PHYSICS

General Guidelines

1. The course content for class XII will be same as presented in the core syllabus in Physics (Higher Secondary Stage) brought out by COBSE in collaboration with NCERT.
2. The individual Boards are free to change the weighting/proportion as per their local specific needs and requirements. It is suggested that the variation may not exceed 10%.
3. Besides using the Question Papers for certification and grading of students, the boards may undertake a detailed exercise to collect feedback on the basis of performance of students to improve the existing syllabi, teaching-learning processes and evaluation techniques.
4. The primary purpose of the Board Examination is to assess the conceptual understanding of the students. Due care may be taken to ensure the required level of learning and abilities of the students are developed to apply their understanding to unfamiliar everyday life situations.
5. In order to develop a standard Question Paper, the characteristics of a good question, the balanced Question Paper and the typology of Question Paper should be given utmost care & attention. Due care should be taken to ensure the complete coverage of syllabus, assessing the desired learning outcomes & requirements of the subject.
6. The language of the Question Paper should be simple, clear, unambiguous & easily understandable by all.

Subject Specific Guidelines

1. A weightage of about 20% may be given to solve numerical problems to assess the numerical ability and conceptual understanding of the subject.
2. All parts in Long Answer Type Question should be inter-related & based on the same concept.
3. There should be no overall choice in the Question Paper. However, internal choices may be provided in one Question of 2 Marks, One Question of 3 marks and all the Questions of Long answer type of 5 marks.
4. The value points & expected length of answer should be such that it can be easily distributed according to total weightage given to Question.
5. Application based Questions should include analysis, synthesis and evaluation.

Guidelines for Practical Work:

There are two sections A and B, for experiments and activities. Each student is required to perform minimum 6 experiments and minimum 3 activities from each section in one academic year. Students should be encouraged to perform such activities which help them in Skill Development and due credit for this should be given in evaluating their performance. For evaluation in Practical Examination, students would be required to perform two experiments (one from each section A and B).

Evaluation Scheme:

Two experiments one from each section	8+8 Marks
Practical record (experiments & activities)	4+2 Marks
Project	3 Marks
Viva on experiments & project	5 Marks
	30 Marks

List of Experiments and Activities

SECTION A:

Experiments

(Any six experiments out of the following to be performed by the students)

1. To find resistance of a given wire using meter bridge and hence determine the specific resistance of its material
2. To determine resistance per cm of a given wire using the experimental set up for Ohm's law by plotting a graph of potential difference (V) versus current (I)
3. To verify the laws of combination (series /parallel) of resistances using meter bridge
4. To compare the emf's of two given primary cells using potentiometer.
5. To determine the internal resistance of a given primary cell using potentiometer.
6. To determine resistance of a galvanometer by half-deflection method and to find its figure of merit.
7. To convert the given galvanometer (of known resistance and figure of merit) into an ammeter and voltmeter of desired range and to verify the same.
8. To find the frequency of the a.c. mains with the help of a sonometer.

Activities

(Any three activities to be performed by the students)

1. To assemble the components of a given electrical current circuit apparatus: resistors, Ammeter, Voltmeter, battery, key etc.,
2. To identify a given device: diode, LED, capacitor, IC, etc.,
3. To verify Tangent Law: $F = H \tan\theta$
4. To assemble a set of given resistors (3Ω, 4Ω, 5Ω) in a suitable combination to obtain desired resistance of (6.7 Ω and 2.2 Ω) and verify with a multimeter.
5. To find value of current by measuring voltages across given resistors
6. To study the effect of damping on a suspended metallic plate oscillating in a magnetic field.

SECTION B: Experiments

(Any six experiments out of the following to be performed by the students)

1. To find the value of v for different values of u in case of a concave mirror and to find the focal length.
2. To find the focal length of a convex mirror, using a convex lens.
3. To find the focal length of a convex lens by plotting graphs between (i) u and v and (ii) between 1/u and 1/v.
4. To find the focal length of a concave lens, using a convex lens.
5. To determine angle of minimum deviation for a given prism by plotting a graph between angle of incidence and angle of deviation.
6. To determine refractive index of a glass slab using a travelling microscope.
7. To find refractive index of a liquid by using (i) concave mirror, (ii) convex lens and plane mirror.
8. To draw the I-V characteristic curves of a p-n junction in forward bias and reverse bias.
9. To draw the characteristic curve of a Zener diode and to determine it's reverse break down voltage.
10. To study the characteristics of a common - emitter npn or pnp transistor and to find out the values of current and voltage gains.

Activities

(Any three activities to be performed by the students)

1. To find refractive index of liquid from the focal length of a plano-convex lens using convex lens and plane mirror
2. To observe refraction and lateral deviation of a beam of light incident obliquely on a glass slab
3. To show that Polaroid produces plane polarized light with the help of two Polaroids
4. To study the nature and size of the image formed by a convex lens using candle and screen (for different distances of the candle from the screen)
5. To design a light signal with the help of a combination of LED's.
6. To design a Full-Wave Rectifier

PHYSICS
COURSE STRUCTURE
Class XII

ONE PAPER TIME:3 HOURS Max:MARKS:70

Units	Titles	Marks
I	Electrostatics	08
II	Current Electricity	07
III	Magnetic effect of Current & Magnetism	08
IV	Electromagnetic induction and Alternating current	08
V	Electromagnetic Waves	03
VI	Optics	14
VII	Dual Nature of Matter	04
VIII	Atoms and Nuclei	06
IX	Electronic Devices	07
X	Communication Systems	05
	Total	**70**

Design 1
Subject – Physics
Class – XII

S.no.	Unit/ Title	Very Short Answer (1 Mark)	Short Answer (2 Mark)	Short Answer (3 Mark)	Long Answer (5 Mark)	Total
1.	Electrostatics	1	1		1	8
2.	Current Electricity	1		2		7
3.	Magnetic Effect of current & magnetism		1	2		8
4.	Electromagnetic Induction & A.C	1	1		1	8
5.	Electromagnetic Waves			1		3
6.	Optics	1	1	2	1	14
7.	Dual Nature of Matter		2			4
8.	Atoms & Nuclei	1	1	1		6
9.	Electronic Devires	1		2		7
10	Communication Systems	2		1		5
	Total	8	7	11	3	29

Question	No. of Question	Marks
VSA (1 Mark)	8	8
SA (2 Marks)	7	14
SA (3 Marks)	11	33
LA (5 Marks)	3	15
Total	**29**	**70**

	Weightage	%
Knowledge	24	34
Understanding	28	40
Application + Skill	18	26
Total	70	100%

	Total Weighatge	%
Difficult Question	15	21
Average Question	34	49
Easy Question	21	30
	70	100 %

Blue Print – Physics

Class - XII

	Knowledge				Understanding				Application			
	VSA	SA	SA	LA	VSA	SA	SA	LA	VSA	SA	SA	LA
Unit	(1)	(2)	(3)	(5)	(1)	(2)	(3)	(5)	(1)	(2)	(3)	(5)
(I) Electrostatics	Q27				Q 5	Q 9 & Q 27				Q.27		
(II) Current Electricity	Q 1						Q 16 Q 17					
(III) Magnetic Effect of current & magnetism	Q 18		Q19			Q 10 Q 18						
(IV) Electromagnetic Induction & A.C		Q28 Q11							Q 2		Q 28	
(V) Electromagnetic Waves							Q 21					
(VI) Optics		Q 23	Q 22		Q 3, 23		Q 29			Q 29 Q 12		
(VII) Dual Nature of Matter		Q 13								Q 14		
(VIII) Atoms & Nuclei	Q 4						Q 20			Q 15		
(IX) Electronic Devices	Q 25					Q 25			Q 7		Q 24	
(X) Communication Systems	Q 6 & Q 8		Q26									
Marks	7	8	9		3	10	15		2	10	6	
	24				28				18			

Sample Question Paper

Physics, Class –XII

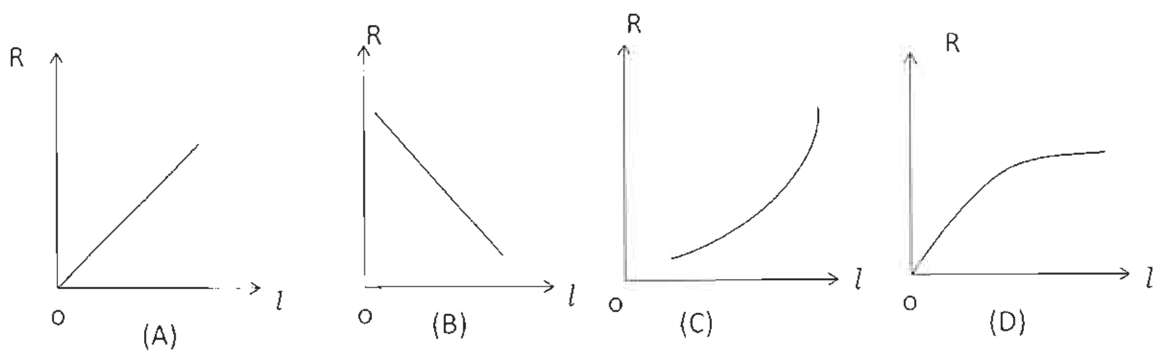
GENERAL INSTRUCTIONS

1. Attempt all Questions.
2. Q. No. 1 to Q. No. 4 are multiple choice questions. Candidates are to choose the most suitable answer. Each carries one mark.
3. Q. No. 5 to Q. No. 8 are very short answer type questions and each carries one mark.
4. Q. No. 9 to Q. No. 15 are short answer type questions carrying two marks each, with internal choice in one question only.
5. Q. No. 16 to Q. No. 26 are short answer type questions carrying three marks each, with internal choice in one question only.
6. Q. No. 27 to Q. No. 29 are long answer type questions carrying five marks each, with internal choice in each question.
7. Use of calculators is not permitted. However, Log Tables will be provided on request.
8. You may use the following values of physical constants wherever necessary:

Speed of light, $c = 3 \times 10^{8}$ m/s
Planck's constant, $h = 6.63 \times 10^{-34}$ J s
Rydberg constant, $R = 10^{7}$ m^{-1}
Radius of earth = 6400 km
Charge on electron, $e = 1.6 \times 10^{-19}$ C
Permeability of free space, $\mu_0 = 4\pi \times 10^{-7}$ T m A^{-1}
Permittivity of free space, $\varepsilon_0 = 8.854 \times 10^{-12}$ $C^2 N^{-1} m^{-2}$
$1/4\pi\varepsilon_0 = 9 \times 10^{9}$ N m^2 C^{-2}
Mass of electron = 9.1×10^{-31} kg
Mass of neutron = 1.675×10^{-27} kg
Mass of proton = 1.673×10^{-27} kg

Section – A

1. A uniform wire of length l and resistance R is gradually stretched by applying a force. Its resistance R versus length l graph will be



2. In an AC circuit, the voltage applied is $E = E_0 \sin \omega t$. The resulting current in the circuit is $I = I_0 \sin(\omega t - \pi/2)$. Power consumption in the circuit is

(A) $\sqrt{2}\ E_0 I_0$ (B) 0 (C) $E_0 I_0/\sqrt{2}$ (D) $E_0 I_0/2$

3. An observer looks at a tree of height 15 m with a telescope of magnifying power 10. The tree appears to him

(A)10 times taller (B) 15 times taller (C) 15 times nearer (D) 10 time nearer

4. In the nuclear reaction

$^{238}_{92}U \rightarrow {}^{A}_{Z}X + 2\ {}^{4}_{2}He + 2\ {}^{0}_{-1}e$

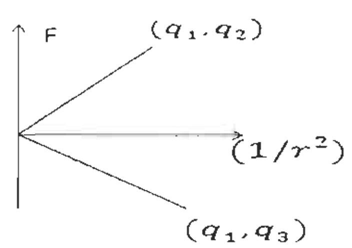
The mass number (A) and charge number (Z) of nucleus X have the respective values

(A) 234, 88 (B) 230, 92 (C) 230, 90 (D) 228, 90

5. An ebonite rod is rubbed with fur. Is there any transfer of mass from the fur to the rod? Justify your answer.
6. What is the importance of modulation index in communication system?
7. The barrier potential of a silicon p-n junction is 0.7 V. Can we measure it using a voltmeter?
8. Write the function of a Repeater used in communication system.

Section B

9. Figure shows a graph of Coulomb force (F) versus $1/r^2$ for two pairs of point charges in two different situations: (a) two charges are q_1 and q_2; and (b) two charges are q_1 and q_3. (q_1 and q_3). Here 'r' is the separation between the point charges. If q_1 is positive and least in magnitude,

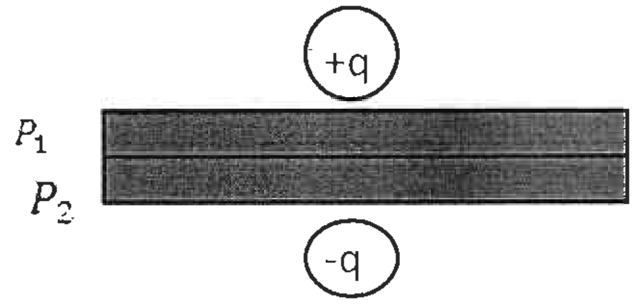


(i) What is the nature i.e. sign of q_2 and q_3, respectively?

(ii) Plot a graph showing variation of force between q_1 and $(q_2 + q_3)$ with $1/r^2$.

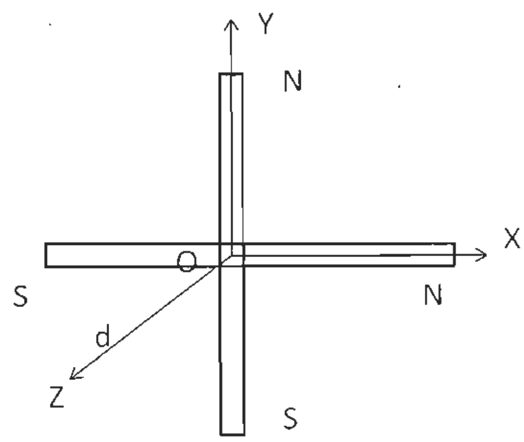
OR

Two large conducting plane plates P_1 and P_2 are kept in contact between two identical metal balls having $-q$ and $+q$ charges as shown in the figure

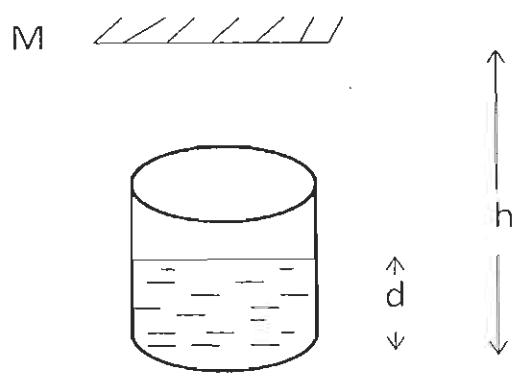


(i) Sketch electric field lines between the balls and plates.
(ii) What happens when the plates are released?

10. Two short magnets having dipole moment M each are fastened perpendicularly at their centers as shown in the figure. Find the magnitude of the magnetic field of the combination at a distance d from the centre on the bisector at right angle to the plane of the system.



11. The electric mains in a house is rated 220 V, 50 Hz. Write down the equation for the instantaneous voltage. What is the time taken by the voltage to change from its maximum value to its rms value?
12. A plane mirror is fixed at a height h above from the bottom of a beaker. The beaker contains water of refractive index, μ height d as shown in the figure. Find the position of the image of the bottom as formed by the mirror.



13. Derive the expression for the de-Broglie wavelength of an electron accelerated through a potential difference of V volts.

14. Using Einstein's photoelectric equation show how one can determine the values of (i) Planck's constant and (ii) work function of the photo-sensitive material used.

15. Draw a plot of binding energy per nucleon (BE/A) vs mass number A for nuclei in the range $2 \leq A \leq 250$.

    Which characteristic property of nuclear force explains the approximate constancy of BE/A in the range of mass number A, 30 < A < 170 ?

Section – C

16. Define drift velocity of free electrons in a conductor. Establish the relationship between drift velocity and the electric current.

OR

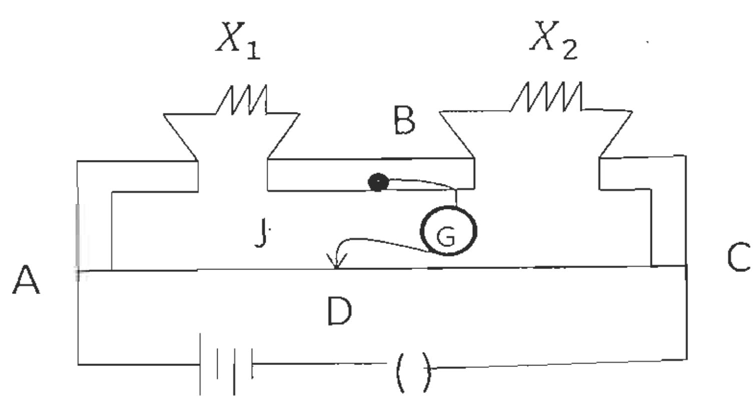
State Kirchhoff's rules for an electrical network and derive the condition of balance in a Wheatstone bridge.

17. Figure shows the experimental set up of a metre bridge. The galvanometer shows no deflection when movable contact (J) touches the metre bridge wire at D such that AD = 40 cm.

    If a 30 Ω resistor is connected in parallel with X_2, the balance point shifts by 10 cm.

    (i) Find The values of $X1$ and $X2$

    (ii) Find the position of balance point, if 30 Ω resistor is connected in parallel with X_1.



18. (i) State principle of working of a moving coil galvanometer.

    (ii) Why do we need radial magnetic field in this device?

    (iii) While using a galvanometer as a voltmeter a high resistance is connected in series while using a galvanometer as an ammeter a shunt is used. Give reason.

19. (i) Two straight long parallel conducting wires carry current I_1 and I_2 in the same direction. Deduce an expression for force per unit length between them.

    (ii) Use this expression to define SI unit of current.

    (iii) Sketch the pattern of magnetic field lines around them.

20. (a) Using Bohr's postulate of quantization of orbital angular momentum, show that the circumference of the orbit of electron in the nth state of hydrogen atom is n times the de-Broglie wavelength associated with it.
(b) Calculate the shortest wavelength of the line emitted in the Balmer series of hydrogen spectrum.

21. (a) Draw a sketch of a plane electromagnetic wave propagating in space. Also indicate the directions of the oscillating electric and magnetic fields associated with the wave. What determines the speed of propagation of electromagnetic wave?
(b) How are electromagnetic waves produced by oscillating charges?

22. What is the importance of coherent sources in Young's double slit experiment? Obtain the pression for the fringe width in terms of wave length λ of light, distance from the slits to the screen D and separation between the two slits d.

23. Explain with the help of a labeled ray diagram, the working of a compound microscope. Why must both the objective and the eye piece of compound microscope have short focal lengths?

24. With the help of a labeled circuit diagram, briefly explain the working of a common emitter n-p-n transistor amplifier. Define its voltage gain.

OR

Draw circuit diagram of a full wave rectifier using p-n junction diodes. Explain its working and show the input and output waveforms.

25. State two differences between n-type and p-type semiconductors.
A specimen of pure semiconductor S is connected in series with a variable resistance R, an ammeter and a cell. How would you change the value of R to keep the reading of the ammeter constant, when the semiconductor is heated? Explain.

26. What is the frequency range at which TV signals are transmitted and why?
The height of a TV Tower is 80 m. calculate the range up to which signals from the tower can be received.

Section – D

27. (a) Define electrostatic potential at a point. Derive expression for the electrostatic potential energy of a pair of charges q_1 and q_2 kept r distance apart in free space.
(b) An electric dipole consists of + 1 μC and −1 μC charges kept 10 cm apart. If it experiences a torque of 2.5×10^{-3} N m in a uniform electric field of 5×10^{4} N/C , find
(i) Its orientation in the field,
(ii) potential energy of the dipole,
(iii) Work done in turning it from its initial orientation to its orientation in unstable equilibrium.

OR

(a) Define capacitance of a capacitor. Obtain expression for the equivalent capacitance of two capacitors C_1 and C_2 connected in parallel across a battery.

(b) A parallel plate capacitor is connected across a battery. After some time, the battery is disconnected. The plates are pulled apart at twice the initial separation and a dielectric slab of dielectric constant $k = 10$ is kept inside the capacitor filling the entire space between its plates. How will the

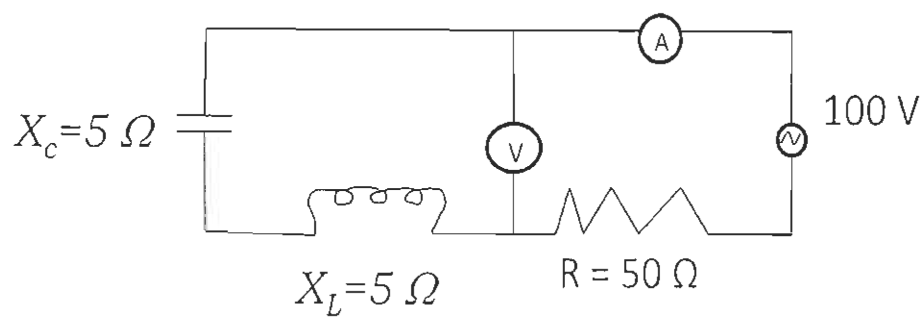
(i) Energy stored in the capacitor,

(ii) Capacitance of the capacitor and

(iii) Electric field between the plates be affected in these cases? Justify your answer in each case.

28. (a) Using phasor diagram, derive an expression for the impedance of a series LCR circuit.

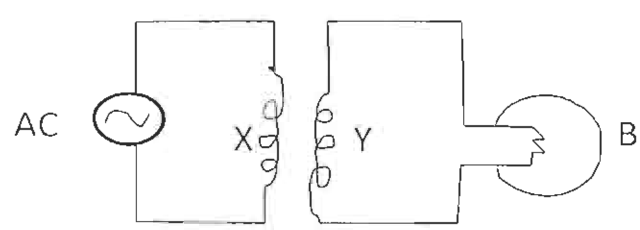
(b) Give the readings in the voltmeter and ammeter of the circuit shown in the figure.



OR

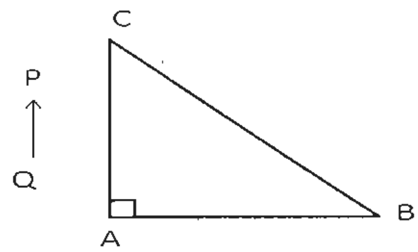
(a) Derive the expression for the mutual inductance of two long coaxial solenoids, each of length l, wound one over the other. The inner solenoid has radius r_1 *and* N_1 number of turns and the outer solenoid has radius r_2 *and* N_2 number of turns.

(b) Figure shows an arrangement by which the current flows in the bulb (B) connected with coil Y when AC is passed through coil X. Explain (i) why the bulb lights up and (ii) if a copper sheet is inserted in the gap between the coils X and Y, how the brightness of the bulb would change.

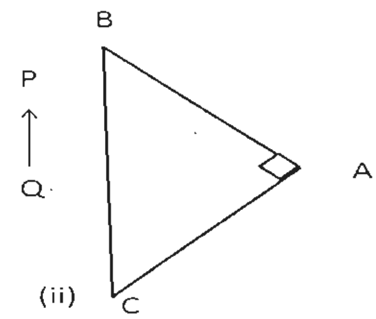


29. (a) Draw a ray diagram to show the formation of a real image of a point object due to a convex spherical refracting surface, when a ray of light is travelling from a rarer medium of refractive μ_1 to a denser medium of refractive index μ_2. Hence derive the relation between object distance, image distance and radius of curvature of the spherical surface.

(b) An object is placed in front of right angled isosceles prism ABC in two positions as shown. The prism is made of crown glass with critical angle of 41°. Trace the path of the two rays from P and Q in each of the two cases.



(i)



(ii)

OR

(a) Distinguish between unpolarized and linearly polarized light.
How is linearly polarized light produced?

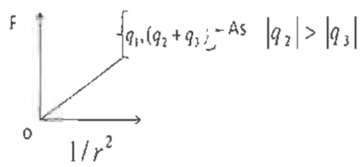
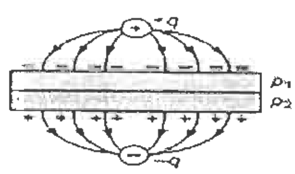
(b) Unpolarized light is incident on a surface separating two media of refractive indices μ_1 and μ_2 ($\mu_1 < \mu_2$). Obtain the condition using suitable diagram when reflected light gets completely polarized.

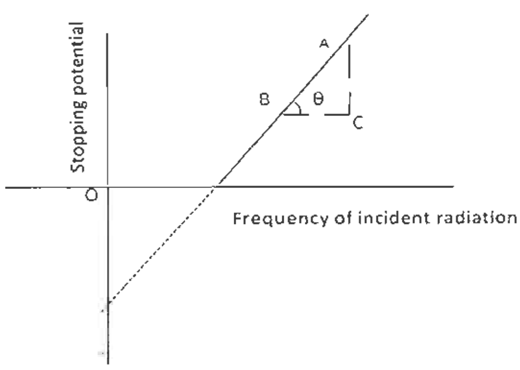
Marking Scheme

PHYSICS

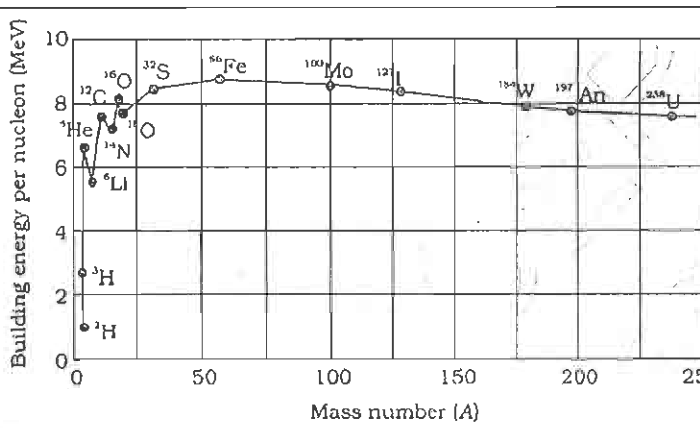
CLASS-XII

Section A

Q.No.	Value points and solution	Marks
1-4	1. (C) 2. (B) 3. (D) 4. (C)	1x4=4
5	Yes, As electrons get transferred from fur to the ebonite rod.	(½ + ½)
6	Modulation index determines the strength and quality of the transmitted signal.	1
7	No, because depletion layer has no free charge carriers i.e. electrons and holes. / In absence of biasing, depletion layer offers infinite resistance.	1
8	A Repeater is a combination of a receiver, an amplifier and a transmitter. It receives a signal, amplifies and transmits it. OR A Repeater compensates the losses of strength of signal during its transmission.	1
	Section B	
9	(i) q_2 is positive and q_3 is negative (ii)  Or (i)  (ii) The plates will move apart due to the attractive force between the charged balls and oppositely charged plates.	1 1 1 (1/2+1/2)
10	Point at a distance d will be in equatorial position with respect to both magnets. Magnetic field due to both magnets will be same in magnitude but acting at an angle 90°. So the effective magnetic field is $\beta = \sqrt{\left(\frac{\mu_0 M}{4\pi d^2}\right)^2 + \left(\frac{\mu_0 M}{4\pi d^2}\right)^2}$ $= \frac{\mu_0}{4\pi} \frac{M}{d^2} \sqrt{2}$	(1/2+1/2) (1/2)+(½)
11	Instantaneous voltage : $E = E_0 \sin \omega t$. Let $t = t_1$ for $E = E_0$ $\therefore E_0 = E_0 \sin \omega t_1 \Rightarrow \sin \omega t_1 = 1 \quad or \quad t_1 = \pi / 2\omega$ Let $t = t_2$ for $E = E_{rms}$ $\therefore E_{rms} = \sqrt{2} E_{rms} \sin \omega t_2$ i.e., $\sin \omega t_2 = 1/\sqrt{2} \quad or \quad t_2 = \pi / 4\omega$ $t_2 - t_1 = \frac{\pi}{4\omega} = \frac{\pi}{4 \times 2\pi f} = \frac{1}{8 \times 50} = \frac{1}{400} s$	(1/2) (1/2) (½) (1/2)

12	The Bottom of the beaker appears to be shifted up by a distance $l = (1 - \frac{1}{\mu})d$ Thus, the apparent distance of the bottom from the mirror is $h - l = h - (1 - \frac{1}{\mu})d = h - d + \frac{d}{\mu}$ The image is formed behind the mirror at a distance $h - d + \frac{d}{\mu}$	(1/2) (1/2)+(1/2) (1/2)
13	Let v be the velocity of the electron accelerated from rest by a potential difference of V volts. The kinetic energy gained is: $KE = \frac{1}{2}mv^2 = \frac{p^2}{2m}$ Work done on the electron = $e\,V$ $\frac{p^2}{2m} = eV \Rightarrow p = \sqrt{2meV}$ $\lambda = \frac{h}{p} = \frac{h}{\sqrt{2meV}}$	(1/2) (1/2) (1/2) (1/2)
14	According to Einstein's photo-electric equation $K_{max} = h\nu - W_0$ If V_0 is the stopping potential, then $K_{max} = eV_0$ $eV_0 = h\nu - W_0 \quad or \quad V_0 = \frac{h}{e}\nu - \frac{W_0}{e}$ Thus plotting a graph of V_0 versus ν will be a straight line.  Slope of $V_0 - \nu$ graph gives $\frac{h}{e} = \frac{AC}{BC} \quad or \quad h = e\frac{AC}{BC}$ Intercept on the vertical axis $= -\frac{W_0}{e}$ Or $W_0 = e \times$ Magnitude of the intercept.	(1/2) (1/2) (1/2) (1/2)

15



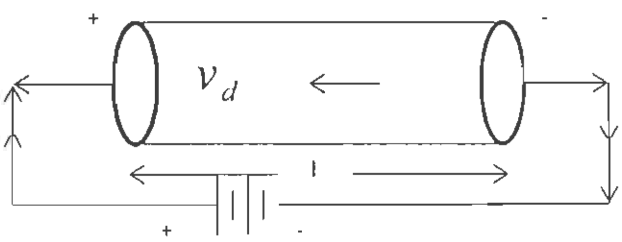
(1)

Characteristic Property: saturation property or short range nature of nuclear force. (1)

Section-C

16

Definition of drift velocity (1)



Let n be the number of free electrons per unit volume in the conductor of length l and cross sectional area A. let I be the current that flows in the conductor when a potential difference is applied across the conductor. (1/2)

Let v_d be the drift velocity of the free electrons (1)

$$I = \frac{dq}{dt} = \frac{nAel}{l/v_d}$$ (1/2)

$$I = neAv_d$$

OR

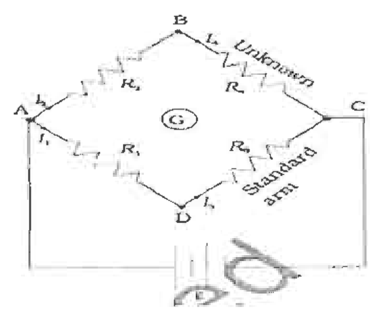
Kirchhoff's two rules (statements) (½ + ½)

If no current flows through BD, then applying Kirchhoff's loop rule for loops ADBA and CBDC

$-I_1R_1 + 0 + I_2R_2 = 0 \quad (I_g = 0)$ ....(i)

$and\ for\ the\ second\ loop, upon\ using\ I_3 = I_1, I_4 = I_2$

$I_2R_4 + 0 - I_1R_3 = 0$ ....(ii)



From Eq.(i), we obtain.

$$\frac{I_1}{I_2} = \frac{R_2}{R_1}$$

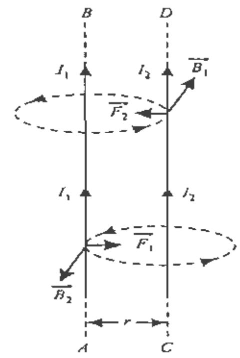
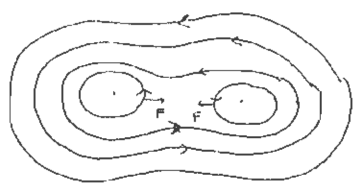
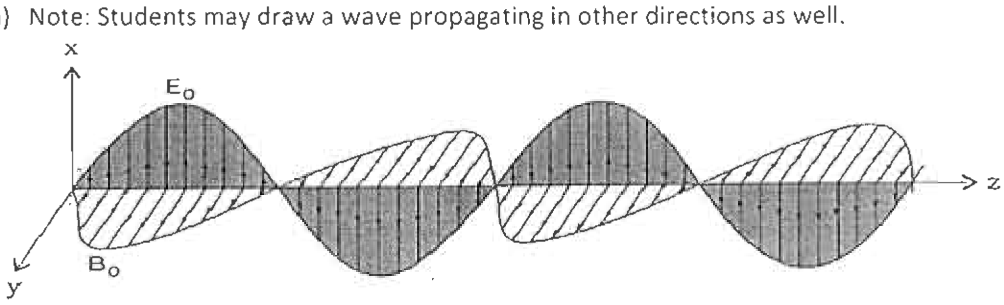
Whereas from Eq.(ii), we obtain,

$$\frac{I_1}{I_2} = \frac{R_4}{R_3}$$

Hence, we obtain the condition

$$\frac{R_2}{R_1} = \frac{R_4}{R_3}$$ (1+1)

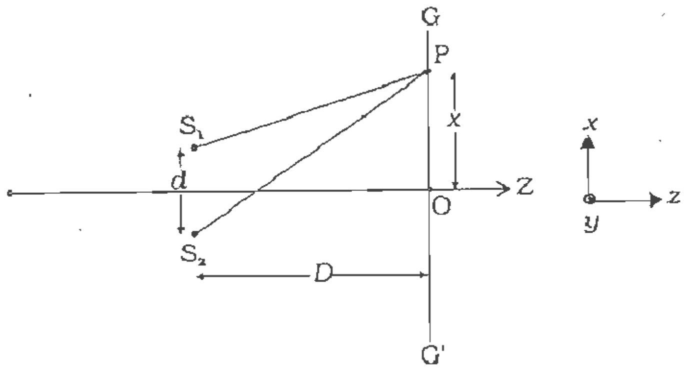
17	(i) $\frac{X_1}{X_2} = \frac{40}{(100-40)}$ Or $X_2 = \frac{3}{2}X_1$ (1) When 30 Ω resistor is connected in parallel with X_2 Resistance in arm $BC, X_2' = \frac{30X_2}{30+X_2} < X_2$ $\frac{X_1}{X_2'} = \frac{50}{(100-50)} = 1$ $\therefore \quad X_1 = X_2' = \frac{30X_2}{30+X_2}$ (2) Solving equation 1 and 2 , we have $X_1 = 10\Omega, \quad X_2 = 15\Omega$ (ii When 30 Ω resistor is connected in parallel with X_1 $\therefore X_1' = \frac{10\times 30}{10+30} = 7.5\Omega$ $\therefore \frac{X_1'}{X_2} = \frac{7.5}{15} = \frac{l}{100-l}$ $\therefore l = 33.3$ cm	(1/2) (1/2) (½) , (½) (1/2) (½)
18	(i) Principle:- A current carrying coil placed in a magnetic field experiences, a torque, the magnitude of which depends on the strength of current. (ii) Need of radial field The current I through the galvanometer coil is given by $I = \left(\frac{K}{\text{NBA}\sin\theta}\right)\alpha$ Because of the factor $sin\theta$, the deflection α is not proportional to the current to make its scale linear. The field is made radial. Then θ = 90 $I = \left(\frac{K}{\text{NBA}}\right)\alpha$ or $I \propto \alpha$ (iii) To measure the potential difference across a resistor in an electric circuit, a high resistance is connected in series with the galvanometer so that maximum of potential difference occurs across the resistor. To measure the current through the circuit, a small resistance is connected in parallel with the galvanometer so that the maximum current flows through the shunt.	(1) (1) (½) (½)
19	(i) Force between two parallel wires carrying currents in the same direction. As shown in figure, let us consider two long parallel wires AB and CD carrying currents I_1 and I_2 in the same direction. Let r be the separation between them. The magnetic field produced by current I_1 at any point on wire CD is $B_1 = \frac{\mu_0 I_1}{2\pi r}$ This field acts perpendicular to the wire CD and points into the plane of paper. It exerts a force on current carrying wire CD. The force acting on length l of the wire CD will be $F_2 = I_2 l B_1 \sin 90^0 = \frac{\mu_0 I_1 I_2}{2\pi r} l$ Force per unit length, $f = \frac{F_2}{l} = \frac{\mu_0 I_1 I_2}{2\pi r}$ According to Fleming's left hand rule, this force acts at right angles to CD, towards AB in the plane of the paper. Similarly, an equal and opposite force is exerted on the wire AB by the field of wire CD. Thus when the currents in the wires are in the same direction, the forces between them are attractive.	 (½) (½)

	 Figure 4.25 Parallel currents attract.	(1/2)
	(ii)Definition of ampere. When $I_1 = I_2 = 1A$ *and* $r = 1m$, *we get* $f = \frac{\mu_0}{2\pi} = 2 \times 10^{-7} Nm^{-1}$ One ampere is that value of steady current, which on flowing in each of the two parallel infinitely long wires placed in vacuum at a distance of 1 m from each other, produces between them a force of 2×10^{-7}newton per metre of their length.	(1/2)
	(iii) Figure 	(1)
20	(a) Bohr's postulate of quantization of orbital angular momentum, L = mvr = $\frac{nh}{2\pi}$. According to de-Broglie hypothesis $\lambda = {}^{h}/_{p}$ Now L=rp = r $\frac{h}{\lambda}$ = $\frac{nh}{2\pi}$; $\therefore\ 2\pi r = n\lambda$ (b) $\lambda_S^{-1} = R(\frac{1}{4} - \frac{1}{\infty}) = {}^{R}/_{4}$; $\lambda_S = 4 x 10^{-7}$ m.	(½) (½) (1) (½ + ½)
21	(a) Note: Students may draw a wave propagating in other directions as well.  As shown, directions of electric and magnetic fields are perpendicular to each other and to the direction of propagation of the wave. Speed of the electromagnetic wave is determined by E_0 and Bo. (b) Oscillating charge produces an oscillating electric field in its neighbourhood. This field in turn produces the oscillating magnetic field. This process continues because the oscillating electric and magnetic fields act as sources of producing each other. Thus electromagnetic waves originate from oscillating charges	(1) (1) (1)

<table>
<tr><td>22</td><td>

(i) Importance of coherent sources is to produce sustained interference patterns.

(ii) Derivation of fringe width. $\beta = \frac{\lambda D}{d}$



$S_2P - S_1P = n\lambda; \quad n = 0, 1, 2 \ldots$

Now,

$$(S_2P)^2 - (S_1P)^2 = \left[D^2 + \left(x + \frac{d}{2}\right)^2\right] - \left[D^2 + \left(x - \frac{d}{2}\right)^2\right] = 2xd$$

$$S_2P - S_1P = \frac{2xd}{S_2P + S_1P}$$

If $x, d << D \Longrightarrow S_2P + S_1P = 2D.$

$S_2P - S_1P = xd/D$

$x = x_n = n\lambda D/d; \; n = 0, \pm 1, \pm 2, \ldots$

β (fringe width) $= x_{n+1} - x_n = \lambda D/d$

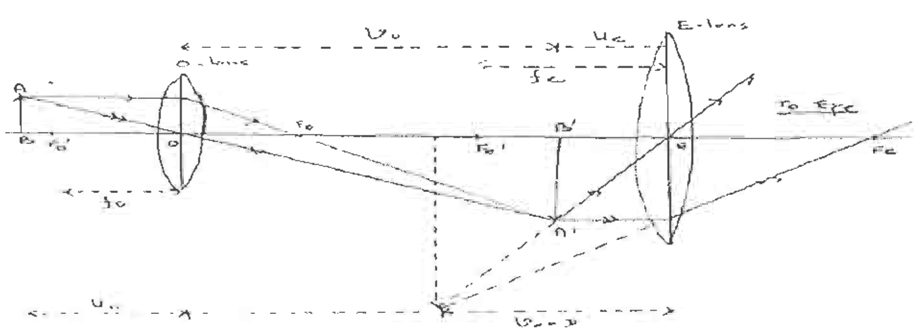
</td><td>

(1)

(2)

</td></tr>
<tr><td>23</td><td>

(i)



Explanation

(ii) Magnifying power of a compound microscope is given by

$$M = \frac{v_0}{u_0}\left(1 + \frac{D}{f_e}\right)$$
$$= \frac{f_0}{u_0 - f_0}\left(1 + \frac{D}{f_e}\right)$$

Angular magnification of objective (m_o) will be large when u_0 is slightly greater than f_0. Since microscope is used for viewing a very close object, so u_0 is small, consequently f_0 has to be small. Moreover, the angular magnification of the eye piece will be large if f_e is small.

</td><td>

(1½)

(½)

(1)

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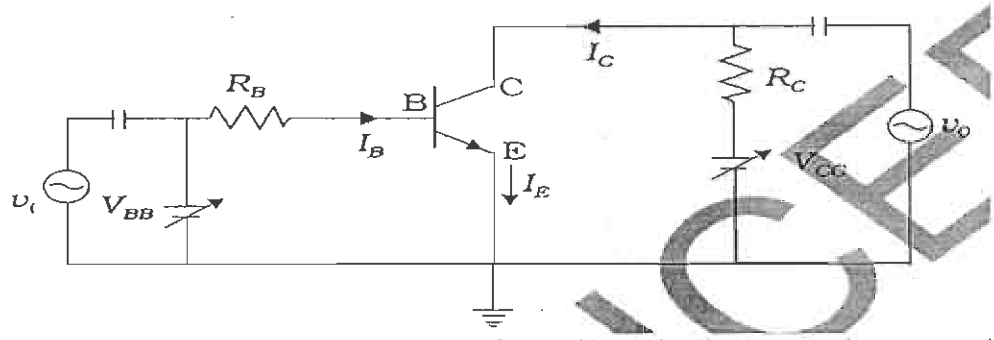
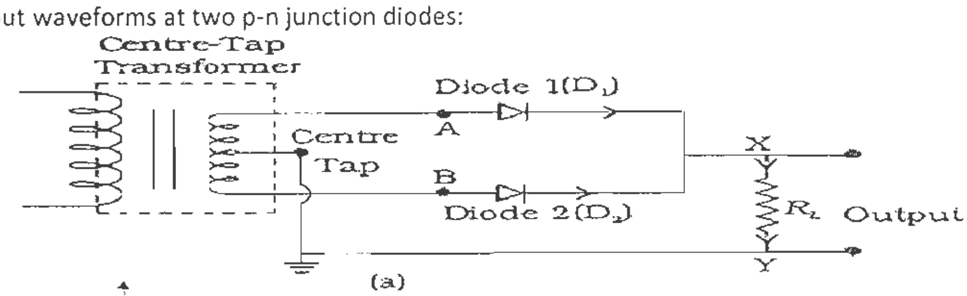
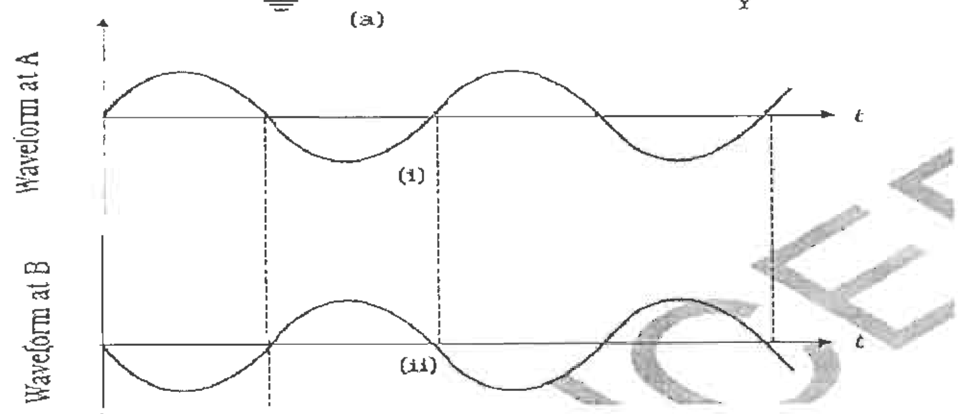
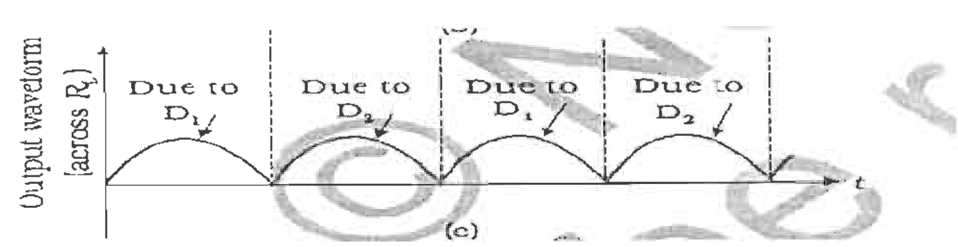
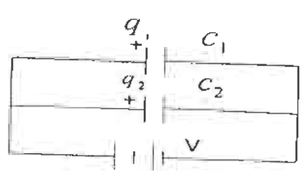
<tr><td>24</td><td>Labeled Diagram of npn transistor amplifier
</td><td>(1)</td></tr>
<tr><td></td><td>Explanation of Working: Since input circuit is forward biased with a very weak input signal connected with it, large but corresponding changes are produced in collector current. As the collector junction is reverse biased therefore the amplified output is obtained.</td><td>(1)</td></tr>
<tr><td></td><td>Voltage Gain: It is defined as the ratio of output voltage to the input voltage.</td><td>(1)</td></tr>
<tr><td></td><td>Or</td><td></td></tr>
<tr><td></td><td>Input waveforms at two p-n junction diodes:
</td><td>(1)</td></tr>
<tr><td></td><td></td><td>(½)</td></tr>
<tr><td></td><td>Output waveform:
</td><td>(½)
(1)</td></tr>
<tr><td></td><td>Working: During the first half cycle of the input signal, Diode D_1 gets forward biased hence conducts and the diode D_2 gets reverse biased and does not conduct. In the second half cycle, the diode D_1 is reverse biased and the diode D_2 is forward biased. Thus giving a rectified out-put.</td><td></td></tr>
</table>

25	n-type semiconductor: (i) pentavalent impurities are added to intrinsic semiconductor; and (ii) majority charge carriers are electrons.	(1 + 1)
	p-type semiconductor: (i) trivalent impurities are added to intrinsic semiconductor; and (ii) majority charge carriers are holes.	
	R should be increased to keep the current same, since heating decreases the resistance of semiconductor S	(1)
26	Frequency Range of TV signals ~ 50 - 900 MHz	(½)
	Reason: Since these frequencies are not reflected by the ionosphere	(½)
	$d = \sqrt{2RH}$	(1)
	$d = \sqrt{2 \times 6400 \times 10^3 \times 80}$	
	$= 4 \times 8 \times 10^3$	
	$= 32$ km	(1)
	Section – D	
27	(a) Definition: - Electrostatic potential at a point is defined as the amount of work done in bringing a unit positive charge from infinity to that point.	(½)
	A ⟵⟶ B q_1 ⟵ r ⟶ q_2	
	Let a charge q_1 be placed at point A and another charge q_2 at a distance r from it.	
	Potential at Point B due to the charge q_1 at A	
	$V_1 = \frac{1}{4\pi\varepsilon_o}\frac{q_1}{r}$	(½)
	∴ Work done in bringing q_2 from infinity to point B	
	$W = q_2 V_1 = \frac{1}{4\pi\varepsilon_o}\frac{q_1 q_2}{r}$	(½)
	∴ Electrostatic potential energy of the system	(½)
	$U = \frac{1}{4\pi\varepsilon_o}\frac{q_1 q_2}{r}$	
	(b) (i) From the expression for the torque, $\tau = pE\sin\theta = q\,.2a\,E\sin\theta$	(1/2)
	$\therefore \sin\theta = \frac{\tau}{q\,.2a\,E} = \frac{2.5 \times 10^{-3}}{10^{-6} \times 10^{-1} \times 5 \times 10^4} = 1/2$	(1/2)
	$\therefore \theta = 30^\circ$	
	(ii) Potential energy $U = -pE\cos\theta$	(½)
	$= -q\,2a\,E\cos 30^0$	
	$= -10^{-6} \times 10^{-1} \times 5 \times 10^4 \times \frac{\sqrt{3}}{2}$	(1/2)
	$= -4.33 \times 10^{-3}$ J	(½ + ½)
	(iii) $W = U_2 - U_1 = pE - (-pE\cos(30^0)) = 9.33 \times 10^{-2}$ J	
	OR	
	Definition of Capacitance	(½)
		
	$q = q_1 + q_2$	
	$CV = C_1 V + C_2 V$	
	$\therefore C = C_1 + C_2$	(1/2)
	(a) (i) Capacitance becomes 5 times of the initial capacitance	(1/2)
	As $C = \frac{kA\varepsilon_o}{2d} = \frac{10}{2}\frac{A\varepsilon_o}{d} = 5C_o$	(1/2)
	(ii) Energy stored becomes one fifth	(1/2)+(1/2)

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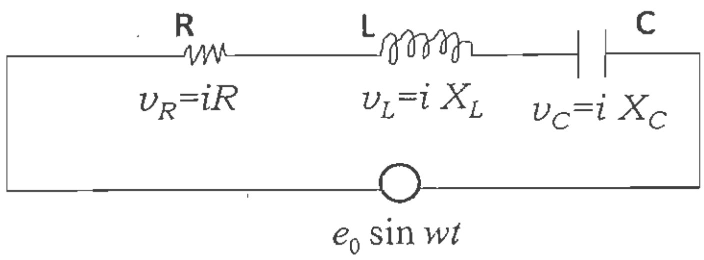
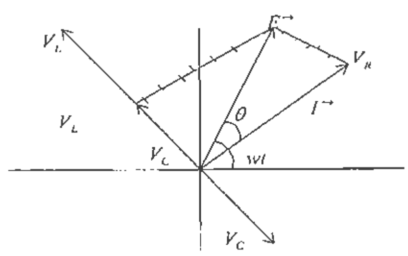
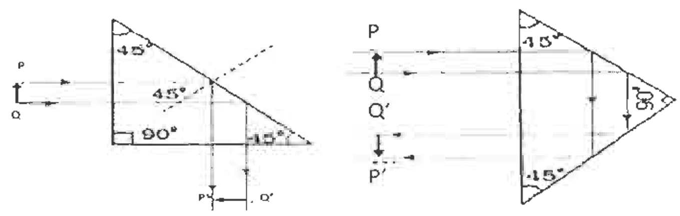
<td>As W = $\frac{q^2}{2c}$ ∴ W ∝ $\frac{1}{C}$ as 'q' remains constant

(iii)Electric field between the plates becomes one tenth
As $E = \frac{E_0}{K} = \frac{1}{10}E_0$
Alternatively Initially $E_0 = \frac{V_0}{d} = \frac{q}{cd} = \frac{q}{AE_0}$
Finally $E = \frac{V}{2d} = \frac{q}{c.2d} = \frac{q}{KAE_0} = \frac{E_0}{10}$</td>
<td>(1/2)+(1/2)

(½)+(1/2)</td>
</tr>
<tr>
<td>28</td>
<td>(a) . Resistance R, inductance L and a capacitance C are connected in series across an AC

Source of voltage e=e_0 sinωt.

$\vec{V_R} = R\ \vec{I}$
$\vec{V_L} = X_L\ \vec{I}$
$\vec{V_C} = X_C\ \vec{I}$
As $\vec{V_L}$ and $\vec{V_C}$ are in opposite directions, their resultant is $\vec{V_L} - \vec{V_C}$.
Using law of parallelogram, $\vec{V_R}$ $(\vec{V_L} - \vec{V_C})$ must equal the
applied emf $\vec{E}$ i.e., $\vec{V_R} + (\vec{V_L} - \vec{V_C}) = \vec{E}$
or
$e_0^2 = V_{0R}^2 + (V_{0L} - V_{0C})^2$
e_o, V_{OR}, V_{OL} and V_{OC} represent the amplitudes of the ac source and of voltages across R, L and C. $I_O = \frac{e_0}{[R^2+(X_L-X_C)^2]^{1/2}}$
The expression for the impedance Z = $\sqrt{R^2 + (X_L - Xc)2}$
(b) Impedance Z = $\sqrt{R^2 + (X_L - Xc)2}$
= $\sqrt{(50)^2 + (5-5)2}$ = 50 Ω
Reading of Ammeter Irms = $\frac{erms}{z} = \frac{100}{50}$ = 2 A
Reading of Voltmeter = $(X_L - Xc)$ Irms = 0</td>
<td>(1)

(½)
(½)
(1/2)
(1/2)

(1)
(1)</td>
</tr>
</table>

	OR (a) On passing a time varying current I_2 through the outer coil magnetic field set up, $B_2 = \mu_0 n_2 I_2 \quad (n_2 = \frac{N_2}{l})$ Total magnetic field linked with inner coil of the solenoid $\phi_1 = B_2 A N_1 = \mu_0 n_2 I_2 A N_1$ Mutual inductance of coil 1 with respect to coil 2 $M_{12} = \frac{\phi_1}{I_2} = \mu_0 n_2 A N_1 = \frac{\mu_0 N_1 N_2 A}{l}$ (b)(i) Bulb lights up due to the induced current set up in the coil 'Y' because of AC passing through coil 'X'. (ii) When copper sheet is inserted, eddy currents are set up in it which opposes the passage of the flux in Y. The induced current decreases and this decreases the brightness of the bulb.	(1) (1) (1) (1) (1)
29	Ray Diagram Derivation: $\frac{\mu_2}{v} = \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R}$  OR (a) Distinguishing between unpolarized and linearly polarized light Producing linearly polarized light (b) Obtaining the condition using proper diagram	(1) (3) (1) (1) (1) (2+1)