



# JEE (MAIN) 2024

MEMORY BASED QUESTIONS & SOLUTIONS

SHIFT-2

**DATE & DAY:** 30<sup>th</sup> January 2024 & Tuesday

**PAPER-1**

**Duration:** 3 Hrs.

**Time:** 03:00 PM - 06:00 PM

**SUBJECT: PHYSICS**

**ADMISSIONS OPEN FOR CLASS 12+**

ACADEMIC SESSION 2024-25



TARGET: JEE (ADV.) 2024

For Class XII Passed Student

**VISHESH COURSE**

MODE: OFFLINE/ONLINE



CLASS STARTS

08<sup>th</sup> APRIL, 2024



TARGET: JEE (MAIN) 2024

For Class XII Passed Student

**ABHYAAS COURSE**

MODE: OFFLINE/ONLINE



CLASS STARTS

08<sup>th</sup> APRIL, 2024

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## PART : PHYSICS

- For a given electric circuit shown, find the time taken to change current from highest peak value to half of peak value

$R = 50\Omega$



$$V = 220 \sin(100t)$$

(1)  $\frac{\pi}{300}$  sec

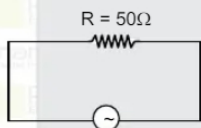
(2)  $\frac{\pi}{200}$  sec

(3)  $\frac{\pi}{400}$  sec

(4)  $\frac{\pi}{100}$  sec

Ans. (1)

Sol.

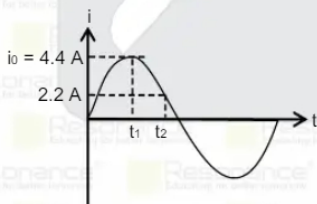


$$V = 220 \sin(100t)$$

$$i = \frac{V}{R} \sin(100t)$$

$$= \frac{220}{50} \sin(100t)$$

$$i = 4.4 \sin(100t)$$



For finding time  $t_1$ , taking  $i = 4.4$  A

$$4.4 = 4.4 \sin(100t_1)$$

$$\sin(100t_1) = 1$$

$$100 t_1 = \frac{\pi}{2}$$

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$$t_1 = \frac{\pi}{200} \text{ sec}$$

For Finding time  $t_2$ , taking  $i = 2.2$  A

$$2.2 = 4.4 \sin(100t_2)$$

$$\frac{1}{2} = \sin(100 t_2)$$

$$\Rightarrow 100t_2 = \frac{5\pi}{6}$$

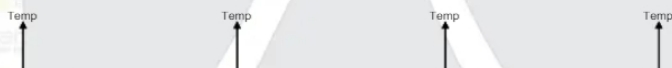
$$t_2 = \frac{5\pi}{600} \text{ sec}$$

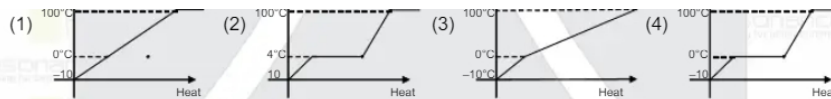
Time taken from peak value to half of peak value of current

$$\Delta t = t_2 - t_1 = \frac{5\pi}{600} - \frac{\pi}{200} \Rightarrow \frac{5\pi}{600} - \frac{3\pi}{600}$$

$$= \frac{2\pi}{600} = \frac{\pi}{300} \text{ Ans}$$

2. Draw true phase diagram for true temperature versus heat supplied when ice at  $(-10^\circ\text{C})$  converts into steam at  $100^\circ\text{C}$ .





Ans. (4)

3. A simple pendulum of length  $\ell = 4$  m is taken to height 'R' from earth surface. Calculate the time period of oscillation of simple pendulum at given height. Given : acceleration due to gravity at earth' surface  $g = \pi^2$

- (1) 4 sec (2) 8 sec (3) 6 sec (4) 10 sec

Ans. (2)

Sol.  $T = 2\pi\sqrt{\frac{\ell}{g_{\text{eff}}}}$  where  $g_{\text{eff}} = g\left[\frac{R}{R+h}\right]^2 = g\left[\frac{R}{R+R}\right]^2 = \frac{g}{4}$

$\therefore T = 2\pi\sqrt{\frac{4}{\frac{g}{4}}} = 2\pi\sqrt{\frac{16}{\pi^2}} = 8 \text{ sec.}$

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4. If  $m = K.c^x G^2 h^2$  then find x if symbols have general meaning and k is dimensionless ( $m = \text{mass}$ ,  $c = \text{speed of light}$ ,  $G = \text{universal gravitation constant}$   $h = \text{plank's constant}$ )

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

Ans. (3)

Sol.  $[M^1] = [L^x T^{-x}][L^3 M^{-1} T^{-2}]^2 [M L^2 T^{-1}]^2$

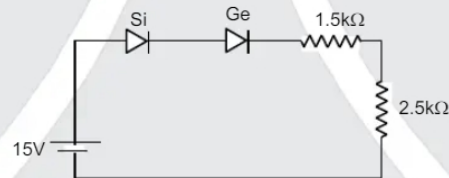
$\Rightarrow [M^1] = [M^1 L^{(x-\frac{1}{2})} T^{(-\frac{1}{2}x)}]$

$\Rightarrow$  After comparing powers

$x - \frac{1}{2} = 0, \quad \frac{1}{2} - x = 0$

$x = \frac{1}{2}, \quad x = \frac{1}{2}$

5. In the given circuit find the potential difference  $2.5 \text{ k}\Omega$ . Given : knew voltages for silicon and germanium P-N junction is 0.7 volt and 0.3 Volt respectively



- (1) 3.25 V (2) 4.75 (3) 9.50 (4) 8.75 V

Ans. (4)

Sol.  $V_{\text{Si}} = 0.7 \text{ V}$

$V_{\text{Ge}} = 0.3 \text{ V}$

$i = \frac{15 - 0.3 - 0.7}{(2.5 + 1.5) \times 10^3} = \frac{14}{4} \text{ mA} = \frac{7}{2} \text{ mA}$

therefor potential difference across resistor

$V = iR$

$$= \frac{7}{2} \times 10^3 \times 2.5 \times 10^3$$

$$= \frac{35}{4} \times 10^6$$

$$= 8.75 \text{ V.}$$

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6. A Charge  $-q$  and mass  $m$  is revolving in circular orbit of radius  $r$  around infinite length wire with linear charge density  $\lambda$ . Find the time period of revolution

(1)  $(2\pi)^{1/2} r \sqrt{\frac{m\epsilon_0}{\lambda q}}$  (2)  $(2\pi)^{3/2} \sqrt{\frac{rm\epsilon_0}{\lambda q}}$  (3)  $(2\pi)^{3/2} r \sqrt{\frac{m\epsilon_0}{\lambda q}}$  (4)  $(2\pi)^{1/2} \sqrt{\frac{rm\epsilon_0}{\lambda q}}$

Ans. (3)

Sol.  $E = \frac{\lambda}{2\pi r \epsilon_0}$

$|F_e|$  = centripetal force required

$$|F_e| = \frac{\lambda q}{2\pi r \epsilon_0} \Rightarrow \frac{\lambda q}{2\pi r \epsilon_0} = m\omega^2 r$$

$$\Rightarrow \omega = \sqrt{\frac{\lambda q}{2\pi m r^2 \epsilon_0}}$$

$$T = \frac{2\pi}{\omega} = \frac{2\pi}{\sqrt{\frac{\lambda q}{2\pi m r^2 \epsilon_0}}} = (2\pi)^{3/2} r \sqrt{\frac{m \epsilon_0}{\lambda q}}$$

7. A 10 N Force is applied on mass 1 kg in upward direction as shown. Find the work done against friction force in taking it up by 10 m along inclined

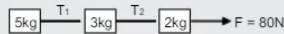


(1) 10 J (2) 5 J (3) 20 J (4) 25 J

Ans. (2)

Sol.  $w = (\mu mg \cos 60^\circ) 10 = 5 \text{ J}$

8. Find the value of tension  $T_1$  and  $T_2$  respectively in the given figure?



(1) 60N, 72 N (2) 72 N, 60N (3) 40 N, 64N (4) 64N, 40 N

Ans. (3)

Sol.  $M_{\text{Total}} = 5 + 3 + 2 = 10 \text{ kg}$

$$a = \frac{F}{M_{\text{Total}}} = \frac{80}{10} = 8 \text{ m/sec}^2$$

$$\Rightarrow T_2 \leftarrow \boxed{2\text{kg}} \rightarrow F = 80\text{N}$$

$$80 - T_2 = 2 \times 8$$

$$T_2 = 80 - 16 = 64 \text{ N}$$

$$\Rightarrow T_1 \leftarrow \boxed{3\text{kg}} \rightarrow T_2$$

$$T_2 - T_1 = 3 \times 8$$

$$T_1 = 64 - 3 \times 8$$

$$T_1 = 64 - 24 = 40 \text{ N}$$

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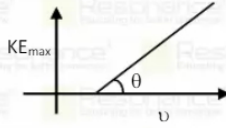
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9. Graph of maximum possible K.E. of photo-electron and frequency of incident photons is as shown in figure. Find slope of graph.



- (1)  $h/e$                       (2)  $h$                       (3)  $e/h$                       (4)  $1/h$

Ans. (2)

Sol.  $K_{\max} = h\nu - h\nu_{\text{th}}$   
Slope =  $h$ .

10. Match the following :

- |  |                                |
|--|--------------------------------|
| A. $\oint \vec{B} \cdot d\vec{A} = 0$                                | P. Faraday & Lens's law        |
| B. $\oint \vec{E} \cdot d\vec{A} = \frac{Q_{\text{in}}}{\epsilon_0}$ | Q. Gauss law of on magnetism   |
| C. $\oint \vec{B} \cdot d\vec{l} = \mu_0 i_{\text{enc}}$             | R. Ampere's law                |
| D. $\oint \vec{E} \cdot d\vec{l} = -\frac{d\phi_B}{dt}$              | S. gauss law of electrostatics |

- (1) (A - Q), (B - S), (C - R), (D - P)  
 (2) (A - S), (B - Q), (C - R), (D - P)  
 (3) (A - Q), (B - R), (C - S), (D - P)  
 (4) (A - Q), (B - S), (C - P), (D - R)

Ans. (1)

Sol. (A - Q), (B - S), (C - R), (D - P)

11. For a given planet  $R_p = \frac{R_e}{3}$  &  $M_p = \frac{M_e}{6}$ , Then find the escape velocity for this planet if the escape velocity for earth is 11.2 km/sec. ( $R_e$  = radius of earth and  $M_e$  = mass of earth)

- (1) 7.92 km/sec                      (2) 11. 2 km/sec                      (3) 10.3 km/sec                      (4) 6.9 km/sec

Ans. (1)

Sol.  $V_{\text{es}} = \sqrt{\frac{2GM}{R}}$

$$\frac{(V_{\text{es}})_p}{(V_{\text{es}})_e} = \sqrt{\frac{M_p}{M_e} \times \frac{R_e}{R_p}}$$

$$\frac{(V_{\text{es}})_p}{11.2} = \sqrt{\frac{3}{6}}$$

$$(V_{\text{es}})_p = 7.92 \text{ km/sec.}$$

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12. 5A current is passing through a square of side 1m then find the magnetic field at the centre of this square.

- (1)  $8\sqrt{2} \times 10^{-6} \text{ T}$                       (2)  $4\sqrt{2} \times 10^{-6} \text{ T}$                       (3)  $2\sqrt{2} \times 10^{-6} \text{ T}$                       (4)  $6\sqrt{2} \times 10^{-6} \text{ T}$

Ans. (2)

Sol.  $B_C = 4 \times \frac{\mu_0 I}{4\pi d} (\sin 45^\circ + \sin 45^\circ)$

$$= 20 \times \frac{\mu_0}{4\pi} \times \frac{1}{2} \times \sqrt{2}$$

$$= 4\sqrt{2} \times 10^{-6} \text{ T}$$

13. A vector which have magnitude same as of  $3\hat{i} + 4\hat{j}$  & direction along  $4\hat{i} + 3\hat{j}$ , is  $x\hat{i} + 3\hat{j}$  then value x will be?

- (1) 3 (2) 2 (3) 4 (4) 10  
**Ans. (3)**

**Sol.**  $\hat{d} = \frac{4\hat{i} + 3\hat{j}}{\sqrt{4^2 + 3^2}} = \frac{4}{5}\hat{i} + \frac{3}{5}\hat{j}$

$$|\vec{d}| = \sqrt{3^2 + 4^2} = \sqrt{25} = 5$$

$$\vec{d} = |\vec{d}| \hat{d}$$

$$\vec{d} = 5 \left( \frac{4}{5}\hat{i} + \frac{3}{5}\hat{j} \right)$$

$$\vec{d} = (4\hat{i} + 3\hat{j})$$

14. An electron is revolving in  $n^{\text{th}}$  orbit of  $\text{He}^+$  ion. Its magnetic moment depends on the radius of orbit as :

- (1)  $r$  (2)  $r^{1/2}$  (3)  $r^{3/2}$  (4)  $r^2$   
**Ans. (2)**

**Sol.**  $M = iA$

$$= \frac{e}{T} A$$

$$= \frac{ev}{2\pi r} \pi r^2$$

$$= \frac{evr}{2}$$

$$= \frac{er}{2} \left[ \frac{nh}{2\pi m r} \right] = \frac{neh}{4\pi m}$$

$$\therefore M \propto n$$

$$M \propto \sqrt{r}$$

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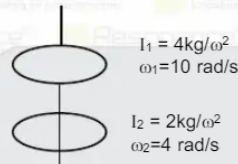
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15. A disc of moment of inertia  $4 \text{ kg/m}^2$  is spinning freely with  $\omega = 10 \text{ rad/s}$ . A second disc of moment of inertia  $2 \text{ kg/m}^2$  and spinning with  $\omega = 4 \text{ rad/s}$  in same direction, slides down on the spindle and combined slowly and start spinning together. What is the loss in kinetic energy?

- (1) 12 J (2) 24 J (3) 36 J (4) 48 J

**Ans. (2)**

**Sol.** Angular momentum conservation



$$L_i = L_f$$

$$I_1\omega_1 + I_2\omega_2 = (I_1 + I_2)\omega$$

$$4 \times 10 + 2 \times 4 = (4 + 2)\omega$$

$$40 + 8 = 6 \times \omega$$

$$\frac{48}{6} = \omega$$

$$W = 8 \text{ rad/s}$$

$$= \frac{1}{2} I_1 \omega_1^2 + \frac{1}{2} I_2 \omega_2^2 - \frac{1}{2} (I_1 + I_2) \omega^2$$

$$E_i = \frac{1}{2} I_1^2 \omega_1^2 + \frac{1}{2} I_2^2 \omega_2^2$$

$$= \frac{1}{2} \times 4 \times (10)^2 + \frac{1}{2} \times 2 \times (4)^2$$

$$E_i = 200 + 16 = 216$$

$$E_f = \frac{1}{2} (I_1 + I_2)^2 \omega^2$$

$$E_f = \frac{1}{2} (4 + 2)^2 8^2$$

$$E_f = 3 \times 64$$

$$E_f = 192.$$

$$\text{Loss in K.E.} = 216 - 192 = 24 \text{ J}$$

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16. Two polarizers are placed at  $45^\circ$  angle. The intensity of final light if unpolarised light of intensity  $I_0$  is incident on one of polarizer.

- (1)  $\frac{I_0}{2}$       (2)  $\frac{I_0}{8}$       (3)  $\frac{I_0}{4}$       (4)  $\frac{I_0}{16}$

Ans. (3)

$$\begin{aligned} \text{Sol. } I &= \frac{I_0}{2} \cos^2 45^\circ \\ &= \frac{I_0}{4} \end{aligned}$$

17. 3 moles of monoatomic gas is mixed with 2 moles of diatomic gas. find  $\gamma_{\text{mix}}$

- (1) 1.32      (2) 1.42      (3) 1.52      (4) 1.72

Ans. (3)

$$\text{Sol. } \gamma_{\text{mix}} = \frac{C_{p_{\text{mix}}}}{C_{v_{\text{mix}}}} = \frac{n_1 C_{p_1} + n_2 C_{p_2}}{n_1 C_{v_1} + n_2 C_{v_2}}$$

$$\begin{aligned} &= \frac{3\left(\frac{5}{2}R\right) + 2\left(\frac{7}{2}R\right)}{3 \times \left(\frac{3}{2}R\right) + 2\left(\frac{5}{2}R\right)} \\ &= \frac{15 + 14}{9 + 10} \\ &= \frac{29}{19} = 1.52 \end{aligned}$$

18. A step down transformer has primary voltage of  $V_p = 3.2 \text{ KV}$ , number of turn in primary coil is 3000 with current 5 A. on secondary coil voltage is 320 V with number of turns  $N_s$ . If efficiency of transformer is 90% then find the current in secondary coil?

- (1) 15 A      (2) 30 A      (3) 45 A      (4) 60 A

Ans. (3)

$$\begin{aligned} \text{Sol. Input power} &= 3.2 \times 5 \times 10^3 \\ &= 16 \text{ kw} \end{aligned}$$

$$\text{eff.} = 90\% = \frac{\text{output power}}{\text{input power}} = \frac{P_{\text{out}}}{16\text{KV}} = \frac{9}{10}$$

$$P_{\text{out}} = \frac{9}{10} \times 16 \times 10^3$$

$$V_s I_s = \frac{9}{10} \times 16 \times 10^3$$

$$I_s = \frac{9 \times 16 \times 10^3}{10 \times 320} = 45A$$

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19. Heat developed in a wire of resistance R is W. If it is cut into two equal parts and connected into parallel with same source battery then heat produced in same time will be.

- (1) W (2) 2 W (3) 3 W (4) 4W

Ans. (4)

Sol. Heat  $W = \frac{V^2}{R} t$

$$\frac{W_2}{W_1} = \frac{R_1}{R_2} = \frac{R}{\left(\frac{R}{4}\right)} = 4$$

$$W_2 = 4W_1 \Rightarrow W_{\text{new}} = 4W$$

20. Number of spectral line in the spectrum of  $\text{He}^+$ , for transition from  $n = 5$  to 1.

- (1) 10 (2) 6 (3) 8 (4) 5

Ans. (1)

Sol. Number of spectral lines =  ${}^n C_2$   
 $= {}^5 C_2 = 10$

21. A mass is to be kept on the surface of curve  $y = x^2 / 4$  such that it does not slip. Find the maximum height at which it should be kept if  $\mu = 0.5$

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

Ans. (2)

Sol. For no slipping

$$\mu mg \cos \theta \geq mg \sin \theta$$

$$\mu \geq \tan \theta$$

$$\mu \geq \frac{dy}{dx}$$

$$0.5 \geq \frac{x}{2}$$

$$1 \geq x$$

$$y = \frac{x^2}{4} \Rightarrow x^2 = 4y$$

$$x^2 \leq 1$$

$$4y \leq 1$$

$$y \leq \frac{1}{4}$$

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22. 1000 drops, each have surface energy  $E_1$  converted into 1 bigger drop of surface energy  $E_2$  then  $\frac{E_1}{E_2}$

will be

- (1)  $\frac{1}{110}$       (2)  $\frac{1}{81}$       (3)  $\frac{1}{100}$       (4)  $\frac{1}{121}$

Ans. (3)

Sol.  $E = S \times A$

$$E_1 = S \times 4\pi r^2 \dots (i)$$

$$E_2 = S \times 4\pi R^2 \dots (ii)$$

Vol. conservation

$$1000 \times \frac{4}{3} \pi r^3 = \frac{4}{3} \pi R^3$$

$$10^3 \times r^3 = R^3$$

$$\frac{r}{R} = \frac{1}{10}$$

$$\frac{E_1}{E_2} = \frac{S \times 4\pi r^2}{S \times 4\pi R^2} = \left(\frac{r}{R}\right)^2$$

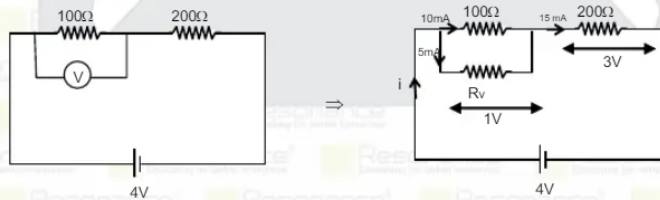
$$\frac{E_1}{E_2} = \frac{1}{100}$$

23. A  $100\Omega$  resistance and  $200\Omega$  resistance is connected in a series with 4v battery. A voltmeter connected across  $100\Omega$  reads 1V. Find internal resistance of voltmeter

- (1) 150      (2) 200      (3) 190      (4) 220

Ans. (2)

Sol.



$$V = I R_v$$

$$1 = 5 \times 10^{-3} \times R_v \Rightarrow R_v = \frac{10^3}{5} = 200\Omega$$

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24. 49 main scale divisions is equal to 50 vernier scale divisions. If one main scale divisions is 0.5 mm then find the value of vernier constant

- (1) 0.01 mm      (2) 0.1mm      (3) 0.02 mm      (4) 0.2 mm

Ans. (1)

Sol. vernier constant = L.C = 1MSD – 1VSD

$$= \left[1 - \frac{49}{50}\right] \text{MSD}$$

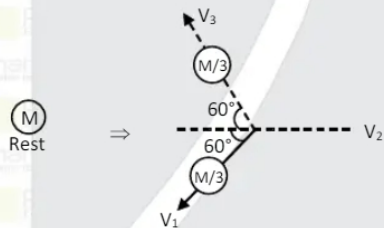
$$= \frac{1}{50} \times 0.5 \text{ mm} = 0.01 \text{ mm}$$

25. A parent nuclei of mass  $M$  is splits into three daughter nuclei of equal mass. Find speed of daughter nuclei if mass defect is  $\Delta m$  :

(1)  $\sqrt{\frac{2\Delta M}{M}}$       (2)  $\sqrt{\frac{2\Delta MC}{M}}$       (3)  $\sqrt{\frac{3\Delta M}{M}}$       (4)  $\frac{2\Delta MC^2}{m}$

Ans. (1)

Sol.



$V_1 = V_2 = V_3$  from symmetry or momentum conservation

$$\text{Energy released } 3 \left( \frac{1}{2} \frac{M}{3} V^2 \right) = \Delta m C^2$$

$$V = \sqrt{\frac{2\Delta m}{M}} \cdot C$$

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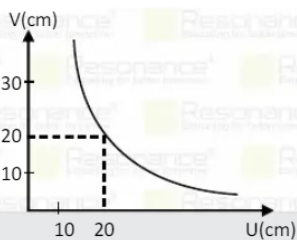
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26. v-u graph is given for a concave mirror. Find focal length of concave mirror.



- (1) 200 cm      (2) 10 cm      (3) 15 cm      (4) 5 cm

Ans. (2)

Sol.  $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$

$$\frac{1}{-20} + \frac{1}{-20} = \frac{1}{f}$$

$$F = 10 \text{ cm}$$



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