Class: XII Session 2023-24

SUBJECT: PHYSICS(THEORY)

MARKING SCHEME

SECTION A

A1: c **1M**

A2: c $q = \tau/[(2a)\ E \sin\theta] = \frac{4}{2\times10^{-2}\times 2\times 10^{5}\sin 30°}$ **1M**

$= 2 \times 10^{-3}$ C = 2 mC

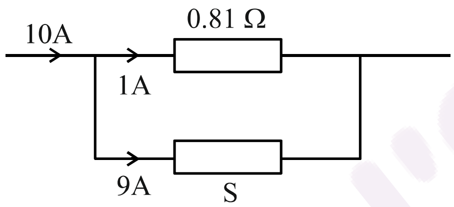
A3: d Higher the frequency, greater is the stopping potential **1M**

A4: c **1M**

A5: b **1M**

A6: d **1M**

A7: b **1M**



9 x S = 1 × 0.81

$S = \frac{0.81}{9} = 0.09\ \Omega$

A8: a **1M**

A9: d **1M**

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 $I - t$ graph, R = 100 ohm

$\therefore \quad \Delta\Phi = 100 \times \frac{1}{2} \times 10 \times 0.5 = 250$ Wb.

A12: b **1M**

A13: a **1M**

A14: a **1M**

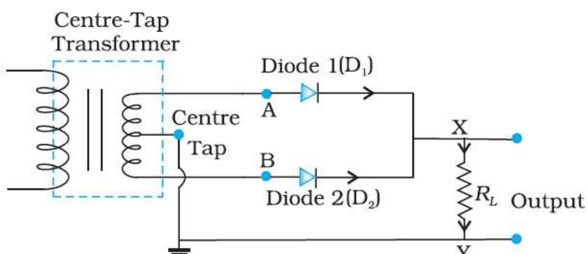
A15: c **1M**

Q16: c **1M**

SECTION B

A17: (a) Rectifier **1M**

(b) Circuit diagram of full wave rectifier **1M**



(a)

A18: As $\lambda = h/mv$, $v = h/m\lambda$ -----------------(i) 1/2M

Energy of photon $E = hc/\lambda$ 1/2M

& Kinetic energy of electron $K = 1/2\ mv^2 = ½\ mh^2/m^2\lambda^2$ --------------(ii) 1/2M

Simplifying equation i & ii we get $E/K = 2\lambda mc/h$ 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

$\therefore\quad i = e = \frac{3}{4}A = \frac{3}{4}\times 60° = 45°$ and $i + e = A + D$,

hence $D_m = 2i - A = 2 \times 45° - 60° = 30°$ 1M

$\therefore$ Refractive index of glass prism

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

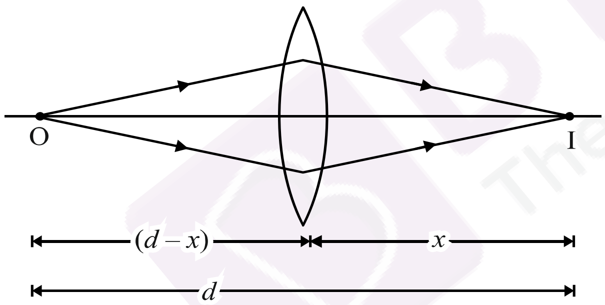
A20:Given: V=230 V, I_0= 3.2A, I=2.8A, T_0 =27 ^{0}C, α=1.70 × 10^{-4} °C^{-1}.

Using equation $R = R_0(1+\alpha\Delta T)$ ½ M

i.e $V/I = \{V/I_0\}[1+\alpha\Delta T]$ ½ M

and solving $\Delta T = 840$, i.e. $T = 840 + 27 = 867\ ^0C$ 1M

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



½M

$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$, $\frac{1}{f} = \frac{1}{x} + \frac{1}{d-x} = \frac{d}{x(d-x)}$ ½ M

$fd = xd - x^2$, $x^2 - dx + fd = 0$, $\Rightarrow x = \frac{d\pm\sqrt{d^2-4fd}}{2}$ ½M

For real roots of *x*, $d^2 - 4fd \geq 0$ ½M

$d \geq 4f$.

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 $f_o + f_e$.

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

$u = -(f_o + f_e)$ and $f = f_e$

$\frac{1}{v} - \frac{1}{[-\{fo+fe\}]} = \frac{1}{fe} \Rightarrow v = \left(\frac{f_o + f_e}{f_o}\right) f_e$ 1M

Linear magnification (eyepiece) = $\frac{v}{u} = \frac{Image\ size}{Object\ size} = \frac{f_e}{f_o} = \frac{l}{L}$ ½ M

∴ Angular magnification of telescope

M = $\frac{f_0}{f_e} = \frac{L}{l}$ ½ M

SECTION C

A22: Number of atoms in 3 gram of Cu coin = $(6.023 \times 10^{23} \times 3) / 63 = 2.86 \times 10^{22}$ ½ M

Each atom has 29 Protons & 34 Neutrons

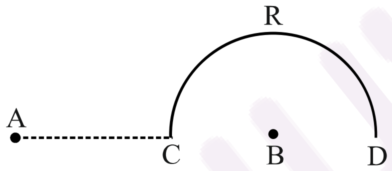
Thus Mass defect $\Delta m = 29 \times 1.00783 + 34 \times 1.00867 - 62.92960\ u = 0.59225u$ 1M

Nuclear energy required for one atom $= 0.59225 \times 931.5$ MeV ½ M

Nuclear energy required for 3 gram of Cu $= 0.59225 \times 931.5 \times 2.86 \times 10^{22}$ MeV

$= 1.58 \times 10^{25}$

A23:



$V_C = 0$, **1M**

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

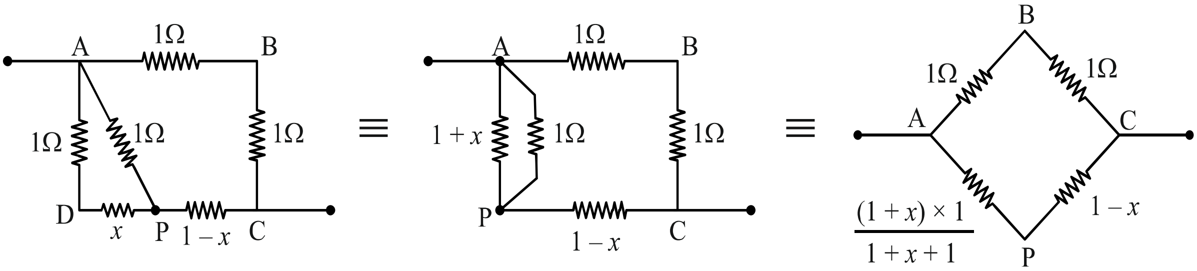
$$W = Q\,[V_D - V_C] = \frac{-Qq}{6\pi\varepsilon_0 L}$$ **1M**

A24 : 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**

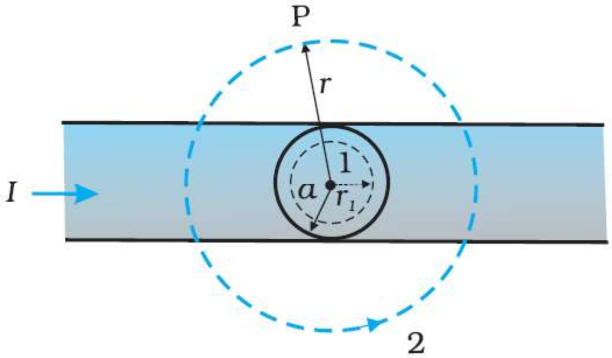
A25:



1.5M

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

A26:



(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_e is not I, but is less than this value. Since the current distribution is uniform, the current enclosed is,

$I_e = I\left(\frac{\pi r^2}{\pi a^2}\right) = \frac{Ir^2}{a^2}$ Using Ampere's law, $B(2\pi r) = \mu_0 \frac{Ir^2}{a^2}$

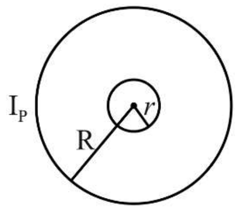
$B = \left(\frac{\mu_0 I}{2\pi a^2}\right) r$ $B \propto r$ $(r < a)$ **1.5M**

A27: (a) Infrared (b) Ultraviolet (c) X rays **½ + ½ + ½** M

Any one method of the production of each one **½ + ½ + ½** M

A28 (a) : Definition and S.I. Unit. **½ + ½ M**

(b)



Let a current I_P flow through the circular loop of radius R. The magnetic induction at the centre of the loop is

$$B_P = \frac{\mu_0 I_P}{2R}$$ **½ M**

As, $r << R$, the magnetic induction B_P 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

$$\phi_S = B_P A_S = \frac{\mu_0 I_P}{2R}\pi r^2$$ **½ M**

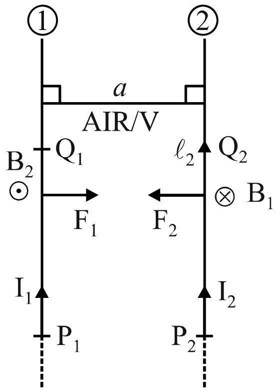
Also, $\phi_S = M I_P$ **½ M**

$$\therefore\ M = \frac{\phi_S}{I_P} = \frac{\mu_0 \pi r^2}{2R}$$ ½ M

OR

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

$$B_1 = \frac{\mu_0 I_1}{2\pi a} \quad ...(1)$$ ½ M



The magnetic force acting on the portion P_2Q_2 of length ℓ_2 of second conductor is

$$F_2 = I_2\,\ell_2\,B_1 \sin 90° \quad ...(2)$$

From equation (1) and (2),

$$F_2 = \frac{\mu_0 I_1 I_2 \ell_2}{2\pi a}$$, towards first conductor ½ M

$$\frac{F_2}{\ell_2} = \frac{\mu_0 I_1 I_2}{2\pi a} \quad ...(3)$$

The magnetic induction B_2 set up by the current I_2 flowing in second conductor at a point somewhere in the middle of first conductor is

$$B_2 = \frac{\mu_0 I_2}{2\pi a} \quad ...(4)$$ ½ M

The magnetic force acting on the portion P_1Q_1 of length ℓ_1 of first conductor is

$$F_1 = I_1 \ell_1 B_2 \sin 90° \quad ...(5)$$

From equation (3) and (5)

$$F_1 = \frac{\mu_0 I_1 I_2 \ell_1}{2\pi a}$$, towards second conductor ½ M

$$\frac{F_1}{\ell_1} = \frac{\mu_0 I_1 I_2}{2\pi a} \quad ...(6)$$

The standard definition of 1A

If $I_1 = I_2 = 1A$

$\ell_1 = \ell_2 = 1m$

$a = 1m$ in V/A then $\frac{F_1}{\ell_1} = \frac{F_2}{\ell_2} = \frac{\mu_0 \times 1 \times 1}{2\pi \times 1} = 2 \times 10^{-7}$ 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^{-7} N/m. **1**M

SECTION D

A29 (i) d (ii) c (iii) c OR b (iv) d

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

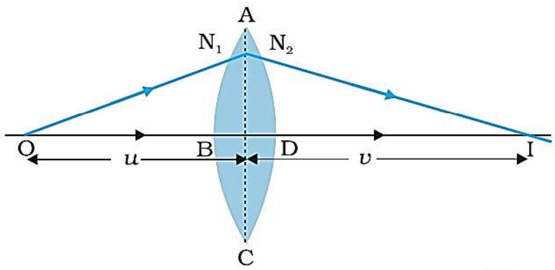
SECTION E

A31: i. DIAGRAM/S : 1M

DERIVATION : 2M

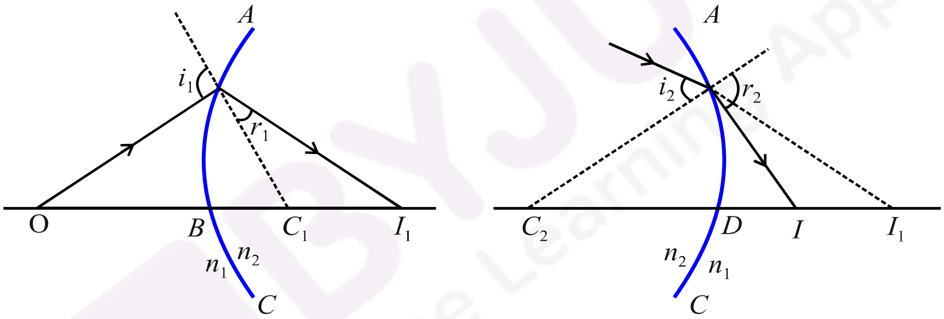
NUMERICAL : 2 M

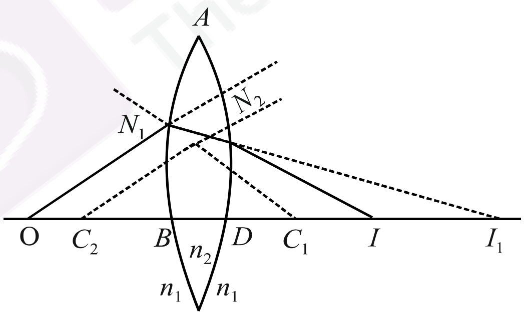
Lens maker's Formula



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 I_1 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

$$\frac{n_2}{BI_1}+\frac{n_1}{OB}=\frac{n_2-n_1}{BC_1} \quad \text{...(i)}$$ ½ M

Similarly for the second interface, ADC we can write.

$$\frac{n_1}{DI}-\frac{n_2}{DI_1}=\frac{n_2-n_1}{DC_2} \quad \text{...(ii)}$$ ½ M

DI_1 is negative as distance is measured against the direction of incident light.

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

$$\frac{n_2}{BI_1}+\frac{n_1}{OB}+\frac{n_1}{DI}-\frac{n_2}{DI_1}=\frac{n_2-n_1}{BC_1}+\frac{n_2-n_1}{DC_2}$$

or $$\frac{n_1}{DI}+\frac{n_1}{OB}=(n_2-n_1)\left(\frac{1}{BC_1}+\frac{1}{DC_2}\right)$$ ...(iii) ($\because$ for thin lens $BI_1 = DI_1$)

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

½ M

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

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

or $$\frac{n_1}{f} = (n_2 - n_1)\left(\frac{1}{BC_1} + \frac{1}{DC_2}\right) \quad ...(iv)$$

Now according to the sign conventions

$BC_1 = +R_1$ and $DC_2 = -R_2$ ...(v) ½ M

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

$$\frac{n_1}{f} = (n_2 - n_1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$\frac{1}{f} = \left(\frac{n_2}{n_1} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

(ii) $$\frac{1}{f} = (n_{21} - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$\frac{1}{f_a} = (1.6 - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) \quad ...(1)$$ **1M**

$$\frac{1}{f_\ell} = \left[\frac{1.6}{1.3} - 1\right]\left(\frac{1}{R_1} - \frac{1}{R_2}\right) \quad ....(2)$$ **1M**

From equation (1) and (2)

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

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.

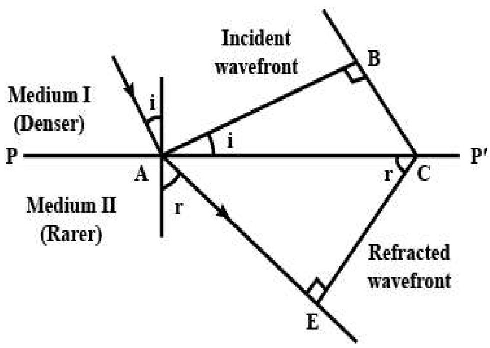
(b) The ray at each point of a wavefront is normal to the wavefront at that point.

1M

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

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

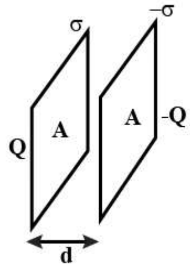
Sin i / Sinr = BC /AE = v_1 /v_2 = constant



(iii) $\Theta = \lambda / a$ i.e. $a = \dfrac{\lambda}{\theta} = \dfrac{6\times10^{-7}}{0.1\times\dfrac{\pi}{180}} = 3.4\times10^{-4}\,\text{m}$ **1M**

(iv) Two differences between interference pattern and diffraction pattern **1M**

A32: (i) Derivation of the expression for the capacitance **2M**



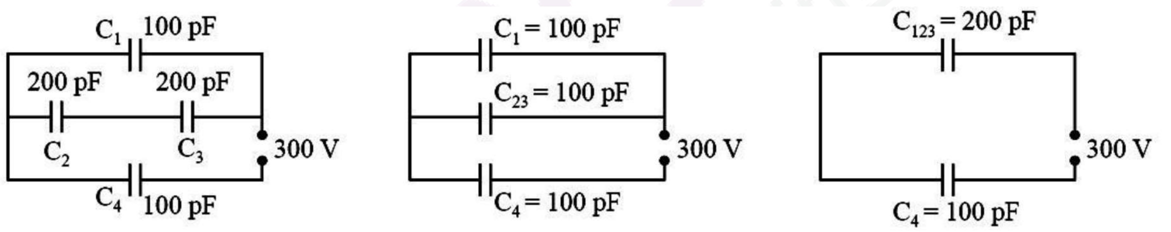
Let the two plates be kept parallel to each other separated by a distance d and cross-sectional area of each plate is A. Electric field by a single thin plate $E = \sigma / 2\epsilon_0$

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

(ii)



1 M

The equivalent capacitance = $\dfrac{200}{3}$ pF

charge on $C_4 = \dfrac{200}{3} \times 10^{-12} \times 300 = 2 \times 10^{-8}$ C, **½ M**

potential difference across $C_4 = \dfrac{200\times10^{-12}\times300}{3\times100\times10^{-12}} = 200$ V

potential difference across $C_1 = 300 - 200 = 100$ V

charge on $C_1 = 100 \times 10^{-12} \times 100 = 1 \times 10^{-8}$ C **½ M**

potential difference across C_2 and C_3 series combination = 100 V

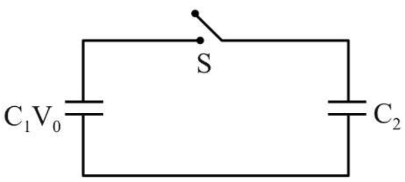
potential difference across C_2 and C_3 each = 50 V

charge on C_2 and C_3 each = $200 \times 10^{-12} \times 50 = 1 \times 10^{-8}$ C **½+½ M**

OR

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

(ii)



Before the connection of switch S,

Initial energy U_i = $\frac{1}{2}C_1V_0^2 + \frac{1}{2}C_2 0^2 = \frac{1}{2}C_1V_0^2$ **½ M**

After the connection of switch S

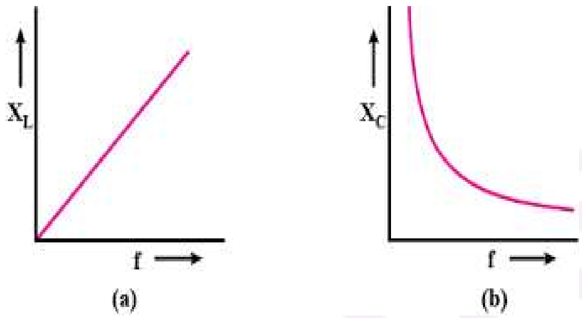
common potential V = $\frac{C_1V_1 + C_2V_2}{C_1 + C_2} = \frac{C_1V_o}{C_1 + C_2}$ **½ M**

Final energy = U_f = $\frac{1}{2}(C_1 + C_2)\frac{(C_1V_0)^2}{(C_1 + C_2)^2} = \frac{1}{2}\frac{C_1^2V_0^2}{(C_1 + C_2)}$ **½ M**

$U_f : U_i = C_1/(C_1 + C_2)$ **½ M**

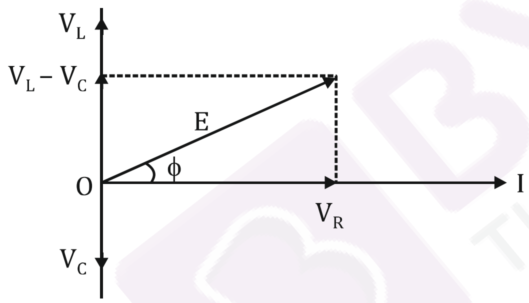
A33:

(a)



½ + ½ M

(b)



1M

(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 **½ + ½ M**

(ii) We are given that

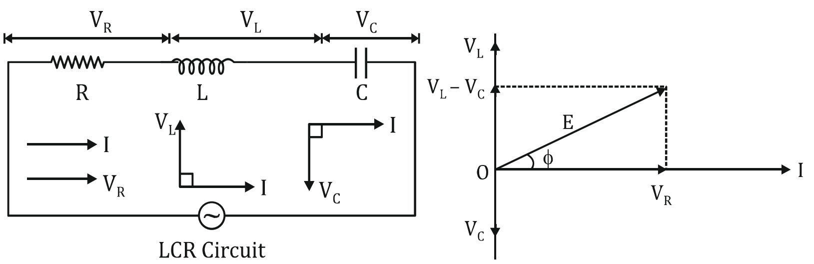
$0.25 = 220/X_L$, $X_L = 880\Omega$, Also $0.25 = 220/R$, $R = 880\Omega$ **1M**

For the series combination of X and Y,

Equivalent impedance $Z = 880\sqrt{2}\ \Omega$, I= 0.177 A **1M**

OR

a.



1M

E = E_0 sinωt 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_L, V_C and V_R 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. **3M**

Emf leads current by a phase angle φ 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**