $-5\hat{i}\ m/s$ 4) $-5\hat{j}\ m/s$
8. A river is flowing from west to east at a speed of $5m/s$. A man on the South bank of the river, capable to swim at $10m/s$ in still water, wants to swim at $10m/s$ in still water, wants to swim across the river in shortest time. He should swim in a direction
   1) due north 2) 30^0 east of north 3) 30^0 west of north 4) 60^0 east of north

9. Person aiming to reach the exactly opposite point on the bank of a stream is swimming with a speed of 0.5m/s. at an angle of 120^0 with the direction of flow of water, the speed of water in the stream is
1) 1m/s 2) 0.67m/s 3) 0.433m/s 4) 0.25m/s

10. A man moves on a cycle with a velocity of 4Kmph the rain appears to fall on him with a velocity of 3Kmph vertically. The actual velocity of the rain is
1) 7Kmph 2) 5Kmph 3) $\frac{4}{3}$ Kmph 4) $\frac{3}{4}$ Kmph

11. A ball is projected with velocity $10ms^{-1}$ in a direction making an angle 30^0 with the horizontal, what is the position coordinate (in metres) of the ball after 1s?
1) (8.66,0.1) 2) (9.8,1.0) 3) 4.26,5.29) 4) (0.4,8.66)

12. A projectile is given an initial velocity of $(\hat{i}+2\hat{j})ms^{-1}$ where $\hat{i}$ is along the ground and $\hat{j}$ is along vertical. If $g=10ms^{-2}$, the equation of its trajectory is
1) $y=x-5x^2$ 2) $y=2x-5x^2$ 3) $4y=2x-5x^2$ 4) $4y=2x-25x^2$

13. At what angle with the horizontal should a ball be thrown so that its range 'R' is related to the time flight as $R=5T^2$ take $g=10m/s^2$
1) 30^0 2) 45^0 3) 60^0 4) 90^0

14. A ball is thrown with a velocity of 20m/s making an angle 30^0 with the horizontal. Its velocity vector will be normal to its initial velocity vector after a time interval of $\left[g=10m/s^2\right]$
1) 4S 2) 1S 3) 1.5S 4) 0.25S

15. The path of projectile is given by the equation $y=\sqrt{3}x-0.8x^2$. its velocity of projection is $\left[g=10m/s^2\right]$
1) 5m/s 2) 2.5m/s 3) 7.5m/s 4) 4m/s

16. A ball is projected upwards from the top of a tower with a velocity 50m/s making an angle 30^0 with the horizontal. The height of the tower is 70m. after how many seconds from the instant of throwing will the ball reach the ground?
1) 2s 2) 5s 3) 7s 4) 9s

17. The x and y - coordinates of the particle at any time are $x=5t-2t^2$ and $y=10t$ respectively, where x and y are in metres and t in seconds. The acceleration of the particle at $t=2s$ is
1) 0 2) $5ms^{-2}$ 3) $-4ms^{-2}$ 4) $-8ms^{-2}$

18. Rain is falling vertically with a speed of $5ms^{-1}$. Winds starts blowing after sometime with a speed of $12ms^{-1}$ in east to west direction. In which direction from vertical should boy waiting at a bus stop hold his umbrella?
1) $\tan^{-1}(0.45)$, west 2) $\tan^{-1}(0.343)$, west
3) $\tan^{-1}(2.4)$ west 4) $\tan^{-1}(0.24)$, east

19. The position of a particle is given by $r=3t\hat{i}+2t^2\hat{j}+5\hat{k}$, then the direction of $v(t)$ at $t=1s$ in
1) 45^0 with X-axis 2) 63^0 with Y-axis
3) 30^0 with Y-axis 4) 53^0 with X-axis

20.` Two stones were projected simultaneously in the same vertical plane from same point obliquely, with different speeds and angles with the horizontal. The trajectory of path followed by one, as seen by the other, is
1) parabola 2) straight line 3) circle 4) hyperbola

21. A car driver is moving towards a fired rocket with a velocity of 8m/s. He observed the rocket to be moving with a speed of 10m/s. A stationary observer will see the rocket to be moving with a speed in m/s is

22. A man standing on a road has to hold his umbrella at 30^0 with the vertical to keep the rain away. He throws the umbrella and starts running at 10 kmh^{-1}. He finds that rain drops are hitting his head vertically. The actual speed of raindrops in kmph is

23. A girl can swim with speed $5kmh^{-1}$ in still water. She crosses a river 2km wide, where the river flows steadily at $2kmh^{-1}$ and she makes strokes normal to the river current. Find how far down the river she go when she reaches the other bank in metre is

24. The speed of a boat is 5Kmph in still water. If it crosses a river of width 1 km along the shortest possible path in 15 minutes. Then velocity of the river in Kmph is

25. To a person going east in a car with a velocity of 25 Kmph a train appears to move towards north of 25 Kmph a train appears to move towards north with a velocity of $25\sqrt{3}$ Kmph. The actual velocity of the train will be in Kmph

26. The equations of motion of a projectile are given by $x = 18t$ and $2y = 54t - 9.8t^2$. The angle θ of projection is $\text{Tan}^{-1}(x)$. The value of x is

27. The path of projectile is given by the equation $y = x - 0.1x^2$. its time of flight is $\left[g = 10m/s^2 \right]$

28. A ball is projected from the top of a tower with a velocity $\hat{i} + 2\hat{j} + 5\hat{k}\, m/s$, where $\hat{i}, \hat{j}$ and $\hat{k}$ are unit vectors along east, north and vertically upwards respectively. If the height of the tower is 30m, its time of flight in sec is $(g = 10m/s^2)$

29. A particle is projected from the ground with an initial velocity $\sqrt{7}\, m/s$ at an angle 60^0 with horizontal. The average velocity of the pariticle if it reaches the maximum height is

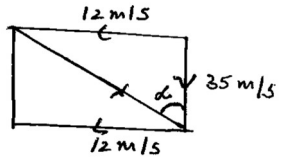
30. A particle is moving such that its position coordinates (x, y) are $(2m, 3m)$ at $t = 0\,s$, $(6m, 7m)$ at times $2s$ and $(13m, 14m)$ at time $t = 5s$. Average velocity vector (v_{av}) from $t = 0s$ to $t = 5\,s$ is $x(\bar{i} + \bar{j})$. The value of x is

Physics-key

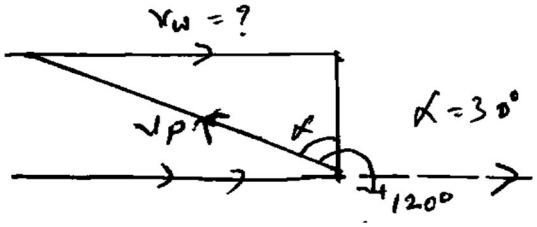
1-10	2	3	3	2	2	2	1	1	4	2
11-20	1	2	2	1	1	3	3	3	4	2
21-30	6	20	800	3	50	2	1	3	2	2

PHYSICS HINTS

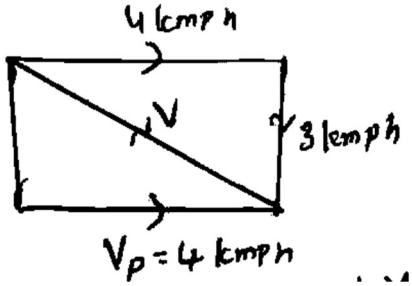
1. Conceptual (Triangle of vectors)
2. $slope = \tan\theta = \dfrac{y - co-ordinate}{x - co-ordinate}$
3. $\left|\bar{A} + \bar{B}\right| = n\left|\bar{A} - \bar{B}\right|$

   $\left[A^2 + B^2 + 2AB\cos\theta \right] = n^2\left[A^2 + B^2 - 2AB\cos\theta \right]$
4. 12,5 and 13 dimensions of right angle triangle (triangle law of vectors)
5. Conceptual
6. 

   $\text{Tan}\,\alpha = \dfrac{12}{35}$
7. $\bar{v}_{AB} = \bar{v}_A - \bar{v}_B$
8. To reach the north bank within the shortest time, the man tries to swim normal to the direction of flow of water.

9. 

$$\text{Sin}\,30^0 = \frac{V_w}{V_p}$$

10. 

11. v-at actual velocity

$$S_x = x\cos\theta \times t$$

$$\therefore S_y = u\sin\theta.t - \frac{1}{2}gt^2$$

$$S_y = u\sin\theta \times t - \frac{1}{2}gt^2$$

12. $$y = \tan\theta.x - \frac{g}{2u^2\cos^2\theta}.x^2$$

13. $$\frac{u^2\sin 2\theta}{g} = 5\left[\frac{2u\sin\theta}{g}\right]^2$$

Find the value of 'θ'

14. Time interval $(t) = \dfrac{g}{u\sin\theta}$

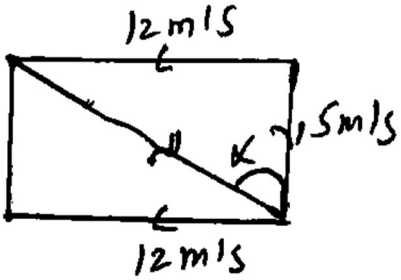
15. $$u = \sqrt{\frac{g(1+A^2)}{2B}} \therefore y = Ax - Bx^2$$

16. $$h = -u_y t + \frac{1}{2}gt^2$$

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

$$u_y = u\sin\theta$$

17. $$a_x = \frac{d^2x}{dt^2} \text{ and } a_y = \frac{d^2y}{dt^2}$$

18. 

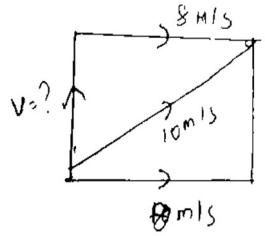
$$\text{Tan}\,\alpha = \frac{12}{5}; \alpha = \text{Tan}^{-1}(2.4)$$

19. $$V(t) = \frac{dr}{dt} = 3\bar{i} + 4t\bar{j} + 0.\bar{k}$$

At $t = 1s, v(t) = 3\bar{i} + 4\bar{j}$

$\text{Tan}\,\alpha = \dfrac{4}{3}; \alpha = 53^0$ with x-axis

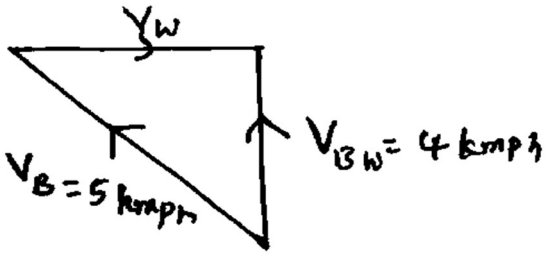
20. Both stones are in relative motion in mutually perpendicular directions

21. 

$$v = \sqrt{10^2 - 8^2} = 6m/s$$

22. $$\text{Sin}\,30^0 = \frac{velocity\ of\ the\ person}{actual\ velocity\ of\ rain}$$

23. $$shift = velocity\ of\ water \times short\ time$$
$$= Vw \times \frac{d}{V_G}$$

24. 

$$V_{Bw} = \frac{1}{15/60} = \frac{60}{15} = 4kmph$$

25. $$V_p = 25Kmph;$$
$$V_R = 25\sqrt{3}Kmph;$$
$$V_{actual} = \sqrt{25^2 + (25\sqrt{3})^2} = 50Kmph$$

26. $$x = u\cos\theta \times t = 18t$$
$$y = u\sin\theta.t - \frac{1}{2}gt^2 = \frac{54}{2}t - \frac{1}{2}\times 9.8 \times t^2$$
$$\text{Tan}\,\theta = \frac{27}{18} = \frac{3}{2}$$

27. $$T = \sqrt{\frac{2A^2}{Bg}}$$
$$y = Ax - Bx^2 = x - 0.1x^2$$

28. $$h = -ut + \frac{1}{2}gt^2$$
$$u = u_g = 5m/s$$
$$h = 70m$$

29. $$Vave = \frac{u}{2}\sqrt{1 + 3\cos^2\theta}$$

30. $$Vave = \frac{displacement}{total\ time\ taken}$$
$$Vx = \frac{13-2}{5} = \frac{11}{5}\hat{i}$$
$$Vy = \frac{14-3}{5} = \frac{11}{5}\bar{j}$$