

Atomic Structure Overview



Model Problems in Electromagnetic Radiation and Photoelectric Effect

Electromagnetic Radiation

Model Problem 1: Wavelength and Frequency

- **Problem:** Calculate the frequency of electromagnetic radiation with a wavelength of 500 nm (nanometers).
- **Solution:** Use the formula $c = \lambda\nu$.

$$\nu = \frac{c}{\lambda} = \frac{3 \times 10^8 \text{ m/s}}{500 \times 10^{-9} \text{ m}} = 6 \times 10^{14} \text{ Hz}$$

Model Problem 2: Energy of a Photon

- **Problem:** Find the energy of a photon with a frequency of 4×10^{14} Hz.
- **Solution:** Use the formula $E = h\nu$.

$$E = 6.626 \times 10^{-34} \text{ Js} \times 4 \times 10^{14} \text{ Hz} = 2.65 \times 10^{-19} \text{ J}$$

Model Problem 3: Electromagnetic Spectrum

- **Problem:** Which region of the electromagnetic spectrum has a wavelength range from 400 nm to 700 nm?
 - **Solution:** This range corresponds to visible light.
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Photoelectric Effect

Model Problem 4: Work Function and Threshold Frequency

- **Problem:** A metal has a work function of 2.0 eV. What is the threshold frequency for this metal?
- **Solution:** Use the formula $\phi = h\nu_0$.

$$\nu_0 = \frac{\phi}{h} = \frac{2.0 \times 1.602 \times 10^{-19} \text{ J}}{6.626 \times 10^{-34} \text{ Js}} = 4.83 \times 10^{14} \text{ Hz}$$

Model Problem 5: Kinetic Energy of Ejected Electrons

- **Problem:** Light of frequency 5×10^{14} Hz shines on a metal surface with a work function of 3 eV. Calculate the maximum kinetic energy of the ejected electrons.
- **Solution:** Use the formula $KE = h\nu - \phi$.

$$KE = 6.626 \times 10^{-34} \text{ Js} \times 5 \times 10^{14} \text{ Hz} - 3 \times 1.602 \times 10^{-19} \text{ J}$$

$$KE = 3.31 \times 10^{-19} \text{ J} - 4.806 \times 10^{-19} \text{ J} = -1.496 \times 10^{-19} \text{ J} \text{ (not possible, indicating threshold frequency)}$$

Multiple Choice Questions (MCQs)

Electromagnetic Radiation

1. What is the wavelength of light with a frequency of 6×10^{14} Hz?

- a) 400 nm
- b) 500 nm
- c) 600 nm
- d) 700 nm

2. Which of the following electromagnetic waves has the longest wavelength?

- a) X-rays
- b) Microwaves
- c) Ultraviolet
- d) Gamma rays

3. Calculate the energy of a photon with a wavelength of 300 nm.

- a) 6.6×10^{-19} J
- b) 5.6×10^{-19} J
- c) 4.1×10^{-19} J
- d) 3.3×10^{-19} J

4. What is the frequency of ultraviolet light with a wavelength of 200 nm?

- a) 1.5×10^{15} Hz
- b) 1.2×10^{15} Hz
- c) 6.0×10^{14} Hz
- d) 3.0×10^{14} Hz

5. Which region of the electromagnetic spectrum has the highest energy per photon?

- a) Infrared
- b) Visible
- c) Ultraviolet
- d) Gamma rays

Photoelectric Effect

6. What is the minimum energy required to eject an electron from a metal with a work function of 4 eV?

- a) 1.6×10^{-19} J
- b) 6.4×10^{-19} J

- c) 3.2×10^{-19} J
- d) 8.0×10^{-19} J

7. If the frequency of incident light is doubled, what happens to the kinetic energy of the ejected electrons, assuming the frequency is above the threshold frequency?

- a) It halves
- b) It doubles
- c) It increases by more than double
- d) It remains the same

8. Which of the following is NOT a factor affecting the photoelectric effect?

- a) Intensity of light
- b) Frequency of light
- c) Work function of the metal
- d) Angle of incidence of light

9. What happens when light with a frequency below the threshold frequency shines on a metal surface?

- a) Electrons are emitted with maximum kinetic energy
- b) Electrons are emitted with minimum kinetic energy
- c) No electrons are emitted
- d) The metal heats up

10. The stopping potential in a photoelectric experiment is related to which of the following?

- a) Work function of the metal
- b) Frequency of incident light
- c) Kinetic energy of ejected electrons
- d) All of the above

Answer Key (Next Page)

- 1. b
- 2. b
- 3. c
- 4. b
- 5. d
- 6. b
- 7. c
- 8. d
- 9. c
- 10. d