Motion in a Plane

1. A particle has an initial velocity of $3\hat{i}+4\hat{j}$ and an acceleration of $0.4\hat{i}+0.3\hat{j}$. Its speed after 10 s is **[AIEEE-2009]**

(1) $7\sqrt{2}$ units (2) 7 units

(3) 8.5 units (4) 10 units

2. A particle is moving with velocity $\vec{v}=K\left(y\hat{i}+x\hat{j}\right)$, where K is a constant. The general equation for its path is **[AIEEE-2010]**

(1) $y^2 = x^2$ + constant (2) $y = x^2$ + constant

(3) $y^2 = x$ + constant (4) xy = constant

3. For a particle in uniform circular motion, the acceleration $\vec{a}$ at a point $P(R, \theta)$ on the circle of radius R is (Here θ is measured from the x-axis) **[AIEEE-2010]**

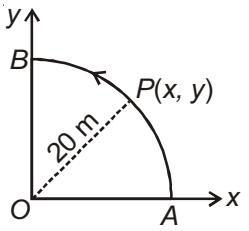
(1) $\frac{v^2}{R}\hat{i}+\frac{v^2}{R}\hat{j}$

(2) $-\frac{v^2}{R}\cos\theta\hat{i}+\frac{v^2}{R}\sin\theta\hat{j}$

(3) $-\frac{v^2}{R}\sin\theta\hat{i}+\frac{v^2}{R}\cos\theta\hat{j}$

(4) $-\frac{v^2}{R}\cos\theta\hat{i}-\frac{v^2}{R}\sin\theta\hat{j}$

4. A point P moves in counter-clockwise direction on a circular path as shown in the figure. The movement of P is such that it sweeps out a length $s = t^3 + 5$, where s is in metres and t is in seconds. The radius of the path is 20 m. The acceleration of P when $t = 2$ s is nearly **[AIEEE-2010]**



(1) 14 m/s^2 (2) 13 m/s^2

(3) 12 m/s^2 (4) 7.2 m/s^2

5. A boy can throw a stone up to a maximum height of 10 m. The maximum horizontal distance that the boy can throw the same stone up to will be **[AIEEE-2012]**

(1) 10 m (2) $10\sqrt{2}$ m

(3) 20 m (4) $20\sqrt{2}$ m

6. A projectile is given an initial velocity of $(\hat{i}+2\hat{j})$m/s where $\hat{i}$ is along the ground and $\hat{j}$ is along the vertical. If g = 10 m/s^2, the equation of its trajectory is **[JEE (Main)-2013]**

(1) $y = x - 5x^2$ (2) $y = 2x - 5x^2$

(3) $4y = 2x - 5x^2$ (4) $4y = 2x - 25x^2$

7. A particle is moving with a velocity $\vec{v}=K\left(y\hat{i}+x\hat{j}\right)$, where K is a constant. The general equation for its path is **[JEE (Main)-2019]**

(1) $y^2 = x$ + constant (2) $y = x^2$ + constant

(3) $y^2 = x^2$ + constant (4) xy = constant

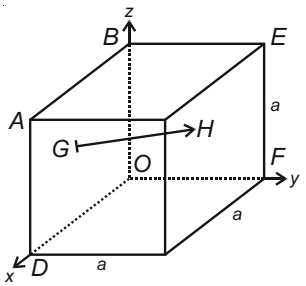
8. The position co-ordinates of a particle moving in a 3-D coordinate system is given by $x = a\cos\omega t$, $y = a\sin\omega t$ and $z = a\omega t$

The speed of the particle is **[JEE (Main)-2019]**

(1) $2a\omega$ (2) $\sqrt{2}\,a\omega$

(3) $\sqrt{3}\,a\omega$ (4) $a\omega$

9. In the cube of side 'a' shown in the figure, the vector from the central point of the face $ABOD$ to the central point of the face $BEFO$ will be **[JEE (Main)-2019]**



(1) $\frac{1}{2}a(\hat{j}-\hat{i})$ (2) $\frac{1}{2}a(\hat{i}-\hat{k})$

(3) $\frac{1}{2}a(\hat{j}-\hat{k})$ (4) $\frac{1}{2}a(\hat{k}-\hat{i})$

10. Two guns *A* and *B* can fire bullets at speeds 1 km/s and 2 km/s respectively. From a point on a horizontal ground, they are fired in all possible directions. The ratio of maximum areas covered by the bullets fired by the two guns, on the ground is

[JEE (Main)-2019]

(1) 1 : 4 (2) 1 : 8

(3) 1 : 2 (4) 1 : 16

11. Two vectors $\vec{A}$ and $\vec{B}$ have equal magnitudes. The magnitude of $\left(\vec{A}+\vec{B}\right)$ is '*n*' times the magnitude of $\left(\vec{A}-\vec{B}\right)$. The angle between $\vec{A}$ and $\vec{B}$ is

[JEE (Main)-2019]

(1) $\cos^{-1}\left[\frac{n-1}{n+1}\right]$ (2) $\cos^{-1}\left[\frac{n^2-1}{n^2+1}\right]$

(3) $\sin^{-1}\left[\frac{n-1}{n+1}\right]$ (4) $\sin^{-1}\left[\frac{n^2-1}{n^2+1}\right]$

12. Two forces *P* and *Q*, of magnitude 2*F* and 3*F*, respectively, are at an angle θ with each other. If the force *Q* is doubled, then their resultant also gets doubled. Then, the angle θ is

[JEE (Main)-2019]

(1) 30° (2) 90°

(3) 60° (4) 120°

13. A particle is moving along a circular path with a constant speed of 10 ms^{-1}. What is the magnitude of the change in velocity of the particle, when it moves through an angle of 60° around the centre of the circle? **[JEE (Main)-2019]**

(1) 10 m/s (2) Zero

(3) $10\sqrt{3}$ m/s (4) $10\sqrt{2}$ m/s

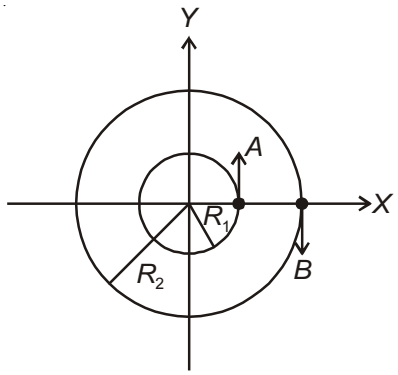
14. A person standing on an open ground hears the sound of a jet aeroplane, coming from north at an angle 60° with ground level. But he finds the aeroplane right vertically above his position. If *v* is the speed of sound, speed of the plane is

[JEE (Main)-2019]

(1) $\frac{2v}{\sqrt{3}}$ (2) $\frac{\sqrt{3}}{2}v$

(3) $\frac{v}{2}$ (4) v

15. Two particles *A*, *B* are moving on two concentric circles of radii R_1 and R_2 with equal angular speed ω. At t = 0, their positions and direction of motion are shown in the figure **[JEE (Main)-2019]**



The relative velocity $\vec{v}_A - \vec{v}_B$ at $t=\frac{\pi}{2\omega}$ is given by

(1) $\omega(R_2-R_1)\hat{i}$ (2) $\omega(R_1-R_2)\hat{i}$

(3) $-\omega(R_1+R_2)\hat{i}$ (4) $\omega(R_1+R_2)\hat{i}$

16. Ship *A* is sailing towards north-east with velocity $\vec{v}=30\hat{i}+50\hat{j}$ km/hr where $\hat{i}$ points east and $\hat{j}$, north. Ship *B* is at a distance of 80 km east and 150 km north of Ship *A* and is sailing towards west at 10 km/hr. A will be at minimum distance from B in **[JEE (Main)-2019]**

(1) 2.2 hrs. (2) 4.2 hrs.

(3) 3.2 hrs. (4) 2.6 hrs.

17. Let $\left|\vec{A_1}\right|=3, \left|\vec{A_2}\right|=5$ and $\left|\vec{A_1}+\vec{A_2}\right|=5$. The value of $\left(2\vec{A_1}+3\vec{A_2}\right)\cdot\left(3\vec{A_1}-2\vec{A_2}\right)$ is : **[JEE (Main)-2019]**

(1) – 106.5

(2) – 118.5

(3) – 99.5

(4) – 112.5

18. The stream of a river is flowing with a speed of 2 km/h. A swimmer can swim at a speed of 4 km/h. What should be the direction of the swimmer with respect to the flow of the river to cross the river straight? **[JEE (Main)-2019]**

(1) 60° (2) 90°

(3) 150° (4) 120°

19. The position vector of a particle changes with time according to the relation $\vec{r}(t) = 15t^2\hat{i} + (4 - 20t^2)\hat{j}$. What is the magnitude of the acceleration at t = 1? **[JEE (Main)-2019]**

(1) 50

(2) 100

(3) 40

(4) 25

20. A particle of mass m is moving along a trajectory given by

$x = x_0 + a\cos\omega_1 t$

$y = y_0 + b\sin\omega_2 t$

The torque, acting on the particle about the origin, at t = 0 is : **[JEE (Main)-2019]**

(1) $-m(x_0 b\omega_2^2 - y_0 a\omega_1^2)\hat{k}$

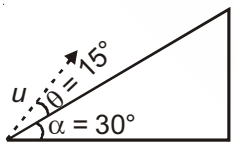
(2) $m(-x_0 b + y_0 a)\omega_1^2\hat{k}$

(3) $+my_0 a\omega_1^2\hat{k}$

(4) Zero

21. A plane is inclined at an angle $\alpha = 30°$ with respect to the horizontal. A particle is projected with a speed u = 2 ms^{-1}, from the base of the plane, making an angle $\theta = 15°$ with respect to the plane as shown in the figure. The distance from the base, at which the particle hits the plane is close to :

(Take g = 10 ms^{-2}) **[JEE (Main)-2019]**



(1) 18 cm (2) 20 cm

(3) 14 cm (4) 26 cm

22. A shell is fired from a fixed artillery gun with an initial speed u such that it hits the target on the ground at a distance R from it. If t_1 and t_2 are the values of the time taken by it to hit the target in two possible ways, the product $t_1 t_2$ is :

[JEE (Main)-2019]

(1) $\frac{R}{2g}$ (2) $\frac{2R}{g}$

(3) $\frac{R}{g}$ (4) $\frac{R}{4g}$

23. The trajectory of a projectile near the surface of the earth is given as $y = 2x - 9x^2$. If it were launched at an angle θ_0 with speed v_0 then (g = 10 ms^{-2}): **[JEE (Main)-2019]**

(1) $\theta_0 = \sin^{-1}\left(\frac{1}{\sqrt{5}}\right)$ and $v_0 = \frac{5}{3}$ms^{-1}

(2) $\theta_0 = \cos^{-1}\left(\frac{2}{\sqrt{5}}\right)$ and $v_0 = \frac{3}{5}$ms^{-1}

(3) $\theta_0 = \cos^{-1}\left(\frac{1}{\sqrt{5}}\right)$ and $v_0 = \frac{5}{3}$ms^{-1}

(4) $\theta_0 = \sin^{-1}\left(\frac{2}{\sqrt{5}}\right)$ and $v_0 = \frac{3}{5}$ms^{-1}

24. Two particles are projected from the same point with the same speed u such that they have the same range R, but different maximum heights, h_1 and h_2. Which of the following is correct?

[JEE (Main)-2019]

(1) $R^2 = 4h_1h_2$ (2) $R^2 = 16h_1h_2$

(3) $R^2 = 2h_1h_2$ (4) $R^2 = h_1h_2$

25. A particle starts from the origin at t = 0 with an initial velocity of $3.0\hat{i}$ m/s and moves in the x-y plane with a constant acceleration $\left(6.0\hat{i} + 4.0\hat{j}\right)$ m/s^2. The x-coordinate of the particle at the instant when its y-coordinate is 32 m is D meters. The value of D is **[JEE (Main)-2020]**

(1) 60 (2) 32

(3) 40 (4) 50

26. Starting from the origin at time t = 0, with initial velocity $5\hat{j}$ ms^{-1}, a particle moves in the x-y plane with a constant acceleration of $\left(10\hat{i} + 4\hat{j}\right)$ ms^{-2}. At time t, its coordinates are (20 m, y_0 m). The values of t and y_0 are, respectively **[JEE (Main)-2020]**

(1) 4 s and 52 m

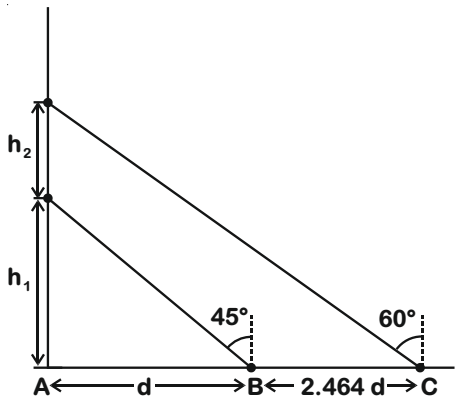
(2) 2 s and 24 m

(3) 5 s and 25 m

(4) 2 s and 18 m

27. A balloon is moving up in air vertically above a point A on the ground. When it is at a height h_1, a girl standing at a distance d (point B) from A (see figure) sees it at an angle 45° with respect to the vertical. When the balloon climbs up a further height h_2, it is seen at an angle 60° with respect

to the vertical if the girl moves further by a distance 2.464 d (point *C*). Then the height h_2 is (given tan30° = 0.5774) **[JEE (Main)-2020]**



(1) d (2) 0.732 d

(3) 1.464 d (4) 0.464 d

28. A clock has a continuously moving second's hand of 0.1 m length. The average acceleration of the tip of the hand (in units of ms^{-2}) is of the order of **[JEE (Main)-2020]**

(1) 10^{-1} (2) 10^{-2}

(3) 10^{-4} (4) 10^{-3}

❑ ❑ ❑

29. When a car is at rest, its driver sees rain drops falling on it vertically. When driving the car with speed v, he sees that rain drops are coming at an angle 60° from the horizontal. On further increasing the speed of the car to $(1 + \beta)v$, this angle changes to 45°. The value of β is close to **[JEE (Main)-2020]**

(1) 0.37 (2) 0.41

(3) 0.73 (4) 0.50

30. The sum of two forces $\vec{P}$ and $\vec{Q}$ is $\vec{R}$ such that $|\vec{R}| = |\vec{P}|$. The angle θ (in degrees) that the resultant of $2\vec{P}$ and $\vec{Q}$ will make with $\vec{Q}$ is, _____. **[JEE (Main)-2020]**

31. A particle is moving along the *x*-axis with its coordinate with time '*t*' given by $x(t) = 10 + 8t - 3t^2$. Another particle is moving along the *y*-axis with its coordinate as a function of time given by $y(t) = 5 - 8t^3$. At $t = 1$ s, the speed of the second particle as measured in the frame of the first particle is given as $\sqrt{v}$. Then *v* (in m/s) is _____. **[JEE (Main)-2020]**