InkPhysics

ANSWER BOOK

Energy levels and photon emission

Quantum phenomena · Year 12

AQA 3.2.2.3 · CIE 22.4 · OCR A 5.5.2

10 questions · 30 marks

NAVY EDITION

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SECTION A · Warm-up

A1 Each line corresponds to a photon of a definite energy, emitted when an electron falls between two levels. Sharp, discrete lines show the electron energies are quantised (only certain values are allowed), not continuous. [2]

A2 3.0 eV = 3.0 × 1.60 × 10^{-19} = 4.80 × 10^{-19} J. [2]

A3 $hf = E_1 - E_2$, where E_1 and E_2 are the higher and lower energy levels of the transition. [2]

SECTION B · Standard

B1 $\Delta E = (-1.5) - (-3.4) = 1.9$ eV = 3.04 × 10^{-19} J. (a) $f = \Delta E/h$ = 4.59 × 10^{14} Hz. (b) $\lambda = c/f$ = 654 nm. [4]

B2 $\lambda = hc/\Delta E = (6.63 \times 10^{-34} \times 3.0 \times 10^{8})/(2.55 \times 1.60 \times 10^{-19})$ = 488 nm. [3]

B3 $\Delta E = (-0.54) - (-3.40) = 2.86$ eV. $\lambda = hc/\Delta E$ = 435 nm. [3]

B4 $E = hc/\lambda = (6.63 \times 10^{-34} \times 3.0 \times 10^{8})/(486 \times 10^{-9})$ = 4.09 × 10^{-19} J = 2.56 eV. [3]

SECTION C · Stretch

C1 $\Delta E = (-1.5) - (-13.6) = 12.1$ eV = 1.94 × 10^{-18} J. $\lambda = hc/\Delta E$ = 103 nm, which is in the ultraviolet. [4]

C2 Three transitions are possible (3→2, 3→1, 2→1), so three lines. The longest wavelength comes from the smallest energy gap, -1.5 to -3.4 eV (1.9 eV): $\lambda = hc/\Delta E$ = 654 nm. [4]

C3 Every element has its own distinct set of electron energy levels, so the differences between levels, and therefore the photon energies and wavelengths emitted, form a pattern unique to that element, like a fingerprint. [3]