

Exercise – I (JEE-Main Pattern)

SECTION-A

- This section contains **TWENTY** questions.
- Each question has **FOUR** options (1), (2), (3) and (4). **ONLY ONE** of these four options is correct.
- For each question, darken the bubble corresponding to the correct option in the ORS.
- For each question, marks will be awarded in one of the following categories:

Full Marks : +4, if only the bubble corresponding to the correct option is darkened.

Zero Marks : 0, if none of the bubbles is darkened.

Negative Marks : -1 in all other cases.

1. Find ratio of average speed and magnitude of average velocity of tip of minute hand in 20 minutes:

(1) $\frac{2\pi}{3\sqrt{3}}$ (2) $\frac{2\pi}{3}$ (3) $\frac{3\sqrt{3}}{2\pi}$ (4) None

PKN001

2. The motion of a particle is defined by the position vector

$$\vec{r} = A(\cos t + t \sin t) \hat{i} + A(\sin t - t \cos t) \hat{j}$$

Where t is expressed in seconds. Determine the value of t for which positions vectors and acceleration vector are perpendicular.

(1) 0 (2) 1 (3) 3 (4) 5

PKN002

3. Now the particle is moving only along the z -axis, and its position is given by, $(t^2 - 2t - 3)\hat{k}$. At what time does the particle stand still?

(1) 1 (2) 3 (3) 5 (4) 7

PKN003

4. A particle is moving towards East with velocity 8 ms^{-1} and acceleration 4 ms^{-2} directed towards West. Find the distance travelled in 6 seconds.

(1) 40 m (2) 24 m (3) 32 m (4) 16 m

PKN004

5. A car moving at 160 km/h when crosses the marker-0, driver applies brake and reduces its speed uniformly to 40 km/h at marker-2. The markers are spaced at equal distances along the road as shown below.

At which part of the track would the car have been traveling at instantaneous speed of 100 km/h ?



- (1) At marker-1 (2) Between marker-0 and marker-1
(3) Between marker-1 and marker-2 (4) More information required to decide.

PKN005

6. Two balls are projected simultaneously from the top of a tall building, one vertically upward and other vertical downwards with the same speed of 60 m/s . Then time interval between the balls striking the ground is :-
 (1) 6 sec. (2) 10 sec. (3) 12 sec. (4) 9 sec.

PKN006

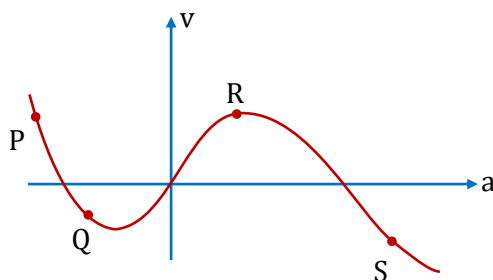
7. A particle moves on x-axis as per equation $x = (t^3 - 9t^2 + 15t + 2)m$. Distance travelled by the particle between $t = 0$ and $t = 5 \text{ s}$ is
 (1) 25 m (2) 39 m (3) 23 m (4) 52 m

PKN007

8. The XIth class students of ALLEN designed a rocket. The rocket was launched from cycle stand of ALLEN straight up into the air. At $t = 0$, the rocket is at $y = 0$ with $V_y(t = 0) = 0$. The velocity of the rocket is given by : $V_y = (24t - 3t^2) \text{ m/s}$ for $0 \leq t \leq t_b$ where t_b is the time at which fuel burns out. Vertically upward direction is taken as positive. ($g = 10 \text{ m/s}^2$)
 The time taken by rocket to reach its maximum height is
 (1) 4 sec. (2) 8 sec. (3) 8.8 sec. (4) 9.6 sec.

PKN008

9. Acceleration-velocity graph of a moving particle is shown in figure. The particle is



- (1) speeding up at P (2) speeding up at Q (3) speeding up at S (4) speeding down at R

PKN009

10. A body of mass 5 kg starts from the origin with an initial velocity $\vec{u} = (30\hat{i} + 40\hat{j})\text{ms}^{-1}$. If a constant force $(-6\hat{i} - 5\hat{j})\text{N}$ acts on the body, the time in which the y component of the velocity becomes zero, is:
 (1) 5s (2) 20 s (3) 40 s (4) 80 s

PKN010

11. A boy throws a ball from shoulder height at an initial velocity of 30 m/s . Spending 4.8 s in air, the ball is caught by another boy as the same shoulder-height level. What is the angle of projection?
 (1) 37° (2) 30° (3) 53° (4) 60°

PKN011

12. A particle is projected from the ground with velocity u at angle θ with horizontal. The horizontal range, maximum height and time of flight are R , H and T respectively.

$$\text{They are given by } R = \frac{u^2 \sin 2\theta}{g} \quad H = \frac{u^2 \sin^2 \theta}{2g} \quad \text{and } T = \frac{2u \sin \theta}{g}$$

Now keeping u fixed, θ is varied from 30° to 60° , then

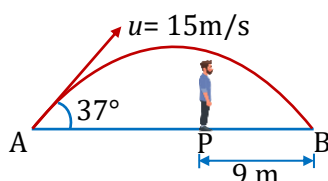
- (1) R will first increase then decrease, H will increase and T will decrease
 (2) R will first increase then decrease while H and T both will increase
 (3) R will decrease while H and T both will increase
 (4) R will increase while H and T both will also increase

PKN012

13. Suppose a player hits several baseballs. Which baseball will be in the air for the longest time?
- (1) The one with the farthest range.
 - (2) The one which reaches maximum height.
 - (3) The one with the greatest initial velocity.
 - (4) The one leaving the bat at 45° with respect to the ground.

PKN013

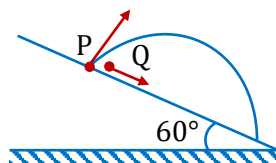
14. A ball is hit by a batsman at an angle of 37° as shown in figure. The man standing at P should run at what minimum velocity so that he catches the ball before it strikes the ground. Assume that height of man is negligible in comparison to maximum height of projectile.



- (1) 3 m/s
- (2) 5 m/s
- (3) 9 m/s
- (4) 12 m/s

PKN014

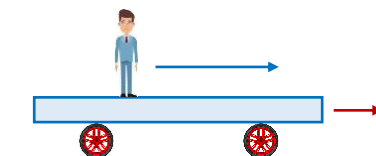
15. A particle P is projected from a point on the surface of smooth inclined plane (see figure). Simultaneously another particle Q is released on the smooth inclined plane from the same position. P and Q collide after $t = 4$ s. The speed of projection of P is :-



- (1) 5 m/s
- (2) 10 m/s
- (3) 15 m/s
- (4) 20 m/s

PKN015

16. A trolley is moving horizontally with a constant velocity of v with respect to earth. A man starts running from one end of the trolley with a velocity $1.5v$ with respect to trolley. After reaching the opposite end, the man returns back and continues running with a velocity of $1.5v$ w.r.t. the trolley in the backward direction. If the length of the trolley is L then the displacement of the man with respect to earth during the process will be :-



- (1) $2.5L$
- (2) $1.5L$
- (3) $\frac{5L}{3}$
- (4) $\frac{4L}{3}$

PKN016

17. An elevator car (lift) is moving upward with uniform acceleration of 2 m/s^2 . At the instant, when its velocity is 2 m/s upwards a ball is thrown upward from its floor. The ball strikes back the floor 2 s after its projection. Find the velocity of projection of the ball relative to the lift.
- (1) $10 \text{ m/s} \uparrow$
 - (2) $10 \text{ m/s} \downarrow$
 - (3) $12 \text{ m/s} \uparrow$
 - (4) $12 \text{ m/s} \downarrow$

PKN017

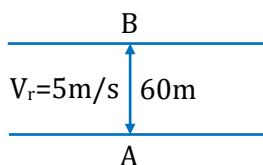
18. A flag is mounted on a car moving due North with velocity of 20 km/hr . Strong winds are blowing due East with velocity of 20 km/hr . The flag will point in direction :-
 (1) East (2) North-East (3) South-East (4) South-West

PKN018

19. Wind is blowing in the north direction at speed of 2 m/s which causes the rain to fall at some angle with the vertical. With what velocity should a cyclist drive so that the rain appears vertical to him:
 (1) 2 m/s south (2) 2 m/s north (3) 4 m/s west (4) 4 m/s south

PKN019

20. A man is crossing a river flowing with velocity of 5 m/s . He reaches a point directly across the river at a distance of 60 m in 5 sec . His velocity in still water should be :-



- (1) 12 m/s (2) 13 m/s (3) 5 m/s (4) 10 m/s

PKN020

SECTION-B

- This section will have **TEN questions**. Candidate can choose to attempt any 5 questions out of these 10 questions. In case if candidate attempts more than 5 questions, first 5 attempted questions will be considered for marking.
- The answer to each question is a **NUMERICAL VALUE**.
- For each question, enter the correct numerical value (Answer should be rounded off to the nearest integer).
- Answer to each question will be evaluated according to the following marking scheme:
 Full Marks : +4, if only correct answer is given.
 Zero Marks : 0, if no answer is given.
 Negative Marks : -1 for incorrect answer.

1. A rocket is fired vertically upwards with initial velocity 40 m/s at the ground level. Its engines then fired and it is accelerated at 2 m/s^2 until it reaches an altitude of 1000 m . At that point the engines shut off and the rocket goes into free-fall. If the velocity (in m/s) just before it collides with the ground is 40α . Then fill the value of α . Disregard air resistance ($g = 10 \text{ m/s}^2$).

PKN021

2. The vertical height y and horizontal distance x of a projectile on a certain planet are given by $x = (3t)m$, $y = (4t - 6t^2)m$ where t is in seconds. Find the speed of projection (in m/s).

PKN022

3. A particle is thrown with a speed 60 ms^{-1} at an angle 60° to the horizontal. When the particle makes an angle 30° with the horizontal in downward direction, it's speed at that instant is v . What is the value of v^2 in SI units ?

PKN023

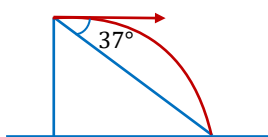
4. A cricketer can throw a ball to a maximum horizontal distance of 100 m. How much high (in m) above the ground can the cricketer throw the same ball ?

PKN024

5. A particle is projected upwards with a velocity of 100 m/s at an angle of 60° with the vertical. Find the time (in sec) when the particle will move perpendicular to its initial direction, taking $g = 10 \text{ m/s}^2$.

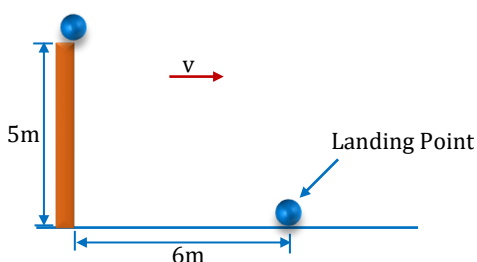
PKN025

6. A ball is thrown horizontally from a cliff such that it strikes ground after 5 s. The line of sight from the point of projection to the point of landing makes an angle of 37° with the horizontal. If the initial velocity of projection is $\frac{50x}{3}$. Find x.



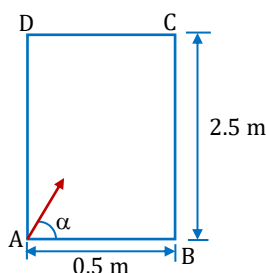
PKN026

7. A ball is dropped from rest from a tower of height 5m. As a result of the wind it lands at a distance 6m from the bottom of the tower as shown. Assuming no air resistance but that the wind gives the ball a constant horizontal velocity v . Find value of v in m/s.



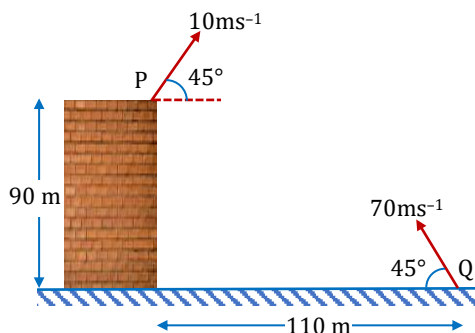
PKN027

8. A cuboidal elevator cabin is shown in the figure. A ball is thrown from point A on the floor of cabin when the elevator is falling under gravity. The plane of motion is ABCD and the angle of projection of the ball with AB, relative to elevator, if the ball collides with point C, is α . Then find the value of $\tan \alpha$.



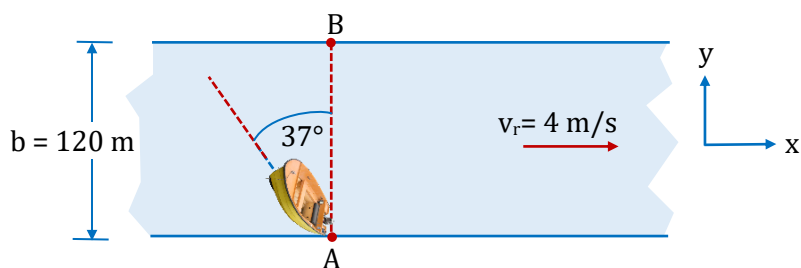
PKN028

9. Two particles P and Q are launched simultaneously as shown in figure. Find the minimum distance between particles in meters.



PKN029

10. Velocity of the boat with respect to river is 10 m/s . From point A it is steered in the direction shown. Find the distance (in m) it will reach on the opposite bank from point B .



PKN030

Exercise - II (JEE-Main PYQs)

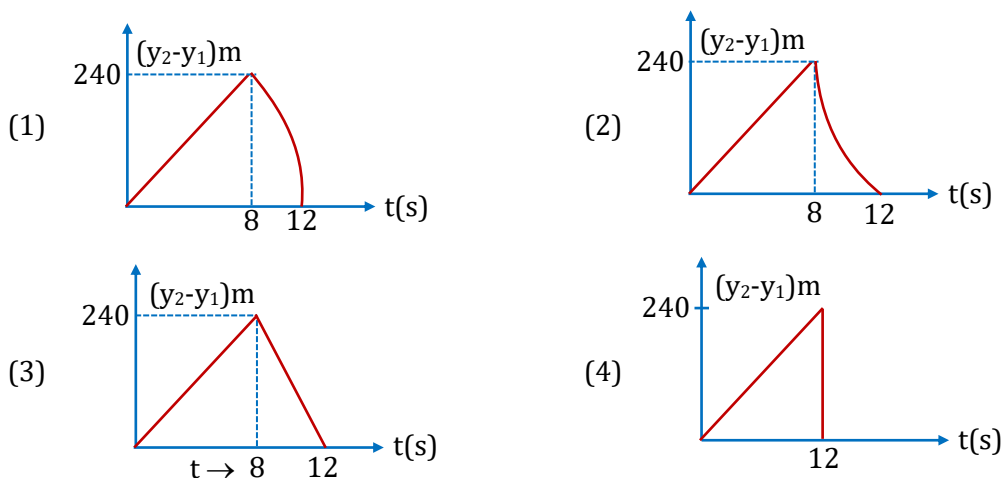
1. A projectile is given an initial velocity of $(\hat{i} + 2\hat{j})$ m/s, where $\hat{i}$ is along the ground and $\hat{j}$ is along the vertical. If $g = 10$ m/s², the equation of its trajectory is : [JEE-Main 2013]

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

PKN031

2. 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/s²) (The figure are schematic and not drawn to scale) [JEE-Main 2015]



PKN032

3. A particle is moving with speed $v = b\sqrt{x}$ along positive x-axis. Calculate the speed of the particle at time $t = \tau$ (assume that the particle is at origin at $t = 0$). [JEE-Main 2019]

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

PKN033

4. 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) $a\omega$ (2) $\sqrt{3}a\omega$ (3) $\sqrt{2}a\omega$ (4) $2a\omega$

PKN034

5. 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 : 2 (2) 1 : 4 (3) 1 : 8 (4) 1 : 16

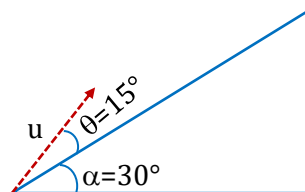
PKN035

6. A particle moves from the point $(2.0\hat{i} + 4.0\hat{j})m$, at $t = 0$, with an initial velocity $(5.0\hat{i} + 4.0\hat{j})ms^{-1}$. It is acted upon by a constant force which produces a constant acceleration $(4.0\hat{i} + 4.0\hat{j})ms^{-2}$. What is the distance of the particle from the origin at time $2s$? [JEE-Main 2019]

(1) $20\sqrt{2}m$ (2) $10\sqrt{2}m$ (3) $5m$ (4) $15m$

PKN036

7. A plane is inclined at an angle $\alpha = 30^\circ$ with respect to the horizontal. A particle is projected with a speed $u = 2ms^{-1}$ from the base of the plane, making an angle $\theta = 15^\circ$ 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 $g = 10ms^{-2}$) [JEE-Main 2019]



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

PKN037

8. 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 ($g = 10ms^{-2}$) : [JEE-Main 2019]

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

PKN038

9. A passenger train of length $60m$ travels at a speed of $80km/hr$. Another freight train of length $120m$ travels at a speed of $30km/hr$. 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 directions is : [JEE-Main 2019]

(1) $\frac{5}{2}$ (2) $\frac{25}{11}$ (3) $\frac{3}{2}$ (4) $\frac{11}{5}$

PKN039

10. 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) 40 (2) 100 (3) 25 (4) 50

PKN040

11. 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) 0.41 (2) 0.50 (3) 0.37 (4) 0.73

PKN041

12. A particle starts from the origin at $t = 0$ with an initial velocity of $3.0\hat{i} \text{ m/s}$ and moves in the x - y plane with a constant acceleration $(6.0\hat{i} + 4.0\hat{j})\text{m/s}^2$. 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) 50 (2) 32 (3) 60 (4) 40

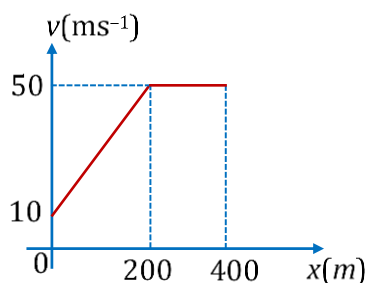
PKN042

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

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

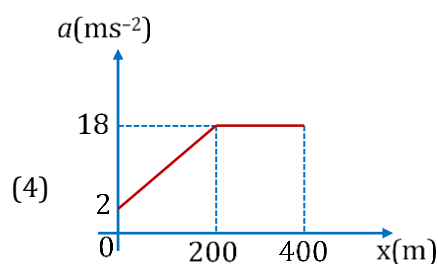
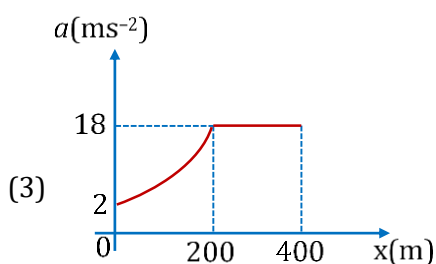
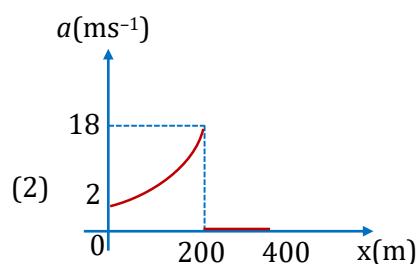
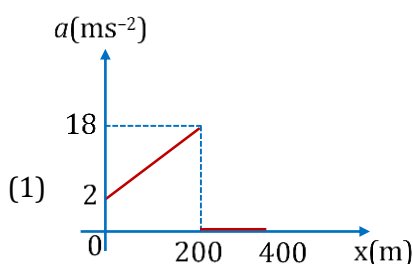
PKN043

14. The velocity-displacement graph describing the motion of a bicycle is shown in the figure.



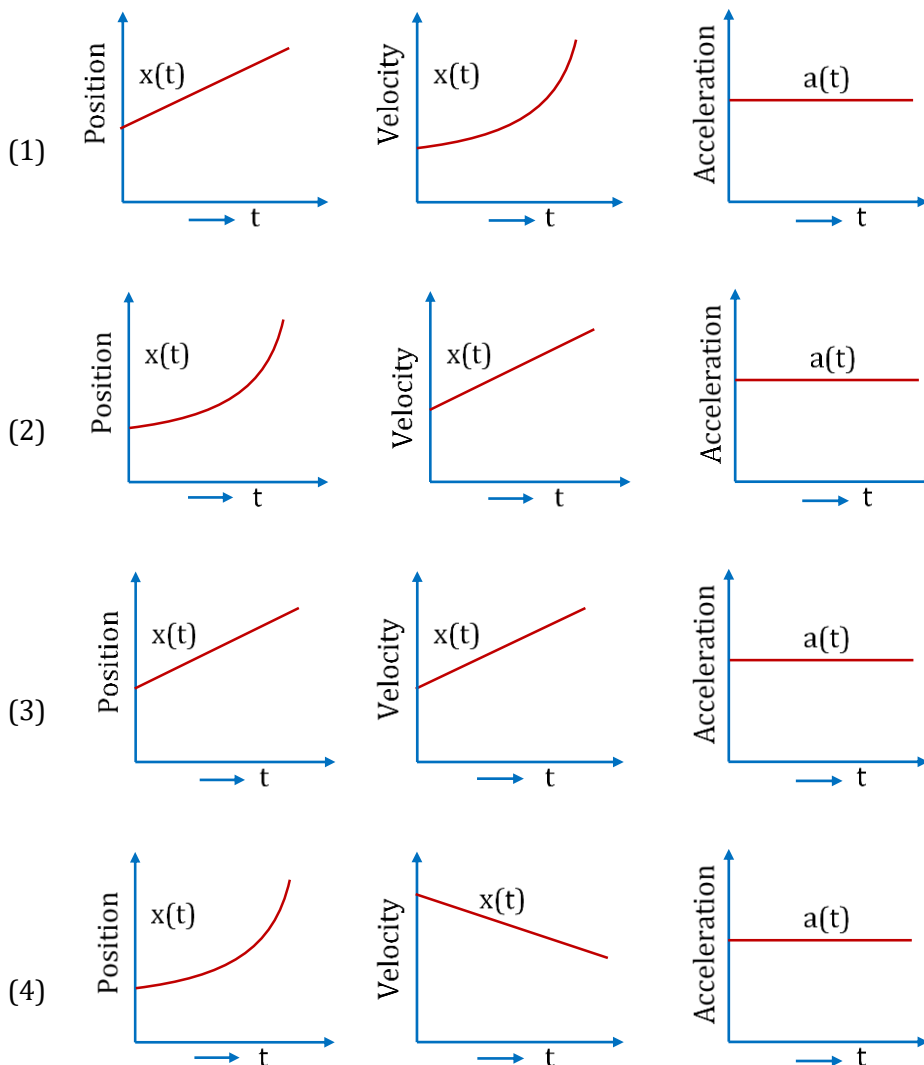
The acceleration-displacement graph of the bicycle's motion is best described by :

[JEE-Main 2021]



PKN044

15. The position, velocity and acceleration of a particle moving with a constant acceleration can be represented by : [JEE-Main 2021]



PKN045

16. 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 $g = 9.8 \text{ m/s}^2$) [JEE-Main 2021]

- (1) 3 drops / 2 seconds (2) 2 drops / second
(3) 1 drop / second (4) 1 drop / 7 seconds

PKN046

17. 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. [JEE-Main 2021]

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

PKN047

18. A butterfly is flying with a velocity $4\sqrt{2} \text{ m/s}$ in North-East direction. Wind is slowly blowing at 1 m/s from North to South. The resultant displacement of the butterfly in 3 seconds is :

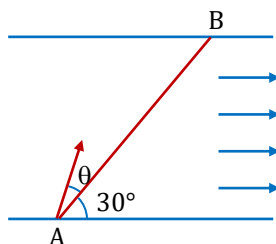
[JEE-Main 2021]

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

PKN048

19. A swimmer wants to cross a river from point A to point B. Line AB makes an angle of 30° with the flow of river. Magnitude of velocity of the swimmer is same as that of the river. The angle θ with the line AB should be _____, so that the swimmer reaches point B.

[JEE-Main 2021]



PKN049

20. A projectile is projected with velocity of 25 m/s at an angle θ with the horizontal. After t seconds its inclination with horizontal becomes zero. If R represents horizontal range of the projectile, the value of θ will be : [Use $g = 10 \text{ m/s}^2$]

[JEE-Main 2022]

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

PKN050

21. A particle starts with an initial velocity of 10.0 ms^{-1} along x -direction and accelerates uniformly at the rate of 2.0 ms^{-2} . The time taken by the particle to reach the velocity of 60.0 ms^{-1} is _____.

[JEE Main-2023]

- (1) 6 s (2) 3 s (3) 30 s (4) 25 s

PKN247

22. Given below are two statements : one is labelled as **Assertion A** and the other is labelled as **Reason R**.

Assertion A : When a body is projected at an angle 45° , its range is maximum.

Reason R : For maximum range, the value of $\sin 2\theta$ should be equal to one.

In the light of the above statements, choose the **correct** answer from the options given below :

[JEE Main-2023]

- (1) Both **A** and **R** are correct but **R** is **NOT** the correct explanation of **A**
 (2) Both **A** and **R** are correct **R** is the correct explanation of **A**
 (3) **A** is true but **R** is false
 (4) **A** is false but **R** is true

PKN248

23. Two projectiles A and B are thrown with initial velocities of 40 m/s and 60 m/s at angles 30° and 60° with the horizontal respectively. The ratio of their ranges respectively is ($g = 10 \text{ m/s}^2$)

[JEE Main-2023]

- (1) $\sqrt{3} : 2$ (2) $2 : \sqrt{3}$ (3) $1 : 1$ (4) $4 : 9$

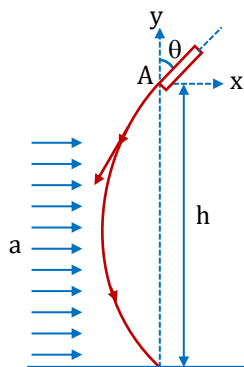
PKN249

Exercise – III (JEE-Advanced Pattern)

SECTION-I

- This section contains **FOUR** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.
- For each question, darken the bubble corresponding to the correct option in the ORS.
- For each question, marks will be awarded in one of the following categories:
Full Marks : +3 if only the bubble corresponding to the correct option is darkened.
Zero Marks : 0 if none of the bubbles is darkened.
Negative Marks : -1 in all other cases.

1. A particle is ejected from the tube at A with a velocity v at an angle θ with the vertical y -axis. A strong horizontal wind gives the particle a constant horizontal acceleration a in the x -direction. If the particle strikes the ground at a point directly under its released position and the downward y -acceleration is taken as g then



$$(A) h = \frac{2v^2 \sin \theta \cos \theta}{a}$$

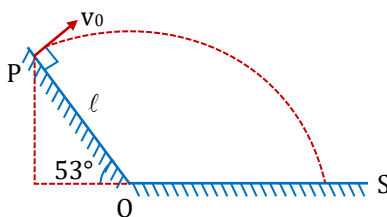
$$(B) h = \frac{2v^2 \sin \theta \cos \theta}{g}$$

$$(C) h = \frac{2v^2}{g} \sin \theta \left(\cos \theta + \frac{a}{g} \sin \theta \right)$$

$$(D) h = \frac{2v^2}{a} \sin \theta \left(\cos \theta + \frac{g}{a} \sin \theta \right)$$

PKN051

2. A stone is projected from point P on the inclined plane with velocity $v_0 = 10 \text{ m/s}$ directed perpendicular to the plane. The time taken by the stone to strike the horizontal ground S is
 (Given $PO = \ell = 10 \text{ meter}$)



$$(A) 1.5 \text{ sec}$$

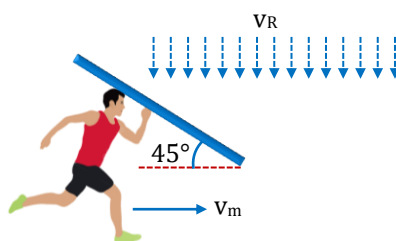
$$(B) 1.4 \text{ sec}$$

$$(C) 2 \text{ sec}$$

$$(D) 2.3 \text{ sec}$$

PKN052

3. On a particular day rain drops are falling vertically at a speed of 5 m/s . A man holding a plastic board is running to escape from rain as shown. The lower end of board is at a height half that of man and the board makes 45° with horizontal. The maximum speed of man so that his feet does not get wet, is



- (A) 5 m/s (B) $5\sqrt{2} \text{ m/s}$ (C) $5/\sqrt{2} \text{ m/s}$ (D) zero

PKN053

4. A 2 m wide truck is moving with a uniform speed of 8 m/s along a straight horizontal road. A pedestrian starts crossing the road at an instant when the truck is 4 m away from him. The minimum constant velocity with which he should run to avoid an accident is :-



- (A) $1.6\sqrt{5} \text{ m/s}$ (B) $1.2\sqrt{5} \text{ m/s}$ (C) $1.2\sqrt{7} \text{ m/s}$ (D) $1.6\sqrt{7} \text{ m/s}$

PKN054

SECTION-II

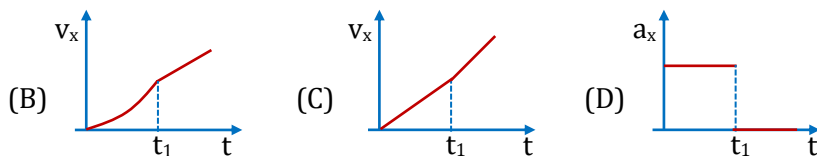
- This section contains **SIX** questions.
- Each question has **FOUR** options for correct answer(s). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct option(s).
- For each question, choose the correct option(s) to answer the question.
- Answer to each question will be evaluated according to the following marking scheme:
Full Marks : +4 if only (all) the correct option(s) is (are) chosen.
Partial Marks : +3 if all the four options are correct but **ONLY** three options are chosen.
Partial Marks : +2 if three or more options are correct but **ONLY** two options are chosen, both of which are correct options.
Partial Marks : +1 if two or more options are correct but **ONLY** one option is chosen and it is a correct option.
Zero Marks : 0 if none of the options is chosen (i.e. the question is unanswered).
Negative Marks : -2 in all other cases.

For Example : If first, third and fourth are the **ONLY** three correct options for a question with second option being an incorrect option; selecting only all the three correct options will result in +4 marks. Selecting only two of the three correct options (e.g. the first and fourth options), without selecting any incorrect option (second option in this case), will result in +2 marks. Selecting only one of the three correct options (either first or third or fourth option), without selecting any incorrect option (second option in this case), will result in +1 marks. Selecting any incorrect option(s) (second option in this case), with or without selection of any correct option(s) will result in -2 marks.

5. The position of a particle with time is given by
 $(x, y) = (8t^2, 3)$ for $t \leq t_1 = (8t, 3)$ for $t > t_1$

Choose the **CORRECT** alternative.

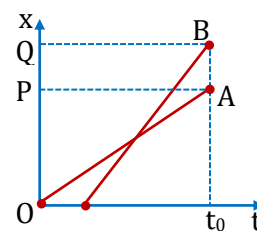
(A) Particle moves along a straight line parallel to x axis.



PKN055

6. The position–time (x – t) graphs for two children A and B returning from their school O to their homes P and Q respectively along straight line path (taken as x axis) are shown in figure below. Choose the **CORRECT** statement (s):

- (A) A lives closer to the school than B
 (B) A starts from the school earlier than B
 (C) A and B have equal average velocities from 0 to t_0 .
 (D) B overtakes A on the way



PKN056

7. A ball is thrown from ground such that it just crosses two poles of equal height kept 80 m apart. The maximum height attained by the ball is 80 m . When the ball passes the first pole, its velocity makes 45° with horizontal. The correct alternatives is/are :- ($g = 10\text{ m/s}^2$)
- (A) Time interval between the two poles is 4 s .
 (B) Height of the pole is 60 m .
 (C) Range of the ball is 160 m .
 (D) Angle of projection is $\tan^{-1}(2)$ with horizontal.

PKN057

8. A projectile is thrown with speed u into air from a point on the horizontal ground at an angle θ with horizontal. If the air exerts a constant horizontal resistive force on the projectile then select correct alternative(s).
- (A) At the farthest point, the velocity is horizontal.
 (B) The time for ascent equals the time for descent.
 (C) The path of the projectile may be parabolic.
 (D) The path of the projectile may be a straight line.

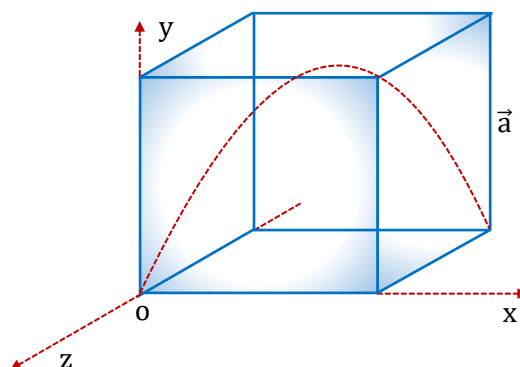
PKN058

9. A block is thrown horizontally with a velocity of 2 m/s (relative to ground) on a belt, which is moving with velocity 4 m/s in opposite direction of the initial velocity of block. If the block stops slipping on the belt after 4 s it was dropped then choose the correct statement(s) :-
- (A) Displacement with respect to ground is zero after 2.66 s and magnitude of displacement with respect to ground is 12 m after 4 s .
 (B) Magnitude of displacement with respect to ground in 4 s is 4 m .
 (C) Magnitude of displacement with respect to belt in 4 s is 12 m .
 (D) Displacement with respect to ground is zero in $8/3\text{ s}$.

PKN059

10. A cubical box dimension $L = 5/4$ meter starts moving with an acceleration $\vec{a} = 0.5 \text{ m/s}^2 \hat{i}$ from the state of rest. At the same time, a stone is thrown from the origin with velocity $\vec{V} = v_1 \hat{i} + v_2 \hat{j} - v_3 \hat{k}$ with respect to earth. Acceleration due to gravity $\vec{g} = 10 \text{ m/s}^2 (-\hat{j})$. The stone just touches the roof of box and finally falls at the diagonally opposite point then :

- (A) $v_1 = \frac{3}{2}$ (B) $v_2 = 5$
 (C) $v_3 = \frac{5}{4}$ (D) $v_3 = \frac{5}{2}$



PKN060

SECTION-III

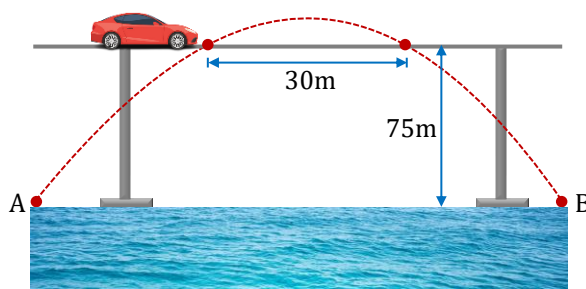
- This section contains **TWO** paragraphs.
- Based on each paragraph, there are **TWO/THREE** questions.
- Each question has **FOUR** options (A), (B), (C) and (D) **ONLY ONE** of these four options is correct.
- For each question, darken the bubble corresponding to the correct option in the ORS.
- For each question, marks will be awarded in one of the following categories :

Full Marks : +3 if only the bubble corresponding to the correct answer is darkened.

Zero Marks : 0 in all other cases.

PARAGRAPH FOR QUESTION NO. 11 TO 13

In the figure shown there is a long horizontal bridge over a river 75 m high from water surface. A strong man throws a stone in the parallel plane of the bridge. A observer in a car travelling on the bridge finds the stone going pass by the car while ascending and also while descending between two points on the road 30 m away. The car is travelling at a speed of 15 m/s. The stone is thrown from the bank of river just at the same level of water.



11. What is the angle the velocity makes with the bridge when it goes past the car while ascending ?
 (A) 30° (B) 45° (C) $\tan^{-1} \left(\frac{2}{3} \right)$ (D) $\tan^{-1} \left(\frac{3}{2} \right)$
12. Horizontal distance AB travelled by stone is :-
 (A) 0 m (B) 75 m (C) 120 m (D) 240 m
13. What is the distance between car and stone at the instant when particle reaches at point B ?
 (A) 0 m (B) 75 m (C) 120 m (D) 240 m

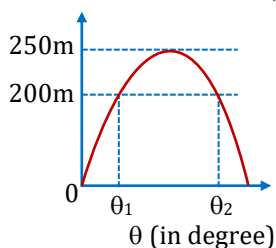
PKN061

PKN062

PKN063

PARAGRAPH FOR QUESTION 14 AND 15

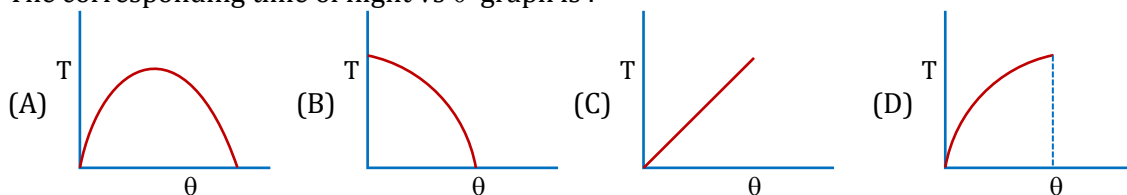
From the ground level, a ball is to be shot with a certain speed. Graph shows the range (R) of the particle versus the angle of projection from horizontal (θ).



14. Values of θ_1 and θ_2 are
 (A) 53° and 37° (B) 26.5° and 63.5° (C) 18.5° and 71.5° (D) 15° and 75°

PKN064

15. The corresponding time of flight vs θ graph is :-



PKN065

SECTION-IV

- This section contains **TWO** questions.
- The answer to each question is a **NUMERICAL VALUE**.
- For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. 6.25, 7.00, -0.33, -30, 30.27, -127.30, if answer is 11.36777..... then both 11.36 and 11.37 will be correct) by darkening the corresponding bubbles in the ORS.

For Example : If answer is -77.25, 5.2 then fill the bubbles as follows:

+										-									
●	●	0	0	0	0	0	0	0	0	●	●	0	0	0	0	0	0	0	0
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9

- Answer to each question will be evaluated according to the following marking scheme:
Full Marks : +3 if ONLY the correct numerical value is entered as answer.
Zero Marks : 0 in all other cases.

16. A body starting from rest accelerates uniformly at the rate of 10 cm s^{-2} and retards uniformly at the rate of 20 cm/sec^2 . Find the least time in which it can complete a journey of 5 km if the maximum velocity attained by the body is 72 km/h^{-1} .

PKN066

17. A ball is thrown vertically upwards from the ground. It crosses a point at the height of 25 m twice at an interval of 4 secs. The ball was thrown with the velocity of

PKN067

SECTION-V

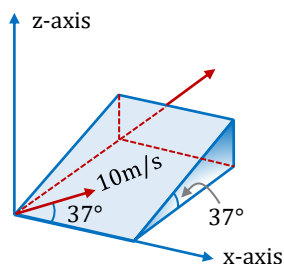
- This section contains **ONE** question.
- Each question contains two columns, **Column-I** and **Column-II**.
- **Column-I** has **three** entries (A), (B) and (C).
- **Column-II** has **four** entries (P), (Q), (R) and (S).
- Match the entries in **Column-I** with the entries in **column-II**.
- One or more entries in **Column-I** may match with one or more entries in **Column-II**.
- The ORS contains a 3×4 matrix whose layout will be similar to the one shown below:

(A) ☐ (P) ☐ (Q) ☐ (R) ☐ (S)(B) ☐ (P) ☐ (Q) ☐ (R) ☐ (S)(C) ☐ (P) ☐ (Q) ☐ (R) ☐ (S)

- For each entry in **column-I**, darken the bubbles of all the matching entries. For example, if entry (A) in **Column-I** matches with entries (Q), (R) and (S), then darken these three bubbles in the ORS. Similarly, for entries (B) and (C).
- For each question, marks will be awarded in one of the following categories :

For each entry in **Column-I***Full Marks* : +2 if only the bubble(s) corresponding to all the correct match(es) is (are) darkened.*Zero Marks* : 0 if none of the bubbles is darkened.*Negative Marks* : -1 in all other cases.

18. A small ball is projected along the surface of a smooth inclined plane with speed 10 m/s along the direction shown at $t = 0$. The point of projection is origin, z -axis is along vertical. The acceleration due to gravity is 10 m/s^2 . Column-I lists values of certain parameters related to motion of ball and column-II lists different time instants. Match appropriately.

**Column-I**

- (A) Distance from x -axis is 2.25 m
 (B) Speed is minimum
 (C) Velocity makes angle 37° with x -axis

Column-II

- (P) 0.5 s
 (Q) 1.0 s
 (R) 1.5 s
 (S) 2.0 s

PKN068

SECTION-VI

- This section contains **TWO** questions.
- Each question contains two columns, **Column-I** and **Column-II**.
- **Column-I** has **four** entries (A), (B), (C) and (D).
- **Column-II** has **five** entries (P), (Q), (R), (S) and (T).
- Match the entries in **Column-I** with the entries in **column-II**.
- One or more entries in **Column-I** may match with one or more entries in **Column-II**.
- The ORS contains a 4×5 matrix whose layout will be similar to the one shown below:

(A)	☐ (P)	☐ (Q)	☐ (R)	☐ (S)	☐ (T)
(B)	☐ (P)	☐ (Q)	☐ (R)	☐ (S)	☐ (T)
(C)	☐ (P)	☐ (Q)	☐ (R)	☐ (S)	☐ (T)
(D)	☐ (P)	☐ (Q)	☐ (R)	☐ (S)	☐ (T)

- For each entry in **column-I**, darken the bubbles of all the matching entries. For example, if entry (A) in **Column-I** matches with entries (Q), (R) and (T), then darken these three bubbles in the ORS. Similarly, for entries (B), (C) and (D).
- For each question, marks will be awarded in one of the following categories :

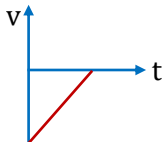
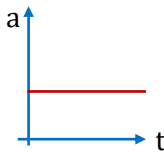
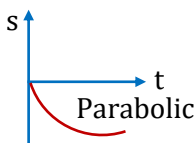
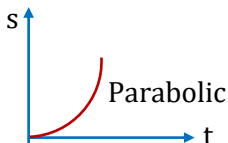
For each entry in **Column-I**

Full Marks : +2 if only the bubble(s) corresponding to all the correct match(es) is (are) darkened.

Zero Marks : 0 if none of the bubbles is darkened.

Negative Marks : -1 in all other cases.

19. v, a, s and t denote velocity, acceleration, displacement and time respectively. Match the columns :-

Column-I	Column-II
(A) 	(P) Velocity of the particle is in positive direction, acceleration in negative direction
(B) 	(Q) Both velocity and acceleration of the particle are in negative directions.
(C) 	(R) Velocity of the particle is in negative direction and acceleration in positive direction
(D) 	(S) Velocity and acceleration both in positive direction
	(T) Acceleration is constant

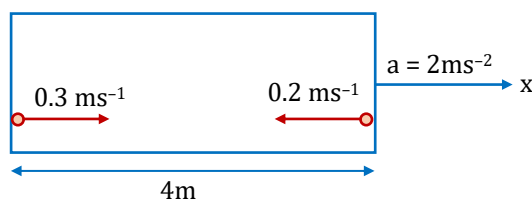
PKN069

20.	Column-I		Column-II
(A)	Time for a boat to cross a river of width ℓ by the shortest distance ($\vec{v}$ -velocity of boat with respect to water; $\vec{u}$ -velocity of water) $ \vec{v} > \vec{u} $	(P)	$\frac{\ell}{ \vec{v} + \vec{u} }$
(B)	Time for two particles moving with velocities $\vec{v}$ and $\vec{u}$ in opposite directions to meet each other. (initial separation of particles is ℓ)	(Q)	$\frac{\ell}{\sqrt{v^2 - u^2}}$
(C)	Time for a boat to cross a river of width ℓ in the shortest time ($\vec{v}$ -velocity of boat with respect to water; $\vec{u}$ -velocity of water)	(R)	$\frac{\ell}{ \vec{v} + \vec{u} }$
(D)	Time for a boat to travel a distance ℓ downstream ($\vec{v}$ -velocity of boat with respect to water; $\vec{u}$ -velocity of water)	(S)	$\frac{\ell}{ \vec{v} }$
		(T)	$\frac{\ell}{\sqrt{u^2 + v^2}}$

PKN070

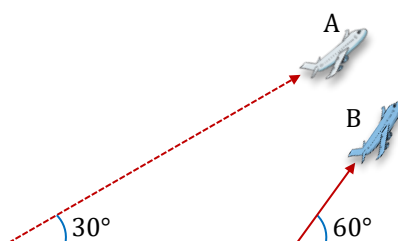
Exercise - IV (JEE-Advanced PYQs)

1. A rocket is moving in a gravity free space with a constant acceleration of 2 ms^{-2} along $+x$ direction (see figure). The length of a chamber inside the rocket is 4 m . A ball is thrown from the left end of the chamber in $+x$ direction with a speed of 0.3 ms^{-1} relative to the rocket. At the same time, another ball is thrown in $-x$ direction with a speed of 0.2 ms^{-1} from its right end relative to the rocket. The time in seconds when the two balls hit each other is [JEE-Advanced 2014]



PKN071

2. Airplanes A and B are flying with constant velocity in the same vertical plane at angles 30° and 60° with respect to the horizontal respectively as shown in figure. The speed of A is $100\sqrt{3} \text{ ms}^{-1}$. At time $t = 0 \text{ s}$, 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-Advanced 2014]



PKN072

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-Advanced 2017]

- (A) R^3 (B) $\frac{1}{R}$ (C) R (D) $R^{2/3}$

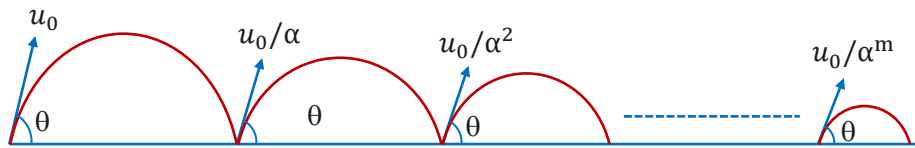
PKN073

4. A ball is projected from the ground at an angle of 45° with the horizontal surface. It reaches a maximum height of 120 m and returns to the ground. Upon hitting the ground for the first time, it loses half of its kinetic energy. Immediately after the bounce, the velocity of the ball makes an angle of 30° with the horizontal surface. The maximum height it reaches after the bounce, in metres, is..... [JEE-Advanced 2018]

PKN074

5. A ball is thrown from ground at an angle θ with horizontal and with an initial speed u_0 . For the resulting projectile motion, the magnitude of average velocity of the ball up to the point when it hits the ground for the first time is V_1 . After hitting the ground, ball rebounds at the same angle θ but with a reduced speed of u_0/α . Its motion continues for a long time as shown in figure. If the magnitude of average velocity of the ball for entire duration of motion is $0.8 V_1$, the value of α is _____.

[JEE-Advanced 2019]



PKN075

6. Starting at time $t = 0$ from the origin with speed 1 ms^{-1} , a particle follows a two-dimensional trajectory in the x - y plane so that its coordinates are related by the equation $y = \frac{x^2}{2}$. The x and y components of its acceleration are denoted by a_x and a_y , respectively. Then
- (A) $a_x = 1 \text{ ms}^{-2}$ implies that when the particle is at the origin, $a_y = 1 \text{ ms}^{-2}$
 (B) $a_x = 0$ implies $a_y = 1 \text{ ms}^{-2}$ at all times
 (C) At $t = 0$, the particle's velocity points in the x -direction
 (D) $a_x = 0$ implies that at $t = 1 \text{ s}$, the angle between the particle's velocity and the x axis is 45°

PKN076

7. A particle of mass m is moving in the xy -plane such that its velocity at a point (x, y) is given as $\vec{v} = \alpha(y\hat{x} + 2x\hat{y})$, where α is a non-zero constant. What is the force $\vec{F}$ acting on the particle?

[JEE-Advanced 2023]

- (A) $\vec{F} = 2m\alpha^2(x\hat{x} + y\hat{y})$ (B) $\vec{F} = m\alpha^2(y\hat{x} + 2x\hat{y})$
 (C) $\vec{F} = 2m\alpha^2(y\hat{x} + x\hat{y})$ (D) $\vec{F} = m\alpha^2(x\hat{x} + 2y\hat{y})$

PKN250

ANSWER KEY

Exercise – I (JEE-Main Pattern)

Section-A	Q.	1	2	3	4	5	6	7	8	9	10
	A.	1	2	1	1	3	3	2	4	2	3
	Q.	11	12	13	14	15	16	17	18	19	20
	A.	3	2	2	2	2	4	3	3	2	2
Section-B	Q.	1	2	3	4	5	6	7	8	9	10
	A.	4	5	1200	50	20	2	6	5	6	30

Exercise – II (JEE-Main PYQs)

Question	1	2	3	4	5	6	7	8	9	10
Answer	2	1	2	3	4	1	2	1	4	4
Question	11	12	13	14	15	16	17	18	19	20
Answer	4	3	3	1	2	3	3	4	30	4
Question	21	22	23							
Answer	4	2	4							

Exercise – III (JEE-Advanced Pattern)

Section-I	Q.	1	2	3	4		
	A.	D	C	A	A		
Section-II	Q.	5	6	7	8	9	10
	A.	AD	ABD	ABCD	BCD	BCD	ABC
Section-III	Q.	11	12	13	14	15	
	A.	C	C	B	B	D	
Section-IV	Q.	16	17				
	A.	400	30				
Section-V	Q.	18					
	A.	(A-P,R), (B-Q), (C-S)					
Section-VI	Q.	19			20		
	A.	(A-R,T), (B-T), (C-R,T), (D-S,T)			(A-P,Q), (B-R), (C-S), (D-P,R)		

Exercise – IV (JEE-Advanced PYQs)

Question	1	2	3	4	5	6	7			
Answer	8 or 2	5	C	30 [29.60, 30.40]	4	ABCD	A			

Important Notes

Important Notes