Exam Solutions
Chapter 8.2- DeBroglie
Answer 1 2014:2:18

(13 marks)

A hydrogen atom, in an excited energy level, undergoes relaxation by emitting a photon. The energy values are given by $E_n = -\frac{13.6}{n^2}$ eV. The initial state of the electron is in energy level n = 4 and the final state after relaxation is ground state (n = 1).

(a) Does the average radius of the electron orbital remain the same, increase or decrease in value during this transition? Circle the correct answer. (1 mark)

remains the same increases decreases

Description	Marks
decreases	1
Total	**1**

(b) Use the formula $E_n = -\frac{13.6}{n^2}$ eV to complete the energy level diagram below. The diagram is **not** drawn to scale. (2 marks)

n=4 _____ E_4 = _____ eV

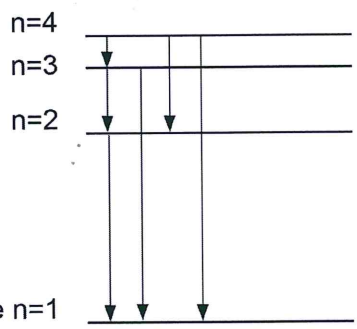
n=3 _____ E_3 = -1.51 eV

n=2 _____ E_2 = -3.40 eV

Ground state n=1 _____ E_1 = _____ eV

Description	Marks
$E_4 = -(13.6/4^2) = -0.85$ eV	1
$E_1 = -(13.6/1^2) = -13.6$ eV	1
Total	**2**

(c) On the diagram above, draw in all the possible transitions when an electron undergoes relaxation from n = 4 to the ground state. (3 marks)



E_4 = _____ eV

E_3 = -1.51 eV

E_2 = -3.40 eV

E_1 = _____ eV

Description	Marks
There are 6: 4-1, 4-2, 4-3, 3-1, 3-2 and 2-1 (1 mark if at least 4-1, 4-2 and 4-3 are drawn)	1–2
Transitions are drawn downwards	1
Total	**3**

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Answer 1 continued

(d) (i) Calculate the wavelength of the photon emitted from the E_3 to E_2 transition. Show **all** workings. (4 marks)

Description	Marks
$E = 3.40 - 1.51 = 1.89$ eV	1
$E = hf = \frac{hc}{\lambda}$ $\lambda = \frac{hc}{E} = \frac{6.63 \times 10^{-34} \times 3 \times 10^{8}}{1.89 \times 1.6 \times 10^{-19}}$ $\lambda = 6.58 \times 10^{-7}$m	1–3
Total	**4**

(ii) The transitions of E_4 to E_2 and E_3 to E_2 produce red and green photons. Explain which transition produces which colour. (3 marks)

Description	Marks
Transitions E_4 to E_2 has more energy so will produce the photon with the shorter wavelength, green.	1–2
E_3 to E_2 will produce red	1
Total	**3**