R2024

No. of Printed Pages : 4

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12

PART – III

இயற்பியல் / **PHYSICS**

(English Version)

Time Allowed : 3.00 Hours] [Maximum Marks : 70

Instructions : (1) Check the question paper for fairness of printing. If there is any lack of fairness, inform the Hall Supervisor immediately

(2) Use **Blue** or **Black** ink to write and underline and pencil to draw diagrams.

PART – I

Note : (i) Answer **all** the questions. 15x1=15

(ii) Choose the most appropriate answer from the given **four** alternatives and write the option code and the corresponding answer.

1. An electric field $\vec{E} = 10x\hat{i}$ exists in a certain region of space. Then the potential difference $V = V_O - V_A$, where V_O is the potential at the origin and V_A is the potential at x = 2 m is :

(a) 10V (b) –20 V (c) +20 V (d) –10 V

2. In Joule's heating law, when R and t are constant, if the H is taken along the y axis and I^2 along the x axis, the graph is

(a) straight line (b) parabola (c) circle (d) ellipse

3. The vertical component of Earth's magnetic field at a place is equal to the horizontal component. What is the value of angle of dip at this place?

(a) 30^o (b) 45^o (c) 60^o (d) 90^o

4. V=230 sin (314t) AC source, the RMS voltage and frequency canbe

(a) 160.6 V, 50 Hz (b) 230 V, 50 Hz

(c) 230 V, 60 Hz (d) 162.6 V, 50 Hz

5. When a biconvex lens of glass having refractive index 1.47 is dipped in a liquid, it acts as a plane sheet of glass. This implies that the liquid must have refractive index,

(a) less than one (b) less than that of glass

(c) greater than that of glass (d) equal to that of glass

[Turn Over

6. Electromagnetic wave which is used in television remote sensor
   (a) visible rays (b) Ultra Violet rays
   (c) Infra-red (d) radio
7. The transverse nature of light is shown in,
   (a) interference (b) diffraction
   (c) scattering (d) polarization
8. The work function of caesium is 1.8 ev then the threshold frequency is
   (a) 4.36×10^{14} Hz (b) 1.42×10^{14} Hz
   (c) 8×10^{14} Hz (d) 1.1×10^{15} Hz
9. In a hydrogen atom, the electron revolving in the fourth orbit, has angular momentum equal to
   (a) h (b) $\frac{h}{\pi}$ (c) $\frac{3h}{\pi}$ (d) $\frac{2h}{\pi}$
10. The specific charge of an electron can be
    (a) 1.6×10^{-19} C/kg (b) 4.8×10^{-10} C/kg
    (c) 1.76×10^{11} C/kg (d) 1.76×10^{-11} C/kg
11. If the input to the NOT gate is A = 1011, its output is
    (a) 0100 (b) 1000 (c) 1100 (d) 0011
12. Frequency of an oscillator
    (a) $f = \frac{1}{2\pi LC}$ (b) $\omega^2 = \frac{1}{LC}$ (c) $\omega = \frac{1}{2\pi\sqrt{LC}}$ (d) $f = \frac{1}{2\pi\sqrt{LC}}$
13. Why dangerous touching the electrical connections by hand
    (a) human body having more water (b) wet hand having low resistance
    (c) pure water conduct electricity (d) wet hand having high resistance
14. The flux linked with a coil at any instant t is given by $\Phi_B = 10t^2 - 50t + 250$. The induced emf at t = 3s is
    (a) −190 V (b) −10 V (c) 10 V (d) 190 V
15. First diffraction minimum due to a single slit of width 1.0×10^{-5} cm is at 30^o. Then wavelength of light used is,
    (a) 400 Å (b) 500 Å (c) 600 Å (d) 700 Å

PART – II

Note : Answer **any six** questions. Question No. **24** is **compulsory.** **6x2=12**

16. State Flemings right hand rule?
17. What is principle of reversibility?
18. What is Corona discharge?
19. What are the differences between interference and diffraction?
20. Define electrical resistivity.
21. Find the momentum of an electron having kinetic energy 2 electron volt.
22. The nuclear fusion never occurs at room temperature unlike nuclear fission. Why?
23. Draw a circuit diagram of Common Emitter Transistor.
24. Suppose a cyclotron is operated to accelerate protons with magnetic field of strength 1 T. Calculate the frequency in which the electric field between two Dees could be reversed.

PART – III

Note : Answer **any six** questions. Question No. **33** is **compulsory.** **6x3=18**

25. Discuss the conversion of galvanometer into Voltmeter.
26. Derive an expression for the torque experienced by a dipole due to a uniform electric field.
27. How will you induce an EMF by changing the area enclosed by the coil?
28. Explain the basic elements of communication system with the necessary block diagram.
29. A compound microscope has a magnifying power of hundred when the image is formed at infinity. The objective has a focal length of 0.5 cm. What is the focal length of the eye piece?
30. What is total internal reflection? And give the conditions for total internal reflection.
31. List out the characteristics of photons.
32. Give Kirchhoff's current and voltage laws.
33. In Bohr atom model an electron in hydrogen atom having an energy of – 3.4 electron volt. Find out the angular momentum of an electron.

[Turn Over

PART – IV

Note : Answer **all** the questions. **5x5=25**

34. (a) Derive the mirror equation.

(OR)

(b) Explain the determination of internal resistance of a cell using potentiometer.

35. (a) Give notes on characteristic X-rays. What are the uses of X-rays in medical and industrial field.

(OR)

(b) Write down Maxwell equations in integral form.

36. (a) Explain in detail the working of Cyclotron.

(OR)

(b) Discuss the spectral series of hydrogen atom.

37. (a) Derive the expression for resultant capacitance when capacitors are connected in series and in parallel.

(OR)

(b) Explain the Young's double slit experimental setup and obtain the equation for path difference.

38. (a) Explain the construction and working of full wave rectifier.

(OR)

(b) Derive an expression for phase angle between the applied voltage and current in a series RLC circuit.

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HIGHER SECONDARY SECOND YEAR SECOND REVISION EXAMINATION – FEBRUARY 2024

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 the corresponding answer.
3. For answers in Part-II, Part-III and 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.

PART – I

Answer all the questions. 15x1=15

Q. No.	OPTION	ANSWER	Q. No.	OPTION	ANSWER
1	(c)	+20V	9	(d)	$\frac{2h}{\pi}$
2	(a)	Straight line	10	(d)	1.76 x 10^{-11} C/kg
3	(b)	45^0	11	(a)	0100
4		Mere attempt Correct ans :162.6 v , 50 Hz	12	(d)	f = $\frac{1}{2\pi\sqrt{LC}}$
5	(d)	equal to that of glass	13	(b)	Wet hand having low resistance
6	(c)	Infrared	14	(b)	-10 V
7	(d)	Polarisation	15	(b)	500Å
8	(a)	4.36x10^{14} Hz			

PART – II

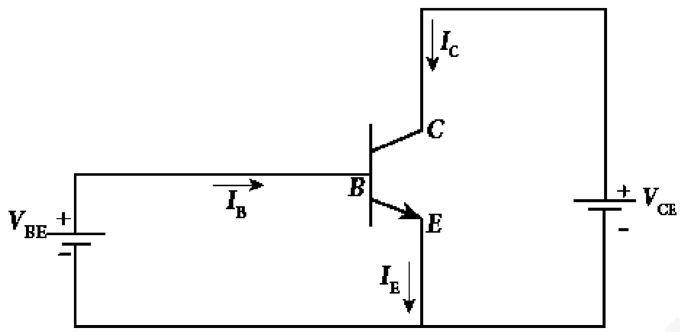
Answer any **six** questions. Question number **24** is compulsory. 6x2=12

16	**Fleming's right hand rule** The thumb, index finger and middle finger of right hand are stretched out in mutually perpendicular directions. If **index finger** points the **direction of magnetic field** and the **thumb points** the **direction of motion of the conductor**, then the **middle finger** will indicate the **direction of the induced current**. Fleming's right hand rule is also known as **generator rule**.	2	2

17	**Principle of reversibility** The principle of reversibility states that, light **will be following exactly the same path if its direction of travel is reversed**. This is true for both reflection and refraction.	2	2
18	**Corona discharge** **Smaller the radius of curvature, larger the charge density**. Hence charges are accumulated at the sharp points. Due to this, the electric field **near this sharp edge is very high and it ionized the surrounding air.** The **positive ions are repelled and negative ions are attracted** towards the sharp edge. This **reduces the total charge of the conductor near the sharp edge.** This is called action of points or corona discharge	2	2
19	(see table below)	Any 4 4x ½ = 2	2

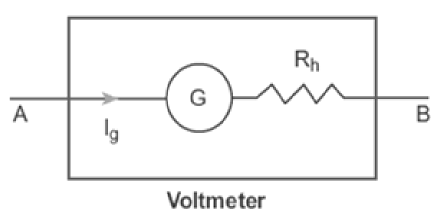
Interference	Diffraction
Superposition of two waves	Bending of waves around edges
Superposition of waves from two Coherent sources.	Superposition wave fronts emitted from various points of the same wave front.
Equally spaced fringes.	**Unequally spaced fringes**
Intensity of all the bright fringes is almost same	**Intensity falls rapidly** for higher orders
Large number of fringes are obtained	**Less number** of fringes are obtained

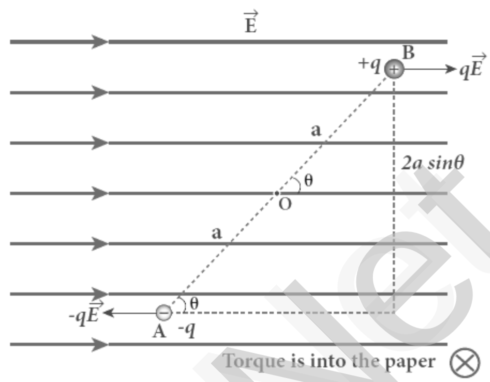
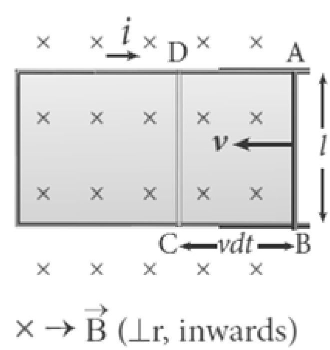
20	**Electrical resistivity of the material** The electrical resistivity of a material is defined as **the resistance offered to current flow** by a conductor of unit length having unit area of cross section. $\rho = \frac{1}{\sigma}$; $= \frac{RA}{l}$ **Its unit is ohm - metre (Ωm)** It depends only the type of material and not the dimension of the material.	1½ ½	2
21	i) **Momentum of the electron is** $p = \sqrt{2mK} = \sqrt{2 \text{ x} 9.1 \text{ x } 10^{-31} \text{x } 2 \text{ x } 1.6 \text{ x } 10^{-19}}$; $\sqrt{58.24 \text{ x } 10^{-50}}$ $p = 7.63 \text{ x } 10^{-25}$ kg ms^{-1} Its de Broglie wavelength is $= \frac{h}{p} = \frac{6.634 \text{ x } 10^{-34}}{7.63 \text{ x } 10^{-25}}$; $= 0.868 \text{ x } 10^{-9}$ m $\lambda = 8.68$ Å	1 ½ ½	2

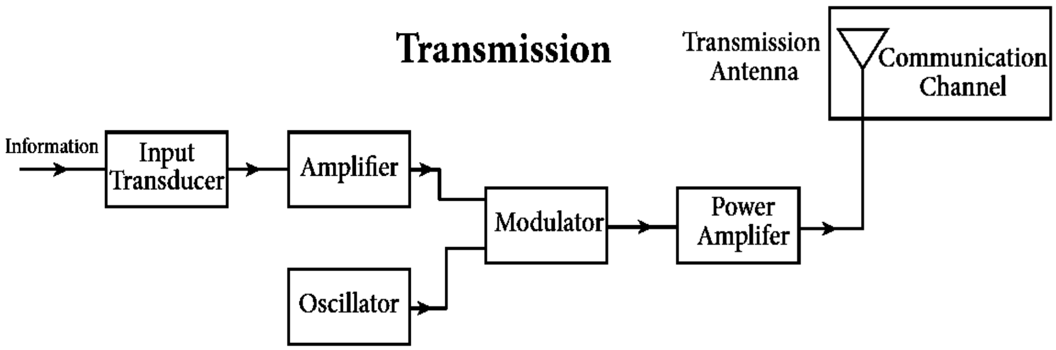
22	When two light nuclei come closer to combine, it is strongly repelled by the coulomb repulsive force. To overcome this repulsion, the two light nuclei must have enough kinetic energy to move closer to each other such that the nuclear force becomes effective. This can be achieved if the **temperature is very much greater than the value 10^7 K. When the surrounding temperature reaches around 10^7K**, lighter nuclei start fusing to form heavier nuclei and this resulting reaction is called thermonuclear fusion reaction.	2	2
23	**<u>Common emitter configuration</u>** 	2	2
24	Magnetic field B = 1 T Mass of the proton, m_p = 1.67 x 10^{-27} kg Charge of the proton, q = 1.6 x 10^{-19} C $f = \frac{qB}{2\pi m_p} = \frac{1.6 \times 10^{-19} \times 1}{2 \times 3.14 \times 1.67 \times 10^{-27}}$ = 15.3 x 10^6 Hz; f = 15.3 MHz	1 1	2

PART – II

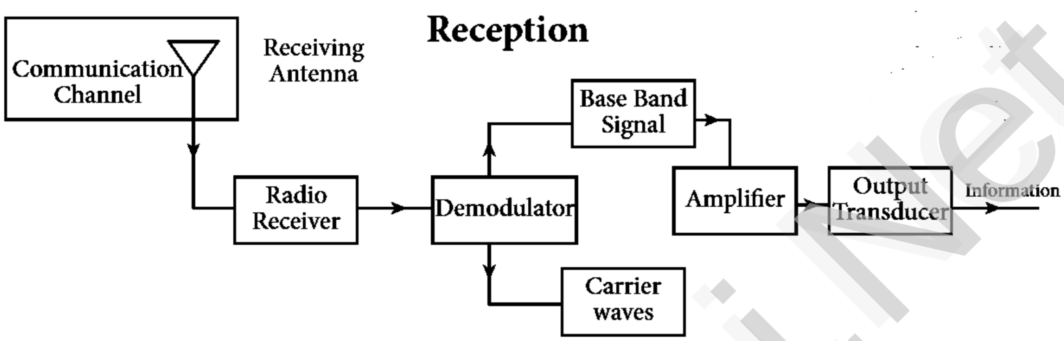
Answer **any six** questions. Question number **33 is compulsory.** 6x3=18

25	**<u>Galvanometer to a voltmeter</u>** A voltmeter is an instrument used to measure potential difference across any two points. **A galvanometer is converted in to voltmeter by connecting high resistance in series** with the galvanometer. The scale is calibrated in volts.  Galvanometer resistance = R_G, High resistance = R_h Current flows through galvanometer= I_G Voltage to be measured = V, Total resistance of this circuit = $R_G + R_h$ Here the **current in the electrical circuit is same as the current passing through the galvanometer.** (i.e) I_G = I	1 1	3

	$I_G = \frac{V}{R_G+R_h}$ (or) $R_G + R_h = \frac{V}{I_G}$; $\therefore R_h = \frac{V}{I_G} - R_G$ Let R_V be the resistance of voltmeter, then $R_V = R_G + R_h$. Here, $R_G < R_h < R_V$ Thus an voltmeter is a high resistance instrument, and it always **connected in parallel to the circuit element. An ideal ammeter has zero resistance.**	1	
26	**<u>Torque experienced by the dipole in electric field</u>** Let a dipole of moment $\vec{p}$ is placed in an uniform electric field $\vec{E}$ The force on '+ q' = $+ q\vec{E}$ The force on '−q' = $- q\vec{E}$ Then the total force acts on the **dipole is zero.** But these two forces constitute a couple and the dipole experience a torque which tends to rotate the dipole along the field. The total torque on the dipole about the point 'O'  $\vec{\tau} = \overrightarrow{OA} \times (-q\vec{E}) + \overrightarrow{OB} \times (+q\vec{E})$; $\lvert\vec{\tau}\rvert = \lvert\overrightarrow{OA}\rvert \lvert -q\vec{E}\rvert \sin\theta + \lvert\overrightarrow{OB}\rvert \lvert q\vec{E}\rvert \sin\theta$ τ = (OA + OB) qE sin θ ; $\tau = 2\,a\,q\,E\sin\theta$ ∵ [OA = OB = a] $\boldsymbol{\tau} = \boldsymbol{p}\,E\,\mathbf{sin}\,\boldsymbol{\theta}$ (Where, $2\,a\,q = p \rightarrow$ dipole moment) In vector notation, $\vec{\tau} = \vec{p} \times \vec{E}$. The torque is maximum, when θ = 90^0	1 1 1	3
27	**<u>EMF induced by changing area enclosed by the coil</u>** Consider a conducting rod of length 'l' moving with a velocity 'v' towards left on a rectangular metallic frame work. The whole arrangement is placed in a uniform magnetic field $\vec{B}$ acting perpendicular to the plane of the coil inwards. As the rod moves from AB to DC in a time 'dt', the area enclosed by the loop and hence the magnetic flux through the loop decreases.  The change in magnetic flux in time 'dt' is $d\phi_B = B\,dA = B(l \times v\,dt)$ $\frac{d\phi_B}{dt} = B\,lv$ This change in magnetic flux results and induced emf and it is given by, $\in = \frac{d\phi_B}{dt}$; $\in = B\,lv$ This emf is called motional emf. **The direction of induced current is found to be clock wise from Fleming's right hand rule.**	1 1 1	3



1½



1½

28

(1) Input transducer:

A transducer is a device that converts variations in a physical quantity (pressure, temperature, sound) into an equivalent electrical signal or vice versa. In communication system, the transducer converts the information which is in the form of sound, music, pictures or computer data into corresponding electrical signals. The electrical equivalent of the original information is called the baseband signal. (e.g.) microphone

(2) Transmitter:

It feeds the electrical signal from the transducer to the communication channel. The transmitter is located at the broadcasting station. It consists,

(i) Amplifier: The transducer output is very weak and is amplified by the amplifier.

(ii) Oscillator: It generates high-frequency carrier wave (a sinusoidal wave) for long distance transmission into space.

(iii) Modulator: It superimposes the baseband signal onto the carrier signal and generates the modulated signal.

(iv) Power amplifier: It increases the power level of the electrical signal in order to cover a large distance.

(3) Transmitting antenna:

It radiates the radio signal into space in all directions. It travels in the form of electromagnetic waves with the velocity of light (3×10^8 m s^{-1})

(**4) Communication channel:**

Communication channel is used to carry the electrical signal from transmitter to receiver with less noise or distortion. The communication medium is basically of two types: **wire line communication and wireless communication.**

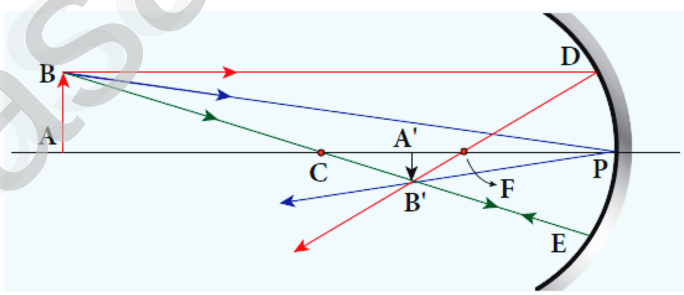
3

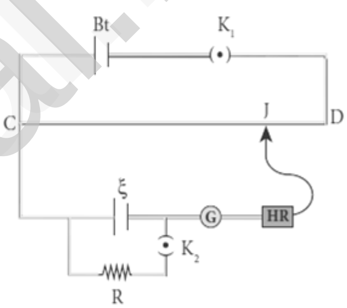
	(5) Receiver: The signals that are transmitted through the communication medium are received with the help of a receiving antenna and are fed into the receiver. The receiver consists of electronic circuits like demodulator, amplifier, detector etc. The demodulator extracts the baseband signal from the carrier signal. Then the baseband signal is detected and amplified using amplifiers. Finally, it is fed to the output transducer. **(6) Output transducer:** It converts the electrical signal back to its original form such as sound, music, pictures or data. (e.g.) loudspeakers, picture tubes, computer monitor, etc.		
29	Magnifying Power, m = 100, Focal length of the objective, f_0 = 0.5 cm Tube length, l = 6.5 cm Since the image is formed at infinity, the real image produced by the objective lens should lie on the focus of the eyepiece. $v_0 + f_e$ = 6.5 cm ....(1) The magnifying power for normal adjustment is given by $M = \left(\frac{v_0}{u_0}\right) \times \frac{D}{f_e}$; $= -\left[1 - \frac{v_0}{f_0}\right]\frac{D}{f_e}$ $100 = -\left[1 - \frac{v_0}{0.5}\right]\frac{25}{f_e}$; $2v_0 - 4f_e = 1$ ....(2) On solving equations (1) and (2), we get v_0 = 4.5 cm and f_e = 2 cm Thus, the focal length of the eyepiece is 2 cm.	1 1 1	3
30	**Total internal reflection** **If the angle of incidence in the denser medium is greater than the critical angle, there is no refraction possible in the rarer medium**. The entire light is **reflected back in to the denser medium** itself; this phenomenon is called total internal reflection. **<u>The conditions to achieve total internal reflection</u>** Light must travel from **denser to rarer medium** Angle of incidence must be **greater than critical angle** ($i > i_C$)	2 1	3
31	**<u>Characteristics of photons</u>** Each photon will have energy given by $E = h\nu = \frac{hc}{\lambda}$ The energy of a photon is determined by the frequency of the radiation and not by its intensity. The photons travel with the velocity of light and its momentum is given by, $p = \frac{h}{\lambda} = \frac{hc}{\lambda}$ Photons are electrically neutral, and hence they are not deflected **knee** electric and magnetic fields. When photon interacts with matter, the total energy, total linear momentum and angular momentum are conserved.	1 1 1	3

32	**Kirchhoff's first law (current rule or junction rule)** It states that the **algebraic sum of currents at any junction** in a circuit **is zero**. ($\sum I = 0$). It is a statement of conservation of electric charge. **Kirchhoff's second law (voltage rule or loop rule)** It states that in a closed circuit the **algebraic sum of the products** of the **current and resistance of each part of the circuit is equal** to the total emf included in the circuit ($\sum IR = \sum \xi$). It is a statement of conservation of energy for an isolated system.	1 2	3
33	$E_n = -\frac{13.6}{n^2}$ ev ; $3.4 = -\frac{13.6}{n^2}$ $n^2 = -\frac{13.6}{3.14}$; $n^2 = 4$ **n = 2** **Angular momentum of Electron: L =** $\frac{nh}{2\pi}$ $= \frac{2h}{2\pi}$; $= \frac{h}{\pi}$ **; =** $= \frac{6.627 \times 10^{-34}}{3.14}$ **L = 2.1 x 10^{-34} Js**	1 1 1	3

PART – IV

Answer **all** the questions. 5x5=25

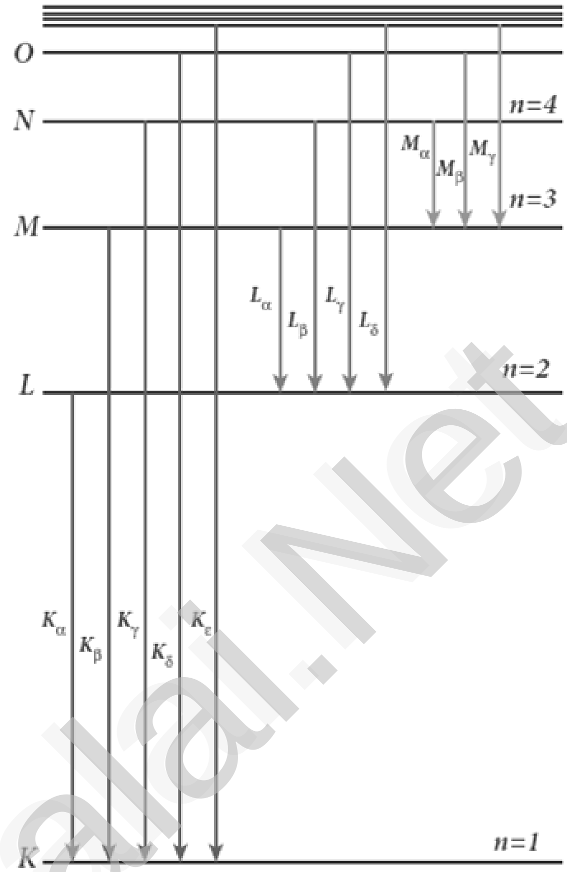
34 (a)	**Mirror equation** The equation which gives the relation between object distance (u), image distance (v) and focal length (f) is of spherical mirror is called mirror equation. Let an object AB is placed on the principle axis of a concave mirror beyond the centre of curvature 'C'  The real and inverted image $A'B'$ is formed between C and F By the laws of reflection, Angle of incidence (i) = angle of reflection (r) $\angle BPA = \angle B'PA'$ From figure, ΔBPA and $\Delta B'PA'$ are similar triangles. So $\frac{A'B'}{AB} = \frac{PA'}{PA}$ .... (1) From figure, ΔDPF and $\Delta B'FA'$ are similar triangles. So $\frac{A'B'}{PD} = \frac{A^1F}{PF}$ [PD = AB] $\frac{A'B'}{AB} = \frac{A^1F}{PF}$ .... (2) From equation (1) and (2), $\frac{PA'}{PA} = \frac{A'F}{PF}$;	1 1 1	5

	$\frac{PA'}{PA} = \frac{PA'-PF}{PF}$ ....(3) By applying sign conventions, $PA = -u; PA' = -v\,; PF = -f$ $\frac{-v}{-u} = \frac{-v-(-f)}{-f}$ (or) $\frac{v}{u} = \frac{v-f}{f}$ (or) $\frac{v}{u} = \frac{v}{f} - 1$ Dividing both sides by v ; $\frac{1}{u} = \frac{1}{f} - \frac{1}{v}$; $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$ .... (4) This is called **mirror equation**. It is also valid for **convex mirror**. **Lateral Magnification:** It is defined as the ratio of the height of the image (h^1) to the height of the object (h). From equation (1) $\frac{A'B'}{AB} = \frac{PA'}{PA}$; $\frac{-h^1}{h} = \frac{-v}{-u}$ Hence **magnification,** $m = \frac{h^1}{h} = -\frac{v}{u}$ .... (5) Using equation (4) $m = \frac{h^1}{h} = \frac{f-v}{f} = \frac{f}{f-u}$ .... (6)	1 1	
34 (b)	**Internal resistance by potentiometer** Potentiometer wire CD is connected to battery (Bt) and a key (K_1) in series. This is the primary circuit. **The cell ξ whose internal resistance 'r' to be measured is connected to the secondary circuit.** A resistance box R and a key K_2 is connected across the cell ξ. With key K_2 open, the balancing point J is found out and balancing length CJ = l_1 is measured.  By the principle, $\xi \propto l_1$ $- - - -$ (1) A suitable resistance is included in R and key K_2 is closed. The current flows through R and cell is, I = $\frac{\xi}{R+r}$ Hence potential difference across R , V = IR = $\frac{\xi}{R+r}$ R For this potential difference, again the balancing point J is found out and the balancing length CJ = l_2 is measured. By the Principle $\frac{\xi}{R+r}$ R $\propto l_2$ .... (2) Divide equation (1) by (2) $\frac{\xi}{\left(\frac{\xi}{R+r}R\right)} = \frac{l_1}{l_2}$; $\frac{R+r}{R} = \frac{l_1}{l_2}$; $1 + \frac{r}{R} = \frac{l_1}{l_2}$ $\frac{r}{R} = \frac{l_1}{l_2} - 1$; $\frac{l_1-l_2}{l_2}$; r = R $\left[\frac{l_1-l_2}{l_2}\right]$ .... (3) By substituting, l_1, l_2 in equation (3) the internal resistance of the cell can be measured. Here the **internal resistance is not constant, and it increased with increase of external resistance R.**	1 1 1 1 1	5

35 (a)

Characteristic X - ray spectra

When the target is hit by fast electrons, the obtained X - ray spectra shows some narrow peaks at some well-defined wavelength. 1



The line spectrum showing these peaks is called characteristic X - ray spectrum. This X -ray spectrum is due to the **electronic transitions** within the atoms. For example, when an energetic electron penetrates in to the target atom and removes the electrons in K - shell and create a vacancy in it. 1

So the electrons from outer orbits jump to fill up the vacancy in K - shell. 1

During the downward transition, the energy difference between the levels is given out in the form of X - ray photon of definite wavelength.

Such wavelengths, characteristic of the target, constitute the line spectrum. It is evident that **K - series** of lines in the X - ray spectrum arise due to the electronic transitions from L, M. N, O, ...shells to K - shell. 5

Similarly **L - series** originates due to electronic transition from M, N, O, ... shells to L - shell.

Applications of X -rays

(1) Medical diagnosis:

X - Rays can pass through flesh more **easily than through bones**. Thus X -ray radiograph containing a deep shadow of the bones and a light shadow of flesh. So X -rays radiographs are used **to detect fractures, foreign bodies, diseased organs etc.,** 1

(2) Medical therapy:

X - ray can kill diseased tissues. So they are employed to **cure skin diseases, malignant tumours etc.,** 1

(3) Industry:

They are used to check for flaws in welded joints, motor tyres, tennis balls and wood, At the custom post, they are used **for detection of contraband goods.**

35 (b)	**Maxwell equations - Integral form** Electrodynamics can be summarized into four basic equations, known as Maxwell's equations. Maxwell's equations completely explain the behaviour of charges, currents and properties of electric and magnetic fields. This equation ensures the existence of electromagnetic waves. **Equation - 1 :** It is nothing but Gauss's law It relates the net electric flu to net electric charge enclosed in a surface. Mathematically, **Gauss law is expressed as,** $\oint \vec{E}.\vec{dA} = \frac{Q_{Closed}}{\varepsilon_0}$ ....(1) Here, $\vec{E}$ → Electric field, Q_{Closed} → Charge enclosed This equation is true for either discrete or continuous distribution of charges. It also indicates that the electric field lines start from positive change and terminate at negative charge. The electric field lines do not form a continuous closed path (i.e.) isolated positive or negative charges can exist.	1 ½	5
	Equation - 2 : It has no name. But **this law of similar to Gauss law in electrostatics.** Hence this law can be called as **Gauss's law in magnetism**. According to this law, the surface integral of magnetic field over a closed surface is zero. **Mathematically, this law can be expressed as,** $\oint \vec{B}.\vec{dA} = 0$ ....(2) $\vec{B}$ → Magnetic field. This equation implies that the magnetic field lines form a continuous closed path. (i.e.) no isolated magnetic monopole exists	1	
	Equation - 3 : This is Faraday's laws of electromagnetic induction. This law relates **electric field with the changing magnetic flux**. This equation implies that, the **line integral of the electric field around any closed path is equal to the rate of change of magnetic flux through the closed path bounded by the surface**. **Mathematically it is expressed as,** $\oint \vec{E}.\vec{dl} = -\frac{d\phi_B}{dt}$ ....(3) $\vec{E}$ → Electric field The electrical energy supplied to our houses from electricity board by using Faraday's law of induction.	1	
	Equation - 4 : It is **modified Ampere's circuital law** and also **called as Ampere - Maxwell's law.** This law relates the magnetic field around any closed path to the conduction current and displacement current through that path. Mathematically, $\oint \vec{B}.\vec{dl} = \mu_0(I_C + I_D)$ (or) $\oint \vec{B}.\vec{dl} = \mu_0 I_C + \mu_0\varepsilon_0 \frac{d}{dt}\int \vec{E}.\vec{dA}$. Here, $\vec{B}$ → Magnetic field. It implies that **both conduction and displacement current produces magnetic field.**	1 ½	

36 (a)

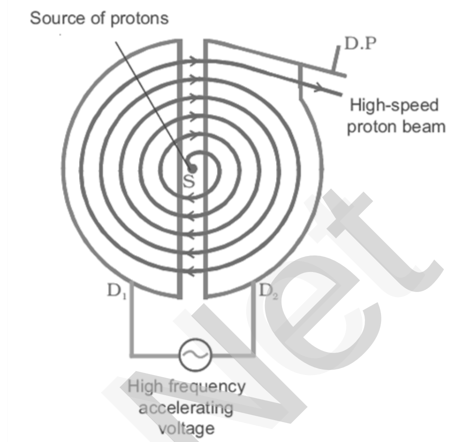
Cyclotron:

It is a device used to **accelerate the charged particles to gain large kinetic energy.** It is also called as **high energy accelerator**. It is invented by Lawrence and Livingston.

Principle:

When a **charged particle** moves normal to the **magnetic field**, it experience **magnetic Lorentz force.** ½

Construction:



It consists two semicircular metal containers called Dees.

The Dees are enclosed in an evacuated chamber and it is kept in a region of uniform magnetic field acts normal to the plane of the Dees. 1

The two Dees are kept separated with a gap and the source 'S' of charged particles to be accelerated is placed at the centre in the gap between the Dees.

Dees are connected to high frequency alternating potential difference.

Working:

Let the positive ions are ejected from source 'S'. It is accelerated towards a Dee-1 which has negative potential at that instant. Since the magnetic field is normal to the plane of the Dees, the ion undergoes circular path. After one semi-circular path in Dee-1, the ion reaches the gap between Dees. 5

At this time the polarities of the Dees are reversed, so that the ion is now accelerated towards Dee-2 with a greater velocity. For this circular motion, the centripetal force of the charged particle is provided by Lorentz force, then 1

$\frac{mv^2}{r}$ = Bqv ; r = $\frac{m\,v}{Bq}$; ∴ $r \propto v$ ½

Thus the increase in velocity increases the radius of the circular path. Hence the particle undergoes spiral path of increasing radius. Once it reaches near the edge, it is taken out with help of deflector plate and allowed to hit the target T. The important condition in cyclotron is the resonance condition. (i.e.) the frequency 'f' of the charged particle must be equal to the frequency of the electrical oscillator 'f_{osc}' . Hence

$f_{osc} = \frac{Bq}{2\pi m}$; The time period of oscillation is, T = $\frac{2\pi m}{Bq}$, 1

The kinetic energy of the charged particle is, KE = $\frac{1}{2}mv^2 = \frac{B^2q^2r^2}{2m}$

Limitations of cyclotron: 1

(i) The speed of the ion is limited

(ii) Electron cannot be accelerated

(iii) Uncharged particles cannot be accelerated.

36 (b)

Spectral series of hydrogen atom:

When an electron jumps from n^{th} orbit to nth orbit, a spectral line was obtained whose wave number (i.e.) reciprocal of wave length is,

$\bar{\nu} = \frac{1}{\lambda} = R\left[\frac{1}{n^2} - \frac{1}{m^2}\right]$. Here, R →Rydberg Constant

(R = 1.097 x 10^7 ms^{-1}) 1

From m>n, various spectral series are obtained.

(1) Lyman Series:

n = 1 and m = 2, 3, 4, ...

Hence the wave number, $\bar{\nu} = \frac{1}{\lambda} = R\left[\frac{1}{1^2} - \frac{1}{m^2}\right]$

They lie in **ultra violet** region. 1

(2) Balmer Series:

n = 2 and m = 3, 4, 5, ... 1

Hence the wave number, $\bar{\nu} = \frac{1}{\lambda} = R\left[\frac{1}{2^2} - \frac{1}{m^2}\right]$

They lie in **visible** region.

1

(3) Paschen Series: 5

n = 3 and m = 4, 5, 6,.....

Hence the wave number, $\bar{\nu} = \frac{1}{\lambda} = R\left[\frac{1}{3^2} - \frac{1}{m^2}\right]$

They lie in **infra-red** region.

1

(4) Brackett Series:

n = 4 and m = 5, 6, 7,.....

Hence the wave number, $\bar{\nu} = \frac{1}{\lambda} = R\left[\frac{1}{4^2} - \frac{1}{m^2}\right]$

They lie in **middle infra-red** region.

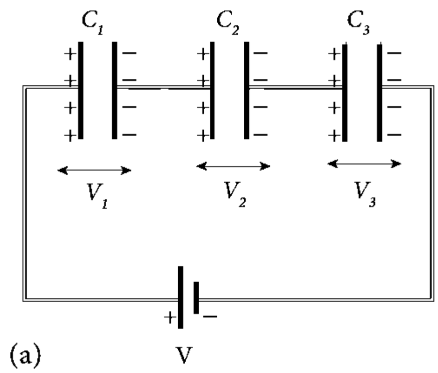
(5) Pfund Series:

n = 5 and m = 6, 7, 8,.....

Hence the wave number, $\bar{\nu} = \frac{1}{\lambda} = R\left[\frac{1}{5^2} - \frac{1}{m^2}\right]$

They lie in **far infra-red** region.

37(a) **Capacitors in series**:



Consider three capacitors of capacitance C_1, C_2 and C_3 connected in series with a battery of voltage V 1

In series connection,

Each capacitor has same amount of charge (Q)

But potential difference across each capacitor will be different.

Let V_1, V_2, V_3 be the potential difference across C_1, C_2, C_3 respectively, then $V = V_1 + V_2 + V_3$ 1

$$V = \frac{Q}{C_1} + \frac{Q}{C_2} + \frac{Q}{C_3} \quad [\because Q = CV] \; ; V = Q\left[\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}\right] \text{ .... (1)}$$

Let C_S be **the equivalent capacitance of capacitor in series** connection,

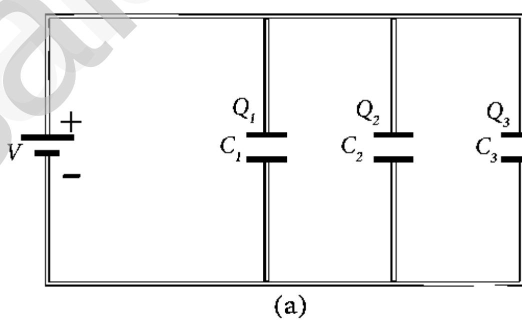
then $V = \frac{Q}{C_S}$ .... (2)

From (1) and (2) , we have $\frac{Q}{C_S} = Q\left[\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}\right]$; $\frac{1}{C_S} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$

Thus **the inverse of the equivalent capacitance of capacitors connected in series is equal to the sum of the inverses of each capacitance.** ½

This equivalent capacitance C_S is always less than the smallest individual capacitance in the series.

Capacitors in parallel: 5



Consider three capacitors of capacitance C_1, C_2 and C_3 connected in parallel with a battery of voltage V. 1

In parallel connection,

Each capacitor has same potential difference (V)

But charges on each capacitor will be different

Let Q_1 , Q_2 , Q_3 be the charge on C_1, C_2, C_3 respectively, then

$Q = Q_1 + Q_2 + Q_3$

$Q = C_1V + C_2V + C_3V$ $[\because Q = CV]$

$Q = V\,[C_1 + C_2 + C_3]$ .... (1)

Let C_P be the **equivalent capacitance of capacitor in parallel connection**, 1

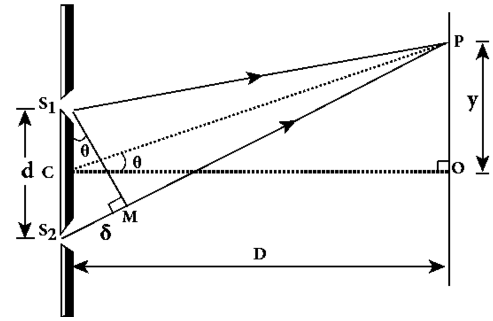
then $Q = C_PV$ .... (2)

From (1) and (2), $C_PV = V\,[C_1 + C_2 + C_3]$

$C_P = C_1 + C_2 + C_3$ ½

Thus **the equivalent capacitance of capacitors connected in parallel is equal to the sum of the individual capacitances.**

The equivalent capacitance C_P in a parallel connection is always greater than the largest individual capacitance.

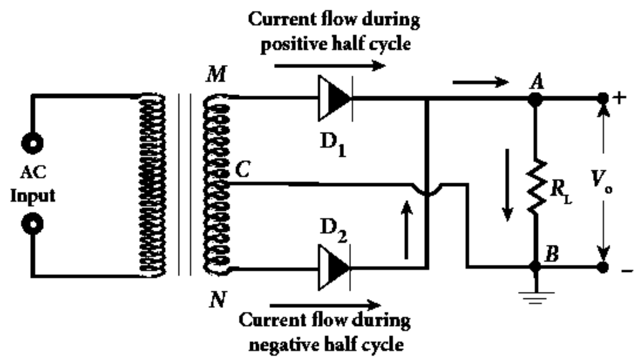
37 (b)	**Path difference (δ) :**  Let distance between S_1 *and* S_2 = d, Distance of the screen from double slit = D, Wavelength of coherent light wave = λ Hence path difference between the light waves from S_1 *and* S_2 to the point 'P' is $\delta = S_2P - S_1P = s_2P - MP = S_2M$ From the figure, $\angle OCP = \angle S_2S_1M = \theta$ In ΔS_2S_1M , $Sin\ \theta = \frac{S_2M}{S_1S_2} = \frac{\delta}{d}$; $\therefore \delta = Sin\ \theta . d$ Here θ is small. Hence, $Sin\ \theta \approx tan\ \theta \approx \theta$ $\delta = \theta . d$ .... (1) Also. in $\Delta OCP, \theta \approx \tan\theta = \frac{OP}{OC} = \frac{y}{D}$ Put this in equation (1) $\delta = \frac{y}{D}d$ -------------- (2) Point 'P' may be appear either bright or dark depending on the path difference. **Condition for bright fringe (maxima):** For constructive interference, the path difference will be, $\delta = n\lambda \quad [n = 0, 1, 2, ...] \quad \frac{y}{D}d = n\lambda$ Thus the distance of the nth bright fringe from "O" is $y_n = \frac{D}{d}n\lambda$ ----------- (3) **Condition for dark fringe (minima):** For destructive interference, the path difference will be, $\delta = (2n-1)\frac{\lambda}{2} \ [n = 1, 2, ...]$ $\frac{y}{D}d = (2n-1)\frac{\lambda}{2}$ Thus the distance of the nth dark fringe from "O" is $y_n = \frac{D}{d}(2n-1)\frac{\lambda}{2}$ ------ (4) **Band width (β) :** The band width is defined as **the distance between any two consecutive bright or dark fringes.** The distance between (n+1)th and nth consecutive bright fringes from 'O' is $\beta = y_{n+1} - y_n$ $\beta = \frac{D}{d}(n+1)\lambda - \frac{D}{d}n\lambda \ ; \beta = \frac{D}{d}\lambda$ ---------- (5) Similarly the distance between (n+1)th and nth Consecutive dark fringes from 'O' is $\beta = y_{n+1} - y_n$ $\beta = \frac{D}{d}[2(n+1)-1]\frac{\lambda}{2} - \frac{D}{d}(2n-1)\frac{\lambda}{2}$ $\boldsymbol{\beta = \frac{D}{d}\lambda}$ ---------- (6) Equation (5) and (6) shows that the bright and dark fringes are of same width equally spaced on either side of central bright fringe.	1 1 1 1 1	5

38 (a)

Full wave rectifier

The positive and negative half cycles of the AC input signal pass through this circuit and hence it is called the full wave rectifier.

It consists of two P-N junction diodes, a center tapped transformer, and a load resistor (R_L).



(a)

1 ½

The centre (C) is usually taken as the ground or zero voltage reference point. Due to the centre tap transformer, the output voltage rectified by each diode is only one half of the total secondary voltage.

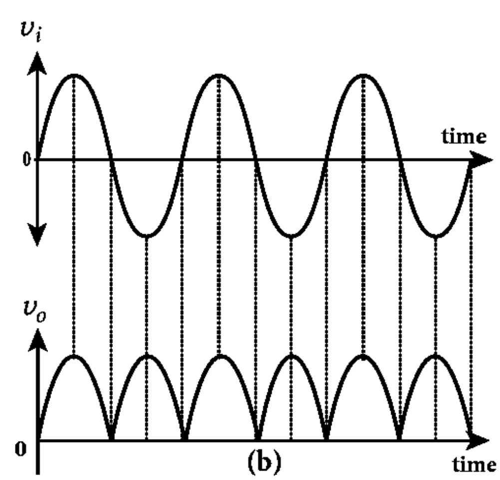
During positive half cycle of input AC	During negative half cycle of input AC
Terminal M is positive, G is at zero potential and N is at negative potential.	Terminal M is negative, G is at zero potential and N is at positive potential.
Diode D_1 is forward biased. Diode D_2 is reverse biased.	Diode D_1 is reverse biased. Diode D_2 is forward biased.
D_1 conducts and current flows along the path MD_1AGC	D_2 conducts and current flows along the path ND_2BGC
The voltage appears across R_L in the direction G to C	The voltage appears across R_L in the same direction G to C

2

5

Hence in a full wave rectifier both positive and negative half cycles of the input signal pass through the circuit in the same direction. The output waveform is shown below.

Though both positive and negative half cycles of ac input are rectified, the output is still pulsating in nature. The efficiency (η) of full wave rectifier is twice that of a **half wave rectifier and is found to be 81.2 %.**

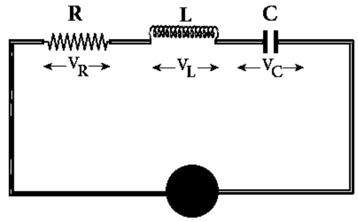


(b)

1 ½

38 (b)

Series RLC circuit



$v = V_m \sin \omega t$

Consider a circuit containing a resistor of resistance 'R', a inductor of inductance 'L' and a capacitor of capacitance 'C' connected across an alternating voltage source. 1

The applied alternating voltage is given by,

$$\mathbf{v} = \mathbf{v_m} \sin \omega t \qquad ------(1)$$

Let 'i' be the current in the circuit at that instant.

Hence the voltage developed across R, L and C

$V_R = iR$ (V_R is in phase with i)

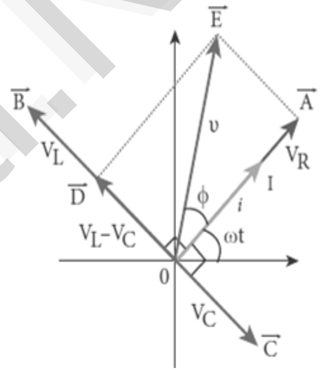
$V_L = iX_L$ (V_L leads i by $\frac{\pi}{2}$) 1

$V_C = iX_C$ (V_C lags i by $\frac{\pi}{2}$)

The Phasor diagram is drawn by representing current along $\overrightarrow{OI}$, V_R along $\overrightarrow{OA}$, V_L along $\overrightarrow{OB}$ and V_C along $\overrightarrow{OC}$,

If $V_L > V_C$ then the net voltage drop across LC combination is (V_L – V_C) which is represented by $\overrightarrow{AD}$

By parallogram law, the diagonal $\overrightarrow{OE}$ gives the resultant voltage"v"



$$v = \sqrt{V_R^2 + (V_L - V_C)^2}\ ;$$ 2

$$v = \sqrt{i^2R^2 + (iX_L - iX_C)^2}$$

$$v = i\sqrt{R^2 + (X_L - X_C)^2} \text{(or)}$$

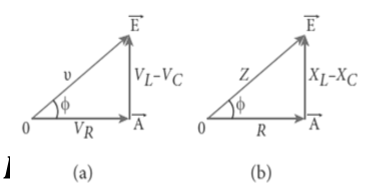
$$\boldsymbol{i} = \frac{v}{\sqrt{R^2+(X_L-X_C)^2}} \text{ (or) } i = \frac{v}{Z}$$ 5

Where, Z = $\sqrt{R^2 + (X_L - X_C)^2}$ is called **impedance of the circuit**, which refers to the effective opposition to the circuit current by the series RLC circuit.

From the Phasor diagram, the phase angle between 'v' and 'i' is found out by

$$\tan \phi = \frac{V_L - V_C}{V_R} = \frac{X_L - X_C}{R}$$

Special cases:



(i) When $X_L > X_C$, the phase angle ϕ is **Positive.** 1

It means that $\boldsymbol{v}$ leads $\boldsymbol{i}$ by ϕ.

($\boldsymbol{i.e.}$) $\boldsymbol{v}$ = V_m $\sin \omega t$ & $\boldsymbol{i}$ = I

This circuit is inductive.

(ii) When $X_L < X_C$, the phase angle ϕ is **negative.**

It means that $\boldsymbol{v}$ lags behind $\boldsymbol{i}$ by ϕ.

($\boldsymbol{i.e.}$) $\boldsymbol{v}$ = V_m $\sin \omega t$ & $\boldsymbol{i} = \boldsymbol{I_m} \sin(\omega t + \phi)$

This circuit is capacitive

(iii) When $X_L = X_C$ the phase angle ϕ ***is zero***.

It means that $\boldsymbol{v}$ in-phase with $\boldsymbol{i}$

($\boldsymbol{i.e.}$) $\boldsymbol{v} = \boldsymbol{V_m} \sin \omega t$ & $\boldsymbol{i} = \boldsymbol{I_m} \sin \omega t$

This circuit is resistive