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JEE
(Main)
PAPER-1 (B.E./B. TECH.)

2022

COMPUTER BASED TEST (CBT)
Memory Based Questions & Solutions

Date: 27 July, 2022 (SHIFT-2) | TIME : (3.00 a.m. to 6.00 p.m)
Duration: 3 Hours | Max. Marks: 300

SUBJECT: PHYSICS

PART : PHYSICS

1. If velocity of a bullet becomes 1/3rd of its initial velocity on penetrating 4 cm in a wooden block. How much will it penetrate more before coming to rest? (Assume retardation is constant)

(1) 1/2 cm   (2) 2 cm   (3) 3 cm   (4) 4 cm

Ans.   **(1)**

Sol.   Let initial velocity of body at point A is v, AB is 4 cm.
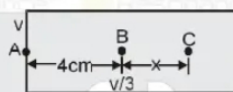
From $v^2 = u^2 - 2as$

$(v/3)^2 = v^2 - 2a \times 4$

$a = v^2/9$

Let on penetrating 4 cm in a wooden block, the body moves x distance form B to C.

So, for B to C

$u = v/3$, $v = 0$,

$x = x$, $a = v^2/9$ (deceleration)

$\therefore \quad (0)^2 = \left(\dfrac{v}{3}\right)^2 - 2.\dfrac{v^2}{9}.x \Rightarrow x = \dfrac{1}{2}$

2. On increasing temperature, drift velocity of electrons in a conductor :

(1) Increases
(2) decrease

(3) remains same
(4) First increases then decreases

Ans. **(2)**

Sol. $V_d = \dfrac{eE}{m}\tau$

on increasing temperature τ decreases

hence V_d also decreases

3. A projectile is fired from the surface of earth of radius R with a speed λv_e in radially outward direction (where v_e is the escape velocity and $\lambda < 1$). Neglecting air resistance, the maximum height from centre of earth is

(1) $\dfrac{R}{\lambda^2 + 1}$
(2) $\lambda^2 R$
(3) $\dfrac{R}{1-\lambda^2}$
(4) λR

Ans. **(3)**

Sol. $V_e = \sqrt{\dfrac{2GM}{R}}$

$V = \lambda V_e = \lambda\sqrt{\dfrac{2GM}{R}}$

Initial total energy $= \dfrac{1}{2}mv^2 - \dfrac{GMm}{R}$

$= \dfrac{1}{2}m.\lambda^2\dfrac{2GM}{R} - \dfrac{GMm}{R}$
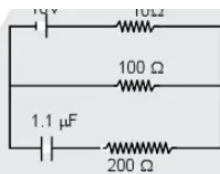
Final total energy $= \dfrac{1}{2}m0^2 - \dfrac{GMm}{x}$

Applying energy conservation

$\dfrac{1}{2}m\lambda^2.\dfrac{2GM}{R} - \dfrac{GMm}{R} = 0 - \dfrac{GMm}{x}$

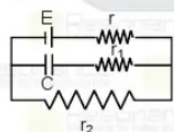$\dfrac{1}{x} = \dfrac{1}{R} - \dfrac{\lambda^2}{R}$ $x = \dfrac{R}{1-\lambda^2}$

4. In the given circuit diagram when the current reaches at steady state in the circuit, the charge on the capacitor of capacitance C = 1.1μF will be :

10V   10Ω
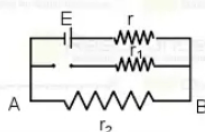
(1) 20 μC (2) 10 μC (3) 30 μC (4) 40 μC

Ans. (2)

Sol.

at steady state

current in the circuit $I = \dfrac{E}{r + r_2}$

Potential difference across AB= $Ir_2 = \dfrac{Er_2}{r + r_2}$

Charge on capacitor = $Q = C(\Delta V)_{AB}$

$Q = \dfrac{CEr_2}{r + r_2} = 10\mu C$

5. A high frequency carrier wave C(t) = 5sin(8πt) is modulated by massage signal m(t) shown in figure. Find modulation index of modulated signal :
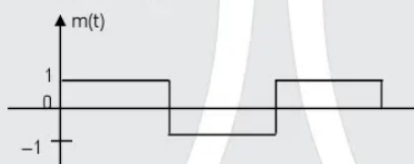
(1) 0.5 (2) 5 (3) 0.2 (4) 1

Ans. (3)

Sol. $A_c = 5$

$A_n = 1$

$\mu = \dfrac{A_m}{A_C} = \dfrac{1}{5} = 0.2$

6. A soap bubble of radius 3 cm enclosed by another soap bubble of radius 6 cm. Pressure inside the enclosed bubble is equivalent to the pressure inside another bubble of radius equivalent to :

(1) 2 cm (2) 4 cm (3) 6 cm (4) 8 cm

Ans. (1)

Sol. $\Delta P = P_1 + P_2$

$\dfrac{4T}{R} = \dfrac{4T}{r_1} + \dfrac{4T}{r_2}$

$1/R = 1/r_1 + 1/r_2$

$= 1/3 + 1/6$

$$= \frac{2+1}{6} = 1/2$$

$$R = 2$$

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7. A block is sliding down on a rough inclined plane with constant velocity. The force exerted by the surface on the block is :

(1) mg

(2) $mg\cos\theta$

(3) $\sqrt{mg\cos2\theta + mg\sin\theta}$

(4) $mg\sqrt{1+\mu^2}$

Ans. (1)

Sol. Block is moving with constant velocity so acceleration of the block is zero.
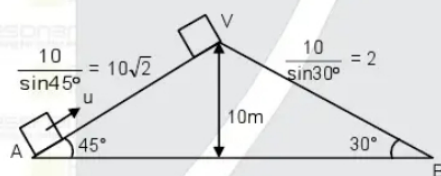
So, net force on the block is zero

$$F_{plane} + mg = 0$$

$$F_{plane} = -mg$$

8. A block is projected with speed u on a given inclined plane as shown. It just reaches to the top of inclined plane. The time taken by the block to reach from A to B is $t(\sqrt{2}+1)$ sec. Find the value of t

(1) 2   (2) 4   (3) 6   (4) 8

Ans. (1)

Sol.

$$\frac{10}{\sin45°} = 10\sqrt{2}$$

$$\frac{10}{\sin30°} = 2$$

In upward motion

$$\frac{1}{2} g\sin45°t^2 = 10\sqrt{2}$$

$$\frac{1}{2}\frac{10}{\sqrt{2}}t^2 = 10\sqrt{2}$$

$$t^2 = 4$$

$$t = 2$$

In downward motion

$$\frac{1}{2} g\sin30°t^2 = \frac{10}{1/2} = 20$$

$$\frac{1}{2} \times \frac{10}{2} t^2 = 20$$

$$t = 2\sqrt{2}$$

total time = $2(1 + \sqrt{2})$

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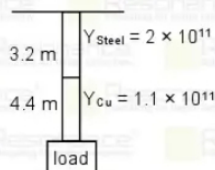Toll Free : 1800 258 5555 7340010333 facebook.com/ResonanceEdu twitter.com/ResonanceEdu www.youtube.com/resowatch blog.resonance.ac.in

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9. For the given two rods, radius of cross-section of each one is 1.4 mm, if net elongation is 1.4 mm, then find load :

$Y_{Steel} = 2 \times 10^{11}$
3.2 m
4.4 m $Y_{Cu} = 1.1 \times 10^{11}$
load

(1) 253 N (2) 553 N (3) 353 N (4) 153 N

Ans. (4)

Sol. $y\dfrac{\Delta \ell}{\ell} = \dfrac{F}{A}$

$\Delta \ell = \dfrac{F\ell}{Ay}$

$\Delta \ell_1 + \Delta \ell_2 = \Delta \ell$

$F\left[\dfrac{\ell_1}{A_1 y_1} + \dfrac{\ell_2}{A_2 y_2}\right] = \Delta \ell$

$F = \dfrac{\Delta \ell}{\left[\dfrac{\ell_1}{Ay_1} + \dfrac{\ell_2}{Ay_1}\right]} = \dfrac{1.4 \times 10^{-3}}{\dfrac{1}{\pi \times (1.4 \times 10^{-3})^2}\left[\dfrac{3.2}{2 \times 10^{11}} + \dfrac{4.4}{1.1 \times 10^{11}}\right]}$

$= \dfrac{\pi (1.4)^3 \times 10^{-9} \times 10^{11}}{(1.6 + 4)} = 1.53 \times 10^2 = 153$ N

10. Two wave of intensity I_1 & I_2 such that $\dfrac{I_1}{I_2} = \dfrac{1}{4}$ produce interference. If relation between I_{max} and I_{min} is given by $\dfrac{I_{max} + I_{min}}{I_{min} - I_{min}} = \dfrac{2\alpha + 1}{\beta + 3}$, then value $\dfrac{\alpha}{\beta}$ is :

(1) 2 (2) 4 (3) 3 (4) 1

Ans. (1)

Sol. $I_{max} = (\sqrt{I_1} + \sqrt{I_2})^2 = (1 + 2)^2 = 9$

$I_{min} = (\sqrt{I_1} - \sqrt{I_2})^2 = (1 - 2)^2 = 1$

$\dfrac{10}{8} = \dfrac{2\alpha + 1}{\beta + 3}$

$5\beta + 15 = 8\alpha + 4$

$\dfrac{2(2) + 1}{1 + 3} = \dfrac{2\alpha + 1}{\beta + 3}$

$\alpha = 2$

$\beta = 1$

$\dfrac{\alpha}{\beta} = 2$.

11. The energy density of EMW is given by $u = \dfrac{\alpha}{\beta} \sin\left(\dfrac{\alpha x}{kT}\right)$, where k = Boltzman constant, T = temperature, x = displacement, then dimensional formula of β is :

(1) $[M^{-1} L^0 T^{-1}]$ (2) $[M^0 L^2 T^0]$ (3) $[M^0 L^2 T^{-1}]$ (4) $[M^{-2} L^{-1} T^{-1}]$

Ans. (2)

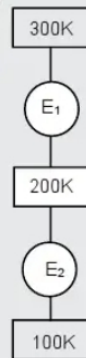Sol. dimensionally $\alpha x = kT$

$\alpha = kT/x$

$= PV/x$

$= F$

$E/V = F/\beta$

$\beta = \dfrac{FV}{E} = \dfrac{FV}{FL} = \dfrac{L^3}{L} = L^2$

12. Two heat engine are operating between 100 k to 300 k as shown. If efficiencies of these, are η_1 and η_2. Then correct relation between them is :

(1) $\eta_1 > \eta_2$ (2) $\eta_1 < \eta_2$ (3) $\eta_1 = \eta_2$ (4) $\eta = \dfrac{1}{2}\eta_2$

Ans. **(1)**

Sol. $\eta_1 = 1 - \dfrac{200}{300} = \dfrac{1}{3} = 0.33$

$\eta_2 = 1 - \dfrac{100}{200} = \dfrac{1}{2} = 0.5$

$\eta_2 > \eta_1.$

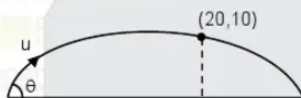**13.** A particle is projected with speed u at angle 45° with horizontal. Time of flight is T and particle passes through point (20,10), then momentum of particle in vector at time $t = \dfrac{T}{\sqrt{2}}$ (mass of particle = 10 kg)

(1) $100\sqrt{2}\,\hat{i} + 10\sqrt{2}(\sqrt{2} - 1)\hat{j}$ (2) $100\sqrt{2}\,\hat{i} - 10\sqrt{2}(\sqrt{2} - 1)\hat{j}$

(3) $100\sqrt{2}\,\hat{i} + 10\sqrt{2}(\sqrt{2} + 1)\hat{j}$ (4) $100\sqrt{2}\,\hat{i} - 10\sqrt{2}(\sqrt{2} + 1)\hat{j}$

Ans. **(2)**

Sol.

$y = x\tan\theta - \dfrac{1}{2}\dfrac{gx^2}{u^2\cos^2\theta}$

$\Rightarrow \quad 10 = 20\tan 45° - \dfrac{1 \times 10 \times 20^2}{2u^2(\cos 45°)^2}$

$\Rightarrow \quad u = 20$

Time of flight $T = \dfrac{2u\sin\theta}{g} = \dfrac{2 \times 20 \times \sin 45°}{10} = 2\sqrt{2}$

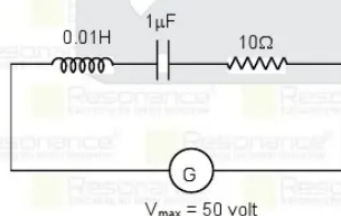Momentum at $t = \dfrac{T}{\sqrt{2}} = 2\sec$ is

$$P = m[u\cos\theta\hat{i} + (u\sin\theta - gt)\hat{j}]$$
$$= 10[20\cos45°\hat{i} + (20\sin45° - 10 \times 2)\hat{j}]$$
$$= 100\sqrt{2}\,\hat{i} - 10\sqrt{2}(\sqrt{2} - 1)\hat{j}.$$

14.

V_{max} = 50 volt

If angular frequency of source is 60% less than the resonant frequency, then find peak value of current in AC circuit.

(1) 100 mA   (2) 238 mA   (3) 438 mA   (4) 800 mA

Ans. (2)

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Sol. $\omega_r = \dfrac{1}{\sqrt{LC}} = \dfrac{1}{\sqrt{0.01 \times 10^{-6}}} = 10^4$

$\omega = 0.4 \times 10^4 = 4000$

$X_L = L\omega = 0.01 \times 4000 = 40$

$X_c = \dfrac{1}{C\omega} = \dfrac{1}{10^{-6} \times 4000} = \dfrac{1000}{4} = 250$

$t = \sqrt{(X_L - X_c)^2 + R^2} = \sqrt{(250 - 40)^2 + 10^2}$

$I_{max} = \dfrac{V_{max}}{Z} = \dfrac{50}{210}$ A

$= \dfrac{50}{210} \times 1000$ mA $= \dfrac{5000}{21} = 238$ mA

15. 4 Coulomb charge split into two part x and 4–x and placed at some distance d. What will be the value of x. So that force between them is maximum

(1) 1   (2) 2   (3) 3   (4) 4

Ans. (2)

16. A proton moves is a circle of radius 60 cm is uniform field B = 1T in a plane perpendicular to magnetic field. Given $m_p = 1.6 \times 10^{-27}$ kg. Find its energy in MeV.

(1) 18 MeV   (2) 16 MeV   (3) 14 MeV   (4) 10 MeV
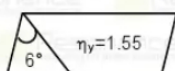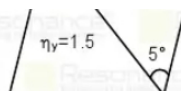
Ans. (1)

Sol. $r = \dfrac{mv}{Bq} = \dfrac{\sqrt{2mk}}{Bq}$

$\Rightarrow K = \dfrac{B^2 q^2 r^2}{2m}$

$= \dfrac{(1.6 \times 10^{-19})^2 \times 1^2 \times \left(\dfrac{60}{100}\right)^2}{2 \times 1.6 \times 10^{-27}} J = \dfrac{(1.6 \times 10^{-19})^2 \times 1^2 \times \left(\dfrac{60}{100}\right)^2}{2 \times 1.6 \times 10^{-27} \times 1.6 \times 10^{-19}} eV = 18$ MeV.

17. If net deviation of ray from the given system of prism is $\dfrac{1}{x°}$ then find value of x.

$\eta_y = 1.55$

6°

$\eta_y = 1.5$

$5°$

(1) 3   (2) 5   (3) 4   (4) 2

Ans. **(3)**

Sol. $\delta_{net} = \delta_1 - \delta_2$

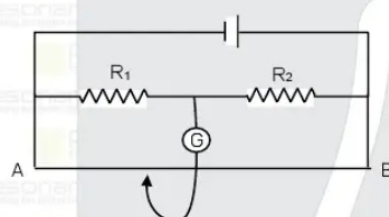$\delta_{net} = (1.5 - 1)6° - (1.55 - 1)5°$

$= 3° - (0.55)5°$

$= 3° - 2.75°$

$= 0.25°$

$\dfrac{1}{x} = \dfrac{1}{0.25} = 4$

Ans. **4**

18.

As shown in meter bridge AC is the balancing length = 40 cm. If the radius of AB wire is doubled then the new balancing length is :

(1) 10 cm   (2) 20 cm   (3) 30 cm   (4) 40 cm

Sol. By volume conservation

$A\ell$ = constant

$\dfrac{\ell_2}{\ell_1} = \left(\dfrac{A_1}{A_2}\right)$

$\dfrac{\ell_2}{\ell_1} = \dfrac{A}{A/4}$

$\ell_2 = \dfrac{\ell_1}{4} = 25$ cm

Let new length is x

then $\dfrac{R_1}{R_2} = \dfrac{x}{25 - x}$

$\dfrac{4}{6} = \dfrac{x}{25 - x}$

$3x = 50 - 2x$

$5x = 50$

$x = 10$ cm

19. Activity of a radio active sample is 64×10^{-4} dps and half life is 5 days. After how many days its activity becomes 5×10^{-5} dps.

    (1) 30 days   (2) 25 days   (3) 35 days   (4) 40 days

Ans. (3)

Sol. $A = \dfrac{A_0}{2^n}$

$2^n = \dfrac{A_0}{A} = \dfrac{64 \times 10^{-4}}{5 \times 10^{-5}} = 128 = 2^7$

$n = 7$

7 half lifes

$7 \times 5 = 35$ days

20. Choose correct option for EMW

    (A) Electric & magnetic field are perpendicular to propagation of wave

    (B) Electric & magnetic field are parallel to propagation of wave

    (C) Energy is equally divided in electric and magnetic field

    (D) Energy divided in electric and magnitude field is different

    (1) A & B   (2) A & C   (3) B & C   (4) C & D

Ans. (2)

21. (A) Drift velocity is independent of potential difference.

    (B) Drift velocity decreases as temperature increase

    (C) Drift velocity is inversely proportional to area assuming current constant

    (D) Drift velocity in proportional to current.

    Which of the following option is correct for conductors

    (1) A and C   (2) B and C   (3) A and B   (4) C and D

Ans. (2)

22. In common-emitter configuration of transistor, base current is increased from 20 to 25 μA and collector correct is increased from 450 mA to 452 mA, then current gain (β) is :

    (1) 200   (2) 400   (3) 300   (4) 100

Ans. (2)

Sol. $\beta = \dfrac{\Delta I_c}{\Delta I_B} = \dfrac{2mA}{5\mu A} = 400$ **Ans.**

23. If voltage across the capacitor with dielectric (K = 5) is 20 V. Find energy stored in it (given $\varepsilon_0 = 9 \times 10^{-12}$ C²/N-m²)
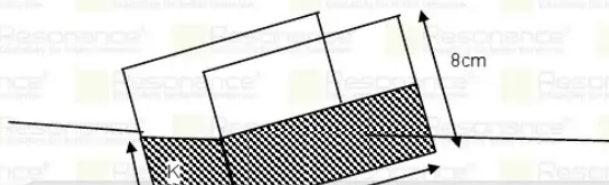
(1) 4.32×10^{-8} J   (2) 4.32×10^{-7} J   (3) 4.32×10^{-6} J   (4) 4.32×10^{-4} J

Ans. (1)

Sol. $U = C_{eq}V^2 = \dfrac{1}{2}\left(\dfrac{K\varepsilon_0 A_1}{d} + \dfrac{\varepsilon_0 A_2}{d}\right)V^2$

$= \dfrac{1}{2}\dfrac{\varepsilon_0}{d}(KA_1 + A_2)V^2$

$= \dfrac{1}{2}\dfrac{9 \times 10^{-12}}{2 \times 10^{-3}}\left(5 \times \dfrac{1 \times 4}{100 \times 100} + \dfrac{7 \times 4}{100 \times 100}\right)(20)^2$

$= \dfrac{1}{2} \times \dfrac{9 \times 10^{-12}}{2 \times 10^{-3}}\dfrac{48}{100 \times 100} \times 20 \times 20 = \dfrac{432 \times 10^{-12}}{100} \times 10^3 = 4.32 \times 10^{-9}$

24. In photon electric effect

(A) Square of maximum velocity of ejected photo electron is inversely proportional to frequency of incident light

(B) Square of maximum velocity of ejected photo electron is linearly dependent on frequency of incident light

(C) Saturation current increase when distance between LED and photoelectric plate increased

(D) If power of LED is increased number of emitted photoelectron increase

(E) Instantaneous emission of photoelectron can be explained by wave theory

Which of the following option is correct :

(1) A & B   (2) B & E   (3) B & D   (4) A & D

Ans. (3)

Sol.

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