Engineering Daily 27 [Set 03] EV

Statics + Motion of a Particle in a Plane

Total Marks: 50 **Negative Marks:** 0.25 **Time:** 1 Hour

MCQ 50 marks

1. The greatest and least resultants of two forces acting at a point are 23 N and 7 N respectively. What is the magnitude of the resultant when the two forces act at right angles to each other?

(A) 15 N (B) 17 N (C) 19 N (D) 16 N

2. The resultant of two forces $2P$ and P is R. If the first force is doubled, the resultant is also doubled. What is the angle between the forces?

(A) $120°$ (B) $\cos^{-1}\left(-\frac{1}{4}\right)$

(C) $\cos^{-1}\left(\frac{3}{8}\right)$ (D) $\cos^{-1}\left(-\frac{3}{8}\right)$

3. The resultant of two forces P and Q is 24 N and is perpendicular to the line of action of P. If Q = 26 N, what is the angle between the forces?

(A) $\cos^{-1}\left(-\frac{12}{13}\right)$ (B) $\cos^{-1}\left(-\frac{5}{13}\right)$

(C) $\cos^{-1}\left(-\frac{5}{12}\right)$ (D) $\cos^{-1}\left(\frac{5}{13}\right)$

4. Two forces $3P$ and $2P$ act at a point. If the first is tripled and the second is increased by 12 units, the direction of the resultant remains unchanged. What is the value of P?

(A) 3 units (B) 2 units (C) 6 units (D) 4 units

5. A body of mass 10 kg hangs from a ceiling by two light strings making angles $30°$ and $45°$ with the vertical. What is the greater tension? ($g = 9.8\ ms^{-2}$)

(A) 50.73 N (B) 84.87 N (C) 71.74 N (D) 69.3 N

6. H is the orthocentre of $\triangle ABC$. Three forces P, Q, R act along HA, HB, HC respectively and are in equilibrium. What is the ratio P : Q : R?

(A) cos A : cos B : cos C (B) sin A : sin B : sin C

(C) $\cos\frac{A}{2} : \cos\frac{B}{2} : \cos\frac{C}{2}$ (D) sin 2A : sin 2B : sin 2C

7. In $\triangle ABC$, BC = 6 cm, CA = 8 cm, AB = 10 cm. Three like parallel forces 9 N, 12 N and F act at A, B, C respectively. If the resultant passes through the incentre of the triangle, what is F?

(A) 15 N (B) 12 N (C) 18 N (D) 10 N

8. Two like parallel forces of 11 N and 5 N act on a rigid rod at points 32 cm apart. If the forces are interchanged in position, by what distance does the point of application of the resultant shift?

(A) 16 cm (B) 6 cm (C) 12 cm (D) 20 cm

9. A uniform rod AB of length 12 m and weight 90 N rests horizontally on two supports, one at end A and the other at a distance x from end B. When a load of 30 N is hung at B, the pressure on the second support is twice that on the first. What is x?

(A) 1.25 m (B) 1.5 m (C) 0.75 m (D) 0.5 m

10. A uniform plank of length 3 m and mass 8 kg is placed on a table with 60 cm of it projecting beyond the edge. What is the maximum mass that can be hung from the outer end before the plank tips over?

(A) 12 kg (B) 14.4 kg

(C) 8 kg (D) 10 kg

11. A man carries a load of 50 N at one end of a light stick resting on his shoulder. The load is 0.9 m from the shoulder and his hand is 0.3 m from the shoulder on the other side. What is the pressure on the shoulder?

(A) 100 N (B) 150 N (C) 250 N (D) 200 N

12. A body on a smooth inclined plane can be held at rest either by a force of 6 N parallel to the plane or by a horizontal force of 10 N, applied separately. What is the weight of the body?

(A) 8 N (B) 12.5 N (C) 10 N (D) 7.5 N

13. A uniform ladder of length 6 m and mass 20 kg rests on a rough horizontal floor and against a smooth vertical wall, making an angle of $60°$ with the floor. The coefficient of static friction between the floor and the ladder is 0.4. A man of mass 60 kg climbs the ladder. What is the maximum distance he can climb from the foot of the ladder?

(A) 4.0 m (B) 4.54 m (C) 3.8 m (D) 5.2 m

14. A smooth sphere of radius r and weight 42 N hangs from a point on a smooth vertical wall by a string of length 1.5r attached to the sphere's surface; the string, when produced, passes through the centre of the sphere. What is the tension in the string?

(A) 48.5 N (B) 18.33 N

(C) 45.83 N (D) 52.5 N

15. Forces of 4 N, 7 N and 9 N act at a point parallel to the sides AB, BC, CA (in that order) of an equilateral triangle ABC. What is the magnitude of the resultant?

(A) $2\sqrt{7}$ N (B) $\sqrt{19}$ N (C) $\sqrt{13}$ N (D) $\sqrt{21}$ N

16. Forces of 6, 3, 2 and 7 N act along the sides AB, BC, CD, DA of a square ABCD respectively, and a force of $5\sqrt{2}$ N acts along the diagonal AC. What is the magnitude of their resultant?

(A) $\sqrt{90}$ N (B) $\sqrt{74}$ N (C) $\sqrt{82}$ N (D) $4\sqrt{2}$ N

17. The line of action of a force $\vec{F}$ passes through the origin O. The moments of the force about the points A(4, 0) and B(0, 3) (anticlockwise positive) are −24 and 30 units respectively. What is $|\vec{F}|$?

(A) $2\sqrt{34}$ units (B) $2\sqrt{41}$ units

(C) 8 units (D) 10 units

18. Two equal forces acting at right angles at a point are balanced by a 10 N force acting at the same point. What is the magnitude of each force?

Ⓐ 10 N Ⓑ 5 N Ⓒ $5\sqrt{2}$ N Ⓓ $10\sqrt{2}$ N

19. Two unlike parallel forces of 9 N and 5 N act at two points of a rod 16 cm apart. If the rod is to be held in equilibrium by a single force, what is the minimum length of the rod?

Ⓐ 20 cm Ⓑ 16 cm Ⓒ 30 cm Ⓓ 36 cm

20. The greatest resultant of two forces is 3 times the least resultant. At what angle must the forces act for the resultant to equal the arithmetic mean of the two forces?

Ⓐ $\cos^{-1}\left(-\frac{11}{16}\right)$ Ⓑ $\cos^{-1}\left(-\frac{5}{8}\right)$

Ⓒ $\cos^{-1}\left(-\frac{3}{4}\right)$ Ⓓ $\cos^{-1}\left(\frac{11}{16}\right)$

21. Forces T_1 and T_2 act at angles 25° and −50° to the positive x-axis. Their resultant is 6000 N and acts along the positive x-axis. What is T_1?

Ⓐ 4758.4 N Ⓑ 2625.2 N

Ⓒ 4000.0 N Ⓓ 5435.7 N

22. Three coplanar forces in equilibrium have angles 150°, 120° and 90° between pairs. If the largest force is 10 N, what is the smallest force?

Ⓐ 5 N Ⓑ 2.5 N

Ⓒ $\sqrt{\frac{10}{3}}$ N Ⓓ $5\sqrt{3}$ N

23. Forces of 6 N, 4 N and 2 N act along the sides BC, CA, AB respectively of an equilateral triangle ABC of side 30 cm. What is the magnitude of the resultant, and where does its line of action meet the line BC?

Ⓐ $2\sqrt{7}$ N; on BC produced, 15 cm beyond C

Ⓑ $2\sqrt{3}$ N; 20 cm from B

Ⓒ $2\sqrt{3}$ N; on BC produced, 30 cm beyond C

Ⓓ $4\sqrt{3}$ N; on BC produced, 30 cm beyond C

24. A uniform pipe of length 12 m and mass 72 kg is carried by two persons A and B. A holds it 1.5 m from one end and B holds it 3 m from the other end. What are the pressures on A and B respectively?

Ⓐ 32.4 kg-wt and 39.6 kg-wt

Ⓑ 28.8 kg-wt and 43.2 kg-wt

Ⓒ 24 kg-wt and 48 kg-wt

Ⓓ 36 kg-wt and 36 kg-wt

25. A uniform rod of weight W rests against a smooth floor and a smooth vertical wall, inclined at 60° to the floor. What horizontal force, applied at its lower end towards the wall, keeps it in equilibrium?

Ⓐ $\frac{\sqrt{3}W}{2}$ Ⓑ $\frac{W}{2}$ Ⓒ $\frac{W}{2\sqrt{3}}$ Ⓓ $\frac{W}{\sqrt{3}}$

26. A ball moves horizontally at a uniform velocity of 24 ms^{-1}. A bat strikes it suddenly at right angles to its original velocity, after which it moves at 25 ms^{-1}. What velocity was imparted by the bat?

Ⓐ 12.5 ms^{-1} Ⓑ 7 ms^{-1}

Ⓒ 1 ms^{-1} Ⓓ 5 ms^{-1}

27. A body is thrown from a train moving at 15 kmh^{-1} with a velocity of 25 kmh^{-1} relative to the train. At what angle to the direction of the train's motion must it be thrown so that, relative to the ground, it moves perpendicular to the train's direction of motion?

Ⓐ 120° Ⓑ $\cos^{-1}\left(-\frac{3}{5}\right)$

Ⓒ $\cos^{-1}\left(-\frac{4}{5}\right)$ Ⓓ $\cos^{-1}\left(\frac{3}{5}\right)$

28. Three velocities 5, 6 and 9 ms^{-1} act simultaneously on a particle. If the particle is at rest, what is the angle between the two smaller velocities?

Ⓐ $\cos^{-1}\left(-\frac{1}{3}\right)$ Ⓑ 60°

Ⓒ $\cos^{-1}\left(\frac{1}{6}\right)$ Ⓓ $\cos^{-1}\left(\frac{1}{3}\right)$

29. Two cyclists start from the same point at the same time along straight paths inclined at 120° to each other, at uniform speeds of 4 ms^{-1} and 6 ms^{-1}. What is the distance between them after 10 s?

Ⓐ $20\sqrt{7}$ m Ⓑ $20\sqrt{13}$ m

Ⓒ 100 m Ⓓ $20\sqrt{19}$ m

30. A ship A sails east at 12 kmh^{-1}. At the same instant, ship B, 26 km north of A, starts sailing south at 5 kmh^{-1}. What is the minimum distance between the ships?

Ⓐ 18 km Ⓑ 24 km Ⓒ 12 km Ⓓ 20 km

31. A man goes from A to B at 40 kmh^{-1} and returns along the same path from B to A at 60 kmh^{-1}. What is his average speed for the whole journey?

Ⓐ 50 kmh^{-1} Ⓑ 48 kmh^{-1}

Ⓒ 45 kmh^{-1} Ⓓ 0 kmh^{-1}

32. The speed of the current in a river is 5 kmh^{-1}, the speed of a boat in still water is 13 kmh^{-1} and the width of the river is 6 km. How long does it take to cross the river by the shortest path?

Ⓐ 36 min Ⓑ 30 min

Ⓒ 27.7 min Ⓓ 25 min

33. Two boats, each with a speed of 10 kmh^{-1} in still water, try to cross a 2 km wide river flowing at 6 kmh^{-1}. One crosses by the shortest path and the other in the shortest time. If both start at the same time, what is the difference in their arrival times on the other bank?

Ⓐ 2 min Ⓑ 3 min

Ⓒ 5 min Ⓓ 4.5 min

34. A river is 80 m wide and its current flows at 5 ms^{-1}. A boat starts from a point O on one bank and wants to reach a point on the opposite bank that is 60 m downstream of the point directly opposite O. What is the minimum speed the boat must have (relative to the water)?

Ⓐ 4 ms^{-1} Ⓑ 6.25 ms^{-1}

Ⓒ 3 ms^{-1} Ⓓ 5 ms^{-1}

35. Two trains of lengths 150 m and 250 m run side by side on parallel tracks in the same direction at 54 kmh^{-1} and 36 kmh^{-1} respectively. How long does the faster train take to completely overtake the other?

Ⓐ 16 s Ⓑ 26.7 s Ⓒ 40 s Ⓓ 80 s

36. Two trains A and B of lengths 120 m and 80 m are passing each other from opposite directions. At the start of the passing, A has a speed of 10 ms^{-1} and an acceleration of 0.2 ms^{-2}, while B moves uniformly at 8 ms^{-1}. How long do they take to pass each other completely?

Ⓐ 10.5 s Ⓑ 9.8 s

Ⓒ 12.5 s Ⓓ 11.11 s

37. Rain falls vertically downward at 12 ms^{-1}. A cyclist rides horizontally at 5 ms^{-1}. At what angle to the vertical, tilted forward, must the umbrella be held to shelter from the rain?

Ⓐ $\tan^{-1}\left(\frac{12}{5}\right)$ Ⓑ $\tan^{-1}\left(\frac{5}{13}\right)$

Ⓒ $\sin^{-1}\left(\frac{5}{12}\right)$ Ⓓ $\tan^{-1}\left(\frac{5}{12}\right)$

38. When a man walks at 4 kmh^{-1}, rain appears to fall vertically. When he increases his speed to 10 kmh^{-1}, the rain appears to fall at 45° to the vertical from the front. What is the actual speed of the rain?

Ⓐ $2\sqrt{13}$ kmh^{-1} Ⓑ 6 kmh^{-1}

Ⓒ $\sqrt{61}$ kmh^{-1} Ⓓ $2\sqrt{10}$ kmh^{-1}

39. A bullet penetrates 5 cm into a target and loses one-third of its velocity. If the resistance of the target is uniform, how much farther will the bullet penetrate?

Ⓐ 4 cm Ⓑ 5 cm

Ⓒ 2.5 cm Ⓓ 6.25 cm

40. A dog sees a cat 24 m ahead and starts running from rest with a uniform acceleration of 4 ms^{-2}. At the same instant the cat runs in the same direction at a uniform speed of 10 ms^{-1}. How long does the dog take to catch the cat?

Ⓐ 5.42 s Ⓑ 7.5 s Ⓒ 6.77 s Ⓓ 6.0 s

41. A bus starts from rest with a uniform acceleration of 4 ms^{-2}. At that moment a cyclist, 30 m behind the bus, starts moving toward the bus at a uniform speed of 20 ms^{-1}. After how long from the start does the bus catch up with the cyclist again?

Ⓐ 10.0 s Ⓑ 6.32 s Ⓒ 1.84 s Ⓓ 8.16 s

42. Two trains approaching each other on the same line at 30 ms^{-1} and 20 ms^{-1} are 625 m apart when both drivers apply brakes with the same retardation. What is the minimum retardation needed to avoid a collision?

Ⓐ 0.8 ms^{-2} Ⓑ 2.08 ms^{-2}

Ⓒ 0.52 ms^{-2} Ⓓ 1.04 ms^{-2}

43. A particle starts from rest and travels 1.2 km in a straight line before stopping. If it moves with a uniform acceleration of 1.5 ms^{-2} in the first part and a uniform retardation of 3 ms^{-2} in the last part, what is its maximum speed?

Ⓐ 34.64 ms^{-1} Ⓑ 60.0 ms^{-1}

Ⓒ 48.99 ms^{-1} Ⓓ 42.43 ms^{-1}

44. A stone is released from a balloon rising vertically at 14.7 ms^{-1} and hits the ground 8 s later. What was the height of the balloon at the instant the stone was released?

Ⓐ 431.2 m Ⓑ 313.6 m

Ⓒ 196 m Ⓓ 98 m

45. A body falling freely from the roof of a building covers $\frac{11}{36}$ of the building's height in the last second of its fall. What is the height of the building?

Ⓐ 240.1 m Ⓑ 78.4 m

Ⓒ 176.4 m Ⓓ 122.5 m

46. A ball is thrown from the top of a vertical cliff 44.1 m high with a velocity of 24.5 ms^{-1} at 30° above the horizontal. At what horizontal distance from the foot of the cliff will the ball hit the ground?

Ⓐ 76.38 m Ⓑ 95.48 m

Ⓒ 110.25 m Ⓓ 63.65 m

47. A gun on the ground, 350 m horizontally from an object at a height of 245 m, is aimed directly at the object and fired. At the instant the bullet leaves the gun, the object starts falling from rest. What is the minimum initial speed of the bullet so that it hits the object before the object reaches the ground?

Ⓐ 49.5 ms^{-1} Ⓑ 34.65 ms^{-1}

Ⓒ 85.4 ms^{-1} Ⓓ 60.42 ms^{-1}

48. A ball is projected from a point on the ground with a velocity of 35 ms^{-1} at an angle α to the horizontal, where $\tan\alpha = \frac{4}{3}$. At what height will it strike a tall vertical wall 63 m from the point of projection?

Ⓐ 39.9 m Ⓑ 44.1 m Ⓒ 84.0 m Ⓓ 31.5 m

49. A body is projected from the top of an 80 m high tower at 40 ms^{-1} at 30° below the horizontal. At the same instant, another body is projected from the foot of the tower at 60° above the horizontal in the same vertical plane. If the two bodies meet, what are the initial speed of the second body and the time of meeting?

(A) $40\sqrt{3}\ ms^{-1}$, 1 s (B) 40 ms^{-1}, 1 s

(C) $20\sqrt{3}\ ms^{-1}$, 2 s (D) $40\sqrt{3}\ ms^{-1}$, 2 s

50. A stone is thrown horizontally from the top of a 122.5 m high hill and lands 75 m from the foot of the hill. What is the speed of the stone at the instant it hits the ground?

(A) 49.0 ms^{-1} (B) 15.0 ms^{-1}

(C) 64.0 ms^{-1} (D) 51.24 ms^{-1}