BUDHA DAL PUBLIC SCHOOL, PATIALA
Second Term Examination (6 December 2023)
Class XII (Science)
Subject - Physics
(Set - A)

Time: 3hrs **M.M. 70**

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 16 questions, 12 MCQ and 4 Assertion Reasoning based of 1 mark each, **Section B** contains 5 questions of two marks each, **Section C** contains 7 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) Use of calculators is not allowed.

i) $c = 3 \times 10^8$ m/s
ii) $me = 9.1 \times 10^{-31}$ kg
iii) $e = 1.6 \times 10^{-19}$ C
iv) $\mu 0 = 4\pi \times 10^{-7}$ Tm$A-1$
v) $h = 6.63 \times 10^{-34}$ Js
vi) $\varepsilon 0 = 8.854 \times 10^{-12}\ C^2\ N^{-1}\ m^{-2}$
Vii) Avogadro's number = 6.023×10^{23} per gram mole

Section - A

Q1. The focal length of the objective of a compound microscope is

a) greater than the focal length of eyepiece
b) lesser than the focal length of eyepiece
c) equal to the focal length of eyepiece
d) equal to the length of it tube

Q2. The potential energy of an electron in the second excited state in hydrogen atom is

a) - 3.4 eV b) - 3.02 eV c) $-1.51\ eV$ d) - 6.8 eV

Q3. The ratio of nuclear densities of two nuclei having mass number 64 and 125 is

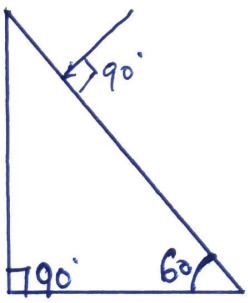
a) $\frac{64}{125}$ b) $\frac{4}{5}$ c) $\frac{5}{4}$ d) 1

Q4. During the formation of a p – n junction

a) diffusion current keeps increasing
b) drift current remains constant
c) both the diffusion and drift current remain constant
d) diffusion current remains almost constant but drift current increases till both currents becomes equal

Q5. Find the value of angle of emergence from the prism. Refractive index of the glass is $\sqrt{3}$.

a) 60^0
b) 30^0
c) 45^0
d) 90^0



Q6. In an interference experiment, third bright fringe is obtained at a point on the screen with a light of 700 nm. What should be the wavelength of the light source in order to obtain fifth fringe at the same point?

a) 420 nm b) 750 nm c) 630 nm d) 500 nm

Q7. A light of frequency v is incident on a metal surface whose work function is W_0. The kinetic energy of emitted electron is K. If the frequency of the incident light is doubled then kinetic energy of emitted electron will be

a) 2 K b) more than 2 K c) between K and 2 K d) less than K

Q8. Frequency of revolution of an electron revolving in nth orbit of H-atom is proportional to

a) Independent of n b) $\frac{1}{n^2}$ c) $\frac{1}{n^3}$ d) n

Q9. Which of the following statements is not correct according to Rutherford model?

a) most of the space inside an atom is empty
b) the electrons revolve around the nucleus under the influence of coulomb force acting on them
c) most part of the mass of the atom and it positive charge are concentrated at its centre
d) the stability of atom established by the model

Q10. Name the electromagnetic wave also known as 'heat waves'

a) Radio waves b) Microwaves c) X-rays d) Infrared rays

Q11. The difference in mass of ${}^{7}X$ nucleus and total mass of its constituent nucleons is 21.00 u. The binding energy per nucleon for this nucleus is equal to the energy equivalent of

a) 3 u b) 3.5 u c) 7 u d) 21 u

Q12. Two convex lenses of focal length f1 and f2 form images with magnification m1 and m2, when used individually for an object kept at the same distance from the lenses. Then $\frac{f_1}{f_2}$ is

a) $\frac{m_1(1-m_1)}{m_2(1-m_2)}$ b) $\frac{m_1(1-m_2)}{m_2(1-m_1)}$ c) $\frac{m_2(1-m_1)}{m_1(1-m_2)}$ d) $\frac{m_2(1-m_2)}{m_1(1-m_1)}$

In the following questions, a statement of Assertion (A) is followed by a statement of Reason (R). Mark the correct choice as:

a) **Both Assertion (A) and Reason (R) true and Reason (R) is the correct explanation of Assertion (A).**
b) **Both Assertion (A) and Reason (R) are true but Reason (R) is not a correct explanation of Assertion (A).**
c) **Assertion (A) is true but Reason (R) is false.**
d) **Assertion (A) is false and Reason (R) is also false.**

Q13. **Assertion (A) :** An electron has a higher potential energy when it is at a location associated with a negative value of potential and has a lower potential energy when at a location associated with a positive potential.

Reason (R) : Electrons move from a region of higher potential to a region of lower potential.

Q14. **Assertion (A) :** 1 amu (or 1 u) is equivalent to 931.5 MeV.

Reason (R) : Energy equivalent to mass m is $E = mc^2$

Q15. **Assertion (A) :** The electrical conductivity of a semiconductor increases on doping.

Reason (R) : Doping always increases the number of electrons in the semiconductor

Q16. **Assertion (A) :** The focal length of a lens for red colour is smaller than its focal length for violet colour.

Reason (R) : Because $\mu_r > \mu_v$

Section - B

Q17. Calculate the radius of curvature of an equiconcave lens of refractive index 1.5, when it is kept in a medium of refractive index 1.4, to have a power of - 5 D?

OR

Write two characteristics of image formed when an object is placed between the optical centre and focus of a thin convex lens. Draw the graph showing variation of image distance v with object distance u in this case.

Q18. Distinguish between P and N type of semiconductors on basis of energy band diagram.

Q19. In a single slit diffraction experiment, the width of the slit is increased. How will the (i) size and (ii) intensity of central bright band be affected? Justify your answer.

Q20. A proton and an α-particle have the same de-Broglie wavelength. Determine the ratio of their accelerating potential.

Q21. The ground state energy of hydrogen atom is - 13.6 eV. If an electron makes a transition from an energy level - 1.51 eV to - 3.4 eV, calculate the wavelength of the spectral line emitted and name the series of hydrogen spectrum to which it belongs.

OR

A heavy nucleus P of mass number 240 and binding energy 7.6 MeV per nucleon splits into two nuclei Q and R of mass numbers 110, 130 and binding energy per nucleon 8.5 MeV and 8.4 MeV, respectively. Calculate the energy released in the fission.

Section - C

Q22. What do you mean by wavefront of light? Using Huygen's principle verify the laws of reflection.

Q23. A card sheet divided into squares each of size 1 mm^2 is being viewed at a distance of 9cm through a magnifying glass (a converging lens of focal length 9 cm) held close to the eye.

a) What is the magnification produced by the lens? How much is the area of each square in the virtual image?

b) What is the angular magnification (magnifying power) of the lens?

Q24. Explain with a proper diagram how an ac signal can be converted into dc (pulsating) signal with output frequency as double than the input frequency using p-n junction diode. Give its input and output waveforms.

Q25. An electron and a proton, each have de Broglie wavelength of 1.00 mm.

a) Find the ratio of their momenta.

b) Compare the kinetic energy of the proton with that of the electron.

Q26. What is the effect on the interference fringes in Young's double slit experiment due to each of the following operations? Justify your answers.

a) The screen is moved away from the plane of the slits.

b) The separation between slits is increased.

c) The source slit is moved closer to the plane of double slit.

Q27. The maximum kinetic energy of the photoelectrons emitted is doubled when the wavelength of light incident of the photosensitive surface changes from λ_1 *and* λ_2. Deduce expression for the threshold wavelength and work function of metal surface in terms of λ_1 *and* λ_2.

a) Draw a graph showing the variation of potential energy between a pair of nucleons as a function of their separation. Indicate the regions in which the nuclear forces is (i) attractive (ii) repulsive

b) Write two important conclusions which you can draw regarding the nature of the nuclear forces.

OR

Explain giving reasons for the following :

a) Photoelectric current in a photocell increases with increase in the intensity of the incident radiations.

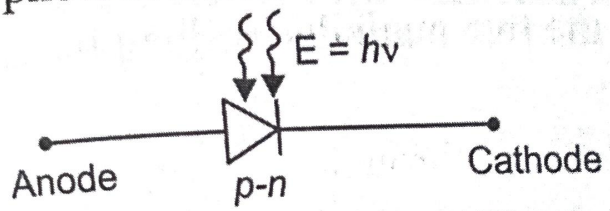
b) The stopping potential vary linearly with frequency of the incident radiations for a given photosensitive surface with the slope remaining the same for different surfaces.

c) Maximum K.E. of the photoelectrons is independent of the intensity of incident radiations.

Section - D

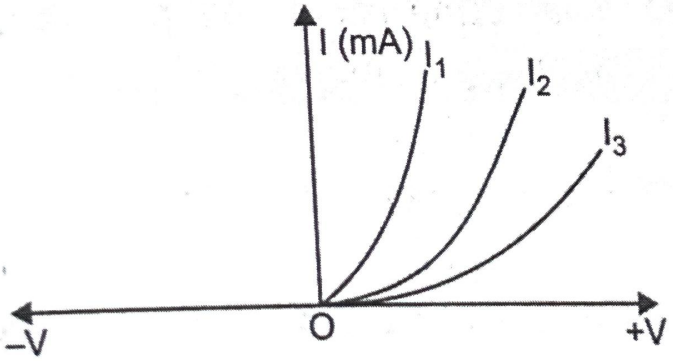
Q29. **Read the following paragraph and answer the questions that follow:**

A photodiode is an optoelectronic device in which current carriers are generated by photons through photoexcitation means photo conduction by light. Photodiode is a *p-n* junction fabricated from a photosensitive semiconductor with a transparernt window, so as allow light to fall on its junction. It works when *p-n* junction is reverse biased. Photodiode contains its current ON and OFF in nanoseconds. So, it can be used as a fastest photodetector.

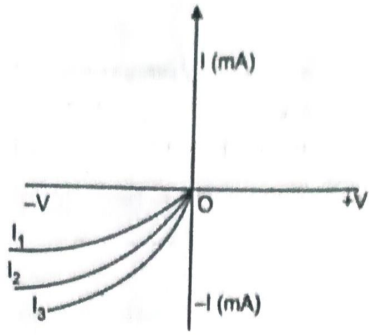


(*i*) I – V characteristic of photodiode is :

(*a*)



(b)



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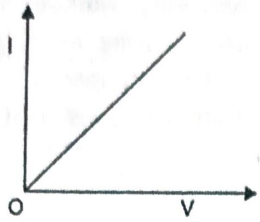
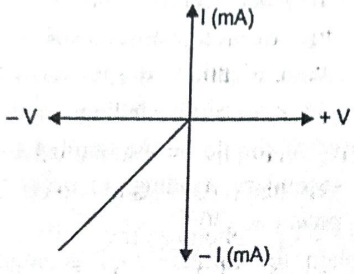


(d)



(*ii*) How is the band gap, E_g of a photodiode related to maximum wavelength λ_m that can be detected by it ?

(*a*) $\lambda_m = \frac{hc}{E_g}$ (*b*) $\lambda_m = \frac{E_g}{hc}$

(*c*) $\lambda_m = \frac{h}{E_g c}$ (*d*) $\lambda_m = \frac{c}{E_g h}$

(*iii*) The wavelength of incident light is 6×10^{-7} m. What will be energy of incident light ?

(*a*) 2.06 eV (*b*) 4.06 eV

(*c*) 1.4 eV (*d*) zero

(*iv*) In a semiconductor material, the mobilities of electrons and holes are μ_e and μ_h respectively. Which of the following is true ?

(*a*) $\mu_e > \mu_h$ (*b*) $\mu_e < \mu_h$

(*c*) $\mu_e > \mu_h$ (*d*) $\mu_e < 0; \mu_h > 0$.

Or

In the following, which one of the diode is reverse biased ?

a) +5V R +10V b) -12V R -5V

c) R -10V d) R +5V

Q30. **Read the following paragraph and answer the questions that follow.**

Types of Lenses and their combination

A convex or converging lens is thicker at the centre than at the edges. It converges a beam of light on refraction through it. It has a real focus. Convex lens is of three types : Double convex lens, Plano convex lens and Concavo-convex lens.

Concave lens is thinner at the centre than at the edges. It diverges a beam of light on refraction through it. It has a virtual focus. Concave lenses are of three types : Double concave lens, Plano concave lens and Convexo-concave lens.

When two thin lenses of focal lengths f_1 and f_2 are placed in contact with each other along their common principal axis, then the two lens system is regarded as a single lens of focal length f and

$$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2}$$

If several thin lenses of focal length $f_1, f_2, \ldots. f_n$ are placed in contact, then the effective focal length of the combination is given by

$$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2} + \ldots + \frac{1}{f_n}$$

and in terms of power, we can write

$$P = P_1 + P_2 + \ldots. + P_n$$

The value of focal length and power of a lens must be used with proper sign consideration.

(*i*) Two thin lenses are kept coaxially in contact with each other and the focal length of the combination is 80 cm. If the focal length of one lens is 20 cm, the focal length of the other would be

(*a*) –26·7 cm (*b*) 60 cm

(*c*) 80 cm (*d*) 30 cm.

(*ii*) A spherical air bubble is embedded in a piece of glass. For a ray of light passing through the bubble, it behaves like a

(*a*) converging lens (*b*) diverging lens

(*c*) mirror (*d*) thin plane sheet of glass.

(*iii*) Lens generally used in magnifying glass is

(*a*) single concave lens

(*b*) single convex lens

(*c*) combination of convex lens of lower power and concave lens of lower focal length

(*d*) planoconcave lens.

(*iv*) The magnification of an image by a convex lens is positive only when the object is placed

(*a*) at its focus F (*b*) between F and 2F

(*c*) at 2F

(*d*) between F and optical centre.

OR

A convex lens of 20 cm focal length forms a real image which is three times magnified. The distance of the object from the lens is

(*a*) 13·33 cm (*b*) 14 cm

(*c*) 26·66 cm (*d*) 25 cm

A-

Section - E

Q31. Draw the circuit arrangement for studying p-n junction diode in (i) forward biasing and (ii) reverse biasing. Draw typical V-I characteristics of a silicon diode. Describe briefly the following terms (i) minority carriers injection in forward biasing and (ii) breakdown voltage in reverse biasing.

OR

a) The number of silicon atoms per m^3 is 5×10^{28}. This is doped simultaneously with 5×10^{22} atoms per m^3 of Arsenic and 5×10^{20} per m^{-3}. Is the material n-type or p-type?

b) Discuss the role of two important processes involved in the formation of a p-n junction.

Q32. a) Draw the graph showing the variation or binding energy per nucle on with the mass number of muclie $2 < A < 240$. What are the main inferences from the graph? How do you explain the constancy of binding energy in the range $30 < A < 170$ using the property that the nuclear force if short-ranged? Explain with the help of this plot the release of energy in the processes of nuclear fission and fusion.

b) Using Bohr's postulates, derive an expression for the orbital period of electron moving in the nth orbit of hydrogen atom.

OR

a) Use Bohr's model of hydrogen atom to obtain the relationship between the angular momentum and magnetic moment of the revolving electron.

b) Calculate de-Broglie wavelength associated with the electron revolving in the first excited state of hydrogen atom. The ground state energy of the hydrogen atom is – 13.6 eV.

Q33. a) When a ray of light passes through a prism of refracting angle A at an angle of incidence i such that angle of refraction is r and angle of deviation be δ then prove that : $i + e = A + \delta$

b) Draw a graph showing the variation of angle of deviations (δ) with angle of incidence (i) for a monochromatic ray of light passing through a prism of refracting angle A. Deduce the relation

$$\mu = \frac{\sin\left(\frac{A+\delta m}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$

OR

A person with a normal near point (25 cm) using a compound microscope with an objective of focal length 8.0 mm and an eye piece of focal length 2.5cm can bring an object placed 9.0 mm from the objective in sharp focus. What I the separation between the two lenses? Calculate the magnifying power of the microscope?