AIEEE Physics -2004

1. Which one of the following represents the correct dimensions of the coefficient of viscosity?
(A) $ML^{-1}T^{-2}$ (B) MLT^{-1}
(C) $ML^{-1}T^{-1}$ (D) $ML^{-2}T^{-2}$

1. C.
Dimensions of η (coefficient of viscosity)
$$= \frac{MLT^{-2}}{M^0L^0 \cdot M^0LT^{-1}} = ML^{-1}T^{-1}$$

2. 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) $\log_e x$

2. A.
$$K_f - K_i = \frac{mk}{2}x^2$$
$$K_f - k_i \propto x^2.$$

3. A ball is released from the top of a tower of height h metres. It takes T seconds to reach the ground. What is the position of the ball in T/3 seconds?
(A) h/9 metres from the ground (B) 7h/9 metres from the ground
(C) 8h/9 metres from the ground (D) 17h/18 metres from the ground.

3. C.

4. If $\vec{A} \times \vec{B} = \vec{B} \times \vec{A}$, then the angle between A and B is
(A) π (B) $\pi/3$
(C) $\pi/2$ (D) $\pi/4$

4. A.

5. A projectile can have the same range R for two angles of projection. If T_1 and T_2 be the time of flights in the two cases, then the product of the two time of flights is directly proportional to
(A) $1/R^2$ (B) $1/R$
(C) R (D) R^2

5. C.
Range is same for complimentary angles.
$$T_1 = \frac{2u\sin\theta}{g} \text{ and } T_2 = \frac{2u\sin(90-\theta)}{g}$$
and $$R = \frac{u^2\sin 2\theta}{g}$$
$$\therefore\ T_1T_2 = \frac{2u\sin\theta}{g} \times \frac{2u\cos\theta}{g} = \frac{2R}{g}.$$

6. Which of the following statements is false for a particle moving in a circle with a constant angular speed?
(A) The velocity vector is tangent to the circle.
(B) The acceleration vector is tangent to the circle.
(C) The acceleration vector points to the centre of the circle.
(D) The velocity and acceleration vectors are perpendicular to each other.

6. **B.**
The acceleration vector is along the radius of circle.

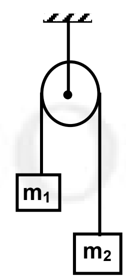
7. An automobile travelling with speed of 60 km/h, can brake to stop within a distance of 20 cm. If the car is going twice as fast, i.e 120 km/h, the stopping distance will be
(A) 20 m (B) 40 m
(C) 60 m (D) 80 m

7. **D.**
If the initial speed is doubled, the stopping distance becomes four times, i.e. 80 m.

8. A machine gun fires a bullet of mass 40 g with a velocity 1200 ms^{-1}. The man holding it can exert a maximum force of 144 N on the gun. How many bullets can he fire per second at the most?
(A) one (B) four
(C) two (D) three

8. **D.**
Change in momentum for each bullet fired is
$$= \frac{40}{1000} \times 1200 = 48 \text{ N}$$
If a bullet fired exerts a force of 48 N on man's hand so ρ man can exert maximum force of 144 N, number of bullets that can be fired = 144/48 = 3 bullets.

9. Two masses m_1 = 5 kg and m_2 = 4.8 kg tied to a string are hanging over a light frictionless pulley. What is the acceleration of the masses when lift free to move?
($g = 9.8 \text{ m/s}^2$)
(A) 0.2 m/s^2 (B) 9.8 m/s^2
(C) 5 m/s^2 (D) 4.8 m/s^2



9. **A.**
$$a = \left(\frac{m_1 - m_2}{m_1 + m_2}\right) g = 0.2 \text{ m/s}^2$$

10. A uniform chain of length 2 m is kept on a table such that a length of 60 cm hangs freely from the edge of the table. The total mass of the chain is 4 kg. What is the work done in pulling the entire chain on the table?
(A) 7.2 J (B) 3.6 J
(C) 120 J (D) 1200 J

10. **B.**
Work done = mgh = 1.2 × 0.3 × 10 = 3.6 J.

11. A block 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 0.8. If the frictional force on the block is 10 N, the mass of the block (in kg) is (take $g = 10 \text{ m/s}^2$)
(A) 2.0 (B) 4.0
(C) 1.6 (D) 2.5

11. **A.**
m = 2 kg

12. A force $\vec{F} = (5\hat{i} + 3\hat{j} + 2\hat{k})N$ is applied over a particle which displaces it from its origin to the point $\vec{r} = (2\hat{i} - \hat{j})m$. The work done on the particle in joules is
(A) –7 (B) +7
(C) +10 (D) +13

12. B.
Work done, W = $\vec{F}\cdot\vec{s}$
Here $\vec{s} = \vec{r}_f - \vec{r}_i = (2\hat{i} - \hat{j})$
$W = (5\hat{i} + 3\hat{j} + 2\hat{k})(2\hat{i} - \hat{j})$ = 10 – 3 = 7 J.

13. A body of mass m, accelerates uniformly from rest to v_1 in time t_1. The instantaneous power delivered to the body as a function of time t is
(A) $\frac{mv_1t}{t_1}$ (B) $\frac{mv_1^2t}{t_1^2}$
(C) $\frac{mv_1t^2}{t_1}$ (D) $\frac{mv_1^2t}{t_1}$

13. B.
Power $P = \vec{F}\cdot\vec{v} = mav = m\left(\frac{v_1}{t_1}\right)\left(\frac{v_1}{t_1}t\right) = \frac{mv_1^2t}{t_1^2}$

14. A particle is acted upon by a force of constant magnitude which is always perpendicular to the velocity of the particle, the motion of the particle takes place in a plane. It follows that
(A) its velocity is constant (B) its acceleration is constant
(C) its kinetic energy is constant (D) it moves in a straight line.

14. C.
When a force of constant magnitude which is always perpendicular to the velocity of the particle acts on a particle, the work done and hence change in kinetic energy is zero.

15. A solid sphere is rotating in free space. If the radius of the sphere is increased keeping mass same which one of the following will not be affected?
(A) moment of inertia (B) angular momentum
(C) angular velocity (D) rotational kinetic energy.

15. B.
Let it be assume that in “free space” not only the acceleration due to gravity it acting but also there are no external torque acting but also there are no external torque acting on the sphere. If due to internal changes in the system, the radius has increased, then the law of the conservation of angular momentum holds good.

16. A ball is thrown from a point with a speed v_0 at an angle of projection θ. From the same point and at the same instant person starts running with a constant speed $v_0/2$ to catch the ball. Will the person be able to catch the ball? If yes, what should be the angle of projection?
(A) yes, 60° (B) yes, 30°
(C) no (D) yes, 45°

16. A.
For the person to be able to catch the ball, the horizontal component of the velocity of the ball should be same as the speed of the person.
$v_0 \cos\theta = \frac{v_0}{2}$
$\Rightarrow \theta = 60°$.

17. One solid sphere A and another hollow sphere B are of same mass and same outer radii. Their moment of inertia about their diameters are respectively I_A and I_B such that
(A) $I_A = I_B$
(B) $I_A > I_B$
(C) $I_A < I_B$
(D) $I_A/I_B = d_A/d_B$
Where d_A and d_B are their densities.

17. C.
Moment of inertia of a uniform density solid sphere, A = $\frac{2}{5}MR^2$
And of hollow sphere B = $\frac{2}{3}MR^2$
Since M and R are same, $I_A < I_B$.

18. A satellite of mass m revolves around the earth of radius R at a height x from its surface. If g is the acceleration due to gravity on the surface of the earth, the orbital speed of the satellite is
(A) gx
(B) $\frac{gR}{R-x}$
(C) $\frac{gR^2}{R+x}$
(D) $\left(\frac{gR^2}{R+x}\right)^{1/2}$

18. D.
For the satellite, the gravitational force provides the necessary centripetal force i.e.
$$\frac{GM_e m}{(R+X)^2} = \frac{Mv_0^2}{(R+X)} \text{ and } \frac{GM_e}{R^2} = g$$
$$\therefore\ v_0 = \left(\frac{gR^2}{R+X}\right)^{1/2}$$

19. The time period of an earth satellite in circular orbit is independent of
(A) the mass of the satellite
(B) radius of its orbit
(C) both the mass and radius of the orbit
(D) neither the mass of the satellite nor the radius of its orbit.

19. A.
The time period of satellite is given by
$$T = 2\pi\sqrt{\frac{(R+h)^3}{GM}}$$
where, R + h = radius of orbit satellite, M = mass of earth.

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

20. B.

21. Suppose the gravitational force varies inversely as the nth power of distance. Then the time period planet in circular orbit of radius R around the sun will be proportional to

(A) $R^{\left(\frac{n+1}{2}\right)}$
(B) $R^{\left(\frac{n-1}{2}\right)}$
(C) R^{n}
(D) $R^{\left(\frac{n-2}{2}\right)}$

21. **A.**
$T \propto R^{(n+1)/2}$

22. A wire fixed at the upper end stretches by length □ by applying a force F. The work done in stretching is

(A) $F/2\ell$
(B) $F\ell$
(C) $2F\ell$
(D) $F\ell/2$

22. **D.**
Work done = $\frac{1}{2}kx^2 = \frac{1}{2}k\ell^2$ where ℓ is the total extensions.

$$= \frac{1}{2}(k\ell)\ell = \frac{1}{2}F\ell$$

23. Spherical balls of radius R are falling in a viscous fluid of viscosity η with a velocity v. The retarding viscous force acting on the spherical ball is
(A) directly proportional to R but inversely proportional to v.
(B) directly proportional to both radius R and velocity v.
(C) inversely proportional to both radius R and velocity v.
(D) inversely proportional to R but directly proportional to velocity v.

23. **B.**
Retarding viscous force = $6\pi\eta Rv$

24. If two soap bubbles of different radii are connected by a tube,
(A) air flows from the bigger bubble to the smaller bubble till the sizes are interchanged.
(B) air flows from bigger bubble to the smaller bubble till the sizes are interchanged
(C) air flows from the smaller bubble to the bigger.
(D) there is no flow of air.

24. **C.**
The pressure inside the smaller bubble will be more $\left(P_i = P_0 + \frac{4T}{r}\right)$

Therefore, if the bubbles are connected by a tube, the air will flow from smaller bubble to the bigger.

25. The bob of a simple pendulum executes simple harmonic motion in water with a period t, while the period of oscillation of the bob is t_0 in air. Neglecting frictional force of water and given that the density of the bob is $\left(\frac{4}{3}\right) \times 1000$ kg/m^3. What relationship between t and t_0 is true?

(A) $t = t_0$
(B) $t = t_0/2$
(C) $t = 2t_0$
(D) $t = 4t_0$

25. **C.**

$$\frac{T}{T_0} = \sqrt{\frac{1}{\left(1-\frac{\rho'}{\rho}\right)}} = \sqrt{\frac{1}{1-\frac{1}{3}}}$$

$$\Rightarrow \frac{T}{T_0} = 2$$

or, $T = 2T_0$

26. A particle at the end of a spring executes simple harmonic motion with a period t_1, while the corresponding period for another spring is t_2. If the period of oscillation with the two springs in series is t, then

(A) $T = t_1 + t_2$
(B) $T^2 = t_1^2 + t_2^2$
(C) $T^{-1} = t_1^{-1} + t_2^{-1}$
(D) $T^{-2} = t_1^{-2} + t_2^{-2}$

26. B.

$t_1^2 + t_2^2 = T^2$

27. The total energy of particle, executing simple harmonic motion is

(A) $\propto x$
(B) $\propto x^2$
(C) independent of x
(D) $\propto x^{1/2}$

27. C.

In simple harmonic motion, as a particle is displaced from its mean position, its kinetic energy is converted to potential energy and vice versa and total energy remains constant. The total energy of simple harmonic motion is independent of x.

28. The displacement y of a particle in a medium can be expressed as $y = 10^{-6}\sin(110t + 20x + \pi/4)$ m, where t is in seconds and x in meter. The speed of the wave is

(A) 2000 m/s
(B) 5 m/s
(C) 20 m/s
(D) 5π m/s.

28. B.

$$v = \frac{\omega}{k} = 5\ ms^{-1}$$

29. A particle of mass m is attached to a spring (of spring constant k) and has a natural angular frequency ω_0. An external force F(t) proportional to $\cos\omega t$ ($\omega \neq \omega_0$) is applied to the oscillator. The time displacement of the oscillator will be proportional to

(A) $\frac{m}{\omega_0^2 - \omega^2}$
(B) $\frac{1}{m(\omega_0^2 - \omega^2)}$
(C) $\frac{1}{m(\omega_0^2 + \omega^2)}$
(D) $\frac{m}{\omega_0^2 + \omega^2}$

29. B.

For forced oscillations, the displacement is given by

$$x = A\ \sin(\omega t + \phi) \text{ with } A = \frac{F_0/m}{\omega_0^2 - \omega^2}$$

30. In forced oscillation of a particle the amplitude is maximum for a frequency ω_1 of the force, while the energy is maximum for a frequency ω_2 of the force, then
(A) $\omega_1 = \omega_2$
(B) $\omega_1 > \omega_2$
(C) $\omega_1 < \omega_2$ when damping is small and $\omega_1 > \omega_2$ when damping is large
(D) $\omega_1 < \omega_2$

30. A.
Both amplitude and energy get maximised when the frequency is equal to the natural frequency. This is the condition of resonance.
$\omega_1 = \omega_2$

31. One mole of ideal monoatomic gas (γ = 5/30) is mixed with one mole of diatomic gas (γ = 7/5). What is γ for the mixture? γ denotes the ratio of specific heat at constant pressure, to that at constant volume.
(A) 3/2 (B) 23/15
(C) 35/23 (D) 4/3

31. A.
$Q = Q_1 + Q_2$

$$\frac{n_1 + n_2}{\gamma_m - 1} = \frac{n_1}{\gamma_1 - 1} + \frac{n_2}{\gamma_2 - 1}$$

$$\gamma_m = \frac{3}{2}$$

32. If the temperature of the sun were to increase from T to 2T and its radius from R to 2R, then the ratio of the radiant energy received on earth to what it was previously will be
(A) 4 (B) 16
(C) 32 (D) 64.

32. D.
According to Stefan's law,
$P \propto AT^4$ and $A \propto r^2$
$P \propto r^2T^4$

33. Which of the following statements is correct for any thermodynamic system?
(A) The internal energy changes in all processes.
(B) Internal energy and entropy are state functions.
(C) The change in entropy can never be zero.
(D) The work done in an adiabatic process is always zero.

33. B.

34. Two thermally insulated vessels 1 and 2 are filled with air at temperatures (T_1, T_2), volume (V_1, V_2) and pressure (P_1, P_2) respectively. If the valve joining two vessels is opened, the temperature inside the vessel at equilibrium will be
(A) $T_1 + T_2$ (B) $(T_1 + T_2)/2$
(C) $\frac{T_1T_2(P_1V_1 + P_2V_2)}{P_1V_1T_2 + P_2V_2T_1}$ (D) $\frac{T_1T_2(P_1V_1 + P_2V_2)}{P_1V_1T_1 + P_2T_2T_2}$

34. C.
The number of moles of system remains same
According to Boyle's law,
$P_1V_1 + P_2V_2 = P(V_1 + V_2)$

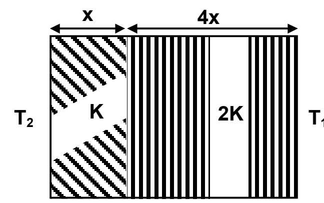
$$\therefore \quad T = \frac{T_1T_2(P_1V_1 + P_2V_2)}{P_1V_1T_2 + P_2V_2T_1}$$

35. A radiation of energy E falls normally on a perfectly reflecting surface. The momentum transferred to the surface is
(A) E/c (B) 2E/c
(C) Ec (D) E/c^2

35. B.

$$\Delta P_{surface} = -\Delta P = \frac{2E}{c}.$$

36. The temperature of two outer surfaces of a composite slab, consisting of two materials having coefficients of thermal conductivity K and 2K and thickness x and 4x, respectively are T_2 and T_1 ($T_2 > T_1$). The rate of heat transfer through the slab, in a steady state is $\left(\frac{A(T_2 - T_1)K}{x}\right)f$, with f equal to



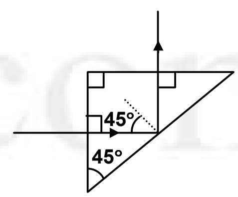
(A) 1 (B) ½
(C) 2/3 (D) 1/3

36. D.

$$\Delta q = \frac{kA}{x}\left[T_2 - \frac{2T_2 - T_1}{3}\right]$$

$$= \frac{kA}{3x}\left[T_2 - T_1\right]$$

37. A light ray is incident perpendicular to one face of a 90° prism and is totally internally reflected at the glass-air interface. If the angle of reflection is 45°, we conclude that the refractive index n



(A) $n < \frac{1}{2}$ (B) $n > \sqrt{2}$
(C) $n > \frac{1}{\sqrt{2}}$ (D) $n < \sqrt{2}$

37. B.
Angle of incidence i > C for total internal reflection.
Here i = 45° inside the medium.
$\therefore$ $45° > \sin^{-1}(1/n)$
$\Rightarrow$ $n > \sqrt{2}$.

38. A plane convex lens of refractive index 1.5 and radius of curvature 30 cm is silvered at the curved surface. Now this lens has been used to form the image of an object. At what distance from this lens an object be placed in order to have a real image of the size of the object?
(A) 20 cm (B) 30 cm
(C) 60 cm (D) 80 cm

38. A.

$$\frac{1}{F} = \frac{2}{f_1} + \frac{1}{f_m}$$

and $\frac{1}{f_1} = (1.5 - 1)\left(\frac{1}{\infty} - \frac{1}{-30}\right) = \frac{1}{60}$

and $f_m = 15$ cm.
$\therefore$ F = 10 cm.
Object should be placed at 20 cm from the lens.

39. The angle of incidence at which reflected light totally polarized for reflection from air to glass (refractive index n), is
(A) $\sin^{-1}(n)$ (B) $\sin^{-1}(1/n)$
(C) $\tan^{-1}(1/n)$ (D) $\tan^{-1}(n)$

39. **D.**
Brewster's law: According to this law the ordinary light is completely polarised in the plane of incidence when it gets reflected from transparent medium at a particular angle known as the angle of polarisation.
$n = \tan i_p$.

40. The maximum number of possible interference maxima for slit-separation equal to twice the wavelength in Young's double-slit experiment is
(A) infinite (B) five
(C) three (D) zero

40. **B.**
For interference maxima, $d \sin\theta = n\lambda$
Here $d = 2\lambda$
$\therefore$ $\sin\theta = n/2$ and is satisfied by 5 integral values of n (–2, –1, 0, 1, 2), as the maximum value of $\sin\theta$ can only be 1.

41. An electromagnetic wave of frequency ν = 3.0 MHz passes from vacuum into a dielectric medium with permittivity ε = 4.0. Then
(A) wavelength is doubled and the frequency remains unchanged
(B) wavelength is doubled and frequency becomes half
(C) wavelength is halved and frequency remains unchanged
(D) wavelength and frequency both remain unchanged.

41. **C.**
Refractive index, $\mu = \sqrt{\frac{\varepsilon}{\varepsilon_0}} = 2$
Speed and wavelength of wave will becomes half, the frequency remaining unchanged (frequency of a wave depends on the source as due to refraction, it is assumed that the energy is conserved. $h\nu$ remains the same)

42. Two spherical conductor B and C having equal radii and carrying equal charges in them repel each other with a force F when kept apart at some distance. A third spherical conductor having same radius as that of B but uncharged brought in contact with B, then brought in contact with C and finally removed away from both. The new force of repulsion, between B and C is
(A) F/4 (B) 3F/4
(C) F/8 (D) 3F/8.

42. **D.**
$$F' = \frac{1}{4\pi\varepsilon_0}\frac{(q/2)(3q/4)}{d^2} = \frac{3F}{8}.$$

43. A charged particle q is shot towards another charged particle Q which is fixed, with a speed v it approaches Q upto a closest distance r and then returns. If q were given a speed 2v, the closest distances of approach would be
(A) r (B) 2r
(C) r/2 (D) r/4

43. **D.**
By principle of conservation of energy
$$\frac{1}{2}mv^2 = \frac{KqQ}{r} \qquad \ldots(i)$$
Finally, $\frac{1}{2}m(2v)^2 = \frac{KqQ}{r^2}$ $\qquad \ldots(ii)$
Equation (i) ÷ (ii),
$$\frac{1}{4} = \frac{r'}{r}$$
$$\Rightarrow \; r' = \frac{r}{4}.$$

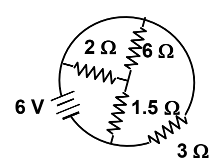
44. Four charges equal to –Q are placed at the four corners of a square and a charge q is at its centre. If the system is in equilibrium the value of q is
(A) $-\frac{Q}{4}(1+2\sqrt{2})$ (B) $\frac{Q}{4}(1+2\sqrt{2})$
(C) $-\frac{Q}{2}(1+2\sqrt{2})$ (D) $\frac{Q}{2}(1+2\sqrt{2})$

44. **B.**
q = $+\frac{Q}{4}(1+2\sqrt{2})$

45. Alternating current can not be measured by D.C. ammeter because
(A) A.C. cannot pass through D.C.
(B) A.C. changes direction
(C) average value of current for complete cycle is zero
(D) D.C. ammeter will get damaged.

45. **C.**

46. The total current supplied to the circuit by the battery is
(A) 1 A (B) 2 A
(C) 4 A (D) 6 A



46. **C.**
The given circuit can be written as
$$I = \frac{6\ V}{1.5\ \Omega} = 4A.$$

47. The resistance of the series combination of two resistances is S. When they are joined in parallel through total resistance is P. If S = nP, then the minimum possible value of n is
(A) 4 (B) 3
(C) 2 (D) 1

47. **A.**
Let resistances be R_1 and R_2
So, S = $R_1 + R_2$;
$$P = \frac{R_1R_2}{R_1 + R_2}$$
S = nP
$$R_1 + R_2 = \frac{nR_1R_2}{R_1 + R_2}$$
$$(R_1 + R_2)^2 = nR_1R_2$$
If $R_1 = R_2$, so minimum value of n = 4.

48. An electric current is passed through a circuit containing two wires of the same material, connected in parallel. If the length and radii of the wires are in the ratio of 4/3 and 2/3, then the ratio of the currents passing through the wire will be
(A) 3
(B) 1/3
(C) 8/9
(D) 2.

48. B.

$$\frac{I_1}{I_2} = \frac{R_2}{R_1}$$

[current divider rule since voltage is same in parallel]

$$\frac{I_1}{I_2} = \frac{L_2}{L_1} \times \frac{r_1^2}{r_2^2}$$

$$\therefore \frac{I_1}{I_2} = \frac{3}{4} \times \left(\frac{2}{3}\right)^2 = \frac{1}{3}.$$

49. In a metre bridge experiment null point is obtained at 20 cm from one end of the wire when resistance X is balanced against another resistance Y. If X < Y, then where will be the new position of the null point from the same end, if one decides to balance a resistance of 4X against Y?
(A) 50 cm
(B) 80 cm
(C) 40 cm
(D) 70 cm

49. A.

We have from meter bridge experiment,

$\frac{R_1}{R_2} = \frac{\ell_1}{\ell_2}$, where $\ell_2 = (100 - \ell_1)$ cm

In the first case, X/Y = 20/80

In the second case $\frac{4X}{Y} = \frac{\ell}{100 - \ell}$

$\ell = 50$ cm.

50. The thermistors are usually made of
(A) metals with low temperature coefficient of resistivity
(B) metals with high temperature coefficient of resistivity
(C) metal oxides with high temperature coefficient of resistivity '
(D) semiconducting materials having low temperature coefficient of resistivity.

50. C.

These are devices whose resistance varies quite markedly with temperature mean having high temperature coefficient of resistivity. [Their name are derived from thermal resistors]. Depending on their composition they can have either negative temperature coefficient or positive temperature coefficient or positive temperature coefficient or positive temperature coefficient characteristics.

The negative temperature coefficient types consists of a mixture of oxides of iorn, nickel and cobalt with small amounts of other substance. The positive temperature coefficient types are based on barium titanate.

51. Time taken by a 836 W heater to heat one litre of water from 10°C to 40°C is
(A) 50 s
(B) 100 s
(C) 150 s
(D) 200 s

51. C.

Let t be the time taken, then

$\frac{836 \times t}{4.2} = 1000 \times 1 \times (40 - 10)$ [using Q = mst]

$\Rightarrow$ t = 150 sec.

52. The thermo emf of a thermocouple varies with the temperature θ of the hot junction as $E = a\,\theta + b\theta^2$ in volts where the ratio a/b is 700°C. If the cold junction is kept at 0°C, then the neutral temperature is
(A) 700°C
(B) 350°C
(C) 1400°C
(D) no neutral temperature is possible for this thermocouple.

52. D.
$E = a\theta + b\theta^2$
At neutral temperature $dE/d\theta = 0$

$\therefore \frac{dE}{d\theta} = a + 2b\theta_n = 0$; $\theta_n = -\frac{a}{2b}$

Now $\frac{a}{b} = 700°C$ (given)

$\theta_n = -700/2 = -350°C$
Now $\theta_c = 0°C$.
So, $\theta_n > 0°C$
But mathematically $\theta_n < 0°C$.

53. The electrochemical equivalent of a metal is 3.3×10^{-7} kg per coulomb. The mass of the metal liberated at the cathode when a 3 A current is passed for 2 seconds will be
(A) 19.8×10^{-7} kg
(B) 9.9×10^{-7} kg
(C) 6.6×10^{-7} kg
(D) 1.1×10^{-7} kg

53. A.
m = Zit,
$m = 3.3 \times 10^{-7} \times 3 \times 2 = 19.8 \times 10^{-7}$ kg.

54. A current I ampere flows along an infinitely long straight thin walled tube, then the magnetic induction at any point inside the tube is
(A) infinite
(B) zero
(C) $\frac{\mu_0}{4\pi}\frac{2i}{r}$ tesla
(D) $\frac{2i}{r}$ tesla

54. B.
Considering Ampere's loop (shown by dotted line), no current is enclosed by this loop. Therefore, the magnetic field will be zero inside the tube.

55. A long wire carries a steady current. It is bent into a circle of one turn and the magnetic field at the centre of the coil is B. It is then bent into a circular loop of n turns. The magnetic field at the centre of the coil will be
(A) nB
(B) n^2 B
(C) 2nB
(D) $2n^2B$

55. B.

$B' = \frac{n\mu_0 i}{2r'} = n^2 \frac{\mu_0 i \pi}{\ell} = n^2B$.

56. The magnetic field due to a current carrying circular loop of radius 3 cm at a point on the axis at a distance of 4 cm from the centre is 54 μT. What will be its value at the centre of the loop?
(A) 250 μT (B) 150 μT
(C) 125 μT (D) 75 μT

56. A.
Using formula $B = \frac{\mu_0 i R^2}{2(R^2 + X^2)^{3/2}}$, we get

$$54 = \frac{\mu_0 i (3)^2}{2[(3)^2 + (4)^2]^{3/2}} \quad \ldots(i)$$

At the centre of the coil, X = 0 and B = $\frac{\mu_0 i}{2(3)}$

Using equation (i)

$$B = \frac{54 \times 5^3}{(3)^2 \times 3} \Rightarrow B = 250\ \mu T.$$

57. Two long conductors, separated by a distance d carry current I_1 and I_2 in the same direction. They exert a force F on each other. Now the current in one of them increased to two times and its direction reversed. The distance is also increased to 3d. The new value of the force between them is
(A) –2F (B) F/3
(C) –2F/3 (D) –F/3

57. C.
Force between two long conductor carrying current

$$F = \frac{\mu_0}{2\pi}\frac{I_1 I_2}{d}\ell$$

According to question

$$F' = \frac{\mu_0}{2\pi}\frac{(-2I_1)(I_2)}{d}\ell$$

From equation (i) and (ii), $F' = -\frac{3}{2}F.$

58. The length of a magnet is large compared to its width and breadth. The time period of its width and breadth. The time period of its oscillation in a vibration magnetometer is 2 s. The magnet is cut along its length into three equal parts and three parts are then placed on each other with their like poles together. The time period of this combination will be
(A) 2 s (B) 2/3 s
(C) 2√3 s (D) 2/√3 s .

58. B.
Time period of vibration, $T = 2\pi\sqrt{\frac{T}{MB}}$

Where ℓ = moment of inertia of magnet, M = magnetic moment

$$I = \frac{m\ell^2}{12} \text{ and } M = \text{pole strength} \times \ell$$

$$I' = \frac{1}{12}\left(\frac{m}{3}\right)\left(\frac{\ell}{3}\right)^2 \times 3 = \frac{I}{9}$$

and M' = pole strength (will remain the same) × (ℓ/3) × 3 = M.

$$T' = \frac{T}{\sqrt{9}} = \frac{2}{9}\text{s.}$$

59. The materials suitable for making electromagnets should have
(A) high retentivity and high coercivity
(B) low retentivity and low coercivity
(C) high retentivity and low coercivity
(D) low retentivity and high coercivity

59. B.

60. In an LCR series a.c. circuit, the voltage across each of the components, L, C and R is 50 V. The voltage across the LC combination will be
(A) 50 V
(B) $50\sqrt{2}$ V
(C) 100 V
(D) 0 V(zero)

60. D.
In series LCR circuit, the voltage across the inductor (L) and the capacitor (C) are in opposite phase.

61. A coil having n turns and resistance 4R Ω. This combination is moved in time t seconds from a magnetic field W_1 weber to W_2 weber. The induced current in the circuit is
(A) $-\frac{W_2 - W_1}{5Rnt}$
(B) $-\frac{(W_2 - W_1)}{5Rt}$
(C) $-\frac{W_2 - W_1}{Rnt}$
(D) $-\frac{n(W_2 - W_1)}{Rt}$

61. B.

$$I = -\frac{n}{R'}\frac{d\phi}{dt}$$

or, $I = -\frac{1}{R'}n\left[\frac{W_2 - W_1}{t_2 - t_1}\right]$

(W_1 and W_2 are not the magnetic field, but the values of flux associated with one turn of coil)

$$I = \frac{-1}{(R+4R)}\frac{n(W_2 - W_1)}{t}$$

or, $I = -\frac{n(W_2 - W_1)}{5Rt}$

62. In a uniform magnetic field of induction B a wire in the form of semicircle of radius r rotates about the diameter of the circle with angular frequency ω. The axis of rotation is perpendicular to the field. If the total resistance of the circuit is R the mean power generated per period of rotation is
(A) $\frac{B\pi r^2\omega}{2R}$
(B) $\frac{(B\pi r^2\omega)^2}{2R}$
(C) $\frac{(B\pi r\omega)^2}{2R}$
(D) $\frac{(B\pi r\omega^2)^2}{8R}$

62. B.

Magnetic flux = BA cos θ = $B \cdot \frac{\pi r^2}{2}\cos\omega t$

$$\therefore\ \varepsilon_{ind} = -\frac{d\phi}{dt} = \frac{1}{2}B\pi r^2\omega\sin\omega t$$

$$\therefore\ P = \frac{\varepsilon^2_{ind}}{R} = \frac{B^2\pi^2 r^4\omega^2\sin^2\omega t}{4R}$$

Now, $\langle \sin^2\omega t\rangle$ = ½ (mean value)

$$\therefore\ \langle P\rangle = \frac{(B\pi r^2\omega)^2}{8R}.$$

63. In a LCR circuit capacitance is changed from C to 2C. For the resonant frequency to remain unchanged, the inductance should be changed from L to
(A) 4L (B) 2L
(C) L/2 (D) L/4

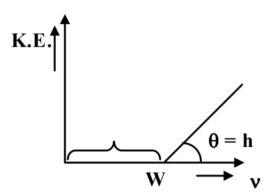
63. C.
$\omega_{res} = \frac{1}{\sqrt{LC}}$
if ω_{res} is to remain same, the product LC should also not change.
$\Rightarrow LC = L'C'$
$\Rightarrow LC = L'2C$
$\Rightarrow L' = L/2$

64. A metal conductor of length 1 m rotates vertically about one of its ends at angular velocity 5 radians per second. If the horizontal component of earth's magnetic field is 0.3×10^{-4} T, then the e.m.f. developed between the two ends of the conductor is
(A) depends on the nature of the metal used
(B) depends on the intensity of the radiation
(C) depends both on the intensity of the radiation and the metal used
(D) is the same for all metals and independent of the intensity of the radiation.

64. B.
emf. developed is given by
$\varepsilon_{ind} = \frac{1}{2}B\omega R^2 = 50\ \mu V.$

65. According to Einstein's photoelectric equation, the plot of the kinetic energy of the emitted photo electrons from a metal V_s the frequency, of the incident radiation gives straight line whose slope
(A) depends on the nature of the metal used
(B) depends on the intensity of the radiation
(C) depends both on the intensity of the radiation and the metal used
(D) is the same for all metals and independent of the intensity of the radiation.

65. D.
$KE_{max} = h\nu - W$ {y = mx + C}
Slope of the line in the graph is h, the Planck's constant.



66. The work function of a substance is 4.0 eV. Then longest wavelength of light that can cause photoelectron emission from this substance approximately
(A) 540 nm (B) 400 nm
(C) 310 nm (D) 220 nm

66. C.
$\frac{hc}{\lambda} = W$
$\lambda_{longest} = \frac{hc}{W} = \frac{6.6 \times 10^{-34} \times 3 \times 10^{8}}{4.0 \times 1.6 \times 10^{-19}}$
$\Rightarrow \lambda_{longest} \approx 310$ nm.

67. A charged oil drop is suspended in a uniform field of 3×10^4 V/m so that it neither falls nor rises. The charge on the drop will be (take the mass of the charge = 9.9×10^{-15} kg and g = 10 m/s^2)
(A) 3.3×10^{-18} C
(B) 3.2×10^{-18} C
(C) 1.6×10^{-18} C
(D) 4.8×10^{-18} C.

67. A.
Since ball is hanging in equilibrium, force by gravity is balanced by electric force.
qE = mg

$$\Rightarrow q = \frac{m \times g}{E}$$

$$\Rightarrow \frac{9.9 \times 10^{-15} \times 10}{3 \times 10^4}$$

$\therefore$ q = 3.3×10^{-18} C

68. A nucleus disintegrates into two nuclear parts which have their velocities in the ratio 2 : 1. The ratio of their nuclear sizes will be
(A) $2^{1/3} : 1$
(B) $1 : 3^{1/2}$
(C) $3^{1/2} : 1$
(D) $1 : 2^{1/3}$

68. B.

$$\frac{R_1}{R_2} = \left(\frac{m_2}{2m_2}\right)^{1/3}$$

$$\Rightarrow \frac{R_1}{R_2} = 1 : 2^{1/3}.$$

69. The binding energy per nucleon of deuteron (^2_1H) and helium nucleus (^4_2He) is 1.1 MeV and 7 MeV respectively. If two deuteron nuclei react to form a single helium nucleus, then the energy released is
(A) 13.9 MeV
(B) 26.9 MeV
(C) 23.6 MeV
(D) 19.2 MeV

69. C.
Energy released = total binding energy of product – total binding energy of reactants
$\Rightarrow$ 28 – (2 × 2.2) = 28 – 4.4 = 236 MeV.

70. An α-particle of energy 5 MeV is scattered through 180° by a fixed uranium nucleus. The distance of the closest approach is of the order of
(A) 1 Å
(B) 10^{-10} cm
(C) 10^{-12} cm
(D) 10^{-15} cm

70. C.
At closest approach, all the kinetic energy of the α-particle will converted into the potential energy of the system, K.E. = P.E.

$$5 \text{ MeV} = \frac{1}{4\pi\varepsilon_0}\frac{q_1q_2}{r}$$

$$5 \times 10^6 \times e = 9 \times 10^9 \ \frac{Z_1 \times Z_2e^2}{r}$$

$$r = \frac{9 \times 10^9 \times 92 \times 2 \times 1.6 \times 10^{-19}}{5 \times 10^6}$$

$\therefore$ r = 5.3×10^{-14} m = 5.3×10^{-12} cm.

71. When npn transistor is used as amplifier
(A) electrons move from base to collector (B) holes move from emitter to base
(C) electrons move from collector to base (D) holes move from base to emitter.

71. A.
When npn transistor is used, majority charge carrier electrons of n type emitter move from emitter to base and then base to collector.

72. For a transistor amplifier in common emitter configuration having load impedance of 1 kΩ (h_{fe} = 50 and h_{oe} = 25) the current gain is
(A) –5.2 (B) –15.7
(C) –24.8 (D) –48.78

72. D.
In CE configuration, $A_i = \frac{-h_{fe}}{1+h_{0e}R_L}$

$= \frac{-50}{1+25\times10^{-6}\times1\times10^{3}} = -48.78$

73. A piece of copper and another of germanium are cooled from room temperature to 77 K, the resistance of
(A) each of them increases
(B) each of them decreases
(C) copper decreases and germanium increases
(D) copper increases and germanium decreases.

73. D.
Copper is metallic conductor and germanium is semiconductor therefore as temperature decreases resistance of good conductor decreases while for semiconductor it increases.

74. The manifestation of band structure in solids is due to
(A) Heisenberg's uncertainty principle (B) Pauli's exclusion principle
(C) Bohr's correspondence principle (D) Boltzmann's law

74. B.

75. When p-n junction diode is forward biased
(A) the depletion region is reduced and barrier height is increased
(B) the depletion region is widened and barrier height is reduced.
(C) both the depletion region and barrier height reduced
(D) both the depletion region and barrier height increased.

75. C.