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) A carbon resistance reads brown-red-yellow. Its resistance will be

A 124Ω.

B $12\times10^{3}\Omega$.

C $12\times10^{4}\Omega$.

D $12\times10^{5}\Omega$.

(ii) The magnification produced by a concave lens is

A more than 1.

B less than 1.

C equal to 1.

D infinity.

(iii) The most commonly used material for making a transistor is

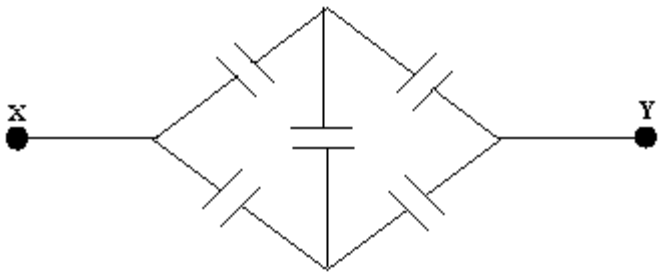
A copper.

B ebonite.

C silicon.

D silver.

(iv) 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 $10\mu F$.

(v) If the relative permeability of a substance A is slightly less than unity and that of substance B is slightly more than unity, then

A A is paramagnetic and B is ferromagnetic.

B A is diamagnetic and B is ferromagnetic.

C A is paramagnetic and B is diamagnetic.

D A is diamagnetic and B is paramagnetic.

(vi) If the current flowing through a wire loop is doubled, then its magnetic moment wil

A half.

B double.

C one-fourth.

D one-third.

(vii) In Young's double slit experiment, if sodium lamp is replaced by green light lamp, then the

A fringes will become brighter.

B fringes will become fainter.

C fringe width will increase.

D fringe width will decrease.

(viii) Green light causes emission of photoelectrons from a surface but not yellow light. Emission of photoelectrons will occur if the surface is illuminated by

A red light.

B blue light.

C radio light.

D infrared waves.

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

A $-3.4eV$.

B $-6.8eV$.

C $-13.6eV$.

D $-27.2eV$.

(x) Solar energy is due to

A combustion reaction.

B chemical reaction.

C fission reaction.

D fusion reaction.

(b) Choose the correct word/s given in the brackets and write them in your answer she

(i) The spectrum containing distinct lines is called ……. spectrum and the substance to give it must be in ..... state. (band/line/atomic/molecular)

(ii) The light having vibrations of electric field vector in all possible directions …… to the direction of wave propagation is called ……. light. (perpendicular/parallel/polarized/unpolarised)

(iii) A semi-conductor like silicon doped with boron is called a ……. semi-conductor and the majority carriers are ……. (p-type/n-type/holes/electrons)

(iv) The saturated current increases linearly with ……. while the stopping voltage increases linearly with ……. of incident radiation. (intensity/work-function/frequency/wavelength)

(v) The binding energy of a nucleus may be defined as the ……. equivalent to the mass defect of the ……. (force/energy/nucleus/atom)

(vi) Leclanche cell is an example of a ……. cell and the electrolyte used in it is ……. (primary/secondary/sulphuric acid/ammonium chloride)

(c) 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) Electric flux	(a) constant phase difference
(ii) Bohr's quantum condition	(b) highest frequency
(iii) One atomic mass unit	(c) $F = 4\pi I$
(iv) Coolant in nuclear reactor	(d) object within focus
(v) Coherent sources	(e) $mvr = \frac{nh}{2\pi}$
(vi) Gamma rays	(f) carbon dioxide
(vii) Simple microscope	(g) lowest frequency
(viii)Luminous flux	(h) $\phi = \int_S \vec{E}.\vec{dS}$
	(i) object at focus
	(j) $931 MeV$

(d) 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.

(e) Answer the following questions.

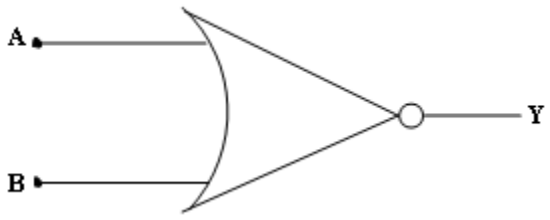
(i) In an a.c circuit, $R = 4\Omega$, $Z = 5\Omega$, $E_{rms} = 200V$ and $I_{rms} = 1.5A$.

Calculate the average power consumed over a full cycle. **[2]**

(ii) An electron from rest is accelerated through a p.d of V volts. The final velocity acquired by it is v m/sec. Obtain an expression for e/m of electron in terms of V and v. **[2]**

(iii) A charged particle enters perpendicularly in a uniform magnetic field. Show that its radius is directly proportional to its momentum. **[2]**

(iv) Name the logic gate shown below and prepare its truth table. **[2]**



(v) The half-life of radon is 3.8 days. Calculate the amount of radon left undecayed in a sample containing 1024 mg of radon after 38 days. **[2]**

(vi) (a) A bar magnet is placed in a uniform magnetic field of 0.3T with its a
at 90° to the field experiences a torque $0.06N-m$. Find the magnetic moment of the bar magnet. **[1]**

(b) Complete the following reaction. **[1]**
$_4Be^9 + {}_2He^4 \rightarrow {}_6C^{12} + ...$

(vii) Rutherford's α-particle scattering experiment uses gold foil. Why? **[2]**

(viii) (a) In Young's double slit experiment the distance of the fourth bright fringe from the central zero is 1.5 mm. The distance between the slits and the screen is 1.5 m and the distance between the slits is 2 mm. Find the wavelength of light used. **[1]**

(b) Two thin lenses of +15 D and -15 D powers are placed in contact with each other. Find the power and nature of this combination. **[1]**

PART II

SECTION A (28 marks)

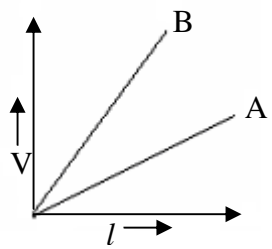
Answer any **four** *questions.*

Question 2.

(a) State ***one*** essential property of a Gaussian surface and its use. **[2]**

(b) Three capacitors of $20\mu F, 30\mu F$ and $60\mu F$ are connected in series to a 100 volt d.c supply. Calculate the total energy stored in the capacitors. **[2]**

(c) The variation of potential difference with length in case of two potentiometers A and B is given below. Which of the two is more sensitive? State ***one*** use of a potentiometer. **[3]**



Question 3.

(a) Define electric conductance of a material. Give its SI unit.

(b) A 200 W – 240 V bulb is connected to a 120 V d.c source. Calculate the power consumed by the bulb. **[2]**

(c) Distinguish between intensity of magnetism $(\overrightarrow{M})$ and magnetic susceptibility (χ_m).

What is the value of magnetic susceptibility of aluminium if its relative permeability is 1.000031? **[3]**

Question 4.

(a) With the help of a sketch diagram, deduce Coulomb's law from Gauss' theorem. **[3]**

(b) On moving away from a point charge, the electric field due to the charge decreases. This is also true for a small electric dipole. Does the electric field decrease at the same rate in both the cases? Give reasons. **[2]**

(c) Draw graphs for growth and decay of a current in a circuit having inductance and resistance in series. **[2]**

Question 5.

(a) State the principle of a moving coil galvanometer. How is the radial magnetic field achieved in it? **[3]**

(b) A charged particle moving in a straight line parallel to a uniform magnetic field enters a field. What will be its path in the field? Will there be any change in its speed or direction of motion? **[2]**

(c) Which is more dangerous in use, a.c or d.c of the same voltage? Support your answer with an example. **[2]**

Question 6.

(a) State Ampere's circuital law. **[1]**

(b) A rectangular loop of area $500cm^2$ is placed in a magnetic field of 0.3T with its plane:

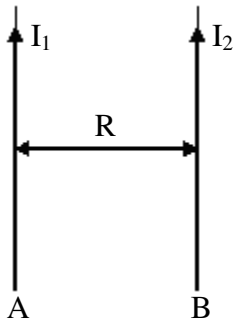
(i) normal to the field.

(ii) parallel to the field.

(iii) inclined at 30° to the field.

Find the flux linked with the coil in each case.

(c) The figure given below shows two infinitely long thin parallel conductors A and B carrying currents I_1 and I_2 respectively. **[3]**



(i) What is the direction of the magnetic field around A due to current in B?

(ii) What is the nature of force between A and B?

(iii) What will be the effect on the force per unit length of B when both I_1 and I_2 are doubled?

Question 7.

(a) Write the direction of a thermoelectric current at the

(i) cold junction of a Cu-Fe thermocouple and

(ii) hot junction of a Sb-Bi thermocouple.

Which of these two thermocouples produces a higher thermo-emf for the same temperature of the hot and the cold junctions? **[3]**

(b) The current and voltage in a circuit are given by $i = 3\sin(600t + 50^0)A$ and $V = 30\sin(600t - 50^0)V$. Calculate: **[3]**

(i) root-mean-square value of current.

(ii) time period of current.

(iii) phase difference between V and i.

(c) State Lenz's law of electromagnetic induction. **[1]**

SECTION B (18 marks)

Answer any **three** *questions.*

Question 8.

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

(b) What are the differences between primary and secondary rainbows? **[2]**

(c) Prove that when light is incident on a transparent surface at the polarizing angle, the reflected and the refracted rays are perpendicular to each other. **[2]**

Question 9.

(a) What type of wavefronts are produced by a

(i) point source,

(ii) line source and

(iii) distant source of light?

Support your answer with the help of sketch diagrams. **[3]**

(b) Calculate the focal length and power of a convex lens whose radius of curvature of each surface is 30 cm and the refractive index of glass is 1.50. **[3]**

Question 10.

(a) A slit of width 'd' is illuminated by a light of wavelength 5500 $\overset{0}{A}$. Calculate: **[2]**

(i) the slit width 'd' when the first minimum falls at an angle of diffraction of 30°.

(ii) the angle θ at which the first maximum is observed.

(b) In viewing through a simple microscope, the eye is put quite close to the lens. How does the angular magnification change if the eye is moved away from the lens? Support your answer with a reason. **[2]**

(c) The magnifying power of a telescope for a relaxed eye is $M = f_0 / f_e$. On inverting it and seeing from the side of the objective, what do you think would happen? Justify your answer. **[2]**

Question 11.

(a) What are the basic differences between diffraction fringes and interference fringes? Draw the intensity distribution pattern for a single slit diffraction. **[3]**

(b) Derive the expression for combined focal length of two thin lenses in contact. **[3]**

SECTION C (14 marks)

Answer any **two** *questions.*

Question 12.

(a) Explain the terms stopping potential and threshold frequency in photoelectric effect. How does photoelectric effect reject the wave nature of light? **[3]**

(b) In a head-on collision between an α-particle and gold (Z=79) nucleus, the closest distance of approach is 45 fermi. Calculate the energy of the α-particle in MeV. (1 fermi = 10^{-15}m) **[3]**

(c) What is Compton scattering? **[1]**

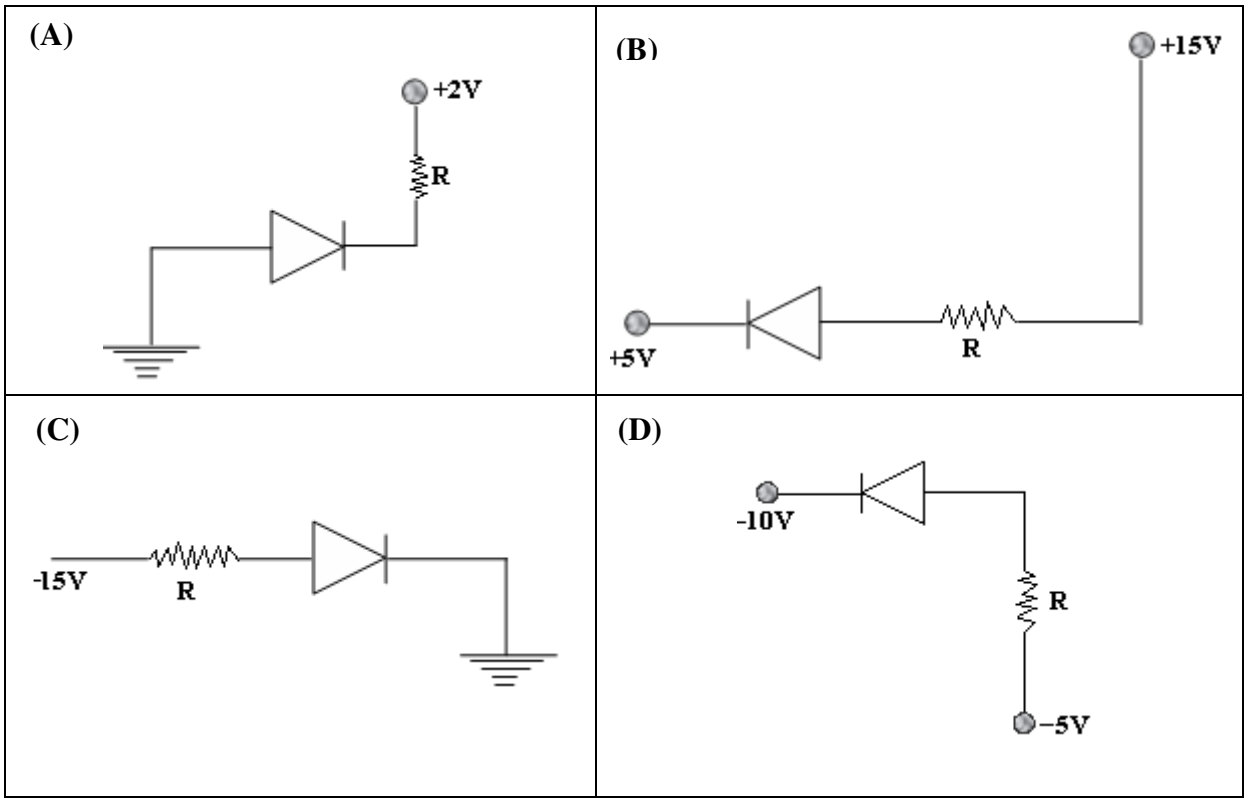
Question 13.

(a) How does soft X-ray differ from hard X-ray? **[1]**

(b) (i) What is a forbidden gap? **[1]**

(ii) Draw the input and output characteristics curves of a n-p-n transistor in a common emitter configuration with proper labelled axes. **[2]**

(iii) In the following diagrams, state which of the diodes are forward biased and reverse biased.



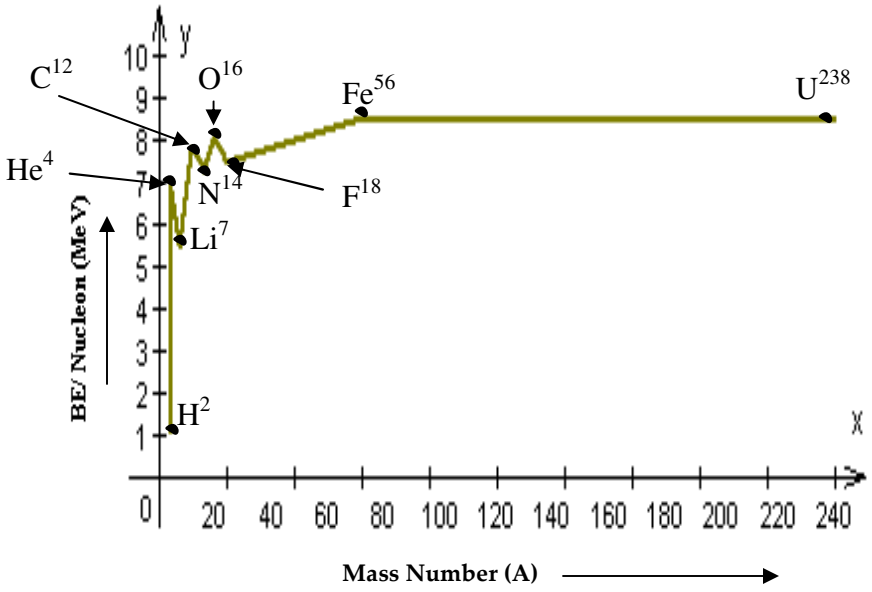
(iv) A n-p-n transistor is more useful than p-n-p transistor. Justify. **[1]**

Question 14.

(a) Define half-life of a radioactive substance. Establish its relation with the decay constant. **[3]**

(b) What is the principle of operation of a nuclear reactor? **[1]**

(c) The graph given below shows the variation of $B.E/_{nucleon}$ with mass number of different nuclei. Give any ***one*** inference from the graph. Study the graph and explain the possibility of energy release in nuclear fusion and fission reactions. **[3]**



[PHYSICAL CONSTANTS]

Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}$ Fm^{-1}
Planck's constant	$h = 6.63 \times 10^{-34}$J.s
Electron charge	$e = 1.6 \times 10^{-19}$ C
1 electron volt	1eV = 1.6×10^{-19} J
Speed of electromagnetic wave	c = 3×10^{8} ms^{-1}
Energy equivalent of	1u = 931 MeV
Mass of an electron	$M_e = 9.1 \times 10^{-31}$ kg
Absolute magnetic permeability	$\mu_0 = 4\pi \times 10^{-7}$ SI unit