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 and **nine** questions from Part II, choosing **four** questions from Sections A, three questions from Section B and 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 [ ].

(Materials to be supplied: Log tables including Trigonometric functions)

A list of useful physical constants is given in the end of this paper.

PART I (40 marks)

Answer **All** questions.

Question 1.

(a) ***Read the following questions carefully. For each question there are four alternatives A, B, C and D. Choose the correct alternative and write it in your answer sheet.***

(i) If the air is replaced by any other medium, the force between two charges **[1]**

A increases.

B decreases.

C remains the same.

D may increase or decrease depending upon the nature of the medium.

(ii) A piece of wire of resistance R is stretched uniformly so that its length is doubled. The resistance of the stretched wire will be

A 2R.

B R/2.

C 4R.

D R/4.

(iii) The result of placing a soft iron inside a coil is the **[1]**

A increase in the magnetic flux.

B decrease in the magnetic flux.

C rate of change in electric field.

D rate of change of magnetic field.

(iv) Though the particle nature of light can explain a number of phenomena observed with light, it is necessary to retain the wave nature of light to explain the phenomenon of **[1]**

A diffraction.

B pair production.

C Compton effect.

D photo electric effect.

(v) A p-type semiconductor is produced by doping silicon or germanium with

A penta-valent atoms. **[1]**

B tetravalent atoms.

C trivalent atoms.

D none of the above.

(vi) The phenomenon of radioactivity is **[1]**

A fusion of the nucleus.

B fission of the nucleus.

C disintegration of the nucleus.

D nuclear reaction caused by cosmic radiation.

(vii) To have a large magnifying power for an astronomical telescope compared to the focal length of the objective, the focal length of the eye lens must be

A any value.

B infinity.

C large.

D small.

(viii) A photon of wavelength λ has a momentum equal to **[1]**

A h/λ.

B $h\lambda/c$.

C zero.

D infinity.

(ix) In purely inductive circuits, the current **[1]**

A leads the voltage by $\pi/2$.

B lags behind voltage by $\pi/2$.

C I is in phase with the voltage.

D none of the above.

(x) X-rays can be made harder by **[1]**

A increasing the potential difference between the cathode and anti- cathode.

B decreasing the potential between cathode and anti- cathode.

C increasing the current through the filament.

D decreasing the current through the filament.

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

(i) The potential at any point in an electric field is said to be 1 volt if ………… joules of work is done in moving a charge of ……….. coulombs between infinity and the point under consideration. (one, two, three, four)

(ii) Kirchhoff's second law states that the algebraic sum of the e.m.f in a cl[...] electric circuit is equal to the algebraic sum of the products of the ……… and ……… through each resistor. (resistance, p.d, current, e.m.f)

(iii) The combination of ………….. gate and ………gate gives rise to the NAND gate. (OR, NOR, AND, NOT)

(iv) 1 unified atomic mass unit is defined as ……. of the mass of ……… atom. (one sixteenth, one twelfth, C^{12}, O^{16})

(v) Rutherford's nuclear model of atom is based on …….. experiment on ……….. (Rutherford's, Geiger-Marsdon's, α – particle scattering, Bohr's scattering)

(vi) The energy production in stars is based on ……….. reaction which is also the principle of ………(thermonuclear, radioactivity, hydrogen bomb, nuclear reactor)

(c) ***Match the items in Column A with the items given in Column B and rewrite the correct pairs in your answer sheet.***
Item 1 has been done as an example. *Example: 1(b)* **[4]**

Column A	**Column B**
1. Interference	a. mass defect
2. Photoelectric effect	b. wave nature of light
3. Binding energy	c. object within focus
4. Carbon dating	d. magnetic field
5. Simple microscope	e. particle nature of light
6. Faraday's law	f. moving coil galvanometer
7. Characteristics curves	g. electromagnetic induction
8. Coulomb's law	h. age of fossils
9. Potentiometer	i. null point
	j. force between two charged particles
	k. transistors

(d) ***State*** **true** ***or*** **false** ***and support your answer with reasons.*** **[4]**

(i) Tangent galvanometer is adjusted with the plane of the coil in the magnetic meridian for measuring current passing through it.

(ii) In a simple microscope for the image to form at infinity, the object must be placed between 'f' and '2f'.

(iii) Right angled prisms are preferred over reflecting mirrors while constructing a periscope.

(iv) The average power consumed by an alternating current in RLC circuit is zero as the power factor is zero.

(e) ***Answer the following questions briefly.*** **[2 x 8 =16]**

(i) a) What is the resistance of a resistor colour coded brown-red-orange?

b) What is the tolerance (percentage accuracy) if the ring at the far end is gold?

(ii) A monochromatic ray of light is incident on an equilateral glass prism under minimum deviation conditions.

What are the relations between the

a) angle of incidence and the angle of emergence?

b) angles of refraction inside the prism?

(iii) A ray of unpolarised light is incident on a medium at the polarizing angle.

a) What is the angle between the reflected and the refracted rays?

b) Which ray is partially polarized?

(iv) For a photosensitive surface the work function is 3.3×10^{-19}J. Calculate the threshold frequency and maximum wavelength of incident light to produce photoelectric emission.

(v) a) Why is heavy water chosen as moderator in a nuclear reactor?

b) What is used for controlling fission reaction?

(vi) a) What will be the path of a charged particle moving at right angles to the uniform magnetic filed?

b) Write the vector equation for the force acting.

(vii) a) What is the ionization energy of the unexcited hydrogen atom if the energy of the ground state is -13.6 eV?

b) What is the energy at n=2 level?

(viii) a) Name the physical principle on which the working of the optica[l] fibres is based.

b) Draw a ray diagram to illustrate its action.

Part II

SECTION A (28 marks)

Answer any FOUR questions.

Question 2.

(a) The distance between two charges is halved and their individual charges are doubled. Obtain the relation of charges before and after the charge. Include the formula used in the steps. **[2]**

(b) Obtain the expression U = -PE for the potential energy of a dipole moment 'p' in a uniform electric field 'E' with the help of a diagram. **[3]**

(c) A 100 μF capacitor is charged to a potential difference of 100 volts. Calculate the energy stored in the capacitor. **[2]**

Question 3.

(a) Two electric lamps are rated 200V, 100W and 200V, 40W. Find the current flowing in each lamp when they are connected in series across 200V supply. **[3]**

(b) What happens to the resistivity of a metal with rise in temperature? **[1]**

(c) Derive an expression for the magnetic field at the centre of a circular coil of *n* turns using Biot-Savart's law. Write Biot-Savart's law in vector form. **[3]**

Question 4.

(a) How does the magnetic susceptibility depend on temperature for para and dia magnetic materials? **[2]**

(b) The resistance of a galvanometer is 10 ohm. It can measure a maximum current of 1 ampere. Draw a diagram to show how this galvanometer can be converted into a voltmeter reading up to 100 volts. Calculate the value of resistance connected. **[2]**

(c) Define relative permeability (μ_r) of a magnetic material. How is it related to the magnetic susceptibility (χ_m)? What are the units of μ_r and χ_m?

Question 5.

(a) Obtain the relation $B_m = B_H \tan \theta$ for a deflection magnetometer, from a vector diagram of $\overrightarrow{B}_m$ and $\overrightarrow{B_H}$. **[2]**

(b) A step-up transformer operates on a 220V line and supplies current of 5A out put. The ratio of the primary and secondary winding is 1:20. Calculate the **[3]**

(i) p.d across the secondary coil.

(ii) power out put.

(c) State two important differences between Joule effect and Pettier effect. **[2]**

Question 6.

(a) A choke coil is preferred to rheostat in controlling the a.c supply. Justify the statement. **[2]**

(b) The equation of an alternating voltage (in volts) is $V=230 \sin (120\pi t)$. What are the peak value of the voltage and the frequency? **[2]**

(c) If an a.c circuit contains inductance 'L' and capacitance 'C', deduce an expression for resonant frequency. **[3]**

Question 7.

(a) What is Mutual inductance? Name a device where it is used. **[2]**

(b) Two parallel wires having current I_1 and I_2 are placed at a distance'd' apart. Write down the expression for the magnetic field B at a point on the second wire to current I_1 in the first wire. Write the expression for the force F_2 acting on a length 'l' of the second wire exerted by the current in the first wire. Indicate in a diagram the direction of B_{21} and F_{21}. **[3]**

(c) What happens to the strength, if a bar magnet is cut into two pieces

(i) perpendicular to its length

(ii) along its length?

SECTION B (18 marks)

Answer any THREE questions

Question 8.

(a) What are coherent sources of light? Why is it not possible to observe interference with non-coherent sources? **[3]**

(b) Two coherent sources of light are placed 0.12 mm apart and the fringes are observed on a screen 70 cm far. The 4^{th} bright fringe is found at a distance of 10.5 mm from the central fringe. Calculate the wavelength of light used. **[3]**

Question 9.

(a) State one difference between interference and diffraction fringes. **[1]**

(b) Show graphically the intensity distribution in the diffraction pattern of a single slit and label the axes. **[2]**

(c) Define dispersive power. Obtain an expression for the dispersive power of the material of prism in terms of refractive indices. **[3]**

Question 10.

(a) Draw and label the ray diagram for Michaelson's experiment. **[3]**

(b) What is a Polaroid? Give one use of Polaroid. **[1]**

(c) A ray of light is incident on the surface of a glass plate of refractive index $\mu = \sqrt{3}$ at the polarising angle. Calculate the polarizing angle and the angle of refraction of the ray. **[2]**

Question 11.

(a) For refraction at a spherical surface, draw a ray diagram showing the formation of a real image (any case). Label the object, image and their distances. Write the formula connecting u, v, n_1, n_2 and R. **[3]**

(b) One face of a prism of refracting angle 30° and refractive index $\mu = \sqrt{2}$ is silvered. At what angle must a ray of light be incident on the unsilvered face so that after refraction by prism and reflection at the silvered surface it retraces its path? **[3]**

SECTION C (14 marks)

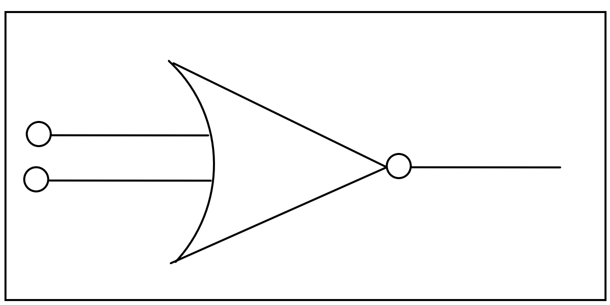
Answer any TWO questions

Question 12.

(a) What do you mean by 'work function' and threshold frequency in photoelectric emission? Give Einstein's equation for photoelectric emission. **[3]**

(b) Draw a labelled circuit diagram of a full wave rectifier and show graphically the input and out put wave forms. **[3]**

(c) Write the truth table for the logic gate shown in the figure? **[1]**



Question 13.

(a) What is Compton scattering? In such a scattering state what happens to the

(i) scattered photons?

(ii) target electron?

(b) A radioactive isotope has a half-life of 12.5 years. **[4]**

(i) After how much time does its activity become 12.5% of its original activity?

(ii) Calculate the value of the decay constant.

Question 14.

(a) What is meant by a line spectrum? The H_2 line of Balmer series is obtained from the transition n = 3 to n = 2. Calculate the wavelength for this line. **[4]**

(b) What do you mean by fusion and fission? Write one equation for any one. **[3]**

PHYSICAL CONSTANTS AND RELATIONS

Permittivity of free space	ε_0	$= 8.85 \times 10^{-12}$ Fm^{-1}
Planck constant	h	$= 6.63 \times 10^{-34}$ J.s
Electron charge	e	$= 1.6 \times 10^{-19}$ C
1 electron volt	1 eV	$= 1.60 \times 10^{-19}$ J
Speed of electromagnetic wave	c	$= 3.00 \times 10^{8}$ ms^{-1}
Energy equivalent of	1u	= 931 MeV
Mass of an electron	m_e	$= 9.10 \times 10^{-31}$ kg
