5 Newton's Laws of Motion

JEE-Main

Laws of Motion

1. A cricket player catches a ball of mass 120 g moving with 25 m/s speed. If the catching process is completed in 0.1 s then the magnitude of force exerted by the ball on the hand of player will be (in SI unit): **[1 Feb, 2024 (Shift-II)]**

(*a*) 24 (*b*) 12 (*c*) 25 (*d*) 30

2. A body of mass 4 kg experiences two forces $\vec{F}_1 = 5\hat{i} + 8\hat{j} + 7\hat{k}$ and $\vec{F}_2 = 3\hat{i} - 4\hat{j} - 3\hat{k}$.

The acceleration acting on the body is: **[1 Feb, 2024 (Shift-II)]**

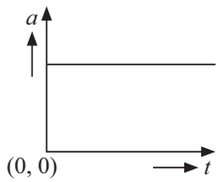
(*a*) $-2\hat{i} - \hat{j} - \hat{k}$ (*b*) $4\hat{i} + 2\hat{j} + 2\hat{k}$

(*c*) $2\hat{i} + \hat{j} + \hat{k}$ (*d*) $2\hat{i} + 3\hat{j} + 3\hat{k}$

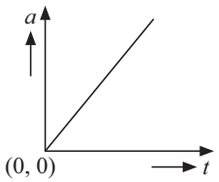
3. A wooden block, initially at rest on the ground, is pushed by a force which increases linearly with time t. Which of the following curve best describes acceleration of the block with time:

[04 April, 2024 (Shift-I)]

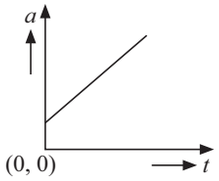
(*a*)



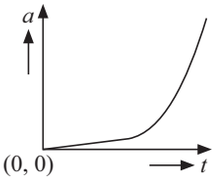
(*b*)



(*c*)



(*d*)



4. A particle moves in x-y plane under the influence of a force $\vec{F}$ such that its linear momentum is $\vec{P}(t) = \hat{i}\cos(kt) - \hat{j}\sin(kt)$. If k is constant, the angle between –F and P– will be:

[05 April, 2024 (Shift-II)]

(*a*) $\pi/2$ (*b*) $\pi/6$ (*c*) $\pi/4$ (*d*) $\pi/3$

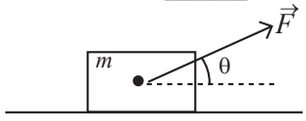
5. A player caught a cricket ball of mass 150 g moving at a speed of 20 m/s. If the catching process is completed in 0.1 s, the magnitude of force exerted by the ball on the hand of the player is:

[08 April, 2024 (Shift-I)]

(*a*) 150 N (*b*) 3 N (*c*) 30 N (*d*) 300 N

6. A spherical body of mass 2 *kg* starting from rest acquires a kinetic energy of 10000 *J* at the end of 5th second. The force acted on the body is _____*N* **[24 Jan, 2023 (Shift-I)]**

7. An object of mass '*m*' initially at rest on a smooth horizontal surface starts moving under the action of a force $F = 2$ N. In the process of its linear motion, the angle θ (as shown in the figure) between the direction of force and horizontal varies as $\theta = kx$, where *k* is a constant and *x* is the distance covered by the object from its initial position. The expression for kinetic energy of the object will be $E = \frac{n}{k}\sin\theta$. The value of *n* is _____. **[25 Jan, 2023 (Shift-I)]**



Smooth horizontal surface

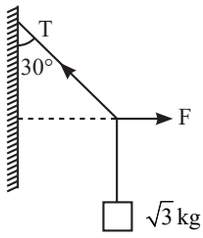
8. Force acts for 20 *sec* on a body of mass 20 kg, starting from rest, after which the force ceases and then the body describes 50 *m* in the next 10 *s*. The value of force will be: **[29 Jan, 2023 (Shift-II)]**

(*a*) 40 N (*b*) 5 N (*c*) 20 N (*d*) 10 N

9. A machine gun of mass 10 kg fires 20 g bullets at the rate of 180 bullets per minute with a speed of 100 ms–1 each. The recoil velocity of the gun is: **[30 Jan, 2023 (Shift-II)]**

(*a*) 0.02 m/s (*b*) 2.5 m/s (*c*) 1.5 m/s (*d*) 0.6 m/s

10. A block of $\sqrt{3}$ kg is attached to a string whose other end is attached to the wall. An unknown force *F* is applied so that the string makes an angle of 30º with the wall. The tension *T* in the string is: (Given $g = 10\ ms^{-2}$) **[30 Jan, 2023 (Shift-II)]**



(*a*) 20 N (*b*) 25 N (*c*) 10 N (*d*) 15 N

11. At any instant the velocity of a particle of mass 500 *g* is $\left(2t\hat{i} + 3t^2\hat{j}\right) ms^{-1}$. If the force acting on the particle at $t = 1$s is $\left(\hat{i} + x\hat{j}\right) N$. Then the value of *x* will be: **[08 Apr, 2023 (Shift-1)]**

(*a*) 3 (*b*) 4 (*c*) 6 (*d*) 2

12. Given below are two statements: One is labelled as Assertion (A) and the other is labelled as Reason (R).

Assertion (A): An electric fan continues to rotate for some time after the current is switched off.

Reason (R): Fan continuous to rotate due to inertia of motion.

In the light of above statements, choose the most appropriate answer from the options given below. **[10 Apr, 2023 (Shift-II)]**

(*a*) A is correct but R is not correct.
(*b*) Both A and R are correct and R is the correct explanation of A.
(*c*) A is not correct but R is correct.
(*d*) Both A and R are correct but R is not the correct explanation of A.

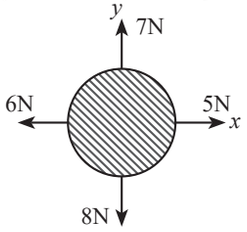
13. Three forces $F_1 = 10N$, $F_2 = 8\ N$, $F_3 = 6\ N$ are acting on a particle of mass 5kg. The forces F_2 and F_3 are applied perpendicular so that particle remains at rest. If the force F_1 is removed, then the acceleration of the particle is: **[12 Apr, 2023 (Shift-I)]**

(*a*) 2 ms^{-2} (*b*) 0.5 ms^{-2}
(*c*) 4.8 ms^{-2} (*d*) 7 ms^{-2}

14. 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 a is a non-zero constant. What is the force $\vec{F}$ acting on the particle? **[JEE Adv, 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*) $\vec{F} = m\alpha^2(x\hat{x} + 2y\hat{y})$

15. For a free body diagram shown in the figure, the four forces are applied in the '*x*' and '*y*' directions. What additional force must be applied and at what angle with positive *x*-axis so that the net acceleration of body is zero? **[25 July, 2022 (Shift-II)]**



(*a*) $\sqrt{2}\text{N}, 45^o$ (*b*) $\sqrt{2}\text{N}, 135^o$
(*c*) $\frac{2}{\sqrt{3}}\text{N}, 30^o$ (*d*) $2\text{N}, 45^o$

16. A bag of sand of mass 9.8 kg is suspended by a rope. A bullet of 200 g travelling with speed 10 ms^{-1} gets embedded in it, then loss of kinetic energy will be: **[25 July, 2022 (Shift-II)]**

(*a*) 4.9 J (*b*) 9.8 J
(*c*) 14.7 J (*d*) 19.6 J

17. A monkey of mass 50 kg climbs on a rope which can withstand the tension (T) of 350 N. If monkey initially climbs down with an acceleration of 4 m/s^2 and then climbs up with an acceleration of 5 m/s^2. Choose the correct option
(Take $g = 10\ ms^{-2}$) **[26 July, 2022 (Shift-I)]**

(*a*) $T = 700$ N while climbing upward
(*b*) $T = 350$ N while going downward
(*c*) Rope will break while climbing upward
(*d*) Rope will break while going downward

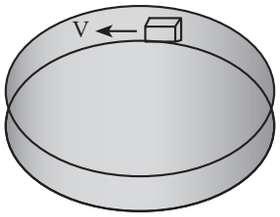
18. The velocity of the bullet becomes one third after it penetrates 4 cm in a wooden block. Assuming that bullet is facing a constant resistance during its motion in the block. The bullet stops completely after travelling at $(4 + x)$ cm inside the block. The value of *x* is: **[27 July, 2022 (Shift-II)]**

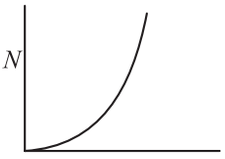
(*a*) 2.0 (*b*) 1.0 (*c*) 0.5 (*d*) 1.5

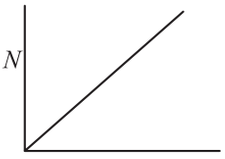
19. A balloon has mass of 10 g in air. The air escapes from the balloon at a uniform rate with velocity 4.5 cm/s. If the balloon shrinks in 5 s completely. Then, the average force acting on the balloon will be (in dyne). **[28 July, 2022 (Shift-I)]**

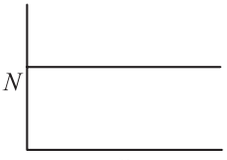
(*a*) 3 (*b*) 9 (*c*) 12 (*d*) 18

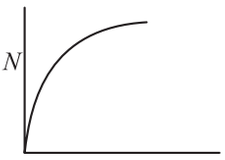
20. A smooth circular groove has a smooth vertical wall as shown in figure. A block of mass m moves against the wall with a speed v. Which of the following curve represents the correct relation between the normal reaction on the block by the wall (N) and speed of the block (v)? **[29 July, 2022 (Shift-I)]**



(*a*) 

(*b*) 

(*c*) 

(*d*) 

21. A particle is projected with velocity v_0 along *x*-axis. *A* damping force is acting on the particle which is proportional to the square of the distance from the origin i.e. $ma = -\alpha x^2$. The distance at which the particle stops: **[24 Feb, 2021 (Shift-II)]**

(*a*) $\left(\frac{2v_0}{3\alpha}\right)^{\frac{1}{3}}$ (*b*) $\left(\frac{3v_0^2}{2\alpha}\right)^{\frac{1}{2}}$
(*c*) $\left(\frac{2v_0^2}{3\alpha}\right)^{\frac{1}{2}}$ (*d*) $\left(\frac{3v_0^2 m}{2\alpha}\right)^{1/3}$

22. Two particles having masses 4 g and 16 g respectively are moving with equal kinetic energies.

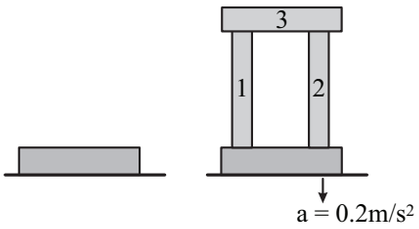
The ratio of the magnitudes of their linear momentum is *n* : 2 The value of *n* will be _____ **[25 Feb, 2021 (Shift-II)]**

23. A boy pushes a box of mass 2kg with a force $\vec{F} = \left(20\hat{i} + 10\hat{j}\right)N$ on a frictionless surface. If the box was initially at rest, then _____*m* is displacement along the *x*-axis after 10 s.

[26 Feb, 2021 (Shift-I)]

24. A body of mass 2 kg moves under a force of $\left(2\hat{i} + 3\hat{j} + 5\hat{k}\right)N$. It starts from rest and was at the origin initially. After 4s, its new coordinates are (8, b, 20). The value of b is: (Round off to the Nearest Integer). **[16 March, 2021 (Shift-II)]**

25. A steel block of 10 kg rests on a horizontal floor as shown. When three iron cylinders are placed on it as shown, the block and cylinders go down with an acceleration 0.2m/s2. The normal reaction *R*' by the floor if mass of the iron cylinders are equal and of 20kg each, is _____N.
[Take g = 10m/s^2 and $\mu_s = 0.2$] **[20 July, 2021 (Shift-I)]**



(*a*) 714 (*b*) 684
(*c*) 716 (*d*) 686

26. A force $\vec{F} = \left(40\hat{i} + 10\hat{j}\right) N$ acts on a body of mass 5 kg. If the body starts from rest, its position vector $\vec{r}$ at time t =10s, will be:

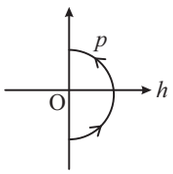
[25 July, 2021 (Shift-II)]

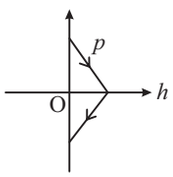
(*a*) $\left(100\hat{i} + 100\hat{j}\right) m$ (*b*) $\left(400\hat{i} + 100\hat{j}\right) m$

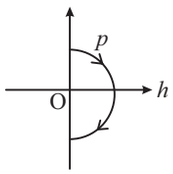
(*c*) $\left(400\hat{i} + 400\hat{j}\right) m$ (*d*) $\left(100\hat{i} + 400\hat{j}\right) m$

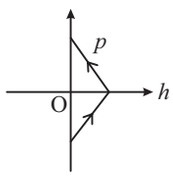
27. A ball is thrown vertically up (taken as +*z*-axis) from the ground. The correct momentum height (*p*-*h*) diagram is:

[9 April, 2019 (Shift-I)]

(*a*) 

(*b*) 

(*c*) 

(*d*) 

28. A bullet of mass 20 g has an initial speed of 1 ms–1, just before it starts penetrating a mud wall of thickness 20 cm. If the wall offers a mean resistance of 2.5 × 10–2 N, the speed of the bullet after emerging from the other side of the wall is close to

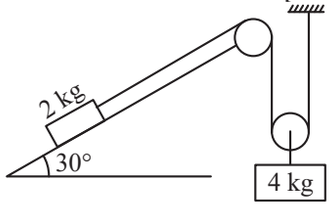
[10 April, 2019 (Shift-II)]

(*a*) 0.4 ms^{-1} (*b*) 0.1 ms^{-1} (*c*) 0.3 ms^{-1} (*d*) 0.7 ms^{-1}

Impulse, Connected Bodies, Constraint Relations

29. All surfaces shown in figure are assumed to be frictionless and the pulleys and the string are light. The acceleration of the block of mass 2 kg is:

[30 Jan, 2024 (Shift-I)]



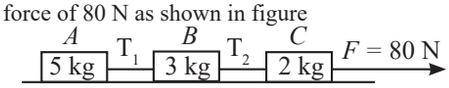
(*a*) g (*b*) $\frac{g}{3}$ (*c*) $\frac{g}{2}$ (*d*) $\frac{g}{4}$

30. A spherical body of mass 100 g is dropped from a height of 10 m from the ground. After hitting the ground, the body rebounds to a height of 5m. The impulse of force imparted by the ground to the body is given by: (given $g = 9.8\ m/s^2$)

[30 Jan, 2024 (Shift-I)]

(*a*) 4.32 kg ms^{-1} (*b*) 43.2 kg ms^{-1}
(*c*) 23.9 kg ms^{-1} (*d*) 2.39 kg ms^{-1}

31. Three blocks A, B and C are pulled on a horizontal smooth surface by a force of 80 N as shown in figure

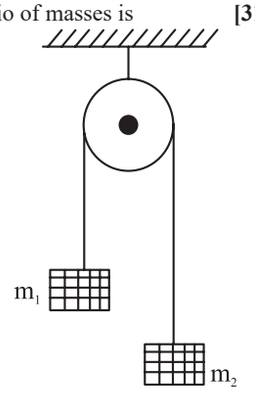


The tensions T_1 and T_2 in the string are respectively:

[30 Jan, 2024 (Shift-II)]

(*a*) 40N, 64N (*b*) 60N, 80N
(*c*) 88N, 96N (*d*) 80N, 100N

32. A light string passing over a smooth light fixedpulley connects two blocks of masses m1 and m2 .If the acceleration of the system is g/8, then the ratio of masses is **[31 Jan, 2024 (Shift-II)]**



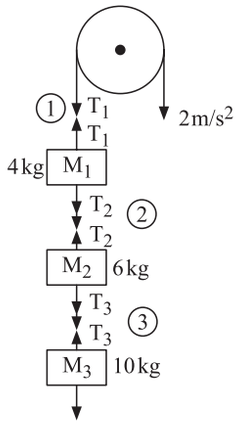
[31 Jan, 2024 (Shift-II)]

(*a*) $\frac{9}{7}$ (*b*) $\frac{8}{1}$ (*c*) $\frac{4}{3}$ (*d*) $\frac{5}{3}$

33. A wooden block of mass 5kg rests on soft horizontal floor. When an iron cylinder of mass 25 kg is placed on the top of the block, the floor yields and the block and the cylinder together go down with an acceleration of 0.1 ms–2. The action force of the system on the floor is equal to: **[05 April, 2024 (Shift-I)]**

(*a*) 297 N (*b*) 294 N (*c*) 291 N (*d*) 196 N

34. Three blocks M1, M2, M3 having masses 4 kg, 6 kg and 10 kg respectively are hanging from a smooth pully using rope 1, 2 and 3 as shown in figure. The tension in the rope 1, T1 when they are moving upward with acceleration of 2ms–2 is ..... N (if g = 10 m/s2) **[05 April, 2024 (Shift-I)]**



35. A light string passing over a smooth light pulley connects two blocks of masses m_1 and m_2 (where $m_2 > m_1$). If the acceleration of the system is $\frac{g}{\sqrt{2}}$, then the ratio of the masses $\frac{m_1}{m_2}$ is:

[06 April, 2024 (Shift-I)]

(*a*) $\frac{\sqrt{2}-1}{\sqrt{2}+1}$ (*b*) $\frac{1+\sqrt{5}}{\sqrt{5}-1}$

(*c*) $\frac{1+\sqrt{5}}{\sqrt{2}-1}$ (*d*) $\frac{\sqrt{3}+1}{\sqrt{2}-1}$

36. A body of weight 200 N is suspended form a tree branch through a chain of mass 10 kg. The branch pulls the chain by a force equal to (if g = 10 m/s^2): **[06 April, 2024 (Shift-II)]**

(*a*) 150 N (*b*) 300 N (*c*) 200 N (*d*) 100 N

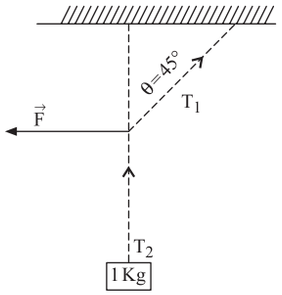
37. A light unstretchable string passing over a smooth light pulley connects two blocks of masses m_1 and m_2. If the acceleration of the system is $\frac{g}{8}$, then the ratio of the masses m_2/m_1 is:

[09 April, 2024 (Shift-I)]

(*a*) 9 : 7 (*b*) 4 : 3 (*c*) 5 : 3 (*d*) 8 : 1

38. A 1 kg mass is suspended from the ceiling by a rope of length 4m. A horizontal force 'F' is applied at the mid point of the rope so that the rope makes an angle of 45° with respect to the vertical axis as shown in figure. The magnitude of F is:

[09 April, 2024 (Shift-II)]



(*a*) $\frac{10}{\sqrt{2}}$ N (*b*) 1 N

(*c*) $\frac{1}{10\times\sqrt{2}}$ N (*d*) 10 N

39. Given below are two statements:

Statement-I: An elevator can go up or down with a uniform speed when its weight is balanced with the tension of its cable.

Statement-II: Force exerted by the floor of an elevator on the foot of a person standing on it is more than his/her weight when the elevator goes down with increasing speed.

In the light of the above statements, choose the correct answer from the options given below: **[24 Jan, 2023 (Shift-I)]**

(*a*) Both statement-I and statement-II are false

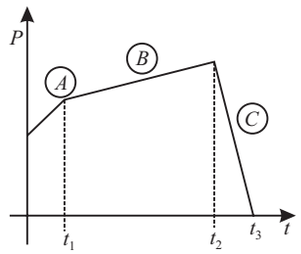
(*b*) Statement-I is true but Statement-II is false

(*c*) Both Statement-I and Statement-II are true

(*d*) Statement-I is false but Statement-II is true

40. The figure represents the momentum time ($P-t$) curve for a particle moving along an axis under the influence of the force. Identify the regions on the graph where the magnitude of the force is maximum and minimum respectively?

If $(t_3 - t_2) < t_1$. **[30 Jan, 2023 (Shift-I)]**



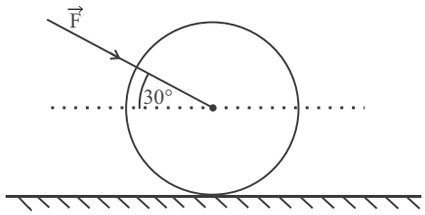
(*a*) *C* and *A* (*b*) *B* and *C* (*c*) *C* and *B* (*d*) *A* and *B*

41. 100 balls each of mass m moving with speed v simultaneously strike a wall normally and are reflected back with the same speed, in time t s. The total force exerted by the balls on the wall is

[31 Jan, 2023 (Shift-I)]

(*a*) $\frac{100mv}{t}$ (*b*) $\frac{200mv}{t}$ (*c*) 200 *mvt* (*d*) $\frac{mv}{100t}$

42. As shown in figure, a 70kg garden roller is pushed with a force of $\vec{F} = 200\,N$ at an angle of 30º with horizontal. The normal reaction on the roller is (Given $g = 10\ ms^{-2}$)

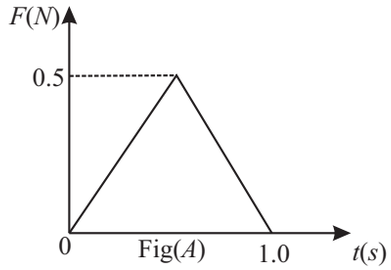


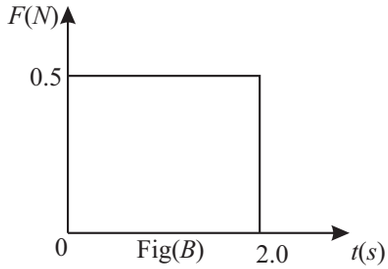
[31 Jan, 2023 (Shift-I)]

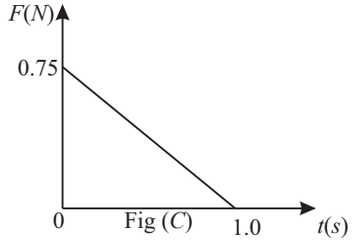
(*a*) $800\sqrt{2}\,N$ (*b*) 600 *N*

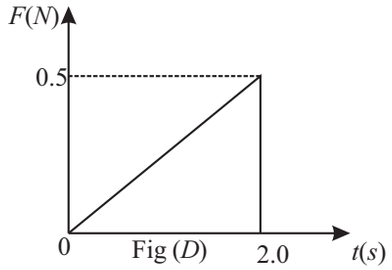
(*c*) 800 *N* (*d*) $200\sqrt{3}\,N$

43. Figures (*A*), (*B*), (*C*) and (*D*) show variation of force with time.









The impulse is highest in figure. **[1 Feb, 2023 (Shift-II)]**

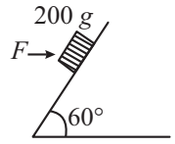
(*a*) Fig (*C*) (*b*) Fig (*B*) (*c*) Fig (*A*) (*d*) Fig (*D*)

44. A bullet 10 g leaves the barrel of gun with a velocity of 600 m/s. If the barrel of gun is 50 cm long and mass of gun is 3 kg, then value of impulse supplied to the gun will be **[13 Apr, 2023 (Shift-I)]**

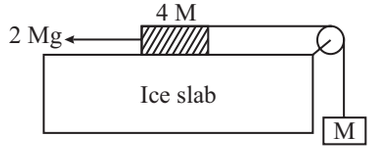
(*a*) 12 Ns (*b*) 6 Ns (*c*) 36 Ns (*d*) 3 Ns

45. A block of mass 200 g is kept stationary on a smooth inclined plane by applying a minimum horizontal force $F = \sqrt{x}N$ as shown in figure. The value of x = _____.

[25 June, 2022 (Shift-II)]

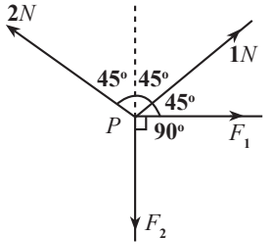


46. A hanging mass M is connected to a four times bigger mass by using a string pulley arrangement, as shown in the figure. The bigger mass is placed on a horizontal ice-slab and being pulled by 2 Mg force. In this situation, tension in the string is x/5 Mg for x = _____. Neglect mass of the string and friction of the block (bigger mass) with ice slab. **[28 June, 2022 (Shift-I)]**



47. Four forces are acting at a point *P* in equilibrium as shown in figure. The ratio of force F_1 to F_2 is 1: *x* where *x* = _____.

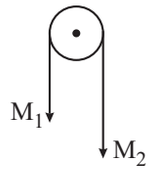
[25 July, 2022 (Shift-I)]



48. Two billiard balls of mass 0.05 kg each moving in opposite directions with 10 ms–1 collide and rebound with the same speed. If the time duration of contact is $t = 0.005$ s. then what is the force exerted on the ball due to each other? **[25 July, 2022 (Shift-II)]**

(*a*) 100 N (*b*) 200 N (*c*) 300 N (*d*) 400 N

49. Two masses M_1 and M_2 are tied together at the two ends of a light inextensible string that passes over a frictionless pulley. When the mass M_2 is twice that of M_1 the acceleration of the system is a1. When the mass M_2 is thrice that of M_1. The acceleration of system is a_2. The ratio a_1/a_2 will be **[26 July, 2022 (Shift-II)]**



(*a*) $\frac{1}{3}$ (*b*) $\frac{2}{3}$

(*c*) $\frac{3}{2}$ (*d*) $\frac{1}{2}$

50. A ball of mass 0.15 kg hits the wall with its initial speed of 12 ms^{-1} and bounces back without changing its initial speed. If the force applied by the wall on the ball during the contact is 100 N, calculate the time during of the contact of ball with the wall.

[26 July, 2022 (Shift-II)]

(*a*) 0.018 s (*b*) 0.036 s (*c*) 0.009 s (*d*) 0.072 s

51. In two different experiments, an object of mass 5 kg moving with a speed of 25 ms^{-1} hits two different walls and comes to rest within (i) 3 second, (ii) 5 seconds, respectively. Choose the correct option out of the following: **[28 July, 2022 (Shift-I)]**

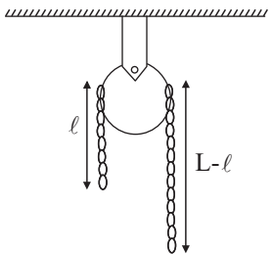
(*a*) Impulse and average force acting on the object will be same for both the cases.

(*b*) Impulse will be same for both the cases but the average force will be different.

(*c*) Average force will be same for both the cases but the impulse will be different.

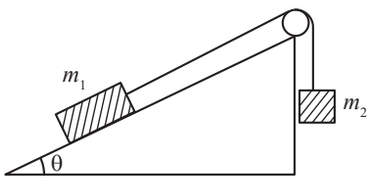
(*d*) Average force and impulse will be different for both the cases.

52. A uniform metal chain of mass *m* and length '*L*' passes over a massless and frictionless pulley. It is released from rest with a part of its length 'ℓ' is hanging on one side and rest of its length '$L - \ell$' is hanging on the other side of the pully. At a certain point of time, when $\ell = \frac{L}{x}$ the acceleration of the chain is $\frac{g}{2}$. The value of *x* is _____. **[28 July, 2022 (Shift-II)]**



(*a*) 6 (*b*) 2 (*c*) 1.5 (*d*) 4

53. Two bodies of masses m_1 = 5kg and m_2 = 3kg are connected by a light string going over a smooth light pulley on a smooth inclined plane as shown in the figure. The system is at rest. The force exerted by the inclined plane on the body of mass m_1 will be: [Take $g = 10\ ms^{-2}$] **[29 July, 2022 (Shift-II)]**



(*a*) 30 *N* (*b*) 40 *N* (*c*) 50 *N* (*d*) 60 *N*

54. An inclined plane is bent in such a way that the vertical cross- section is given by $y = \frac{x^2}{4}$ where y is in vertical and x in horizontal direction. If the upper surface of this curved plane is rough with coefficient of friction $\mu = 0.5$, the maximum height in cm at which a stationary block will not skip downward is _____cm.

[24 Feb, 2021 (Shift-I)]

55. A person standing on a balance inside a stationary lift measures 60 kg. The weight of that person if the lift descends with uniform downward acceleration of 1.8 m/s^2 will be _____ N. [g = 10 m s^2]

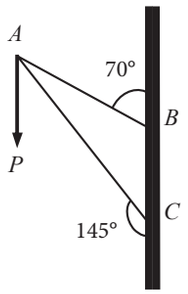
[26 Feb, 2021 (Shift-I)]

56. Consider a frame that is made up of two thin massless rods AB and AC as shown in the figure. A vertical force $\vec{P}$ of magnitude 100N is applied at point A of the frame. Suppose the force is $\vec{P}$ resolved parallel to the arms AB and AC of the frame. The magnitude of the resolved component along the arm AC is xN.

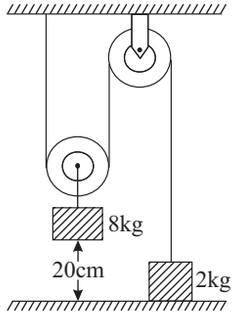
[16 March, 2021 (Shift-I)]

The value of x, to the nearest integer, is _____.

[Given: sin(35°) = 0.573, cos(35°) = 0.819
sin(110°) = 0.939, cos(110°) = –0.342]



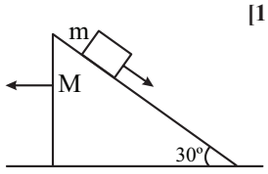
57. The boxes of masses 2 kg and 8 kg are connected by a massless string passing over smooth pulleys. Calculate the time taken by box of mass 8 kg to strike the ground starting from rest. (use g = 10 m/s^2) **[27 Aug, 2021 (Shift-II)]**



(*a*) 0.25 s (*b*) 0.4 s (*c*) 0.34 s (*d*) 0.2 s

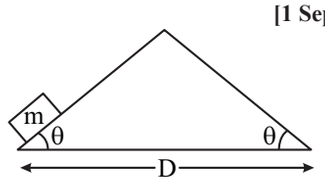
58. A block of mass m slides on the wooden wedge, which in turn slides backward on the horizontal surface. The acceleration of the block with respect to the wedge is: Given m = 8 kg, M = 16 kg Assume all the surfaces shown in the figure to be frictionless.

[1 Sept, 2021 (Shift-II)]

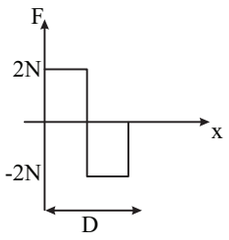


(*a*) $\frac{6}{5}g$ (*b*) $\frac{3}{5}g$ (*c*) $\frac{2}{3}g$ (*d*) $\frac{4}{3}g$

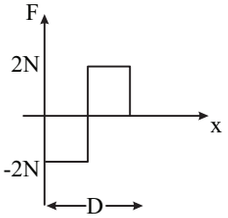
59. An object of mass 'm' is being moved with a constant velocity under the action of an applied force of 2N along a frictionless surface with following surface profile. The correct applied force vs distance graph will be: **[1 Sept, 2021 (Shift-II)]**



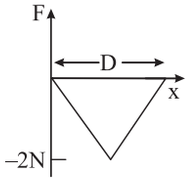
(*a*)



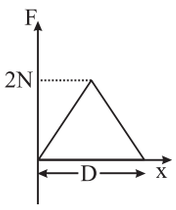
(*b*)



(*c*)



(*d*)



60. A mass of 10 kg is suspended by a rope of length 4m, from the ceiling. A force F is applied horizontally at the mid-point of the rope such that the top half of the rope makes an angle of 45° with the vertical. Then F equals
(Take g = 10 ms^{-2} and the rope to be massless)

[7 Jan, 2020 (Shift-II)]

(*a*) 75 N (*b*) 90 N (*c*) 100 N (*d*) 70 N

61. A small ball of mass m is thrown upward with velocity u from the ground. The ball experiences a resistive force mkv^2, where v is its speed. The maximum height attained by the ball is

[04 Sep, 2020 (Shift-II)]

(*a*) $\frac{1}{2K}\tan^{-1}\frac{ku^2}{g}$ (*b*) $\frac{1}{K}\ln\left(1+\frac{ku^2}{2g}\right)$

(*c*) $\frac{1}{2K}\ln\left(1+\frac{ku^2}{g}\right)$ (*d*) $\frac{1}{K}\tan^{-1}\frac{ku^2}{2g}$

62. A mass of 10 kg is suspended vertically by a rope from the roof. When a horizontal force is applied on the rope at some point, the rope deviated at an 45° at the roof point. If the suspended mass is at equilibrium, the magnitude of the force applied is (g = 10 ms^{-2})

[9 Jan, 2019 (Shift-II)]

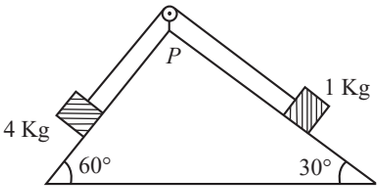
(*a*) 200 N (*b*) 140 N (*c*) 70 N (*d*) 100 N

63. A particle of mass m is initially at rest at the origin. It is subjected to a force and starts moving along the x-axis. Its kinetic energy K changes with time as dK/dt = γt, where γ is a positive constant of appropriate dimensions. Which of the following statements is (are) true? **[JEE Adv, 2018]**

(*a*) The force applied on the particle is constant
(*b*) The speed of the particle is proportional to time
(*c*) The distance of the particle from the origin increases linearly with time
(*d*) The force is conservative

Constraint Relation, Dynamics of Multi System, Springs

64. As per given figure, a weightless pulley P is attached on a double inclined frictionless surface. The tension in the string (massless) will be (if $g = 10 m/s^2$) **[24 Jan, 2023 (Shift-I)]**



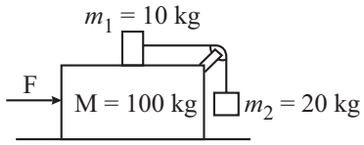
(*a*) $\left(4\sqrt{3}+1\right)N$ (*b*) $4\left(\sqrt{3}+1\right)N$

(*c*) $4\left(\sqrt{3}-1\right)N$ (*d*) $\left(4\sqrt{3}-1\right)N$

65. A block of mass M placed inside a box descends vertically with acceleration 'a'. The block exerts a force equal to one-fourth of its weight on the floor of the box. The value of 'a' will be: **[29 June, 2022 (Shift-II)]**

(*a*) $g/4$ (*b*) $g/2$ (*c*) $3g/4$ (*d*) g

66. Three masses M = 100 kg, m_1 = 10 kg and m_2 = 20 kg are arranged in a system as shown in figure. All the surfaces are frictionless and strings are inextensible and weightless. The pulleys are also weightless and frictionless. A force F is applied on the system so that the mass m_2 moves upward with an acceleration of 2 ms^{-2}. The value of F is
(Take g = 10 ms^{-2}) **[26 July, 2022 (Shift-I)]**



(*a*) 3360 N (*b*) 3380 N (*c*) 3120 N (*d*) 3240 N

67. A car is moving on a plane inclined at 30º to the horizontal with an acceleration of 10 ms^{-2} parallel to the plane upward. A bob is suspended by a string from the roof of the car. The angle in degrees which the string makes with the vertical is_____.
(Take g = 10 ms^{-2}) **[31 Aug, 2021 (Shift-I)]**

68. A spring whose unstretched length is l has a force constant k. The spring is cut into two pieces of unstretched lengths l_1 and l_2 where, $l_1 = n_1^2$ and n is an integer. The ratio k^1/k^2 of the corresponding force constants, k_1 and k_2 will be **[12 April, 2019 (Shift-II)]**

(*a*) $\frac{1}{n^2}$ (*b*) n^2 (*c*) $\frac{1}{n}$ (*d*) n

Static Friction & Kinetic Friction

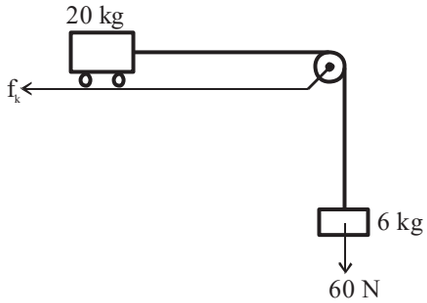
69. Given below are two statements: **[27 JAN, 2024 (Shift-II)]**
Statement-I: The limiting force of static friction depends on the area of contact and independent of materials.

[27 JAN, 2024 (Shift-II)]
Statement-II: The limiting force of kinetic friction is independent of the area of contact and depends on materials.

[27 JAN, 2024 (Shift-II)]
In the light of the above statements, choose the most appropriate answer from the options given below: **[27 JAN, 2024 (Shift-II)]**

(*a*) Statement-I is correct but Statement-II is incorrect
(*b*) Statement-I is incorrect but Statement-II is correct
(*c*) Both Statement-I and Statement-II are incorrect
(*d*) Both Statement-I and Statement-II are correct

70. Consider a block and trolley system as shown in figure. If the coefficient of kinetic friction between the trolley and the surface is 0.04, the acceleration of the system in ms^{-2} is:
(Consider that the string is massless and unstretchable and the pulley is also massless and frictionless): **[1 Feb, 2024 (Shift-I)]**



(*a*) 3 (*b*) 4 (*c*) 2 (*d*) 1.2

71. The vehicles carrying inflammable fluids usually have metallic chains touching the ground: **[05 April, 2024 (Shift-II)]**

(*a*) To conduct excess charge due to air friction to ground and prevent sparking.
(*b*) To alert other vehicles.
(*c*) To protect tyres from catching dirt from ground.
(*d*) It is a custom.

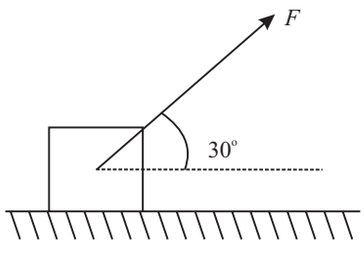
72. A body of mass 10 kg is moving with an initial speed of 20 m/s. The body stops after 5 s due to friction between body and the floor. The value of the coefficient of friction is:
(Take acceleration due to gravity g = 10 ms^{-2})
[31 Jan, 2023 (Shift-II)]

(*a*) 0.2 (*b*) 0.3 (*c*) 0.5 (*d*) 0.4

73. A block of mass 5 kg is placed at rest on a table of rough surface. Now, if a force of 30 N is applied in the direction parallel to surface of the table, the block slides through a distance of 50 m in an interval of time 10 s. Coefficient of kinetic friction is (given, g = 10 ms^{-2}):
[1 Feb, 2023 (Shift-1)]

(*a*) 0.60 (*b*) 0.75 (*c*) 0.50 (*d*) 0.25

74. As shown in the figure a block of mass 10 kg lying on a horizontal surface is pulled by a force F acting at an angle 30º, with horizontal. For μ_s = 0.25, the block will just start to move for the value of F:
[Given g = 10ms^{-2}] **[1 Feb, 2023 (Shift-II)]**

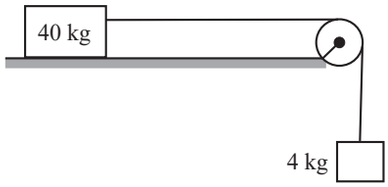


(*a*) 33.3 N (*b*) 25.2 N (*c*) 20 N (*d*) 35.7 N

75. A bullet of mass 0.1 *kg* moving horizontally with speed 400 ms^{-1} hits a wooden block of mass 3.9 *kg* kept on a horizontal rough surface. The bullet gets embedded into the block and moves 20 *m* before coming to rest. The coefficient of friction between the block and the surface is
(Given g = 10ms^2) **[8 April, 2023 (Shift-II)]**
(*a*) 0.50 (*b*) 0.90 (*c*) 0.65 (*d*) 0.25

76. A uniform chain of 6 m length is placed on a table such that a part of its length is hanging over the edge of the table. The system is at rest. The co-efficient of static friction between the chain and the surface of the table is 0.5, the maximum length of the chain hanging from the table is _____m. **[25 June, 2022 (Shift-I)]**

77. A block of mass 40 kg slides over a surface, when a mass of 4 kg is suspended through an inextensible massless string passing over frictionless pulley as shown below.

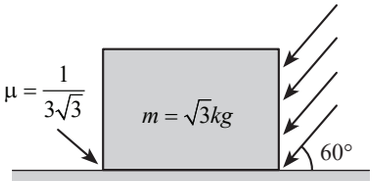


The coefficient of kinetic friction between the surface and block is 0.02. The acceleration of block is.
(given g = 10 ms^{-2}) **[29 June, 2022 (Shift-II)]**
(*a*) 1 ms^{-2} (*b*) 1/5 ms^{-2} (*c*) 4/5 ms^{-2} (*d*) 8/11 ms^{-2}

78. A bag is gently dropped on a conveyor belt moving at a speed of 2 m/s. The coefficient of friction between the conveyor belt and bag is 0.4. Initially, the bag slips on the belt before it stops due to friction. The distance travelled by the bag on the belt during slipping motion is:
[Take g = 10 m/s^{-2}] **[27 July, 2022 (Shift-I)]**
(*a*) 2 m (*b*) 0.5 m (*c*) 3.2 m (*d*) 0.8 m

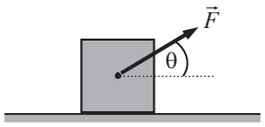
79. The coefficient of static friction between a wooden block of mass 0.5 kg and a vertical rough wall is 0.2. The magnitude of horizontal force that should be applied on the block to keep it adhere to the wall be _____N. [*g* = 10 ms–2] **[24 Feb, 2021 (Shift-I)]**

80. As shown in the figure, a block of mass $\sqrt{3}\,kg$ is kept on a horizontal rough surface of coefficient of friction $\frac{1}{3\sqrt{3}}$. The critical force to be applied on the vertical surface as shown at an angle 60° with horizontal such that it does not move, will be 3*x*. The value of *x* will be **[26 Feb, 2021 (Shift-I)]**



$$\left[g = 10 m/s^2; \sin 60^\circ = \frac{\sqrt{3}}{2}; \cos 60^\circ = \frac{1}{2}\right]$$

81. A block of mass m slides along a floor while a force of magnitude F is applied to it at an angle θ as shown in figure. The coefficient of kinetic is μ_K. Then, the block's acceleration 'a' is given by:
(g is acceleration due to gravity) **[16 March, 2021 (Shift-I)]**



(*a*) $\frac{F}{m}\cos\theta + \mu_K\left(g - \frac{F}{m}\sin\theta\right)$

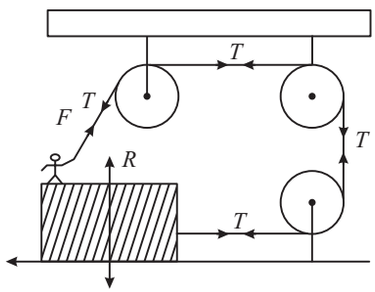
(*b*) $\frac{F}{m}\cos\theta + \mu_K\left(g + \frac{F}{m}\sin\theta\right)$

(*c*) $\frac{F}{m}\cos\theta - \mu_K\left(g - \frac{F}{m}\sin\theta\right)$

(*d*) $-\frac{F}{m}\cos\theta - \mu_K\left(g - \frac{F}{m}\sin\theta\right)$

82. A body of mass 1 kg rests on a horizontal floor with which it has a coefficient of static friction $\frac{1}{\sqrt{3}}$. It is desired to make the body move by applying the minimum possible force F (in N). The value of F will be _____ (Round off to the Nearest Integer)
[Take g = 10 ms^{-2}] **[17 March, 2021 (Shift-II)]**

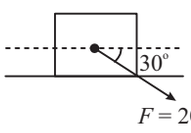
83. A boy of mass 4 kg is standing on a piece of wood having mass 5 kg. If the coefficient of friction between the wood and the floor is 0.5, what is the maximum force that the boy can exert on the rope so that the piece of wood does not move from its place is _____ (in N). (Round off to the Nearest Integer) [Take g = 10 ms–2]
[17 March, 2021 (Shift-II)]



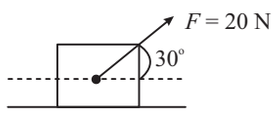
84. An insect is at the bottom of a hemispherical ditch of radius 1 m. It crawls up the ditch but starts slipping after it is at height h from the bottom. If the coefficient of friction between the ground and the insect is 0.75, then h is (g = 10 ms–2) **[6 Sep, 2020 (Shift-I)]**
(*a*) 0.45 m (*b*) 0.80 m
(*c*) 0.20 m (*d*) 0.60 m

85. A block of mass 5 kg is (i) pushed in case (a) and (ii) pulled in case (b). by a force F = 20 N. Making an angle of 30º with the horizontal, as shown in the figures. The coefficient of friction between the block and floor is m = 0.2. The difference between the accelerations of the block, in case (b) and case (a) will be: (g = 10 ms^{-2})
[12 April, 2019 (Shift-II)]

(*a*)



(*b*)



(*a*) 0 ms^{-2} (*b*) 0.8 ms^{-2} (*c*) 0.4 ms^{-2} (*d*) 3.2 ms^{-2}

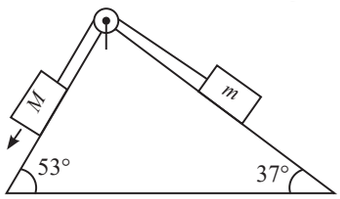
Two block & Inclined Plane Problems

86. A block of mass m is placed on a surface having vertical cross section given by $y = x^2/4$. If coefficient of friction is 0.5, the maximum height above the ground at which block can be placed without slipping is: **[30 Jan, 2024 (Shift-II)]**

(*a*) 1/4 m (*b*) 1/2 m (*c*) 1/6 m (*d*) 1/3 m

87. In the given arrangement of a doubly inclined plane two blocks of masses *M* and m are placed. The blocks are connected by a light string passing over an ideal pulley as shown. The coefficient of friction between the surface of the plane and the blocks is 0.25. The value of *m*, for which *M* = 10 kg will move down with an acceleration of 2 m/s², is: (take g = 10 m/s² and tan 37° = 3/4)

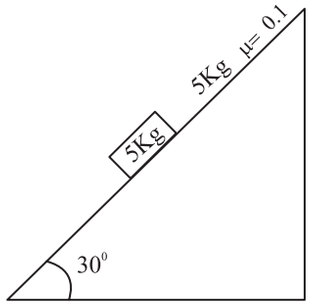
[31 Jan, 2024 (Shift-I)]



[31 Jan, 2024 (Shift-I)]

(*a*) 9 kg (*b*) 4.5 kg (*c*) 6.5 kg (*d*) 2.25 kg

88. A block of mass 5 kg is placed on a rough inclined surface as shown in the figure. **[31 Jan, 2024 (Shift-II)]**



[31 Jan, 2024 (Shift-II)]

If $\overrightarrow{F_1}$ is the force required to just move the block up the inclined plane and $\overrightarrow{F_2}$ is the force required to just prevent the block from sliding down, then the value of $|\overrightarrow{F_1}| - |\overrightarrow{F_2}|$ is: [Use g = 10m/s²]

(*a*) $25\sqrt{3}N$ (*b*) $50\sqrt{3}N$ (*c*) $\frac{5\sqrt{3}}{2}N$ (*d*) 10 N

89. A 2 kg brick begins to slide over a surface which is inclined at an angle of 45° with respect to horizontal axis. The co-efficient of static friction between their surfaces is: **[04 April, 2024 (Shift-II)]**

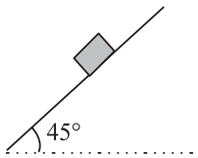
(*a*) 1 (*b*) $\frac{1}{\sqrt{3}}$ (*c*) 0.5 (*d*) 1.7

90. A given object takes n times the time to slide down 45° rough inclined plane as it takes the time to slide down an identical perfectly smooth 45° inclined plane. The coefficient of kinetic friction between the object and the surface of inclined plane is:

[08 April, 2024 (Shift-II)]

(*a*) $1-\frac{1}{n^2}$ (*b*) $1-n^2$ (*c*) $\sqrt{1-\frac{1}{n^2}}$ (*d*) $\sqrt{1-n^2}$

91. Consider a block kept on an inclined plane (inclined at 45º) as shown in the figure. If the force required to just push it up the incline is 2 times the force required to just prevent it from sliding down, the coefficient of friction between the block and inclined plane (μ) is equal to: **[25 Jan, 2023 (Shift-II)]**



(*a*) 0.33 (*b*) 0.60 (*c*) 0.25 (*d*) 0.50

92. A block of mass *m* slides down an inclined plane inclined at angle 30º with an acceleration $\frac{g}{4}$. The value of coefficient of kinetic friction will be: **[29 Jan, 2023 (Shift-I)]**

(*a*) $\frac{2\sqrt{3}+1}{2}$ (*b*) $\frac{1}{2\sqrt{3}}$ (*c*) $\frac{\sqrt{3}}{2}$ (*d*) $\frac{2\sqrt{3}-1}{2}$

93. The time taken by an object to slide down a 45º rough inclined plane is *n* times as it takes to slide down a perfectly smooth 45º inclined plane. The coefficient of kinetic friction between the object and the incline plane is **[29 Jan, 2023 (Shift-II)]**

(*a*) $\sqrt{\frac{1}{1-n^2}}$ (*b*) $\sqrt{1-\frac{1}{n^2}}$ (*c*) $1+\frac{1}{n^2}$ (*d*) $1-\frac{1}{n^2}$

94. A child of mass 5kg is going round a merry-go-round that makes 1 rotation in 3.14 s. The radius of the merry-go-round is 2 m. The centrifugal force on the child will be **[6 April 2023 (Shift-II)]**

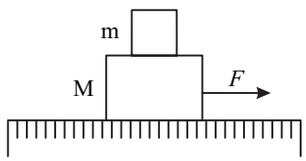
(*a*) 80 N (*b*) 50 N (*c*) 100 N (*d*) 40 N

95. A block of mass 10 kg, starts sliding on a surface with an initial velocity of 9.8 ms^{-1}. The coefficient of friction between the surface and block is 0.5. The distance covered by the block before coming to rest is:

[Used $g = 9.8\ ms^{-2}$] **[24 June, 2022 (Shift-I)]**

(*a*) 4.9 m (*b*) 9.8 m (*c*) 12.5 m (*d*) 19.6 m

96. A system of two blocks of masses m = 2 kg and m = 8 kg is placed on a smooth table as shown in figure. The coefficient of static friction between two blocks is 0.5. The maximum horizontal force F that can be applied to the block of mass M so that the blocks move together will be: [27 June, 2022 (Shift-I)]



(*a*) 9.8 N (*b*) 39.2 N (*c*) 49 N (*d*) 78.4 N

97. A block of mass *M* slides down on a rough inclined plane with constant velocity. The angle made by the incline plane with horizontal is θ. The magnitude of the contact force will be:

[27 July, 2022 (Shift-II)]

(*a*) Mg (*b*) $Mg\cos\theta$

(*c*) $\sqrt{Mg\sin\theta + Mg\cos\theta}$ (*d*) $Mg\sin\theta\sqrt{1+\mu}$

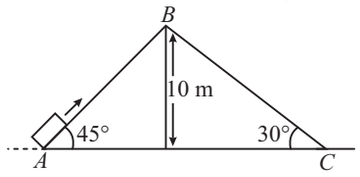
98. A block '*A*' takes 2 *s* to slide down a frictionless incline of 30° and length 'ℓ', kept inside a lift going up with uniform velocity '*v*'. If the incline is changed to 45°, the time taken by the block, to slide down the incline, will be approximately: [27 July, 2022 (Shift-II)]

(*a*) 2.66 s (*b*) 0.83 s (*c*) 1.68 s (*d*) 0.70 s

99. Two inclined planes are placed as shown in figure. A block is projected from the point A of inclined plane AB along its surface with velocity just sufficient to carry it to the top Point B at a height 10 m. After reaching the point B the block slide down on inclined plane BC. Time it takes to reach to the point C from point A is $t\left(\sqrt{2}+1\right)s$.

The value of t is _____ (use g = 10 m/s2)

[27 July, 2022 (Shift-II)]



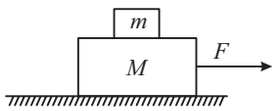
100. A metal wire of length 0.5m and cross-sectional area $10^{-4}m^2$ has breaking stress $5 \times 10^8\ Nm^{-2}$. A block of 10 kg is attached at one of the string and is rotating in a horizontal circle. The maximum linear velocity of block will be _____ ms^{-1}. **[29 July, 2022 (Shift-II)]**

101. A block of 200 g mass moves with a uniform speed in a horizontal circular groove, with vertical side walls of radius 20cm. If the block takes 40 s to complete one round, the normal force by the side walls of the groove is: **[16 March, 2021 (Shift-I)]**

(*a*) 6.28×10^{-3}N (*b*) 0.0314 N

(*c*) 9.859×10^{-2}N (*d*) 9.859×10^{-4}N

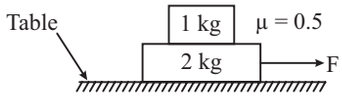
102. Two blocks (m = 0.5 kg and M = 4.5 kg) are arranged on a horizontal frictionless table as shown in figure. The coefficient of static friction between the two blocks is $\frac{3}{7}$. Then the maximum horizontal force that can be applied on the larger block so that the blocks move together is _____ N. (Round off to the Nearest Integer)
[Take g as 9.8 ms^{-2}] **[17 March, 2021 (Shift-I)]**



103. A body of mass '*m*' is launched up on a rough inclined plane making an angle of 30º with the horizontal. The coefficient of friction between the body and plane is $\frac{\sqrt{x}}{5}$ if the time of ascent is half of the time of descent. The value of *x* is _____.

[20 July, 2021 (Shift-II)]

104. The coefficient of static friction between two blocks is 0.5 and the table is smooth. The maximum horizontal force that can be applied to move the blocks together is _____ N. (take g = 10 ms^{-2}) **[26 Aug, 2021 (Shift-II)]**



105. A huge circular arc of length 4.4 ly subtends an angle '4s' at the centre of the circle. How long it would take for a body to complete 4 revolution if its speed is 8 AU per second?
Given: 1 ly = 9.46×10^{15} m **[27 Aug, 2021 (Shift-I)]**
1 AU = 1.5×10^{11} m

(*a*) 4.5×10^{10} s (*b*) 4.1×10^8 s

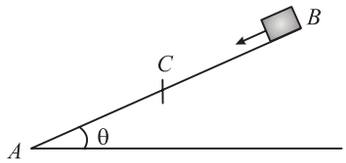
(*c*) 3.5×10^6 s (*d*) 7.2×10^8 s

106. When a body slides down from rest along a smooth inclined plane making an angle of 30° with the horizontal, it takes time *T*. When the same body slides down from the rest along a rough inclined plane making the same angle and through the same distance, it takes time αT, where α is a constant greater than 1. The co-efficient of friction between the body and the rough plane is $\frac{1}{\sqrt{x}}\left(\frac{\alpha^2-1}{\alpha^2}\right)$ where

x = _____. **[1 Sep, 2021 (Shift-II)]**

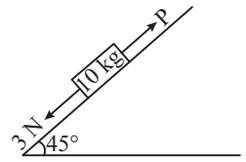
107. A small block starts slipping down from a point *B* on an inclined plane *AB*, which is making an angle θ with the horizontal section. *BC* is smooth and the remaining section *CA* is rough with a coefficient of friction μ. It is found that the block comes to rest as it reaches the bottom (point *A*) of the inclined plane. If $BC = 2AC$, the coefficient of friction is given by $\mu = k\tan\theta$. The value of k is _____.

[2 Sep, 2020 (Shift-I)]



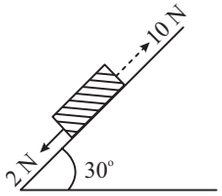
108. A block starts moving up an inclined plane of inclination 30° with an initial velocity of v_0. It comes back to its initial position with velocity $\frac{v_0}{2}$. The value of the coefficient of kinetic friction between the block and the inclined plane is close to $\frac{I}{1000}$. The nearest integer to *I* is _____. **[3 Sep, 2020 (Shift-II)]**

109. A block of mass 10 kg is kept on a rough inclined plane as shown in the figure. A force of 3 N is applied on the block. The coefficient of static friction between the plane and the block is 0.6. What should be the minimum value of force P, such that the block does not move downward? (Take g = 10 ms^{-2}) **[9 Jan, 2019 (Shift-I)]**



(*a*) 32 N (*b*) 18 N (*c*) 23 N (*d*) 25 N

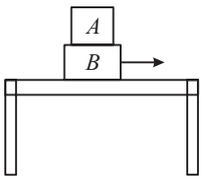
110. A block kept on a rough inclined plane, as shown in the figure, remains at rest up-to a maximum force 2 N down the inclined plane. The maximum external force up the inclined plane that does not move the block is 10 N. The coefficient of static friction between the block and the plane is: **[12 Jan, 2019 (Shift-II)]**



(*a*) $\frac{\sqrt{3}}{2}$ (*b*) $\frac{\sqrt{3}}{4}$ (*c*) $\frac{1}{2}$ (*d*) $\frac{2}{3}$

111. Two blocks A and B of masses $m_A = 1$ kg and $m_B = 3$ kg are kept on the table as shown in figure. The coefficient of friction between A and B is 0.2 and between B and the surface of the table is also 0.2. The maximum force F that can be applied on horizontally, so that the block A does not slide over the block B is: (Take g = 10 m/s^2)

[10 April, 2019 (Shift-II)]



(*a*) 16 N (*b*) 40 N (*c*) 12 N (*d*) 8 N

Dynamics of Circular Motion, Centripetal Force.

112. A train is moving with a speed of 12 m/s on rails which are 1.5 m apart. To negotiate a curve radius 400 m, the height by which the outer rail should be raised with respect to the inner rail is (Given, g = 10 m/s^2): **[27 Jan, 2024 (Shift-I)]**

(*a*) 6.0 cm (*b*) 5.4 cm (*c*) 4.8 cm (*d*) 4.2 cm

113. A coin is placed on a disc. The coefficient of friction between the coin and the disc is μ. If the distance of the coin from the center of the disc is r, the maximum angular velocity which can be given to the disc, so that the coin does not slip away, is:

[31 Jan, 2024 (Shift-I)]

(*a*) $\frac{\mu g}{r}$ (*b*) $\sqrt{\frac{r}{\mu g}}$ (*c*) $\sqrt{\frac{\mu g}{r}}$ (*d*) $\frac{u}{\sqrt{\mu g}}$

114. A ball of mass 0.5 kg is attached to a string of length 50 cm. The ball is rotated on a horizontal circular path about its vertical axis. The maximum tension that the string can bear is 400 N. The maximum possible value of angular velocity of the ball in rad/s is,:

[1 Feb, 2024 (Shift-I)]

(*a*) 1600 (*b*) 40 (*c*) 1000 (*d*) 20

115. A man carrying a monkey on his shoulder does cycling smoothly on a circular track of radius 9m and completes 120 revolutions in 3 minutes. The magnitude of centripetal acceleration of monkey is (in m/s2):

[05 April, 2024 (Shift-II)]

(*a*) zero (*b*) 16 π^2 ms^{-2}

(*c*) 4 π^2 ms^{-2} (*d*) 57600 π^2 ms^{-2}

116. A car of 800 kg is taking turn on a banked road of radius 300 m and angle of banking 30°. If coefficient of static friction is 0.2 then the maximum speed with which car can negotiate the turn safely: (g = 10 m/s^2, 3 = 1.73) **[06 April, 2024 (Shift-II)]**

(*a*) 70.4 m/s (*b*) 51.4 m/s (*c*) 264 m/s (*d*) 102.8 m/s

117. A body of mass 200 *g* is tied to a spring of spring constant 12.5 *N*/*m*, while the other end of spring is fixed at point *O*. If the body moves about *O* in a circular path on a smooth horizontal surface with constant angular speed 5 *rad*/*s*, then the ratio of extension in the spring to its natural length will be: **[24 Jan, 2023 (Shift-II)]**

(*a*) 1 : 2 (*b*) 1 : 1

(*c*) 2 : 3 (*d*) 2 : 5

118. A car is moving with a constant speed of 20 m/s in a circular horizontal track of radius 40 m. A bob is suspended from the roof of the car by a massless string. The angle made by the string with the vertical will be: (Take g = 10 m/s^2) **[25 Jan, 2023 (Shift-I)]**

(*a*) $\frac{\pi}{6}$ (*b*) $\frac{\pi}{2}$

(*c*) $\frac{\pi}{4}$ (*d*) $\frac{\pi}{3}$

119. A car is moving on a horizontal curved road with radius 50*m*. The approximate maximum speed of car will be, if friction coefficient between tyres and road is 0.34. [Take $g = 10\ ms^{-2}$]

[29 Jan, 2023 (Shift-I)]

(*a*) 3.4 ms^{-1} (*b*) 22.4 ms^{-1} (*c*) 13 ms^{-1} (*d*) 17 ms^{-1}

120. A small block of mass 100 g is tied to a spring of spring constant 7.5 N/m and length 20 cm. The other end of spring is fixed at a particular point A. If the block moves in a circular path on a smooth horizontal surface with constant angular velocity 5 rad/s about point A, then tension in the spring is **[6 April, 2023 (Shift-I)]**

(*a*) 1.5 N (*b*) 0.75 N (*c*) 0.25 N (*d*) 0.50 N

121. A coin placed on a rotating table just slips when it is placed at a distance of 1 cm from the center. If the angular velocity of the table in halved, it will just slip when placed at a distance of from the centre: **[11 April, 2023 (Shift-I)]**

(*a*) 2 cm (*b*) 1 cm (*c*) 8 cm (*d*) 4 cm

122. A vehicle of mass 200 kg is moving along a levelled curved road of radius 70 m with angular velocity of 0.2 rad/s. The centripetal force acting on the vehicle is: **[13 April, 2023 (Shift-II)]**

(*a*) 560 *N* (*b*) 2800 *N* (*c*) 14 *N* (*d*) 2240 *N*

123. A boy ties a stone of mass 100 g to the end of 2 m long string and whirls it around in a horizontal plane. The string can withstand the maximum tension of 80 N. If the maximum speed with which the stone can revolve is $\frac{K}{\pi}$ rev. /min. The value of *K* is:

(Assume the string is massless and unstretchable)

[24 June, 2022 (Shift-I)]

(*a*) 400 (*b*) 300 (*c*) 600 (*d*) 800

124. A boy ties a stone of mass 100 g to the end of 2 m long string and whirls it around in a horizontal plane. The string can withstand the maximum tension of 80 N. If the maximum speed with which the stone can revolve is $\frac{K}{\pi}$ rev. /min. The value of *K* is:

(Assume the string is massless and unstretchable)

[24 June, 2022 (Shift-I)]

(*a*) 400 (*b*) 300 (*c*) 600 (*d*) 800

125. A curved in a level road has a radius 75 m. The maximum speed of a car turning this curved road can be 30 m/s without skidding. If radius of curved road is changed to 48m and the coefficient of friction between the tyres and the road remains same, then maximum allowed speed would be _____m/s. **[25 June, 2022 (Shift-II)]**

126. A disc with a flat small bottom beaker placed on it at a distance R from its center is revolving about an axis passing through the center and perpendicular to its plane with an angular velocity ω. The coefficient of static friction between the bottom of the beaker and the surface of the disc is μ. The beaker will revolve with the disc if: **[25 June, 2022 (Shift-II)]**

(*a*) $R \le \frac{\mu g}{2\omega^2}$ (*b*) $R \le \frac{\mu g}{\omega^2}$

(*c*) $R \ge \frac{\mu g}{2\omega^2}$ (*d*) $R \ge \frac{\mu g}{\omega^2}$

127. One end of a massless spring of spring constant k and natural length l0 is fixed while the other end is connected to a small object of mass m lying on a frictionless table. The spring remains horizontal on the table. If the object is made to rotate at an angular velocity ω about an axis passing through fixed end, then the elongation of the spring will be: **[27 June, 2022 (Shift-II)]**

(*a*) $\frac{k - m\omega^2 l_0}{m\omega^2}$ (*b*) $\frac{m\omega^2 l_0}{k + m\omega^2}$

(*c*) $\frac{m\omega^2 l_0}{k - m\omega^2}$ (*d*) $\frac{k + m\omega^2 l_0}{m\omega^2}$

128. A particle is moving with uniform speed along the circumference of a circle of radius of radius *R* under the action of a central fictitious force *F* which is inversely proportional to R^3. Its time period of revolution will be given by: **[26 Feb, 2021 (Shift-I)]**

(*a*) $T \propto R^{\frac{3}{2}}$ (*b*) $T \propto R^{\frac{5}{2}}$ (*c*) $T \propto R^{\frac{4}{3}}$ (*d*) $T \propto R^2$

129. Statement I: A cyclist is moving on an un-banked road with a speed of 7 kmh–1 and takes a sharp circular turn along a path of radius of 2m without reducing the speed. The static friction coefficient is 0.2 The cyclist will not slip and pass the curve. (g = 9.8 m/s2)

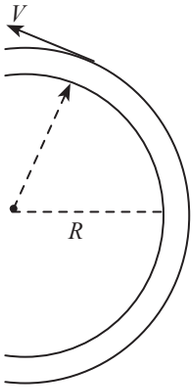
Statement II: If the road is at an angle of 45°, cyclist can cross of the curve of 2m radius with the speed of 18.5 kmh^{-1} without slipping

In the light of the above statements, choose the correct the answer from the options given below. **[16 March, 2021 (Shift-II)]**

(*a*) Statement I is incorrect and statement II is correct
(*b*) Both statement I and statement II are true
(*c*) Statement I is correct and statement II is incorrect
(*d*) Both statement I and statement II are false

130. A modern grand - prix racing car of mass *m* is traveling on a flat track in a circular arc of radius *R* with a speed *v*. If the coefficient of static friction between the tyres and the track is μ_s, then the magnitude of negative lift F_L acting downwards on the car is :

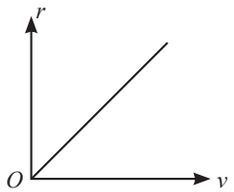
(Assume forces on the four tyres are identical and *g* = acceleration due to gravity) **[17 March, 2021 (Shift-I)]**

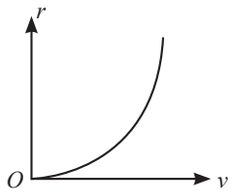


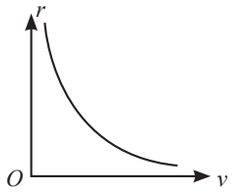
(*a*) $m\left(\frac{v^2}{\mu_s R} - g\right)$ (*b*) $-m\left(g + \frac{v^2}{\mu_s R}\right)$

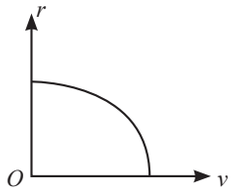
(*c*) $m\left(g - \frac{v^2}{\mu_s R}\right)$ (*d*) $m\left(\frac{v^2}{\mu_s R} + g\right)$

131. A particle of mass m moves in a circular orbit under the central potential field, $V(r) = -\frac{C}{r}$, where *C* is a constant. The correct radius-velocity graph of the particle's motion is: **[18 March, 2021 (Shift-II)]**

(*a*) 

(*b*) 

(*c*) 

(*d*) 

132. The normal reaction '*N*' for a vehicle of 800 kg mass, negotiating a turn on a 30º banked road at maximum possible speed without skidding is ____ × 103 kg m/s². [Given cos30º = 0.87, μs = 0.2]

[20 July, 2021 (Shift-I)]

(*a*) 6.96 (*b*) 10.2
(*c*) 12.4 (*d*) 7.2

133. A particle of mass m is suspended form a ceiling through a string of length L. The particle moves in a horizontal circle of radius r such that $r = \frac{L}{\sqrt{2}}$. The speed of particle will be:

[26 Aug, 2021 (Shift-II)]

(*a*) $\sqrt{rg}$ (*b*) $\sqrt{\frac{rg}{2}}$

(*c*) $2\sqrt{rg}$ (*d*) $\sqrt{2rg}$

134. A particle of mass m is fixed to one end of light spring having force constant k and unstretched length ℓ. The other end is fixed. The system is given an angular speed ω about the fixed end of the spring such that it rotates in a circle in gravity free space. Then the stretch in the spring is: **[8 Jan, 2020 (Shift-I)]**

(*a*) $\frac{m\ell\omega^2}{k - m\omega^2}$ (*b*) $\frac{m\ell\omega^2}{k - \omega m}$

(*c*) $\frac{m\ell\omega^2}{k + m\omega^2}$ (*d*) $\frac{m\ell\omega^2}{k + m\omega}$

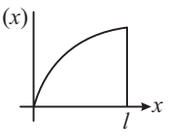
135. A body of mass *m* = 10 kg is attached to one end of a wire of length 0.3 m. The maximum angular speed (in rad s^{-1}) with which it can be rotated about its other end in space station (Breaking stress of wire = 4.8×10^7 Nm^{-2} and area of cross section of the wire = 10^{-2} cm^2) is: **[9 Jan, 2020 (Shift-I)]**

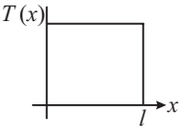
136. A spring mass system (mass m, spring constant k and natural length *l*) rests in equilibrium on a horizontal disc. The free and of the spring is fixed at the centre of the disc. If the disc together with spring mass system, rotates about it's axis with an angular velocity ω, (k >> mω²) the relative change in the length of the spring is best given by the option **[9 Jan, 2020 (Shift-II)]**

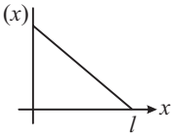
(a) $\sqrt{\frac{2}{3}}\left(\frac{m\omega^2}{k}\right)$ (b) $\frac{m\omega^2}{3k}$

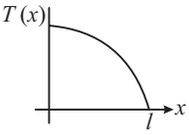
(c) $\frac{2m\omega^2}{k}$ (d) $\frac{m\omega^2}{k}$

137. A uniform rod of length l is being rotated in a horizontal plane with a constant angular speed about an axis passing through one of its ends. If the tension generated in the rod due to rotation is T(x) at a distance x from the axis, then which of the following graphs depicts it most closely? **[12 April, 2019 (Shift-I)]**

(a) 

(b) 

(c) 

(d) 

JEE-Advanced

Laws of Motion, Application of Force/Impulse, Statics and Dynamics Involving Single System

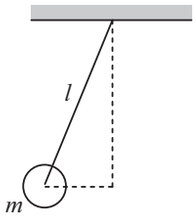
Single Correct

1. 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? **C-16.53 W-42.74 UA-40.73 (JEE Adv. 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) $\vec{F} = m\alpha^2(x\hat{x} + 2y\hat{y})$

2. A ball of mass (m) 0.5kg is attached to the end of a string having length (l) 0.5m. The ball is rotated on a horizontal circular path about vertical axis. The maximum tension that the string can bear is 324N. The maximum possible value of angular velocity of ball (in rad/s) is **(IIT-JEE 2011)**



(a) 9 (b) 18 (c) 27 (d) 36

3. A piece of wire is bent in the shape of a parabola $y = kx^2$ (y-axis vertical) with a bead of mass m on it. The bead can slide on the wire without friction. It stays at the lowest point of the parabola when the wire is at rest. The wire is now accelerated parallel to the x-axis with a constant acceleration a. The distance of the new equilibrium position of the bead, where the bead can stay at rest with respect to the wire, from the y axis is **(IIT-JEE 2009)**

(a) $\frac{a}{gk}$ (b) $\frac{a}{2gk}$ (c) $\frac{2a}{gk}$ (d) $\frac{a}{4gk}$

4. **Statement-I:** A cloth covers a table. Some dishes are kept on it. The cloth can be pulled out without dislodging the dishes from the table.
Statement-II: For every action there is an equal and opposite reaction. **(IIT-JEE 2007)**

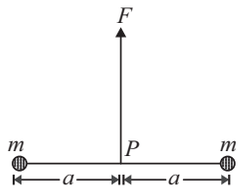
(a) If Statement-I is true, Statement-II is true; Statement-II is the correct explanation for Statement-I

(b) If Statement-I is true, Statement-II is true; Statement-II is not a correct explanation for Statement-I

(c) If Statement-I is true; Statement-II is false

(d) If Statement-I is false; Statement-II is true

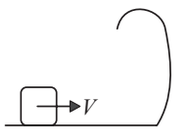
5. Two particles of mass m each are tied at the ends of a light string of length $2a$. The whole system is kept on a frictionless horizontal surface with the string held tight so that each mass is at a distance a from the center P (as shown in the figure). Now, the mid-point of the string is pulled vertically upwards with a small but constant force F. As a result, the particles move towards each other on the surface. The magnitude of acceleration, when the separation between them becomes $2x$, is **(IIT-JEE 2007)**

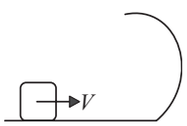


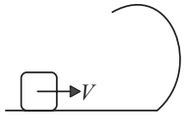
(a) $\frac{F}{2m}\frac{a}{\sqrt{a^2 - x^2}}$ (b) $\frac{F}{2m}\frac{x}{\sqrt{a^2 - x^2}}$

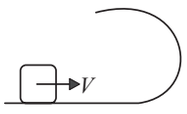
(c) $\frac{F}{2m}\frac{x}{a}$ (d) $\frac{F}{2m}\frac{\sqrt{a^2 - x^2}}{x}$

6. A small block is shot into each of the four tracks as shown below. Each of the tracks rises to the same height. The speed with which the block enters the track is the same in all cases. At the highest point of the track, the normal reaction is maximum in **(IIT-JEE 2001)**

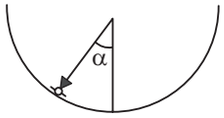
(a) 

(b) 

(c) 

(d) 

7. An insect crawls up a hemispherical surface very slowly (see Fig.). The coefficient of friction between the insect and the surface is $\frac{1}{3}$. If the line joining the center of the hemispherical surface to the insect makes an angle α with the vertical, the maximum possible value of α is the given by **(IIT-JEE 2001)**



(*a*) $\cot\alpha = 3$ (*b*) $\tan\alpha = 3$ (*c*) $\sec\alpha = 3$ (*d*) $\operatorname{cosec}\alpha = 3$

8. A car is moving in a circular horizontal track of radius 10 *m* with a constant speed of 10 *m*/*s*. A plumb bob is suspended from the roof of the car by a light rigid rod. The angle made by the rod with the vertical is (Take = 10 m/s^2) **(IIT-JEE 1992)**

(*a*) 0° (*b*) 30° (*c*) 45° (*d*) 60°

9. A simple pendulum with a bob of mass *m* swings with an angular amplitude of 40°. When its angular displacement is 20°, the tension in the string is greater than *mg*cos20° **(IIT-JEE 1984)**

(*a*) > *mg*cos20° (*b*) *mg*cos20°

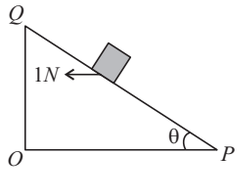
(*c*) *mg* (*d*) < *mg*cos20°

10. A ship of mass 3×10^7 kg initially at rest, is pulled by a force of 5×10^4 N through a distance of 3 m. Assuming that the resistance due to water is negligible, the speed of the ship is **(IIT-JEE 1980)**

(*a*) 1.5 m/s (*b*) 60 m/s (*c*) 0.1 m/s (*d*) 5 m/s

Multiple Correct

11. A small block of mass of 0.1 kg lies on a fixed inclined plane *PQ* which makes an angle θ with the horizontal. A horizontal force of 1*N* acts on the block through its center of mass as shown in the figure. The block remains stationary if (take g = 10 m/s^2) **C-22.83 W-72.81 UA-4.37 (IIT-JEE 2012)**



(*a*) $\theta = 45°$

(*b*) $\theta > 45°$ and a frictional force acts on the block towards *P*

(*c*) $\theta > 45°$ and a frictional force acts on the block towards *Q*

(*d*) $\theta < 45°$ and a frictional forces acts on the block towards *Q*

12. A simple pendulum of length *L* and mass (bob) *M* is oscillating in a plane about a vertical line between angular limits $-\phi$ and $+\phi$. For an angular displacement $\theta(|\theta| < \phi)$, the tension in the string and the velocity of the bob are *T* and *v* respectively. The following relations hold good under the above conditions **(IIT-JEE 1986)**

(*a*) $T\cos\theta = Mg$

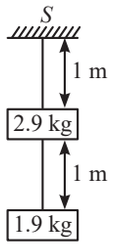
(*b*) $T - Mg\cos\theta = \frac{Mv^2}{L}$

(*c*) The magnitude of the tangential acceleration of the bob $|a_T| = g\sin\theta$

(*d*) $T = Mg\cos\theta$

Subjective

13. Two blocks of mass 2.9 kg and 1.9 kg are suspended from a rigid support *S* by two inextensible wires each of length 1 *m* (see figure). The upper wire has negligible mass and the lower wire has a uniform mass of 0.2 kg/m. The whole system of blocks, wires and support have an upward acceleration of 0.2 m/s^2. The acceleration due to gravity is 9.8 m/s^2.



(*a*) Find the tension at the midpoint of the lower wire.

(*b*) Find the tension at the midpoint of the upper wire.

(IIT-JEE 1989)

14. A uniform rope of length *L* and mass *M* lying on a smooth table is pulled by a constant force *F*. What is the tension in the rope at a distance *l* from the end where the force is applied? **(IIT-JEE 1978)**

Kinetic Friction

Single Correct

15. A uniform wooden stick of mass 1.6 kg of length *l* rests in an inclined manner on a smooth, vertical wall of height $h(<l)$ such that a small portion of the stick extends beyond the wall. The reaction force of the wall on the stick is perpendicular to the stick. The stick makes an angle of 30° with the wall and the bottom of the stick is on a rough floor. The reaction of the wall on the stick is equal in magnitude to the reaction of the floor on the stick. The ratio $\frac{h}{l}$ and the frictional force *f* at the bottom of the stick are ($g = 10\ ms^{-2}$)

C-26.12 W-23.58 UA-50.3 (JEE Adv. 2016)

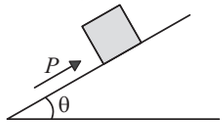
(*a*) $\frac{h}{l} = \frac{\sqrt{3}}{16}, f = \frac{16\sqrt{3}}{3}N$

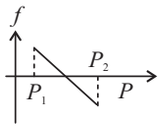
(*b*) $\frac{h}{l} = \frac{3}{16}, f = \frac{16\sqrt{3}}{3}N$

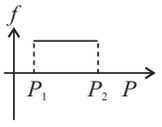
(*c*) $\frac{h}{l} = \frac{3\sqrt{3}}{16}, f = \frac{8\sqrt{3}}{3}N$

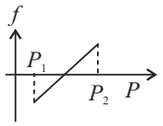
(*d*) $\frac{h}{l} = \frac{3\sqrt{3}}{16}, f = \frac{16\sqrt{3}}{3}N$

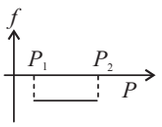
16. A block of mass *m* is on an inclined plane of angle θ. The coefficient of friction between the block and the plane is μ and $\tan\theta > \mu$. The block is held stationary by applying a force *P* parallel to the plane. The direction of force pointing up the plane is taken to be positive. As *P* is varied from $P_1 = mg(\sin\theta - \mu\cos\theta)$ to $P_2 = mg(\sin\theta + \mu\cos\theta)$, the frictional force *f* versus *P* graph will look like **(IIT-JEE 2010)**



(*b*) 

(*b*) 

(*c*) 

(*d*) 

17. **Statement-I:** It is easier to pull a heavy object than to push it on a level ground.

Statement-II: The magnitude of frictional force depends on the nature of the two surfaces in contact. **(IIT-JEE 2008)**

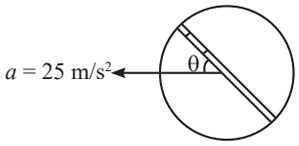
(*a*) If Statement-I is true, Statement-II is true; Statement-II is the correct explanation for Statement-I

(*b*) If Statement-I is true, Statement-II is true; Statement-II is not a correct explanation for Statement-I

(*c*) If Statement-I is true; Statement-II is false

(*d*) If Statement-I is false; Statement-II is true

18. A circular disc with a groove along its diameter is placed horizontally. Block of mass 1kg is placed as shown. The coefficient of friction between the block and all surfaces of groove in contact is $\mu = 2/5$. The disc has an acceleration of 25 m/s^2. Find the acceleration of the block with respect to the disc. **(IIT-JEE 2006)**



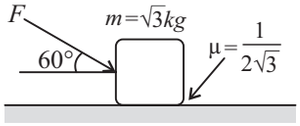
$\cos\theta = 4/5$

$\sin\theta = 3/5$

(*a*) 10 m/s^2 (*b*) 5 m/s^2

(*c*) 20 m/s^2 (*d*) 15 m/s^2

19. What is the maximum value of the force F such that the block shown in the arrangement does not move? **(IIT-JEE 2003)**

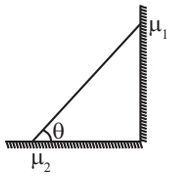


(*a*) 20 *N* (*b*) 10 *N*

(*c*) 12 *N* (*d*) 15 *N*

Multiple Correct

20. In the figure, a ladder of mass m is shown leaning against a wall. It is in static equilibrium making an angle θ with the horizontal floor. The coefficient of friction between the wall and the ladder is μ_1 and that between the floor and the ladder is μ_2. The normal reaction of the wall on the ladder is N_1 and that of the floor is N_2. If the ladder is about to slip, then **C-12.91 W-75.92 UA-11.18 (JEE Adv. 2014)**



(*a*) $\mu_1 = 0$, $\mu_2 \neq 0$ and $N_2\tan\theta = \frac{mg}{2}$

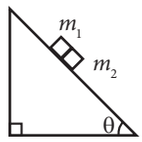
(*b*) $\mu_1 \neq 0$, $\mu_2 = 0$ and $N_2\tan\theta = \frac{mg}{2}$

(*c*) $\mu_1 \neq 0$, $\mu_2 \neq 0$ and $N_2 = \frac{mg}{1+\mu_1\mu_2}$

(*d*) $\mu_1 = 0$, $\mu_2 \neq 0$ and $N_1\tan\theta = \frac{mg}{2}$

Match the Column

21. A block of mass $m_1 = 1$ kg another mass $m_2 = 2$ kg are placed together (see figure) on an inclined plane with angle of inclination θ. Various values of θ are given in List-I. The coefficient of friction between the block m_1 and the plane is always zero. The coefficient of static and dynamic friction between the block m_2 and the plane are equal to $\mu = 0.3$



In List-II expressions for the friction on the block m_2 are given. Match the correct expression of the friction in List-II with the angles given in List-I, and choose the correct option. The acceleration due to gravity is denoted by g.

[Useful information tan (5.5°) ≈ 0.1; tan(11.5°) ≈ 0.2;tan(16.5°) ≈ 0.3]

C-17.24 W-48.85 UA-33.91 (JEE Adv. 2014)

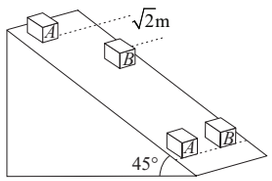
List-I		List-II	
P.	$\theta = 5°$	1.	$m_2 g\sin\theta$
Q.	$\theta = 10°$	2.	$(m_1 + m_2)g\sin\theta$
R.	$\theta = 15°$	3.	$\mu m_2 g\cos\theta$
S.	$\theta = 20°$	4.	$\mu(m_1 + m_2)g\cos\theta$

(*a*) P-1, Q-1, R-1, S-3 (*b*) P-2, Q-2, R-2, S-3

(*c*) P-2, Q-2, R-2, S-4 (*d*) P-2, Q-2, R-3, S-3

Subjective

22. Two blocks A and B of equal masses are released from an inclined plane of inclination 45° at $t = 0$. Both the blocks are initially at rest. The coefficient of kinetic friction between the block A and the inclined plane is 0.2 while it is 0.3 for block B. Initially the block A is $\sqrt{2}$ m behind the block B. When and where their front faces will come in a line? (Take g =10 m/s^2) **(IIT-JEE 2004)**



23. Two blocks of mass $m_1 = 10$ kg and $m_2 = 5$ kg connected to each other by a massless inextensible string of length 0.3 m are placed along the diameter of the turn table. The coefficient of friction between the table and m_1 is 0.5 while there is no friction between m_2 and the table. The table is rotating with an angular velocity of 10 rad/s about a vertical axis passing through its center O. The masses are placed along the diameter of table on either side of the center O such that the mass m_1 is at a distance of 0.124 m from O. The masses are observed to be at rest with respect to an observer on the turntable.

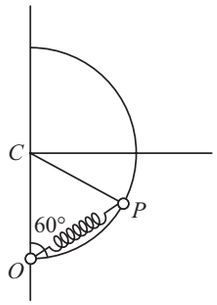
(*a*) Calculate the frictional force on m_1.

(*b*) What should be the minimum angular speed of the turntable, so that the masses will slip from this position?

(*c*) How should the masses be placed with the string remaining taut so that there is no frictional force acting on the mass m_1?

(IIT-JEE 1997)

24. A smooth semicircular wire track of radius R is fixed in a vertical plane (figure). One end of a massless spring of natural length $3R/4$ is attached to the lowest point O of the wire track. A small ring of mass m which can slide on the track is attached to the other end of the spring. The ring is held stationary at point P such that the spring makes an angle 60° with the vertical. The spring constant $k = mg/R$. Consider the instant when the ring is making an angle 60° with the vertical. The spring is released, (*a*) Draw the free body diagram of the ring. (*b*) Determine the tangential acceleration of the ring and the normal reaction **(IIT-JEE 1996)**

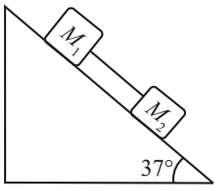


25. A hemispherical bowl of radius $R = 0.1$m is rotating about its own axis (which is vertical) with an angular velocity ω. A particle of mass 10^{-2} kg on the frictionless inner surface of the bowl is also rotating with the same ω. The particle is at a height h from the bottom of the bowl.

(*a*) Obtain the relation between h and ω. What is the minimum value of ω needed, in order to have a non-zero value of h?

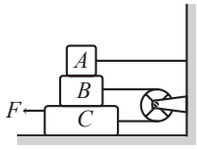
(*b*) It is desired to measure g (acceleration due to gravity) using the set-up by measuring h accurately. Assuming that R and ω are known precisely and that the least count in the measurement of h is 10^{-4} m, what is minimum possible error Δg in the measured value of g? **(IIT-JEE 1993)**

26. Two blocks connected by a massless string slides down an inclined plane having an angle of inclination of 37°. The masses of the two blocks are $M_1 = 4$ kg and $M_2 = 2$ kg respectively and the coefficients of friction of M_1 and M_2 with the inclined plane are 0.75 and 0.25 respectively. Assuming the string to be taut, find (*a*) the common acceleration of two masses and (*b*) the tension in the string. (sin 37° = 0.6, cos 37° = 0.8). (Take $g = 9.8$. m/s^2) **(IIT-JEE 1979)**



27. A block of mass 2 kg slides on an inclined plane which makes an angle of 30° with the horizontal. The coefficient of friction between the block and the surface is $\sqrt{3}/\sqrt{2}$. What force along the plane should be applied to the block so that it moves (*a*) down and (*b*) up without any acceleration? (Take $g = 10$ m/s^2.) **(IIT-JEE 1978)**

28. In the figure, the blocks A, B and C have masses 3 kg, 4 kg and 8 kg respectively. The coefficient of sliding friction between any two surfaces is 0.25. A is held at rest by a massless rigid rod fixed to the wall, while B and C are connected by a light flexible cord passing around a fixed frictionless pulley. Find the force F necessary to drag C along the horizontal surface to the left at a constant speed. Assume that the arrangement shown in the figure. i.e. B on C and A on B, is maintained throughout.(Take $g = 10$ m/s^2). **(IIT-JEE 1978)**



Numerical Types/Integer Type

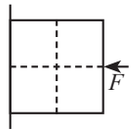
29. A block is moving on an inclined plane making an angle 45° with the horizontal and the coefficient of friction is μ.

The force required to just push it up the inclined plane is 3 times the force required to just prevent it from sliding down. If we define $N = 10\mu$, then N is **(IIT-JEE 2011)**

Static Friction

Single Correct

30. A block of mass m is at rest under the action of force F against a wall as shown in figure. Which of the following statements is incorrect? **(IIT-JEE 2005)**



(*a*) $f = mg$ (where f is the frictional force)

(*b*) $F = N$ (where N is the normal force)

(*c*) F will not produce torque

(*d*) N will not produce torque

31. A block of mass 0.1 kg is held against a wall applying a horizontal force of 5 N on the block. If the coefficient of friction between the block and the wall is 0.5, the magnitude of the frictional force acting on the block is **(IIT-JEE 1994)**

(*a*) 2.5 N (*b*) 0.98 N (*c*) 4.9 N (*d*) 0.49 N

32. During paddling of a bicycle, the force of friction exerted by the ground on the two wheels is such that it acts **(IIT-JEE 1990)**

(*a*) In the backward direction on the front wheel and in the forward direction on the rear wheel

(*b*) In the forward direction on the front wheel and in the backward direction on the rear wheel

(*c*) In the backward direction on both the front and the rear wheels

(*d*) In the forward direction on both the front and the rear wheels

33. A block of mass 1 kg lies on a horizontal surface in a truck. The coefficient of static friction between the block and the surface is 0.6. If the acceleration of the truck is 5 m/s^2, the frictional force acting on the block is... **(IIT-JEE 1984)**

(*a*) 5N (*b*) 4N (*c*) 8N (*d*) 16N

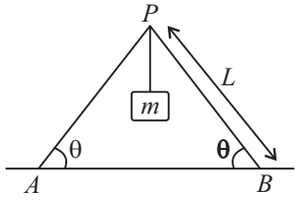
34. A block of mass 2 kg rests on a rough inclined plane making an angle of 30° with the horizontal. The coefficient of static friction between the block and the plane is 0.7. The frictional force on the block is **(IIT-JEE 1980)**

(*a*) 9.8 N (*b*) $0.7 \times 9.8 \times \sqrt{3}$ N

(*c*) $9.8 \times \sqrt{3}$ N (*d*) 0.7×9.8 N

Subjective

35. Two identical ladders are arranged as shown in the figure. Mass of each ladder is *M* and length *L*. The system is in equilibrium. Find direction and magnitude of frictional force *A* acting at *A* or *B*. **(IIT-JEE 2005)**

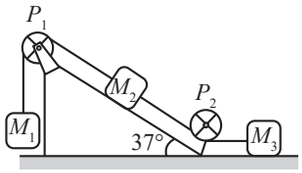


36. A block of mass *m* rests on a horizontal floor with which it has a coefficient of static friction μ. It is desired to make the body move by applying the minimum possible force *F*. Find the magnitude of *F* and the direction in which it has to be applied **(IIT-JEE 1987)**

Two and Three Blocks Problems

Subjective

37. Masses M_1, M_2 and M_3 are connected by strings of negligible mass which passes over massless and frictionless pulleys P_1 and P_2 as shown in figure.



The masses move such that the portion of the string between P_1 and P_2 is parallel to the inclined plane and the portion of the string between P_2 and M_3 is horizontal. The masses M_2 and M_3 are 4.0 kg each and the coefficient of kinetic friction between the masses and the surfaces is 0.25. The inclined plane makes an angle of 37° with the horizontal.

If the mass M_1 moves downwards with a uniform velocity, find

(*a*) The mass of M_1,

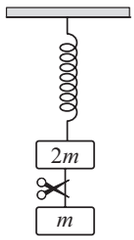
(*b*) The tension in the horizontal portion of the string.

(Take $g = 9.8\ m/s^2$, $\sin 37° = 3/5$) **(IIT-JEE 1981)**

Constraint Relation, Dynamics of Multi System Spring

Single Correct

38. System shown in the figure is in equilibrium and at rest. The spring and string are massless, now the string is cut. The acceleration of mass 2*m* and *m* just after the string is cut will be **(IIT-JEE 2006)**



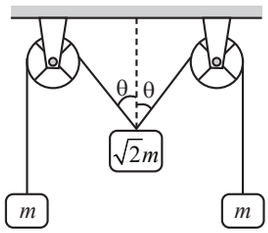
(*a*) *g*/2 upwards, *g* downwards

(*b*) *g* upwards, *g*/2 downwards

(*c*) *g* upwards, 2*g* downwards

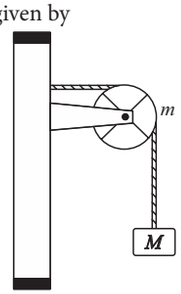
(*d*) 2*g* upwards, *g* downwards

39. The pulleys and strings shown in the figure are smooth and of negligible mass. For the system to remain in equilibrium, the angle θ should be **(IIT-JEE 2001)**



(*a*) 0° (*b*) 30° (*c*) 45° (*d*) 60°

40. A string of negligible mass going over a clamped pulley of mass *m* supports a block of mass *M* as shown in the figure. The force on the pulley by the clamp is given by **(IT-JEE 2001)**



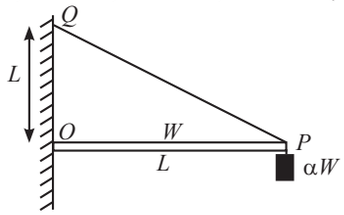
(*a*) $\sqrt{2}\,Mg$ (*b*) $\sqrt{2}\,mg$

(*c*) $g\sqrt{(M+m)^2+m^2}$ (*d*) $g\sqrt{(M+m)^2+M^2}$

Multiple Correct

41. One end of a horizontal uniform beam of weight *W* and length *L* is hinged on a vertical wall at point *O* and its other end is supported by a light inextensible rope. The other end of the rope is fixed at point *Q*. at a height *L* above the hinge at point *O*. A block of weight αW is attached at the point *P* of the beam, as shown in the figure (not to scale). The rope can sustain a maximum tension of $(2\sqrt{2})$ W. Which of the following statement(s) is(are) correct?

C-6.23, W-15.59, UA-47.35, PC-30.84 (JEE Adv.2021)



(*a*) The vertical component of reaction force at *O* does not depend on α

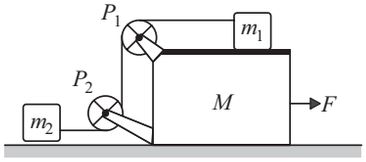
(*b*) The horizontal component of reaction force at *O* is equal to *W* for $\alpha = 0.5$

(*c*) The tension in the rope is $2W$ for $\alpha = 0.5$

(*d*) The rope breaks if $\alpha > 1.5$

Subjective

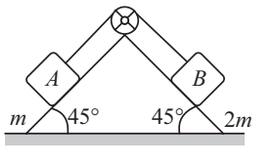
42. In the figure masses m_1, m_2 and *M* are 20 kg, 5 kg and 50 kg respectively. The coefficient of friction between *M* and ground is zero. The coefficient of friction between m_1 and *M* and that between m_2 and ground is 0.3. The pulleys and the strings are massless. The string is perfectly horizontal between P_1 and m_1 and also between P_2 and m_2. The string is perfectly vertical between P_1 and P_2. An external horizontal force *F* is applied to the mass *M*. (Take $g = 10\ m/s^2$).



(*a*) Draw a free body diagram of mass *M*, clearly showing all the forces.

(*b*) Let the magnitude of the force of friction between m_1 and *M* be f_1 and that between m_2 and ground be f_2. For a particular force *F* it is found that $f_1 = 2f_2$. Find f_1 and f_2. Write equations of motion of all the masses. Find *F*, tension in the string and accelerations of the masses. **(IIT-JEE 2000)**

43. Block *A* of mass *m* and block *B* of mass $2m$ are placed on a fixed triangular wedge by means of a massless, extensible string and a frictionless pulley as shown in figure. The wedge is inclined at 45° to the horizontal on both sides. The coefficient of friction between block *A* and the wedge is 2/3 and that between block *B* and the wedge is 1/3. If the blocks *A* and *B* are released from rest, find **(IIT-JEE 1997)**



(*a*) The acceleration of *A*,

(*b*) Tension in the string and

(*c*) The magnitude and direction of the force of friction acting on *A*.

Non Inertial Reference Frame and Pseudo Force

Multiple Correct

44. A reference frame attached to the earth **(IIT-JEE 1986)**

(*a*) Is an inertial frame by definition

(*b*) Cannot be an inertial frame because the earth is revolving round the sun

(*c*) Is an inertial frame because Newton's laws are applicable in this frame

(*d*) Cannot be an inertial frame because the earth is rotating about its own axis

ANSWER KEY

JEE-Main

1. (*d*)	**2.** (*c*)	**3.** (*b*)	**4.** (*a*)	**5.** (*c*)	**6.** [40]	**7.** [2]	**8.** (*b*)	**9.** (*d*)	**10.** (*a*)
11. (*a*)	**12.** (*b*)	**13.** (*a*)	**14.** (*a*)	**15.** (*a*)	**16.** (*b*)	**17.** (*c*)	**18.** (*c*)	**19.** (*b*)	**20.** (*a*)
21. (*d*)	**22.** [1]	**23.** [500]	**24.** [12]	**25.** (*d*)	**26.** (*b*)	**27.** (*c*)	**28.** (*d*)	**29.** (*b*)	**30.** (*d*)
31. (*a*)	**32.** (*a*)	**33.** (*c*)	**34.** [240]	**35.** (*a*)	**36.** (*b*)	**37.** (*a*)	**38.** (*d*)	**39.** (*b*)	**40.** (*c*)
41. (*b*)	**42.** (*c*)	**43.** (*b*)	**44.** (*b*)	**45.** [12]	**46.** [6]	**47.** [3]	**48.** (*b*)	**49.** (*b*)	**50.** (*b*)
51. (*b*)	**52.** (*d*)	**53.** (*b*)	**54.** [25]	**55.** [492]	**56.** [164]	**57.** (*b*)	**58.** (*c*)	**59.** (*b*)	**60.** (*c*)
61. (*c*)	**62.** (*d*)	**63.** (*a*,*b*,*d*)	**64.** (*b*)	**65.** (*c*)	**66.** (*a*)	**67.** [30]	**68.** (*c*)	**69.** (*b*)	**70.** (*c*)
71. (*a*)	**72.** (*d*)	**73.** (*c*)	**74.** (*b*)	**75.** (*d*)	**76.** [2]	**77.** (*d*)	**78.** (*b*)	**79.** [25]	**80.** [3.3]
81. (*c*)	**82.** [5]	**83.** [30]	**84.** (*c*)	**85.** (*b*)	**86.** (*a*)	**87.** (*b*)	**88.** (Bonus)	**89.** (*a*)	**90.** (*a*)
91. (*a*)	**92.** (*b*)	**93.** (*d*)	**94.** (*d*)	**95.** (*b*)	**96.** (*c*)	**97.** (*a*)	**98.** (*c*)	**99.** [2]	**100.** [50]
101. (*d*)	**102.** [21]	**103.** [3]	**104.** [15]	**105.** (*a*)	**106.** [$\sqrt{3}$]	**107.** [3]	**108.** [346]	**109.** (*a*)	**110.** (*a*)
111. (*a*)	**112.** (*b*)	**113.** (*c*)	**114.** (*b*)	**115.** (*b*)	**116.** (*b*)	**117.** (*c*)	**118.** (*c*)	**119.** (*c*)	**120.** (*b*)
121. (*d*)	**122.** (*a*)	**123.** (*c*)	**124.** (*c*)	**125.** [24]	**126.** (*b*)	**127.** (*c*)	**128.** (*d*)	**129.** (*b*)	**130.** (*a*)
131. (*c*)	**132.** (*b*)	**133.** (*a*)	**134.** (*a*)	**135.** [4]	**136.** (*d*)	**137.** (*d*)			

JEE-Advanced

1. (*a*)	**2.** (*d*)	**3.** (*b*)	**4.** (*b*)	**5.** (*b*)	**6.** (*a*)	**7.** (*a*)	**8.** (*c*)	**9.** (*a*)	**10.** (*c*)
11. (*a*, *c*)	**12.** (*b*,*c*)	**15.** (*d*)	**16.** (*a*)	**17.** (*b*)	**18.** (*a*)	**19.** (*a*)	**20.** (*c*,*d*)	**21.** (*d*)	**29.** [5]
30. (*d*)	**31.** (*b*)	**32.** (*a*)	**33.** (*a*)	**34.** (*a*)	**38.** (*a*)	**39.** (*c*)	**40.** (*d*)	**41.** (*a*, *b*, *d*)	**44.** (*b*,*d*)