

**Annexure - ' H '****PHYSICS (042)  
CLASS-XII – (2012-13)**

<b>One Paper</b>	<b>Time: 3 Hours</b>	<b>Total Periods : 180 70 Marks</b>
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
<b>Total</b>		<b>70</b>

**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 field.

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 appearance 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, reflection 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	<b>8+8 Marks</b>
Practical record (experiments & activities)	<b>6 Marks</b>
Project	<b>3 Marks</b>
Viva on experiments & project	<b>5 Marks</b>

## **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.

#### ***Recommended Textbooks.***

1. Physics, Class XI, Part -I & II, Published by NCERT.
2. Physics, Class XII, Part -I & II, Published by NCERT.

**DESIGN OF QUESTION PAPER**  
**PHYSICS (042)**  
**CLASS-XII – (2012-13)**

**Time: 3 hours**

**Maximum Marks: 70**

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

**A. Weightage to content/subject units**

S. No.	Unit	Marks
1.	Electrostatics	08
2.	Current Electricity	07
3.	Magnetic Effect 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
	<b>Total</b>	<b>70</b>

**The Question Paper will include question(s) based on values to the extent of 3-5 marks**

**SAMPLE QUESTION PAPER**  
**PHYSICS (042)**  
**CLASS-XII – (2012-13)**

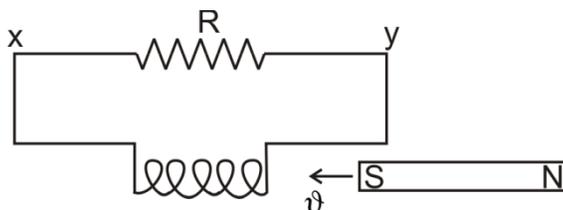
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S. No.	Unit	VSA (1mark)	SA I (2marks)	SA II (3marks)	Value Based Question (4 Marks)	LA (5marks)	TOTAL
1.	Electrostatics	1 (1)	4 (2)	3 (1)	-	-	8 (4)
2.	Current Electricity	2 (2)	2 (1)	3 (1)	-	-	7 (4)
3.	Magnetic effect of current & Magnetism	1 (1)	-	3 (1)	4 (1)	-	8 (3)
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	-	-	6 (2)	-	-	6 (2)
9.	Electronic Devices	-	2 (1)	-	-	5 (1)	7 (2)
10.	Communication Systems	2 (2)	-	3 (1)	-	-	5 (3)
	<b>Total</b>	<b>8 (8)</b>	<b>16 (8)</b>	<b>27 (9)</b>	<b>4 (1)</b>	<b>15 (3)</b>	<b>70 (29)</b>

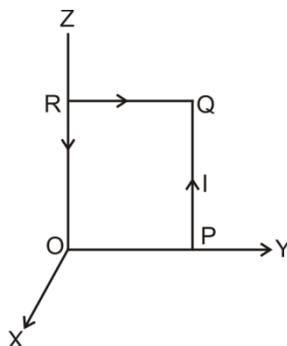
**The Question Paper will include value based question(s) to the extent of 3-4 marks.**

**SAMPLE QUESTION PAPER**  
**PHYSICS (042)**  
**CLASS-XII – (2012-13)**

- Q1. A magnet is moving towards a coil with a uniform speed  $v$  as shown in the figure. State the direction of the induced current in the resistor R. 1

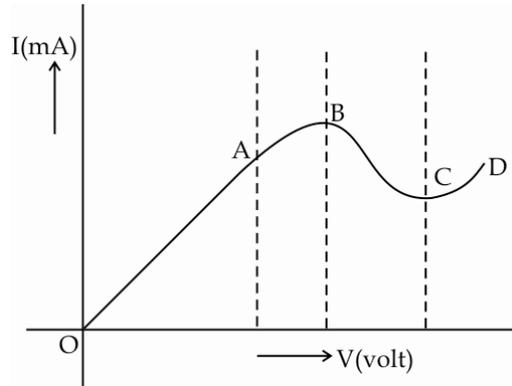


- Q2. A square coil, OPQR, of side  $a$ , carrying a current  $I$ , is placed in the Y-Z plane as shown here. Find the magnetic moment associated with this coil. 1

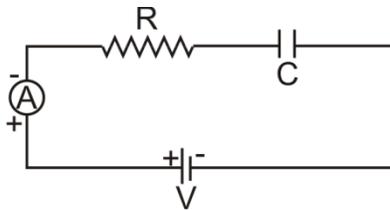


- Q3. Give one example each of a 'system' that uses the  
 (i) Sky wave                      (ii) Space wave  
 mode of propagation 1
- Q4. A concave mirror, of aperture 4cm, has a point object placed on its principal axis at a distance of 10cm from the mirror. The image, formed by the mirror, is not 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.



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

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

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

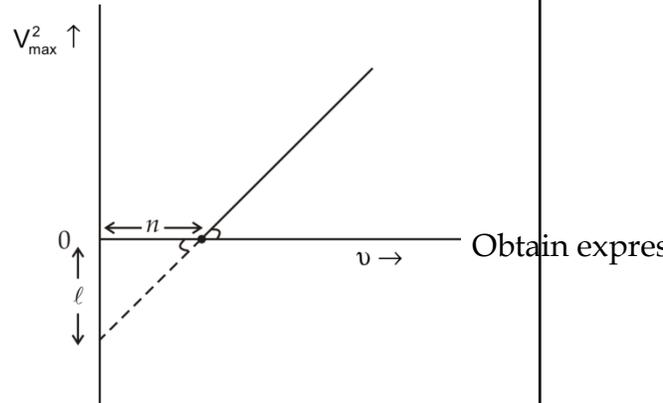
- Q10.  $N$  spherical droplets, each of radius  $r$ , have been charged to have a potential  $V$  each. If all these droplets were to coalesce to form a single large drop, what would be the potential of this large drop?

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

OR

Two point charges,  $q_1$  and  $q_2$ , are located at points  $(a, 0, 0)$  and  $(0, b, 0)$  respectively. Find the electric field, due to both these charges, at the point,  $(0, 0, c)$ . 2

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



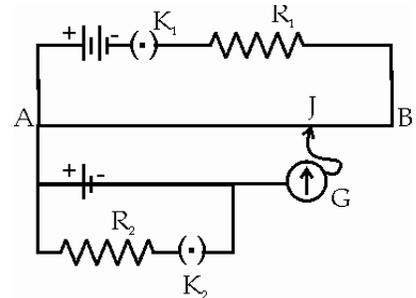
- (i) Planck's constant, and
- (ii) The work function of the given photosensitive material,

in terms of the parameters,  $\ell$ ,  $n$  and the mass,  $m$ , of the electron.

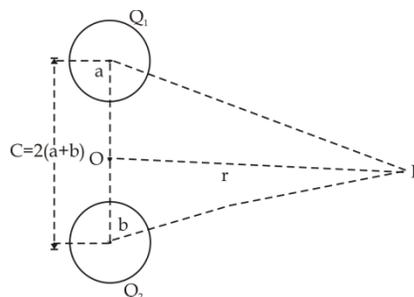
Q12. For the circuit shown here, would the balancing length increase, decrease or remain the same, if 2

- (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.

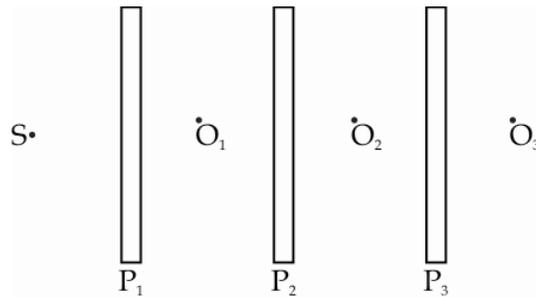


Q13. Find the P.E. associated with a charge ' $q$ ' if it were present at the point P with respect to the 'set-up' of two charged spheres, arranged as shown. Here O is the mid-point of the line  $O_1 O_2$ . 2





- Q19. 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  $60^\circ$  and  $90^\circ$ , 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.

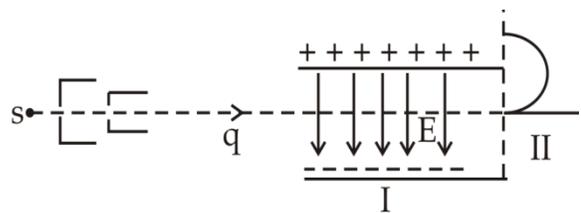


- Q20. A fine pencil of  $\beta$ -particles, moving with a speed  $v$ , enters a region (region I), where a uniform electric and a uniform magnetic field are both present. These  $\beta$ -particles then move into region II where only the magnetic field, (out of the two fields present in region I), exists. The path of the  $\beta$ -particles, in the two regions, is as shown in the figure.

- State the direction of the magnetic field.
- State the relation between 'E' and 'B' in region I.
- Derive the expression for the radius of the circular path of the  $\beta$ -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



- Q21. 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,  $\mu$ , of the material of a prism, depends on the wavelength,  $\lambda$ , 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  $\mu$  on  $\lambda$  and identify the pair of variables, that can be used here, to get a straight line graph. 3

Q22. Define the terms (i) mass defect (ii) binding energy for a nucleus and state the relation between the two.

For a given nuclear reaction the B.E./nucleon of the product nucleus/nuclei is more than that for the original nucleus/nuclei. Is this nuclear reaction exothermic or endothermic in nature? Justify your choice.

OR

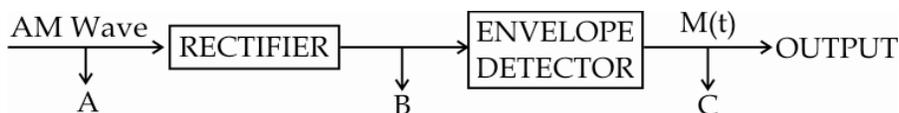
(a) The number of nuclei, of a given radioactive nucleus, at times  $t=0$  and  $t=T$ , are  $N_0$  and  $(N_0/n)$  respectively. Obtain an expression for the half life ( $T_{1/2}$ ) of this nucleus in terms of  $n$  and  $T$ .

(b) Identify the nature of the 'radioactive radiations', emitted in each step of the 'decay chain' given below: 3

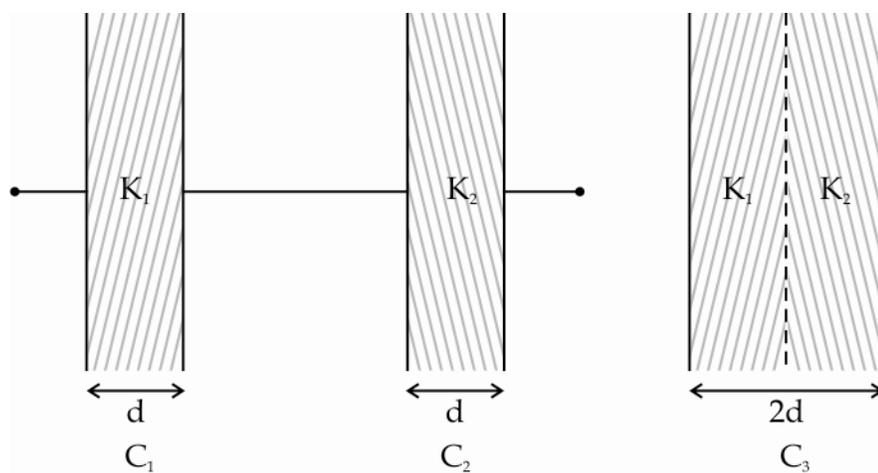


Q23. Draw the waveforms for

The (i) Input AM wave at A, (ii) output, B, of the rectifier and (iii) output signal, C, of the envelope detector. 3



Q24. The capacitors  $C_1$ , and  $C_2$ , having plates of area A each, are connected in series, as shown. Compare 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

- Q25 (a) Write the formula for the velocity of light in a material medium of relative permittivity  $\epsilon_r$  and relative magnetic permeability  $\mu_r$ . 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

**Q26. Suhasini's uncle, was advised by his doctor to have an MRI scan of his chest. Her uncle did not know much about the details and significance of this test. He also felt that it was too expensive and thought of postponing it.**

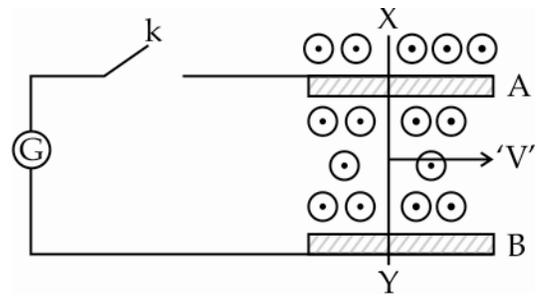
When Suhasini learnt about her uncle's problems, she immediately decided to do something about it. She took the help of her family, friends and neighbors and arranged for the cost of the test. She also told her uncle that an MRI (Magnetic Resonance Imaging) scan of his chest would enable the doctors to know of the condition of his heart and lungs without causing any (test related) harm to him. This test was expensive because of its set up that needed strong magnetic fields (0.5 T to 3T) and pulses of radio wave energy.

Her uncle was convinced and had the required MRI scan of his chest done. The resulting information greatly helped his doctors to treat him well.

(a) What according to you, are the values displayed by Suhasini and her family, friends and neighbours to help her uncle ? (2)

(b) Assuming that the MRI scan of her uncle's chest was done by using a magnetic field of 1.0 T, find the maximum and minimum values of force that this magnetic field could exert on a proton (charge =  $1.6 \times 10^{-19}$ ) that was moving with a speed of  $10^4$  m/s. State the condition under which the force has its minimum value. 2

Q27. 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 though the magnetic force is acting on them due to the motion of the rod?

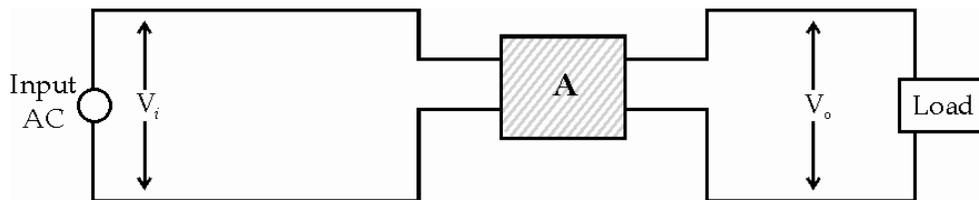
- (b) How much power needs to be delivered, (by an external agency), to keep the rod moving at its uniform speed when key k is (i) closed (ii) open?
- (c) With key k closed, how much power gets dissipated as heat in the circuit? State the source of this power.

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

Q28. 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?

- Q29. (i) A thin lens, having two surfaces of radii of curvature  $r_1$  and  $r_2$ , made from a material of refractive index  $\mu_2$ , is kept in a medium of refractive index  $\mu_1$ . 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.

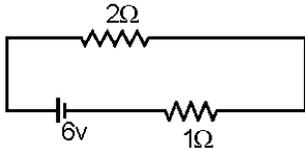
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## MARKING SCHEME

Q.No.	Value point/ expected points	Marks	Total
1.	From X to Y	1	1
2.	The magnetic moment, associated with the coil, is  $\vec{\mu}_m = Ia^2 \hat{i}$	1	1
3.	(i) Short wave broadcast services  (ii) Television broadcast (or microwave links or Satellite communication)	1/2  1/2	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 $\theta = 0^\circ$	1/2  1/2	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.  $\therefore \theta = \frac{\lambda}{d} \text{ and } q\theta = \frac{p\lambda}{d'}$  $\therefore \frac{d}{d'} = \frac{q}{p}$  Yes, this ratio would also equal $q$	  1/2+1/2  1/2  1/2	2
10.	Total (initial) charge on all the droplets		

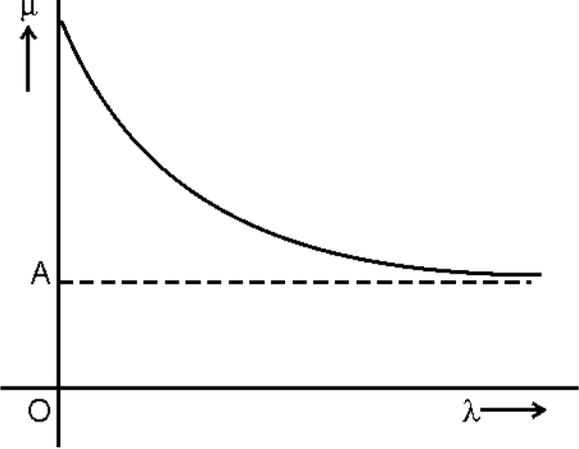


	(ii) increases  (The terminal p.d across the cell would increase)	$\frac{1}{2} + \frac{1}{2}$	
13.	$r_1 = O_1P = \sqrt{r^2 + (2a + b)^2}$ $r_2 = O_2P = \sqrt{r^2 + (a + 2b)^2}$ $\therefore V = \frac{1}{4\pi\epsilon_0} \left[ \frac{Q_1}{r_1} + \frac{Q_2}{r_2} \right]$ $\therefore$ P.E of charge , q, at P = qV $= \frac{q}{4\pi\epsilon_0} \left[ \frac{Q_1}{[r^2 + (2a+b)^2]^{1/2}} + \frac{Q_2}{[r^2 + (a+2b)^2]^{1/2}} \right]$	$\frac{1}{2}$  $\frac{1}{2}$  $\frac{1}{2}$  $\frac{1}{2}$	2
14.	(i) The maximum emf 'ε' generated in the coil is, $\epsilon = N B A \omega$ $= N B A 2\pi f$ $= [100 \times 0.01 \times 0.1 \times 2\pi \frac{5}{6}] V$ $= \frac{\pi}{6} V \approx 0.52 V$ (ii) The average emf generated in the coil over one complete revolution = 0	$\frac{1}{2}$          $\frac{1}{2}$	2
15.	Energy of one photon = $E = \frac{hc}{\lambda}$ $E = \frac{6.6 \times 10^{-34} \times 3 \times 10^8}{6 \times 10^{-7}}$ $\approx 3.3 \times 10^{-19} J$ $E_1 =$ energy emitted by the source in one second = 66J $\therefore$ number of photons emitted by the source in 1s = $n = \frac{66}{3.3 \times 10^{-19}} = 2 \times 10^{20}$ $\therefore$ Total number of photons emitted by	$\frac{1}{2}$          $\frac{1}{2}$	

	<p>source in 2 minutes</p> <p>= N = n x 2 x 60</p> <p>= 2 x 10<sup>20</sup> x 120 = 2.4 x 10<sup>22</sup> photons</p>	1/2	2
16.	<p>Diode D<sub>1</sub> is forward biased while Diode D<sub>2</sub> is reverse biased</p> <p>Hence the resistances, of (ideal) diodes, D<sub>1</sub> and D<sub>2</sub>, can be taken as zero and infinity, respectively.</p> <p>The given circuit can, therefore, be redrawn as shown in the figure.</p>  <p>∴ Using ohm's law,</p> $I = \frac{6}{(2+1)} \text{ A} = 2\text{A}$ <p>∴ current flowing in the 1Ω resistor, is 2A.</p>	<p>1/2</p> <p>1/2</p> <p>1/2</p>	2
17.	<p>For circuit 1, we have, (from the Wheatstone bridge balance condition),</p> $\frac{R_1}{9} = \frac{4}{6}$ <p>∴ R<sub>1</sub> = 6Ω</p> <p>In circuit 2, the interchange of the positions of the battery and the galvanometer, does not change the (wheatstone Bridge) balance condition.</p> $\therefore \frac{R_2}{8} = \frac{6}{12}$	<p>1/2</p> <p>1/2</p> <p>1/2</p> <p>1/2</p>	

	<p>or <math>R_2 = 4\Omega</math></p> <p><math>\therefore \frac{R_1}{R_2} = \frac{6}{4} = \frac{3}{2}</math></p>	<p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p>	3
18.	<p>In a hydrogen atom, the energy (<math>E_n</math>) of electron, in a state, having principal quantum number 'n', is given by</p> <p><math>E_n = \frac{-13.6}{n^2} \text{ eV}</math></p> <p><math>\therefore E_1 = -13.6\text{eV}</math> and <math>E_2 = -3.4 \text{ eV}</math></p> <p>It follows that the state <math>n=2</math> has an excitation energy of 10.2 eV. Hence the electron is making a transition from <math>n=n_1</math> to <math>n=2</math> where (<math>n_1&gt;2</math>).</p> <p>Now <math>E_{n_1} - E_2 = \frac{hc}{\lambda}</math></p> <p>But <math>\frac{hc}{\lambda} = \frac{6.63 \times 10^{-24} \times 3 \times 10^8}{487.3 \times 10^{-9} \times 1.6 \times 10^{-19}} \text{ eV} = 2.55 \text{ eV}</math></p> <p><math>\therefore E_{n_1} = (-3.4 + 2.55) \text{ eV}</math></p> <p><math>\approx -0.85 \text{ eV}</math></p> <p>But we also have <math>E_{n_1} = \frac{-13.6}{n_1^2} \text{ eV}</math></p> <p><math>\therefore</math> we get <math>n_1 = 4</math></p>	<p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p>	3
19.	<p>Intensity observed by</p> <p>(i) Observer <math>O_1 = \frac{I_0}{2}</math></p> <p>(ii) Observer <math>O_2 = \frac{I_0}{2} \cos^2 60^\circ</math></p> <p style="text-align: center;"><math>= \frac{I_0}{8}</math></p> <p>(iii) Observer <math>O_3 = \left(\frac{I_0}{8}\right) \cos^2 (90^\circ - 60^\circ)</math></p>	<p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p> <p>1</p>	3

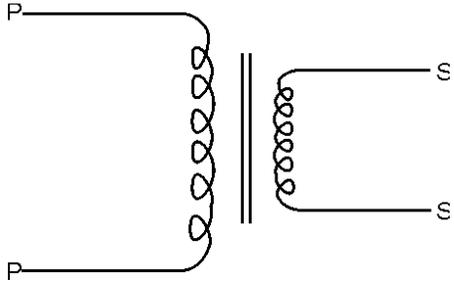
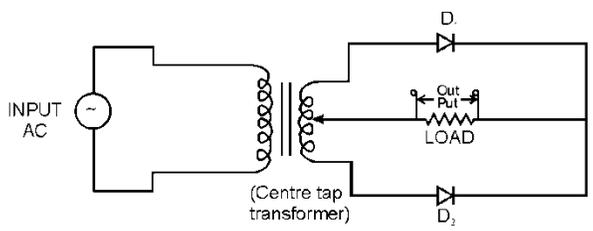


	 <p>To get a straight line graph, we need to use <math>\mu</math> and <math>1/\lambda^2</math> as the pair of variables.</p>	<p>1</p> <p><math>1/2</math></p>	<p>3</p>
<p>22.</p>	<p>(i) Mass defect (<math>\Delta M</math>), of any nucleus <math>{}^A_Z X</math>, is the difference in the mass of the nucleus (<math>=M</math>) and the sum of masses of its constituent nucleons (<math>=M'</math>).</p> <p><math>\therefore \Delta M = M' - M</math></p> $= [Z m_p + (A - Z) m_n] - M$ <p>where <math>m_p</math> and <math>m_n</math> denote the mass of the proton and the neutron respectively.</p> <p>(ii) Binding energy is the energy required to separate a nucleus into its constituent nucleons. The relation between the two is:</p> <p>B.E. = (mass defect) <math>c^2</math></p> <p>(iii) There is a release of energy i.e., the reaction is exothermic.</p> <p>Reason: Increase in B.E/nucleon implies that more mass has been converted into energy. This would result in release of energy.</p>	<p>1</p> <p><math>1/2</math></p> <p><math>1/2</math></p> <p><math>1/2</math></p> <p><math>1/2</math></p>	<p>3</p>

	<p style="text-align: center;">OR</p> <p>(a) According to the (exponential) law of radioactive decay.</p> $N = N_0 e^{-\lambda t}$ <p>Given <math>N = N_0/n</math> and <math>t = T</math></p> $\therefore \left(\frac{N_0}{n}\right) = N_0 e^{-\lambda T}$ <p>or <math>n = e^{\lambda T}</math></p> $\therefore \lambda = \frac{\ln(n)}{T}$ $\therefore \text{half life } \tau_{\frac{1}{2}} = \frac{0.6931}{\lambda} = \frac{0.693T}{\ln(n)}$ <p>(b)</p> <p>(i) <math>\alpha</math> - rays</p> <p>(ii) <math>\gamma</math> - rays</p> <p>(iii) <math>\beta</math> - rays</p>	<p style="text-align: center;"><math>\frac{1}{2}</math></p>	3
23.		<p>1</p> <p>1</p> <p>1</p>	3

24.	<p>We have <math>C_1 = \frac{A\epsilon_0 K_1}{d}</math></p> <p>and <math>C_2 = \frac{A\epsilon_0 K_2}{d}</math></p> <p><math>\therefore C_{eq} = \frac{C_1 C_2}{C_1 + C_2} = \frac{A\epsilon_0}{d} \left( \frac{K_1 K_2}{K_1 + K_2} \right)</math></p> <p>Now, capacitor <math>C_3</math> can be considered as made up of two capacitors <math>C_1</math> and <math>C_2</math>, each of plate area <math>A</math> and separation <math>d</math>, connected in series.</p> <p>We have : <math>C_1' = \frac{A\epsilon_0 K_1}{d}</math></p> <p>and <math>C_2' = \frac{A\epsilon_0 K_2}{d}</math></p> <p><math>\Rightarrow C_3 = \frac{C_1' C_2'}{C_1' + C_2'} = \frac{A\epsilon_0}{d} \left( \frac{K_1 K_2}{K_1 + K_2} \right)</math></p> <p><math>\therefore \frac{C_3}{C_{eq}} = 1</math></p> <p>Hence net capacitance of the combination is equal to that of <math>C_3</math>.</p>	<p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p>	<p>3</p>
25. (a) (b)	<p>We have <math>\vartheta = \frac{1}{\sqrt{\mu\epsilon}} = \frac{1}{\sqrt{\mu_0 \mu_r \epsilon_0 \epsilon_r}}</math></p> <p>(i) Wavelength range : [0.1m to 1mm] (Microwaves)</p> <p>(ii) Wavelength range: [1mm to 700 nm] (Infrared waves)</p>	<p><math>\frac{1}{2} + \frac{1}{2}</math></p> <p><math>\frac{1}{2} + \frac{1}{2}</math></p> <p><math>\frac{1}{2} + \frac{1}{2}</math></p>	<p>1</p> <p>3</p>
26.	<p>(a) (i) Presence of mind</p> <p>High degree of general awareness</p> <p>Ability to take prompt decisions</p> <p>Concern for her uncle (Any two)</p> <p>(ii) Empathy; Helping and caring</p>	<p><math>(\frac{1}{2} + \frac{1}{2})</math></p>	

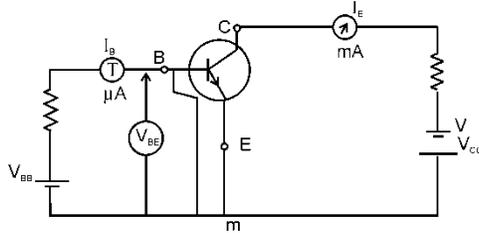
	<p>nature</p> <p>(b) Maximum force = <math>qVB</math></p> <p><math>= 1.6 \times 10^{-19} \times 10^4 \times 1 \text{ N}</math></p> <p><math>= 1.6 \times 10^{-15} \text{ N}</math></p> <p>Minimum force = zero</p> <p>Condition: when <math>\vec{v}</math> is parallel to <math>\vec{B}</math></p>	<p><math>(\frac{1}{2} + \frac{1}{2})</math></p> <p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p>	<p>4</p>
27.	<p>(a)</p> <p>(i) X : negative , Y: positive</p> <p>(ii) Magnetic force, <math>F_m</math>, 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.</p> <p>(b) The power, that needs to be delivered by the external agency, when key k is closed, is</p> <p><math>P = F_m V = (I l B) V = \frac{BlV}{R} \cdot lBV</math></p> <p><math>= B^2 l^2 V^2 / R</math></p> <p>When k is open, there is an induced emf, but no induced current. Hence power that needs to be delivered is zero.</p> <p>(c) Power, dissipated as heat</p> <p><math>= i^2 R = \frac{B^2 l^2 V^2}{R}</math></p> <p>The source of this power is the mechanical work done by the external agency.</p> <p style="text-align: center;"><b>OR</b></p>	<p><math>\frac{1}{2}</math></p> <p><math>1 + \frac{1}{2}</math></p> <p><math>\frac{1}{2} + \frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2} + \frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p>	<p>5</p>

	<p>(a) Step down transformer.</p>  <p>(b) Diagram</p> <p>Principle</p> <p>Working</p> <p>Obtaining the expression</p> <p>(c) Input power = output power  <math>\therefore V_p i_p = V_s i_s</math>  <math>\Rightarrow \frac{i_p}{i_s} = \frac{V_s}{V_p} = \frac{N_s}{N_p}</math></p>	<p>1/2</p> <p>1/2</p> <p>1/2</p> <p>1/2</p> <p>2</p> <p>1/2</p>	<p>5</p>
<p>28.</p>	<p>The space charge region, on either side of the junction (taken together), is known as the depletion layer.</p> <p>The p.d across the depletion layer is known as the barrier potential</p> <p>The width of the depletion region decreases with an increase in the doping concentration.</p> <p>The circuit of a full-wave rectifier is shown below.</p>  <p>(Centre tap transformer)</p>	<p>1/2</p> <p>1/2</p> <p>1/2</p> <p>1 1/2</p>	

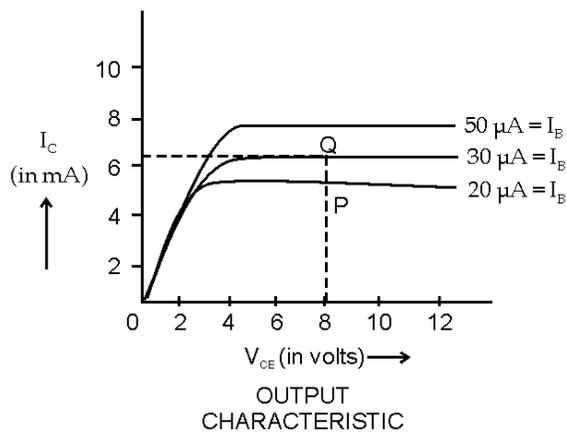
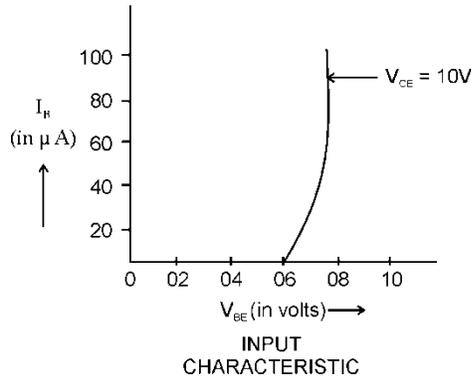
Working details

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 ( $I_E$ ).



(Circuit for studying the characteristics of a npn transistor in its CE configuration)



The current gain ( $\beta$ ) of a transistor in common emitter configuration is

2

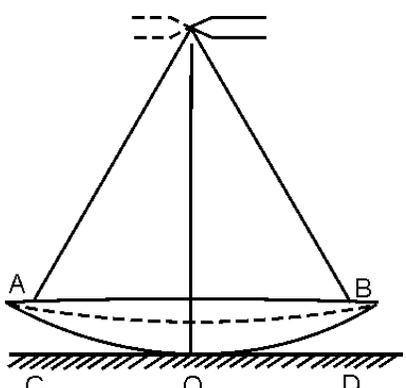
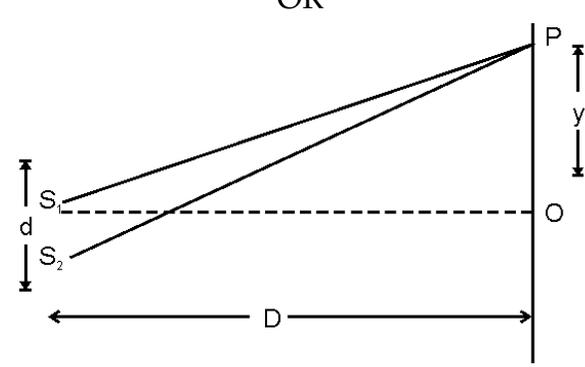
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1

1

1

1

	$\beta = \frac{\Delta I_C}{\Delta I_B}$ <p><math>\Delta I_C</math> and <math>\Delta I_B</math> can be obtained, from the two curves, in the output characteristics.</p>	1	5
29.	<p>(i) Diagram</p> <p>Derivation</p> <p>(ii) The rays must fall normally on the plane mirror so that the image of the pin coincides with itself</p>  <p>Hence rays, like CA and DB, form a parallel beam incident on the lens.</p> <p><math>\therefore</math> P is the position of the focus of the lens</p> <p><math>\therefore</math> Distance OP equals the focal length of the lens</p> <p>OR</p>  <p><math>\Delta_0 =</math> initial path different between <math>S_1</math> and <math>S_2</math>  <math>= SS_2 - SS_1 = \lambda/4</math></p> <p><math>\Delta = S_2P - S_1P =</math> path difference between</p>	1 2½ ½ ½ ½	5
		1 ½	

	<p>disturbance from <math>S_1</math> and <math>S_2</math>, at point P</p> $= \frac{yd}{D}$ <p><math>\Delta_T</math> = Total path difference between the two disturbances at P</p> $= \Delta_o + \Delta = \frac{\lambda}{4} + \frac{yd}{D}$ <p><math>\therefore</math> For constructive interference:</p> $\Delta_T = \left(\frac{\lambda}{4} + \frac{yd}{D}\right) = n\lambda; n = 0, 1, 2, \dots$ $\therefore \frac{y_n d}{D} = \left(n - \frac{1}{4}\right) \lambda \dots (i)$ <p>For destructive interference</p> $\Delta_T = \left(\frac{\lambda}{4} + \frac{yd}{D}\right) = (2n-1) \frac{\lambda}{2} \dots (ii)$ $\therefore \frac{Y_n d}{D} = \left(2n - 1 - \frac{1}{2}\right) \frac{\lambda}{2}$ $\therefore \frac{Y_n d}{D} = \left(2n - \frac{3}{2}\right) \frac{\lambda}{2}$ <p><math>\beta</math> = fringe width = <math>y_{n+1} - y_n = \frac{\lambda D}{d}</math></p> <p>The position <math>Y_o</math> of central fringe is obtained by putting <math>n=0</math> in Eqn (i). Therefore,</p> $\therefore y_o = -\frac{\lambda D}{4d}$ <p>[Negative sign shows that the central fringe is obtained at a point below the (central) point O.]</p>	<p><math>\frac{1}{2}</math></p> <p>1</p> <p>1</p> <p>1</p>	<p>5</p>
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