DCE - 2006

PHYSICS — MEMORY BASED QUESTIONS

1. A T-shaped rod is hinzed at O. Rod A and Rod B are identical. B is joined at mind point of A from one of its end and is hanged from its other end. Find moment of inertia about the axis passing through O. Mass of each rod is one kg and length is 1m.

(a) 4/3 (b) 16/3 (c) 17/12 (d) 8/3

Sol: Ans [c]

$$I = \frac{ml^2}{3} + \left(\frac{ml^2}{12} + ml^2\right)$$

$$= \frac{17}{12}ml^2 = \frac{17}{12} \times 1 \times 1^2 = \frac{17}{12}$$

2. A particle executing S.H.M. at mid point of mean position and extremity. What is potential energy in terms of total energy (E)

(a) $\frac{E}{4}$ (b) $\frac{E}{16}$ (c) $\frac{E}{2}$ (d) $\frac{E}{8}$

Sol: Ans [a]

$$E = \frac{1}{2}KA^2$$

$$\therefore \quad PE = \frac{1}{2}Kx^2 = \frac{1}{2}K(A/2)^2 = \frac{E}{4}$$

3. A train is approaching with velocity 25 m/sec towards a pedestrian standing on track, frequency of horn of train is 1 KHz. Frequency heard by the pedestrian (v = 350)

(a) 1077 (b) 1167 Hz (c) 986 Hz (d) 945 Hz

Sol: Ans [a]

$$f = f_0\left(\frac{350}{350 - 25}\right) = 1000\left(\frac{350}{325}\right)$$

$$= 1077 \text{ Hz}$$

4. Focal length of objective and eyepiece of telescope are 200 cm and 4 cm respectively. What is length of telescope for normal adjustment

(a) 196 cm (b) 204 cm (c) 250 cm (d) 225 cm

Sol: Ans [b]

Length = $f_0 + f_e$ = 204 cm

5. Two lenses of power 3D and –1D are kept in contact. What is focal length and nature of combined lens

(a) 50 cm, convex (b) 200 cm, convex (c) 50 cm, concave (d) 200 cm, concave

Sol: Ans [a]

$P = 3D - 1D = 2D$

Convex lens and $f = \frac{1}{2}$ m = 50 cm

6. Intensity of A is 9I, while B is I. What is maximum and minimum intensity in YDSE

(a) 82 I, 80 I (b) 8 I, 10 I (c) 16 I, 4 I (d) 4 I, I

Sol: Ans [c]

$I_{max} = (\sqrt{9I} + \sqrt{I})^2 = 16\ I$

$I_{min} = (\sqrt{9I} - \sqrt{I})^2 = 4I$

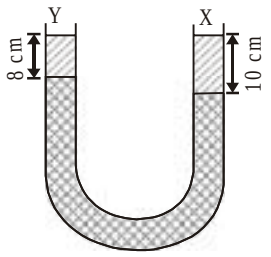
7. What happens inside optical fibre

(a) diffraction (b) polarization

(c) interference (d) total internal reflection

Sol: Ans [d]

8. A liquid X of density 3.36 gm/cm^3 is poured in a U-tube, which contains Hg. Another liquid Y is poured in left arm with height 8 cm, upper levels of X and Y are same. What is density of Y



(a) 0.8 g/cc (b) 1.2 g/cc

(c) 1.4 g/cc (d) 1.6 g/cc

Sol: Ans [a]

$P_0 + \rho_X g \times 10 = P_0 + \rho_Y g \times 8 + \rho_{Hg} \times g \times 2$

$\Rightarrow \quad \rho_Y = 0.8$ gm/cm^3

9. A sphere of mass M and radius R is dropped in a liquid, then terminal velocity of sphere is proportional to

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

Sol: Ans [c]

10. A sphere of radius R is rolling without sliding. What is ratio of rotational kinetic energy and total kinetic energy associated with body (radius of gyration of body is K)

(a) $\frac{2}{7}$ (b) $\frac{2}{5}$ (c) 1 (d) $\frac{1}{2}$

Sol: Ans [b]

$$K_r = \frac{1}{2} \cdot \frac{2}{5} mr^2 \left(\frac{v}{r} \right)^2 = \frac{1}{5} mv^2$$

$$K_t = \frac{1}{2} mv^2$$

$$\frac{K_r}{K_t} = \frac{2}{5}$$

11. A particle is projected with velocity $2\sqrt{gh}$, such that it just crosses two walls of height *h* and separated by *h*. Find the angle of projection

(a) 15° (b) 75° (c) 60° (d) 30°

Sol: Ans [d]

$$h = u \sin\theta t \quad \frac{1}{2} gt^2$$

$$\Rightarrow \quad gt^2 - 2u \sin\theta t + 2h = 0$$

if particle crosses the wall at time t_1 and t_2 then time of flight *t* is

$$t = \sqrt{t_1 t_2}$$

$$\left(\frac{2u \sin\theta}{g} \right)^2 = \left(\frac{2h}{g} \right)$$

Solving

$$\theta = 30°$$

12. For a projectile, $(\text{Range})^2$ is 48 times of $(\text{maximum height})^2$ obtained. Find angle of projection

(a) 60° (b) 30° (c) 45° (d) 75°

Sol: Ans [b]

$$\left[\frac{\mu^2 \sin 2\theta}{g} \right]^2 = 48 \left(\frac{\mu^2 \sin^2 \theta}{2g} \right)^2$$

$$\Rightarrow \quad \theta = 30°$$

13. Which of the following cannot be explained on the basis of wave nature of light?

(i) Polarization (ii) Optical activity (iii) Photoelectric effect (iv) Compton effect

(a) (iii) & (iv) (b) (ii) & (iii) (c) (i) & (iii) (d) (ii) & (iv)

Sol: Ans [a]

14. A ice cube is kept on an inclined plane of angle 30°. Coefficient of kinetic friction between block and inclined plane is $\frac{1}{\sqrt{3}}$. What is acceleration of block

(a) zero (b) 2 m/sec^2 (c) 1.5 m/sec^2 (d) 5 m/sec^2

Sol: Ans [a]

$mg \sin 30° = \mu mg \cos 30°$

$\Rightarrow \quad a = 0$

15. If error in radius is 3%, what is error in volume of sphere

(a) 3% (b) 27% (c) 9% (d) 6%

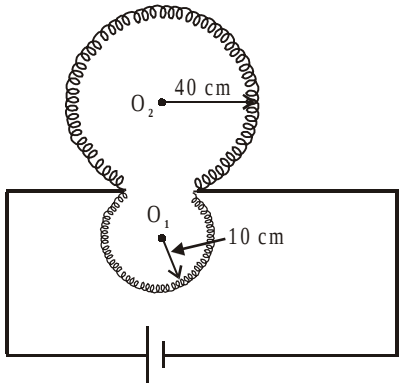
Sol: Ans [c]

$$V = \frac{4}{3}\pi R^3$$

$$\frac{\partial V}{V} = 3\frac{\partial R}{R}$$

$$\frac{\partial V}{V}\% = 3 \times 3\% = 9\%$$

16. Two loops are connected in a circuit shown in the figure. What is ratio of magnetic field at their centers



(a) 1 : 1

(b) 1 : 4

(c) 4 : 1

(d) 1 : 5

Sol: Ans [a]

17. What is de-Broglie wavelength electron having energy 10 KeV

(a) 0.12 Å (b) 1.2 Å (c) 12.2 Å (d) none of these

Sol: Ans [c]

$$\lambda = \frac{h}{\sqrt{2m K_e}}$$

$$= \frac{6.6 \times 10^{-34}}{\sqrt{2 \times 9.1 \times 10^{-31} \times 10 \times 10^3 \times 1.6 \times 10^{-19}}}$$

$= 1.22 \times 10^{-11} = 12.2$ Å

18. Motion of two particles is given by

$y_1 = 0.25 \sin (310\, t)$

$y_2 = 0.25 \sin (316\, t)$.

Find beat frequency

(a) 3 (b) $\frac{3}{\pi}$ (c) $\frac{6}{\pi}$ (d) 6

Sol: Ans [b]

Beat frequency

$$f_b = \frac{316 - 310}{2\pi} = \frac{3}{\pi}$$

19. A coin is of mass 4.8 kg and radius one meter rolling on a horizontal surface without sliding with angular velocity 600 rotations/min. What is total kinetic energy of the coin

(a) 360 J (b) 1440 π^2 J (c) 4000 π^2 (d) 600 π^2 J

Sol: Ans [b]

$$\omega = \frac{600 \times 2\pi}{60} = 20\pi$$

$$K = \frac{1}{2} \times 4.8\left(\frac{20\pi}{1}\right)^2 + \frac{1}{2} \times \frac{1}{2} \times 4.8 \times (1)^2 \times (20\pi)^2$$

$$= 1440\ \pi^2 \text{ J}$$

20. Half life of radioactive substance is 3.20 hrs. What is the time taken for a 75 % of substance to be used

(a) 6.38 hr (b) 12 hr (c) 4.18 day (d) 1.2 day

Sol: Ans [a]

It will take two half life

$\therefore$ time = $3.2 \times 2 = 6.4$ hr

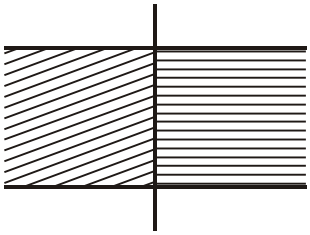
21. What is order of energy of X-rays (E_X) short waves (E_S) and red waves (E_R)

(a) $E_X < E_R < E_S$ (b) $E_X > E_R > E_S$ (c) $E_S > E_R > E_X$ (d) $E_S < I_R < E_X$

Sol: Ans [b]

$$\lambda_X < \lambda_R < \lambda_S$$

22. A capacitor of capacitance 1 μF is filled with two dielectrics of dielectric constant 4 and 6. What is new capacitance



(a) 10 μF (b) 5 μF

(c) 4 μF (d) 7 μF

Sol: Ans [b]

$$1\ \mu F = \frac{\varepsilon_0 A}{d}$$

When dielectric is inserted

$$C' = \frac{4 \times \varepsilon_0 (A/2)}{d} + \frac{6 \times \varepsilon_0 (A/2)}{d} = 5\mu F$$

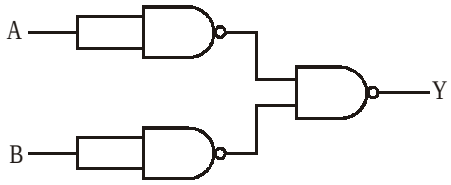
23. The given combination represents the following gate

(a) OR

(b) XOR

(c) NAND

(d) NOR



Sol: Ans [a]

$$Y = \overline{\overline{A \cdot A} \cdot \overline{B \cdot B}} = \overline{\overline{A} \cdot \overline{B}} = \overline{\overline{A}} + \overline{\overline{B}} = A + B$$

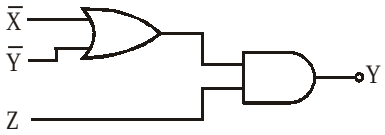
24. Output Y is given by

(a) $(X + Y)Z$

(b) $(\overline{X} + Y)Z$

(c) $\overline{X} \cdot \overline{Y} + Z$

(d) $Z(\overline{X} + \overline{Y})$



Sol: Ans [d]

$$Y = (\overline{X} + \overline{Y}) \cdot Z$$

25. In BJT, maximum current flows in which of the following

(a) emitter region (b) base region

(c) collector region (d) equal in all the regions

Sol: Ans [a]

$i_e = i_b + i_c$

26. In PN junction both sides are doubly dopped, what will be effect on depletion layer

(a) no effect (b) becomes four times less

(c) becomes double (d) none of these

Sol: Ans [b] Factual

27. If coil is open then L and R becomes

(a) $\infty, 0$ (b) $0, \infty$ (c) ∞, ∞ (d) $0, 0$

Sol: Ans [b]

When coil is open, there is no current in it, hence no flux associated with it

$\because \quad L = \frac{\phi}{i} = 0$

$\because \quad i = 0 \quad \Rightarrow \quad R = \infty$

28. In a coil when current changes from 10 A to 2 A in time 0.1 sec, induced emf is 3.28 V. What is self inductance of coil

(a) 4 H (b) 0.4 H (c) 0.04 H (d) 5 H

Sol: Ans [c]

$$3.28 = L \times \left(\frac{10-2}{0.1}\right)$$

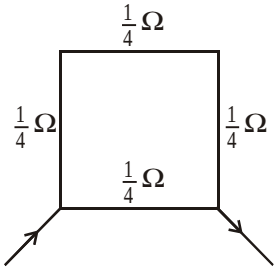
$\Rightarrow$ L = 0.04 H

29. Resistance of rod is 1Ω. It is bent in form of square. What is resistance across adjoint corner

(a) 1Ω (b) 3Ω (c) $\frac{3}{16}\Omega$ (d) $\frac{3}{4}\Omega$

Sol: Ans [c]

$$R_{eq} = \frac{\left(\frac{1}{4}+\frac{1}{4}+\frac{1}{4}\right)\times\frac{1}{4}}{\frac{1}{4}+\frac{1}{4}+\frac{1}{4}+\frac{1}{4}} = \frac{3}{16}\Omega$$



30. Fleming's left and right hand rule are used in

(a) D.C. motor & A.C. generator (b) D.C. generator & A.C. motor

(c) D.C. motor & D.C. generator (d) both rules are same, any one can be used

Sol: Ans [c] Factual

31. How does current flow in armature of D.C. generator

(a) pulsated curve (b) sine curve (c) constant (d) none of these

Sol: Ans [a] Factual

32. In frequency modulated wave

(a) frequency varies with time (b) amplitude varies with time

(c) both frequency & amplitude varies with time (d) both frequency & amplitude are constant

Sol: Ans [a] Factual

33. What is angle between electric field and equipotential surface

(a) 90° always (b) 0° always (c) 0° to 90° (d) 0° to 180°

Sol: Ans [a]

Potential gradient along equipotential surface is zero

i.e. $\frac{dV}{dr} = 0 = -E\cos\theta$

$\Rightarrow$ $\theta = 90°$

34. Dimension of impulse is same as

(a) force (b) momentum (c) energy (d) acceleration

Sol: Ans [b]

Impulse = change in momentum

35. A ball falls from 20 m height on floor and rebounds to 5 m. Time of contact 0.02 sec. Find acceleration during impact

(a) 1200 m/sec^2 (b) 1000 m/sec^2 (c) 2000 m/sec^2 (d) 1500 m/sec^2

Sol: Ans [b]

$$a = \frac{\text{change in momentum during impact}}{m \times \text{time of collision}}$$

$$= \frac{m \times \left[\sqrt{2 \times 10 \times 20} + \sqrt{2 \times 10 \times 5}\right]}{m \times 0.02}$$

$$= 1500 \text{ m/sec}^2$$

36. A satellite moves in elliptical orbit about a planet. Its maximum and minimum velocities of satellites are 3×10^4 m/sec and 1×10^3 m/sec respectively. What is the maximum distance of satellite from planet if minimum distance is 4×10^4 km

(a) 4×10^3 km (b) 3×10^3 km (c) $4/3 \times 10^3$ km (d) 1×10^3 km

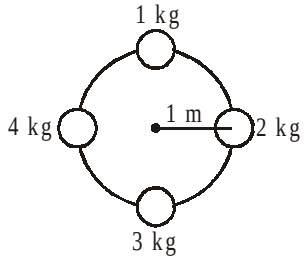
Sol: Ans [c]

Applying conservation of angular momentum

$$m \times 3 \times 10^4 \times r = m \times 1 \times 10^3 \times 4 \times 10^4$$

$$\Rightarrow \quad r = \frac{4}{3} \times 10^3 \text{ km}$$

37. Four balls each of radius 10 cm and mass 1 kg, 2 kg, 3 kg and 4 kgs are attached to the periphery of mass less plate of radius 1 m. What is moment of inertia of the system about the centre of plate



(a) 12.04 kg m^2

(b) 10.04 kg m^2

(c) 11.50 kg m^2

(d) 5.04 kg m^2

Sol: Ans [b]

$$I = \left[\frac{2}{5} \times 1 \times (0.1)^2 + 1 \times (1)^2\right] + \left[\frac{2}{5} \times 2 \times (0.1)^2 + 2(1)^2\right]$$

$$+ \left[\frac{2}{5} \times 3 \times (0.1)^2 + 3 \times (1)^2\right] + \left[\frac{2}{5} \times 4 \times (0.1)^2 + 4(1)^2\right]$$

$$= 10.04 \text{ kg m}^2$$

38. Eight identically charged drops are joined to form bigger drop. By what factor the charge and potential changes

(a) 8, 4 (b) 8, 8 (c) 6, 8 (d) 8, 10

Sol: Ans [a]

Let charge on each drop is q and it potential is V

$\Rightarrow \quad q' = 8q$

$$8 \times \frac{4}{3}\pi r^3 = \frac{4}{3}\pi r'^3$$

$\Rightarrow \quad r' = 2r$

$$V' = \frac{K \times 8q}{2r} = 4V$$

39. Two drops of equal radius coalesce to form a bigger drop. What is ratio of surface energy of bigger drop to smaller one

(a) $2^{1/2} : 1$ (b) 1 : 1 (c) $2^{2/3} : 1$ (d) none of these

Sol: Ans [c]

$$E_{small} = (4\pi R^2 T)$$

$$E_{bigger} = 4\pi [2^{1/3}]^2 T$$

40. We can obtain polarized light with the help of which of the following instrument

(a) Nicole prism (b) Biprism (c) Polymeter (d) none of these

Sol: Ans [a] Factual

41. A Carnot engine has efficiency 1/5. Efficiency becomes 1/3 when temperature of sink is decreased by 50 K. What is the temperature of sink

(a) 325 K (b) 375 K (c) 300 K (d) 350 K

Sol: Ans [c]

Let temperature of sink is T_1 and of source is T_2

$$\frac{1}{5} = 1 - \frac{T_1}{T_2}$$

also $$\frac{1}{3} = 1 - \frac{T_1 - 50}{T_2}$$

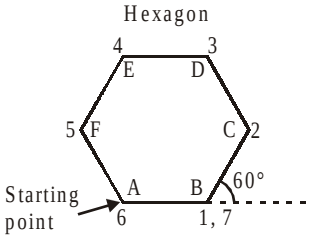
Solving

$$T_1 = 300 \text{ K}$$

42. A cyclist moves in such a way that he takes 60° turn after 100 mts. What is the displacement when he takes seventh turn

(a) 100 m (b) 200 m

(c) $100\sqrt{3}$ m (d) $100/\sqrt{3}$ m



Sol: Ans [a]

At the time of sevent turn he is at point B

$\Rightarrow$ displacement = 100 m

43. What is time period of pendulum hanged in satellite? (T is time period on Earth)

(a) Zero (b) T (c) Infinite (d) $T/\sqrt{6}$

Sol: Ans [c]

In Satellite $g_{eff} = 0$

$\Rightarrow T = 2\pi\sqrt{\frac{l}{0}} = \infty$

44. If boiling point of water to 95°F. What will be reduction at Celsius scale

(a) 7°C (b) 65°C (c) 63°C (d) 35°C

Sol: Ans [d]

$$\frac{95-32}{9} = \frac{C}{5}$$

C = 35°C

45. A spring of spring constant K is cut into two equal parts. A block of mass *m* is attached with one part of spring. What is the frequency of the system if α is frequency of block with original spring

(a) $\sqrt{2}\alpha$ (b) $\frac{\alpha}{2}$ (c) 2α (d) α

Sol: Ans [a]

Spring constant of one part $K' = 2K$

$$\alpha = \frac{1}{2\pi}\sqrt{\frac{K}{m}}$$

$$\alpha' = \frac{1}{2\pi}\sqrt{\frac{2K}{m}}$$

$\Rightarrow \alpha' = \sqrt{2}\alpha$

46. Why is there sudden increase in current in zener diode

(a) due rupture of bonds (b) resistance of depletion layer becomes less

(c) due to high doping (d) none of these

Sol: Ans [a] Factual

47. Coefficient of coupling between two coils of self inductances L_1 and L_2 is unity. If means

(a) 50% flux of L_1 is linked with L_2 (b) 100% flux of L_1 is linked with L_2

(c) $\sqrt{L_1}$ time of flux of L_1 is linked with L_2 (d) none of these

Sol: Ans [b]

Coupling co-efficient (K) determines fraction of flux of one coil associated with other coil

for K = 1, coupling is perfect.

48. One curie is equal to

(a) 3.7×10^6 disintegration per second (b) 3.7×10^{10} disintegration per second

(c) 3.7×10^7 disintegration per second (d) one disintegration per second

Sol: Ans [b] Factual

49. A gas has bulk modulus K and natural density ρ. If pressure P is applied, what is change in density

(a) $\frac{K}{P\rho}$ (b) $\frac{PK}{\rho}$ (c) $\frac{P\rho}{K}$ (d) $\frac{K\rho}{P}$

Sol: Ans [c]

$$\frac{\Delta V}{V} = \frac{P}{K}$$

also $\left|\frac{\Delta V}{V}\right| = \frac{\Delta\rho}{\rho}$ (Since $V \cdot \rho$ = constant)

or $\frac{\Delta\rho}{\rho} = \frac{P}{K}$

$\Rightarrow \Delta\rho = \frac{P\rho}{K}$