

Motion in a Plane — NEET Physics PYQ (2005-2021)

Class 11 Physics · 32 real NEET & AIPMT questions, year-tagged · answers checked by RankUp

NEET 2021

1. A car starts from rest and accelerates at 5 m/s^2 . At $t = 4 \text{ s}$, a ball is dropped out of a window by a person sitting in the car. What is the velocity and acceleration of the ball at $t = 6 \text{ s}$? (Take $g = 10 \text{ m/s}^2$)

- (A) 20 m/s , 5 m/s^2
- (B) 20 m/s , 0
- (C) $20\sqrt{2} \text{ m/s}$, 0
- (D) $20\sqrt{2} \text{ m/s}$, 10 m/s^2

NEET 2021

2. A particle moving in a circle of radius R with a uniform speed takes a time T to complete one revolution.

If this particle were projected with the same speed at an angle ' θ ' to the horizontal, the maximum height attained by it equals $4R$. The angle of projection, θ , is then given by :

- (A) $\theta = \cos^{-1} (gT^2/\pi^2 R)^{1/2}$
- (B) $\theta = \cos^{-1} (\pi^2 R/gT^2)^{1/2}$
- (C) $\theta = \sin^{-1} (\pi^2 R/gT^2)^{1/2}$
- (D) $\theta = \sin^{-1} (2gT^2/\pi^2 R)^{1/2}$

NEET 2019 · Q32

3. The speed of a swimmer in still water is 20 m/s . The speed of river water is 10 m/s and is flowing due east. If he is standing on the south bank and wishes to cross the river along the shortest path, the angle at which he should make his strokes w.r.t. north is given by:

- (A) 30° west
- (B) 0°
- (C) 60° west
- (D) 45° west

NEET 2019 · Q34

4. Two particles A and B are moving in uniform circular motion in concentric circles of radii r_A and r_B with speed v_A and v_B respectively. Their time period of rotation is the same. The ratio of angular speed of A to that of B will be:

- (A) $r_A : r_B$
- (B) $v_A : v_B$
- (C) $r_B : r_A$
- (D) $1 : 1$

NEET 2017 · Q169

5. 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 meters and t in seconds. The acceleration of the particle at $t = 2 \text{ s}$ is:

- (A) 0
- (B) 5 m/s^2
- (C) -4 m/s^2
- (D) -8 m/s^2

NEET 2017 (Gujarati paper) · Q147

6. A ball of mass 1 kg is thrown vertically upwards and returns to the ground after 3 seconds. Another ball, thrown at 60° with vertical also stays in air for the same time before it touches the ground. The ratio of the two heights are:

- (A) 1 : 2
- (B) 1 : 1
- (C) 2 : 1
- (D) 1 : 3

NEET 2017 (Gujarati paper) · Q169

7. The angle between $\vec{A} - \vec{B}$ and $\vec{A} \times \vec{B}$ is ($\vec{A} \neq \vec{B}$):

- (A) 90°
- (B) 120°
- (C) 45°
- (D) 60°

NEET 2016 Phase 1 · Q24

8. A particle of mass 10 g moves along a circle of radius 6.4 cm with a constant tangential acceleration. What is the magnitude of this acceleration if the kinetic energy of the particle becomes equal to 8×10^{-4} J by the end of the second revolution after the beginning of the motion?

- (A) 0.1 m/s^2
- (B) 0.15 m/s^2
- (C) 0.18 m/s^2
- (D) 0.2 m/s^2

NEET 2016 Phase 1 · Q27

9. A particle moves so that its position vector is given by $\vec{r} = \cos \omega t \hat{x} + \sin \omega t \hat{y}$, where ω is a constant. Which of the following is true?

- (A) Velocity and acceleration both are perpendicular to $\vec{r}$.
- (B) Velocity and acceleration both are parallel to $\vec{r}$.
- (C) Velocity is perpendicular to $\vec{r}$ and acceleration is directed towards the origin.
- (D) Velocity is perpendicular to $\vec{r}$ and acceleration is directed away from the origin.

NEET 2016 Phase 1 · Q37

10. If the magnitude of sum of two vectors is equal to the magnitude of difference of the two vectors, the angle between these vectors is:

- (A) 0°
- (B) 90°
- (C) 45°
- (D) 180°

AIPMT 2015

11. A ship A is moving Westwards with a speed of 10 km h^{-1} and a ship B 100 km South of A, is moving Northwards with a speed of 10 km h^{-1} . The time after which the distance between them becomes shortest, is:

- (A) $10\sqrt{2} \text{ h}$
- (B) 0 h
- (C) 5 h
- (D) $5\sqrt{2} \text{ h}$

AIPMT 2014

12. A particle is moving such that its position coordinates (x, y) are (2 m, 3 m) at time $t = 0$, (6 m, 7 m) at time $t = 2$ s and (13 m, 14 m) at time $t = 5$ s. Average velocity vector (V_{av}) from $t = 0$ to $t = 5$ s is:

- (A) $(7/3)(\hat{i} + \hat{j})$
- (B) $2(\hat{i} + \hat{j})$
- (C) $(11/5)(\hat{i} + \hat{j})$
- (D) $(1/5)(13\hat{i} + 14\hat{j})$

AIPMT 2014

13. A projectile is fired from the surface of the earth with a velocity of 5 ms^{-1} and angle θ with the horizontal. Another projectile fired from another planet with a velocity of 3 ms^{-1} at the same angle follows a trajectory which is identical with the trajectory of the projectile fired from the earth. The value of the acceleration due to gravity on the planet is (in ms^{-2}) is: (given $g = 9.8 \text{ ms}^{-2}$)

- (A) 5.9
- (B) 16.3
- (C) 110.8
- (D) 3.5

NEET 2013

14. The velocity of a projectile at the initial point A is $(2\hat{i} + 3\hat{j})$ m/s. Its velocity (in m/s) at point B (the point where it returns to the same horizontal level as A) is

- (A) $-2\hat{i} - 3\hat{j}$
- (B) $-2\hat{i} + 3\hat{j}$
- (C) $2\hat{i} - 3\hat{j}$
- (D) $2\hat{i} + 3\hat{j}$

AIPMT 2012 Prelims

15. The horizontal range and the maximum height of a projectile are equal. The angle of projection of the projectile is

- (A) $\theta = 45^\circ$
- (B) $\theta = \tan^{-1}(1/4)$
- (C) $\theta = \tan^{-1}(4)$
- (D) $\theta = \tan^{-1}(2)$

AIPMT 2012 Prelims

16. A particle has initial velocity $(2\hat{i} + 3\hat{j})$ and acceleration $(0.3\hat{i} + 0.2\hat{j})$. The magnitude of velocity after 10 seconds will be

- (A) 9 units
- (B) $9\sqrt{2}$ units
- (C) $5\sqrt{2}$ units
- (D) 5 units

AIPMT 2011 Mains

17. A projectile is fired at an angle of 45° with the horizontal. Elevation angle of the projectile at its highest point as seen from the point of projection is

- (A) $\tan^{-1}(\sqrt{3}/2)$
- (B) 45°
- (C) 60°
- (D) $\tan^{-1}(1/2)$

AIPMT 2011 Prelims

18. A particle moves in a circle of radius 5 cm with constant speed and time period 0.2π s. The acceleration of the particle is

- (A) 5 m/s^2
- (B) 15 m/s^2
- (C) 25 m/s^2
- (D) 36 m/s^2

AIPMT 2011 Prelims

19. A body is moving with velocity 30 m/s towards east. After 10 seconds its velocity becomes 40 m/s towards north. The average acceleration of the body is

- (A) 5 m/s^2
- (B) 1 m/s^2
- (C) 7 m/s^2
- (D) $\sqrt{7} \text{ m/s}^2$

AIPMT 2011 Prelims

20. A missile is fired for maximum range with an initial velocity of 20 m/s. If $g = 10 \text{ m/s}^2$, the range of the missile is

- (A) 20 m
- (B) 40 m
- (C) 50 m
- (D) 60 m

AIPMT 2010 Mains · Q72

21. The speed of a projectile at its maximum height is half of its initial speed. The angle of projection is

- (A) 60°
- (B) 15°
- (C) 30°
- (D) 45°

AIPMT 2010 Mains · Q74

22. A particle moves in x-y plane according to rule $x = a \sin \omega t$ and $y = a \cos \omega t$. The particle follows

- (A) An elliptical path
- (B) A circular path
- (C) A parabolic path
- (D) A straight line path inclined equally to x and y-axes

AIPMT 2010 Prelims · Q4

23. A particle has initial velocity $(3\hat{i} + 4\hat{j})$ and has acceleration $(0.4\hat{i} + 0.3\hat{j})$. Its speed after 10 s is

- (A) 10 units
- (B) 7 units
- (C) $7\sqrt{2}$ units
- (D) 8.5 units

AIPMT 2007 Prelims · Q4

24. A particle starting from the origin (0, 0) moves in a straight line in the (x, y) plane. Its coordinates at a later time are $(\sqrt{3}, 3)$. The path of the particle makes with the x-axis an angle of

- (A) 45°
- (B) 60°
- (C) 0°
- (D) 30°

AIPMT 2007 Prelims · Q32

25. $\mathbf{A}$ and $\mathbf{B}$ are two vectors and θ is the angle between them, if $|\mathbf{A} \times \mathbf{B}| = \sqrt{3} (\mathbf{A} \cdot \mathbf{B})$, the value of θ is

- (A) 45°
- (B) 30°
- (C) 90°
- (D) 60°

AIPMT 2006 Prelims · Q14

26. For angles of projection of a projectile at angles $(45^\circ - \theta)$ and $(45^\circ + \theta)$, the horizontal ranges described by the projectile are in the ratio of :

- (A) 1 : 1
- (B) 2 : 3
- (C) 1 : 2
- (D) 3 : 2

AIPMT 2006 Prelims · Q45

27. A car runs at a constant speed on a circular track of radius 100 m, taking 62.8 s for every circular lap. The average velocity and average speed for each circular lap respectively is :

- (A) 0, 0
- (B) 0, 10 m/s
- (C) 10 m/s, 20 m/s
- (D) 20 m/s, 0

AIPMT 2006 Prelims · Q49

28. The vectors $\mathbf{A}$ and $\mathbf{B}$ are such that $|\mathbf{A} + \mathbf{B}| = |\mathbf{A} - \mathbf{B}|$. The angle between the two vectors is :

- (A) 90°
- (B) 60°
- (C) 30°
- (D) 0°

AIPMT 2005 Prelims · Q29

29. If a vector $2\hat{i} + 3\hat{j} + 8\hat{k}$ is perpendicular to the vector $4\hat{j} - 4\hat{i} + \alpha\hat{k}$, then the value of α is :

- (A) -2
- (B) $1/2$
- (C) $-1/2$
- (D) 2

AIPMT 2005 Prelims · Q32

30. A stone tied to the end of a string of 1 m long is whirled in a horizontal circle with a constant speed. If the stone makes 22 revolutions in 44 s, what is the magnitude and direction of acceleration of the stone ?

- (A) $(\pi^2/4) \text{ m s}^{-2}$ and direction along the radius towards the centre
- (B) $2\pi^2 \text{ m s}^{-2}$ and direction along the radius away from centre
- (C) $\pi^2 \text{ m s}^{-2}$ and direction along the radius towards the centre
- (D) $4\pi^2 \text{ m s}^{-2}$ and direction along the tangent to the circle

31. Two boys are standing at the ends A and B of a ground, where $AB = a$. The boy at B starts running in a direction perpendicular to AB with velocity v_1 . The boy at A starts running simultaneously with velocity v and catches the other boy in a time t , where t is :

- (A) $a/\sqrt{v^2 + v_1^2}$
- (B) $\sqrt{a^2/(v^2 - v_1^2)}$
- (C) $a/(v - v_1)$
- (D) $a/(v + v_1)$

32. If the angle between the vectors $\vec{A}$ and $\vec{B}$ is θ , the value of the product $(\vec{B} \times \vec{A}) \cdot \vec{A}$ is equal to :

- (A) $BA^2 \cos^2 \theta$
- (B) $BA^2 \sin^2 \theta$
- (C) $BA^2 \sin \theta \cos \theta$
- (D) zero

Answer key and explanations

1. Answer: (D) $20\sqrt{2}$ m/s, 10 m/s^2

At $t = 4 \text{ s}$ the car's speed is $5 \times 4 = 20 \text{ m/s}$, which the ball keeps horizontally. After 2 s of free fall its vertical speed is $10 \times 2 = 20 \text{ m/s}$, so $v = \sqrt{20^2 + 20^2} = 20\sqrt{2} \text{ m/s}$. Once released, only gravity acts, so its acceleration is $g = 10 \text{ m/s}^2$, not the car's 5 m/s^2 .

2. Answer: (D) $\theta = \sin^{-1} (2gT^2/\pi^2 R)^{1/2}$

Speed $v = 2\pi R/T$. Maximum height $H = v^2 \sin^2 \theta / (2g) = 4R$ gives $\sin^2 \theta = 8gR/v^2 = 8gR \cdot T^2 / (4\pi^2 R^2) = 2gT^2/(\pi^2 R)$. Hence $\theta = \sin^{-1} (2gT^2/\pi^2 R)^{1/2}$.

3. Answer: (A) 30° west

For the shortest path his resultant velocity must point due north, so the westward component of his swimming velocity must cancel the current: $20 \sin \theta = 10$, $\theta = 30^\circ$ west of north. Swimming straight north (0°) gives minimum time, not the shortest path.

4. Answer: (D) 1 : 1

Angular speed $\omega = 2\pi/T$; equal time periods mean equal angular speeds, ratio 1 : 1. The ratio $v_A : v_B$ equals $r_A : r_B$ here, which is the ratio of linear, not angular, speeds.

5. Answer: (C) -4 m/s^2

$a_x = d^2x/dt^2 = -4 \text{ m/s}^2$ (constant) and $a_y = d^2y/dt^2 = 0$ since y grows uniformly. The acceleration is therefore -4 m/s^2 along x at every instant, including $t = 2 \text{ s}$. -8 m/s^2 comes from substituting $t = 2$ into $-4t$, which is not the acceleration.

6. Answer: (B) 1 : 1

Time of flight $T = 2u_y/g$ depends only on the vertical component of velocity, and maximum height $H = u_y^2/2g = gT^2/8$. Equal flight times mean equal vertical components, so both balls rise to the same height, 1 : 1 (each $H = 10 \times 9/8 \approx 11.25 \text{ m}$ with $g = 10 \text{ m/s}^2$). The 60° angle changes only the horizontal motion.

7. Answer: (A) 90°

$\vec{A} \times \vec{B}$ is perpendicular to the plane containing $\vec{A}$ and $\vec{B}$, and $\vec{A} - \vec{B}$ lies in that plane. So $(\vec{A} - \vec{B}) \cdot (\vec{A} \times \vec{B}) = 0$ and the angle is 90° for any non-parallel $\vec{A}$ and $\vec{B}$.

8. Answer: (A) 0.1 m/s^2

$\frac{1}{2}mv^2 = 8 \times 10^{-4} \text{ J}$ with $m = 0.01 \text{ kg}$ gives $v^2 = 0.16 \text{ m}^2/\text{s}^2$. The distance covered in two revolutions is $s = 2 \times 2\pi r = 4\pi \times 0.064 \approx 0.804 \text{ m}$. From $v^2 = 2a_t s$, $a_t = 0.16/(2 \times 0.804) \approx 0.0995 \approx 0.1 \text{ m/s}^2$; 0.15 m/s^2 does not satisfy this.

9. Answer: (C) Velocity is perpendicular to $\vec{r}$ and acceleration is directed towards the origin.

This is uniform circular motion of unit radius. $\vec{v} = \omega(-\sin \omega t \hat{x} + \cos \omega t \hat{y})$, and $\vec{v} \cdot \vec{r} = 0$, so velocity is perpendicular to $\vec{r}$. $\vec{a} = -\omega^2 \vec{r}$, so acceleration points towards the origin, not away from it.

10. Answer: (B) 90°

$|\vec{A} + \vec{B}|^2 = |\vec{A} - \vec{B}|^2$ gives $A^2 + B^2 + 2AB \cos \theta = A^2 + B^2 - 2AB \cos \theta$, so $\cos \theta = 0$ and $\theta = 90^\circ$. At 0° the sum would exceed the difference, and at 180° the difference would exceed the sum.

11. Answer: (C) 5 h

Take A as origin: B starts at $(0, -100)$ km and its velocity relative to A is $(10, 10)$ km/h, i.e. $10\sqrt{2}$ km/h at 45° . Time of closest approach $t = -(r \cdot v)/v^2 = (100 \times 10)/200 = 5$ h. The minimum separation is then $50\sqrt{2}$ km, which is the trap behind $5\sqrt{2}$ h.

12. Answer: (C) $(11/5)(\hat{i} + \hat{j})$

Average velocity = total displacement/total time. Displacement from $(2, 3)$ to $(13, 14)$ is $11\hat{i} + 11\hat{j}$ in 5 s, giving $(11/5)(\hat{i} + \hat{j})$; dividing the final position by time ignores the starting point.

13. Answer: (D) 3.5

The trajectory $y = x \tan \theta - gx^2/(2u^2 \cos^2 \theta)$ is identical when g/u^2 is the same. $g' = 9.8 \times 3^2/5^2 = 3.53 \approx 3.5 \text{ m s}^{-2}$; scaling with u instead of u^2 gives the wrong value.

14. Answer: (C) $2\hat{i} - 3\hat{j}$

With no horizontal force the horizontal component stays $2\hat{i}$, while at the same level the vertical component has the same size but reverses, becoming $-3\hat{j}$. So the velocity at B is $2\hat{i} - 3\hat{j}$; reversing both components would wrongly reverse the horizontal motion too.

15. Answer: (C) $\theta = \tan^{-1}(4)$

Range $R = u^2 \sin 2\theta/g = 2u^2 \sin \theta \cos \theta/g$ and maximum height $H = u^2 \sin^2 \theta/(2g)$. Setting $R = H$ gives $2 \cos \theta = \sin \theta/2$, i.e. $\tan \theta = 4$, so $\theta = \tan^{-1} 4$. An angle of 45° gives maximum range, not $R = H$.

16. Answer: (C) $5\sqrt{2}$ units

$v = u + at = (2 + 0.3 \times 10)\hat{i} + (3 + 0.2 \times 10)\hat{j} = 5\hat{i} + 5\hat{j}$. Magnitude = $\sqrt{(25 + 25)} = 5\sqrt{2}$ units. Adding the components as scalars ($5 + 5$ or 9) is the trap.

17. Answer: (D) $\tan^{-1}(1/2)$

At the top the projectile is at height H and horizontal distance $R/2$. $\tan \alpha = H/(R/2) = (u^2 \sin^2 \theta/2g)/(u^2 \sin \theta \cos \theta/g) = \tan \theta/2 = 1/2$ for $\theta = 45^\circ$. So $\alpha = \tan^{-1}(1/2)$; 45° would be the launch angle, not the elevation of the highest point.

18. Answer: (A) 5 m/s^2

$\omega = 2\pi/T = 2\pi/(0.2\pi) = 10 \text{ rad/s}$, and the centripetal acceleration is $a = \omega^2 r = 100 \times 0.05 = 5 \text{ m/s}^2$. Forgetting to convert 5 cm to metres gives a value 100 times too large.

19. Answer: (A) 5 m/s^2

The velocity changes from 30 m/s east to 40 m/s north; the change Δv has magnitude $\sqrt{(30^2 + 40^2)} = 50 \text{ m/s}$. Average acceleration = $50/10 = 5 \text{ m/s}^2$. Taking the difference of speeds (1 m/s^2) ignores the change in direction.

20. Answer: (B) 40 m

Maximum range occurs at 45° , $R = u^2/g = 20^2/10 = 40 \text{ m}$. The value 20 m is the range for $u^2/2g$, which is the maximum height formula at 90° , not the range.

21. Answer: (A) 60°

At the highest point only the horizontal component $u \cos \theta$ remains. Setting $u \cos \theta = u/2$ gives $\cos \theta = 1/2$, so $\theta = 60^\circ$. An angle of 30° would leave a speed of $(\sqrt{3}/2)u$ at the top.

22. Answer: (B) A circular path

Squaring and adding $x = a \sin \omega t$ and $y = a \cos \omega t$ gives $x^2 + y^2 = a^2(\sin^2 \omega t + \cos^2 \omega t) = a^2$, the equation of a circle of radius a . An ellipse would need unequal amplitudes, and a straight line would need the two motions to be in phase.

23. Answer: (C) $7\sqrt{2}$ units

$v = u + at = (3 + 0.4 \times 10)\hat{i} + (4 + 0.3 \times 10)\hat{j} = 7\hat{i} + 7\hat{j}$. Speed = $\sqrt{(49 + 49)} = 7\sqrt{2} \approx 9.9$ units. Adding the initial speed 5 and the gain 5 to get 10 units wrongly adds magnitudes of non-parallel vectors.

24. Answer: (B) 60°

For a straight line from the origin, $\tan \theta = y/x = 3/\sqrt{3} = \sqrt{3}$, so $\theta = 60^\circ$. 30° would be the angle with the y -axis instead.

25. Answer: (D) 60°

$AB \sin \theta = \sqrt{3} AB \cos \theta$ gives $\tan \theta = \sqrt{3}$, so $\theta = 60^\circ$. 30° would come from $\tan \theta = 1/\sqrt{3}$.

26. Answer: (A) 1 : 1

The range is $R = u^2 \sin 2\theta/g$. For $(45^\circ - \theta)$, $\sin(90^\circ - 2\theta) = \cos 2\theta$; for $(45^\circ + \theta)$, $\sin(90^\circ + 2\theta) = \cos 2\theta$. The two ranges are therefore equal, a ratio of 1 : 1, for any θ .

27. Answer: (B) 0, 10 m/s

After a complete lap the car is back at its start, so displacement and hence average velocity are zero. Average speed = distance/time = $2\pi \times 100/62.8 = 10 \text{ m/s}$. Average speed cannot be zero for a moving car.

28. Answer: (A) 90°

Squaring both sides, $A^2 + B^2 + 2\mathbf{A} \cdot \mathbf{B} = A^2 + B^2 - 2\mathbf{A} \cdot \mathbf{B}$, so $\mathbf{A} \cdot \mathbf{B} = 0$. The vectors are therefore perpendicular, at 90° . At 0° the sum would be larger than the difference.

29. Answer: (C) $-1/2$

Perpendicular vectors have zero dot product: $2(-4) + 3(4) + 8\alpha = 0$, so $4 + 8\alpha = 0$ and $\alpha = -1/2$. Ignoring the sign of the $\hat{i}$ component gives the wrong -2 or 2 .

30. Answer: (C) $\pi^2 \text{ m s}^{-2}$ and direction along the radius towards the centre

$f = 22/44 = 0.5 \text{ rev/s}$, so $\omega = 2\pi f = \pi \text{ rad/s}$. $a = \omega^2 r = \pi^2 \times 1 = \pi^2 \text{ m s}^{-2}$, directed along the radius towards the centre (centripetal). Acceleration of uniform circular motion is never tangential or outward.

31. Answer: (B) $\sqrt{a^2/(v^2 - v_1^2)}$

The catcher runs along the hypotenuse of a right triangle with legs a and $v_1 t$: $(vt)^2 = a^2 + (v_1 t)^2$, so $t = \sqrt{a^2/(v^2 - v_1^2)}$. $a/(v - v_1)$ would apply only if both ran along the same line.

32. Answer: (D) zero

$\mathbf{B} \times \mathbf{A}$ is perpendicular to $\mathbf{A}$, so its dot product with $\mathbf{A}$ is zero for any θ . The $\sin \theta$ and $\cos \theta$ forms wrongly treat the product as non-zero.

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