

Time: 2½ Hours

PHYSICS

Subject Code

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Total No. Of Questions: 5

(Printed Pages: 11)

Maximum Marks: 55

- INSTRUCTIONS:**
- (i) All questions are compulsory
  - (ii) Answers to the Multiple Choice Questions should be written by choosing and writing the correct alternative.
  - (iii) There is no overall choice. However internal choice has been provided in two questions of four marks each, and one question of three marks.
  - (iv) Use of calculators is not permitted. However, you may ask for mathematical tables.
  - (v) You may use the following values of physical constants wherever necessary:

Constants:

$$c = 3 \times 10^8 \text{ ms}^{-1}$$

$$e = 1.6 \times 10^{19} \text{ C}$$

$$h = 6.6 \times 10^{34} \text{ Js}$$

$$m_e = 9.1 \times 10^{31} \text{ kg}$$

$$\mu_0 = 4\pi \times 10^{-7} \text{ TmA}^{-1}$$

$$\frac{1}{4\pi\epsilon_0} = 9 \times 10^9 \text{ Nm}^2\text{C}^{-2}$$

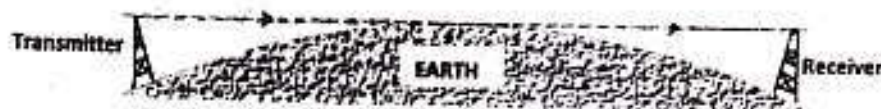
Energy of ground state of H atom = -13.6 eV.

Q.1 (A) The particle which is not deflected either by an electric field or a magnetic field is: [1]

- Ion
- photon
- Proton
- Electron

(B) An electric dipole has a charge strength ' $q$ ' and a length ' $2a$ '. Write the expression for the potential energy of the dipole. [1]

(C) (i)



With reference to the above diagram, identify the type of communication used.

(ii) What is the role of the 'ionosphere' in communication? [2]

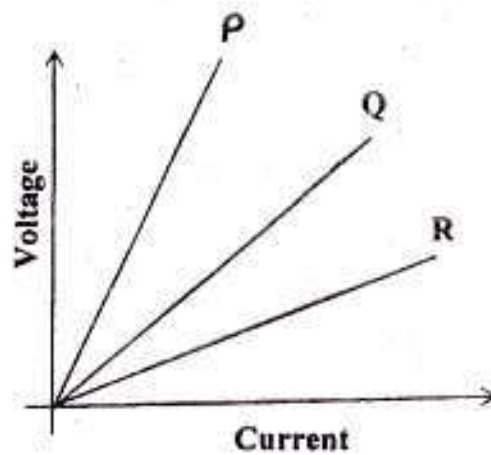
(D) An object is placed at a distance of 15 cm in front of a concave mirror of focal length 10 cm. Calculate the image distance. [2]

(E) A plane wavefront is incident on a boundary separating two media.

Using Huygen's Principle, derive the Snell's law of refraction. Draw the necessary ray diagram.

[2]

(F) The diagram shows a 'Voltage against Current' graph for 3 metal wires P, Q and R of the same material and of the same thickness.

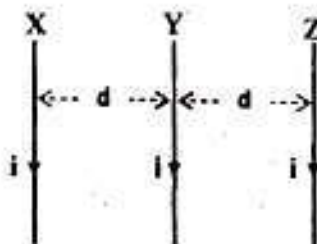


- (i) Which wire has the highest resistance? [3]
- (ii) Which wire has the highest conductance?
- (iii) Which wire has the largest length? [3]

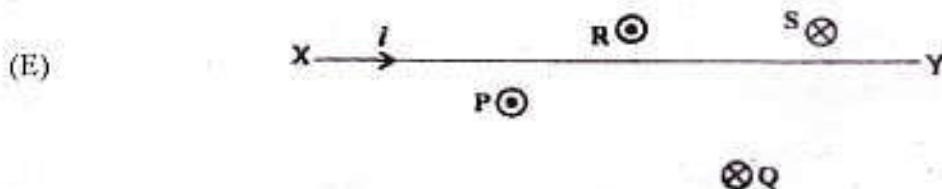
Q.2 (A) Three resistors  $R_1$ ,  $R_2$  and  $R_3$  having equal resistances are connected in parallel. A constant potential difference is applied across their parallel combination. If  $I_1$ ,  $I_2$  and  $I_3$  are the currents through  $R_1$ ,  $R_2$  and  $R_3$  respectively, then: [1]

- $I_1 > I_2 > I_3$
- $I_1 < I_2 \leq I_3$
- $I_1 = I_2 = I_3$
- $I_1 \geq I_2 > I_3$

- (B) The diagram drawn, shows three parallel conductors X, Y and Z, each carrying an electric current as shown. What will be the net force experienced by Y due to X and Z? Why? [1]



- (C) Draw a neat circuit diagram of a Wheatstone's bridge network. Derive the balancing condition for the bridge. [2]
- (D) A square coil of side 10 cm is suspended vertically in a uniform magnetic field of strength 0.8 T. The normal to the plane of the coil makes an angle of  $30^\circ$  with the direction of the field. The coil has 20 turns and it carries a current of 12 A. Calculate the magnitude of the torque acting on the coil. [2]



The diagram drawn above shows a thin metal wire XY carrying a current 'i', placed in the plane of the paper. Four different directions of magnetic field are shown at the points P, Q, R and S.

- (i) Which of the points show the correct direction of the magnetic field produced by the current?
- (ii) At which point is the strength of the magnetic field due to the current the least? [2]



(F) With the help of a neat diagram, derive an expression for the magnetic field at a point on the axis of a circular current carrying loop. [3]

Q.3 (A) Which of the following statements is true? [1]

- In transformers, the laminated metal cores are used to increase the eddy currents.
- A direct current can operate an induction furnace.
- Eddy currents produce the magnetic braking in the electrically powered trains.
- In the electric power meters, the electric currents are induced in the disc by the electric fields.

(B) When the North Pole of a bar magnet is brought near the face of a circular coil, it experiences a force of repulsion. Why? [1]

(C) An alternating voltage source is connected across a capacitor having a capacitance of  $100 \mu\text{F}$ . If the frequency of the source is  $50 \text{ Hz}$ , calculate the reactance due to the capacitor. [2]

(D) For a transformer, derive an expression for the output voltage in terms of the number of turns of the primary and that of the secondary coil, when an alternating voltage is given at the input. [2]

(E) Identify the electromagnetic waves in the applications stated below, [2]

- (i) These waves are used in killing the harmful bacteria, in water purifiers.
- (ii) The frequency of these waves is selected to match the resonant frequency of water molecules, so that the energy from these waves is transferred to the food molecules.

- (F) With the help of a neat ray diagram, derive the expression for the refractive index of the material of a prism, in terms of the angle of the prism and its angle of minimum deviation. [3]

**OR**

Assuming the formula for the refraction at a spherical surface, derive the thin lens formula. Draw the necessary ray diagram. [3]

- Q.4 (A) Two convex lenses X and Y have focal lengths ' $f$ ' and ' $2f$ ' respectively. If their respective powers are  $P_x$  and  $P_y$  then: [1]

- $P_x = 0.5P_y$
- $P_y = P_x$
- $P_x = 2P_y$
- $P_y = 2P_x$

- (B) Calculate the de Broglie wavelength associated with an electron which is accelerated through a potential difference of 100 volt. [1]

(C)



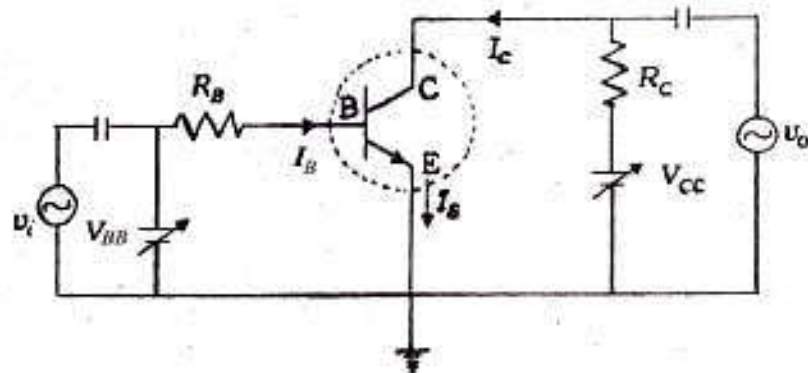
The diagram drawn above shows two slits  $S_1$  and  $S_2$  illuminated by a parallel beam of light of wavelength  $\lambda$ . Points M and N belong to the interference pattern formed on the screen P.

- (i) The path difference between the waves from the slits to M, is  $1.5\lambda$  and the path difference between the waves from the slits to N, is  $2\lambda$ . Which among M and N will have a bright fringe?
- (ii) What will be the effect on the distance between M and N, if the distance between  $S_1$  and  $S_2$  is decreased? [2]

(D) A certain potential difference is applied across a parallel plate air-filled capacitor.

- (i) The air is replaced by a dielectric medium having a dielectric constant greater than that of the air. How will this affect the capacitance of the capacitor?
- (ii) What is the direction of the electric field in the region between the plates?
- (iii) What will be the effect on this (electric) field, if the distance between the plates is decreased? [3]

(E)



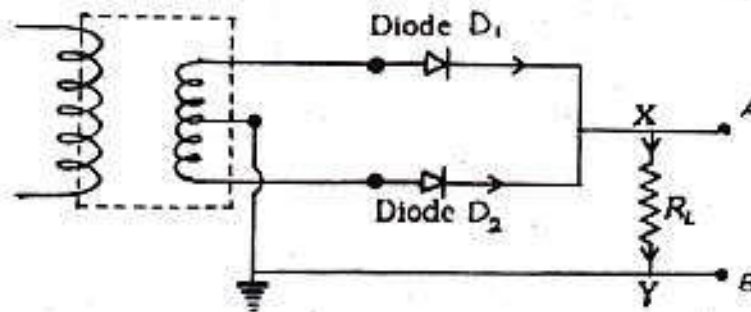
- (i) Identify the circuit drawn above. State one use of it.
- (ii) Write the loop equation for its output voltage.

(iii) State the type of biasing used at the input voltage.

(iv) Write the equation for its d.c. current gain.

[4]

**OR**



(i) Identify the circuit drawn above. State one use of it.

(ii) For a positive half cycle of the input sine wave, both the diodes  $D_1$  and  $D_2$  do not conduct simultaneously. Why?

(iii) State the type of the transformer used in the circuit.

(iv) Does the voltage between the points A and B have a steady value?

[4]

Q.5 (A) The truth table of a certain logic gate is given below. A and B are its inputs and Y is its output.

[1]

A	B	Y
0	0	1
1	0	1
0	1	1
1	1	0



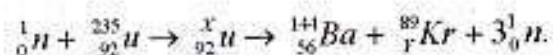
The gate is a:

- OR gate
- NOR gate
- AND gate
- NAND gate

(B) With reference to the data given in the following table, which material when added to a pure silicon semiconductor will produce an n-type semiconductor? What are the minority charge carries in this type of semiconductor? [1]

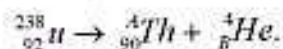
Material 1	Divalent
Material 2	Trivalent
Material 3	Tetravalent
Material 4	Pentavalent

(C) (i) The equation given below shows a uranium-235 nucleus bombarded by a neutron undergoing fission:



Determine the values of X and Y.

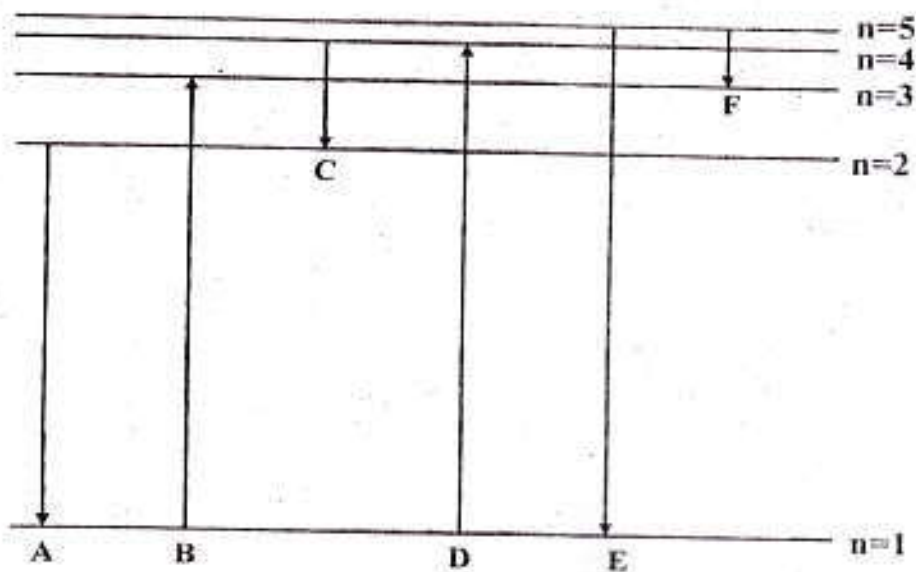
(ii) The equation below shows a Uranium-238 nucleus undergoing an alpha decay:



Determine the values of A and B. [2]

- (D) The following diagram shows the energy levels of a hydrogen atom along with their respective principal quantum numbers. Letters A, B, C, D, E and F indicate the transitions of the electrons between the levels as shown.

[3]



- (i) Which letters indicate the transitions that will emit radiation?
- (ii) Which letter indicates a transition which will emit a radiation that belongs to the ultraviolet region?
- (iii) Which letter indicates a transition that belongs to the Balmer series?
- (E) (i) Two bodies X and Y are rubbed together,  $10^{10}$  electrons move out from X to Y in 10 seconds. How much time is required to transfer 1 coulomb of charge to Y?
- (ii) The metal bodies of the electrical appliances are required to be connected to the 'earth wire'. Why?
- (iii) A certain system contains six electrons and six protons in it. What is the net charge inside the system?

[4]

OR

- (E) (i) An equilateral triangle ABC has sides each of length 3 m. A charge of  $+10 \mu\text{C}$  is kept at the vertex B. Another charge of  $+10 \mu\text{C}$  is kept at the vertex C. Calculate the net electric field at the vertex A.
- (ii) In order to determine the electric field at a point due to a point charge 'Q', the test charge 'q' placed at the point should be very small, i.e.  $q \ll Q$ . Why?
- (iii) In a certain region of space, a uniform electric field has a direction from the East to the West. When a negative charge is placed in this field, it experiences a force. State the direction of this force.

[4]

-----X-----X-----