CLASS : XII

SESSION: 2023-24

SAMPLE QUESTION PAPER NO. 5

SUBJECT: PHYSICS (THEORY)

Maximum Marks: 70 Time Allowed: 3 hours.

General Instructions:

(1) There are 33 questions in all. All questions are compulsory.
(2) This question paper has five sections: **Section A, Section B, Section C, Section D and Section E.**
(3) All the sections are compulsory.
(4) Section A contains sixteen questions, twelve MCQ and four Assertion Reasoning based of 1 mark each, Section B contains five questions of two marks each, Section C contains seven questions of three marks each, Section D contains two case study based questions of four marks each and Section E contains three long answer questions of five marks each.
(5) There is no overall choice. However, an internal choice has been provided in one question in Section B, one question in Section C, one question in each CBQ in Section D and all three questions in Section E. You have to attempt only one of the choices in such questions.
(6) Use of calculators is not allowed.
(7) You may use the following values of physical constants where ever necessary
i. c = 3 x 108 m/s
ii. m_e = 9.1 x10-31 kg
iii. e = 1.6 x 10-19 C
iv. μ_0 = 4π x 10-7 Tm$\boldsymbol{A^{-1}}$
v. h = 6.63 x10-34 Js
vi. ε0 = 8.854 x10-12 $\boldsymbol{C^2N^{-1}m^{-2}}$
vii. Avogadro's number = 6.023 X $\boldsymbol{1023}$ per gram mole

SECTION-A

1. Equipotential surfaces associated with an electric field ,which is increasing in in magnitude along the X – direction , are
   (a)planes parallel to XY -plane
   (b)planes parallel to YZ -plane
   (c)planes parallel to XZ -plane
   (d)coaxial cylinders of increasing radii around the X- axis.

2. Electric field intensity due to a short dipole remains directly proportional to (r is the distance of a point from centre of dipole)
   (a)r^{2}
   (b)r^{3}
   (c)r^{-2}
   (d)r^{-3}

3. A metallic plate exposed to white light emits electrons. For which of the following colours of light, the stopping potential will be minimum?
   (a) Blue

(b) Yellow
(c) Red
(d) Violet

4. In terms of Bohr radius r_0, the radius of the second Bohr orbit of a hydrogen atom is given by
(a) $4\ r_0$
(b) $8\ r_0$
(c) $\sqrt{2}\ r_0$
(d) $2\ r_0$

5. Two long conductors separated by a distance d carry currents I_1 and I_2 in the same direction. They exert a force of F on each other. Now the current in one of them is increased to two times and its direction is reversed. The distance is also increased to 3d . The new value of force between them is
(a) -2F
(b)F/3
(c) -2F/3
(d) –F/3

6. The net magnetic moment of an atom of a diamagnetic material is
(a) greater than 1
(b) less than 1 but greater than zero
(c) less than zero but greater than –1
(d) zero

7. The current sensitivity of a galvanometer increases by 20%. If its resistance also increases by 25%, the voltage sensitivity will
(a) decrease by 1%
(b) increase by 5%
(c) increase by 10%
(d) decrease by 4%

8. The ratio of the energies of the hydrogen atom in its first to second excited state is :
(a) 14
(b) 4/9
(c) 9/4
(d) 4.

9. In the case of an inductor
(a) voltage lags the current by π/2
(b) voltage leads the current by π/2
(c) voltage leads the current by π/3
(d) voltage leads the current by π/4

10. If E and B denote electric and magnetic fields respectively, which of the following is dimensionless?

(a) $\sqrt{\mu_0 \varepsilon_0}\ \frac{E}{B}$ (b) $\mu_0 \varepsilon_0\ \frac{E}{B}$

(c) $\mu_0 \varepsilon_0 \left(\frac{B}{E}\right)^2$ (d) $\frac{E}{\varepsilon_0}\frac{\mu_0}{B}$

11. Lenz's law is a consequence of the law of conservation of

(a) charge
(b) energy
(c) induced emf
(d) induced current

12. In Bohr model of hydrogen atom, let P.E. represents potential energy and T.E. represents the total energy. In going to a higher level.

(a) P. E. decreases, T.E. increases
(b) P. E. increases, T.E. decreases
(c) P. E. decreases, T.E. decreases
(d) P. E. increases, T.E. increases

For Questions 13 to 16, two statements are given –one labelled Assertion (A) and other labelled Reason (R). Select the correct answer to these questions from the options as given below.

a) If both Assertion and Reason are true and Reason is correct explanation of Assertion.
b) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.
c) If Assertion is true but Reason is false.
d) If both Assertion and Reason are false.

13. Assertion(A): No work is done in moving a test charge from one point to another over an equipotential surface.
Reason(R): Electric field is always normal to the equipotential surface at every point

14. Assertion : A pure semiconductor has negative temperature coefficient of resistance.
Reason : In a semiconductor on raising the temperature, more charge carriers are released, conductance increases and resistance decreases.

15. Assertion :Light of frequency 1.5 times the threshold frequency is incident on photosensitive material.If the frequency is halved and intensity is doubled the photo current remains unchanged.
Reason.The photo electric current varies directly with the intensity of light and frequency of light.

16. Assertion : The frequencies of incident, reflected and refracted beam of monochromatic light incident from one medium to another are same
Reason : The incident, reflected and refracted rays are coplanar.

SECTION B

17. Draw V-I characteristics of a p-n junction diode in
(a) forward bias,
(b) reverse bias.

18. A proton and an electron have same kinetic energy. Which one has greater de-Broglie wavelength and why?

19. For the same value of angle of incidence, the angles of refraction in three media A, B and C are 15°, 25° and 35° respectively. In which medium would the velocity of light be minimum?

20. (i) Show on a graph the variation of resistivity with temperature for a typical semiconductor .

(ii) Two wires of equal length, one of copper and the other of manganin have the same resistance. Which wire is thicker?

21. (i) If the wavelength of light incident on a convex lens is increased, how will its focal length change?

(ii) How does the angle of minimum deviation of a glass prism vary, if the incident violet light is replaced by red light? Give reason.

OR

(i) Draw a ray diagram for a convex minor showing the image formation of an object placed anywhere in front of the mirror.

(ii) Use this ray diagram to obtain the expression for its linear magnification produced by the mirror.

SECTION C

22. (a)Define the term 'mass defect' of a nucleus. (b)How is it related with its binding energy?
(ii) Determine the Q-value of the following reaction:

$$_1^1H + _1^3H \longrightarrow _1^2H + _1^2H$$

Given $m(_1^2H) = 2.014102\ u$, $m(_1^3H) = 3.016049\ u$,

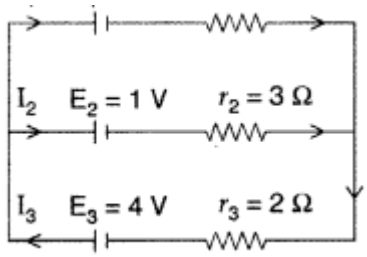
$m(_1^1H) = 1.00783\ u$,

$1u = 931.5\ MeV/c^2$

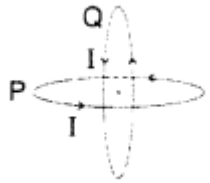
23. Two point charges 20 x 10-6 C and -4 X 10-6 C are separated by a distance of 50 cm in air.
(i) Find the point on the line joining the charges, where the electric potential is zero.
(ii) Also find the electrostatic potential energy of the system.

24. In hydrogen atom, an electron undergoes transition from 3rd excited state to the first excited state and then to the ground state. Identify the spectral series to which these transitions belong.
(ii) Find out the ratio of the wavelengths of the emitted radiations in the two cases.

25. State Kirchhoff's rules. Use these rules to write the expressions for the current I_1 I_2 and I_3 in the circuit diagram shown.



26. 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.



27. (a) How are radio waves produced?

(b) Welders wear special goggles or face masks with glass windows to protect their eyes from electromagnetic radiations. Name the radiations and write the range of their frequency.

(c) Why are microwaves considered suitable for radar systems used in aircraft navigation?

28. Define mutual inductance between a pair of coils. Derive an expression for the mutual inductance of two long coaxial solenoids of same length wound one over the other.

OR

(a)Write the expression for Lorentz magnetic force on a particle of charge 'q' moving with velocity $\vec{v}$ in a magnetic field $\vec{B}$. Show that no work is done by this force on the charged particle.

(b) An ammeter of resistance 0.80 Ω can measure current upto 1.0 A. What must be the value of shunt resistance to enable the ammeter to measure current upto 5.0A?

SECTION D

29. When p side of p-n junction is connected to positive terminal of battery and n side of p-n junction is connected to negative terminal of battery then the p-n junction is said to be in forward bias mode or forward biased. And When p side of p-n junction is connected to negative terminal of battery and n side of p-n junction is connected to positive terminal of battery then the p-n junction is said to be in reverse bias mode or reverse biased. The diode used to rectify an AC voltage is called as rectifier. Zener diode is also a p-n junction diode which works in reverse bias condition and used as voltage regulator. Also, p-n junction diodes are used in solar cells which is used to convert light energy into electrical energy. Light emitting diodes are also p-n junction diodes which are used to produce light.

(i)The rectifier in which the rectified output is only for half of the input AC wave is called as___

a) full wave rectifier

b) half wave rectifier

c) transformer

d) transducer

(ii) In case of p-type semiconductors___

a) $n_h << n_e$

b) $n_h = n_e$

c) $n_h >> n_e$

d) $n_h = n_e = 0$

(iii) Reverse bias applied to a junction diode
(a) increases the minority carrier current
(b) lowers the potential barrier
(c) raises the potential barrier
(d) increases the majority carrier current

(iv)The diffusion current in a p-n junction is from the
(a) n-side to the p-side
(b) p-side to the n-side
(c) n-side to the p-side if the junction is forward-biased
and in the opposite direction if it is reverse-biased
(d) p-side to the n-side if the junction is forward-biased
and in the opposite direction if it is reverse-biased

30. As we know that, when light ray travels from one medium to another changes its direction of path due to the change in optical density of the medium. We know that, when a ray of light travels from denser medium to rarer medium then it get bended away from the normal. If we increase the angle of incidence slowly then angle of refraction also get increased and at one stage the angle of refraction is 90° for some angle of incidence. And further if we increase the angle of incidence then there will be no refraction of light and the ray will be totally internally get reflected. Such phenomenon of reflection of light is called as total internal reflection of light. And the angle of incidence in denser medium for which the angle of refraction in rarer medium is 90°, that angle of incidence is called as critical angle. So we define total internal reflection as, if the angle of incidence exceeds the critical angle then the total light get internally reflected.

(i)As the refractive index of the medium increases the corresponding value of critical angle for that medium ____

a) decreases

b) increases

c) remains same

d) independent of refractive index of the medium

(ii)Critical angle for glass air interface,where refractive index ,μ for glass is 3/2 is
(a)41.8^O
(b)60^O
(c)30^O

(d)15^{O}

(iii)Which of the following is not due to total internal reflection?

(a)working of optical fibre

(b)difference between real depth and apparent depth of a pound.

(c)mirage on hot summer day

(d)brilliance of diamond.

(iv) Which of the following is a necessary condition for total internal reflection?

(a) The angle of incidence in the denser medium must be greater than the critical angle for the two media

(b) The angle of incidence in the rarer medium must be greater than the critical angle for the two media

(c) The angle of incidence in the denser medium must be lesser than the critical angle for the two media

(d) The angle of reflection in the denser medium must be greater than the critical angle for the two media

SECTION E

31. (a)(i)Draw a neat and labelled diagram of a compound microscope. Explain briefly its working .

(ii)Why must both the objective and the eyepiece of a compound microscope have short focal lengths?

(b)A convex lens made up of glass of refractive index 1.5 is dipped in a medium of refractive index 1.65.Will it behave as a converging or a diverging lens? What will be its focal length in the given medium?

OR

(a)(i)In Young's double slit experiment, monochromatic light of wavelength 630 nm illuminates the pair of slits and produces an interference pattern in which two consecutive bright fringes are separated by 8.1 mm. Another source of monochromatic light produces the interference pattern in which the two consecutive bright fringes are separated by 7.2 mm. Find the wavelength of light from the second source.

(ii) What is the effect on the interference fringes if the monochromatic source is replaced by a source of white light?

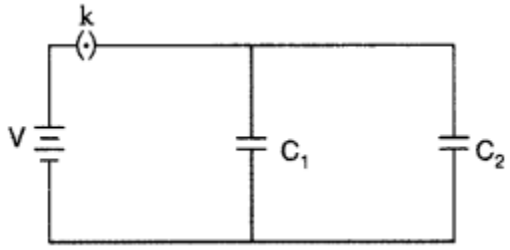
(b) State two points of difference between the interference pattern obtained in Young's double slit experiment and the diffraction pattern due to a single slit.

32. .(a)A parallel plate capacitor ,each with plate area A and separation d, is charged to potential difference V . The battery used to charge it remains connected .A dielectric slab of thickness d and dielectric constant k is now placed between plates .What changes ,if any ,will take place in:

(i)charge of plate?

(ii)electric field intensity between the plates?

(b) Two parallel plate capacitors of capacitances C_1 and C_2 such that $C_1 = (C_2)/2$ are connected across a battery of V volts as shown in the figure. Initially the key (k) is kept closed to fully charge the capacitors. The key is now thrown open and a dielectric slab of dielectric constant 'K' is inserted in the two capacitors to completely fill the gap between the plates.



Find the ratio of

(i) the net capacitance and

(ii) the energies stored in the combination, before and after the introduction of the dielectric slab.

OR

(a)A slab of material of dielectric constant K has the same area as that of the plates of a parallel plate capacitor but has the thickness d/2, where d is the separation between the plates. Find out the expression for its capacitance when the slab is inserted between the plates of the capacitor.

(b) A capacitor of unknown capacitance is connected across a battery of V volts. The charge stored in it is 300 μC. When potential across the capacitor is reduced by 100 V, the charge stored in it becomes 100 V. Calculate the potential V and the unknown capacitance.

33. (a)Explain briefly, with the help of a labelled diagram, the basic principle of the working of an a.c. generator.

(b)In an a.c. generator, coil of N turns and area A is rotated at v revolutions per second in a uniform magnetic field B. Deduce the expression for the emf produced.

(c)A 100-turn coil of area 0.1 m^2 rotates at half a revolution per second. It is placed in a magnetic field 0.01 T perpendicular to the axis of rotation of the coil. Calculate the maximum voltage generated in the coil.

OR

a) With the help of a labelled diagram, describe briefly the underlying principle and working of a step-up transformer.

(b) Write any two sources of energy loss in a transformer.

(c) A step up transformer converts a low input voltage into a high output voltage. Does it violate law of conservation of energy? Explain.