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

## 2022

### COMPUTER BASED TEST (CBT) Memory Based Questions & Solutions

Date: 26 June, 2022 (SHIFT-2) | TIME : (3.00 p.m. to 6.00 p.m)  
Duration: 3 Hours | Max. Marks: 300

**SUBJECT: PHYSICS**

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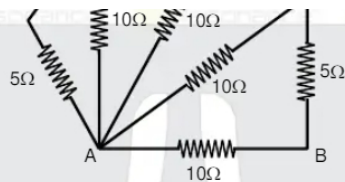
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**PART : PHYSICS**

1. Find resistance between points A and B.

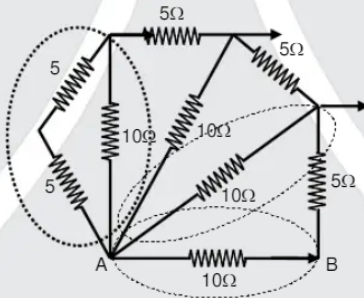




- (1)  $10\ \Omega$       (2)  $5\ \Omega$       (3)  $200\ \Omega$       (4)  $15\ \Omega$

Ans. (2)

Sol. By reduction method



2. Two inductor are connected as shown in figure. Mutual inductance between the inductor is  $M$ . Equivalent self-inductance of the circuit is.



- (1)  $L_{eq} = L_1 + L_2 + 2M$     (2)  $L_{eq} = L_1 + L_2 - 2M$     (3)  $L_{eq} = L_1 + L_2 + M$     (4)  $L_{eq} = L_1 + L_2 - M$

Ans. (2)

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3. Consider a conducting rod of length  $l = 1\text{ m}$  rotating in horizontal earth magnetic field  $B_H = 3.9 \times 10^{-5}\text{ T}$  about one end in vertical plane passing through east west direction with angular speed  $\omega = 5\text{ rad/sec}$ . Then potential difference between the both ends of the rod will be :

- (1)  $9.75 \times 10^{-5}\text{ V}$     (2)  $3.75 \times 10^{-5}\text{ V}$     (3)  $11.75 \times 10^{-5}\text{ V}$     (4)  $5.75 \times 10^{-5}\text{ V}$

Ans. (1)

Sol. Potential difference between the ends of rod =  $\frac{1}{2} B_H \omega l^2 = \frac{1}{2} \times 3.9 \times 10^{-5} \times 5 \times 1^2$   
 $= 9.75 \times 10^{-5}\text{ V}$

4. Formula of Reynolds number is ( $\rho$  = density of the fluid,  $u$  = flow speed,  $D$  = diameter of pipe,  $\eta$  = coefficient of viscosity of the fluid)

- (1)  $\frac{\rho u D}{\eta}$       (2)  $\frac{\eta u D}{\rho}$       (3)  $\frac{\eta \rho D}{u}$       (4)  $\frac{\eta \rho u}{D}$

Ans. (1)

5. Dimension formula of mutual inductance is :

- (1)  $M^1 L^1 T^{-2} A^{-2}$     (2)  $M^1 L^2 T^{-2} A^{-2}$     (3)  $M^2 L^2 T^{-2} A^{-2}$     (4)  $M^1 L^2 T^{-1} A^{-2}$

Ans. (2)

6. Two parallel wires of length 1 m and other is infinite are lying at a distance of 2m. If the current flowing in each wire is 5 ampere then the force between them will be—  
 (1) 2.5  $\mu\text{N}$  (2) 3.5  $\mu\text{N}$  (3) 4.5  $\mu\text{N}$  (4) 5.5  $\mu\text{N}$

Ans. (1)

Sol. 
$$\frac{F}{\ell} = \frac{\mu_0 I_1 I_2}{2\pi d} = 2.5 \mu\text{N}$$

7. The ratio of rotational kinetic energy to the total kinetic energy of a rolling solid sphere

- (1)  $\frac{2}{7}$  (2)  $\frac{5}{7}$  (3)  $\frac{3}{7}$  (4)  $\frac{7}{5}$

Ans. (1)

Sol. 
$$K.E.R = \frac{1}{2} m v^2 \left( \frac{k^2}{R^2} \right)$$

$$K.E.Total = \frac{1}{2} I \omega^2 + \frac{1}{2} m v^2$$

$$= \frac{1}{2} m v^2 \left( 1 + \frac{k^2}{R^2} \right)$$

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$$\frac{(K.E.)_{rotational}}{(K.E.)_{Total}} = \frac{\frac{1}{2} m v^2 \left( \frac{k^2}{R^2} \right)}{\frac{1}{2} m v^2 \left( 1 + \frac{k^2}{R^2} \right)} = \frac{2}{7}$$

For solid sphere

$$I = mK^2$$

$$I = \frac{2}{5} mR^2$$

$$\frac{k^2}{R^2} = \frac{2}{5}$$

8. Arrange the EM waves according to increasing order of wavelength.

- (1)  $\lambda_{x\text{-ray}} > \lambda_{\text{gamma}} > \lambda_{\text{microwave}} > \lambda_{x\text{-ray}}$  (2)  $\lambda_{\text{gamma}} > \lambda_{x\text{-ray}} > \lambda_{\text{visible}} > \lambda_{\text{microwave}}$   
 (3)  $\lambda_{\text{gamma}} < \lambda_{x\text{-ray}} < \lambda_{\text{visible}} < \lambda_{\text{microwave}}$  (4)  $\lambda_{\text{gamma}} = \lambda_{x\text{-ray}} = \lambda_{\text{visible}} > \lambda_{\text{microwave}}$

Ans. (3)

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

$$E_{\text{max}} \propto \frac{1}{\lambda_{\text{min}}}$$

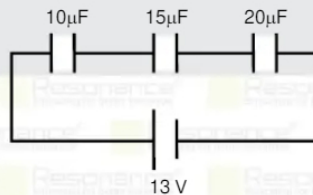
Energy of proton

$$E_{\text{gamma}} > E_{x\text{-ray}} > E_{\text{visible}} > E_{\text{microwave}}$$

wavelength of proton

$$\lambda_{\text{gamma}} < \lambda_{x\text{-ray}} < \lambda_{\text{visible}} < \lambda_{\text{microwave}}$$

9. Find charge on 15  $\mu\text{F}$  capacitor



- (1)  $60 \mu\text{C}$  (2)  $30 \mu\text{C}$  (3)  $40 \mu\text{C}$  (4)  $20 \mu\text{C}$

Ans. (1)

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Sol.  $\frac{1}{C_{eq}} = \frac{1}{10} + \frac{1}{15} + \frac{1}{20}$

$$= \frac{6+4+3}{60} = \frac{13}{60}$$

$$C_{eq} = \frac{60}{13} \mu\text{F}$$

$$q = C_{eq}V$$

$$= \frac{60}{13} \times 13$$

$$q = 60 \mu\text{C}$$

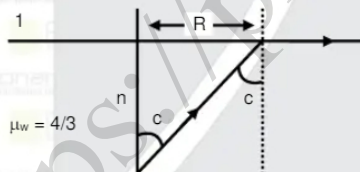
All capacitors have same charges.

10. A light source is present at depth  $d = \sqrt{7}$  meter from water surface in a pond. r.f. of water is  $\frac{4}{3}$  calculate maximum area of water surface from which light rays will come out in air.

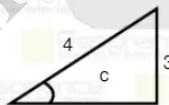
- (1)  $\pi \text{ m}^2$  (2)  $7 \text{ m}^2$  (3)  $9 \pi^2$  (4)  $11 \pi^2$

Ans. (3)

Sol.



$$\sin c = \frac{\mu_w}{\mu_d} = \frac{3}{4}$$



$$\sqrt{16-9} = \sqrt{7}$$

$$\frac{R}{h} = \tan c = \frac{3}{\sqrt{7}}$$

$$R = 3$$

$$A = \pi R^2 = 9\pi \text{ m}^2$$

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11. A bar magnet of magnetic moment  $M = 2 \times 10^5 \text{ A-m}^2$  is rotated from  $\theta = 0$  to  $\theta = 60^\circ$  in uniform magnetic field  $B = 14 \times 10^{-5} \text{ Tesla}$ . The work done against magnetic field is :  
 (1) 14 J (2) 7 J (3) 1.4 J (4) 140 J

Ans. (1)

Sol.  $W = U_f - U_i$   
 $= (-MB \cos 60) - (-MB \cos 0)$   
 $= MB \left(1 - \frac{1}{2}\right)$   
 $= 2 \times 10^5 \times 14 + 10^{-5} \times \frac{1}{2}$   
 $= 14 \text{ Joule}$

12. A ball of mass 200 gram moving with velocity 15 m/s collides to a bat and return with same speed in reverse direction, calculate the impulse given by bat to ball :  
 (1) 2 N – sec (2) 4 N – sec (3) 6 N – sec (4) 8 N – sec

Ans. (3)

Sol.  $I = P_f - P_i = (mv) - (-mv)$   
 $= 2mV$   
 $= 2 \times (200 \times 10^{-3}) \times 15$   
 $I = 6 \text{ N – sec}$

13. Two particles are thrown upwards with a time interval of 2 sec, with same speed 50 m/s. How much later from first one, particles will collide in mid air :  
 (1) 2 sec (2) 4 sec (3) 6 sec (4) 8 sec.

Ans. (3)

Sol. After 2 sec.

The relative position between them

$$r_{12} = \left(50 \times 2 - \frac{1}{2} \times 10 \times 2^2\right) - 0$$

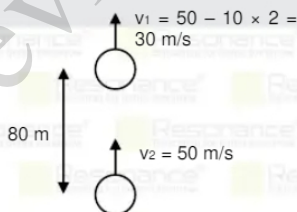
$$= 100 - 20 = 80 \text{ m}$$

$$V_{21} = 50 - 30 = 20 \text{ m/s}$$

$$a_{\text{rel}} = g - g = 0$$

$$\Delta t = \frac{r_{\text{rel}}}{V_{\text{rel}}} = \frac{80}{20} = 4 \text{ sec.}$$

$$\text{Time to meet} = 2 + 4 = 6 \text{ sec.}$$



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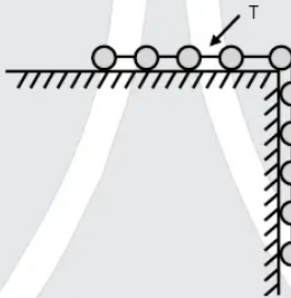
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14. Statement –1 : An object is moving from pole to equator on earth surface. Gravitational force on it remains constant.  
 Statement –2 : Direction of gravitational force on object at equator is towards centre of the earth.  
 (1) Statement–1 is true, Statement–2 is true  
 (2) Statement–1 is false, Statement–2 is false  
 (3) Statement–1 is false, Statement–2 is true  
 (4) Statement–1 is true, Statement–2 is false

15. 10 balls are connected by light strings and are placed on friction less table, mass of each ball is 2 kg. When 6<sup>th</sup> ball is about to fall from table, calculate tension in string connecting 7<sup>th</sup> & 8<sup>th</sup> ball.



- (1) 9 Newton      (2) 18 Newton      (3) 36 Newton      (4) 72 Newton

Ans. (3)

Sol. Acceleration  $a = \frac{6mg}{10m} = 6 \text{ m/s}^2$



$T = (3m) a$

$T = 3 \times 2 \times 6 = 36 \text{ Newton}$

16. A positive feedback circuit for an amplifier to act as an oscillator –

- (1) is the 'feedback' from input to output  
 (2) is the 'feedback' from output to input  
 (3) is the external 'feedback' from input to output  
 (4) is the external 'feedback' from output to input

Ans. (2)

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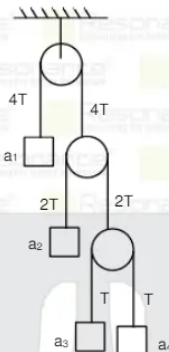
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17. In given diagram assuming  $a_1, a_2, a_3$  and  $a_4$  upwards, the correct relation between them is :



- (1)  $4a_1 - 2a_2 - a_3 - a_4 = 0$       (2)  $4a_1 + 2a_2 + a_3 + a_4 = 0$   
 (3)  $2a_1 + 4a_2 + 4a_3 + a_4 = 0$       (4)  $4a_1 - 2a_2 + a_3 + a_4 = 0$

Ans. (2)

Sol. Wall (int) = 0

$\sum \vec{F} \cdot \vec{v} = 0$

$\sum \vec{F} \cdot \vec{a} = 0$

$a_1(4T) + a_2(2T) + a_3(T) + a_4(T) = 0$

$$4a_1 + 2a_2 + a_3 + a_4 = 0$$

18. 64 identical charged drops of conducting liquid are combined to form a big drop. Calculate the ratio of surface charge density of a bigger drop to smaller drop.  
 (1) 2 (2) 4 (3) 6 (4) 8

Ans. (2)

Sol. From charge conservation

$$64 (4\pi r^2) \sigma_i = 1 (4\pi R^2) \sigma_f$$

$$\frac{\sigma_i}{\sigma_f} = \left(\frac{R}{r}\right)^2 \times \frac{1}{64} \dots(1)$$

from volume conservation

$$(64) \left(\frac{4}{3} \pi r^3\right) = 1 \left(\frac{4}{3} \pi R^3\right)$$

$$R = 4r \dots(2)$$

from (1) & (2)

$$\frac{\sigma_i}{\sigma_f} = \frac{1}{4}$$

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19. An atom emits a photon of wavelength  $\lambda = 670$  nm, when it was at rest when atom is in motion and emits a photon in opposite direction of motion the wavelength of photon is  $670.7n$ . Calculate fractional change in speed of atom :

- (1)  $\frac{0.7}{670}$  (2)  $\frac{0.7}{570}$  (3)  $\frac{0.5}{470}$  (4)  $\frac{0.3}{370}$

Ans. (1)

Sol.  $p = \frac{h}{\lambda}$

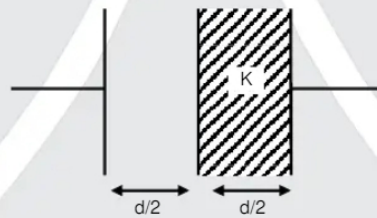
$$\frac{\Delta p}{p} = -\frac{\Delta \lambda}{\lambda}$$

$$\Delta p = \frac{\Delta \lambda}{\lambda} \cdot p$$

$$|\Delta u| = \frac{\Delta \lambda}{\lambda} (v)$$

$$\frac{\Delta u}{v} = \left(\frac{\Delta \lambda}{\lambda}\right) = \frac{0.7}{670}$$

20. A capacitor of capacitance  $C_0$  is filled with dielectric constant  $K=3$  as shown.



Now it's capacitance becomes  $C$ , calculate ratio  $\frac{C}{C_0}$

- (1)  $\frac{1}{2}$  (2)  $\frac{3}{2}$  (3)  $\frac{5}{2}$  (4)  $\frac{7}{2}$

Ans. (2)

Sol.  $C = \frac{\epsilon_0 A}{\frac{d}{2} + \frac{d}{2K}} = \frac{2C_0}{1 + \frac{1}{K}}$

$$\frac{C}{C_0} = \frac{2}{1 + \frac{1}{3}} = \frac{6}{4} = \frac{3}{2}$$

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21. Heat energy given to Carnot engine is 300 J. Heat energy flow towards sink is 180 J. If lower temperature is 324K, then higher temperature is :

- (1) 340 K                      (2) 430 K                      (3) 540 K                      (4) 640 K

Ans. (3)

Sol. Efficiency  $\eta = 1 - \frac{T_2}{T_1} = 1 - \frac{Q_2}{Q_1}$

$$\frac{Q_1}{Q_2} = \frac{T_{\text{high}}}{T_{\text{low}}}$$

$$\frac{300}{180} = \frac{T_{\text{high}}}{324}$$

$$T_{\text{high}} = 540 \text{ K}$$

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