PRE-BOARD / XII / PHYSICS / 2020-21

TIME: 3 Hrs. **MM: 70**

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 one 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 choices have been provided. You have to attempt only one of the choices in such questions.

SECTION A

Q1 A lens behaves as a converging lens in air and a diverging lens in water ($\mu = 4/3$). What will be the condition on the value of refractive index (μ) of the material of the lens? **1**

Q2 How are X-rays produced? **1**

OR

The relative electric permittivity of a medium is 9 and the relative permeability is close to unity. What is the speed of EMW in the medium?

Q3 An ammeter and a milliammeter are converted from the same galvanometer. Out of the two, which current measuring instrument has higher resistance? **1**

Q4 Define gyromagnetic ratio. **1**

OR

The susceptibility of a magnetic material is 1.9×10^{-5}. Name the type of magnetic materials it represents.

Q5 What is the distance of closest approach? **1**

Q6 Ultraviolet radiations of different frequencies v_1 and v_2 are incident on two photosensitive materials having work functions W_1 and W_2 ($W_1 > W_2$) respectively. The kinetic energy of the emitted electrons is same in both the cases. Which one of the two radiations will be of higher frequency? **1**

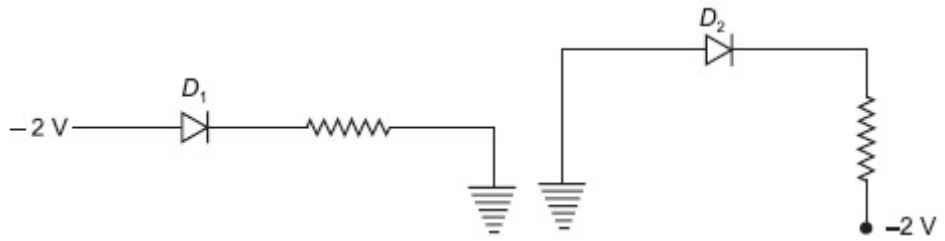
Q7 Two nuclei have mass numbers in the ratio 27 : 125. What is the ratio of their nuclear radii? **1**

Q8 State the reason, why GaAs is most commonly used in making of a solar cell. **1**

OR

What do you understand by a dynamic resistance of *p*-*n* junction diode?

Q9 Which one of the two diodes D_1 and D_2 in the given figures (i) forward biased, (ii) reverse biased ? **1**



Q10 Draw energy band diagram for an intrinsic semiconductor at $T > 0$ K. **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

Q11 **Assertion:** When an uncharged capacitor of capacitance C is charged by a cell of emf V, the energy stored by capacitor is $\frac{1}{2}CV^2$ and energy supplied by the battery is CV^2 **1**

Reason: In charging an uncharged capacitor, energy is lost in form of heat.

(A) A (B) B (C) C (D) D

Q12 **Assertion:** In a uniform electric field, equipotential surfaces must be plane surface. **1**

Reason: Electrons move from a region of lower potential to a region of higher potential if electrons start from rest

(A) A (B) B (C) C (D) D

Q13 **Assertion:** A lens has two principal focal lengths which may differ. **1**

Reason: Light can fall on either surface of the lens. Two principal focal lengths differ when medium on the two sides have different refractive indices.

(A) A (B) B (C) C (D) D

Q14 **Assertion**: Image formed by concave lens is not always virtual. **1**

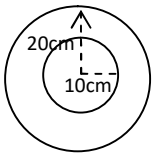
Reason: Image formed by a lens is real if the image is formed in the direction of the ray of light with respect to the lens.

(A) A (B) B (C) C (D) D

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.

Q15 We have an isolated conducting spherical shell of radius 10 cm. Some positive charge is given to it so that the resulting electric field has a maximum intensity of 1.8×10^{6} N/C. The same amount of negative charge is given to another isolated conducting spherical shell of radius 20 cm. Now, the first shell is placed inside the second so that both are concentric as shown in the figure **4**



(i) The electric potential at any point inside the first shell is:

(A) $18\times10^{4}V$ (B) $9\times10^{4}V$ (C) $4.5\times10^{4}V$ (D) $1.8\times10^{4}V$

(ii) The electric field intensity just inside the outer sphere is:

(A) $4.5\times10^{5}\,N/C$ (B) $9\times10^{5}\,N/C$

(C) $4.5\times10^{4}\,N/C$ (D) $5\times10^{4}\,N/C$

(iii) The electrostatic energy stored in the system is:

(A) 1.0 J (B) 0.045J (C) 0.09 J (D) 1.8 J

(iv) If both the spheres are connected by a conducting wire, then

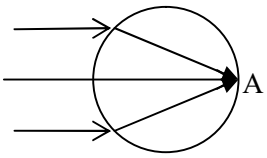
(A) Nothing will happen

(B) Some part of the energy stored in the system will convert in to heat

(C) Charge on both spheres will be positive

(D) Entire amount of the energy stored in the system will convert in to heat

Q16 A parallel beam of light falls on a solid transparent sphere. **4**



(i) Which is correct?
(A) If the beam is thick, then whole beam can be focussed at A.
(B) The whole beam can be focussed at A only if the beam is thin enough
(C) if the beam is thin, then beam can not be focused
(D) None of these

(ii) If however thin beam is focused at A, then the refractive index of the material of sphere is

(A) 1.5 (B) 1.7 (C) 2.0 (D) 2.5

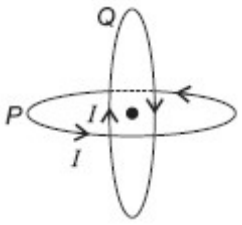
(iii) For what value of refractive index μ, the thin beam can be focused at the center of the sphere

(A) 1.5 (B) 2 (C) 2.5 (D) none of these

SECTION – C

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

Q17 Two identical circular wires P and Q each of radius R and carrying current I are kept in perpendicular planes such that they have a common centre as shown in the figure. Find the magnitude and direction of the net magnetic field at the common centre of the two coils. **2**

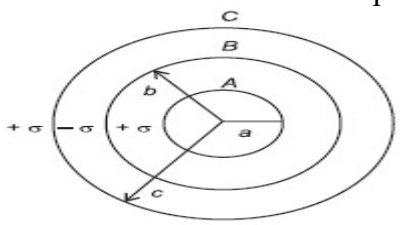


Q18 Show that a convex lens produces an N times magnified image when the object distances, from the lens, have magnitudes $\left(f \pm \frac{f}{N} \right)$ where f is the magnitude of the focal length of the lens. Hence find the two values of object distance, for which a convex lens, of power 2.5 D, will produce an image that is four times as large as the object? **2**

OR

Draw a ray diagram showing the image formation of a distant object by a refracting telescope. Define its magnifying power and write the two important factors considered to increase the magnifying power. Describe briefly the two main limitations and explain

Q19 Three concentric metallic shells *A*, *B* and *C* of radii *a*, *b* and *c* ($a < b < c$) have surface charge densities + σ, – σ and + σ respectively as shown in the figure. If shells *A* and *C* are at the same potential, then obtain the relation between the radii *a*, *b*, *c*. **2**



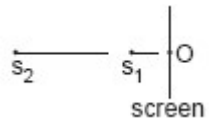
OR

Two metal spheres A and B of radius r and $2r$, whose centers are separated by a distance of $6r$, are given charge Q each and are at potential V_1 and V_2. Find the ratio of V_1/V_2. These spheres are connected to each other with the help of a connecting wire keeping the separation unchanged, what is the amount of charge that will flow through the wire?

Q20 Mention the important considerations required while fabricating a p–n junction diode to be used as a light emitting diode (LED). What should be the order of band gap of an LED, if it is required to emit light in the visible range? **2**

Q21 Calculate self-inductance for a long solenoid of length l, number of turns N and radius r. **2**

Q22 If two sources slits S_1 and S_2 placed at a distance λ apart are producing red colour of light of wavelength λ and intensity I_0. **2**



(a) What will be the colour and intensity at the centre O of the screen?

(b) If the distance between these two is increased to $\frac{3\lambda}{2}$ then find the answer for part a.

Q23 Explain how a solar cell is fabricated. What are the basic processes involved in the generation of emf by a solar cell? **2**

Q24 State the principle of working of a galvanometer. **2**
A galvanometer of resistance G is converted into a voltmeter to measure upto V volts by connecting a resistance R_1 in series with the coil. If a resistance R_2 is connected in series with it, then it can measure upto $V/2$ volts. Find the resistance, in terms of R_1 and R_2, required to be connected to convert it into a voltmeter that can read upto 2 V. Also find the resistance G of the galvanometer in terms of R_1 and R_2.

OR

Two long straight parallel conductors carry steady currents I_1 and I_2 separated by a distance d. If the currents are flowing in the same direction, show how the magnetic field set up in one produce an attractive force on the other. Obtain the expression for this force. Hence define one ampere.

Q25 How is the focal length of a spherical mirror affected when it is immersed in glycerin? **2**

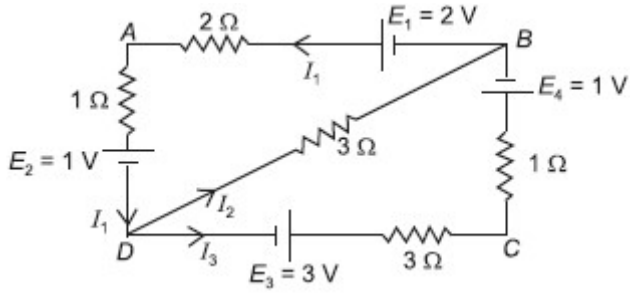
A convex lens has 15 cm focal length in air. What is its focal length in water? (Refractive index of air-water = 1.33, refractive index of air-glass = 1.5)

SECTION – D

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

Q26 The currents flowing in the two coils of self-inductance L_1 = 16 mH and L_2 = 12 mH are increasing at the same rate. If the power supplied to the two coils are equal, find the ratio of (i) induced voltages, (ii) the currents and (iii) the energies stored in the two coils at a given instant. **3**

Q27 In the given network, find the values of the currents, I_1, I_2 and I_3. **3**



OR

The length of a potentiometer wire is 600 cm and it carries a current of 40 mA. For a cell of emf 2 V and internal resistance 10 Ω, the null point is found to be at 500 cm. If a voltmeter is connected across the cell, the balancing length is decreased by 10 cm. Find (i) the resistance of whole wire, (ii) reading of voltmeter, and (iii) resistance of voltmeter

Q28 Write Einstein's photoelectric equation and point out any two characteristic properties of photons on which this equation is based. **3**
Briefly explain the three observed features which can be explained by this equation.

OR

Why are de Broglie waves associated with a moving football not visible? The wavelength, λ, of a photon and the de Broglie wavelength of an electron have the same value. Show that the energy of the photon is $\frac{2\lambda mc}{h}$ times the kinetic energy of the electron, where m, c, and h have their usual meanings.

Q29 Write Bohar's postulate and obtain the expression for the total energy of the electron in the stationary states of the hydrogen atom. Hence draw the energy level diagram showing how the line spectra corresponding to Balmer series occur due to transition between energy levels. **3**

Q30 (a) Draw the plot of binding energy per nucleon (BE/A) as a function of mass number A. Write two important conclusions that can be drawn regarding the nature of nuclear force. **3**
(b) Use this graph to explain the release of energy in both the processes of nuclear fusion and fission.

SECTION – E

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

Q31 Derive the expression for the energy stored in a parallel plate capacitor of capacitance C with air as medium between its plates having charges Q and $\frac{1}{2}\varepsilon_0 E^2 Ad$, where A is the area of each plate, E is electric field intensity and d is the separation between the plates. **5**

How will the energy stored in a fully charged capacitor change when the separation between the plates is doubled and a dielectric medium of dielectric constant 4 is introduced between the plates?

OR

(a) Define electric flux. Write its SI units.

(b) Using Gauss's law, prove that the electric field at a point due to a uniformly charged infinite plane sheet is independent of the distance from it. How is the field directed if (i) the sheet is positively charged, (ii) negatively charged?

Derive an expression for the electric field between two uniformly charged large parallel sheets with surface charge densities σ and – σ respectively

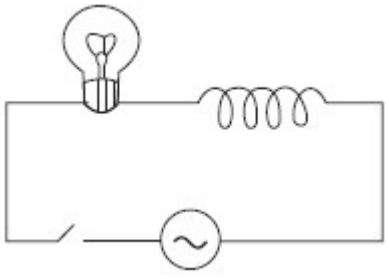
Q32 (a) An a.c. source of voltage $V = V_m \sin \omega t$ is connected to a series combination of L, C and R. Use the phasor diagram to obtain expressions for impedance of the circuit and phase angle between voltage and current. Find the condition when current will be in phase with the voltage. What is the circuit in this condition called? **5**

(b) In a series LR circuit $X_L = R$ and power factor of the circuit is P_1. When capacitor with capacitance C such that $X_L = X_C$ is put in series the power factor becomes P_2. Calculate P_1 / P_2.

OR

Explain the term 'inductive reactance'. Show graphically the variation of inductive reactance with frequency of the applied alternating voltage. An ac voltage $E = E_m \sin \omega t$ is applied across a pure inductor of inductance L. Show mathematically that the current flowing through it lags behind the applied voltage by a phase angle of $\pi / 2$

A light bulb and an open coil inductor are connected to an ac source through a key as shown in the figure.



The switch is closed and after sometime, an iron rod is inserted into the interior of the inductor. The glow of the light bulb (a) increases; (b) decreases;
(c) is unchanged, as the iron rod is inserted. Give your answer with reason. What will be your answer if ac source is replaced by a dc source?

Q33 In Young's double slit experiment, deduce the conditions for obtaining constructive and destructive interference fringes. Hence deduce the expression for the fringe width. Show that the fringe pattern on the screen is actually a superposition of single slit diffraction from each slit. **5**

What should be the width of each slit to obtain 10 maxima of the double slit pattern within the central maximum of the single slit pattern, for green light of wavelength 500 nm, if the separation between two slits is 1 mm?

OR

Using Huygens's construction of secondary wavelets explain how a diffraction pattern is obtained on a screen due to a narrow slit of width d (or a) on which a monochromatic beam of light is incident normally.
Show that the angular width of the first diffraction fringe is half that of the central fringe.

Explain why the maxima at $\theta_n = (2n+1)\frac{\lambda}{2d}$ become weaker and weaker with increasing n.