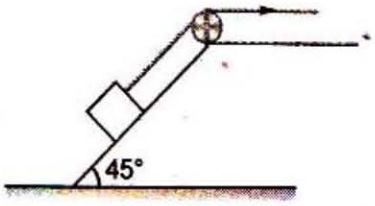
1. A block of mass 200 kg is being pulled up by men on an inclined plane at angle of 45° as shown in the figure. The coefficient of static friction is 0.5. Each man can only apply a maximum force of 500 N. Calculate the number of men required for the block to just start moving up the plane.



(a) 10 (b) 15
(c) 5 (d) 3

2. Two strings *A* and *B* are slightly out tune and produces beats of frequency 5 Hz. Increasing the tension in *B* reduces the beat frequency to 3 Hz. If the frequency of string *A* is 450 Hz, calculate the frequency of string *B*.
(a) 460 Hz (b) 455 Hz
(c) 445 Hz (d) 440 Hz

3. A resonance pipe is open at both ends and 30 cm of its length is in resonance with an external frequency 1.1 kHz. If the speed of sound is 330 m/s, which harmonic is in resonance?
(a) First (b) Second
(c) Third (d) Fourth

4. The SHM of a particle is given by
$x(t) = 5\cos\left(2\pi t + \frac{\pi}{4}\right)$ (in MKS units).
Calculate the displacement and the magnitude of acceleration of the particle at $t = 1.5$ s.
(a) -3.0 m, 100 m/s^2
(b) $+2.54$ m, 200 m/s^2
(c) -3.54 m, 140 m/s^2
(d) $+3.55$ m, 120 m/s^2

5. Calculate the ratio of rms speeds of oxygen gas molecules to that of hydrogen gas molecules kept at the same temperature.
(a) 1 : 4 (b) 1 : 8 (c) 1 : 2 (d) 1 : 6

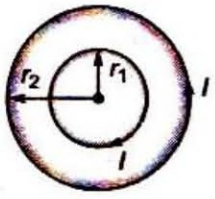
6. The coefficient of volume expansion of a liquid is $49 \times 10^{-5}\,K^{-1}$. Calculate the fractional change in its density when the temperature is raised by 30°C.
(a) 7.5×10^{-3} (b) 3.0×10^{-3}
(c) 1.5×10^{-3} (d) 1.1×10^{-3}

7. Avalanche breakdown in a *p-n* junction diode is due to
(a) sudden shift of Fermi level
(b) increase in the width of forbidden gap
(c) sudden increase of impurity concentration
(d) cumulative effect of increased electron collision and creation of added electron hole pairs

8. Any digital circuit can be realised by repetitive use of only
(a) NOT gate (b) OR gate
(c) AND gate (d) NOR gate

9. A solid sphere of mass 1 kg, radius 10 cm rolls down an inclined plane of height 7 m. The velocity of its centre as it reaches the ground level is
(a) 7 m/s (b) 10 m/s
(c) 15 m/s (d) 20 m/s

10. Two circular concentric loops of radii $r_1 = 20$ cm and $r_2 = 30$ cm are placed in the X-Y plane as shown in the figure. A current $I = 7$ A is flowing through them. The magnetic moment of this loop system is



(a) $+0.4\hat{k}$(A-m^2) (b) $-1.5\hat{k}$(A-m^2)

(c) $+1.1\hat{k}$(A-m^2) (d) $+1.3\hat{j}$(A-m^2)

11. In a Young's double slit experiment (slit distance d) monochromatic light of wavelength λ is used and the fringe pattern observed at a distance L from the slits. The angular position of the bright fringes are

(a) $\sin^{-1}\left(\frac{n\lambda}{d}\right)$ (b) $\sin^{-1}\left(\frac{\left(n+\frac{1}{2}\right)\lambda}{d}\right)$

(c) $\sin^{-1}\left(\frac{n\lambda}{L}\right)$ (d) $\sin^{-1}\left(\frac{\left(n+\frac{1}{2}\right)\lambda}{L}\right)$

12. Two energy levels of an electron in an atom are separated by 2.3 eV. The frequency of radiation emitted when the electrons to go from higher to lower level is

(a) 6.95×10^{14} Hz (b) 3.68×10^{15} Hz

(c) 5.6×10^{14} Hz (d) 9.11×10^{15} Hz

13. What is the work function (in eV) of a substance if photoelectrons are just ejected for a monochromatic light of wavelength $\lambda = 3300$ Å?

(a) 3.75 (b) 3.25

(c) 1.63 (d) 0.75

14. The linear momentum of an electron, initially at rest, accelerated through a potential difference of 100 V is

(a) 9.1×10^{-24} (b) 6.5×10^{-24}

(c) 5.4×10^{-24} (d) 1.6×10^{-24}

15. The de-Broglie wavelength of a ball of mass 120 g moving at a speed of 20 m/s is

(a) 3.5×10^{-34} m (b) 2.8×10^{-34} m

(c) 1.2×10^{-34} m (d) 2.1×10^{-34} m

16. A square card of side length 1 mm is being seen through a magnifying lens of focal length 10 cm. The card is placed at a distance of 9 cm from the lens. The apparent area of the card through the lens is

(a) 1 cm^2 (b) 0.81 cm^2

(c) 0.27 cm^2 (d) 0.60 cm^2

17. An object moving at a speed of 5 m/s towards a concave mirror of focal length $f = 1$ m is at a distance of 9 m. The average speed of the image is

(a) $\frac{1}{5}$ m/s (b) $\frac{1}{10}$ m/s

(c) $\frac{5}{9}$ m/s (d) $\frac{4}{10}$ m/s

18. The magnetic field of an electromagnetic wave is given by

$B_y = 3\times10^{-7}\sin(10^3x + 6.28\times10^{12}t)$.

The wavelength of the electromagnetic wave is

(a) 6.28 cm (b) 3.14 cm

(c) 0.63 cm (d) 0.32 cm

19. A 50 V AC is applied across an R-C (series) network. The rms voltage across the resistance is 40 V, then the potential across the capacitance would be

(a) 10 V (b) 20 V

(c) 30 V (d) 40 V

20. A pure inductive coil of 30 mH is connected to an AC source of 220 V, 50 Hz. The rms current in the coil is

(a) 50.35 A (b) 23.4 A

(c) 30.5 A (d) 12.3 A

21. A square loop of wire, side length 10 cm is placed at angle of 45° with a magnetic field that changes uniformly from 0.1 T to zero in 0.7 s. The induced current in the loop (its resistance is 1 Ω) is

(a) 1.0 mA (b) 2.5 mA

(c) 3.5 mA (d) 4.0 mA

22. The angle of dip at a certain place on earth is 60° and the magnitude of earth's horizontal component of magnetic field is 0.26 G. The magnetic field at the place on earth is

(a) 0.13 G (b) 0.26 G

(c) 0.52 G (d) 0.65 G

23. The dimensional formula for the magnetic field is
(a) $[MT^{-2}A^{-1}]$ (b) $[ML^2T^{-1}A^{-2}]$
(c) $[MT^{-2}A^{-2}]$ (d) $[MT^{-1}A^{-2}]$

24. The maximum velocity to which a proton can be accelerated in a cyclotron of 10 MHz frequency and radius 50 cm is
(a) 6.28×10^8 m/s (b) 3.14×10^8 m/s
(c) 6.28×10^7 m/s (d) 3.14×10^7 m/s

25. The radius of the path of an electron moving at a speed of 3×10^7 m/s perpendicular to a magnetic field 5×10^{-4} T is nearly
(a) 15 cm (b) 45 cm
(c) 27 cm (d) 34 cm

26. The resistance of the wire in the platinum resistance thermometer at ice point is 5Ω and at steam point is 5.25Ω. When the thermometer is inserted in an unknown hot bath its resistance is found to be 5.5Ω. The temperature of the hot bath is
(a) 100°C (b) 200°C
(c) 300°C (d) 350°C

27. The density of copper is 9×10^3 kg/m^3 and its atomic mass is 63.5 u. Each copper atom provides one free electron. Estimate the number of free electrons per cubic metre in copper.
(a) 10^{19} (b) 10^{23}
(c) 10^{25} (d) 10^{29}

28. A conductor has been given a charge -3×10^{-7} by transferring electrons. Mass increase (in kg) of the conductor and the number of electrons added to the conductor are respectively
(a) 2×10^{-16} and 2×10^{31}
(b) 5×10^{-31} and 5×10^{19}
(c) 3×10^{-19} and 9×10^{16}
(d) 2×10^{-18} and 2×10^{12}

29. Under the action of a given coulombic force the acceleration of an electron is 2.5×10^{22} m/s^2. Then the magnitude of the acceleration of a proton under the action of same force is nearly
(a) 1.6×10^{-19} m/s^2 (b) 9.1×10^{31} m/s^2
(c) 1.5×10^{19} m/s^2 (d) 1.6×10^{27} m/s^2

30. An electron initially at rest fall a distance of 1.5 cm in a uniform electric field of magnitude 2×10^4 N/C. The time taken by the electron to fall this distance is
(a) 1.3×10^2 s (b) 2.1×10^{-12} s
(c) 1.6×10^{-10} s (d) 2.9×10^{-9} s

31. The constant of proportionality $\frac{1}{4\pi\varepsilon_0}$ in Coulomb's law has the following dimensions
(a) $C^{-2}N\,m^2$ (b) $C^2N^{-1}m^{-2}$
(c) $C^2N\,m^2$ (d) $C^{-2}N^{-1}m^{-2}$

32. The pressure on a swimmer 20 m below the surface of water at sea level is
(a) 1.0 atm (b) 2.0 atm
(c) 2.5 atm (d) 3.0 atm

33. The potential energy of 4-particles each of mass 1 kg placed at the four vertices of a square of side length 1 m is
(a) + 4.0 G (b) − 7.5 G
(c) − 5.4 G (d) + 6.3 G

34. Two masses 8 kg and 12 kg are connected at the two ends of a string that goes over a frictionless pulley. Calculate the acceleration of the masses and the tension in the string. Take $g = 10$ m/s^2
(a) 8 m/s^2, 144 N (b) 4 m/s^2, 112 N
(c) 6 m/s^2, 128 N (d) 2 m/s^2, 96 N

35. The backside of a truck is open and a box of 40 kg is placed 5 m away from the rear end. The coefficient of friction of the box with the surface of the truck is 0.15. The truck starts from rest with 2 m/s^2 acceleration. Calculate the distance covered by the truck when the box falls off.
(a) 20 m (b) 30 m
(c) 40 m (d) 50 m

36. The position of a particle x (in metre) at a time t second is given by the relation $r = (3t\,\hat{i} - t^2\,\hat{j} + 4\hat{k})$. Calculate the magnitude of velocity of the particle after 5 s.
(a) 3.55 m/s
(b) 5.03 m/s
(c) 8.75 m/s
(d) 10.44 m/s

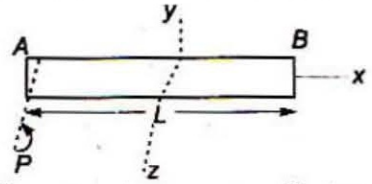
37. A monoatomic gas is kept at room temperature 300 K. Calculate the average kinetic energy of gas molecule (Use $k = 1.38 \times 10^{-23}$ MKS units)

(a) 0.138 eV
(b) 0.062 eV
(c) 0.039 eV
(d) 0.013 eV

38. A uniform magnetic field $B = 1.2$ mT is directed vertically upward throughout the volume of a laboratory chamber. A proton ($m_p = 1.67 \times 10^{-27}$ kg) enters the laboratory horizontally from south to north. Calculate the magnitude of centripetal acceleration of the proton if its speed is 3×10^7 m/s.

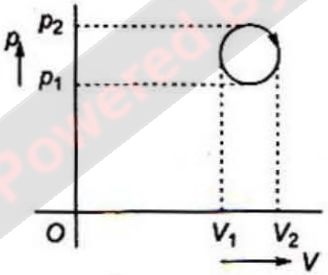
(a) 3.45×10^{12} m/s^2
(b) 1.67×10^{12} m/s^2
(c) 5.25×10^{12} m/s^2
(d) 2.75×10^{12} m/s^2

39. A rod of length L and mass M is rotating about an axis P perpendicular to the rod and parallel to z-axis, passing through one end A of the rod. The moment of inertia for rotation about this axis P is



(a) $\frac{1}{12}ML^2$ (b) $\frac{1}{4}ML^2$
(c) $\frac{1}{3}ML^2$ (d) $\frac{5}{12}ML^2$

40. In the cyclic process shown in the p-V diagram calculate the work done.



(a) $\pi\left(\frac{V_2 - V_1}{2}\right)^2$
(b) $\pi\left(\frac{p_2 - p_1}{2}\right)^2$
(c) $\frac{\pi}{4}(p_2 - p_1)(V_2 - V_1)$
(d) $\pi(p_2V_2 - p_1V_1)$

Answer – Key

1. c	2. c	3. b	4. c	5. a	6. X	7. d	8. d	9. b	10. c
11. a	12. c	13. a	14. c	15. b	16. a	17. a	18. c	19. c	20. b
21. a	22. c	23. a	24. d	25. d	26. b	27. d	28. d	29. c	30. d
31. a	32. d	33. c	34. d	35. a	36. d	37. c	38. a	39. c	40. c