# DIRECTORATE OF GOVERNMENT EXAMINATIONS, CHENNAI- 6
## HSE SECOND YEAR EXAMINATION – MARCH/APRIL – 2023
## PHYSICS KEY ANSWER

**NOTE:**

1. Answers written with Blue or Black ink only to be evaluated.
2. Choose the most suitable answer in Part A from the given alternatives and write the option code and their corresponding answer.
3. For answers in Part – II , Part – III , Part – IV like reasoning , explanation, narration description and listing of points, students may write in their own words but without changing the concepts and without skipping any point.
4. In numerical problems if formula is not written , marks should be given for the remaining correct steps.
5. In graphical representation, physical variables for X-axis and Y-axis should be marked.

**TOTAL MARKS : 70**
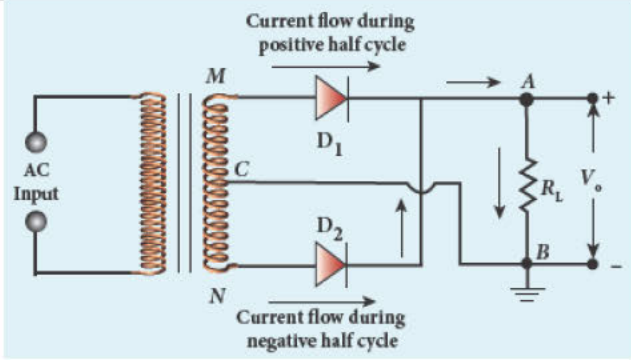
## PART-I

**Answer all the Questions :**                                    **15x1=15**

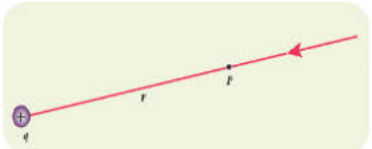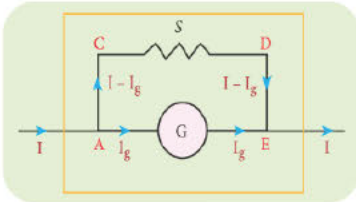| Q.NO | OPTION | TYPE-A | Q.NO. | OPTION | TYPE-B |
|------|--------|--------|-------|--------|--------|
| 1 | c | $\lambda_p \propto \lambda_e^2$ | 1 | b | Shape memory alloys |
| 2 | c | $\dfrac{3}{8} I$ | 2 | c | 900 V$m^{-1}$ |
| 3 | c | 900 V$m^{-1}$ | 3 | c | 4.5 Ω |
| 4 | c | 4.5 Ω | 4 | b | Water |
| 5 | d | Yellow–Violet–Orange–Silver | 5 | a | −40 V |
| 6 | d | $\dfrac{h}{\pi}$ | 6 | a | +Z direction |
| 7 | b | 2 D | 7 | c | Energy density |
| 8 | c | Energy density | 8 | b | 2 D |
| 9 | a | +Z direction | 9 | d | 1.1eV |
| 10 | b | $30^0$ | 10 | c | $\dfrac{3}{8} I$ |
| 11 | c | Voltage regulator | 11 | b | $30^0$ |
| 12 | a | − 40 V | 12 | d | Yellow–Violet–Orange–Silver |
| 13 | b | Water | 13 | d | $\dfrac{h}{\pi}$ |
| 14 | d | 1.1eV | 14 | c | Voltage regulator |
| 15 | b | Shape memory alloys | 15 | c | $\lambda_p \propto \lambda_e^2$ |

| 16 | The electric field at a point P at a distance r from the point charge q is defined as the force experienced by a unit charge placed at that point. | 2 | |
| | (or) | | 2 |
| | The force experienced by unit positive charge    (or) | 2 | |
| | $\vec{E} = \dfrac{\vec{F}}{q_0}$    (or)    $\vec{E} = K\dfrac{q}{r^2}\hat{r}$   (or)   $\vec{E} = \dfrac{1}{4\pi\varepsilon_0}\dfrac{q}{r^2}\hat{r}$ | 1 | |
| 17 | Q factor is defined as the ratio of voltage across L or C at resonance to Applied voltage. | 2 | |
| | (or) | | |
| | $Q - factor = \dfrac{Voltage\ across\ L\ (or)\ C\ at\ resonance}{Applied\ Voltage}$ | 2 | 2 |
| | (or) | | |
| | $Q = \dfrac{I_m X_L}{I_m R}$ (or)  $Q = \dfrac{X_L}{R}$  (or)  $Q = \dfrac{\omega_r L}{R}$    (or)  $Q = \dfrac{1}{R}\sqrt{\dfrac{L}{C}}$ | 1 | |
| 18 | The line integral of magnetic field over a closed loop is $\mu_0$ times net current enclosed by the loop. | 2 | |
| | (or) | | 2 |
| | $\oint \vec{B} \cdot \overrightarrow{d\ell} = \mu_0 I_{enclosed}$ | 1 | |
| 19 | The total internal reflection of light that happens inside the diamond. | 1 | |
| | n=2.417  (or)  $i_c = 24.4°$ | 1 | 2 |
| 20 | $I \propto a^2$   (or)  $I_1 \propto a_1^2$ and  $I_2 \propto a_2^2$ | 1 | |
| | $\dfrac{I_1}{I_2} = \dfrac{a_1^2}{a_2^2}$   (or)   $\dfrac{a_1}{a_2} = \sqrt{\dfrac{I_1}{I_2}} = \sqrt{\dfrac{36}{1}}$ | ½ | |
| | | ½ | |
| | $\dfrac{a_1}{a_2} = \dfrac{6}{1}$ | | |
| | (or) | | 2 |
| | $I \propto a^2$   (or)  $I_{max} \propto (a_1 + a_2)^2$ and  $I_{min} \propto (a_1 - a_2)^2$ | 1 | |
| | $\dfrac{I_{max}}{I_{min}} = \dfrac{(a_1+a_2)^2}{(a_1-a_2)^2}$   (or)   $\dfrac{(a_1+a_2)}{(a_1-a_2)} = \sqrt{\dfrac{I_{max}}{I_{min}}} = \sqrt{\dfrac{36}{1}}$ | ½ | |
| | $\dfrac{(a_1+a_2)}{(a_1-a_2)} = \dfrac{6}{1}$   and    $\dfrac{a_1}{a_2} = \dfrac{7}{5}$ | ½ | |
| 21 | The minimum energy needed for an electron to escape from the metal surface is called work function | 1½ | |
| | **Unit** - eV or Joule | ½ | 2 |
| | (or) | | |
| | $\phi_0 = h\nu_o$ | 1 | |

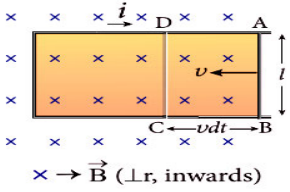| 22 | Activity or decay rate        cl    e       r seco d. <br> **Unit :** Becquerel (or) curie <br> (or) <br> $R = \left\|\dfrac{dN}{dt}\right\|$ (or) $R = \lambda\, N_0 e^{-\lambda t}$ (or) $R = R_0 e^{-\lambda t}$ (or) $R = \lambda N$ | 1½ <br> ½ <br><br> 1 | 2 |
| --- | --- | --- | --- |
| 23 |  | 2 | 2 |
| 24 | $R_T = R_0 (1 + \propto (T - T_0))$ <br> Substitution <br> Answer 3.96 $\Omega$ | 1 <br> ½ <br> ½ | 2 |

## PART-III

**Answer Any Six** ue to   : **Q.No. 33 is Compulsory**            **6×3=18**

| 25 | iag     a d xp an ti n <br> Upto $V = -\dfrac{1}{4\pi\,\varepsilon_0}\displaystyle\int_\infty^r \dfrac{q}{r^2}\; r \cdot \overrightarrow{dr}$ <br><br> $V = \dfrac{1}{4\pi\,\varepsilon_0}\dfrac{q}{r}$ | 1 <br><br> 1 <br><br> 1 | 3 |
| --- | --- | --- | --- |
| 26 | **Kirchhoff'** urr nt u ꞉ :   t     t    a     c su   o   the rre t t n   n t o   f a circuit is zero. <br> **Ki c off'** l ag ru e :It states that in a closed circuit, the algebraic su f p oducts of the current and resistance of each part o t e rcu t s equal to the total emf included in the circuit. | 1½ <br><br> 1½ | 3 |
| 27 | o                i      l nome er we v rt g l no e er into an ammeter. <br><br> Diagram <br><br><br> Upto $S = \dfrac{I_g}{I - I_g} R_g$ (or) $'g = \dfrac{S}{S + R_g} I$ <br><br> $\dfrac{1}{R_{eff}} = \dfrac{1}{R_g} + \dfrac{1}{S}$ (or) $R_{eff} = \dfrac{R_g\,S}{R_g + S}$ (or) $\theta = \dfrac{1}{G} I_g$ (or) $\theta \alpha I_g$ (or) $\theta \alpha I$ | 1 <br><br><br> ½ <br><br><br> 1 <br><br> ½ | 3 |

| 28 | Diagram & Explanation<br><br>upto $\dfrac{d\phi_B}{dt} = Blv$<br><br>$\mathcal{E} = Blv$ |  | 1<br><br>1<br><br>1 | 3 |
|---|---|---|---|---|
| 29 | ... in e i ... e o a· spectrum are known as Fraunhofer l nes.<br><br>... ti n  ctra  r various  m  are  w th the<br> u  r n s i t e olar spectrum  which helps in identifying<br>em ns re en i t e ·un's atmosphere | | 2<br><br>1 | 3 |
| 30 | $R_{net} = 2 + 2 = 4\Omega$<br><br>$I = \dfrac{V}{R} = \dfrac{10}{4}$<br><br>$I = 2.5\ A$ | | 1<br><br>1<br><br>1 | 3 |
| 31 | Optical path o a  e i  ı is defined as the distance d' l g t  av ls in<br> u  e a e ti e it travels a distance d in the medium<br>Optical path **d′ = n d**<br>Where,  **d′** --- ist nce travelled by the light in vacuum<br>      **n** --- R fracti ·e index of the medium<br>      **d** --- ist ce travelled by the light in medium | 1½<br><br>½<br><br>1 | 3 |
| 32 | a s  h o l c c e iect – **any Three** | | 3×1 | 3 |
| 33 | Number of atoms in $1\ kg$ Of $^{235}_{92}U$<br><br>$$N = \dfrac{6.02\ X\ 10^{23}}{235}\ X\ 1000$$<br><br>Total energy, $Q = \dfrac{6.02\ X\ \ 0^{26}}{235} X\ 200\ MeV\ = 5.123\ X\ 10^{26} MeV$<br><br>In terms of  joule ,   $Q\ = 8.197\ X\ 10^{13}\ J$ | 1<br><br>1<br><br>1 | 3 |

## PART-IV

Answer all the Que t  s :                                         5×5=25
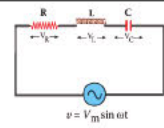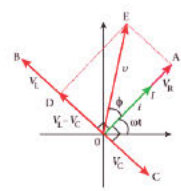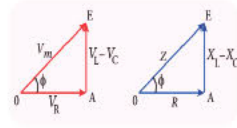
| 34 (a) | (i) | Coulomb's law – Statement<br>      (or) Fo  ula | 2<br>1 | 5 |
|---|---|---|---|---|
| | (ii) | Differences b        o b'        g  t i na   rce<br>(Any Three) | 3 | |

**(OR)**

| | | | | |
|---|---|---|---|---|
| 34 (b) | Diagram | | 1 | |
| | Explanation | | 1 | |
| | upto $\theta = \dfrac{\pi}{N}$ | | 1 | 5 |
| | upto $t = \dfrac{\pi}{N\omega}$ | | 1 | |
| | $V = \dfrac{2dN\omega}{\pi}$ | | 1 | |



Light source S, Partially silvered glass plate, G, 45°, Toothed wheel, M, d, Tooth, Slot
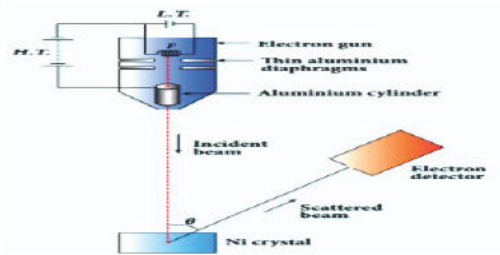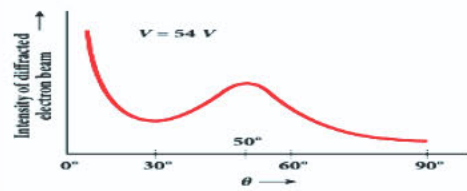
| | | | | |
|---|---|---|---|---|
| 35 (a) | Principle | | 1 | |
| | Diagram | | 1 | |
| | C n ru o a d orki g | | 1 | 5 |
| | Upto $r = \dfrac{mv}{Bq}$ | | 1 | |
| | $f = \dfrac{Bq}{2\pi m}$ (or) $T = \dfrac{2\pi m}{Bq}$ (or) $KE = \dfrac{q^2 B^2 r^2}{2m}$ | | 1 | |



Source of protons, D.P, High-speed proton beam, $D_1$, S, $D_2$, High frequency accelerating voltage

**(OR)**

| | | | | |
|---|---|---|---|---|
| 35 (b) | Diagram | | 1 | |
| | Explanation | | 1 | |
| | Path difference $\delta = \dfrac{a}{2}\sin\theta$ | | 1 | 5 |



Slit, Screen, $L_1$, $L_2$, S, A, a, C, B, N, $\theta$, Plane wave front, D, P, y, O

| | | | | |
|---|---|---|---|---|
| | Condition for first mini um a sin $\theta = \lambda$  C n t f c n m nimum a sin$\theta$ = 2$\lambda$ | | 1 | |
| | C n t f hir i i um a sin$\theta$ = 3$\lambda$  Condition for $n^{th}$ min m m a sin$\theta$ = n$\lambda$  Where n = 1, 2, 3,...... | | 1 | |

| 36 (a) | Series RLC circuit Diag am & Explanation | | 1 | |
| | Phasor diagram | OR | 1 | 5 |
| | Upto $V_m^2 = V_R^2 + (V_L - V_C)^2$ | | 1 | |
| | Upto $Z = \sqrt{R^2 + (X_L - X_C)^2}$ | | 1 | |
| | $\tan \phi = \dfrac{V_L - V_C}{V_R}$  (or)  $\tan \phi = \dfrac{X_L - X_C}{R}$ | | 1 | |
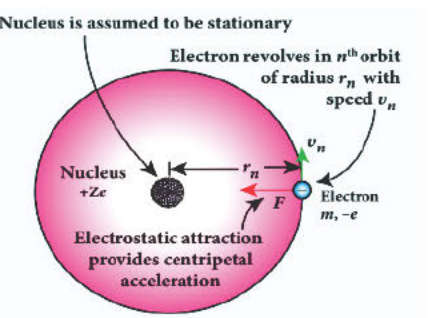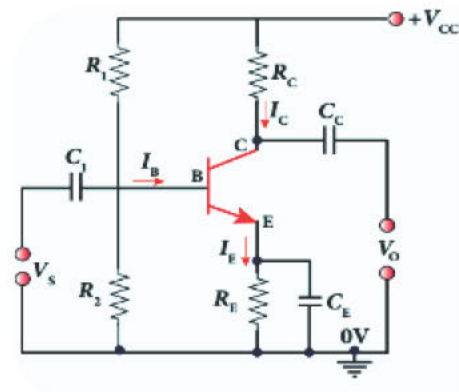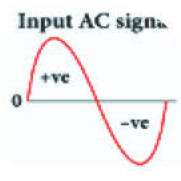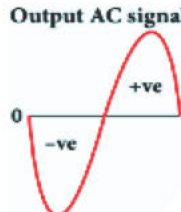
**(OR)**

| 36 (b) | Diagram | | 1 | |
| | Explanation | | 2 | |
| | Graph | | 1 | 5 |
| | $\lambda = \dfrac{12.27}{\sqrt{V}}A^0 = \dfrac{12.27}{\sqrt{54}} A^0 \; : 1.67A^0$ | | 1 | |

| 37 (a) | Diagram | | 1 | |
| | Explanation | | 1 | |
| | $Up\ to \quad I = \dfrac{dQ}{dt}$ | | 1 | 5 |
| | $I = n\,e\,A\,v_d$ | | 1 | |
| | $\vec{J} = -\sigma \vec{E}$  (or)  $\vec{J} = \sigma \vec{E}$ | | 1 | |
| | | | 1 | |

**(OR)**

| 37 (b) | Diagram | 1 | |
|---|---|---|---|
| | Upto $\left|\vec{F}_{coulomb}\right| = \left|\vec{F}_{entripetal}\right|$ | 1 | |
| | | 1 | |
| | $r_n = \dfrac{4\pi\varepsilon_0 (mv_n r_n)^2}{Zme^2}$ | 1 | 5 |
| | Upto $r_n = a_0 \dfrac{n^2}{Z}$ | 1 | |
| | $v_n = \dfrac{h}{2\pi m a_0}\dfrac{Z}{n}$ (or) $v_1 \alpha \dfrac{1}{n}$ | 1 | |



Nucleus is assumed to be stationary

Electron revolves in $n^{th}$ orbit of radius $r_n$ with speed $v_n$

Nucleus +Ze

Electron m, –e

Electrostatic attraction provides centripetal acceleration

| 38 (a) | Any **Four** r p r i s of M waves | 4×1 | |
|---|---|---|---|
| | $n = \sqrt{\epsilon_r \mu_r}$ | ½ | 5 |
| | $n = \sqrt{2.5 \times 2.25} = 2.37$ (no unit) | ½ | |

**(OR)**

| 38 (b) | Circuit diagram | 1 | |
|---|---|---|---|
| |  | | 5 |
| | Explanation | 1 | |
| | $I_C = \beta I_B$ (or) $\beta = \dfrac{I_C}{I_B}$ (or) $V_{CE} = V_{CC} - I_C R_C$ | 1 | |
| | an o d n p s t ve half cycle | 1 | |
| | an o d n N gative half cycle | 1 | |