Section A

1. Inside (1/2)
   Outside (1/2)

2. (i) Cu (metals, alloys) (1/2)
   (ii) Si (semiconductor) (1/2)

3. (i) A (1/2)
   (ii) Capacitor (1/2)

4. \[
   \frac{1}{f} = \frac{1}{u} - \frac{1}{v}, \quad \frac{1}{f} = (\frac{\mu}{\mu_m} - 1) \left( \frac{1}{R_1} - \frac{1}{R_2} \right)
\]

   If \( \mu_m \) increases, \( 1/f \) decreases, \( \therefore \) \( v \) increases. (1/2)

5. LAN (1)
SECTION B

6. \[ \varepsilon_{eq} = \left( \frac{\varepsilon_1}{r_1} + \frac{\varepsilon_2}{r_2} \right) / \left( \frac{1}{r_1} + \frac{1}{r_2} \right) \]  

\[ \varepsilon_{eq} = (10/10 - 2/5) / (1/10 + 1/5) \]  

\[ \varepsilon_{eq} = 2V \]  

7. \( I_1 = I_0/2 \)  
   \( I_2 = I_1 \cos^2 60^0 \)  
   \( I_2 = I_0/8 \)  

OR

7. Huygens’ Principle
   Ray diagram using Huygen’s construction

8. \( P = 5 \times 10^{-3} \text{ W} \)
   \[ n = \frac{P}{E}, \]  
   \[ E = \frac{P}{n} = 6.25 \times 10^{-19} \text{ J} \]  
   \[ E = 3.9 \text{ eV} \]  
   \[ W_o = E - eV_o \]  
   \[ = (3.9 - 2) eV_o \]  
   \[ W_o = 1.9 \text{ eV} \]

9. \( R = R_o e^{-\lambda t} \)
   \[ \ln R = \ln R_o - \lambda t \]
   \[ \ln R = -\lambda t + \ln R_o \]
   slope of \( \ln R \) v/s \( t \) is ‘-\( \lambda \)’
   \[ -\lambda = \frac{0-1.52}{218-164} \]
   \[ \lambda = 0.028 \text{ minute}^{-1} \]
<table>
<thead>
<tr>
<th>Frequency range</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ground wave</td>
<td>500-1500KHz  (1/2) Standard AM broadcast (1/2)</td>
</tr>
<tr>
<td>Space wave</td>
<td>Above 40 MHz     (1/2) Television         (1/2)</td>
</tr>
</tbody>
</table>

**SECTION C**

11. (i) at A, \( E = \frac{\sigma}{2\varepsilon_0} \)  
\[ E = 1.1 \times 10^{28} \text{ N/C} \]  
Directed away from the sheet  
(ii) Point Y  
Because at 50cm, the charge sheet acts as a finite sheet and thus the magnitude remains same towards the middle region of the planar sheet.

12. (i) \( V = Ir \) (without voltmeter) \( R_v \)  
\[ V' = \frac{Ir}{r+R_v} = \frac{Ir}{1+\frac{r}{R_v}} \]  
\( V' < V \)  
(ii) Percentage error  
\[ \left(\frac{V-V'}{V}\right) \times 100 \]  
\[ = \left(\frac{r}{r+R_v}\right) \times 100 \]  
(iii) \( R_v \rightarrow \infty, V' = Ir = V \)

OR

12 (a) \[ I = \frac{\varepsilon}{R+\frac{\rho_1 l}{A_1}} \] for Set A  
\[ I = \frac{\varepsilon}{R+\frac{\rho_1 l}{2A_1} + \frac{\rho_2 l}{2A_2}} \] for set B  
Equating the above two expressions and simplifying
(b) Potential gradient of the potentiometer wire for set A, \( K = \frac{I}{A_1} \)

Potential drop across the potentiometer wire in set B

\[
V = I \left( \frac{\rho_{11}}{2A_1} + \frac{\rho_{21}}{2A_2} \right)
\]

\[
V = \frac{l}{2} \left( \frac{\rho_{1}}{A_1} + \frac{\rho_{2}}{A_2} \right) l
\]

\[
K' = \frac{l}{2} \left( \frac{\rho_{1}}{A_1} + \frac{\rho_{2}}{A_2} \right), \text{ using the condition obtained in part (i)}
\]

\[
K' = I \frac{\rho_{1}}{A_1}, \text{ which is equal to } K.
\]

Therefore, balancing length obtained in the two sets is same.

13. (i) Machine: Cyclotron

Diagram

Resonance condition

(ii) Particle will accelerate and decelerate alternately. However, the radius of the path will remain unchanged

14. \( \epsilon = -\frac{d\phi}{dt} \),

\( \epsilon = -0.023 \text{ V}, \)

\( I = \epsilon/R = -2.7 \text{ mA for } 0<t<2s. \)

<table>
<thead>
<tr>
<th>( t )</th>
<th>0&lt;( t )&lt;2s</th>
<th>2&lt;( t )&lt;4s</th>
<th>4&lt;( t )&lt;6s</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \epsilon ) (V)</td>
<td>-0.023</td>
<td>0</td>
<td>+0.023</td>
</tr>
<tr>
<td>I (A)</td>
<td>-2.7</td>
<td>0</td>
<td>+2.7</td>
</tr>
</tbody>
</table>
15. | Type of wave | Application |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Gamma rays (1/2)</td>
<td>Treatment of tumors (1/2)</td>
</tr>
<tr>
<td>(b) Radio waves (1/2)</td>
<td>Radio and television Communication systems (1/2)</td>
</tr>
<tr>
<td>(c) X-rays (1/2)</td>
<td>Study of crystals (1/2)</td>
</tr>
</tbody>
</table>

16. \[ T_2P = D + x, \quad T_1P = D - x \] 
\[ S_1P = \left[ (S_1T_1)^2 + (PT_1)^2 \right]^{1/2} \]
\[ = \left[ D_2 + (D - x)^2 \right]^{1/2} \] 
\[ S_2P = \left[ D_2 + (D + x)^2 \right]^{1/2} \]
Minima will occur when \( S_2P - S_1P = \lambda/2 \)
\[ D = \frac{\lambda}{2(\sqrt{5} - 1)} \] 

17. \[ \frac{1}{f_e} = \frac{1}{ve} - \frac{1}{ue} \]
solving \( u_e = -4.2 \text{ cm} \) (1) 
\[ \frac{1}{f_o} = \frac{1}{vo} - \frac{1}{uo} \]
solving \( u_o = -1.1 \text{ cm} \) (1)
\[ m = \frac{v}{u} \left( 1 + \frac{B}{f \phi} \right) = -44 \tag{1} \]

18. Explanation of Photoelectric effect (1)
   - Explanation of the effect using particle concept (1)
   - Explanation of the failure of wave theory in the explanation (1)

19. \[ \frac{mv^2}{r} = \frac{e^2}{4\pi\epsilon_0 r^2} \]
   \[ v^2 = \frac{e^2}{m} \frac{4\pi\epsilon_0 r}{2} \tag{1/2} \]
   Bohr’s quantisation condition
   \[ Mr = nh/2\pi \tag{1/2} \]
   Solving, \[ v = \frac{e^2}{2\epsilon_0 h}, r = \epsilon_0 h^2 / \pi me^2 \tag{1/2} \]
   Magnetic field at the centre
   \[ B = \mu_0 I / 2r \tag{1/2} \]
   \[ I = ev / 2\pi r \tag{1/2} \]
   \[ B = \mu_0 e^7 \pi m^2 / 8\epsilon_0 ^3 h^5 \tag{1/2} \]

20. B: reverse biased (1/2)
   C: forward biased (1/2)
   Justification (2)

21. (i) Emitter base junction is forward biased whereas base collector junction is reverse biased. (1)
   (ii) Small change in the current \( I_B \) in the base circuit controls the larger current \( I_C \) in the collector circuit. \( I_C = \beta I_B \) (1)
   (iii) Elemental semiconductor’s band gap is such that the emitted wavelength lies in IR region. Hence cannot be used for making LED (1)

22. (i) Size of the antenna (1/2)
   Effective power radiated by the antenna (1/2)
   Mixing up of signals from different transmitters (1/2)
   (ii) Modulation (1/2)
   Block diagram of amplitude modulation (1)
SECTION D

23. (i) Any meaningful activity and values which could be inculcated (2)
(ii) Diagram with labelling three magnetic elements of earth (1+1)

SECTION E

24. (a) (i) \( C_A = 4\pi \varepsilon_o R, C_B = 4\pi \varepsilon_o(2R) \) (1/2)
\( C_B > C_A \) (1/2)
(ii) \( u = \frac{1}{2} \varepsilon_o E^2 \) (1/2)
\( E = \frac{\sigma}{\varepsilon_o} = \frac{Q}{A \varepsilon_o}, u \propto 1/ A^2 \)
\therefore u_A > u_B \) (1/2)
(b) (i) \( E = -\frac{dV}{dr} \) (1/2)

For same change in dV, \( E \propto 1/dr \) (1/2)

where ‘dr’ represents the distance between equipotential surfaces.

Diagram of equipotential surface due to a dipole (1)

(ii) Polarity of charge – negative (1/2)
Direction of electric field – radially inward (1/2)

OR

<table>
<thead>
<tr>
<th>Absence of electric field (1)</th>
<th>Non-Polar (O(_2)) –(1/2)</th>
<th>Polar (H(_2)O)- (1/2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual</td>
<td>No dipole moment exists</td>
<td>Dipole moment exists</td>
</tr>
<tr>
<td>Specimen</td>
<td>No dipole moment exists</td>
<td>Dipoles are randomly oriented. Net ( \mathbf{P}=0 )</td>
</tr>
</tbody>
</table>
### Presence of electric field

<table>
<thead>
<tr>
<th>Individual</th>
<th>Dipole moment exists (molecules become polarised)</th>
<th>Torque acts on the molecules to align them parallel to $E$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specimen</td>
<td>Dipole moment exists</td>
<td>Net dipole moment exists parallel to Dipole moment exists $E$.</td>
</tr>
</tbody>
</table>

(b) (i) $V = E_0 d + \frac{E_0}{k}d + E_0 d + 0 + E_0 d$  

$$V = 3 E_0 d + \frac{E_0}{k}d$$

(ii) Graph

![Graph](image)

25. (a) AC generator

- Diagram  
- Principle  
- Working

(b) (i) Capacitor – electric field  
- Inductor – magnetic field  
- (ii) resistance of the circuit
Radiation in the form of EM waves

OR

25 (a) B : inductive reactance

C: resistance

(b) At resonance $X_L = X_C$

$$Z = [(X_L - X_C)^2 + R^2]^{1/2}, \ Z = R$$

Phasor diagrams

phase difference is $\phi$

(c) Acceptor circuit: Series LCR circuit
Radio tuning

26. (a) To derive \[ \frac{\mu_2}{\nu} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R} \] \hspace{1cm} (3)

(b) Diagram \hspace{1cm} (2)

OR

26 (a) Diagram -

\[ \frac{\mu_g}{\mu_w} = \frac{1}{\sin i_c} \] \hspace{1cm} (1)
Sin $i_c = 8/9$  

(b) Graph

Interpretation: Path of the ray can be traced back resulting in same angle of deviation if $i$ & $e$ are interchanged

$$\delta + A = i + e$$

To derive $\mu = \frac{\sin(\frac{A+\delta m}{2})}{\sin A/2}$