Physics

1. Consider the following statements about the four fundamental forces in nature.
(i) The strong nuclear force binds protons and neutrons in a nucleus.
(ii) The strong nuclear force is about 10 times the electromagnetic force in strength.
(iii) The weak nuclear force is the weakest of all the four fundamental forces.
(iv) The range of the weak nuclear is about
$10^{-16}\mathrm{m}$
The correct statement(s) is (are)
(a) (i) only
(b) (ii) and (iii)
(c) (iii) and (iv)
(d) (i), (ii) and (iv)

Correct: a

2. A particle moving with an initial velocity ums^{-1} is retarded by a force at the rate of a=-k$\sqrt{v}$, where k is a positive constant and v is the instantaneous velocity. The particle comes to rest in a time given by
(a) $\frac{2\sqrt{u}}{k}$
(b) $k\sqrt{u}$
(c) $\frac{\sqrt{2u}}{k}$
(d) $\frac{\sqrt{u}}{2k}$

Correct: a

3. The expression of the trajectory of a projectile is given as $y = px - qx^2$, where y and x are respectively the vertical and horizontal displacements and p and q are constants. The time of flight of the projectile is
(a) $\frac{p^2}{4q}$
(b) $\frac{p^2}{2q}$
(c) $\sqrt{\frac{2p}{qg}}$
(d) $p\sqrt{\frac{2}{qg}}$

Correct: d

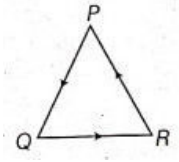
4. The displacement x of a body varies with time as
$x = -\frac{1}{3}t^2 + 16t + 3,$
where x is in metres and t is in seconds. The time taken by the body to come to rest is
(a) 12 s
(b) 24 s
(c) 30 s
(d) 36 s

Correct: b

5. If a particle's position is given by $x = 4 - 12t + 3t^2$ where t is in the seconds and x in meters. What is its velocity at t=1s?
Whether the particle is moving in positive x direction or negative x direction?
(a) - 6 m/s, + x direction
(b) - 6 m/s, - x direction
(c) 6 m/s, + x direction
(d) 4 m/s, - x direction

Correct: b

6. Three particles P, Q and R are at rest at the vertices of an equilateral triangle of side s. Each of the particles starts moving with constant speed v ms^{-1}. P is moving along PQ, Q along QR and R along RP. The particles will meet each other at time t given by



(a) s/v
(b) 3s/v
(c) 3s/2v
(d) 2s/3v

Correct: d

7. Two cars are in a race. The white car passed the finishing point with a velocity vms^{-1} more and took time t s less than the red car. If both the cars start from rest and travel with constant accelerations a_w and a_r respectively, v/t is given
(a) $\mathrm{a_w a_t}$
(b) $\sqrt{\frac{a_w}{a_t}}$
(c) $\sqrt{a_w a_r}$
(d) $\sqrt{\frac{\mathrm{a_r}}{\mathrm{a_w}}}$

Correct: c

8. Starting from origin, a body moves along x-axis. Its velocity at any time is given by $v = 4t^3 - 2t\mathrm{m/s}$. Acceleration of the particle when it is 2 m away from the origin is
(a) $28\mathrm{ms}^{-2}$
(b) $12\mathrm{ms}^{-2}$
(c) $22\mathrm{ms}^{-2}$
(d) $14\mathrm{ms}^{-2}$

Correct: c

9. The kinetic energy of a particle of mass m kg is half of that of another particle of mass m/2 kg. If the speed of heavier particle is increased by 3 ms^{-1}, its kinetic energy becomes equal to the original kinetic energy of the lighter particle. The original speeds of the heavier and lighter particles are
(a) $3ms^{-1}, 6ms^{-1}$
(b) $2ms^{-1}, 4ms^{-1}$
(c) $2ms^{-1}, 6ms^{-1}$
(d) $4ms^{-1}, 8ms^{-1}$

Correct: a

10. A man who weighs 670 N runs the first 7.0 m in 1.6 s, starting from rest and accelerating uniformly. What is the average power does the man generate during the 1.6 s time interval?
(a) 3.2 kW
(b) 16 kW
(c) 0.9 kW
(d) None of these

Correct: b

11. If the moment of inertia of a disc about an axis tangential and parallel to its surface be I, then the moment of inertia about an axis tangential but perpendicular to the surface will be
(a) $\frac{6}{5}l$
(b) $\frac{3}{4}l$
(c) $\frac{3}{2}l$
(d) $\frac{5}{4}l$

Correct: a

12. If S is the stress and Y is Young's modulus of material of a wire, the energy stored in the wire per unit volume is
(a) S/2Y
(b) 2Y/S

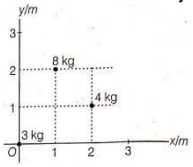
(c) $\frac{S^2}{2Y}$
(d) $2S^{2Y}$

Correct: c

13. The torque acting on a body about a given point is given by $\tau = \hat{\mathbf{A}} \times \hat{\mathbf{L}}$ where $\hat{A}$ is a constant vector and $\hat{L}$ is the angular momentum of the body about this point. It follows that
(a) the magnitude of $\hat{L}$ does not change with time
(b) the component of $\hat{L}$ in the direction of $\hat{A}$ does not
change with time
(c) $\frac{d\hat{L}}{dt}$ is perpendicular to $\hat{L}$ at all instants of time (d) All of the above choices are correct

Correct: d

14. Find the x and y-coordinates of the centre of inass of the three particle system (as shown).



(a) 1.0 m, 1.0 m
(b) 1.3 m, 0.9 m
(c) 1.1 m; 1.3 m
(d) 1.3, 1.1 m

Correct: c

15. The density of a newly discovered planet is twice that of earth. The acceleration due to gravity at the surface of the planet is equal to that at the surface of the earth. If the radius of the earth is R, the radius of the planet would be
(a) 4R
(b) 2
(c) R/2
(d) R/4

Correct: c

16. An asteroid of mass $2 \times 10^{-4} M_e$, where M_e is the mass of the earth, revolves in a circular orbit around the sun at a distance that is twice earth's distance from the sun. Find the ratio of the kinetic energy of the asteroid to that of earth.
(a) 0.9 x 10-6
(b) 1.6 x 10-5
(c) 3.6 x 10-5
(d) 1.0 x 10-4

Correct: d

17. Two wires of equal cross-section but one made of steel and the other of copper, are joined end to end. When the combination is kept under tension, the elongations in the two wires are found to be equal. (Y for steel = $2 \times 10^{11} \mathrm{N/m^2}$ and Y for copper $= 1.1 \times 10^{11} \mathrm{N/m^2}$). The ratio of the lengths of the two wires is
(a) 20:11
(b) 2:1
(c) 1:2
(d) 1:1

Correct: a

18. The density of air in atmosphere decreases with height and can be expressed by the relation $\rho = \rho_0 e^{-\alpha h}$, where ρ_0, is the density at sea level, α is a constant and h is the height. The atmospheric pressure at the sea level is
(a) $\frac{\rho_0 g}{\alpha}$
(b) $\frac{\rho_0 g h}{\alpha}$
(c) $\frac{\alpha h}{\rho_0 g}$
(d) $\frac{h}{\rho_0 \alpha}$

Correct: a

19. At 600 Hz, an inductor and capacitor have equal reactances, the ratio of the capacitive reactance to the inductive reactance at 60 Hz will be
(a) 100:1
(b) 200:1

(c) 300:1
(d) 400:1

Correct: a

20. Work done in increasing the size of a soap bubble from a radius of 3 cm to 5 cm is nearly (surface tension of soap solution = $0.03\mathrm{Nm}^{-1}$).
(a) $4\pi\mathrm{mJ}$
(b) $0.4\pi\mathrm{mJ}$
(c) $0.2\pi\mathrm{mJ}$
(d) $2\pi\mathrm{mJ}$

Correct: b

21. A gas under constant pressure of $4.5 \times 10^5 P_a$ when subjected to 800 kJ of heat, changes the volume from $0.5\mathrm{m}^3$ to $2.0\mathrm{m}^3$. The change in internal energy of the gas is
(a) $6.75 \times 10^5\mathrm{J}$
(b) $5.25 \times 10^5\mathrm{J}$
(c) $3.25 \times 10^5\mathrm{J}$
(d) $1.25 \times 10^5\mathrm{J}$

Correct: d

22. A gas at pressure p, is contained in a vessel. If the masses of all the molecules are halved and their speeds doubled, the resulting pressure would be
(a) $4p_0$
(b) $2p_0$
(c) p_0
(d) $\frac{p_o}{2}$

Correct: b

23. The red shift observed for stars due to the natural expanding of universe is given by the expression
(a) $(\lambda' - \lambda) = \left(\frac{c+v}{C}\right)\lambda$
(b) $(\lambda' - \lambda) = \left(\frac{c-v}{C}\right)\lambda$
(c) $(\lambda' - \lambda) = \left(\frac{v\lambda}{c}\right)$
(d) $(\lambda' - \lambda) = \left(\frac{c\lambda}{v}\right)$

Correct: c

24. An ideal gas at pressure p is adiabatically compressed so that its density becomes n times the initial value. If $\gamma = C_p/C_v$, the final pressure of the gas will be
(a) $n^{(1-\gamma)p}$
(b) $n^{(t-y)p}$
(c) $n^{(-\gamma)p}$
(d) $n^{(\gamma)p}$

Correct: d

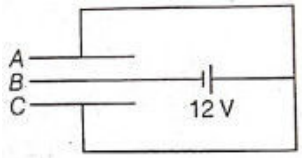
25. A quantity of a substance in a closed system is made to undergo a reversible process from an initial volume of $3\mathrm{m}^3$ and initial pressure $10^3\mathrm{N/m}^2$ to a final volume of $5m^3$. If the pressure is proportional to the square of the volume (i.e. $p = AV^2$), the work done by the substance will be
(a) $3.6 \times 10^2\mathrm{J}$
(b) $7.4 \times 10^3\mathrm{J}$
(c) $2.2 \times 10^4\mathrm{J}$
(d) $3.6 \times 10^5 J$

Correct: d

26. A photographic flash unit consists of a xenon filled tube. It gives a flash of average power 2000 W for 0.04 s. The flash is due to discharge of a fully charged capacitor of $40\mu F$. The voltage to which it is charged before a flash is given by the unit is
(a) $1.5 \times 10^3\mathrm{V}$
(b) $2 \times 10^3\mathrm{V}$
(c) $2.5 \times 10^3\mathrm{V}$
(d) $3 \times 10^3\mathrm{V}$

Correct: b

27. Three plates A, B and C each of area 50 cm^2 have separation 3 mm between A and B and 6 mm between B and C. The energy stored when the plates are fully charged by a 12 v battery is



(a) $2\mu J$
(b) 1.6 nJ
(c) $5\mu J$
(d) 3.2 nJ

Correct: b

28. A point charge +q is placed at a distance d/2 directly above the centre of a square of side d. The magnitude of electric flux through the square is
(a) $\frac{Q}{6d}$
(b) $\frac{Q}{6\varepsilon_0}$
(c) $\frac{Qd}{6\varepsilon_0}$
(d) $\frac{Q\varepsilon_0}{6d}$

Correct: b

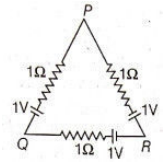
29. Three resistances P, Q and R, each of 2Ω an unknown resistance S form the four arms of a Wheatstone bridge circuit. When a resistance of 6Ω is connected in parallel to S, the bridge gets balanced. The value of S is
(a) 3Ω
(b) 6Ω
(c) 1Ω
(d) 2Ω

Correct: a

30. What is power dissipation in an a.c. circuit in which voltage and current are given by $V = 300\sin(\omega t + \pi/2), I = 5\sin\omega\theta$
(a) zero
(b) 300 units
(c) 150 units
(d) 75 units

Correct: a

31. Three batteries of emf 1 V and internal resistance 1ω each are connected as shown. Effective emf of the combination between the points P and Q is



(a) zero
(b) 1 V
(c) 2 V
(d) $\frac{2}{3}V$

Correct: a

32. A wire is being drawn to make it thinner such that the length of the wire l increases and radius r decreases. Its resistance R will finally be proportional to
(a) $\frac{1}{r}$
(b) $\frac{1}{r^2}$
(c) $\frac{1}{r^3}$
(d) $\frac{1}{r^4}$

Correct: d

33. Two particles X and Y having equal charges, after being accelerated through the same potential difference enter a region of uniform

magnetic field and describe circular paths of radii R_1 and R_2 respectively. The ratio of masses of X and Y is
(a) $\left(\frac{R_1}{R_2}\right)^{1/2}$
(b) $\left(\frac{R_2}{R_1}\right)$
(c) $\left(\frac{R_1}{R_2}\right)^{2}$
(d) $\left(\frac{R_1}{R_2}\right)$

Correct: c

34. An ions with a charge of $+3.2 \times 10^{-19}\mathrm{C}$ is in a region where a uniform electric field of $5 \times 10^{4}\mathrm{V/m}$ is perpendicular to a uniform magnetic field of 0.8 T. If its acceleration is zero, then its speed must be
(a) 0
(b) $1.6 \times 10^{4}\mathrm{m/s}$
(c) $4.0 \times 10^{4}\mathrm{m/s}$
(d) $6.3 \times 10^{4}\mathrm{m/s}$

Correct: d

35. A long straight wire of radius R carries a steady current I. The current is uniformly distributed across its cross-section. The ratio of magnetic field at R/2 and 2R is
(a) 1/2
(b) 2
(c) 1/4
(d) 1

Correct: d

36. Two circular coils 1 and 2 are made from the same wire but the radius of the first coil is twice that of the second coil. What potential difference ratio should be applied across them so that the magnetic field at their centres is the same?
(a) 2
(b) 3
(c) 4
(d) 6

Correct: c

37. A solenoid of inductance 50 mH and resistance 10 ω is connected to a battery of 6V. The time elapsed before the current acquires half of its steady state value is
(a) 2 ms
(b) 3.5 ms
(c) 5 ms
(d) 5.5 ms

Correct: b

38. A flat rectangular coil is placed in a uniform magnetic field and rotated about an axis passing through its centre, parallel to its shorter edges and perpendicular to the field. The maximum flux linked and maximum induced emf are ϕ and E, respectively. If the axis is shifted to coincide with one of the shorter edges, then
(a) Maximum flux and induced emf are $\phi/2$ and E/2
(b) Maximum flux and induced emf are $\phi/3$ and E/3
(c) Maximum flux and induced emf are $\phi/4$ and E/4
(d) Maximum flux and induced emf remain ϕ and E

Correct: d

39. In a series L-C-R circuit, the voltages across resistance, capacitance and inductance are 20 V each. If the capacitance is short-circuited, the voltage across the inductance will be
(a) $\frac{20}{\sqrt{2}}\mathrm{v}$
(b) 20
(c) $20\sqrt{2}\mathrm{v}$
(d) 40 V

Correct: a

40. Electromagnetic waves travel in a medium with a speed of $2 \times 10^{8}\mathrm{m/s}$. If the relative permeability of the medium is 1, the relative permittivity will be

(a) 1.5
(b) 2.25
(c) 3.3
(d) 1.0

Correct: b

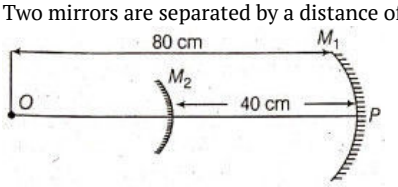
41. Two lenses have 10 D power each and they
are separated by a distance. Beyond which distance does the power of combination changes from positive to negative?
(a) 5 cm
(b) 10 cm
(c) 20 cm
(d) 50 cm

Correct: c

42. A vessel of depth d is half filled with a liquid of refractive index n, and the upper half is occupied by immiscible liquid of refractive index n. Viewing it from an eye in the upper liquid, the apparent depth of the lower liquid is
(a) $\frac{d}{2n_2}$
(b) $\frac{dn_1}{2n_2}$
(c) $\frac{d}{2}\left(\frac{n_2}{n_1}\right)$
(d) $\frac{d}{2}\left(\frac{n_1+n_2}{n_1n_2}\right)$

Correct: c

43. Consider an optical system consisting of a concave mirror M_1, and convex mirror M_2, of radii of curvature 60 cm and 20 cm, respectively. Two mirrors are separated by a distance of 40 cm. An object O is placed at a distance 80 cm from P. The final image is formed at a distance



(a) 40 cm on the right of M_2
(b) 40 cm on the right of M_2
(c) 40 cm on the right of M_1
(d) 48 cm on the left of M_2

Correct: d

44. The spherical aberration is minimized in a reflecting telescope using
(a) a concave mirror as objective
(b) a convex mirror as objective
(c) a parabolic mirror as objective
(d) an elliptical mirror as objective

Correct: c

45. A radioisotope has a half-life of 5 yr. The fraction of atoms of this material, that would decay in 15 yr would be
(a) 1
(b) 3/4
(c) 7/8
(d) 5/8

Correct: c

46. Lines of Balmer series are emitted by the hydrogen atom when the electron jumps from the
(a) first (n = 1) orbit to any higher orbit
(b) second orbit (n = 2) to any higher orbit
(c) higher orbits to the first orbit
(d) higher orbits to the second orbit

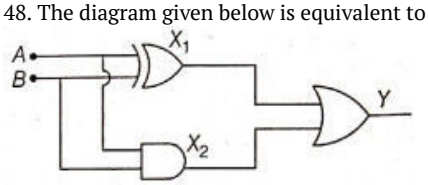
Correct: d

47. The half-life of radioactive nucleus is 100 years. The time interval between 20% and 80% decay of the parent nucleus is
(a) 100 years
(b) 200 years
(c) 300 years

(d) 400 years

Correct: b

48. The diagram given below is equivalent to a logic function of



(a) OR
(b) AND
(c) NAND
(d) XOR

Correct: a

49. In an n-p-n transistor circuit, the collector current is 10 mA. If 90% of the electrons emitted reach the collector, then
(a) the emitter current will be nearly 9 mA
(b) the emitter current will be nearly 11.1 mA
(c) the base current will be nearly 0.9 mA
(d) the base current will be nearly 0.3 mA

Correct: b

50. If the modulation index of an AM wave is changed from 0 to 1, the transmitted power is
(a) unchanged
(b) doubled
(c) increased by 50%
(d) zero

Correct: c