PHYSICS PAPER 1
(THEORY)

Maximum Marks: 70

Time Allowed: Three hours

*(Candidates are allowed **additional 15 minutes** for **only** reading the paper.*

*They must **NOT** start writing during this time).*

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*This paper is divided into **four** sections – **A**, **B**, **C** and **D**.*

*Answer **all** questions.*

***Section A** consists of **one** question **having sub-parts** of **one** mark each.*

***Section B** consists of **seven** questions of **two** marks each.*

***Section C** consists of **nine** questions of **three** marks each, and*

***Section D** consists of **three** questions of **five** marks each.*

***Internal choices have been provided in two questions each in Section B, Section C and Section D**.*

The intended marks for questions are given in brackets [ ].

All working, including rough work, should be done on the same sheet as and adjacent to the rest of the answer.

Answers to sub parts of the same question must be given in one place only.
A list of useful physical constants is given at the end of this paper.

A simple scientific calculator without a programmable memory may be used for calculations.


SECTION A – 14 MARKS

Question 1

(A)   In questions (i) to (vii) below, choose the correct alternative (a), (b), (c) or (d) for each of the questions given below:

(i) The **surface charge density** of a large **conducting** sheet is $17.7 \times 10^{-6}\,\text{Cm}^{-2}$. **[1]** The **electric field intensity** at a point outside the sheet but close to it is:

(a) $1 \times 10^4\,\text{NC}^{-1}$

(b) $5 \times 10^4\,\text{NC}^{-1}$

(c) $1 \times 10^5\,\text{NC}^{-1}$

(d) $1 \times 10^6\,\text{NC}^{-1}$

(ii) If R_1 and R_2 are filament resistances of a 100W bulb and a 50W bulb **[1]** respectively, designed to operate on the **same** voltage, then:

(a) $R_1 = R_2$

(b) $R_1 = 4R_2$

(c) $R_2 = 4R_1$

(d) $R_2 = 2R_1$

(iii) **Magnetic flux density (B)** of the magnetic field at a point on the axis of a **[1]** long straight solenoid is given by:

(a) $B = \mu_o n I$

(b) $B = \dfrac{\mu_o I}{2r}$

(c) $B = \dfrac{\mu_o I}{4\pi r}$

(d) $B = \mu_o I$

(iv) Two **thin** lenses having optical powers of -8D and +12D are placed in contact **[1]** with each other. The **focal length** of this combination is:

(a) $+0.25$ m

(b) -0.25 m

(c) $+0.25$ cm

(d) -0.25 cm

ISC SPECIMEN QUESTION PAPER 2023

2

(v)   **Cylindrical** wavefronts are produced by: **[1]**

    (a)   a point source of light

    (b)   a line source of light

    (c)   a source at infinity

    (d)   all types of sources of light

(vi)   The graph of **de-Broglie wavelength** (λ) of a moving electron versus its   **[1]**
velocity (v) is:

    (a)

    (b)

    (c)

    (d)
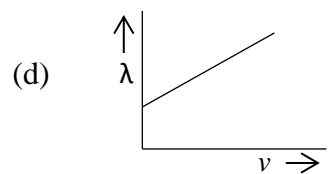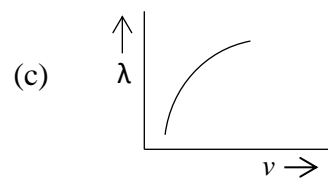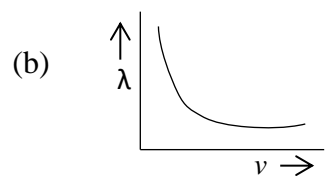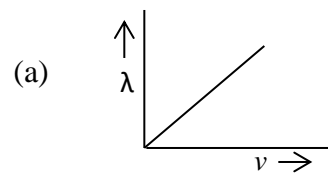
(vii) **'n'** type semiconductor is that which has   **[1]**

    (a)   holes as majority carriers.

    (b)   free electrons as majority carriers.

    (c)   holes and free electrons equal in number.

    (d)   trivalent element as an impurity.

ISC SPECIMEN QUESTION PAPER 2023

3

(B)   Answer the following questions **briefly**:

    (i)   In an electric dipole, what is the **locus** of a point having **zero potential**?   **[1]**

    (ii)   Name the **conservation** principle implied in **Kirchhoff's Junction law** for   **[1]**
           electric circuits.

    (iii)   Give *any one* reason why efficiency of a transformer is always less than 1.   **[1]**

    (iv)   Give an example of **coherent sources** of light.   **[1]**

    (v)   In **Young's double slit experiment**, what is the **path difference** between the   **[1]**
           two light waves forming 5th **bright fringe** on the screen?

    (vi)   State the **function** of a **moderator** in a nuclear reactor.   **[1]**

    (vii) In **semiconductors**, what is meant by "**doping**"?   **[1]**

SECTION B – 14 MARKS

Question 2   **[2]**

(i)   You are provided with many identical capacitors each of capacitance 100μF.
        How will you connect a **minimum** number of them to obtain a capacitance of 75μF?
        Draw a diagram in support of your answer.

OR

(ii)   Three point charges of 50nC each are kept at the vertices of an equilateral triangle
       having each side = 3m. Calculate **electrostatic potential energy** of the system.

Question 3   **[2]**

(i)   With reference to **free electron theory** of conductors, define:

    (a)   Drift velocity

   (b)   State *any one* use of a **potentiometer**.

Question 4   **[2]**

Explain why a blue coloured spark is often seen in a switch when a circuit containing an
electric iron/geyser is switched off.

Question 5 [2]

(i) Two long straight wires **A** and **B** are kept parallel to each other, 5 cm apart, in vacuum. They carry currents of 5A and 10A respectively in the same direction as shown in *Figure 1* below. Calculate the **force per unit length** acting on the wire **B** due to the current flowing in the wire **A**.
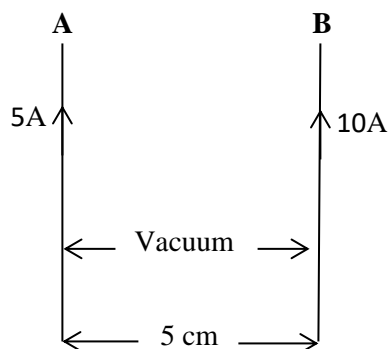
Figure 1

OR

(ii) An electron moving with a velocity of 8×10^6 m/s enters a **uniform and transverse** magnetic field of 3×10^{-3} T. Calculate the radius of the circular path described by it.

Question 6 [2]

Name the **electromagnetic radiation**:

(i) used for viewing through haze and fog.

(ii) which has the wavelength of 0·1 nm.

Question 7 [2]

Draw a neat and labelled ray diagram to show the formation of a primary rainbow.

Question 8 [2]

With reference to a **semiconductor diode**, explain the terms:

(i)   Depletion region

(ii)   Potential barrier or barrier p.d.

SECTION C – 27 MARKS

Question 9 [3]

Obtain an expression for **intensity of electric field** at a point in **end on** position i.e. on an **axial line** of an electric dipole.

Question 10 [3]

(i)   In a **meter bridge** circuit, resistance in the left gap is 4Ω and an unknown resistance R is in the right-hand gap as shown in *Figure 2* below. The null point is found to be 40 cm from the left end of the wire.
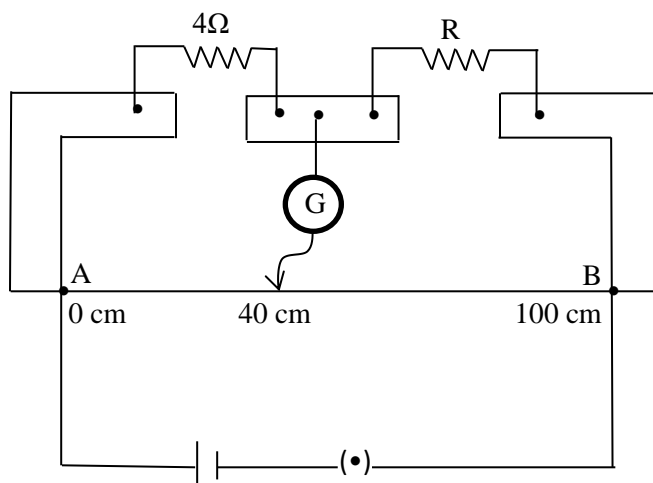

Figure 2

(a)   Calculate the value of the unknown resistance R.

(b)   What change will you make in R to bring the null point to the midpoint of the wire AB?

OR

(ii)   A circuit is used to determine the internal resistance and the emf of a cell. It consists of the cell, a variable resistor, an ideal ammeter A and an ideal voltmeter V. *Figure 3* shows part of the circuit with the ammeter and voltmeter missing.
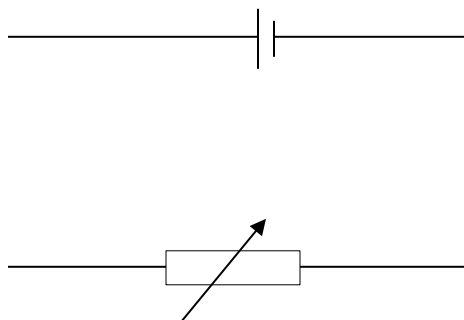

Figure 3

The variable resistor is set to be 1.5Ω. When the cell converts 7.2mJ of energy., 5.8mC of charge moves completely around the circuit. The potential difference across the variable resistor is 0.55V.

(a)   Redraw the diagram showing the positions of the ammeter and the voltmeter.

(b)   Calculate the emf of the cell.

Question 11   [3]

Obtain an expression for **magnetic flux density B** at the centre of a current carrying circular coil.

Question 12   [3]

Using **Huygen's wave theory**, prove **Snell's law** of **refraction of light**.

Question 13   [3]

(i)   Obtain **Prism formula** i.e. prove that

$$n = \frac{Sin\{(A + dm)/2\}}{Sin\left(\frac{A}{2}\right)}$$

Where the terms have their usual meaning.

OR

(ii)   Derive **Lens Maker's formula.**

Question 14   [3]

(i)   Calculate the **angular width** of the central maxima obtained in **Fraunhofer single slit diffraction experiment,** when a monochromatic light of wavelength 550 nm falls **normally** on a rectangular slit of width $1{\cdot}1{\times}10^{-4}$ cm.

(ii)   How will its value change if the experiment is repeated with monochromatic light of **greater wavelength**?

Question 15   [3]

(i)   With reference to **photoelectric effect**, plot a **labelled** graph of stopping potential (V_s) versus frequency (*f*) of the incident radiation.

(ii)   State how will you use this graph to determine the value of **Planck's constant.**

Question 16   [3]

(i)   State *any two* differences between Nuclear **fusion** and Nuclear **fission**.

(ii)   What is the **essential** difference between the working of a **fission bomb** and a **nuclear reactor**?

Question 17   [3]

What is meant by **reverse biasing** of a semiconductor diode? Draw a labelled characteristic curve i.e. I - V graph for a semiconductor diode during **reverse bias**.

ISC SPECIMEN QUESTION PAPER 2023

8

SECTION D – 15 MARKS

Question 18 [5]

(i) An 80Ω resistor, a 1·0 H inductor and a 40 μF capacitor are connected in **series** to an a.c. supply of 220V such that the circuit draws the **maximum** current. At this stage, calculate:

(a) **Resonant frequency** of the circuit.

(b) **Capacitive reactance of the circuit.**

(c) **Impedance** of the circuit

(d) **Current** flowing through the circuit.

(e) **Phase difference** between capacitive and inductive voltages.

OR

(ii) *Figure 4* below shows two thick metallic rails CD and GH kept **parallel** to each other 0·8m apart. They are joined to each other by a resistance wire R having a resistance of 5Ω. A thick metallic rod PQ rests on the rails. There is a uniform magnetic field B = 0·2T, which is **perpendicular** to the plane of the rails, pointing into the paper.
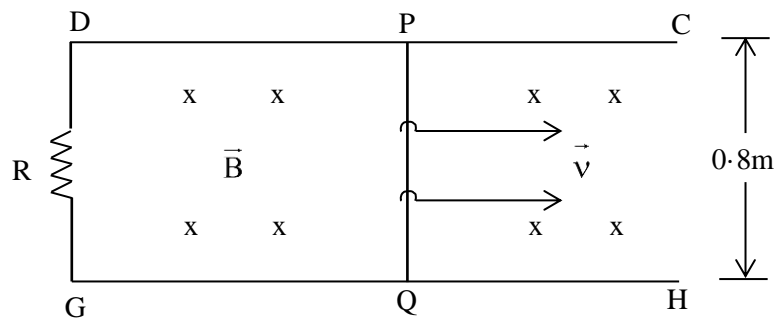

Figure 4

(a) Calculate magnitude and direction of the current **induced** in the rod PQ if it is moved towards right with a constant velocity v = 36 km/hr.

(b) The rod PQ is now made to perform **simple harmonic motion** with a frequency of 3Hz and an amplitude of 4cm. Calculate the **maximum** value of the emf induced in the rod.

Question 19 **[5]**

(i) (a) Using **Bohr's theory** of hydrogen atom, obtain an expression for the radius of the nth orbit of an electron in an atom.

 (b) Draw a **labelled** graph of binding energy of a nucleus per nucleon versus its mass number. Mark the region where nuclei are relatively **more stable**.

OR

(ii) (a) State the postulate of **Bohr's theory** regarding

 (1) Quantisation of angular momentum of an electron.

 (2) Emission of energy by an atom.

 (b) What is meant by the following terms?

 (1) **Mass defect** of a nucleus.

 (2) **Binding energy** of a nucleus.

 State how these two are related to each other.

Question 20 **[5]**

Read the passage given below and answer the questions that follow.

Optical instruments are of great utility. They help us in studying very tiny objects as well as very large heavenly bodies. Scientists have developed microscopes like electron microscopes which aid in studying tiny molecules of matter. They have also devised giant telescopes like Hubble telescope and James Web Space telescope which have enabled us to view distant galaxies hitherto unknown.

(i) Which **optical instrument** is used to study detailed structure of a **virus**?

(ii) What is the ability of an instrument to form an enlarged image of an object called?

(iii) **Hubble telescope** orbits around the earth like a satellite. What is the advantage of such a telescope over a similar one on earth's surface?

(iv) An **astronomical telescope** consists of two convex lenses having focal length of 200cm and 4cm. When it forms final image at infinity, calculate its

 (a) Magnifying power

 (b) Length.

Useful Constants & Relations:

1	Permittivity of vacuum	ε_0	$8 \cdot 85 \times 10^{-12}$ F/m
2	Constant for Coulomb's law	$(1/4\pi\,\varepsilon_0)$	9×10^9 m/F
3	Constant in Magnetism	$(\mu_0/4\pi)$	1×10^{-7} H/m
4	Elementary charge	e	1.6×10^{-19} C
5	Mass of an electron	m	9×10^{-31} kg

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11