Physics Practice Problems

JEE Main

EXAM DATE 8th, 9th, 10th & 12th April

- Laws of Motion
- Work, Energy and Power
- System of Particles and Rotational Motion
- Gravitation

Time: 100 min. **Max. Marks:** 200

LEVEL - 1

1. Physical independence of force is a consequence of
(a) third law of motion
(b) second law of motion
(c) first law of motion
(d) All of these laws.

2. A player caught a cricket ball of mass 150 g moving at the rate of 20 m s^{-1}. If the catching process be completed in 0.1 s the force of the blow exerted by the ball on the hands of the player is
(a) 0.3 N (b) 30 N
(c) 300 N (d) 3000 N.

3. A cyclist is moving in a circular track of radius 80 m with a velocity v = 36 km h^{-1}. He has to lean from the vertical approximately through an angle (Take g = 10 m s^{-2})
(a) $\tan^{-1}(4)$ (b) $\tan^{-1}\left(\frac{1}{3}\right)$
(c) $\tan^{-1}\left(\frac{1}{4}\right)$ (d) $\tan^{-1}\left(\frac{1}{8}\right)$.

4. An ice cart of mass 60 kg rests on a horizontal snow patch with coefficient of static friction $\frac{1}{3}$. Assuming that there is no vertical acceleration, find the magnitude of the maximum horizontal force required to move the ice cart (g = 9.8 m s^{-2})
(a) 100 N (b) 110 N
(c) 209 N (d) 196 N.

5. An elastic ball is dropped from a height h and it rebounds many times from the floor. If the coefficient of restitution is e, the time for third impact after second impact is
(a) $\frac{e}{g}$ (b) $\frac{e^2}{g}$
(c) $e^2\sqrt{\left(\frac{8h}{g}\right)}$ (d) $e^2\sqrt{\left(\frac{h}{g}\right)}$.

6. An object of mass m falls on to a spring of constant k from a height h. Then the spring undergoes compression by a length x. The maximum compression x is given by the equation
(a) $mgh = \frac{1}{2}kx^2$ (b) $mg(h+x) = \frac{1}{2}kx^2$
(c) $mg(h+x) = -kx$ (d) $mgh = -kx$.

7. In the stable equilibrium position, a body has
(a) maximum potential energy
(b) minimum potential energy
(c) minimum kinetic energy
(d) neither maximum nor minimum potential energy.

8. A quarter horse power motor runs at a speed of 600 rpm. Assuming 40% efficiency the work done by the motor in one rotation will be
(a) 7.46 J (b) 7460 J
(c) 746 J (d) 74.6 J.

9. A stone of mass m tied to a string of length l is rotating along a circular path with constant speed v. The torque on the stone is
(a) zero (b) $\frac{mv}{l}$
(c) $\frac{mv^2}{l}$ (d) mv^2l.

10. In the HCl molecule, the separation between the nuclei of the two atoms is about 1.27 Å (1 Å = 10^{-10} m). The approximate location of the centre of mass of the molecule, assuming the chlorine atom to be about 35.5 times as massive as hydrogen is
(a) 1 Å (b) 2.5 Å
(c) 1.24 Å (d) 1.5 Å.

11. A circular thin disc of mass 2 kg has a diameter 0.2 m. Calculate its moment of inertia about an axis passing through the edge and perpendicular to the plane of the disc (in kg m^2)
(a) 0.01 (b) 0.03
(c) 0.02 (d) 3.

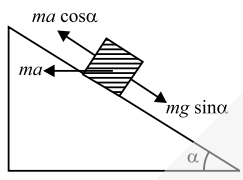
12. Moment of a couple is called
(a) impulse (b) angular momentum
(c) torque (d) None of these.

13. A body is projected vertically upwards from the surface of a planet of radius R with a velocity equal to $1/3^{rd}$ the escape velocity for that planet. The maximum height attained by the body is
(a) $R/2$ (b) $R/5$ (c) $R/8$ (d) $R/9$.

14. The period of moon's rotation around the earth is nearly 29 days. If moon's mass were 2 fold its present value and all other things remained unchanged, the period of moon's rotation would be nearly
(a) $29\sqrt{2}$ days (b) $\frac{29}{\sqrt{2}}$ days
(c) 29×2 days (d) 29 days.

15. Assume that the acceleration due to gravity on the surface of the moon is 0.2 times the acceleration due to gravity on the surface of the earth. If R_e is the maximum range of a projectile on the earth's surface, what is the maximum range on the surface of the moon for the same velocity of projection?
(a) $0.2R_e$ (b) $2R_e$ (c) $0.5R_e$ (d) $5R_e$.

16. A block is kept on a frictionless inclined surface with angle of inclination α. The incline is given an acceleration a to keep the block stationary. Then a is equal to



(a) g (b) $g\tan\alpha$
(c) $g/\tan\alpha$ (d) $g\,\mathrm{cosec}\alpha$.

17. A light string passing over a smooth light pulley connects two blocks of masses m_1 and m_2 (vertically). If the acceleration of the system is $g/8$, then the ratio of the masses is
(a) 8 : 1 (b) 9 : 7 (c) 4 : 3 (d) 5 : 3.

18. The minimum velocity (in m s^{-1}) with which a car driver must traverse a flat curve of radius 150 m and coefficient of friction 0.6 to avoid skidding is
(a) 60 (b) 30 (c) 15 (d) 25.

19. A particle moves in a straight line with retardation proportional to its displacement. Its loss of kinetic energy for any displacement x is proportional to
(a) x^2 (b) e^x (c) x (d) $\log_e x$.

20. Consider the following two statements.
Statement 1: Linear momentum of a system of particles is zero.
Statement 2: Kinetic energy of a system of particles is zero.
Then
(a) Statement 1 does not imply Statement 2 and Statement 2 does not imply Statement 1
(b) Statement 1 implies Statement 2 but Statement 2 does not imply Statement 1
(c) Statement 1 does not imply Statement 2 but Statement 2 implies Statement 1
(d) Statement 1 implies Statement 2 and Statement 2 implies Statement 1.

21. A car is racing on a circular track of radius 180 m with a speed of 32 m s^{-1}. What should be the banking angle of the road to avoid chances of skidding of the vehicle at this speed without taking into consideration the friction between the tyre and the road?
(a) 45° (b) 60°
(c) 30° (d) 15°.

22. A circular disc X of radius R is made from an iron plate of thickness t, and another disc Y of radius $4R$ is made from an iron plate of thickness $t/4$. Then the relation between the moments of inertia I_X and I_Y is
(a) $I_Y = 32I_X$ (b) $I_Y = 16I_X$
(c) $I_Y = I_X$ (d) $I_Y = 64I_X$.

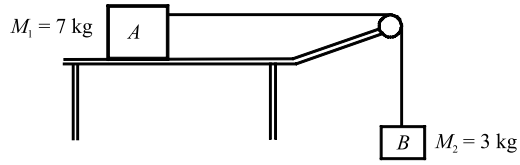
23. A solid sphere, a hollow sphere and a ring are released from top of an inclined plane (frictionless) so that they slide down the plane. Then maximum acceleration down the plane is for (no rolling)
(a) solid sphere (b) hollow sphere
(c) ring (d) Same for all of these.

24. The time period of a satellite of earth is 5 hours. If the separation between the earth and the satellite is increased to 4 times the previous value, the new time period will become
(a) 10 hours (b) 80 hours
(c) 40 hours (d) 20 hours.

25. If suddenly the gravitational force of attraction between earth and a satellite revolving around it becomes zero, then the satellite will
(a) continue to move in its orbit with same velocity
(b) move tangentially to the original orbit with the same velocity
(c) become stationary in its orbit
(d) move towards the earth.

LEVEL - 2

26. A block A of mass 7 kg is placed on a frictionless table. A thread tied to it passes over a frictionless pulley and carries a body B of mass 3 kg at the other end. The acceleration of the system is
(Given g = 10 m s^{-2})



(a) 100 m s^{-2} (b) 3 m s^{-2}
(c) 10 m s^{-2} (d) 30 m s^{-2}.

27. A stone of mass m is tied to a string and is moved in a vertical circle of radius r making n revolutions per minute. The total tension in the string when the stone is at its lowest point is
(a) $m(g + nr)$ (b) $m(g + \pi nr^2)$
(c) $m\left\{g + \frac{\pi^2 n^2 r}{900}\right\}$ (d) $m(g + n^2r^2)$.

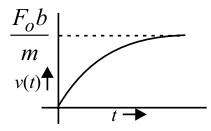
28. A block of mass 10 kg is placed on an inclined plane. When the angle of inclination is 30°, the block just begins to slide down the plane. The force of static friction is

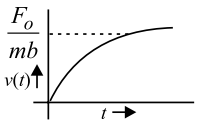
(a) 10 kg wt (b) 9.8 kg wt
(c) 49 kg wt (d) 5 kg wt.

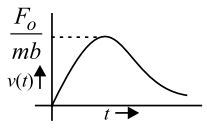
29. A running man has the same kinetic energy as that of a boy of half his mass. The man speeds up by 2 m s^{-1} and the boy changes his speed by x m s^{-1} so that the kinetic energies of the boy and the man are again equal. Then x in m s^{-1} is

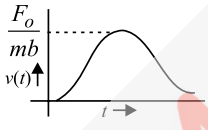
(a) $-2\sqrt{2}$ (b) $+2\sqrt{2}$
(c) $\sqrt{2}$ (d) $1/\sqrt{2}$.

30. A particle of mass m is at rest at the origin at time $t = 0$. It is subjected to a force $F(t) = F_o e^{-bt}$ in the x direction. Its speed $v(t)$ is depicted by which of the following curves?

(a) 

(b) 

(c) 

(d) 

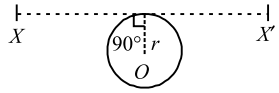
31. A body of mass 2 kg moving with velocity 2 m s^{-1} makes an elastic collision with another body at rest and continues to move in the original direction with one-fourth its original speed. The mass of the second body which collides with the first body is

(a) 2 kg (b) 1.2 kg
(c) 3 kg (d) 1.5 kg.

32. If the potential energy of a gas molecule is $U = \frac{M}{r^6} - \frac{N}{r^{12}}$, M and N being positive constants, then the potential energy at equilibrium must be

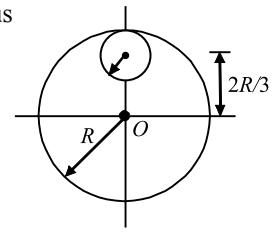
(a) $\frac{NM^2}{4}$ (b) $\frac{M^2}{4N}$
(c) $\frac{N^2}{4M}$ (d) $\frac{MN^2}{4}$.

33. A thin wire of length l and uniform linear mass density ρ is bent into a circular loop with centre O and radius r as shown in figure. The moment of inertia of the loop about the axis XX' is



(a) $\frac{3\rho l^3}{8\pi^2}$ (b) $\frac{\rho l^3}{16\pi^2}$ (c) $\frac{3\rho l^3}{8\pi^2 r}$ (d) $\frac{\rho l^3}{8\pi^2 r}$.

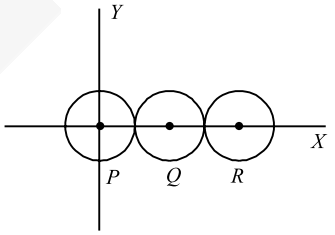
34. From a circular disc of radius R and mass $9M$, a small disc of radius $R/3$ is removed from the disc. The moment of inertia of the remaining disc about an axis perpendicular to the plane of the disc and passing through O is



(a) $4MR^2$ (b) $\frac{40}{9}MR^2$
(c) $10MR^2$ (d) $\frac{37}{9}MR^2$.

35. Three identical spheres, each of mass 1 kg are kept as shown in figure, touching each other, with their centres on a straight line. If their centres are marked P, Q, R respectively, the distance of centre of mass of the system from P is

(a) $\frac{PQ + PR + QR}{3}$
(b) $\frac{PQ + PR}{3}$
(c) $\frac{PQ + QR}{3}$
(d) $\frac{PR + QR}{3}$.



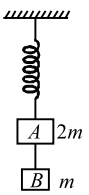
36. Acceleration due to gravity is g on the surface of the earth. Then the value of the acceleration due to gravity at a height of 32 km above earth's surface is (Assume radius of earth to be 6400 km)

(a) 0.99 g (b) 0.8 g (c) 1.01 g (d) 0.9 g.

37. A man weighs 80 kg on earth surface. The height above ground where he will weigh 40 kg, is (radius of earth is 6400 km)

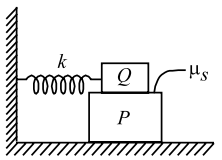
(a) 0.31 times r (b) 0.41 times r
(c) 0.51 times r (d) 0.61 times r.

38. Two blocks A and B of masses $2m$ and m, respectively are connected by a massless and inextensible string. The whole system is suspended by a massless spring as shown in the figure. The magnitudes of acceleration of A and B, immediately after the string is cut, are respectively



(a) $g, g/2$ (b) $g/2, g$ (c) g, g (d) $g/2, g/2$.

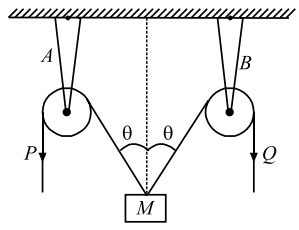
39. A block P of mass m is placed on a horizontal frictionless plane. A second block of same mass m is placed on it and is connected to a spring of spring constant k. The two blocks are pulled by



distance A. Block Q oscillates without slipping. What is the maximum value of frictional force between the two blocks?

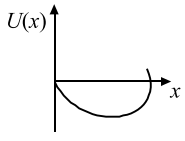
(a) $kA/2$ (b) kA (c) $\mu_s mg$ (d) zero.

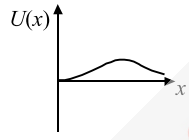
40. In the arrangement, shown in the figure, the ends P and Q of an unstretchable string move downwards with uniform speed u. Pulleys A and B are fixed. Mass M moves upwards with a speed

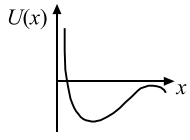


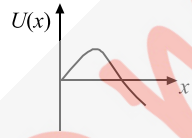
(a) $2u\cos\theta$ (b) $u/\cos\theta$ (c) $2u/\cos\theta$ (d) $u\cos\theta$.

41. A particle, which is constrained to move along the x-axis, is subjected to a force in the same direction which varies with the distance x of the particle from the origin as $F(x) = -kx + ax^3$. Here k and a are positive constants. For $x \geq 0$ the functional graphically form of the potential energy $U(x)$ of the particle is

(a) 

(b) 

(c) 

(d) 

42. A stone tied to a string of length l is whirled in a vertical circle with the other end of the string at the centre. At a certain instant of time, the stone is at its lowest position, and has a speed u. The magnitude of the change in its velocity as it reaches a position where the string is horizontal is

(a) $\sqrt{u^2 - 2gl}$ (b) $\sqrt{2gl}$

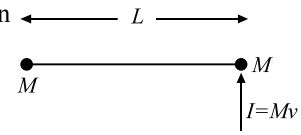
(c) $\sqrt{u^2 - gl}$ (d) $\sqrt{2(u^2 - gl)}$.

43. A particle of mass m is moving in a circular path of constant radius r such that its centripetal acceleration a_c is varying with time t as $a_c = k^2rt^2$ where k is a constant. The power delivered to the particle by the force acting on it is

(a) $2\pi\, mk^2r^2t$ (b) mk^2r^2t

(c) $\dfrac{(mk^4r^2t^5)}{3}$ (d) zero.

44. Consider a body, shown in figure, consisting of two identical balls, each of mass M connected by a light rigid rod. If an impulse $I = Mv$ is imparted to the body at one of its ends, what would be its angular velocity?



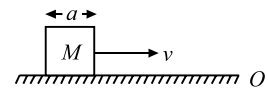
(a) v/L (b) $2v/L$ (c) $v/3L$ (d) $v/4L$.

45. A smooth sphere A is moving on a frictionless horizontal plane with angular speed ω and centre of mass velocity v. It collides elastically and head-on with an identical sphere B at rest. Neglect friction everywhere. After the collision, their angular speeds are ω_A and ω_B, respectively. Then

(a) $\omega_A < \omega_B$ (b) $\omega_A = \omega_B$

(c) $\omega_A = \omega$ (d) $\omega_B = \omega$.

46. A cubical block of side a is moving with velocity v on a horizontal smooth plane as shown in figure. It hits a ridge at point O. The angular speed of the block after it hits O is



(a) $3v/(4a)$ (b) $3v/(2a)$

(c) $\sqrt{3}v/(\sqrt{2}a)$ (d) zero.

47. Two point masses of 0.3 kg and 0.7 kg are fixed at the ends of a rod of length 1.4 m and of negligible mass. The rod is set rotating about an axis perpendicular to its length with a uniform angular speed. The point on the rod through which the axis should pass in order that the work required for rotation of the rod is minimum, is located at a distance of

(a) 0.42 m from mass of 0.3 kg
(b) 0.70 m from mass of 0.7 kg
(c) 0.98 m from mass of 0.3 kg
(d) 0.98 m from mass of 0.7 kg.

48. A binary star system consists of two stars A and B which have time periods T_A and T_B, radii R_A and R_B and masses M_A and M_B. Then

(a) if $T_A > T_B$ then $R_A > R_B$
(b) if $T_A > T_B$ then $M_A > M_B$
(c) $\left(\dfrac{T_A}{T_B}\right)^2 = \left(\dfrac{R_A}{R_B}\right)^3$
(d) $T_A = T_B$.

49. A geo-stationary satellite orbits around the earth in a circular orbit of radius 36,000 km. Then, the time period of a spy satellite orbiting a few hundred km above the earth's surface (R_e = 6,400 km) will approximately be
(a) (1/2) hr (b) 1 hr (c) 2 hr (d) 4 hr.

50. If g is the acceleration due to gravity on the earth's surface, the gain in the potential energy of an object of mass m raised from the surface of the earth to a height equal to the radius R of the earth, is
(a) $\frac{1}{2}mgR$ (b) $2mgR$
(c) mgR (d) $\frac{1}{4}mgR$.