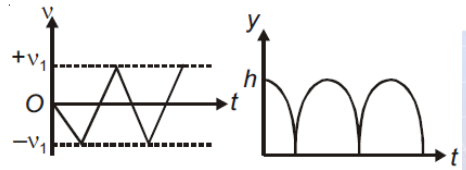
Chapter 03

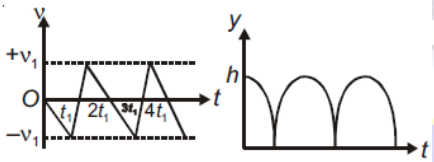
Kinematics

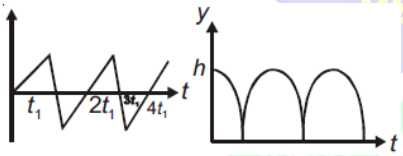
JEE-FLASHBACK

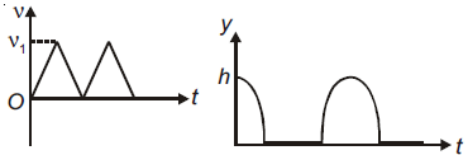
JEE MAINS QUESTION

Q.1 Consider a rubber ball freely falling from a height h = 4.9 m onto a horizontal elastic plate. Assume that the duration of collision is negligible and the collision with the plate is totally elastic. Then the velocity as a function of time and the height as a function of time will be **[AIEEE-2009]**

(1) 

(2) 

(3) 

(4) 

Q.2 A particle has a 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

Q.3 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

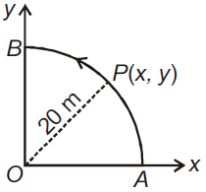
Q.4 For a particle in uniform circular motion, the acceleration $\vec{a}$ at a point P(R, θ) on the circle of radius R is (Here 'v' is the speed of the particle and θ is measured from the x-axis) **[AIEEE-2010]**

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

Q.5 A point P moves in counter-clockwise direction on a circular path as shown in the figure. The movement of P is such that is sweeps out a length $s = t^3 + 5$, where s is in meter 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

Q.6 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

Q.7 A projectile is given an initial velocity of $\left(\hat{i}+2\hat{j}\right)$ 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) $4y = 2x - 25x^2$

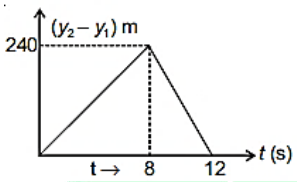
Q.8 From a tower of height H, a particle is thrown vertically upwards with a speed u. The time taken by the particle, to hit the ground, is n times that taken by it to reach the highest point of its path. The relation between H, u and n is **[JEE (Main)-2014]**

(1) $2gH = n^2u^2$ (2) $gH = (n-2)^2u^2$

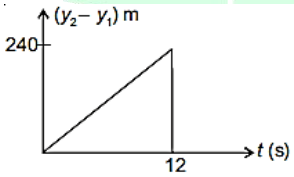
(3) $2gH = nu^2(n-2)$ (4) $gH = (n-2)u^2$

Q.9 Two stones are thrown up simultaneously from the edge of a cliff 240 m high with initial speed of 10 m/s and 40 m/s respectively. Which of the following graph best represents the time variation of relative position of the second stone with respect to the first? (Assume stones do not rebound after hitting the ground and neglect air resistance, take g = 10 m/s^2) (The figures are schematic and not drawn to scale) **[JEE (Main)-2015]**

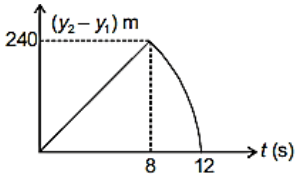
(1)



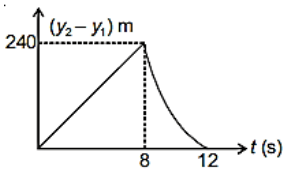
(2)



(3)

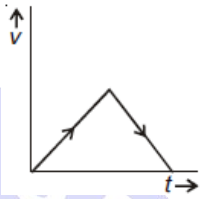


(4)

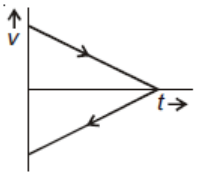


Q.10 A body is thrown vertically upwards. Which one of the following graphs correctly represent the velocity vs time? **[JEE (Main)-2017]**

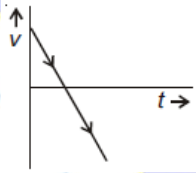
(1)



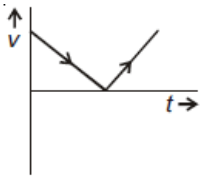
(2)



(3)

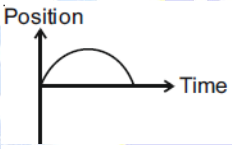


(4)

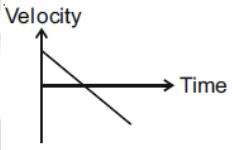


Q.11 All the graphs below are intended to represent the same motion. One of them does it incorrectly. Pick it up. **[JEE (Main)-2018]**

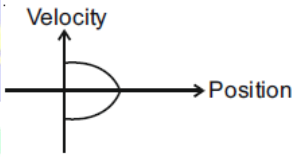
(1)



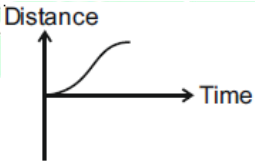
(2)



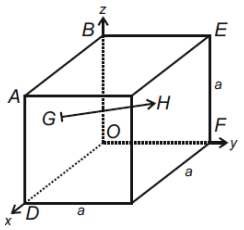
(3)



(4)



Q.12 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) $\frac{1}{2}a\left(\hat{j}-\hat{i}\right)$ (2) $\frac{1}{2}a\left(\hat{i}-\hat{k}\right)$

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

Q.13 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 on the ground fired by the two guns is **[JEE (Main)-2019]**

(1) 1 : 4 (2) 1 : 16 (3) 1 : 8 (4) 1 : 2

Q.14 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) $R^2 = h_1h_2$

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

Q.15 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 center of the circle? **[JEE (Main)-2019]**

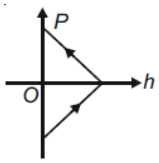
(1) 10 m/s (2) Zero

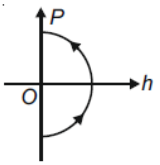
(3) $10\sqrt{3}$ m/s (4) $10\sqrt{2}$ m/s

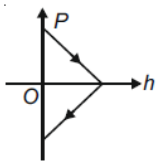
Q.16 A person standing on an open ground hears the sound of a jet airplane, coming from north at an angle 60° with ground level. But he finds the airplane right vertically above his position. If v is the speed of sound, speed of the plane is **[JEE (Main)-2019]**

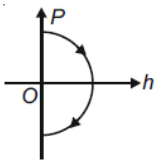
(1) $\frac{2v}{\sqrt{3}}$ (2) $\frac{\sqrt{3}}{2}v$ (3) $\frac{v}{2}$ (4) V

Q.17 A ball is thrown vertically up (taken as + z- axis) from the ground. The correct momentum-height (P-h) diagram is **[JEE (Main)-2019]**

(1) 

(2) 

(3) 

(4) 

Q.18 A particle is moving with speed $v = b\sqrt{x}$ along positive X-axis. Calculate the speed of the particle at time t = τ(assume that the particle is at origin at t = 0). **[2019, 12 April Shift-II]**

(1) $\frac{b^2\tau}{4}$ (2) $\frac{b^2\tau}{2}$ (3) $b^2\tau$ (4) $\frac{b^2\tau}{\sqrt{2}}$

Q.19 The position of a particle as a function of time t, is given by $x(t) = at + bt^2 - ct^3$ where a, b and c are constants. When the particle attains zero acceleration, then its velocity will be **[2019, 9 April Shift-II]**

(1) $a+\frac{b^2}{2c}$ (2) $a+\frac{b^2}{4c}$

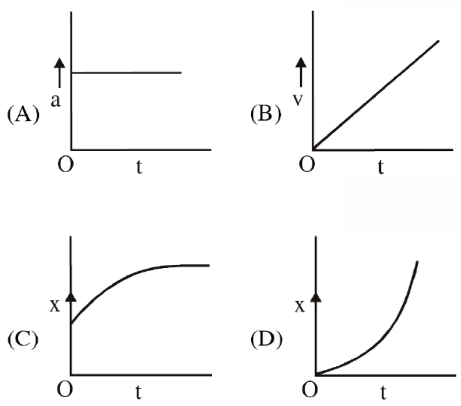
(3) $a+\frac{b^2}{3c}$ (4) $a+\frac{b^2}{c}$

Q.20 In a car race on a straight path, car A takes a time t less then car B at the finish and passes finishing point with a speed 'V' more than that of car B. Both the cars start from rest and travel with constant acceleration a_1 and a_2 respectively. Then 'v' is equal to **[2019, 9 Jan Shift-II]**

(1) $\frac{2a_1a_2}{a_1+a_2}t$ (2) $\sqrt{2a_1a_2}t$

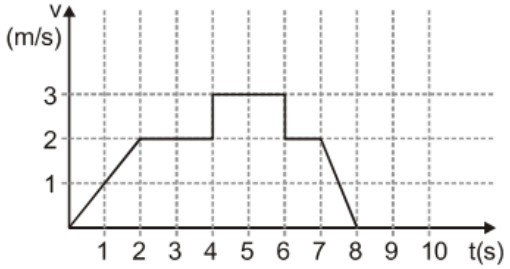
(3) $\sqrt{a_1a_2}t$ (4) $\frac{a_1+a_2}{2}t$

Q.21 A particle starts from origin 0 from rest and moves with a uniform acceleration along the positive X-axis. Identify all figures that correctly represent the motion qualitatively. (a = acceleration, v = velocity, x = displacement, t = time) **[2019, 8 April Shift-II]**



(1) (A) (2) (A), (B), (C)
(3) (B), (C) (4) (A), (B), (D)

Q.22 A particle starts from the origin at time t = 0 and moves along the positive X-axis. The graph of positive with respect to time is shown in figure. What is the position of the particle at time t = 5 s? **[2019, 10 Jan Shift-II]**

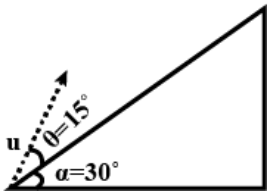


(1) 6 m (2) 3 m (3) 10 m (4) 9 m

Q.23 The position vector of particle changes with time according to the relation $r(t)=15t^2\hat{i}+(4-20t^2)\hat{j}$. What is the magnitude of the acceleration (in ms^{-2}) at t = 1? **[2019, 9 April Shift-II]**

(1) 50 (2) 100 (3) 25 (4) 40

Q.24 A plane is inclined at an angle α =30° with respect to the horizontal. A particle is projected with a speed u = $2ms^{-2}$, from the base of the plane, making an angle θ = 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 = $10\ ms^{-2}$] **[2019, 10 April Shift-II]**



(1) 26 cm (2) 20 cm
(3) 18 cm (4) 14 cm

Q.25 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 value of the time taken by it to hit the target in two possible ways, the product t_1t_2 is **[2019, 12 April Shift-I]**

(1) $\frac{R}{4g}$ (2) $\frac{R}{g}$ (3) $\frac{R}{2g}$ (4) $\frac{2R}{g}$

Q.26 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 (take, g = $10\ ms^{-2}$) **[2019, 12 April Shift-I]**

(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 $v_0=\frac{3}{5}ms^{-1}$

Q.27 A ball is thrown upward with an initial velocity v_0 from the surface of the earth. The motion of the ball is affected by a drag force equal to $m\gamma v^2$ (where, m is mass of the ball, v is its instantaneous velocity and γ is a constant). Time taken by the ball to rise to its maximum height is **[JEE (Main)2019]**

(1) $\frac{1}{\sqrt{\gamma g}}\tan^{-1}\left(\sqrt{\frac{\gamma}{g}}v_0\right)$

(2) $\frac{1}{\sqrt{\gamma g}}\tan^{-1}\left(\sqrt{\frac{2\gamma}{g}}v_0\right)$

(3) $\frac{1}{\sqrt{\gamma g}}\sin^{-1}\left(\sqrt{\frac{\gamma}{g}}v_0\right)$

(4) $\frac{1}{\sqrt{\gamma g}}\ln\left(1+\sqrt{\frac{\gamma}{g}}v_0\right)$

Q.28 In three dimensional system, the position coordinates of a particle (in motion) are given below x = a cosωt, y = a sinωt, z = aωt
The velocity of particle will be
[2019, 9 Jan Shift-II]
(1) $\sqrt{2}a\omega$ (2) 2 aω (3) aω (4) $\sqrt{3}a\omega$

Q.29 The position co-ordinates of a particle moving in a 3-D coordinate system is given by
x= a cosωt
y = a sinωt and $\frac{2\sqrt{3}}{\pi}$H
z = awt
The speed of the particle is :
(1) aω (2) $\sqrt{2}a\omega$ (3) $\sqrt{3}a\omega$ (4) 2aω
[JEE Main 2019 (Online) 9th January Evening Slot]

Q.30 A body is projected at t = 0 with a velocity 10 ms^{-1} at an angle of 60° with the horizontal. The radius of curvature of its trajectory at t = 1s is R. Neglecting air resistance and taking acceleration due to gravity g = 10 ms^{-2}, the value of R is **[2019, 11 Jan Shift-I]**
(1) 10.3 m (2) 2.8 m (3) 5.1 m (4) 2.5 m

Q.31 A particle moves from the point $\left(2.0\hat{i}+4.0\hat{j}\right)$ m at t = 0 with an initial velocity $\left(5.0\hat{i}+4.0\hat{j}\right)$ ms^{-1}. It is acted upon by a constant force which produces a constant acceleration $\left(4.0\hat{i}+4.0\hat{j}\right)$ ms^{-2}. What is the distance of the particle from the origin at time 2s? **[2019, 11 Jan Shift-II]**
(1) 5 m (2) $20\sqrt{2}$m
(3) $10\sqrt{2}$m (4) 15 m

Q.32 Ship A is sailing towards north-east with velocity $v=30\hat{i}+50\hat{j}$ km/h, 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/h. A will be at minimum distance from B in
[2019, 8 April Shift-I]
(1) 4.2 h (2) 2.6 h (3) 3.2 h (4) 2.2 h

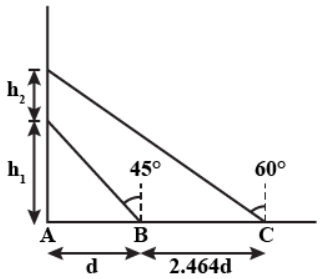
Q.33 The stream of a river is flowing with a speed of 2 km/h. A swimmer can swim at a speed of 4 km/h. What should be the direction of the swimmer with respect to the flow of the river to cross the river straight? **[2019, 9 April Shift-I]**
(1) 60° (2) 120° (3) 90° (4) 150°

Q.34 A passenger train of length 60m travels at a speed of 80 km/hr. Another freight train of length 120 m travels at a speed of 30 km/hr. The ratio of times taken by the passenger train to completely cross the freight train when: (i) they are moving in the same direction and (ii) in the opposite direction is
[2019, 12 Jan Shift-I]
(1) $\frac{3}{2}$ (2) $\frac{25}{11}$ (3) $\frac{11}{5}$ (4) $\frac{5}{2}$

Q.35 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 $(6.0\hat{i}+4.0\hat{j})$ m/s^2. The y-coordinate is 32 m is D meters. The value of D is **[JEE (Main)-2020]**
(1) 60 (2) 32 (3) 40 (4) 50

Q.36 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}

Q.37 A balloon is moving up in air vertically above a point A on the ground (d) 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 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) **[2020, 5 Sep Shift-I]**



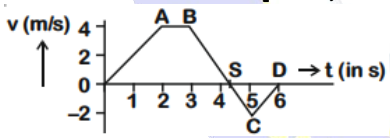
(1) 1.464 d (2) d
(3) 0.464 d (4) 0.732 d

Q.38 A helicopter rises from rest on the ground vertically upwards with a constant acceleration g. A food packet is dropped from the helicopter when it is at a height h. The time taken by the packet to reach the ground is close to (Here, g is the acceleration due to gravity). **[2020, 5 Sep Shift-I]**

(1) $t=\frac{2}{3}\sqrt{\frac{h}{g}}$ (2) $t=1.8\sqrt{\frac{h}{g}}$

(3) $t=\sqrt{\frac{2h}{3g}}$ (4) $t=3.4\sqrt{\frac{h}{g}}$

Q.39 The v – t graph of a body in a straight one motion is shown in the figure. The point S is at 4.333 s. The total distance covered by the body in 6 s is **[2020, 5 Sep Shift-II]**



(1) $\frac{37}{3}$m (2) 12 m

(3) 11 m (4) $\frac{49}{4}$m

Q.40 Starting from the origin at time t = 0, with initial velocity $5\hat{j}\,ms^{-1}$, a particle moves in the xy-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 respectively, are **[2020 4 Sep Shift-I]**

(1) 2 s and 18 m (2) 5 s and 25 m
(3) 2 s and 24 m (4) 4 s and 52 m

Q.41 Trains A and B are running on parallel tracks in the opposite directions with speeds of 36 km/h and 72 km/h, respectively. A person is walking in train A in the opposite direction to its motion with a speed of 1.8 km/h. Speed (in ms^{-1}) of this person as observed from train B will be close to (take, the distance between the tracks as negligible) **[2020, 2 Sep Shift-I]**

(1) 28.5 (2) 30.5 (3) 29.5 (4) 31.5

Q.42 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 + β)v, this angle changes to 45°. The value of β is close to **[2020, 6 Sep Shift-II]**

(1) 0.50 (2) 0.41 (3) 0.37 (4) 0.73

Q.43 The instantaneous velocity of a particle moving in a straight as $v = \alpha t + \beta t^2$, where α and β are constants. The distance travelled by the particle between 1s and 2s is **[2021, 25 July Shift-II]**

(1) 3α + 7α (2) $\frac{3}{2}\alpha+\frac{7}{3}\beta$

(3) $\frac{\alpha}{2}+\frac{\beta}{3}$ (4) $\frac{3}{2}\alpha+\frac{7}{2}\beta$

Q.44 The relation between time t and distance x for a moving body is given as $t = mx^2 + nx$, where m and n are constants. The retardation of the motion is (when v stands for velocity) **[2021, 25 July Shift-II]**

(1) $2mv^3$ (2) $2mnv^3$ (3) $2nv^3$ (4) $2n^2v^3$

Q.45 A boy reaches the airport and finds that the escalator is not working. He walks up the stationary escalator in time t_1. If he remains stationary on a moving escalator takes him up in time t_2. The time taken by him to walk up on the moving escalator will be **[2021, 20 July Shift-II]**

(1) $\frac{t_1t_2}{t_2-t_1}$ (2) $\frac{t_1+t_2}{2}$ (3) $\frac{t_1t_2}{t_2+t_1}$ (4) $t_2 - t_1$

Q.46 The velocity of a particle is $v = v_0 + gt + Ft^2$. Its position is x = 0 at t = 0, then its displacement after time (t = 1) is **[2021, 17 March Shift-I]**

(1) $v_0 + g + F$ (2) $v_0+\frac{g}{2}+\frac{F}{3}$

(3) $v_0+\frac{g}{2}+F$ (4) $v_0 + 2g + 3F$

Q.47 Water drops are falling from a nozzle of a shower onto the floor, from a height of 9.8 m. The drops fall at a regular interval of time. When the first

drop strikes the floor, at that instant, the third drop begins to fall. Locate the position of second drop strikes the floor. **[2021, 27 Aug Shift-II]**

(1) 4.18 m (2) 2.94 m
(3) 2.45 m (4) 7.35 m

Q.48 A ball is thrown up with a certain velocity, so that it reaches a height h. Find the ratio of the two different times of the ball reaching $\frac{h}{3}$ in both the directions. **[2021, 27 July Shift-I]**

(1) $\frac{\sqrt{2}-1}{\sqrt{2}+1}$ (2) $\frac{1}{3}$
(3) $\frac{\sqrt{3}-\sqrt{2}}{\sqrt{3}+\sqrt{2}}$ (4) $\frac{\sqrt{3}-1}{\sqrt{3}+1}$

Q.49 A balloon was moving upwards with a uniform velocity of 10 m/s. An object of finite mass is dropped from the balloon when it was at a height of 75 m from the ground level. The height of the balloon from the ground when object strikes the ground was around is
(Take, the value of g = 10 m/s^2
[2021, 25 July Shift-II]

(1) 300 m (2) 200 m (3) 125 m (4) 250 m

Q.50 Water droplets are coming from an open tap at a particular rate. The spacing between a droplet observed at 4th second after its fall to the next droplet is 34.3 m. At what rate, the droplets are coming from the tap ? (Take, g = 9.8 m/s^2)
[2021, 25 July Shift-I]

(1) 3 drops/2s (2) 2 drops/s
(3) 1 drop/s (4) 1 drop/7s

Q.51 A scooter accelerates from rest for time t_1 at constant rate a_1 and then retards at constant rate a_2 for time t_2 and comes to rest. The correct value of $\frac{t_1}{t_2}$ will be **[2021, 26 Fab Shift-II]**

(1) $\frac{a_1+a_2}{a_2}$ (2) $\frac{a_2}{a_1}$
(3) $\frac{a_1}{a_2}$ (4) $\frac{a_1+a_2}{a_1}$

Q.52 A stone is dropped from the top of a building. When it crosses a point 5 m below the top, another stone starts to fall from a point 25 m below the top. Both stones reach the bottom of building simultaneously. The height of the building is **[2021, 25 Fab Shift-II]**

(1) 45 m (2) 25 m (3) 35 m (4) 50 m

Q.53 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 of the train passes the signal post is: **[2021, 25 Feb Shift-I]**

(1) $\sqrt{\frac{v^2+u^2}{2}}$ (2) $\frac{v-u}{2}$
(3) $\frac{u+v}{2}$ (4) $\sqrt{\frac{v^2+u^2}{2}}$

Q.54 A car accelerates from rest at a constant rate α for some time after which it decelerates at a constant rate β to come to rest. If the total time elapsed is t then, the total distance travelled is
[2021, 17 March Shift-I]

(1) $\frac{4\alpha\beta}{2(\alpha+\beta)}t^2$ (2) $\frac{2\alpha\beta}{(\alpha+\beta)}t^2$
(3) $\frac{\alpha\beta}{2(\alpha+\beta)}t^2$ (4) $\frac{\alpha\beta}{4(\alpha+\beta)}t^2$

Q.55 A player kicks a football with an initial speed of 25 ms^{-1} at an angle of 45° from the ground. What are the maximum height and the time taken by the football to reach at the highest point during motion ? (Take, g = 10 ms^{-2})
[2021, 27 Aug Shift-I]

(1) h_{max} = 10 m, T = 2.5 s
(2) h_{max} = 15.625 m, T = 3.54 s
(3) h_{max} = 15.625 m, T = 1.77 s
(4) h_{max} = 3.54 m, T = 0.125

Q.56 A helicopter is flying horizontally with a speed v at an altitude h has to drop a food packet for a man on the ground. What is the distance of helicopter from the man when the food packet is dropped ? **[2021, 31 Aug Shift-I]**

(1) $\sqrt{\frac{2ghv^2+1}{h^2}}$ (2) $\sqrt{2ghv^2+h^2}$

(3) $\sqrt{\frac{2hv^2}{g}+h^2}$ (4) $\sqrt{\frac{2gh}{v^2}+h^2}$

Q.57 A bomb is dropped by fighter plane flying horizontally. To an observer sitting in the plane, the trajectory of the bomb is a **[2021, 26 Aug Shift-I]**

(1) Hyperbola
(2) Parabola in the direction of motion of plane
(3) Straight line vertically down the plane
(4) Parabola in a direction opposite to the motion of plane

Q.58 A mosquito is moving with a velocity $\vec{v}=\left(0.5t^2\hat{i}+3t\hat{j}+9\hat{k}\right)m/s$ and accelerating in uniform conditions. What will be the direction of mosquito after 2s ? **[2021, 16 March Shift-I]**

(1) $\tan^{-1}\left(\frac{2}{3}\right)$ from X – axis

(2) $\tan^{-1}\left(\frac{2}{3}\right)$ from Y – axis

(3) $\tan^{-1}\left(\frac{5}{2}\right)$ from Y – axis

(4) None of the above

Q.59 The trajectory of a projectile in a vertical plane is $y = \alpha x - \beta x^2$, where α and β are constant and x and y are respectively the horizontal and vertical distance of the projectile from the point of projection. The angle of projection θ and the maximum height attained *H* are respectively given by **[2021, 26 Feb. Shift-I]**

(1) $\tan^{-1}\alpha, \frac{\alpha^2}{4\beta}$ (2) $\tan^{-1}\beta, \frac{\alpha^2}{2\beta}$

(3) $\tan -1\alpha, \frac{4\alpha^2}{\beta}$ (4) $\tan^{-1}\left(\frac{\beta}{\alpha}\right), \frac{\alpha^2}{\beta}$

Q.60 A butterfly is flying with a velocity $4\sqrt{2}m/s$ in North-East direction. Wind is slowly blowing at 1 m/s from North to South. The resultant displacement of the butterfly in 3 s is **[2021, 20 July Shift-I]**

(1) 3 m (2) 20 m
(3) $12\sqrt{2}$m (4) 15 m

Q.61 A projectile is projected with velocity of 25 m/s at an angle θ with the horizontal. After t second its inclination with horizontal becomes zero. If R represents horizontal range of the projectile, the value of θ will be [use, g = 10 m/s^2] **[2022 Main]**

(1) $\frac{1}{2}\sin^{-1}\left(\frac{5t^2}{4R}\right)$ (2) $\frac{1}{2}\sin^{-1}\left(\frac{4R}{5t^2}\right)$

(3) $\tan^{-1}\left(\frac{4t^2}{5R}\right)$ (4) $\cot^{-1}\left(\frac{R}{20t^2}\right)$

Q.62 A projectile is launched at an angle α with the horizontal with a velocity 20 ms^{-1}. After 10 s, its inclination with horizontal is β. The of tan β will be (g = 10 ms^{-2}) **[2022 Main]**

(1) tan α + 5sec α (2) tan α – 5sec α
(3) 2tan α – 5sec α (4) 2tan α + 5sec α

Q.63 A projectile fired at 30º to the ground is observed to be at same height at time 3 s and 5 s after projection, during its flight. The speed of projection of the projectile is _____ ms^{-1}. (Given g = 10 ms^{-2}) **[JEEMain-2023]**

Q.64 A ball is thrown vertically upward with an initial velocity of 150 m/s. The ratio of velocity after 3 s and 5 s is $\frac{x+1}{x}$ The value of x is _____. {take, g = 10 m/s^2} **[JEEMain-2023]**

(1) 10 (2) –5 (3) 6 (4) 5

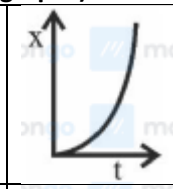
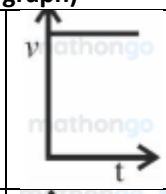
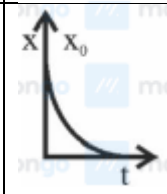
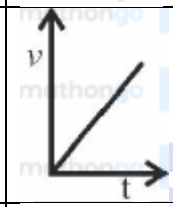
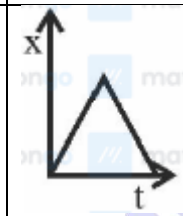
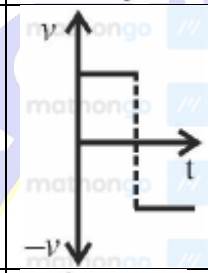
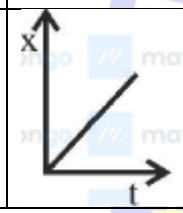
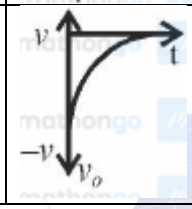
Q.65 A passenger sitting in a train A moving at 90 km/h observes another train B moving in the opposite direction for 8 s. If the velocity of the train B is 54 km/h, then length of train B is: **[JEEMain-2023]**

(1) 120 m (2) 320 m (3) 80 m (4) 200 m

Q.66 Two trains 'A' and 'B' of length 'l' and '4l' are travelling into a tunnel of length 'L' in parallel tracks from opposite directions with velocities 108 km/h and 72 km/h, respectively. If train 'A' take 35s less time than train 'B' to cross the tunnel then, length 'L' of tunnel is: (Given L = 60 l) **[JEEMain-2023]**

(1) 1200 m (2) 900 m (3) 1800 m (4) 2700 m

Q.67 Match the column-I with column-II

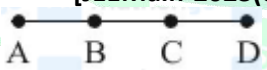
Column-I (x-t graphs)		Column-II (v-t graph)	
A.		I	
B.		II	
C.		III	
D		IV	

Choose the correct answer from the options given below: **[JEEMain-2023(30 Jan. shift-1)]**

(1) A-II, B-IV, C-III, D-I (2) A-I, B-II, C-III, D-IV

(3) A-II, B-III, C-IV, D-I (4) A-I, B-III, C-IV, D-II

Q.68 An object moves with speed v_1, v_2 and v_3 along a line segment AB, BC and CD respectively as shown in figure. Where AB = BC and AD = 3 AB, then average speed of the object will be: **[JEEMain-2023(01 Feb. shift-1)]**



(1) $\frac{(v_1+v_2+v_3)}{3}$ (2) $\frac{v_1v_2v_3}{3(v_1v_2+v_2v_3+v_3v_1)}$

(3) $\frac{3v_1v_2v_3}{v_1v_2+v_2v_3+v_3v_1}$ (4) $\frac{(v_1+v_2+v_3)}{3v_1v_2v_3}$

Q.69 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 ____ (Assuming same retardation is produced by brakes): **[JEEMain-2023(01 Feb. shift-2)]**

Q.70 A particle of mass 100 g is projected at time t = 0 with a speed 20 ms^{-1} at an angle 45° to the horizontal as given in the figure. the magnitude of the angular momentum of the particle about the starting point at time t = 2s is found to be $\sqrt{x}kgm^2/s$. The value of K is_____

(Take g = 10 ms^{-2})

[JEEMain-2023(29 Jan. shift-2)]

Q.71 The speed of a swimmer is 4 km h^{-1} in stull water. If the swimmer makes his strokes normal to the flow of river of width 1 km, he reaches a point 750 m down the stream on the opposite bank. The speed of the river water is _____ km h^{-1}. **[JEEMain-2023(31 Jan. shift-1)]**

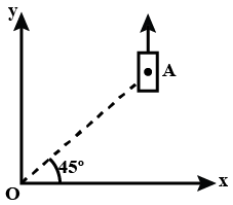
Q.72 Two bodies are projected from ground with same speed 40 ms^{-1} at two different angles with respect to horizontal. The bodies were found to have same range. If one of the body was projected at an angle of 60°, with horizontal then sum of the maximum heights, attained by the two projectiles, is _____ m. (Given g = 10 ms^{-2}) **[JEEMain-2023(31 Jan. shift-2)]**

JEE ADVANCED QUESTION

Q.1 On a frictionless horizontal surface, assumed to be the x-y plane, a small trolley A is moving along a straight line parallel to the y-axis with a constant velocity of $\left(\sqrt{3}-1\right)$ m/s. at a particular instant when the line OA makes an angle of 45° with the x-axis, a ball is thrown along the

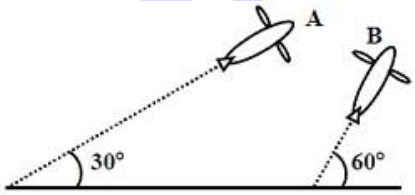
surface from the origin O. its velocity makes an angle ϕ with the x-axis and it hits the trolley.

(i) The motion of the ball is observed from the frame of the trolley. Calculate the angle θ made by the velocity vector of the ball with the x-axis in this frame.



(ii) Find the speed (m/s) of the ball with respect to the surface, if $\phi = \frac{4\theta}{3}$. **[JEE (Adv)-2002]**

Q.2 Airplanes A and B are flying with constant velocity in the same vertical plane 30° and 60° with respect to the horizontal respectively as shown in figure. The speed of A is $100\sqrt{3}$ ms^{-1}. At time t = 0s, an observer in A finds B at a distance of 500 m. this observer sees B moving with a constant velocity perpendicular to the line of motion of A. If at t = t_0, A just escapes being hit by B, t_0 in seconds is **[JEE (Adv)2014]**



Q.3 Consider an expanding sphere of instantaneous radius R whose total mass remains constant. The expansion is such that the instantaneous density ρ remains uniform throughout the volume. The rate of fractional change in density $\left(\frac{1}{\rho}\frac{d\rho}{dt}\right)$ is constant. The velocity v of any point on the surface of the expanding sphere is proportional to

[JEE (Adv)-2017(Paper-2)]

(1) R (2) $\frac{1}{R}$ (3) R^3 (4) $R^{2/3}$

ANSWER KEY

JEE-FLASHBACK

Jee-mains

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	2	1	1	4	1	3	2	3	3	3	4	1	2	4	1
Que.	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
Ans.	3	4	2	3	3	4	4	1	2	4	3	1	1	2	2
Que.	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**	**45**
Ans.	2	2	2	3	1	4	2	4	1	1	3	4	2	1	3
Que.	**46**	**47**	**48**	**49**	**50**	**51**	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**	**60**
Ans.	2	4	3	3	3	2	1	1	3	3	3	3	4	1	4
Que.	**61**	**62**	**63**	**64**	**65**	**66**	**67**	**68**	**69**	**70**	**71**	**72**			
Ans.	4	2	80	4	2	3	1	3	200	800	3	80			

Jee-Advanced

Que.	1(i)	1(ii)	2	3	
Ans.	45°	2	5	1	