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JEE (Main)

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

2022

COMPUTER BASED TEST (CBT)

Memory Based Questions & Solutions

Date: 28 June, 2022 (SHIFT-2) | TIME : (3.00 p.m. to 6.00 p.m)

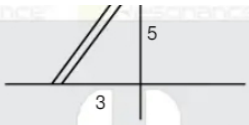
Duration: 3 Hours | Max. Marks: 300

SUBJECT: PHYSICS

Resonance Eduventures Ltd.
Reg. Office & Corp. Office : CG Tower, A-46 & 52, IPIA, Near City Mall, Jhalawar Road, Kota (Raj.) - 324005
Ph. No.: +91-744-2777777, 2777700 | FAX No. : +91-022-39167222
To Know more : sms RESO at 56677 | Website : www.resonance.ac.in | E-mail : contact@resonance.ac.in | CIN : U80302RJ2007PLC024029
Toll Free : 1800 258 5555 7340010333 facebook.com/ResonanceEdu twitter.com/ResonanceEdu www.youtube.com/resowatch blog.resonance.ac.in

PART : PHYSICS

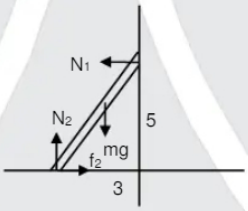
1. A rod is in rest against a smooth vertical wall and a rough horizontal surface. Find the ratio of total reaction by wall & surface :



(1) $\frac{3}{\sqrt{109}}$ (2) $\frac{\sqrt{109}}{3}$ (3) $\frac{\sqrt{109}}{2}$ (4) $\frac{2}{\sqrt{109}}$

Ans. **(1)**

Sol.



$N_1 = f_2$, $N_2 = mg$

$N_1 \times 5 = mg \times \frac{3}{2} \Rightarrow N_1 = \frac{3}{10} mg$

$R_1 = N_1 = \frac{3}{10} mg$, $R_2 = \sqrt{N_2^2 + f_2^2} = \frac{\sqrt{109}}{10} mg$

$\frac{R_1}{R_2} = \frac{3}{\sqrt{109}}$

2. The resistance of a wire is 2Ω at 10ºC and 3 Ω at 30º find the temperature coefficient of resistivity.

(1) 0.022 (2) 0.025 (3) 0.033 (4) 0.05

Ans. **(3)**

Sol. $R = R_0 (1 + \alpha \Delta T)$

$2 = R_0(1 + 10\alpha)$

$3 = R_0(1 + 30\alpha)$

$1 = 30\alpha$

3. An electromagnetic wave moving along x-axis with speed C. Frequency of wave 10^6 Hz and amplitude of electric field $E_0 = 60$ N/C $\hat{j}$. Which of the following option is correct :

(1) $-\frac{60}{C}\hat{k}\sin\left(2\times10^6\pi\left(t-\frac{x}{C}\right)\right)$ (2) $\frac{60}{C}\hat{k}\sin\left(2\times10^6\pi\left(t-\frac{x}{C}\right)\right)$

(3) $-60C\hat{k}\sin\left(2\times10^6\pi\left(t-\frac{x}{C}\right)\right)$ (4) $60C\hat{k}\sin\left(2\times10^6\pi\left(t-\frac{x}{C}\right)\right)$

Ans. **(2)**

Sol. $|B_0| = E_0/C$

$\hat{E} = -(\hat{V}\times\hat{B})$

$\hat{E} = -\hat{V}\times\hat{B}$

4. Angular acceleration of a body is given by $\alpha = 6t^2 + 2t$

If $\omega(t = 0) = 10$ rad/s, $\theta(t = 0) = 4$ rad

Find $\theta(t)$ =

(1) $4+10t+\frac{t^4}{2}+\frac{t^3}{3}$ (2) $14+10t+\frac{t^4}{2}+\frac{t^3}{3}$ (3) $16+10t+\frac{t^4}{2}+\frac{t^3}{3}$ (4) $4-10t-\frac{t^4}{2}+\frac{t^3}{3}$

Ans. (1)

$\frac{d\omega}{}$

Sol. $\frac{d\omega}{dt} = 6t^2 + 2t$

$$\int_{10}^{w} d\omega = \int_{0}^{t} (6t^2 + 2t)dt$$

$$\omega - 10 = 2t^3 + t^2$$

$$\omega = 10 + 2t^3 + t^2$$

$$\frac{d\theta}{dt} = 10 + 2t^3 + t^2$$

$$\int_{4}^{\theta} d\theta = \int_{0}^{t} (10 + 2t^3 + t^2)dt$$

$$\theta = 4 + 10t + \frac{t^4}{2} + \frac{t^3}{3}$$

5. A particle travels first one third of distance with speed 11 m/s, next one third with 22 m/s and last one third with speed 33 m/s. Find the average speed.

(1) 16 m/s (2) 18 m/s (3) 20 m/s (4) 22 m/s

Ans. **(2)**

Sol. $$V_{av} = \frac{x}{\frac{x}{3\times11} + \frac{x}{3\times22} + \frac{x}{3\times33}} = \frac{3}{\frac{1}{11} + \frac{1}{22} + \frac{1}{33}}$$

$$= \frac{3}{\frac{6+3+2}{66}} = \frac{3\times66}{11} = 18 \text{ m/s.}$$

6. Two identical bodies are at separation d and force between them is F. If m/3 is removed from one body and added to other body, find the new force.

(1) 6/9 F (2) 7/9 F (3) 8/9 F (4) 9/8 F

Ans. **(3)**

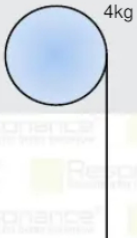
Sol. $F = \frac{Gmm}{d^2}$

$$F' = \frac{G\frac{2m}{3}\times\frac{4}{3}m}{d^2} = \frac{8}{9}\frac{Gmm}{d^2}$$

$$\frac{F'}{F} = \frac{8}{9}$$

$$F' = \frac{8}{9}F$$

7. Find the tension in the string if there is no slipping between disc and string, radius of disc is 10 cm :



(1) 8 N (2) 10 N (3) 12 N (4) 20 N

Ans. **(2)**

Sol. $T_r = \frac{4r^2}{2}\alpha$

$\alpha = \frac{T}{2r} = \frac{T}{2\times 0.1} = 5T$

$2g - T = 2a = 2 \times 0.1 \times \alpha$

$20 - T = 0.2 \times 5T = T$

$20 = 2T$

$T = 10$ N.

8. C_1 is charged to 30 V then connected to C_2. Find final charge on C_2.

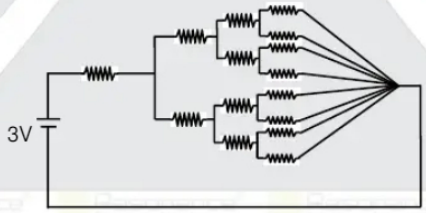
(1) 100 μC (2) 200 μC (3) 300 μC (4) 400 μC

Ans. **(1)**

Sol. $V = \frac{C_1V_1 + C_2V_2}{C_1 + C_2} = \frac{5\times 30 + 0}{5 + 10} = 10$

$Q_2 = C_2V = 10 \times 10 = 100$ μC

9. If current through the battery is A/5 then A is : (R = 1Ω)



(1) 8 (2) 10 (3) 12 (4) 14

Ans. **(1)**

Sol. $R_{eq} = \frac{15}{8}$

$i = \frac{3}{\frac{15}{8}} = \frac{8}{5}$ A

10. Water is falling from height 40 m at rate of 9×10^4 kg/hr. If 50% of potential energy is convert in electrical energy by turbine. Then how many bulb of 100 W can be light up.

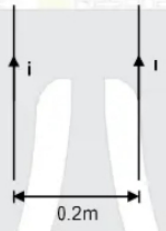
(1) 20 (2) 50 (3) 75 (4) 80

Ans. (2)

Sol. $\frac{40\times9\times10^4 kg}{3600sec} g \times \frac{50}{100} = 100N$

N = 50

11. If force per unit length between 2 parallel wires is $F/\ell = 2 \times 10^{-6}$ N/m. Find current i in each wire.



(1) $\sqrt{2}$ ampere (2) 2 ampere (3) $\sqrt{3}$ ampere (4) 3 ampere

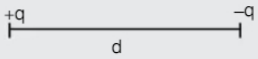
Ans. **(1)**

Sol. $\frac{F}{\ell} = \frac{\mu_0 ii}{2\pi d}$

$2\times10^{-6} = \frac{2\times10^{-7} i^2}{0.2}$

$i^2 = 2$; $i = \sqrt{2}$ m

12. Two charges q & –q are separated by a distance d. If electric field at the mid-point is $E = 6.4 \times 10^{-6}$ V/m and $q = 8 \times 10^{-6}$C find d :



(1) 3×10^{-5} (2) 2×10^5 (3) 3×10^3 (4) 3×10^5

Ans. **(4)**

Sol. $E = \frac{2Kq}{\frac{d^2}{4}} = \frac{8Kq}{d^2}$

$6.4 \times 10^{-6} = \frac{8\times9\times10^9\times8\times10^{-6}}{d^2}$

$d^2 = \frac{9\times64\times10^9}{6.4} = 9\times10^{10}$

$d = 3 \times 10^5$

13. Ratio of wavelengths of two photon is $\lambda_1/\lambda_2 = 3$ and energy of these photons are K_1 & K_2 respectively, then :

(1) $K_1 = 3\,K_2$ (2) $3K_1 = K_2$ (3) $K_1 = K_2$ (4) $K_1 = \sqrt{3}\,K_2$

Ans. **(2)**

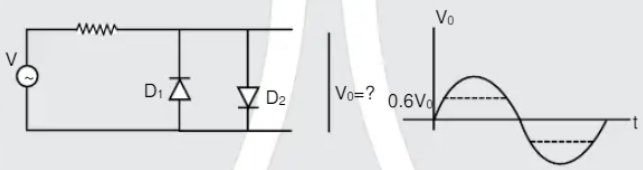
Sol. $K = \frac{hc}{\lambda}$

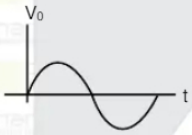
$K \propto \frac{1}{\lambda}$

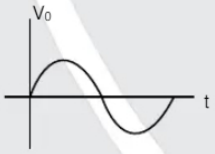
$\frac{K_2}{K_1} = \frac{\lambda_1}{\lambda_2} = 3$

$\frac{\lambda_1}{K_1} = \frac{\lambda_2}{\lambda_2} = 3$

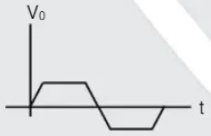
14. Given cut-off voltage = 0.6 V of diddle



(1)


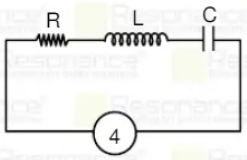
(2)


(3)


(4)


Ans. (4)

15. In L – C – R AC circuit $V_L = V_C = 2V_R$ and R = 5 Ω, if $L = \frac{1}{K\pi}$ then find K.



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

Ans. **(1)**

Sol. $V_S = \sqrt{V_R^2 + (V_L - V_C)^2}$

$V_L = V_C = 2V_R$

$\therefore$ $V_S = V_R = 220$ volt $= I_{rms} R$

$I_{rms} = \frac{220}{5} = 44A$

$V_L = I_{rms} X_L = 2V_R$

$44 X_L = 2 \times 220$

$X_L = \frac{440}{44} = 10\Omega$

$L\omega = 10$; $L = \frac{10}{100\pi} = \frac{1}{10\pi}$ $\therefore$ $K = 10$

16. Measured values of quantity x are 1.19 mm, 1.20 mm, 1.21 mm and 1.22 mm. Then find % error in x.
(1) 3.3 (2) 2.3 (3) 4.2 (4) 1.25

Ans. **(1)**

Sol. Average value of $x = \frac{1.19\text{ mm} + 1.20\text{ mm} + 1.21\text{ mm} + 1.22\text{ mm}}{4} = 1.205$

Total error in x = 0.040

% error in $x = \left(\frac{0.040}{1.205} \times 100\right) = 3.3\%$

17. Bend width transmission will be if amplitude modulated signal is given as

$E = 10(1 + \cos 10^{-4} t) \sin (10^6 t)$ is :
(1) 2×10^{-6} Hz (2) 2×10^{-4} Hz (3) 2×10^{-7} Hz (4) 2×10^{-9} Hz

Ans. **(1)**

Ans. Band width = $2f_c$

$= 2 \times 10^{6}$ Hz

18. A time dependent magnetic field is present in coil. If number of turns becomes half and radius is doubled. Then electrical power dissipated becomes –

(1) Double (2) Half (3) quadruple (4) Same

Ans. **(3)**

Sol. Resistance of coil remains same if number of turn becomes half and radius is doubled.

$E = \frac{Nd\phi}{dt}$

$= -\frac{NAdB}{dt}$

$P = \frac{e^2}{R}$

$P \propto e^2 \propto N^2A^2 \propto N^2r^4$

$(1/2)^2 (2)^4 = 2^2$

19. Drop of radius 1 μm is falling with terminal velocity in air (bouncy force due to air is negligible), density of drop is 10^3 kg/m^3, coefficient of viscosity is 1.8×10^{-5} N sm^{-2} then find terminal velocity.

(1) 123.4×10^{-6} m/s (2) 62.4×10^{-6} m/s (3) 93.4×10^{-6} m/s (4) 73.4×10^{-6} m/s

Ans. (1)

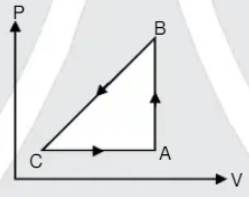
Sol. $\frac{4}{3}\pi r^3 \rho g = 6\pi n r V$

$\frac{4}{3 \times 6} r^2 \frac{\rho g}{n} = \upsilon$

$\frac{4}{3} \times \frac{10^{-12} \times 10^3 \times 10}{1.8 \times 10^{-5} \times 6}$

$v = 123.4 \times 10^{-6}$ m/s

20. Initial internal energy of gas at A is 1560 J. Energy lost from C to A is 60 J. Work done by gas from B to C is 30 J and energy given to gas form B to C is zero. Energy given to gas from A to B is 40 J. Then work done from C to A is :



(1) –50 J (2) –30 J (3) –60 J (4) 60 J

Ans. (1)

Sol. For cycle process

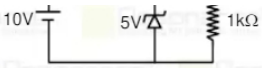
Total heat = $W_{total} + \Delta v$

$-60 + 40 + 0 = W_{CA} + W_{AB} + W_{BC}$

$-20 = W_{CA} + 0 + 30$

$W_{CA} = -50$.

21. Determine current 2kΩ resistance

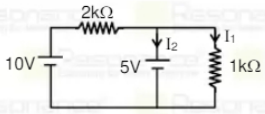


For the circuit above current through Zener diode.

(1) 1.125 mA (2) 2.25 mA (3) 4 mA (4) 4.5 mA

Ans. **(1)**

Sol.



$-10 + 2000I + 5 = 0$

$I = \frac{5}{2000}\text{ Amp} = 2.5\text{ mA}$

22. Two particles are moving with uniform acceleration a_1 & a_2 from rest. Their acceleration and velocity are related as $V_2 = \frac{n^2}{m}V_1$, $a_2 = \frac{1}{mn}a_1$. Which of the following relations are correct.

(1) $t_2 = \frac{n^2}{m}t_1, s_2 = \frac{n^2}{m^3}s_1$ (2) $t_2 = n^3t_1, s_2 = \frac{n^5}{m^2}s_1$

(3) $t_2 = n^3t_1, s_2 = \frac{n^5}{m}s_1$ (4) $t_2 = n^2t_1, s_2 = \frac{m^2}{n^3}s_1$

Ans. (3)

Sol. $\frac{V_1}{V_2} = \frac{a_1}{a_2}\frac{t_1}{t_2}$

$\frac{m}{n^2} = mn\frac{t_1}{t_2}$

$t_2 = n^3 t_1$

$\frac{V_1^2}{V_2^2} = \frac{2a_1s_1}{2a_2s_2}$

$\frac{m^2}{n^4} = mn\frac{s_1}{s_2}$

$s_2 = \frac{n^5}{m}s_1$