

QUESTION BANK

**ATOMS AND NUCLEI**

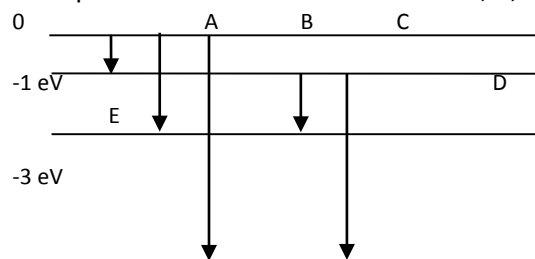
*Question bank (Schrödinger Group)*

**ONE MARK QUESTIONS**

1. What will be the ratio of radii of two nuclei of mass numbers  $A_1$  and  $A_2$ ?
2. What is Bohr quantization condition for the angular momentum of electron in the second orbit?
3. The sequence is represented as  $D \xrightarrow{\alpha} D_1 \xrightarrow{\beta} D_2$  if the mass numbers and atomic numbers of  $D_2$  are 176 and 71 respectively, what is the mass number and atomic number of D.
4. The wavelength of some of the spectral lines obtained in hydrogen spectrum are 9546 Å, 6463 Å, 1216 Å. which one of these wavelengths belongs to Lyman series.
5. Why do  $\alpha$  particles have high ionizing power?
6. What happens to the neutron to proton ratio after the emission of alpha particles?
7. Define impact parameter.
8. What is the ratio of nuclear densities of two nuclei having mass number 1:4?

**TWO MARKS QUESTIONS**

9. Assuming the nuclei to be spherical in shape how does the surface area of nucleus of mass number  $A_1$  vary with that of nucleus of mass number  $A_2$ ?
10. Radioactive isotope of silver has half-life of 20 minutes. What fraction of the original mass would remain after one hour?
11. Group the following four nuclides into two pairs of isotones and isobars.  ${}^3_2\text{He}$ ,  ${}^{198}_{80}\text{Hg}$ ,  ${}^3_1\text{H}$ ,  ${}^{197}_{79}\text{Au}$
12. Draw a graph showing the variation of potential energy between the pair of nucleons as the function of their separation. Indicate the regions in which the nuclear force is attractive and repulsive.
13. Calculate the radius of the smallest orbit of hydrogen atom.
14. Calculate the frequency of the photon which can excite an electron to -3.4 eV from -13.6 eV.
15. You are given two nuclei  ${}^7_3\text{X}$  and  ${}^4_3\text{Y}$ , explain giving reasons as to which one of the nuclei is likely to be more stable.
16. Show that the speed of the electron in the second orbit of hydrogen like atom  $\text{He}^+$  is equal to speed of an electron in the hydrogen atom.
17. What are the limitations of Bohr atomic model?
18. The energy levels of an element X are shown in the figure. A photon of wavelength 620 nm is emitted and this corresponds to which of the transition A, B, C, D or E?



**3 MARKS QUESTIONS**

19. Calculate the speed of electron revolving around the nucleus of a hydrogen atom in order that it may not be pulled into the nucleus by electrostatic attraction.

20. What is the distance of closest approach and derive an expression for the same?
21. Draw a labeled diagram of Geiger – Marsden experiment on the scattering of  $\alpha$  particles. How is the size of the nucleus estimated based on the experiment?
22. Derive an expression for the potential and kinetic energy of an electron in any orbit of a hydrogen atom. How does the potential energy change with increasing  $n$ ?
23. Show that Bohr's second postulate "The electron revolves around the nucleus only in certain fixed orbits without radiating energy" can be explained on the basis of de – Broglie hypothesis of wave nature of electron.
24. Calculate the longest and shortest wavelength in the Balmer series of hydrogen spectrum. Given  $R = 1.0987 \times 10^7/\text{m}$ .
25. Calculate the binding energy per nucleon in the case of  ${}^{56}_{26}\text{Fe}$ . Given mass of proton = 1.007825 amu. Mass of neutron = 1.00865 amu, mass of the  ${}^{56}_{26}\text{Fe}$  nucleus is 55.934939 amu.
26. State and explain the laws of radioactive disintegration and hence define disintegration constant and half life period. Establish the relation between them.
27. Plot a graph between mass number and average binding energy per nucleon and hence explain the energy released in the process of nuclear fission and fusion.

### FIVE MARKS QUESTIONS

28. State the basic postulates Bohr's atom model. Obtain the relation for the frequency of spectral lines emitted from hydrogen atom.
29. Which of the following radiations are  $\alpha$ ,  $\beta$  and  $\gamma$  rays.
  - a. Similar to X rays
  - b. Easily absorbed by the matter
  - c. Travel with greatest speed.
  - d. Similar in nature to cathode rays

After two hours  $1/16$  th of initial amount of certain radioactive isotope remains undecayed. What is the half life of the isotope?
30. If 200 MeV energy is released in the fission of single nucleus of  ${}^{235}_{92}\text{U}$ , how many fissions must occur to produce a power of 1 kW. What are the functions of moderator and control rods in nuclear reactor? Give an example for each.

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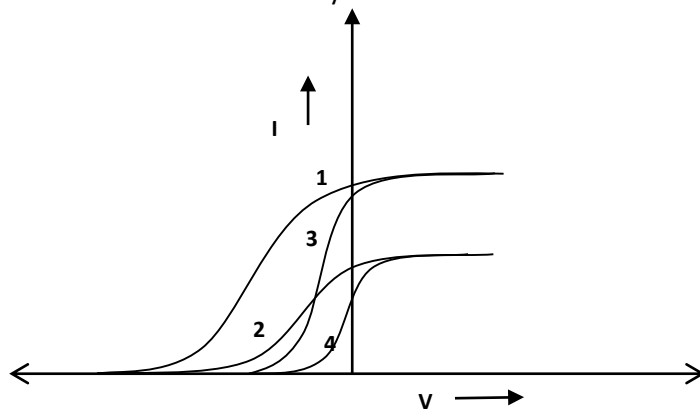
## DUAL NATURE OF MATTER AND RADIATION

### ONE MARK QUESTIONS

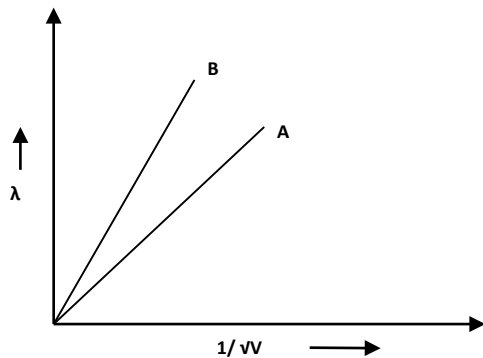
1. What is the stopping potential applied to a photocell if the maximum KE of the photoelectron is 5eV? Hint:  $eV_0 = 5\text{eV}$
2. If the intensity of radiation in a photocell is increased how does the stopping potential vary? Unchanged
3. Two metals A and B have work function 2eV and 4 eV respectively. Which has lower threshold wavelength? Hint:  $\lambda \propto 1/W_0$
4. What is photoelectric effect?
5. De Broglie wavelength associated with an electron accelerated through a potential difference  $V$  is  $\lambda$ . What will be the wave length when potential is increased to 4V? Hint:  $\lambda = h/2meV$
6. Which of the following radiations will be more effective for electron emission from the surface of zinc? Microwaves, infrared, ultraviolet Hint: UV has max freq
7. An electron and an  $\alpha$  particle and a proton has the same KE. Which one has the shortest wavelength? Hint:  $\lambda \propto 1/\sqrt{V}$
8. With what purpose Davisson Germer experiment performed?

**TWO MARKS QUESTIONS**

9. For a photosensitive surface threshold wavelength is  $\lambda_0$ . Does photoemission occur if the wavelength of radiation is (a) more than  $\lambda_0$  (b) less than  $\lambda_0$ . Justify.  
Hint: for emission  $E \geq W_0$
10. Explain the terms threshold frequency and stopping potential.
11. Draw a graph showing the variation of stopping potential with frequency of radiation. How can the value of Planck's constant be determined from the graph?  
Hint:  $h = \text{slope of the graph}$ .
12. Why de Broglie wave associated with a moving football is not visible?
13. A photon and an electron have the same de Broglie wavelength. Which has greater KE? Hint:  $mv = \sqrt{2mE}$ ,  $\lambda = h/\sqrt{2mE}$
14. In the  $n$ th orbit of hydrogen atom find the ratio of radius of electron orbit and de Broglie wavelength associated with it.  
Hint:  $r_n = nh/2\pi mv_n$   
 $= h/mv_n$
15. Number of ejected photoelectrons increases with increase in intensity of light, but not with increase in frequency. Explain.
16. Calculate the retarding potential needed to stop the photoelectrons ejected from a metal surface of work function 1.2 eV with light of energy 2eV. Hint:  $eV_0 = hv - W_0$
17. The given graph shows the variation of photoelectric current with applied voltage for two different materials and for two different intensities of the incident radiation. Identify the pair of curves corresponding to different materials but same intensity of incident radiation.



18. Two lines A and B shown in the graph represent the de Broglie wavelength ( $\lambda$ ) as a function of  $1/\sqrt{V}$  ( $V$  is the accelerating potential) for two particles having the same charge. Which of the two represents the particle of smaller mass?



Hint: Slope of graph =  $h/\sqrt{2mq} \propto 1/\sqrt{m}$

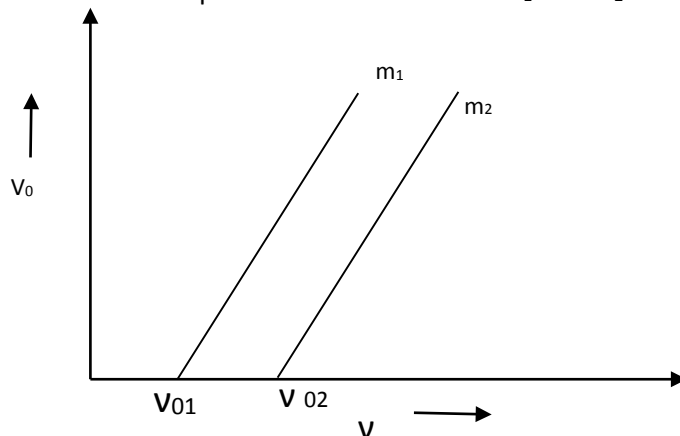
**THREE MARKS QUESTIONS**

19. Show that de Broglie hypothesis of matter supports the Bohr concept of stationary orbit.

20. Draw a graph showing the variation of stopping potential with frequency of incident radiation in relation to photoelectric effect. Deduce an expression for the slope of graph using Einstein's photo electric equation.
21. X rays of wavelength  $\lambda$  fall on a photosensitive surface, emitting electrons assuming that the work function of the surface can be neglected, prove that the de Broglie wavelength of electrons emitted will be  $h\lambda/2mc$
22. Draw the graph showing the variation of photo current with collector potential for different intensity of incident radiation and define stopping potential.
23. A particle is moving three times as fast as electrons. The ratio of the de Broglie wavelength of the particle to that of electron is  $1.813 \times 10^{-4}$ , calculate the particle's mass and identify the particle.
24. Sketch a graph between frequency of incident radiation and stopping potential for given photosensitive material. What information can we obtain from the value of the intercept on the potential axis? A Source of light of frequency greater than threshold frequency is placed at a distance of 1 m from the cathode of a photocell. The stopping potential is found to be V. if the distance of the light source from the cathode is reduced, explain giving reason, what change will you observe in the (i) photoelectric current (ii) stopping potential.
25. An  $\alpha$  particle and a proton are accelerated from the state of rest through the same potential difference V. Find the ratio of the de Broglie wavelength associated with them.
26. If the frequency of incident radiation on a photocell is doubled for the same intensity, what changes will you observe in (i) kinetic energy of photo electrons emitted (ii) photoelectric current (iii) stopping potential? Justify your answer in each case.
27. Show that Bohr's second postulate, "electron revolves around the nucleus only in certain fixed orbits without radiating energy" can be explained on the basis of de Broglie hypothesis of wave nature of electron.

#### FIVE MARKS QUESTIONS

28. Draw a schematic experimental arrangement used by Davisson and Germer to establish wave nature of electrons. Describe briefly how the de Broglie relation was experimentally verified in the case of electrons.
29. Write Einstein's photo electric equation. State clearly the salient features observed in photoelectric effect which can be explained on the basis of the above equation.
30. The given graphs show the variation of the stopping potential  $V_0$  with the frequency  $\nu$  of the incident radiations for two different photosensitive materials  $m_1$  and  $m_2$ .



- (i) What are the values of work function for  $m_1$  and  $m_2$
- (ii) The values of the stopping potential for  $m_1$  and  $m_2$  for a frequency  $\nu_3 (> \nu_{02})$ .

If the stopping potential of the incident radiations are  $V_1$  and  $V_2$  respectively, show that the slope of the line =

$$\frac{V_1 - V_2}{\nu_{02} - \nu_{01}}$$

# ELECTROMAGNETIC WAVES

## ONE MARK QUESTIONS

1. Name the scientist who first (i) predicted the existence of EM wave. (ii) Experimentally demonstrate the existence of EM wave
2. Write 4 properties of em waves.
3. Write an expression for speed of em wave in free space.
4. Write two applications of microwaves.
5. Which part of the electromagnetic spectrum is used in operating RADAR?
6. What is the ratio of speed of infrared and ultraviolet rays in vacuum?
7. State modified Ampere's circuital law.
8. What is Maxwell's displacement current?

## TWO MARKS QUESTIONS

9. A plane electromagnetic wave in vacuum along Y direction. Write the (i) ratio of magnitude and (ii) direction of its electric and magnetic field vectors.
10. Identify the following electromagnetic waves per the wavelengths given below
  - (i)  $10^{-3}\text{nm}$
  - (ii)  $10^{-3}\text{m}$
11. Write the dimensions of  $1/\mu_0\epsilon_0$
12. What is the wavelength of a television station, which transmits vision on 500 MHz?
13. The oscillating magnetic field in a plane electromagnetic wave is given by  $B_y = 8 \times 10^{-6} \sin [2 \times 10^{11}t + 300 \pi x]$ . Calculate the wavelength of the wave.
14. Why can light travel in vacuum whereas sound cannot do so?
15. What are infrared rays? Write their two uses.
16. How are infrared rays detected? Write the name of instrument also.
17. What is common between different types of em waves?
18. Find the amplitude of the electric field in parallel beam of light of intensity  $8 \text{ Wm}^{-2}$

## THREE MARKS QUESTIONS

19. Draw a labeled diagram of Hertz experimental setup to produce electromagnetic waves. Explain the generation of electromagnetic waves using this setup.
20. Prove that electromagnetic waves are transverse in nature.
21. What is meant by em spectrum? Give its four uses.
22. Write the order of frequency range and one use of the following radiations.
  - (i) Microwaves
  - (ii) Ultraviolet rays
  - (iii) X rays
23. Why did Maxwell introduce the concept of displacement current? How does the concept of displacement current lead to the production of electromagnetic waves?
24. A plane electromagnetic wave of frequency 25 MHz travels in free space along X direction. At a particular point in space at time  $\vec{E} = 6.3 \hat{j} \text{Vm}^{-1}$ . What is  $\vec{B}$  at this point?
25. Give two uses each of the following
  - (a) Gamma ray
  - (b) Infrared rays
  - (c) Ultraviolet radiations
26. Give the frequency range and source of production of X rays. Also write two uses of it.
27. Prove  $E_0 = cB_0$  that (i)
$$c = \frac{1}{\sqrt{\mu_0\epsilon_0}}$$

(iii)

**FIVE MARKS QUESTIONS**

- 28. A parallel plate capacitor has plates of area  $0.32 \text{ m}^2$ , which are separated by a distance of 5 mm. The capacitor is raised to a potential of 1200 V. Estimate the average value of  $I_D$ , when it is discharged for  $1 \mu \text{ s}$ .
- 29. A radio can tune into any station in the 7.5 MHz to 12 MHz Band. What is the corresponding wavelength band?
- 30. About 5% of power of a 100W bulb is connected to visible radiation. What is the average intensity of visible radiation (a) at a distance of 1 m from the bulb and (b) at a distance of 10 m. Assume that the radiation is emitted isotropically and neglect reflection.

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