PHYSICS

Paper – 1

(THEORY)

Three hours and a quarter

(The first 15 minutes of the examination are for reading the paper only.

Candidates must NOT start writing during this time).

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*Answer **all** questions in Part I. From Part II, answer any four questions from Section A, any three questions from Section B and any two questions from Section C.*

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

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

A list of useful physical constants is given at the end of the question paper.

PART I (40 marks)
Answer **all** *questions.*

Question 1.

(a) Each question is followed by four possible choices of answers. Choose the correct answer and write it in your answer sheet. **[10]**

(i) The S.I. unit of specific conductance (σ) is

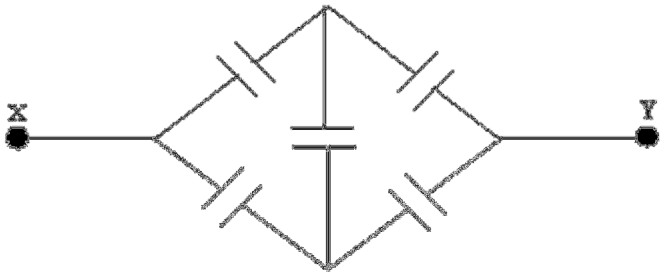
A $(\Omega m)^{-1}$.

B mho.

C Ωm.

D $\frac{\Omega}{m}$.

(ii) The capacitors in the given circuit diagram have equal capacitance of $10\mu F$ each.



The equivalent capacitance between the points X and Y is

A $40\mu F$.

B $30\mu F$.

C $20\mu F$.

D $10\mu F$.

(iii) In order to experience a magnetic force, the test charge must be

A at rest in the magnetic field.

B in motion in the magnetic field.

C at rest outside the magnetic field.

D in motion outside the magnetic field.

(iv) When the current flowing through a wire loop is halved, its magnetic moment will become

A half.

B one-fourth.

C double.

D quadruple.

(v) In a circuit containing either inductance or capacitance, the phase difference between the current and voltage is

A 45°.

B 90°.

C 270°.

D 360°.

(vi) The phenomenon of interference can take place in

A all waves.

B standing waves.

C transverse waves.

D longitudinal waves.

(vii) The magnification produced by a concave lens is

A more than 1.

B less than 1.

C equal to 1.

D infinity.

(viii) When a uniform magnetic field is in a vertically downward direction and an electron is projected in a horizontal direction, the electron will move in a circular path with a constant speed,

A clockwise in a vertical plane.

B clockwise in a horizontal plane.

C anticlockwise in a vertical plane.

D anticlockwise in a horizontal plane.

(ix) If the ionization potential of hydrogen atom is $13.6V$, its electron energy in $n = 2$ wi

A $-3.4eV$.

B $-6.8eV$.

C $-13.6eV$.

D $-27.2eV$.

(x) In the reaction ${}_{Z}P^{A} \rightarrow {}_{Z+1}Q^{A} \rightarrow {}_{Z-1}R^{A-4} \rightarrow {}_{Z-1}R^{A-4}$, the sequence of the radioactive radiations emitted are

A α, β, γ .

B β, γ, α .

C β, α, γ .

D γ, β, α .

(b) Choose the correct word/s given in the brackets and write them in your answer sheets. **[6]**

(i) Guass' law relates the ……. field at points on a closed Gaussian surface to the ……. charge enclosed by the surface. (magnetic, electric, net, test)

(ii) If the radius of the Bohr's orbit is a_0, then the electron path in the n[th] orbit has radius ……. and ……. angular momentum. ($na_0, n^2a_0, \frac{nh}{2\pi a_0}, \frac{nh}{2\pi}$)

(iii) Interference diffraction and polarization explain ……. nature and, photoelectric effect and compton effect explain ……. nature of light. (emission, wave, dual, particle)

(iv) Gold foil is used in α-particle scattering experiment because it is ……. and can produce a ……. deflection in the path of α-particle. (light, heavy, large, small)

(v) ……. rods are used in a nuclear reactor to control the fission rate of ……. (copper, cadmium, neutrons, protons)

(vi) Forward biasing means connecting positive terminal of the battery with ……. semi-conductor and the negative terminal with ……. semi-conductor. (extrinsic, N-type, intrinsic, P-type)

(c) Write True or False and give reasons for the false statements.

(i) When a pure semi-conductor is heated, the number of electrons increases and number of holes decreases.

(ii) An X-ray photon of wavelength λ suffers Compton scattering. The scattered photon has a wavelength greater than λ.

(iii) When two unequal resistances are joined in parallel to a cell, the current will be the same in both the resistances.

(iv) A dipole in a non-uniform electric field experiences only a torque.

(d) Match the items of column A with the items in column B. Rewrite the correct pairs in your answer sheet. **[4]**

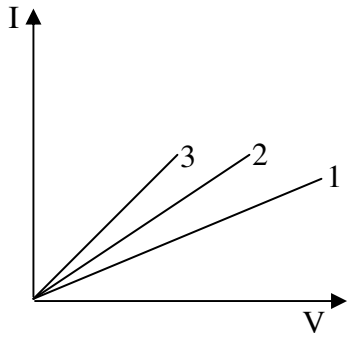
Column A	**Column B**
(i) J.J Thompson	(a) self-inductance
(ii) Coulomb's law	(b) polarization
(iii) Decay law	(c) plums in a pudding
(iv) Nuclear reactor	(d) fusion
(v) Oersted experiment	(e) fission
(vi) Huygen's principle	(f) inverse square law
(vii) Lenz's law	(g) radioactivity
(viii) Compton's effect	(h) photon nature of light
	(i) magnetic effect of current
	(j) refraction of light

(e) Answer the following questions.

(i) Explain the basis of difference between magnetic and electric lines of force. **[1]**

(ii) A ray of light incident on an equilateral glass prism shows a minimum deviation of 30°. Calculate the speed of light through the glass prism. **[2]**

(iii) The V-I graphs of two resistors and their series combination are shown in the figure given below. Which of the graphs represents the series combination of the other two? Give reasons for your answer. **[2]**



(iv) Show diagrammatically how ordinary and plane polarized light are represented? **[2]**

(v) Give an expression relating de Broglie wave length and velocity of a particle. **[½]**

(vi) A transmitter operates on a wave length of 1200 m at a power of 300 kW. Find the energy of the radio photons in joule. **[1½]**

(vii) Explain depletion layer in a p-n junction. **[2]**

(viii) Why is an atom bomb used as a triggering agent for a hydrogen bomb? **[2]**

(ix) Draw the symbol of a npn and pnp transistor. **[1]**

(x) When ${}^{7}_{3}Li$ is bombarded with a certain particle, two alpha particles are produced. Find the bombarding particle. **[1]**

(xi) Obtain the relation between refractive index and critical angle. **[1]**

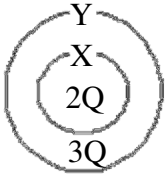
PART II

SECTION A (28 marks)

Answer any **four** *questions.*

Question 2.

(a) X and Y are two hollow concentric spheres enclosing charge 2Q and 3Q respectively as shown in the diagram given below. What is the ratio of the electric flux through X and Y? **[2]**



(b) A square of sides $\sqrt{2}m$ has charge of $5\times10^{-9}C, 2\times10^{-9}C, 3\times10^{-9}C$ and $-6\times10^{-9}C$ at its corners. Find the potential at the centre of the square.

(c) Define relative permittivity. What is its unit? **[2]**

Question 3.

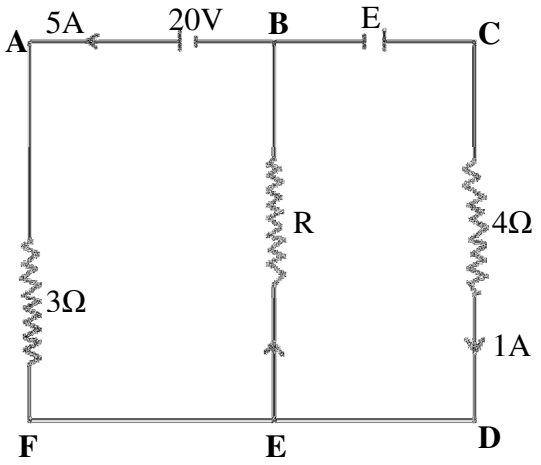
(a) The area of each plate of a parallel plate capacitor is 10^4 cm^2 and the electric field between the plates is 10^6 N/C. Compute the charge on each plate. **[2]**

(b) Derive the expression for internal resistance of a cell. **[3]**

(c) Define drift velocity of free electrons in a conductor. Give its mathematical expression. **[2]**

Question 4.

(a) Solve for the value of R using Kirchoff's laws only in the diagram given below. **[2]**



(b) Establish the equation $i_g = \dfrac{S}{S+G} i$ with the help of a circuit diagram (the symbols have their usual meaning). **[3]**

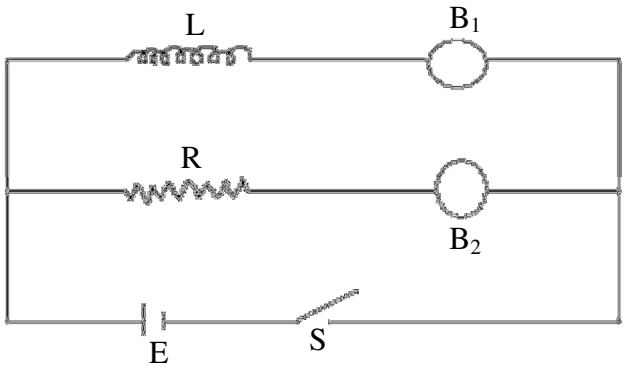
(c) Define magnetic field lines and mention ***two*** of its properties. **[2]**

Question 5.

(a) A short magnet placed with its axis 30° to a uniform magnetic field of 0.2T experiences a torque of 5 Nm^2. Compute the magnetic moment of the magnet. **[3]**

(b) Why are permanent magnets made of steel while electromagnets are made of soft iron? **[1]**

(c) In the circuit given below, inductor L and resistor R have identical resistance. Two similar electric bulbs B_1 and B_2 are connected as shown below.



When the switch S is closed: **[3]**

(i) Which of the bulbs will glow first?

(ii) Will the bulbs be of equal brightness after sometime?

Question 6.

(a) Apply Biot-savart law and F=IB*l* to derive the expression for force between two long parallel wires carrying the same amount of current. **[3]**

(b) Explain the working of a moving coil galvanometer. **[2]**

(c) A wire is bent into a rectangle loop of size 10 cm ×6 cm and placed perpendicular to a magnetic field of 1.0T. Within 0.5 sec., the loop is changed into a square of side 8 cm and the field increases to 1.4T. Calculate the emf induced in the loop. **[2]**

Question 7.

(a) Derive the expression for root mean square value of current. **[3]**

(b) Mention ***four*** advantages of alternating current over direct current. **[2]**

(c) The capacitive reactance and inductive reactance respectively for three series of RLC circuit are given below: **[2]**

A. 50Ω, 100Ω

B. 100Ω, 50Ω

C. 50Ω, 50Ω

(i) For each series, state whether the current leads or lags or is in phase with the applied emf.

(ii) Which circuit is in resonance?

SECTION B (18 marks)

Answer any **three** *questions.*

Question 8.

(a) A slit is illuminated by a light of wavelength $8000\,\overset{0}{\text{A}}$. With the help of a labelled diagram, find out the width of the slit so that the first minimum falls at an angle of 30° diffraction. **[3]**

(b) Explain with an illustration, Young's double slit experiment for obtaining interference fringes. **[3]**

Question 9.

(a) Show that when a ray of light is incident on a refracting surface at polarizing angle, the refracted and the reflected rays are at right angle to each other. **[2]**

(b) State ***four*** characteristics of wave fronts. **[2]**

(c) Prisms are used instead of plane mirrors in a periscope. Explain the statement with the help of a diagram. **[2]**

Question 10.

(a) Draw a labelled ray diagram of an astronomical telescope. Define magnification and give its expression. **[3]**

(b) A convex lens of refractive index μ_1 is kept in a liquid of refractive index μ_2.

Parallel rays of light are incident on the lens. Draw and complete the path of rays of light emerging from the convex lens if:

(i) $\mu_1 > \mu_2$ and

(ii) $\mu_1 = \mu_2$. **[3]**

Question 11.

(a) Construct an expression for combined focal length of two thin convex lenses in contact.

(b) Define dispersive power of a prism and write its expression. **[2]**

(c) A lamp is placed 5 cm away from a screen. It produces the same illumination as a 60 cd lamp placed 10 cm away on the other side of the screen. Solve the luminous intensity of the first lamp. **[2]**

SECTION C (14 marks)

Answer any **two** *questions.*

Question 12.

(a) An electron beam moving with a velocity of 10^6 m/s passes between two parallel plates having an electric field of 4 v/cm. Find the magnetic field required to keep this beam undeflected. **[2]**

(b) Why is the wave nature of matter not apparent in our daily observation? Support your answer with an example. **[2]**

(c) Compare Bohr's model and Rutherford's model of an atom. Mention ***three*** points for each. **[3]**

Question 13.

(a) Give the expression for the distance of closest approach r_0 of an α-particle to the nucleus. **[1]**

(b) Why is there danger to the people working in nuclear power plants from radiation? **[3]**

(c) Why $_1H^3$ and $_2He^3$ donot have the same nuclear binding energy although they have almost the same atomic mass? **[3]**

Question 14.

(a) State the radio active decay law. **[1]**

(b) Explain forward and reverse biasing with illustrations and draw their voltage current characteristics. **[4]**

(c) Differentiate between NOT and AND gate in terms of symbol and truth table. **[2]**

[PHYSICAL CONSTANTS]

Planck's constant	$h = 6.63 \times 10^{-34}$ J.s
Electron charge	$e = 1.6 \times 10^{-19}$ C
1 electron volt	$1eV = 1.6 \times 10^{-19}$ J
Speed of electromagnetic wave	$c = 3 \times 10^{8}$ ms^{-1}
Energy equivalent of	1u = 931 MeV
Mass of an electron	$M_e = 9.1 \times 10^{-31}$ kg