Annexure 'H'

SYLLABUS
PHYSICS (042)
CLASS-XII (2013-14)

One Paper	**Time: 3 Hours**	**70 Marks**
Unit I	Electrostatics	08
Unit II	Current Electricity	07
Unit III	Magnetic effect of current & Magnetism	08
Unit IV	Electromagnetic Induction and Alternating current	08
Unit V	Electromagnetic Waves	03
Unit VI	Optics	14
Unit VII	Dual Nature of Matter	04
Unit VIII	Atoms and Nuclei	06
Unit IX	Electronic Devices	07
Unit X	Communication Systems	05
	Total	**70**

The question paper will include value based question(s) to the extent of 3-5 marks.

Unit I: Electrostatics **(Periods 25)**

Electric Charges; Conservation of charge, Coulomb's law-force between two point charges, forces between multiple charges; superposition principle and continuous charge distribution.

Electric field, electric field due to a point charge, electric field lines, electric dipole, electric field due to a dipole, torque on a dipole in uniform electric fleld.

Electric flux, statement of Gauss's theorem and its applications to find field due to infinitely long straight wire, uniformly charged infinite plane sheet and uniformly charged thin spherical shell (field inside and outside).

Electric potential, potential difference, electric potential due to a point charge, a dipole and system of charges; equipotential surfaces, electrical potential energy of a system of two point charges and of electric dipole in an electrostatic field.

Conductors and insulators, free charges and bound charges inside a conductor. Dielectrics and electric polarisation, capacitors and capacitance, combination of capacitors in series and in parallel, capacitance of a parallel plate capacitor with and without dielectric medium between the plates, energy stored in a capacitor. Van de Graaff generator.

Unit II: Current Electricity **(Periods 22)**

Electric current, flow of electric charges in a metallic conductor, drift velocity, mobility and their relation with electric current; Ohm's law, electrical resistance, V-I characteristics (linear and non-linear), electrical energy and power, electrical resistivity and conductivity. Carbon resistors, colour code for carbon resistors; series and parallel combinations of resistors; temperature dependence of resistance.

Internal resistance of a cell, potential difference and emf of a cell,combination of cells in series and in parallel.

Kirchhoff's laws and simple applications. Wheatstone bridge, metre bridge.

Potentiometer - principle and its applications to measure potential difference and for comparing emf of two cells; measurement of internal resistance of a cell.

Unit III: Magnetic Effects of Current and Magnetism **(Periods 25)**

Concept of magnetic field, Oersted's experiment.

Biot - Savart law and its application to current carrying circular loop.

Ampere's law and its applications to infinitely long straight wire. Straight and toroidal solenoids, Force on a moving charge in uniform magnetic and electric fields. Cyclotron.

Force on a current-carrying conductor in a uniform magnetic field. Force between two parallel current-carrying conductors-definition of ampere. Torque experienced by a current loop in uniform magnetic field; moving coil galvanometer-its current sensitivity and conversion to ammeter and voltmeter.

Current loop as a magnetic dipole and its magnetic dipole moment. Magnetic dipole moment of a revolving electron. Magnetic field intensity due to a magnetic dipole (bar magnet) along its axis and perpendicular to its axis. Torque on a magnetic dipole (bar magnet) in a uniform magnetic field; bar magnet as an equivalent solenoid, magnetic field lines; Earth's magnetic field and magnetic elements. Para-, dia- and ferro - magnetic substances, with examples. Electromagnets and factors affecting their strengths. Permanent magnets.

Unit IV: Electromagnetic Induction and Alternating Currents (Periods 20)

Electromagnetic induction; Faraday's laws, induced emf and current; Lenz's Law, Eddy currents. Self and mutual induction.

Alternating currents, peak and rms value of alternating current/voltage; reactance and impedance; LC oscillations (qualitative treatment only), LCR series circuit, resonance; power in AC circuits, wattless current.

AC generator and transformer.

Unit V: Electromagnetic waves (Periods 4)

Need for displacement current, Electromagnetic waves and their characteristics (qualitative ideas only).Transverse nature of electromagnetic waves.

Electromagnetic spectrum (radio waves, microwaves, infrared, visible, ultraviolet, X-rays, gamma rays) including elementary facts about their uses.

Unit VI: Optics (Periods 30)

Reflection of light, spherical mirrors, mirror formula. Refraction of light, total internal reflection and its applications, optical fibres, refraction at spherical surfaces, lenses, thin lens formula, lens-maker's formula. Magnification, power of a lens, combination of thin lenses in contact combination of a lens and a mirror. Refraction and dispersion of light through a prism.

Scattering of light - blue colour of sky and reddish apprearance of the sun at sunrise and sunset.

Optical instruments : Human eye, image formation and accommodation correction of eye defects (myopia, hypermetropia) using lenses. Microscopes and astronomical telescopes (reflecting and refracting) and their magnifying powers.

Wave optics: Wave front and Huygen's principle, relection and refraction of plane wave at a plane surface using wave fronts. Proof of laws of reflection and refraction using Huygen's principle. Interference Young's double slit experiment and expression for fringe width, coherent sources and sustained interference of light. Diffraction due to a single slit, width of central maximum. Resolving power of microscopes and astronomical telescopes. Polarisation, plane polarised light Brewster's law, uses of plane polarised light and Polaroids.

Unit VII: Dual Nature of Matter and Radiation (Periods 8)

Dual nature of radiation. Photoelectric effect, Hertz and Lenard's observations; Einstein's photoelectric equation-particle nature of light.

Matter waves-wave nature of particles, de Broglie relation. Davisson-Germer experiment (experimental details should be omitted; only conclusion should be explained).

Unit VIII: Atoms & Nuclei (Periods 18)

Alpha-particle scattering experiment; Rutherford's model of atom; Bohr model, energy levels, hydrogen spectrum.

Composition and size of nucleus, atomic masses, isotopes, isobars; isotones. Radioactivity-alpha, beta and gamma particles/rays and their properties; radioactive decay law. Mass-energy relation, mass defect; binding energy per nucleon and its variation with mass number; nuclear fission, nuclear fusion.

Unit IX: Electronic Devices (Periods 18)

Energy bands in solids (Qualitative ideas only) conductors, insulator and semiconductors; semiconductor diode – I-V characteristics in forward and reverse bias, diode as a rectifier; I-V characteristics of LED, photodiode, solar cell, and Zener diode; Zener diode as a voltage regulator. Junction transistor, transistor action, characteristics of a transistor, transistor as an amplifier (common emitter configuration) and oscillator. Logic gates (OR, AND, NOT, NAND and NOR). Transistor as a switch.

Unit X: Communication Systems **(Periods 10)**

Elements of a communication system (block diagram only); bandwidth of signals (speech, TV and digital data); bandwidth of transmission medium. Propagation of electromagnetic waves in the atmosphere, sky and space wave propagation. Need for modulation. Production and detection of an amplitude-modulated wave.

Practicals

Every student will perform atleast 15 experiments (7 from section A and 8 from Section B) The activities mentioned here should only be for the purpose of demonstration. One Project of three marks is to be carried out by the students.

B. Evaluation Scheme for Practical Examination: ***Total Periods : 60***

Two experiments one from each section	**8+8 Marks**
Practical record (experiments & activities)	**6 Marks**
Project	**3 Marks**
Viva on experiments & project	**5 Marks**

Total 30 Marks

SECTION A

Experiments

(Any 7 experiments out of the following to be performed by the students)

1. To find resistance of a given wire using metre bridge and hence determine the specific resistance of its material
2. To determine resistance per cm of a given wire by plotting a graph of potential difference versus current.
3. To verify the laws of combination (series/parallel) of resistances using a metre bridge.
4. To compare the emf of two given primary cells using potentiometer.
5. To determine the internal resistance of 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 a sonometer.

Activities

1. To measure the resistance and impedance of an inductor with or without iron core.
2. To measure resistance, voltage (AC/DC), current (AC) and check continuity of a given circuit using multimeter.
3. To assemble a household circuit comprising three bulbs, three (on/off) switches, a fuse and a power source.
4. To assemble the components of a given electrical circuit.
5. To study the variation in potential drop with length of a wire for a steady current.
6. To draw the diagram of a given open circuit comprising at least a battery, resistor/rheostat, key, ammeter and voltmeter. Mark the components that are not connected in proper order and correct the circuit and also the circuit diagram.

SECTION B

Experiments

(Any 8 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 u and v or 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 curve of a p-n junction in forward bias and reverse bias.

9. To draw the characteristic curve of a zener diode and to determine its reverse break down voltage.

10. To study the characteristic of a common - emitter npn or pnp transistor and to find out the values of current and voltage gains.

Activities (For the purpose of demonstration only)

1. To identify a diode, an LED, a transistor, and IC, a resistor and a capacitor from mixed collection of such items.

2. Use of multimeter to (i) identify base of transistor (ii) distinguish between npn and pnp type transistors (iii) see the unidirectional flow of current in case of a diode and an LED (iv) check whether a given electronic component (e.g. diode, transistor or

IC) is in working order.

3. To study effect of intensity of light (by varying distance of the source) on an L.D.R.

4. To observe refraction and lateral deviation of a beam of light incident obliquely on a glass slab.

5. To observe polarization of light using two Polaroids.

6. To observe diffraction of light due to a thin slit.

7. To study the nature and size of the image formed by (i) convex lens (ii) concave mirror, on a screen by using a candle and a screen (for different distances of the candle from the lens/ mirror).

8. To obtain a lens combination with the specified focal length by using two lenses from the given set of lenses.

SUGGESTED INVESTIGATORY PROJECTS

CLASS XII

1 To study various factors on which the internal resistance/emf of a cell depends.

2. To study the variations, in current flowing, in a circuit containing a LDR, because of a variation.
   (a) in the power of the incandescent lamp, used to 'illuminate' the LDR. (Keeping all the lamps at a fixed distance).
   (b) in the distance of a incandescent lamp, (of fixed power), used to 'illuminate' the LDR.

3. To find the refractive indices of (a) water (b) oil (transparent) using a plane mirror, a equiconvex lens, (made from a glass of known refractive index) and an adjustable object needle.

4. To design an appropriate logic gate combinatin for a given truth table.

5. To investigate the relation between the ratio of
   (i) output and input voltage and
   (ii) number of turns in the secondary coil and primary coil of a self designed transformer.

6. To investigate the dependence, of the angle of deviation, on the angle of incidence, using a hollow prism filled, one by one, with different transparent fluids.

7. To estimate the charge induced on each one of the two identical styro foam (or pith) balls suspended in a vertical plane by making use of Coulomb's law.

8. To set up a common base transistor circuit and to study its input and output characteristic and to calculate its current gain.

9. To study the factor, on which the self inductance, of a coil, depends, by observing the effect of this coil, when put in series with a resistor/(bulb) in a circuit fed up by an a.c. source of adjustable frequency.

10. To construct a switch using a transistor and to draw the graph between the input and output voltage and mark the cut-off, saturation and active regions.

11. To study the earth's magnatic field using a tangent galvanometer.

SAMPLE QUESTION PAPER

PHYSICS (042)

CLASS XII (2013-14)

Design of Question paper

Time: 3 hrs. **Maximum Marks: 70**

The weightage of the distribution of marks over different dimensions of the question paper shall be as follows

A. Weightage to different units

S. No.	Unit	Marks
1.	Electrostatics	08
2.	Current Electricity	07
3.	Magnetic Effects of current and Magnetism	08
4.	Electromagnetic Induction and Alternating Current	08
5.	Electromagnetic waves	03
6.	Optics	14
7.	Dual Nature of Radiation and Matter	04
8.	Atoms and Nuclei	06
9.	Electronic Devices	07
10	Communication Systems	05
	Total	70

B. Weightage to form of questions

S. No.	Type of question	Marks per Question	Total number of Questions	Total marks
1	VSA	1	8	8
2	SA I	2	10	20
3	SA II/Value Based Question	3	9	27
4	LA	5	3	15
Total			**30**	**70**

C. Typology of Questions

S. No.	Typology	Weightage in marks	Weightage in percentage
1	Knowledge Based	14	20%
2	Conceptual Understanding	21	30%
3	Inferential Type	14	20%
4	Reasoning Based	11	15%
5	Skill Based	10	15%
	Total	70	100%

D. Weightage to Numericals

The question paper will include numerical questions of 12-15 marks.

E. Scheme of options

There will be no overall choice. However, internal choice in any one question of two marks, any one question of three marks and all the three questions of five marks weightage has been provided.

F. Difficulty level of questions

S. No.	Estimated difficulty level	Percentage of marks
1	Easy	15
2	Average	70
3	Difficult	15

The question paper will include value based question(s) to the extent of 3–5 marks.

PHYSICS

CLASS - XII

SAMPLE PAPER

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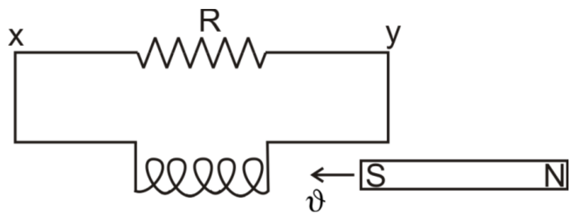
S. No.	Unit	VSA (1 mark)	SA I (2 marks)	SA II/VBQ* (3 marks)	LA (5 marks)	TOTAL
1.	Electrostatics	1 (1)	4 (2)	3 (1)	–	8 (4)
2.	Current Electricity	2 (2)	2 (1)	3 (1)	–	7 (4)
3.	Magnetic effect of current & Magnetism	1 (1)	4(2)	3 (1)	–	8 (4)
4.	Electromagnetic Induction and Alternating Current	1 (1)	2 (1)	–	5 (1)	8 (3)
5.	Electromagnetic Waves	–	–	3 (1)	–	3 (1)
6.	Optics	1 (1)	2 (1)	6 (2)	5 (1)	14 (5)
7.	Dual nature of Radiation and matter	–	4 (2)	–	–	4 (2)
8.	Atoms and Nuclei	–	–	3 (1) 3 (1)*	–	6 (2)
9.	Electronic Devices	–	2 (1)	–	5 (1)	7 (2)
10.	Communication Systems	2 (2)	–	3 (1)	–	5 (3)
	Total	**8 (8)**	**20 (10)**	**27 (9)**	**15 (3)**	**70 (30)**

The question paper will include value based question(s) to the extent of 3–5 marks.

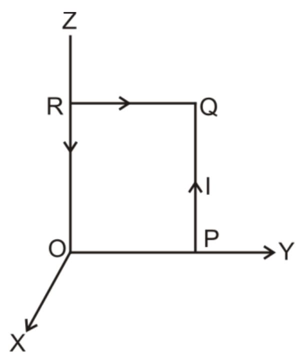
PHYSICS CLASS-XII

SAMPLE PAPER-1

Q1. A magnet is being moved towards a coil with a uniform speed ϑ as shown in the figure. State the direction of the induced current in the resistor R. 1



Q2. A square coil, OPQR, of side a, carrying a current I, is placed in the Y-Z plane as shown here. Find the magnetic moment associated with this coil. 1



Q3. Give one example each of a 'system' that uses the

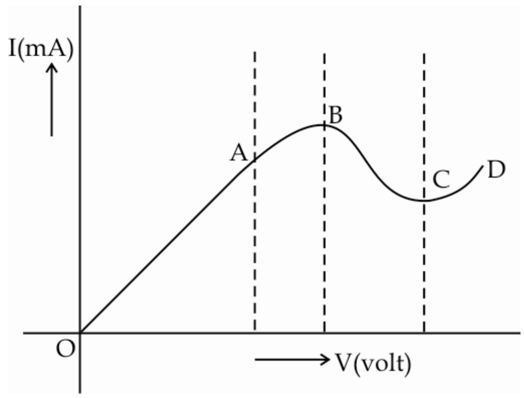
(i) Sky wave (ii) Space wave

mode of propagation 1

Q4. A concave mirror, of aperture 4cm, has a point object placed on its principal axis at a distance of 10cm from the mirror. The image, formed by the mirror, is not likely to be a sharp image. State the likely reason for the same. 1

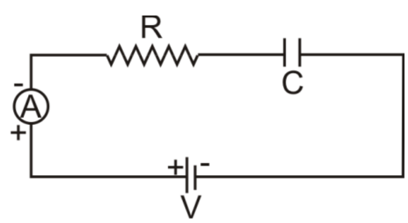
Q5. Two dipoles, made from charges $\pm$ q and $\pm$ Q, respectively, have equal dipole moments. Give the (i) ratio between the 'separations' of the these two pairs of charges (ii) angle between the dipole axis of these two dipoles. 1

Q6. The graph, shown here, represents the V-I characteristics of a device. Identify the region, if any, over which this device has a negative resistance. 1



Q7. Define the term 'Transducer' for a communication system. 1

Q8. State the steady value of the reading of the ammeter in the circuit shown below.



1

Q9. The following table gives data about the single slit diffraction experiment:

Wave length of Light	Half Angular width of the principal maxima
λ	θ
$p\lambda$	$q\theta$

Find the ratio of the widths of the slits used in the two cases. Would the ratio of the half angular widths of the first secondary maxima, in the two cases, be also equal to q? 2

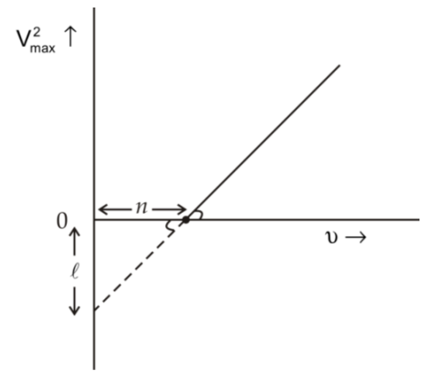
Q10. N spherical droplets, each of radius r, have been charged to have a potential V each. If all these droplets were to coalesce to form a single large drop, what would be the potential of this large drop?

(It is given that the capacitance of a sphere of radius r equals $4\pi\epsilon_0 kr$.)

OR

Two point charges, q_1 and q_2, are located at points (a, o, o) and (o, b, o) respectively. Find the electric field, due to both these charges, at the point, (o, o, c). 2

Q11. When a given photosensitive material is irradiated with light of frequency ν, the maximum speed of the emitted photoelectrons equals ν_{max}. The square of ν_{max}, i.e., ν_{max}^2, is observed to vary with ν, as per the graph shown here.



Obtain expressions for

(i) Planck's constant, and

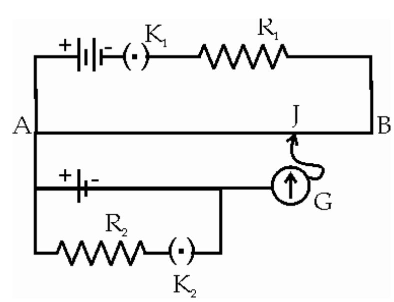
(ii) The work function of the given photosensitive material,

in terms of the parameters, ℓ, n and the mass, m, of the electron.

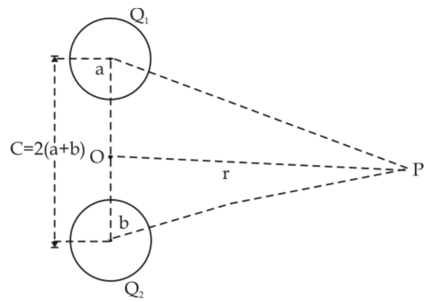
Q12. For the circuit shown here, would the balancing length increase, decrease or remain the same, if 2

(i) R_1 is decreased
(ii) R_2 is increased

without any other change, (in each case) in the rest of the circuit. Justify your answers in each case.



Q13. Find the P.E. associated with a charge 'q' if it were present at the point P with respect to the 'set-up' of two charged spheres, arranged as shown. Here O is the mid-point of the line $O_1 O_2$. 2



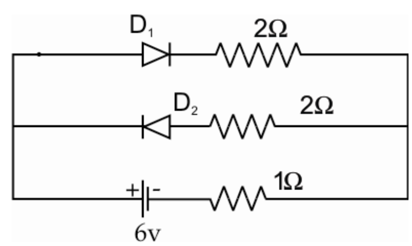
Q14. An athlete peddles a stationary tricycle whose pedals are attached to a coil having 100 turns each of area $0.1m^2$. The coil, lying in the X-Y plane, is rotated, in this plane, at the rate of 50 rpm, about the Y-axis, in a region where a uniform magnetic field, $\vec{B} = (0.01)\,\hat{k}$ tesla, is present. Find the

(i) maximum emf (ii) average e.m.f

generated in the coil over one complete revolution. 2

Q15. A monochromatic source, emitting light of wave length, 600 nm, has a power output of 66W. Calculate the number of photons emitted by this source in 2 minutes. 2

Q16. For the circuit shown here, find the current flowing through the 1Ω resistor. Assume that the two diodes, D_1 and D_2, are ideal diodes. 2



Q17. The following table shows the range of values of susceptibility and relative magnetic permeability of two different type of magnetic substances

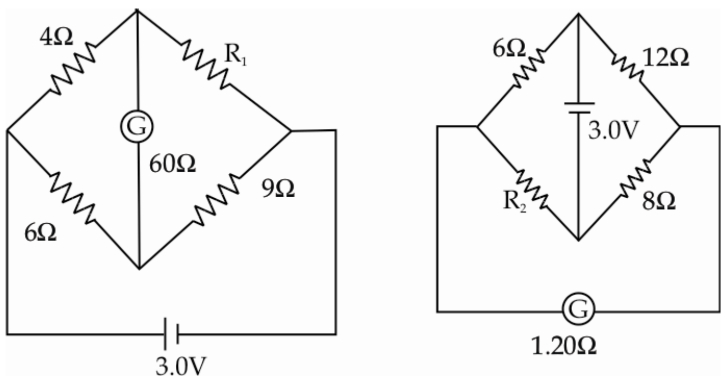
Substance	Susceptibility	Magnetic Permeability
X	-1 to 0	0 to 1
Y	>> 1	>> 1

(a) Identify the type of magnetic materials X and Y.

(b) How does the susceptibility and permeability of X and Y vary with rise in temperature? 2

Q18. Two wires are aligned parallel to each other. One is carrying an electric current and the other is not. Will there be any kind of electromagnetic force between the two? Give reason for your answer. 2

Q19. The galvanometer, in each of the two given circuits, does not show any deflection. Find the ratio of the resistors R_1 and R_2, used in these two circuits. 3



Q20. The electron, in a hydrogen atom, initially in a state of quantum number n_1 makes a transition to a state whose excitation energy, with respect to the ground state, is 10.2 eV. If the wavelength, associated with the photon emitted in this transition, is 487.5 mm, find the

(i) energy in ev, and (ii) value of the quantum number, n_1 of the electron in its initial state. 3

OR

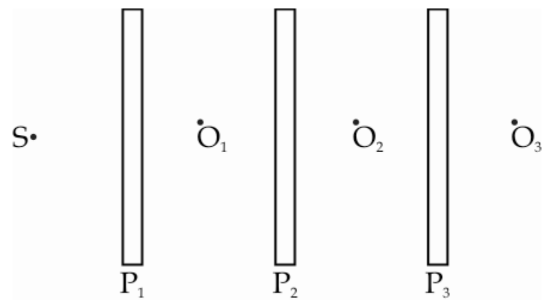
The spectrum of a star in the visible and the ultraviolet region was observed and the wavelength of some of the lines that could be identified were found to be

824 Å, 970 Å, 1120 Å, 2504 Å, 5173 Å, 6100 Å.

Which of these lines cannot belong to hydrogen atom spectrum? Support your answer with suitable calculations.

Take Rydberg constant R = 1.03 X 10^7 m^{-1} and $\frac{1}{R}$ = 970 Å.

Q21. Three identical polaroid sheets P_1, P_2, and P_3 are oriented so that the (pass) axis of P_2 and P_3 are inclined at angles of 60^0 and 90^0, respectively, with respect to the (pass) axis of P_1. A monochromatic source, S, of intensity I_0, is kept in front of the polaroid sheet P_1. Find the intensity of this light, as observed by observers O_1, O_2, and O_3, positioned as shown below.



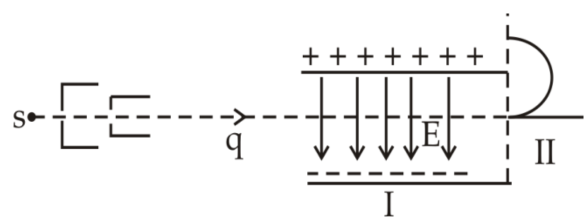
Q22. A fine pencil of β-particles, moving with a speed ϑ, enters a region (region I), where a uniform electric and a uniform magnetic field are both present. These β-particles then move into region II where only the magnetic field, (out of the two fields present in region I), exists. The path of the β-particles, in the two regions, is as shown in the figure.

(i) State the direction of the magnetic field.

(ii) State the relation between 'E' and 'B' in region I.

(iii) Drive the expression for the radius of the circular path of the β-particle in region II.

If the magnitude of magnetic field, in region II, is changed to n times its earlier value, (without changing the magnetic field in region I) find the factor by which the radius of this circular path would change. 3



Q23. Draw an appropriate ray diagram to show the passage of a 'white ray', incident on one of the two refracting faces of a prism. State the relation for the angle of deviation, for a prism of small refracting angle.

It is known that the refractive index, μ, of the material of a prism, depends on the wavelength , λ, of the incident radiation as per the relation

$$\mu = A + \frac{B}{\lambda^2}$$

where A and B are constants. Plot a graph showing the dependence of μ on λ and identify the pair of variables, that can be used here, to get a straight line graph. 3

Q24. Excessively large amount of energy is released in an uncontrolled way in a nuclear bomb explosion. Some scientists have expressed fear that a future nuclear war on Earth would be followed by a severe 'nuclear winter' with a devasting effect on life on Earth. 3

Answer the following questions based on above possible scenario:

a) Name the basic principle responsible for release of large amount of energy in a nuclear bomb explosion. How will the nuclear bomb explosion result in 'nuclear winter'?

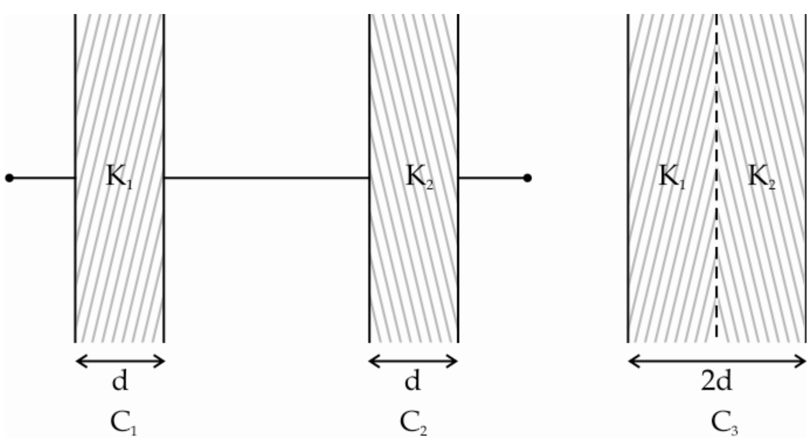
b) Which two human values need to be promoted in individuals so that such a situation of nuclear winter does not arise?

c) Suggest any one method to promote these values in school students.

Q25. The modulation index of an amplitude modulated wave is 0.5. What does it mean?

Calculate the modulation index for an AM wave for which the maximum amplitude is 'a' while the minimum amplitude is 'b'. 3

Q26. The capacitors C_1, and C_2, having plates of area A each, are connected in series, as shown. Campare the capacitance of this combination with the capacitor C_3, again having plates of area A each, but 'made up' as shown in the figure. 3



3

Q27. (a) Write the formula for the velocity of light in a material medium of relative permittivity $\in_r$ and relative magnetic permeability μ_r. 1

(b) The following table gives the wavelength range of some constituents of the electromagnetic spectrum.

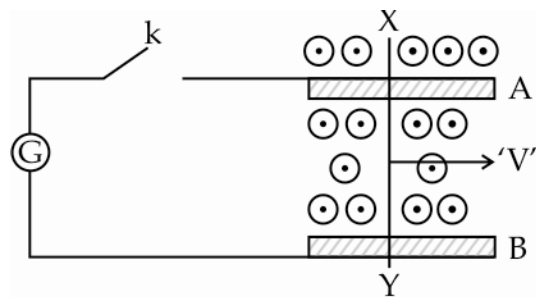
S.No.	Wavelength Range
1.	1mm to 700nm
2.	0.1m to 1mm
3.	400 nm to 1nm
4.	$< 10^{-3}$ nm

Select the wavelength range, and name the (associated) electromagnetic waves, that are used in

(i) Radar systems for Aircraft navigation

(ii) Earth satellites to observe growth of crops. 2

Q28. A conducting rod XY slides freely on two parallel rails, A and B, with a uniform velocity 'V'. A galvanometer 'G' is connected, as shown in the figure and the closed circuit has a total resistance 'R'. A uniform magnetic field, perpendicular to the plane defined by the rails A and B and the rod XY (which are mutually perpendicular), is present over the region, as shown.



(a) With key k open:

(i) Find the nature of charges developed at the ends of the rod XY.

(ii) Why do the electrons, in the rod XY, (finally) experience no net force even through the magnetic force is acting on them due to the motion of the rod?

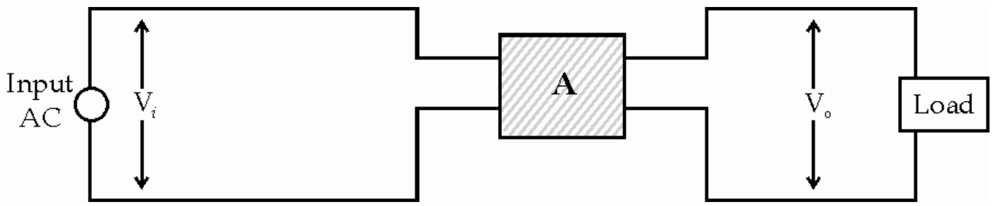
(b) How much power needs to be delivered, (by an external agency), to keep the rod moving at its uniform speed when key k is (i) closed (ii) open?

(c) With key k closed, how much power gets dissipated as heat in the circuit? State the source of this power.

OR

'Box' A, in the set up shown below, represents an electric device often used/needed to supply, electric power from the (ac) mains, to a load.

It is known that $V_o < V_i$.



(a) Identify the device A and draw its symbol.

(b) Draw a schematic diagram of this electric device. Explain its principle and working. Obtain an expression for the ratio between its output and input voltages.

(c) Find the relation between the input and output currents of this device assuming it to be ideal. 5

Q29. Define the terms 'depletion layer' and 'barrier potential' for a P-N junction diode. How does an increase in the doping concentration affect the width of the depletion region?

Draw the circuit of a full wave rectifier. Explain its working.

OR

Why is the base region of a transistor kept thin and lightly doped?

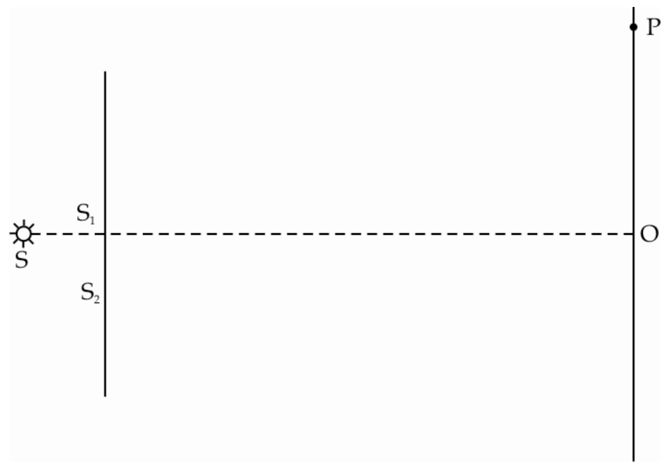
Draw the circuit diagram of the 'set-up' used to study the characteristics of a npn transistor in its common emitter configuration. Sketch the typical (i) Input characteristics and (ii) Output characteristics for this transistor configuration.

How can the out put characteristics be used to calculate the 'current gain' of the transistor?

Q30. (i) A thin lens, having two surfaces of radii of curvature r_1 and r_2, made from a material of refractive index μ_2, is kept in a medium of refractive index μ_1. Derive the Lens Maker's formula for this 'set-up'

(ii) A convex lens is placed over a plane mirror. A pin is now positioned so that there is no parallax between the pin and its image formed by this lens-mirror combination. How can this observation be used to find the focal length of the convex lens? Give appropriate reasons in support of your answer.

OR



The figure, drawn here, shows a modified Young's double slit experimental set up. If $SS_2 - SS_1$, $= \lambda/4$,

(i) state the condition for constructive and destructive interference

(ii) obtain an expression for the fringe width.

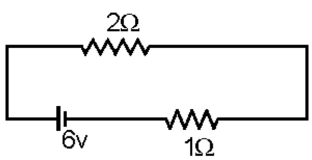
(iii) locate the position of the central fringe. 5

MARKING SCHEME

Q.No.	Value point/ expected points	Marks	Total
1.	From X to Y	1	1
2.	The magnetic moment, associated with the coil, is $\vec{\mu}_m = Ia^2\,\hat{\imath}$	1	1
3.	(i) Short wave broadcast services (ii) Television broadcast (or microwave links or Satellite communication)	½ ½	1
4.	The incident rays are not likely to be paraxial.	1	1
5.	As qa = Qa′, we have $\frac{a'}{a} = \frac{q}{Q}$ and $\theta = 0^o$	½ ½	1
6.	Region BC	1	1
7.	A 'transducer' is any device that converts one form of energy into another	1	1
8.	Zero	1	1
9.	Let d and d′ be the width of the slits in the two cases. $\therefore\ \theta = \frac{\lambda}{d}$ and $q\theta = \frac{p\lambda}{d'}$ $\therefore \frac{d}{d'} = \frac{q}{p}$ Yes, this ratio would also equal q	½+½ ½ ½	2
10.	Total (initial) charge on all the droplets		

	$= N \times (4\pi \epsilon_0 k\, r\, V)$ Also $N \times \frac{4}{3}\Pi r^3 = \frac{4}{3}\Pi R^3$ $\therefore R = N^{1/3} r$ If V' is the potential of the large drop, we have $4\Pi \in_o R \times V' = N \times 4\Pi \in_o kr \times V$ $\therefore V' = \frac{Nr}{R} V = N^{2/3} V$ OR We have $\vec{E}_{net} = \vec{E}_1 + \vec{E}_2$ $= \frac{1}{4\Pi \in_o} \frac{q_1}{r_1^3} \vec{r}_1 + \frac{1}{4\Pi \in_o} \frac{q_2}{r_2^3} \vec{r}_2$ where $\vec{r}_1 = -a\,\hat{\imath} + c\,\hat{k}$ and $\vec{r}_2 = -b\,\hat{\jmath} + c\,\hat{k}$ $\vec{E}_{net} = \frac{1}{4\Pi\in_o}\left[\frac{q_1(-a\,\hat{\imath}+c\,\hat{k})}{(a^2+c^2)^{3/2}} + \frac{q_2(-b\,\hat{\jmath}+c\,\hat{k})}{(b^2+c^2)^{3/2}}\right]$	½ ½ ½ ½ ½ ½ 1	2 2
11.	According to Einestein's Equation: $K_{max} = \frac{1}{2} m\, \vartheta^2_{max} = h^2 - \phi_o$ $\therefore \vartheta^2_{max} = \left(\frac{2h}{m}\right)\nu - \frac{2\phi_o}{m}$ This is the equation of a straight line having a slope 2h/m and an intercept (on the ϑ^2_{max} axis) of $\left(-\frac{2\phi_o}{m}\right)$. Comparing these, with the given graph, we get $\frac{2h}{m} = \frac{\ell}{n}$ or $h = \frac{\ell m}{2n}$ and $\ell = \frac{2\phi_o}{m}$ or $\phi_o = \frac{m\ell}{2}$	½ ½ ½+½	2
12.	(i) decreases (The potential gradient would increase)	½+½	

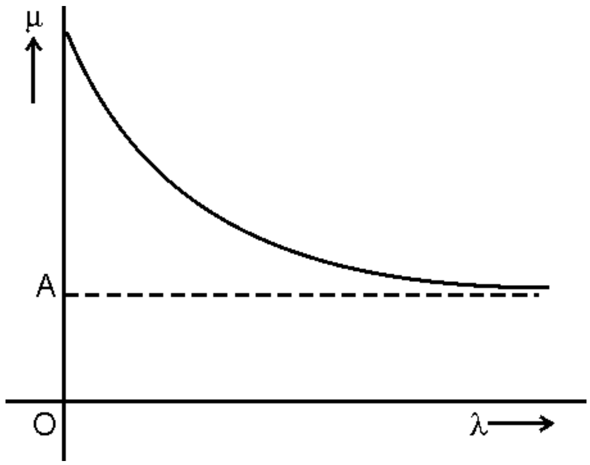
	(ii) increases (The terminal p.d across the cell would increase)	½+½	
13.	$r_1 = O_1P = \sqrt{r^2 + (2a+b)^2}$ $r_2 = O_2P = \sqrt{r^2 + (a+2b)^2}$ $\therefore V = \frac{1}{4\Pi\epsilon_0}\left[\frac{Q_1}{r_1} + \frac{Q_2}{r_2}\right]$ ∴ P.E of charge , q, at P = qV $= \frac{q}{4\Pi\epsilon_0}\left[\frac{Q_1}{[r^2+(2a+b)^2]^{1/2}} + \frac{Q_2}{[r^2+(a+2b)^2]^{1/2}}\right]$	½ ½ ½ ½	2
14.	(i) The maximum emf '∈' generated in the coil is, $\in = N\ B\ A\ \omega$ = N B A 2Πf $= [100 \times 0.01 \times 0.1 \times 2\Pi \frac{(5)}{6}]$ V $= \frac{\Pi}{6}$ V $\simeq$ 0.52 V (ii) The average emf generated in the coil over one complete revolution = 0	 ½ 1 ½	2
15.	Energy of one photon = E = $\frac{hc}{\lambda}$ $E = \frac{6.6\times10^{-34}\times3\times10^{8}}{6\times10^{-7}}$ $\simeq 3.3 \times 10^{-19}$ J E_1 = energy emitted by the source in one second = 66J ∴ number of photons emitted by the source in 1s = n = $\frac{66}{3.3\times10^{-19}} = 2 \times 10^{20}$ ∴ Total number of photons emitted by	 ½ ½ ½	2

	source in 2 minutes = N = n x 2 x 60 = 2 x 10^{20} x 120 = 2.4 x 10^{22} photons	½	
16.	Diode D_1 is forward biased while Diode D_2 is reverse biased Hence the resistances, of (ideal) diodes, D_1 and D_2, can be taken as zero and infinity, respectively. The given circuit can, therefore, be redrawn as shown in the figure.  ∴ Using ohm's law, $I = \frac{6}{(2+1)}$ A = 2A ∴ current flowing in the 1Ω resistor, is 2A.	½ ½ ½ ½	2
17.	(a) X-Diamagnetic, Y-Ferromagnetic (b) X- No change (c) Y- Decreases with temperature		
18.	No - Since there is only one magnetic field, there is no interaction and hence no force between the two wires.		
19.	For circuit 1, we have, (from the Wheatstone bridge balance condition),		

	$\frac{R_1}{9} = \frac{4}{6}$ $\therefore R_1 = 6\Omega$ In circuit 2, the interchange of the positions of the battery and the galvanometer, does not change the (wheatstone Bridge) balance condition. $\therefore \frac{R_2}{8} = \frac{6}{12}$ or $R_2 = 4\Omega$ $\therefore \frac{R_1}{R_2} = \frac{6}{4} = \frac{3}{2}$	½ ½ ½ ½ ½ ½	3
20.	In a hydrogen atom, the energy (E_n) of electron, in a state, having principal quantum number 'n', is given by $E_n = \frac{-13.6}{n^2}$ eV $\therefore E_1 = -13.6$eV and $E_2 = -3.4$ eV It follows that the state n=2 has an excitation energy of 10.2 eV. Hence the electron is making a transition from $n=n_1$ to n=2 where ($n_1>2$). Now $E_{n1} - E_2 = \frac{hc}{\lambda}$ But $\frac{hc}{\lambda} = \frac{6.63\text{x}10^{-24}\text{x}3\text{x}10^{8}}{487.3\text{x}10^{-9}\text{x}1.6\text{x}10^{-9}}$ eV = 2.55eV $\therefore E_{n1}$= (-3.4 + 2.55) eV $\simeq$ - 0.85 eV But we also have $E_{n1} = \frac{-13.6}{n_1^2}$ eV $\therefore$ we get $n_1 = 4$	½ ½ ½ ½ ½ ½	3

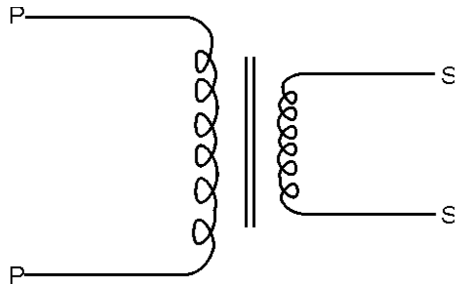
	OR $\bar{\nu} = \frac{1}{\lambda} = R\left[\frac{1}{n_2^2} - \frac{1}{n_1^2}\right]$ $\lambda = \frac{\frac{1}{R}}{\left[\frac{1}{n_2^2} - \frac{1}{n_1^2}\right]} = \frac{970\text{ Å}}{\left[\frac{1}{n_2^2} - \frac{1}{n_1^2}\right]}$ If we take $n_2 = 1$ (Lyman series of Hydrogen Spectrum) λ can take values $\frac{970\text{ Å}}{3/4}$, $\frac{970\text{ Å}}{8/9}, \frac{970\text{ Å}}{15/16}, \ldots\ldots\ldots, \frac{970\text{ Å}}{1}$ Corresponding to $n_1 = 2, 3, 4, \ldots\ldots\ldots$ Thus, permitted values of λ are 1293 Å, 1091 Å, 1034 Å, ……., 970 Å. Similarly if we take $n_2 = 2$ (Balmer Series of Hydrogen Spectrum), corresponding to $n_1 = 3, 4, 5, \ldots\ldots$ λ can have values $\frac{970\text{ Å}}{\frac{5}{36}}, \frac{970\text{ Å}}{\frac{3}{16}}, \frac{970\text{ Å}}{\frac{21}{100}}, \ldots\ldots\ldots, \frac{970\text{ Å}}{\frac{1}{4}}$ i.e. 6984 Å, 5173 Å, 4619 Å, ………., 3880 Å. Hence out of the given values λ = 824 Å, 1120 Å, 2504 Å, 6100 Å cannot belong to the hydrogen atom spectrum.	½ ½ ½ ½ ½ ½	3
21.	Intensity observed by (i) Observer $O_1 = \frac{I_o}{2}$ (ii) Observer $O_2 = \frac{I_o}{2}\cos^2 60^o$	½ ½	3

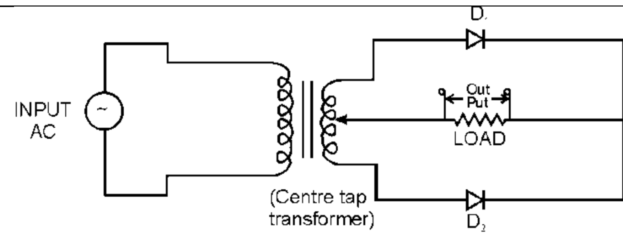
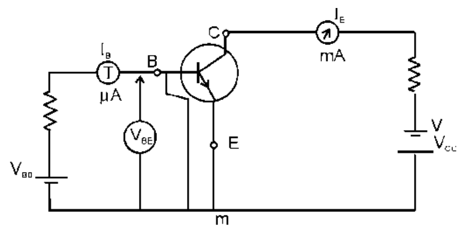
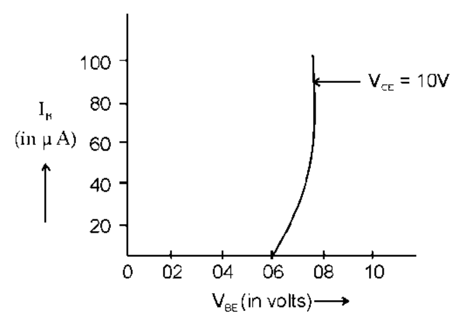
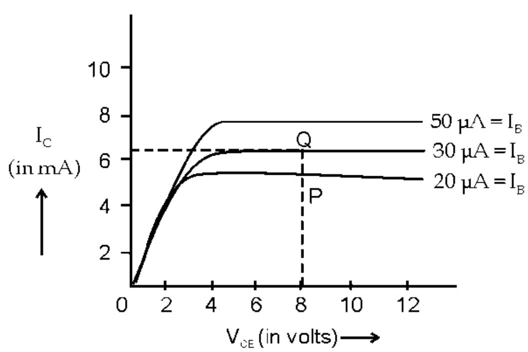
	$= \frac{I_o}{8}$	½	
	(iii) Observer O_3 $= \left(\frac{I_o}{8}\right) \cos^2 (90^o - 60^o)$	1	
	$= \frac{I_o}{8} \times \frac{3}{4} = \frac{3I_o}{32}$	½	
22.	(i) The magnetic field is perpendicular to the plane of page and is directed inwards	½	
	(ii) In region I		
	$\lvert\vec{F}_e\rvert = \lvert\vec{F}_m\rvert$	½	
	$qE = q\,\vartheta B$		
	$\therefore E = \vartheta B$		
	(iii) In region II	½	
	$\frac{mv^2}{r} = q\vartheta B \Rightarrow r = \frac{m\vartheta}{qB}$		3
	Substituting the value of ϑ, we get		
	$r = \frac{mE}{qB^2}$	½	
	Let B′ (=nB) denote the new magnetic field in region II. If r′ is the radius of the circular path now, we have		
	$\Rightarrow r^1 = \frac{m\vartheta}{qB'} = \frac{mE}{qnB^2}$	½	
	Hence radius of the circular path, would decrease by a factor n.	½	
23.	See (fig 9.25, Page 332 Part II NCERT)	1	
	For a small angled prism, of refracting angle α :		
	Angle of deviation $\propto = (\mu - 1) \propto$ where μ is	½	

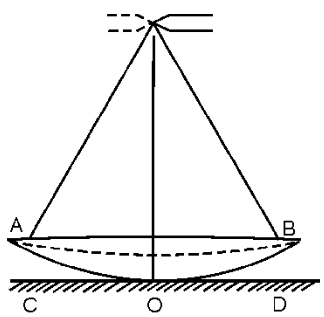
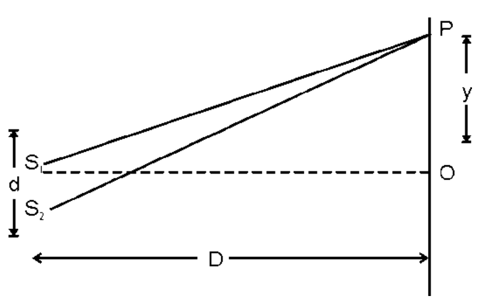
	the refractive index of the material of the prism.  To get a straight line graph, we need to use μ and $1/_{\lambda^2}$ as the pair of variables.	1 ½	3
24.	a) - Uncontrolled nuclear chain reaction. - The thick smoke produced due to nuclear explosion would perhaps cover substantial parts of the sky preventing solar light from reaching many parts of the Earth resulting in lowering of atmospheric temperature. b) - International understanding and Brotherhood. - Love for humanity/non violence c) - Group discussion for value clarification - Vigorous campaign for spreading awareness using mass media.	½ ½ ½ ½ ½	3
25.	• It means that the ratio of peak value of the modulating signal to the peak	2	

	value of carrier wave is 0.5. • If A_m is the peak value of modulating signal and A_c is the peak value of carrier wave. We have $a = A_c + A_m$ and $b = A_c - A_m$ Thus, $A_c = \frac{a+b}{2}$ and $A_m = \frac{a-b}{2}$ Therefore modulation index $\mu = \frac{A_m}{A_c} = \frac{a-b}{a+b}$	1	3
26.	We have $C_1 = \frac{A\epsilon_o K_1}{d}$ and $C_2 = \frac{A\epsilon_o K_2}{d}$ $\therefore C_{eq} = \frac{C_1 C_2}{C_1+C_2} = \frac{A\epsilon_o}{d}\left(\frac{K_1K_2}{K_1+K_2}\right)$ Now, capacitor C_3 can be considered as made up of two capacitors C_1 and C_2, each of plate area A and separation d, connected in series. We have : $C_1' = \frac{A\epsilon_o K_1}{d}$ and $C_2' = \frac{A\epsilon_o K_2}{d}$ $\Longrightarrow C_3 = \frac{C_1' C_2'}{C_1'+C_2'} = \frac{A\epsilon_o}{d}\left(\frac{K_1K_2}{K_1+K_2}\right)$ $\therefore \frac{C_3}{C_{eq}} = 1$ Hence net capacitance of the combination is equal to that of C_3.	½ ½ ½ ½ ½ ½	3

27.	(a) We have $\vartheta = \frac{1}{\sqrt{\mu\epsilon}} = \frac{1}{\sqrt{\mu_0\mu_r\epsilon_o\epsilon_r}}$ (b) (i) Wavelength range: [0.1m to 1mm] (Microwaves) (ii) Wavelength range: [1mm to 700 nm] (Infrared waves)	½+½ ½+½ ½+½	3
28.	(a) (i) X : negative , Y: positive (ii) Magnetic force, F_m, experienced by the moving electrons, gets balanced by the electric force due to the electric field, caused by the charges developed at the ends of the rod. Hence net force on the electrons, inside the rod, (finally) become zero. (b) The power, that needs to be delivered by the external agency, when key k is closed, is $P=F_mV = (I\,l\,B)V = \frac{BlV}{R}.lBV$ $= B^2l^2V^2/R$ When k is open, there is an induced emf, but no induced current. Hence power that needs to be delivered is zero. (c) Power, dissipated as heat $= i^2\,R = \frac{B^2\ell^2V^2}{R}$ The source of this power is the mechanical work done by the external agency.	½ 1+½ ½+½ ½ ½+½ ½	5

	OR (a) Step down transformer.  (b) Diagram Principle Working Obtaining the expression (c) Input power = output power $\therefore V_p i_P = V_s i_s$ $\Rightarrow \frac{i_p}{i_s} = \frac{V_s}{V_p} = \frac{N_s}{N_p}$	½ ½ ½ ½ ½ 2 ½	5
29.	The space charge region, on either side of the junction (taken together), is known as the depletion layer. The p.d across the depletion layer is known as the barrier potential The width of the depletion region decreases with an increase in the doping concentraction. The circuit of a full-wave rectifier is shown below.	½ ½ ½ 1½	5

	 Working details	2	
	OR		
	The base region of a transistor is thin and lightly doped so that the base current (I_B) is very small compared to emitter current (I_E).	1	
	 (Circuit for studying the characterist cs of a npn transistor in its CE configuration)	1	
	 INPUT CHARACTERISTIC	1	5
	 OUTPUT CHARACTERISTIC	1	

	The current gain (β) of a transistor in common emitter configuration is $\beta = \frac{\Delta I_C}{\Delta I_B}$ ΔI_C and ΔI_B can be obtained, from the two curves, in the output characteristics.	1	
30.	(i) Diagram Derivation (ii) The rays must fall normally on the plane mirror so that the image of the pin coincides with itself  Hence rays, like CA and DB, form a parallel beam incident on the lens. ∴ P is the position of the focus of the lens ∴ Distance OP equals the focal length of the lens OR 	1 2½ ½ ½ ½ 1	5

	Δ_o = initial path different between S_1 and S_2 $= SS_2 - SS_1 = \lambda/4$ Δ = S_2P–S_1P = path difference between disturbance from S_1 and S_2, at point P $= \frac{yd}{D}$ Δ_T = Total path difference between the two disturbances at P $= \Delta_o + \Delta = \frac{\lambda}{4} + \frac{yd}{D}$ ∴ For constructive interference: $\Delta_T = \left(\frac{\lambda}{4} + \frac{yd}{D}\right) = n\lambda$; n = 0, 1, 2,…. $\therefore \frac{y_n d}{D} = (n - \frac{1}{4})\ \lambda$ …(i) For destructive interference $\Delta_T = \left(\frac{\lambda}{4} + \frac{yd}{D}\right) = (2n-1)\ \frac{\lambda}{2}$ . . . (ii) $\therefore \frac{Y_{n'} d}{D} = \left(2n - 1 - \frac{1}{2}\right)\frac{\lambda}{2}$ $\therefore \frac{Y_{n'} d}{D} = \left(2n - \frac{3}{2}\right)\frac{\lambda}{2}$ β = fringe width = $y_{n+1} - y_n = \frac{\lambda D}{d}$ The position Y_o of central fringe is obtained by putting n=o in Eqn (i). Therefore, $\therefore y_o = -\frac{\lambda D}{4d}$ [Negative sign shows that the central fringe is obtained at a point below the (central) point O.]	½ ½ 1 1 1	5