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).

---

*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 answers.

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) A wire having a very high value of conductance is said to be

A a moderately good conductor.

B a very good conductor.

C a semi conductor.

D an insulator.

(ii) A well cut diamond appears bright due to

A emission of bright light.

B total internal reflection.

C scattering of light.

D dispersion of light.

(iii) The base of a transistor should be of

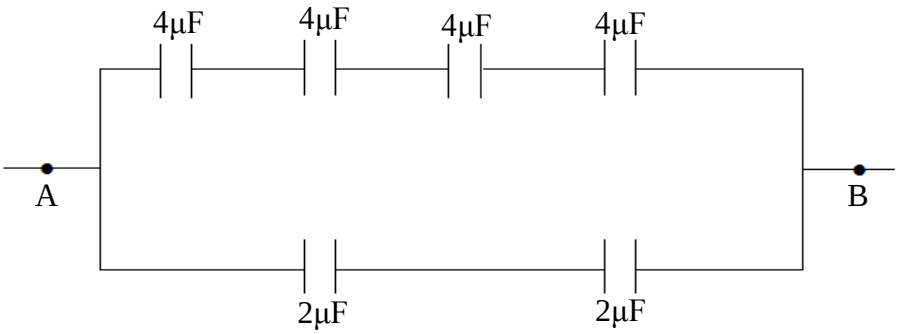
A any good conductor.

B high doping.

C zero doping.

D low doping.

(iv) The equivalent capacitance between the points A and B from the network of capacitors shown below is



A 2 μF.

B 3 μF.

C 4 μF.

D 20 μF.

(v) When a magnetic needle is kept in a uniform magnetic field, it experiences

A neither a force nor a torque.

B a force and not a torque.

C a torque and a force.

D only a torque.

(vi) Which of the following relations represents Biot-Savart's law?

A $\overrightarrow{dB} = \frac{\mu_0}{4\pi}\frac{i\vec{dl}\times\vec{r}}{r}$

B $\overrightarrow{dB} = \frac{\mu_0}{4\pi}\frac{i\vec{dl}\times\hat{r}}{r^3}$

C $\overrightarrow{dB} = \frac{\mu_0}{4\pi}\frac{i\vec{dl}\times\vec{r}}{r^3}$

D $\overrightarrow{dB} = \frac{\mu_0}{4\pi}\frac{i\vec{dl}\times\hat{r}}{r^4}$

(vii) 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

A photo electric effect.

B Compton effect.

C pair production.

D diffraction.

(viii) The de-Broglie wavelength of an electron of kinetic energy 100 eV will be

A $12.27\ \overset{0}{A}$.

B $122.7\ \overset{0}{A}$.

C $1.227\ \overset{0}{A}$.

D $0.1227\ \overset{0}{A}$.

(ix) For which of the following voltages applied to an X- ray tube, will the minimum wavelength of the emitted X-rays be smallest?

A 40 kV

B 30 kV

C 20 kV

D 10 kV

(x) The curve of binding energy per nucleon against mass number has a sharp peak for helium nucleus. This means that helium nucleus is

A easily fissionable.

B radioactive.

C very stable.

D none of these.

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

(i) The magnification of a …… lens may be less than 1, 1 or more than 1, while the magnification of a …… lens is always less than 1. (concave/achromatic/convex)

(ii) The diffraction of light due to single slit is observed in the physics laboratory. The diffraction pattern will be …… if the light of small wavelength is used and will be …… if slit is made narrower. (colourful/wider/white/narrower)

(iii) The process of adding impurity to an intrinsic semi-conductor in a controlled manner is called …… and this increases the …… significantly and it becomes an extrinsic semi-conductor. (biasing/conductivity/doping/resistivity)

(iv) Photoelectric effect shows …… nature of light and the light emitting diode (LED) converts electrical energy to …… energy. (wave/kinetic/light/particle)

(v) In beta decay where a positron is emitted, a …… is released, whereas in beta decay involving an electron emission, …… is emitted. (neutron/neutrino/proton/antineutrino)

(vi) A galvanometer of 1Ω resistance gives a full scale deflection with a 5×10^{-3}A current. To measure 5 V with this galvanometer, a resistance of …… has to be connected in …… to the galvanometer. (1000Ω/999Ω/parallel/series)

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

Column A	**Column B**
(i) Coulomb's law	a) high penetrating power
(ii) Alpha scattering experiment	b) controls the intensity of light
(iii) Gamma rays	c) determination of angle of prism
(iv) Nuclear reactor	d) chromatic aberration
(v) Polaroids	e) force between two charged particles
(vi) Coherent sources	f) no chromatic aberration
(vii) Spectrometer	g) nucleus contain whole mass
(viii)Monochromatic light	h) no phase difference
	i) control rods
	j) high ionizing power

(d) Write True or False and give reasons for the false statements. **[4]**

(i) The reverse current in a p-n junction diode is due to the movement of majority charge carriers across the junction.

(ii) Cathode rays produce X-rays on striking a heavy metal.

(iii) From 25 W and 100 W bulbs, the 100 W bulb glows brighter whether the two bulbs are connected in series or in parallel.

(iv) If an electric dipole of moment $\vec{p}$ is placed normal to the lines of force of an electric field $\vec{E}$, then the potential energy of dipole is 2pE.

(e) Answer the following questions:

(i) A 100Ω resistor is connected to 220V-50 Hz a.c supply. Find the rms value of current in the circuit and the net power consumed for a complete cycle. **[2]**

(ii) No photoelectrons can be liberated from a metal surface, if the wave length of the incident light exceeds a certain value. Why? **[2]**

(iii) Using Biot-Savart's law, derive the expression for the magnetic field at the centre of a circular current carrying coil of radius r. **[2]**

(iv) Explain why the input resistance of a transistor is low while the output resistance is high. **[2]**

(v) Calculate the binding energy of deuteron ($_1H^2$) in MeV, if mass of neutron = 1.008665u; mass of hydrogen atom ($_1H^1$) = 1.007825u and mass of deuteron ($_1H^2$) = 2.014103u. **[2]**

(vi) (a) Magnetic lines of force prefer to pass through ferromagnetic substances than through air. Why? **[1]**

(b) A radioactive nucleus A decays as $A \xrightarrow{\beta+} A_1 \xrightarrow{\alpha} A_2$. If the mass number and atomic number of A_2 are 176 and 71 respectively, find mass number for A_1 and A. **[1]**

(vii) The target of Coolidge tube gets heated up at the time of emission of X-rays. Justify. **[2]**

(viii) Arrange the focal length of the given convex lenses of powers 5D, 5.6D, 6.7D, 4.5D, in their descending order. **[2]**

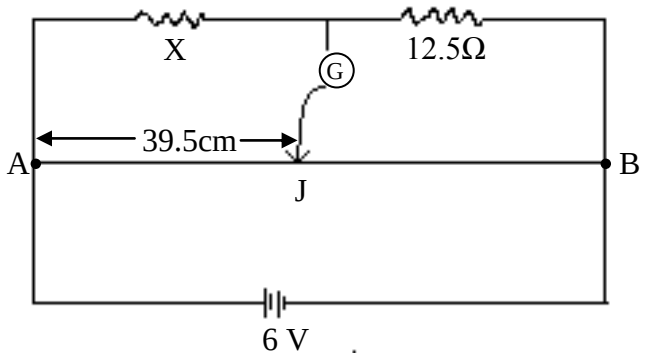
PART II

SECTION A (28 marks)

Answer any **four** *questions.*

Question 2.

(a) Study the diagram given below.



Use the above figure to,

(i) find the unknown resistance X, **[1]**

(ii) determine the balance point if resistance X and 12.5Ω are interchanged. **[1]**

(iii) state why the resistors in a meter bridge are connected by thick copper strips? **[1]**

(b) An electric dipole is free to move in a uniform electric field. Explain its motion when it is placed **[2]**

(i) parallel to the field,

(ii) perpendicular to the field.

(c) Derive an expression for the electric field intensity at any point due to a plane sheet of charge of uniform charge density σ Cm^{-2}. **[2]**

Question 3.

(a) What are Seebeck and Peltier effects? **[2]**

(b) Given that the p.d applied across a variable resistor is constant, draw a graph between current 'I' in the resistor and the resistance 'R'. **[2]**

(c) Distinguish between paramagnetic and diamagnetic materials based on their behavior in a uniform magnetic field and in a non-uniform magnetic field. **[3]**

Question 4.

(a) Obtain an expression for the electric potential at a point distant 'r' from a point charge 'q'. What will be the potential at a point as a combined effect of several charges? **[3]**

(b) When a medium of dielectric constant K is introduced between the plates of a parallel plate capacitor, how do the

(i) capacitance and **[1]**

(ii) p.d across the plate change? **[1]**

(c) What is meant by inductive reactance (X_L) in an a.c. circuit? What is its value for d.c? **[2]**

Question 5.

(a) Draw a labelled diagram of an a.c. generator and state its principle. **[2]**

(b) A choke coil is found to be more efficient than a rheostat in controlling the a.c. supply. Justify the statement. **[2]**

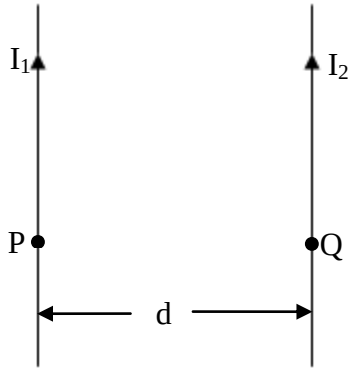
(c) Derive the expression $I = K\theta$ for a moving coil galvanometer, given the deflecting torque $\vec{\tau_d} = \vec{P_m} \times \vec{B}$, where $\vec{P_m}$ is the magnetic dipole moment of the coil placed in the magnetic field B, I is the current in the galvanometer and θ is the deflection. **[3]**

Question 6.

(a) Define the term self-inductance of a coil and name its S.I unit. **[1]**

(b) A short bar magnet of magnetic moment $0.9JT^{-1}$ placed with its axis at 45° with a uniform internal magnetic field experiences a torque of 0.036 J. Find the strength of the magnetic field. What orientation of the bar magnet corresponds to the stable equilibrium in the magnetic field? **[3]**

(c) Two very long conductors carrying current I_1 and I_2 are separated by a distance d as shown in the figure.



Give the expression (do not derive) for the magnetic field B_{12} and B_{21} at point P and Q produced by the currents I_1 and I_2. What are the directions of these fields? Define the S.I unit of current using the above set-up. **[3]**

Question 7.

(a) (i) The current flowing through a conductor is given by an equation, $i = V_d enA$. Identify each term on the right hand side of the equation. **[1]**

(iii) Obtain an expression for V_d, if the current flowing through a conductor of length '*l*' has its ends maintained at a potential difference of V volt. **[2]**

(b) You have, L = 4.0H, C = 100μF, R = 40Ω in a series L-C-R circuit connected to a variable frequency of 220V source. Calculate the

(i) resonant frequency of the circuit,

(ii) impedance of the circuit (Z),

(iii) amplitude of current (I_o) at resonant frequency. **[3]**

(c) Name ***two*** methods to reduce Eddy currents in a conductor. **[1]**

SECTION B (18 marks)

Answer any **three** *questions.*

Question 8.

(a) State ***four*** factors on which the deviation produced by a prism depends. **[2]**

(b) Rays of red and blue lights are incident on a given prism. Explain which will have the larger angle of minimum deviation. **[2]**

(c) The distance between the first and the sixth bright fringes formed in Young's double slit experiment is found to be 12.5 mm. The separation between the slits is 0.12 mm and the distance of the screen from the slits is 60 cm.
Calculate the

(i) fringe width,

(ii) wavelength of light used (in m). **[2]**

Question 9.

(a) State ***one*** similarity and ***one*** difference between interference and diffraction of light. Show graphically the intensity distribution in a single slit diffraction pattern. **[3]**

(b) A convex lens of focal length 5 cm is to be used as a simple microscope. Where should the object be kept so that the image formed by the lens lies at the least distance D of distinct vision (D = 25cm)? Also, calculate the magnifying power of this instrument in the set-up. **[3]**

Question 10.

(a) If a ray of light is incident at an angle of polarization i_p on a transparent medium, prove that $\mu = \tan i_p$, where μ is the refractive index of the transparent medium. **[2]**

(b) Differentiate between luminous flux and intensity of illumination of a surface. Mention their S.I. units. **[2]**

(c) For achromatic doublet, both the lenses should be of different materials. Support the statement. **[2]**

Question 11.

(a) Draw a sketch of electromagnetic spectrum showing the relative positions of ultra violet rays, infrared rays, X-rays and microwaves with respect to visible light. State ***one*** use of each. **[3]**

(b) Using a labelled ray diagram of astronomical telescope in normal adjustment, derive the expression for its magnifying power. **[3]**

SECTION C (14 marks)

Answer any **two** *questions.*

Question 12.

(a) Explain work function and threshold frequency in photo electric emission. Give Einstein's equation for photoelectric emission. **[3]**

(b) The potential difference between the cathode and the target electrode in a Coolidge tube is 24.75 kV.
Calculate the
(i) minimum wavelength of the emitted X-ray photon,
(ii) momentum of this photon. **[3]**

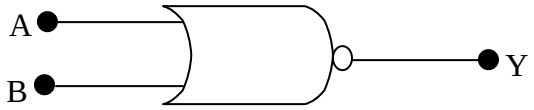
(c) What is meant by Compton Effect? **[1]**

Question 13.

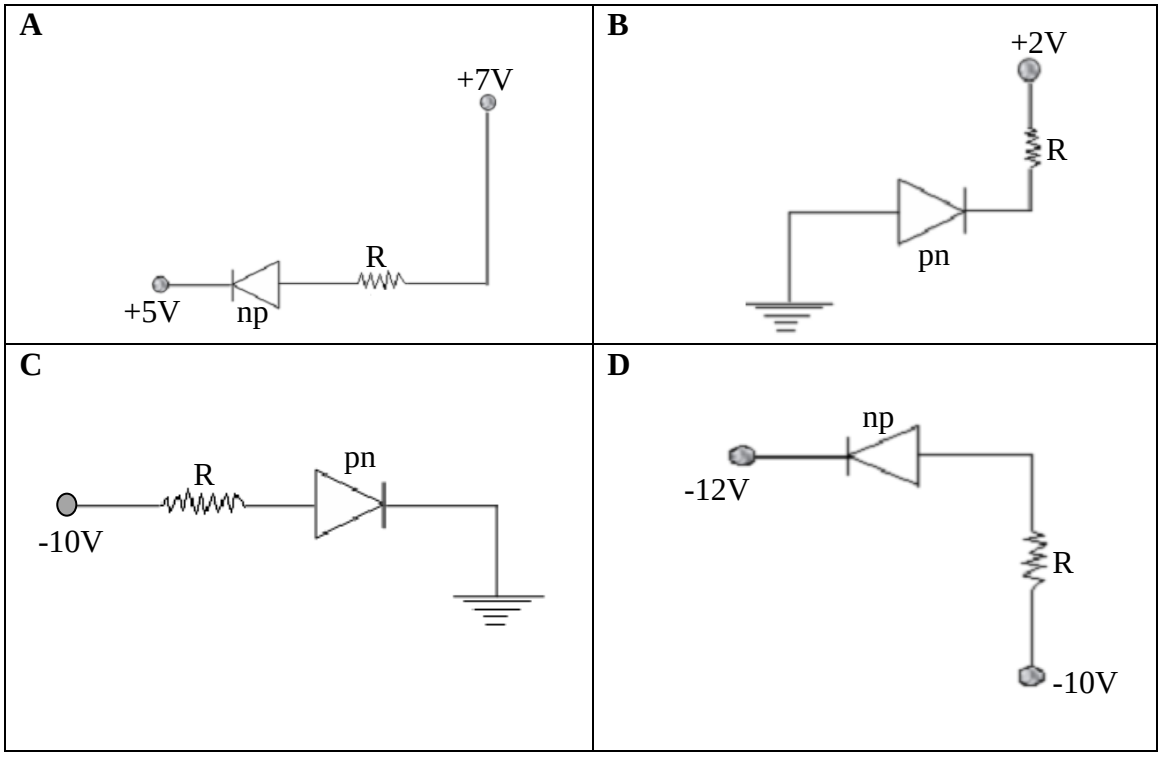
(a) Write down the expressions for velocity and kinetic energy of an electron in Bohr model. **[1]**

(b) (i) What is meant by the term doping of an intrinsic semi-conductor? How does it affect the conductivity of a semi-conductor? **[1]**

(ii) Prepare the truth Table for the logic gate shown in the figure. **[2]**



(iii) Indicate which of the following p-n junction diodes are forward biased and which are reverse biased.



(iv) Which one of the transistors p-n-p or n-p-n is more useful and why? **[1]**

Question 14.

(a) (i) Complete the equation, ${}_{92}U^{235} + {}_{o}n^{1} \longrightarrow$..... **[1]**

(ii) What are the sources of energy in a nuclear reactor and in stars? **[2]**

(b) Compare the radioactive radiations Alpha (α), Beta (β) and gamma (λ) rays in terms of their penetrating powers and effect of electric and magnetic field. **[3]**

(c) Give the names of antiparticles of positron and neutron. **[1]**

[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
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-}12$ Fm^{-1}
Absolute magnetic permeability	$\mu_0 = 4\pi \times 10^{-7}$ SI unit