The Photoelectric Effect & Photons

Modern physics · 5 questions · step-by-step answers at the end

Name: Date: Score: / 5

USEFUL EQUATIONS

$E = hf = hc/\lambda$ $K_{max} = hf - \varphi$ $f_0 = \varphi/h$ $eV_s = K_{max}$ $hc = 1240$ eV·nm

Questions

Show your working in the space under each question.

1. Will 300 nm light free electrons from zinc (φ = 4.3 eV)?

2. 400 nm light shines on sodium (φ = 2.28 eV). Find the photon energy, K_{max}, the stopping voltage, and the threshold wavelength.

3. The light intensity is doubled at the same frequency. What happens to the current and to K_{max}?

4. What is the momentum of a 500 nm photon?

5. Two metals are tested. What is the same about their K_{max}–f graphs, and what differs?

Step-by-step answers

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1. $E = 1240/300 = 4.13$ eV < 4.3 eV, so **no emission**, however bright the light.

2. 1. $E = 1240/400 =$ **3.10 eV**.
2. $K_{max} = 3.10 - 2.28 =$ **0.82 eV**.
3. $V_s = K_{max}/e =$ **0.82 V**.
4. Threshold: $\lambda_0 = 1240/2.28 =$ **544 nm** (green). Longer, redder light frees no electrons at all.

Answer: $E = 3.10$ eV, $K_{max} = 0.82$ eV, $V_s = 0.82$ V, $\lambda_0 = 544$ nm

3. Current **doubles**; K_{max} **unchanged**.

4. $p = h/\lambda =$ **1.3×10^{-27} kg·m/s**.

5. Same **slope (h)**; different **intercepts** (work function and threshold).