MODEL EXAMINATION (2020-'21)

PHYSICS (THEORY-042)

CLASS – XII **Marks: 70**
Time:3hours

General Instructions.

(1) All questions are compulsory. There are 33 questions in all.

(2) This question paper has five sections: Section A, Section B, Section C, Section D and Section E.

(3) Section A contains ten very short answer questions and four assertion reasoning MCQs of 1 mark each, Section B has two case based questions of 4 marks each, Section C contains nine short answer questions of 2 marks each, Section D contains five short answer questions of 3 marks each and Section E contains three long answer questions of 5 marks each.

(4) There is no overall choice. However internal choice is provided. You have to attempt only one of the choices in such questions.

$c = 3 \times 10^8$ m/s

$h = 6.63 \times 10^{-34}$ Js

$e = 1.6 \times 10^{-19}$ C

$\mu_0 = 4\pi \times 10^{-7}$ TmA^{-1}

$\varepsilon_0 = 8.854 \times 10^{-12}$ C^{2}N^{-1}m^{-2}

$\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9$ N m^2 C^{-2}

$m_e = 9.1 \times 10^{-31}$ kg

mass of neutron = 1.675×10^{-27} kg

mass of proton = 1.673×10^{-27} kg

Avogadro's number = 6.023×10^{23} per gram mole

Boltzmann constant = 1.38×10^{-23} JK^{-1}

Section – A

All questions are compulsory. In case of internal choices, attempt any one of them.

1 What is the electrostatic potential due to an electric dipole at an equatorial point? 1

Or

The plates of charged capacitor are connected to a voltmeter. What happens to its reading, if the plates of the capacitor are separated farther?

2 In Gauss's law $\varepsilon_0 \oint \vec{E}.d\vec{s} = q_{enclosed}$, is $\vec{E}$ only due to charges enclosed? 1

3 The instant at which a bulb is switched on, the power is maximum, then it decreases to a steady value. Explain 1

Or

Show on a graph the variation of resistivity with temperature for a typical semiconductor.

4 The instantaneous current from an AC source is I= $6\sqrt{2}\sin 314t$. What is the rms value of current? 1

Or

How much power is consumed in i) pure inductor ii) pure capacitor when connected to AC source?

5 Name the physical quantity which has same dimension as that of the plank's constant. 1

6 What is the impact parameter for scattering of an alpha particle by 180^0? 1

7 Does the change in magnetic flux induce current or emf? 1

Or

An electric heater is heated in turn with DC and AC keeping the potential difference across the ends of the heater same. In which case will the rate of heat production be more?

8 A fish under water is viewing obliquely a fisher man, standing on the bank of a river. For the fish, does the man look taller or shorter than what actually he is? 1

9 The refractive index of air with respect to the glass is 2/3. The refractive index of diamond with respect to air is 12/5. Find the refractive index of glass with respect to diamond. 1

10 What is the value of potential barrier of p-n junction made of silicon semiconductor? 1

For question numbers 11, 12, 13 and 14, two statements are given-one labeled Assertion (A) and the other labeled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.

a) Both A and R are true and R is the correct explanation of A

b) Both A and R are true but R is NOT the correct explanation of A
c) A is true but R is false
d) A is false and R is also false

11 **Assertion(A):** For a given potential function, electric intensity function can be uniquely derived. 1
Reason(R): For a given electric intensity function, electric potential function can be uniquely derived.

12 **Assertion(A):** Faraday's law is an experimental law. 1
Reason(R): The varying magnetic field cannot generate induced emf.

13 **Assertion(A):** The chief characteristic of series resonant circuit is voltage magnification. 1
Reason(R): At resonance the voltage drop across inductance (or capacitance) is Q times the applied voltage.

14 **Assertion (A):** Speed of light in still water is not same as that in flowing water. 1
Reason(R): The speed of light in water is not independent of the relative motion between observer and the medium

Section – B

Questions 15 and 16 are Case Study based questions and are compulsory. Attempt any 4 sub parts from each question. Each question carries 1 mark.

15 A piece of pure semiconductor of silicon of size 1cmx1cmx1mm is having $5x10^{28}$ number of atoms per cubic metre. It is doped simultaneously with $5x10^{22}$ atoms per m^3 of arsenic and $5x10^2m^3$ atoms of indium. The number density of intrinsic current carrier (electrons and holes) in the pure silicon semiconductor is $1.5x10^{16}m^{-3}$. Mobility of electrons is $3800cm^2V^{-1}s^{-1}$ 4

1) The number of electron in this semiconductor are
   (a) $5x10^{15}$ (b) $4.95x10^{15}$
   (b) (c) $4.95x10^{22}$ (d) $25x10^{22}$

2) The number of holes in the semiconductor are
   (a)$5x10^{20}$ (b) $4.54x10^{13}$
   (c) $4.54x10^9$ (d) 4.5410^2

3) Total number of current carriers in this semiconductor are
   (a) $5x10^{15}$ (b) $5.05x10^{22}$
   (c) $4.95x10^{15}$ (d) $4.95x10^{22}$

4) The conductivity of doped semiconductor(in Sm-1) is
   (a) $2x10^3$ (b) $3x10^3$
   (c)$4x10^3$ (d) $1x10^3$

5) Ratio of conductivity of doped silicon and pure silicon semiconductor is

(a)2.2×10^{6} (b)3.3×10^{6}
(c)2.2×10^{8} (d) 3.3×10^{8}

16 The electromagnetic waves were produced experimentally by Hertz in 1888 using hertz oscillator, which were of wavelength 6m. Jagdish Chander Bose in 1895 graduated these waves which were of wavelength 5mm to 25mm and in 1896 G. Margoni established a wireless communication between two stations 50 km apart using electromagnetic wave, the amplitude of electric field is 10V/m. The frequency of wave is 5×10^{14} Hz. The wave is propagating along Z-axis 4

1) If $\mu_0, \mu_r, \varepsilon_0, and \varepsilon_r$ are the absolute permeability, relative permeability, absolute permittivity and relative permittivity of the medium then the velocity of electromagnetic wave in a medium is

(a) $\frac{1}{\sqrt{\mu_0\varepsilon_0}}$ (b) $\frac{1}{\sqrt{\mu_r\varepsilon_r}}$

(c) $\frac{1}{\sqrt{\mu_0\varepsilon_0\mu_r\varepsilon_r}}$ (d) $\sqrt{\frac{\mu_r\varepsilon_r}{\mu_0\varepsilon_0}}$

2) In electromagnetic wave, the average energy density due to magnetic field is
(a)$8.85\times10^{-10}Jm^{-3}$ (b)$4.42\times10^{-10}Jm^{-3}$
(c)$2.21\times10^{-10}Jm^{-3}$ (d)$6.63\times10^{-10}Jm^{-3}$

3) In electromagnetic wave, the total average energy density is
(a)$8.85\times10^{-10}Jm^{-3}$ (b)$4.42\times10^{-10}Jm^{-3}$
(c)$2.21\times10^{-10}Jm^{-3}$ (d)$6.63\times10^{-10}Jm^{-3}$

4) Sun sends electromagnetic waves to earth. Which one of the electromagnetic wave out of the visible portion, from sun will be reaching the surface of earth earlier than others?
(a) violet waves (b)green waves
(b) (c)yellow waves (d) red waves

5) An electromagnetic wave propagating along north has its electric field vector upwards. Its magnetic field vector points towards
(a) north (b)east
(c) west (d)down wards

Section – C

All questions are compulsory. In case of internal choices, attempt anyone.

17 Two opposite charges each of magnitude 2μC are 1cm apart. Find an electric field at a distance of 5cm from the mid-point on axial line of the dipole. Also find the field on equatorial line at the same distance from mid-point. 2

18 The horizontal component and vertical components of Earth's magnetic field at a place are 0.15 G and 0.26 G respectively. Calculate the angle of dip and resultant magnetic field. 2

19 Derive an expression for the torque experienced by an electric dipole kept in a uniform electric field. 2

OR

Plot a graph showing the variation of coulomb force (F) versus ($\frac{1}{r^2}$), where r is the distance between the two charges of each pair of charges: (1μC, 2μC) and (2μC, – 3μC). Interpret the graphs obtained.

20 Deduce an expression for the magnetic dipole moment orbiting around the central nucleus. 2

21 A circular copper disc of radius 0.1m rotates at 20π rad/s about an axis perpendicular to the disc through it centre. A uniform magnetic field 0.2T acts perpendicular to the disc. Calculate 2

i) The p.d between axis and the rim.

ii) Induced current in the circuit if the resistance of the circuit is 2 ohm.

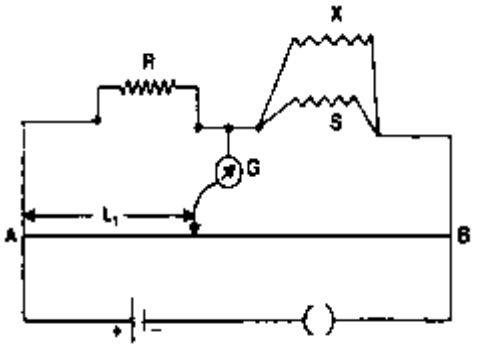
22 Show that the mean value of AC in a complete cycle is zero. 2

23 Draw a neat circuit diagram of potentiometer to compare the emf's of two cells and find the relevant expression. 2

OR

In a meter bridge, balance point is found at a distance l_1 with resistances R and S as shown in the figure.

When an unknown resistance X is connected in parallel with the resistance S, the balance point shifts to a distance l_2. Find the expression for X in terms of l_1 l_2 and S.



24 Distinguish between an intrinsic semiconductor and p-type semiconductor. 2

OR

Draw a circuit diagram for full wave rectifier using PN junction diodes. Explain its principle of working and the wave form of input and output voltages.

25 Calculate the velocity of electron in Bohr's 1st orbit of Hydrogen atom. How many times does the electron go in the 1st orbit in second? 2

Section –D

All questions are compulsory. In case of internal choices, attempt any one.

26 Net capacitance of three identical capacitors in series is 3 pF. What will be their net capacitance if connected in parallel? 3

Find the ratio of energy stored in the two configurations if they are both connected to the same source.

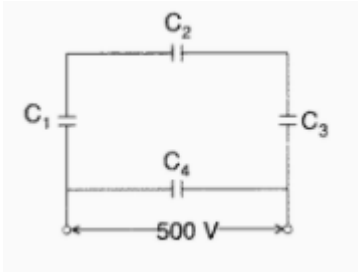
OR

A network of four capacitors each of 12μF capacitance is connected to a 500 V supply as shown in the figure.

Determine

(a) equivalent capacitance of the network and

(b) charge on each capacitor.



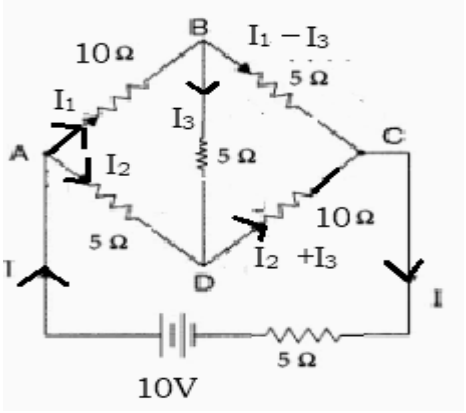
27 a) Draw a graph showing the variation potential energy of a pair of nucleons as a function of their separation. Indicate the region in which nuclear force is 3

i) attractive

ii) repulsive.

b) Write two characteristic features of nuclear force which distinguish it from the coulomb force.

28 Use Kirchhoff's rules to determine the value of the current I_1, I_2 and I_3 flowing in the circuit shown in the figure. 3



29 How is a wave front defined? Using Huygen's construction draw a figure showing the propagation of a plane wave refracting at a plane surface separating two media. Hence verify Snell's law of refraction. 3

30 (a) In Young's double slit experiment, the two slits are illuminated by two different lamps having same wavelength of light. Explain with reason, whether interference pattern will be observed on the screen or not. 3
(b) Light waves from two coherent sources arrive at two points on a screen with path differences of 0 and A/2. Find the ratio of intensities at the points.

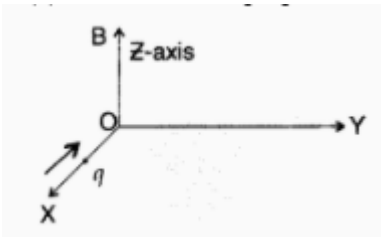
OR

(a) In a single slit diffraction experiment, a slit of width 'd' is illuminated by red light of wavelength 650 nm. For what value of 'd' will
(i) the first minimum fall at an angle of diffraction of 30°, and
(ii) the first maximum fall at an angle of diffraction of 30°?
(b) Why does the intensity of the secondary maximum become less as compared to the central maximum?

Section – E

All questions are compulsory. In case of internal choices, attempt any one.

31 a) Using Ampere's circuital law obtain an expression for the magnetic field along the axis of a current carrying solenoid of length l and having N number of turns. 5
b) A charge 'q' moving B along the X-axis with a velocity v is subjected to a uniform magnetic field B acting along the Z-axis as it crosses the origin O.
(i)Trace its trajectory.
(ii) Does the charge gain kinetic energy as it enters the magnetic field? Justify your answer.

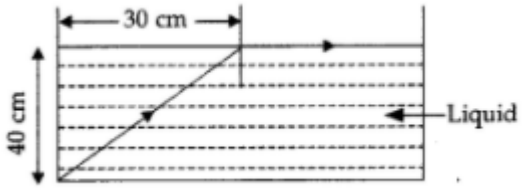


OR

(a) Draw a schematic sketch of a moving coil galvanometer and describe briefly its working.
(b) "Increasing the current sensitivity of a galvanometer does not necessarily increase the voltage sensitivity." Justify this statement.

32 a) Draw a ray diagram to show refraction of a ray of monochromatic light passing through a glass prism. 5
Deduce the expression for the refractive index of glass in terms of angle of prism and angle of minimum deviation.

b) In the following ray diagram, calculate the speed of light in the liquid of unknown refractive index.



OR

a) Draw a ray diagram to show the formation of the image of an object placed on the axis of a convex refracting surface, of radius of curvature 'R', separating the two media of refractive indices "n_1 and 'n_2' ($n_2 > n_1$). Use this diagram to deduce the relation $\frac{n_2}{v} - \frac{n_1}{u} = \frac{n_2 - n_1}{R}$, where u and v represent respectively the distance of the object and the image formed.

b) A convex lens of focal length 30 cm is placed coaxially in contact with a concave lens of focal length 40 cm. Determine the power of the combination. Will the system be converging or diverging in nature?

33 Define the terms 5

(i)cut-off voltage and

(ii) 'threshold frequency' in relation to the phenomenon of photoelectric effect.

Using Einstein's photoelectric equation, show how the cut-off voltage and threshold frequency for a given photosensitive material can be determined with the help of a suitable plot/graph.

(iii) Plot a graph showing the variation of photoelectric current as a function of anode potential for two light beams having the same frequency but different intensities I_1 and I_2 ($I_1 > I_2$).

OR

(a) Describe briefly three experimentally observed features in the phenomenon of photoelectric effect.

(b) Discuss briefly how wave theory of light cannot explain these features.