# Class: XII Session 2023-24 SUBJECT: PHYSICS(THEORY) MARKING SCHEME SECTION A

A1: c		1 <b>M</b>
A2: c	$q = \tau/[(2a) \operatorname{E} \sin \theta] = \frac{4}{2 \times 10^{-2} \times 2 \times 10^{5} \sin 30^{\circ}}$	1M
	$= 2 \times 10^{-3} \text{ C} = 2 \text{ mC}$	
A3: d	Higher the frequency, greater is the stopping potential	1 <b>M</b>
A4: c		1M
A5: b		1 <b>M</b>
A6: d		1M
A7: b		1 <b>M</b>
	$10A$ $0.81 \Omega$	
	9A S	
	9 x S = 1 × 0.81	
	0.81 0.00 0	
	$S = \frac{1}{9} = 0.09 \Omega_2$	
A8: a		1 <b>M</b>
A9: d		1 <b>M</b>
A10: a		1M
A11: d	$e = \frac{\Delta \Phi}{\Delta t}, I = \frac{1}{R} \frac{\Delta \Phi}{\Delta t}$	1M
	$I \Delta t = \frac{\Delta \Phi}{R}$ = Area under <i>I</i> – <i>t</i> graph, <i>R</i> = 100 ohm	
	:. $\Delta \Phi = 100 \times \frac{1}{2} \times 10 \times 0.5 = 250$ Wb.	
A12: b		1 <b>M</b>
A13: a		1M
A14: a		1M
A15: c		1 <b>M</b>
Q16: c		1 <b>M</b>
	SECTION B	

# A17: (a) Rectifier

(b) Circuit diagram of full wave rectifier



1M

<b>A18</b> : As $\lambda = h / mv$ , $v = h / m\lambda$	(i)		1/2M
Energy of photon E = hc $/\lambda$			1/2M
& Kinetic energy of electron K =1/	2 mv <sup>2</sup> = $\frac{1}{2}$ mh <sup>2</sup> / m <sup>2</sup> $\lambda^2$	(ii)	1/2M
Simplifying equation i & ii we get E	/ K = 2λmc /h		1/2M

**A19**: Here angle of prism A = 60°, angle of incidence i = angle of emergence e and

under this condition angle of deviation is minimum

:. 
$$i = e = \frac{3}{4}A = \frac{3}{4} \times 60^{\circ} = 45^{\circ}$$
 and  $i + e = A + D$ ,  
hence  $D_m = 2i - A = 2 \times 45^{\circ} - 60^{\circ} = 30^{\circ}$  1M

∴ Refractive index of glass prism

$$n = \frac{\sin\left(\frac{A+D_m}{2}\right)}{\sin\left(\frac{A}{2}\right)} = \frac{\sin\left(\frac{60^\circ + 30^\circ}{2}\right)}{\sin\left(\frac{60^\circ}{2}\right)} = \frac{\sin 45^\circ}{\sin 30^\circ} = \frac{1/\sqrt{2}}{1/2} = \sqrt{2}.$$
 1M

**A20**:Given: V=230 V, I<sub>0</sub>= 3.2A, I=2.8A,  $T_0 = 27 \ ^{\circ}\text{C}$ ,  $\alpha = 1.70 \times 10^{-4} \ ^{\circ}\text{C}^{-1}$ .

Using equation  $R = R_0 (1 + \alpha \Delta T)$  % M

i.e V/I = 
$$\{V/I_0\} [1 + \alpha \Delta T]$$
 % M

and solving 
$$\Delta T$$
 = 840 , i.e. T = 840 + 27 = 867 °C 1M

A21: Let *d* be the least distance between object and image for a real image formation.



1⁄2 M

$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}, \qquad \qquad \frac{1}{f} = \frac{1}{x} + \frac{1}{d-x} = \frac{d}{x(d-x)}$$
<sup>1</sup>/<sub>2</sub> M

$$fd = xd - x^2$$
,  $x^2 - dx + fd = 0$ ,  $x = \frac{d \pm \sqrt{d^2 - 4fd}}{2}$   $\frac{1}{2}$ 

For real roots of x, 
$$d^2 - 4fd \ge 0$$
  $\frac{1}{2}$  M

### OR

Let  $f_o$  and  $f_e$  be the focal length of the objective and eyepiece respectively. For normal adjustment the distance from objective to eyepiece is  $f_o + f_e$ .

 $d \ge 4f$ .

Taking the line on the objective as object and eyepiece as lens

$$u = -(f_o + f_e) \quad \text{and} \quad f = f_e$$

$$\frac{1}{v} - \frac{1}{\left[-\{f_o + f_e\}\right]} = \frac{1}{f_e} \quad \Rightarrow \quad V = \left(\frac{f_o + f_e}{f_o}\right) f_e$$

$$1M$$

Linear magnification (eyepiece) =	$\frac{v}{u} =$	Image size Object size	=	<u>fe</u> fo	=	l L	y.	٤M
				,0		-		

∴ Angular magnification of telescope

$$M = \frac{f_0}{f_e} = \frac{L}{l}$$
SECTION C

A22: Number of atoms in 3 gram of Cu coin = (6.023 x 10<sup>23</sup> X 3) / 63 = 2.86 X 10<sup>22</sup> ½ M Each atom has 29 Protons & 34 Neutrons

Thus Mass defect Δm= 29X 1.00783 + 34X 1.00867 – 62.92960 u =0.59225u	1M
Nuclear energy required for one atom =0.59225 X 931.5 MeV	1⁄2 M
Nuclear energy required for 3 gram of Cu =0.59225 X 931.5 X 2.86X 10 <sup>22</sup> MeV	
= 1.58 X 10 <sup>25</sup> MeV	1M

$$V_{c} = 0,$$

$$V_{D} = \frac{1}{4\pi\varepsilon_{0}} \left[ \frac{q}{3L} - \frac{q}{L} \right] = \frac{-q}{6\pi\varepsilon_{0}L}$$

$$W = Q \left[ V_{D} - V_{c} \right] = \frac{-Qq}{6\pi\varepsilon_{0}L}$$

$$IM$$

<b>A24</b> : formula K=-E , U = -2K	1M
(a) K = 3.4 eV & (b) U= -6.8 eV	1M
(c) The kinetic energy of the electron will not change. The value of potential energy and	
consequently, the value of total energy of the electron will change.	1M

A25:

A23:



As the points B and P are at the same potential,  $\frac{1}{1} = \frac{\frac{(1+x)}{(2+x)}}{(1-x)} \Rightarrow x = (\sqrt{2} - 1) ohm$  **1.5**M



(a) Consider the case r > a. The Amperian loop, labelled 2, is a circle concentric with the cross-section. For this loop,  $L = 2 \pi r$ 

Using Ampere circuital Law, we can write,

$$B(2\pi r) = \mu_0 I$$
,  $B = \frac{\mu_0 I}{2\pi r}$ ,  $B \propto \frac{1}{r}$   $(r > a)$  1.5 M

(b)Consider the case r < a. The Amperian loop is a circle labelled 1. For this loop, taking the radius of the circle to be r,  $L = 2 \pi r$ 

Now the current enclosed *I<sub>e</sub>* is not *I*, but is less than this value. Since the current distribution is uniform, the current enclosed is,

$$I_e = I \left(\frac{\pi r^2}{\pi a^2}\right) = \frac{Ir^2}{a^2} \quad \text{Using Ampere's law, } B(2\pi r) = \mu_0 \frac{Ir^2}{a^2}$$
$$B = \left(\frac{\mu_0 I}{2\pi a^2}\right) r \qquad B \propto r \qquad (r < a) \qquad 1.5M$$
Infrared (b) Ultraviolet (c) X rays

A27: (a) Infrared (b) Ultraviolet (c) X rays Any one method of the production of each one



**(b)** 



Let a current I<sub>P</sub> flow through the circular loop of radius R. The magnetic induction at the centre of the loop is

$$B_{\rm P} = \frac{\mu_0 I_{\rm P}}{2R}$$

As,  $r \ll R$ , the magnetic induction B<sub>P</sub> may be considered to be constant over the entire cross sectional area of inner loop of radius r. Hence magnetic flux linked with the smaller loop will be

$\Phi_{\rm S} = B_{\rm P}A_{\rm S} = \frac{\mu_0 I_{\rm P}}{2R}\pi r^2$	½ M	
ф <sub>5</sub> = М I <sub>Р</sub>	½ M	

Also,

1/2 + 1/2 + 1/2 M

 $\frac{1}{2} + \frac{1}{2} M$ 

½ M

$$M = \frac{\Phi_S}{I_P} = \frac{\mu_0 \pi r^2}{2R}$$

½ M

The magnetic induction  $B_1$  set up by the current  $I_1$  flowing in first conductor at a point somewhere in the middle of second conductor is



The magnetic force acting on the portion  $\mathsf{P}_2\mathsf{Q}_2$  of length  $\ell_2$  of second conductor is

$$F_2 = I_2 \ell_2 B_1 \sin 90^\circ$$
 ...(2)

From equation (1) and (2),

:.

$$F_{2} = \frac{\mu_{0}I_{1}I_{2}\ell_{2}}{2\pi a}, \text{ towards first conductor} \qquad \% M$$

$$\frac{F_{2}}{\ell_{2}} = \frac{\mu_{0}I_{1}I_{2}}{2\pi a} \qquad ...(3)$$

The magnetic induction B<sub>2</sub> set up by the current I<sub>2</sub> flowing in second conductor at a point somewhere in the middle of first conductor is

$$B_2 = \frac{\mu_0 I_2}{2\pi a} \qquad ...(4) \qquad \frac{1}{2} M$$

The magnetic force acting on the portion  $P_1Q_1$  of length  $\ell_1$  of first conductor is

$$F_1 = I_1 \ell_1 B_2 \sin 90^\circ$$
 ...(5)

From equation (3) and (5)

$$F_{1} = \frac{\mu_{0}I_{1}I_{2}\ell_{1}}{2\pi a}, \text{ towards second conductor} \qquad \qquad \checkmark_{2} M$$

$$\frac{F_{1}}{\ell_{1}} = \frac{\mu_{0}I_{1}I_{2}}{2\pi a} \qquad \qquad \dots (6)$$

The standard definition of 1A

If 
$$l_1 = l_2 = 1A$$
  
 $\ell_1 = \ell_2 = 1m$   
 $a = 1m \text{ in V/A}$  then  $\frac{F_1}{\ell_1} = \frac{F_2}{\ell_2} = \frac{\mu_0 \times 1 \times 1}{2\pi \times 1} = 2 \times 10^{-7} \text{ N/m}$ 

 $\therefore$  One ampere is that electric current which when flows in each one of the two infinitely long straight parallel conductors placed 1m apart in vacuum causes each one of them to experience a force of 2 × 10<sup>-7</sup> N/m. **1**M

A29 (i) d (ii) c (iii) c OR b (iv) d A30: (i) a (ii) b (iii) b (iv) d OR c

### **SECTION E**

A31: i. DIAGRAM/S : 1M DERIVATION : 2M NUMERICAL : 2 M Lens maker's Formula



When a ray refracts from a lens (double convex), in above figure, then its image formation can be seen in term of two steps :

Step 1: The first refracting surface forms the image I1 of the object O



**Step 2:** The image of object O for first surface acts like a virtual object for the second surface. Now for the first surface ABC, ray will move from rarer to denser medium, then

$$\frac{n_2}{BI_1} + \frac{n_1}{OB} = \frac{n_2 - n_1}{BC_1} \qquad ...(i) \qquad \frac{1}{2} M$$

Similarly for the second interface, ADC we can write.

$$\frac{n_1}{DI} - \frac{n_2}{DI_1} = \frac{n_2 - n_1}{DC_2} \qquad ...(ii)$$

 $\mathsf{D}\mathsf{I}_1$  is negative as distance is measured against the direction of incident light.

Adding equation (1) and equation (2), we get

$$\frac{n_2}{BI_1} + \frac{n_1}{OB} + \frac{n_1}{DI} - \frac{n_2}{DI_1} = \frac{n_2 - n_1}{BC_1} + \frac{n_2 - n_1}{DC_2}$$
$$\frac{n_1}{DI} + \frac{n_1}{OB} = (n_2 - n_1) \left( \frac{1}{BC_1} + \frac{1}{DC_2} \right) \qquad \dots \text{(iii) (:: for thin lens } BI_1 = DI_1\text{)}$$

or

Now, if we assume the object to be at infinity *i.e.*  $OB \rightarrow \infty$ , then its image will form at focus *F* (with focal length *f*), *i.e.*  $\frac{1}{2}$  M

DI = f, thus equation (iii) can be rewritten as

$$\frac{n_1}{f} + \frac{n_1}{\infty} = (n_2 - n_1) \left( \frac{1}{BC_1} + \frac{1}{DC_2} \right)$$
$$\frac{n_1}{f} = (n_2 - n_1) \left( \frac{1}{BC_1} + \frac{1}{DC_2} \right) \qquad \dots \text{(iv)}$$

or

Now according to the sign conventions

$$BC_1 = +R_1$$
 and  $DC_2 = -R_2$  ...(v)

Substituting equation (v) in equation (iv), we get

$$\frac{n_{1}}{f} = (n_{2} - n_{1}) \left( \frac{1}{R_{1}} - \frac{1}{R_{2}} \right)$$

$$\frac{1}{f} = \left( \frac{n_{2}}{n_{1}} - 1 \right) \left( \frac{1}{R_{1}} - \frac{1}{R_{2}} \right)$$

$$\frac{1}{f} = (n_{21} - 1) \left( \frac{1}{R_{1}} - \frac{1}{R_{2}} \right)$$
(ii) 
$$\frac{1}{f_{a}} = (1.6 - 1) \left( \frac{1}{R_{1}} - \frac{1}{R_{2}} \right) \qquad \dots(1)$$
1M

$$\frac{1}{f_{\ell}} = \left[\frac{1.6}{1.3} - 1\right] \left(\frac{1}{R_1} - \frac{1}{R_2}\right) \qquad \dots (2)$$

From equation (1) and (2)

$$\frac{f_{\ell}}{f_a} = \left[\frac{0.6}{0.3} \times 1.3\right] \implies f_{\ell} = 2.6 \times 10 \,\mathrm{cm} \implies f_{\ell} = 26 \,\mathrm{cm}$$

OR

### (i) A wavefront is defined as a surface of constant phase.

- (a) The ray indicates the direction of propagation of wave while the wavefront is the surface of constant phase.
- (b) The ray at each point of a wavefront is normal to the wavefront at that point.

(ii) AB: Incident Plane Wave Front & CE is Refracted Wave front . 2M

Sin i =BC/AC & Sin r = AE /AC

Sin i / Sinr = BC /AE =  $v_1$  / $v_2$  = constant



1/2 M

(iii) 
$$\Theta = \lambda / a$$
 i.e.  $a = \frac{\lambda}{\theta} = \frac{6 \times 10^{-7}}{0.1 \times \frac{\pi}{180}} = 3.4 \times 10^{-4} \,\mathrm{m}$  1M

(iv) Two differences between interference pattern and diffraction pattern1MA32: (i) Derivation of the expression for the capacitance2M



Let the two plates be kept parallel to each other separated by a distance d and cross-sectional area of each plate

is A. Electric field by a single thin plate  $E = \sigma / 2\epsilon_0$ Total electric field between the plates  $E= \sigma / \epsilon_0 = Q/A \epsilon_0$ Potential difference between the plates V=Ed = [Q/A  $\epsilon_0$ ] d.

Capacitance C= Q / V = A $\epsilon_0$  / d



OR

(i) Derivation of the expression for capacitance with dielectric slab (t < d) **3M** 



Before the connection of switch S,

Initial energy 
$$U_i = \frac{1}{2}C_1V_0^2 + \frac{1}{2}C_2O^2 = \frac{1}{2}C_1V_0^2$$
 % M

After the connection of switch S

common potential V = 
$$\frac{C_1 V_1 + C_2 V_2}{C_1 + C_2} = \frac{C_1 V_0}{C_1 + C_2}$$
 1/2 M

Final energy = 
$$U_f = \frac{1}{2}(C_1 + C_2)\frac{(C_1 V_0)^2}{(C_1 + C_2)^2} = \frac{1}{2}\frac{C_1^2 V_0^2}{(C_1 + C_2)}$$
 % M

 $U_f: U_i = C_1 / (C_1 + C_2)$ 

A33:

(a)



(b)



1M

1M

½ M

 (c)(i) In device X, Current lags behind the voltage by π /2, X is an inductor In device Y, Current in phase with the applied voltage, Y is resistor
 (ii) We are given that 0.25=220/X<sub>L</sub>, X<sub>L</sub> =880Ω, Also 0.25=220/R, R = 880Ω

For the series combination of X and Y,

Equivalent impedance  $Z = 880 \sqrt{2} \Omega$ , I = 0.177 A



 $E = E_0 \sin \omega t$  is applied to a series LCR circuit. Since all three of them are connected in series the current through them is same. But the voltage across each element has a different phase relation with current. The potential difference V<sub>L</sub>, V<sub>C</sub> and V<sub>R</sub> across L, C and R at any instant is given by

 $V_L = IX_L$ ,  $V_C = IX_C$  and  $V_R = IR$ , where I is the current at that instant.

 $V_R$  is in phase with I.  $V_L$  leads I by 90° and  $V_C$  lags behind I by 90° so the phasor diagram will be as shown Assuming  $V_L > V_C$ , the applied emf E which is equal to resultant of potential drop across R, L & C is given as  $E^2 = I^2 [R^2 + (X_L - X_C)^2]$ 

Or  $I = \frac{E}{\sqrt{[R^2 + (X_L - X_C)2]}} = \frac{E}{Z}$ , where Z is Impedance. Emf leads current by a phase angle  $\varphi$  as  $\tan \varphi = \frac{V_L - V_C}{R} = \frac{X_L - X_C}{R}$ 

b. The curve (i) is for  $R_1$  and the curve (ii) is for  $R_2$ 



1M