MOTHER'S PUBLIC SCHOOL

MOCK EXAMINATION   MARKING SCHEME

PHYSICS THEORY

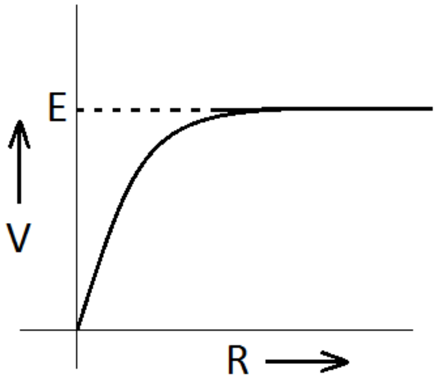
SECTION A

1. $V_C = 0$ [½]

$$V_D = \frac{1}{4\pi\varepsilon_0}\left[\frac{q}{3L} - \frac{q}{L}\right] = -\frac{q}{6\pi\varepsilon_0}$$

$W = q[V_D - V_C] = -\frac{qQ}{6\pi\varepsilon_0 L}$ [½]

2. [1]



3. $p = \frac{U}{c} = \frac{18\times1\times20}{3\times10^8} = \frac{360J}{3\times10^8 m/s} = 1.2\times10^{-6} kgm/s$ [½ + ½]

4. If they intersect, then there will be two rays or two directions of propagation of energy at the point of intersection which is not possible. [1]

5. In photon picture, intensity is determined by the number of photons crossing per unit time. [1]

SECTION B

6. $Z = \sqrt{\left(X_L^2 - X_C^2\right) + R^2}$. Given Z is same at two frequencies f_1 and f_2

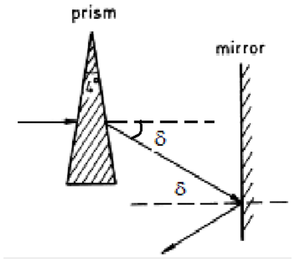
⇨ $\left(X_L - X_C\right)_{f_1} = \left(X_L - X_C\right)_{f_2} \Rightarrow 2\pi f_1 L - \frac{1}{2\pi f_1 C} = \frac{1}{2\pi f_2 C} - 2\pi f_2 L$ [½]

⇨ $2\pi(f_1 + f_2)L = \frac{1}{2\pi C}\left(\frac{1}{f_1} + \frac{1}{f_2}\right) \Rightarrow 4\pi^2(f_1 + f_2) = \frac{1}{LC}\left(\frac{1}{f_1} + \frac{1}{f_2}\right)$ [1]

⇨ $4\pi^2 = 4\pi^2 f_r^2 \frac{1}{f_1 f_2} \Rightarrow f_r = \sqrt{f_1 f_2}$ [½]

7. $E = Bc = (1.2\times10^{-8}\ T)(3\times10^8 m/s) = 3.6\ V/m$ [½ + ½]

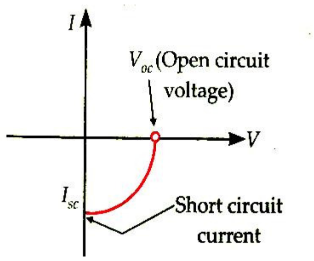
$\vec{B}$ is along z-direction and the wave propagates along x-direction. So $\vec{E}$ should be along y directions. $\therefore\ \vec{E} = 3.6\,\hat{j}\ V/m$ [½ + ½]

8. 

$\delta=(n-1)A \Rightarrow \delta = (1.5-1)4^0 = 2^0$ [1]

Since the reflected ray gets rotated by 2θ if the mirror gets rotated by θ, one should rotate the mirror by 1^0 [1]

9. Solar cell is based on the principle of photovoltaic effect where a potential difference is generated due to bombardment of light photons on an optoelectronic junction diode. [1]



[1]

10. The refractive index increases with increase in frequency which implies that for higher frequency waves, angle of refraction is less, i.e., bending is less. Hence the condition of Total Internal Reflection is attained after travelling larger distance by the 3 MHz wave. [1 + 1]

OR

Modulation index $\mu = \frac{A_m}{A_C}$ [1]

It should be kept less than 1, to avoid distortion. [1]

SECTION C

11. $CV+CV=CV_1+CV_2$ or $V = (V_1+V_2)/2$ [1]

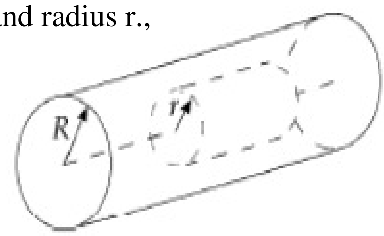
Decrease in energy $= \frac{1}{2}CV_1^2 + \frac{1}{2}CV_2^2 - \frac{1}{2}C\left[\frac{V_1+V_2}{2}\right]^2$ [½]

$= \frac{1}{2}C\left[V_1^2 + V_2^2 - \left(\frac{V_1+V_2}{2}\right)^2\right]$ [½]

$= \frac{1}{4}C\left[2V_1^2 + 2V_2^2 - (V_1+V_2)^2\right] = \frac{1}{4}C\left[V_1^2 + V_2^2 - 2V_1V_2\right]$ [½]

$= \frac{1}{4}C(V_1 - V_2)^2$ [½]

12. If ρ is positive, the field must be radially outward.
Choose the Gaussian surface as a cylinder of length L and radius r., contained inside the charged rod. [½]



The volume of the cylinder = $\pi r^2 L$

The charge enclosed in the cylinder = $\rho \pi r^2 L$ [½]

Since the charge distribution is long, no electric flux passes through the circular end caps.

E.*d***A** = *EdA*cos 90°= 0 [½]

The curved surface has **E**.*d***A** = *EdA*cos 0° and *E* must be the same strength everywhere over the curved surface. [½]

Gauss's law, $\oint E.dA = \frac{q}{\varepsilon_0}$ => $E \int_{\substack{\text{curved}\\ \text{surface}}} dA = \frac{\rho\pi r^2 L}{\varepsilon_0}$ [½]

$E(2\pi r)L = \frac{\rho\pi r^2 L}{\varepsilon_0}$. Therefore, $E = \frac{\rho r}{2\varepsilon_0}$ [½]

13. (i) $V = Ir$ (without voltmeter) but with resistance R_V [½]

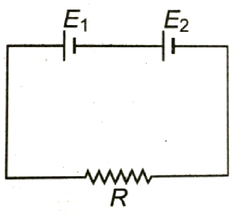
$V' = \frac{IrR_V}{r + R_v} = \frac{Ir}{1 + \frac{r}{R_v}}$ [½]

$V' < V$ [½]

(ii) Percentage error $\left(\frac{V - V'}{V}\right) \times 100 = \left(\frac{r}{r + R_V}\right) \times 100$ [1]

(iii) $R_V \to \infty, V' = Ir = V$ [½]

14. If E be the emf of each cell, resultant emf = 2E [½]



Total resistance = $R_1 + R_2 + R$ [½]

$i = \frac{2E}{R_1 + R_2 + R}$ [½]

Potential difference across terminals of source

$= \Delta V = E - iR_2 = E - \left(\frac{2E}{R_1 + R_2 + R}\right) R_2$ [½]

Since, $\frac{2R_2}{R_1 + R_2 + R} = 1$ [½]

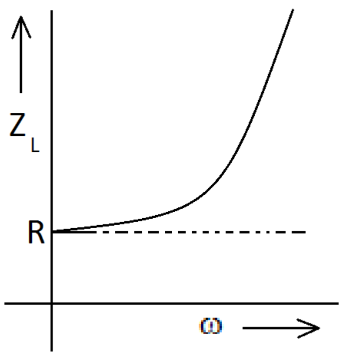
$2R_2 = R_1 + R_2 + R \Rightarrow R = R_2 - R_1$ [½]

15. Transformer works on the principle of Mutual Induction. [½]
Diagram on pg. 260 NCERT Part I [½]
Working and explanation [1 ½]
Energy conservation is not violated since $P_{in} = P_{out}$ [½]

16. Phasor diagram [½]
Derivation of
$I = I_0 \sin(\omega t)$ [½]
$V = V_0 \sin(\omega t + \varphi)$ [½]

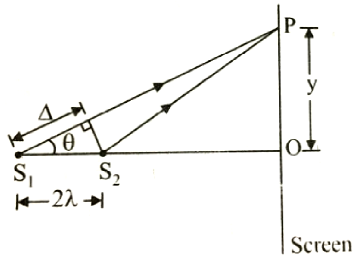
$Z_L = \sqrt{X_L^2 + R^2}$ where $X_L = \omega L$ [1]

Graph



[½]

17. [1]



Path difference $\Delta = 2\lambda\cos\theta = n\lambda$ [½]

Taking n=1, cosθ = ½ => θ=60^0 [½]

tanθ = y/D => tan 60^0 =y/D [½]

y=√3 D [½]

18. Statement of Malus Law [1]

Since transmitted intensity $I = I_0\cos^2\theta$

And avg. of $\cos^2\theta$ i.e., $<\cos^2\theta> = ½$

Therefore $I = I_0/2$ [1]

Polarization displays the transverse nature of light that is not displayed by YDSE [1]

19. (i) Figure-NCERT II page 391 [½]

Explanation [1]

(ii) Figure- NCERT II page 392 [½]

Explanation [1]

OR

(i) Davisson Germer experiment [½]

An electron of charge e, mass 'm' accelerated through a potential difference of V volts

Kinetic Energy K = eV [½]

$$K = \frac{p^2}{2m} \Rightarrow p = \sqrt{2mK} \Rightarrow p = \sqrt{2meV}$$ [½]

Then the deBroglie wavelength of the electron is given by

$$\lambda = \frac{h}{p} \Rightarrow \lambda = \frac{h}{\sqrt{2meV}}$$ [1]

(ii) For same KE, $\lambda \ \alpha \ \frac{1}{\sqrt{m}}$

As mass of proton is greater than that of electron, $\lambda_P < \lambda_e$ [½]

20. Figure- NCERT II pg.444, fig. 13.1 [1]

Explanation for fission [1]

Explanation for fusion [1]

21. $$h\nu = E_n - E_{n-1} = = -\frac{13.6Z^2}{n^2} + \frac{13.6Z^2}{(n-1)^2}$$ [1]

$$= 13.6Z^2\left[\frac{1}{(n-1)^2} - \frac{1}{n^2}\right] = 13.6Z^2\left[\frac{n^2-(n-1)^2}{n^2(n-1)^2}\right]$$

$$= \frac{13.6Z^2}{n^2}\left[\frac{n^2}{(n-1)^2} - 1\right] = \frac{13.6Z^2}{n^2}\left[\frac{1}{\left(1-\frac{1}{n}\right)^2} - 1\right]$$ [1]

$$= \frac{13.6Z^2}{n^2}\left[\left(1-\frac{1}{n}\right)^{-2} - 1\right] = \frac{13.6Z^2}{n^2}\left[1+\frac{2}{n} - 1\right] = = \frac{2\times 13.6Z^2}{n^3}$$ [1]

22. Modulation definition [1]
Need for modulation- 2 reasons and explanation [1+1]

SECTION-D

23. Mayank displayed friendly and helpful nature [1]
Arvind displayed curiosity and eagerness to learn [1]
Mayank must have connected the voltmeter in parallel [1]
Potentiometer is more accurate than voltmeter because it is based on the method of null deflection and does not draw current from the circuit. [1]

SECTION E

24. Principle of Cyclotron and diagram [1 ½]
Derivation of expression of frequency $f = qB/2\pi m$ [2]

$\frac{1}{2}mv^2 = qV \Rightarrow v = \sqrt{\frac{2qV}{m}}$ [½]

$r = \frac{mv}{qB} = \frac{m}{qB}\sqrt{\frac{2qV}{m}}$ => $R \propto \sqrt{m}$ => $m \propto R^2$ [½]

Therefore $m_A : m_B = 2^2 : 3^2 = 4 : 9$ [½]

OR

Derivation of the expression $M = neh/4\pi m = n\,\mu_B$ [2]
Diagram for magnetic field lines for Cu- diamagnetic [1]
Diagram for magnetic field lines for Al- Paramagnetic [1]
Diagram for magnetic field lines for Fe- Ferromagnetic [1]

25. Diagram of Compound Microscope
Derivation of magnifying power
Expression of magnifying power for image formed at far point (normal setting) [5]

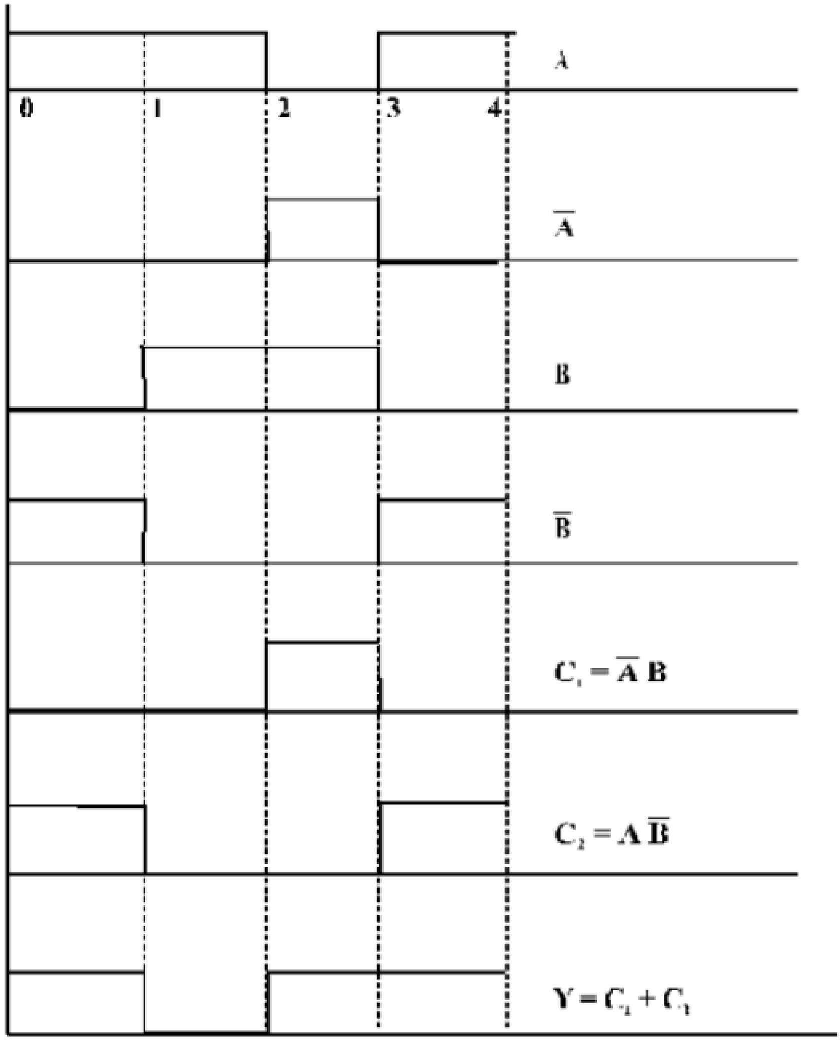
OR

Derivation of relation $\delta = (n-1) A$ [3]
Since the ray retraces its path , the ray must be incident normally on the silvered face
Angle of emergence $e = 0$ => $r_2 = 0$
Since $r_1 + r_2 = A$ => $r_1 = A = 30^0$ [1]
By snell's law
$n_1 \sin i = n_2 \sin r_1$
⇨ $1. \sin i = \sqrt{2} \sin r_1$ => $\sin i = 1/\sqrt{2}$ => $i = 45^0$ [1]

26. Circuit diagram of npn CE type transistor. [1]
Typical Input and output characteristics [1 + 1]
Cut off, Active and Saturation region description [½ + ½ + ½]
To be operated as Switch it must not be operated in Active region. [½]

OR

The output C_1 is the output of an AND gate having $\bar{A}$ and B as its two inputs. [½]
The output C_2 is the output of an AND gate having A and $\bar{B}$ as its two inputs. [½]
The output Y is the output of an OR gate having C_1 and C_2 as its two inputs. [½]
Using the truth tables for AND and OR gates, we can or therefore get the wave forms shown for C_1, C_2 and Y.



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Looking at the shapes of A, B and Y, we can say that :

(1) The output Y is low when both A and B are high. [½]

(2) The output Y is high when one of the input signals is high while the other is low.