Assessment Schedule – 2007

Physics: Demonstrate understanding of atoms, photons and nuclei (90522)

Evidence Statements

Q	Evidence	Achievement	Achievement with Merit	Achievement with Excellence
1(a)	$E = 4.78 \times 10^{6} \times 1.6 \times 10^{-19}$ $= 7.648 \times 10^{-13}$ $\mathbf{= 7.6 \times 10^{-13}\ J}$	[2] Correct answer (working must be shown because they could work backwards from Δm in next question).		
1(b)	$\Delta E = mc^2 \Rightarrow m = \frac{7.648\times10^{-13}}{(3.00\times10^{8})^2}$ $= 8.49778 \times 10^{-30}$ $\mathbf{= 8.5 \times 10^{-30}}$	[2] Correct working [1] Answer rounded to 2sf, plus THREE answers given with a correct unit. (not including 1 (a) or (b))		
1(c)	The nucleons in the product nuclei have lower energy than the nucleons in the reactant nuclei, which means that energy must be released. This energy is given off (in the form of heat and electromagnetic energy). As mass includes energy, a reduction of energy means a reduction of mass.	[1] *Mass loss due to energy being released. (Do **not** accept mass is **changed** into energy.)*	[1] Some idea of the lower energy of the nucleons meaning a lower mass. OR higher binding energy per nucleon means lower mass per nucleon.	[1] Explanation is clear and complete.
1(d)	$8.49778 \times 10^{-30} =$ $2 \times m_C - (33.197 + 6.6465) \times 10^{-27}$ $\Rightarrow m_C = ½ \times (8.49778 \times 10^{-30} + 39.844 \times 10^{-27})$ $= 19.9260 \times 10^{-27}$ $\mathbf{= 19.926 \times 10^{-27}\ kg}$		[2] Correct answer (Look out for 19.922 – Δm has not been included and 19.918 -Δm has been subtracted)	
1(e)	Nuclear stability relates to how much energy (per nucleon) would be required to split a nucleus into its individual nucleons. The greater the energy needed, the more stable the nucleus. OR Nuclear stability relates to the binding energy per nucleon. The greater the binding energy per nucleon, the more stable the nucleus.	[1] Links nuclear stability to energy needed to split the nucleus **OR** to binding energy.	[1] Links nuclear stability to energy to remove nucleon from the nucleus **OR** to binding energy per nucleon.	
2(a)	n = 2	[1] Correct level.		

2(b)	When white light is shone through hydrogen gas, the photons that have energy values that exactly coincide with one of the energy differences between the allowed energy levels for hydrogen will be absorbed by the hydrogen electron. This means the light frequency related to this energy will be removed. Because red light has lowest frequency and hence lowest energy in the visible spectrum, the transition that involves red light must involve the least energy difference and so is between levels 2 and 3. Because this frequency of light is removed, there is a dark line.	[1] *Idea of energy being absorbed from photons and so removing that frequency.* *OR Absorption of specific frequency /wavelength (implied) associated with a transition.*	[1] Clear and correct idea of energy being absorbed by electrons from specific photons and so removing that specific frequency.	[1] Clear and correct idea of energy being absorbed from specific photons and so removing that specific frequency. Correct transition clearly explained.
2(c)	$\Delta E = hf$ $\Delta E = (13.6 - 1.51)$ eV $= 12.09 \times 1.6 \times 10^{-19}$ J $\Rightarrow f = \frac{1.9344 \times 10^{-18}}{6.63 \times 10^{-34}}$ $= 2.91765 \times 10^{15}$ $= \mathbf{2.92 \times 10^{15}\ Hz}$		[2] Correct answer. (Note: 2.93 if used $E = hcR/n^2$ or Rydberg formula)	
2(d)	$\Delta E(4 \to 1) = hcR\left(\frac{1}{1^2} - \frac{1}{4^2}\right)$ $= 2.0456 \times 10^{-18}$ $\Delta E(n \to 1) = hf = 6.63 \times 10^{-34} \times 3.200 \times 10^{15}$ $= 2.1216 \times 10^{-18}$ J $\Delta E(4 \to n) = (2.1216 - 2.04556) \times 10^{-18}$ $= 0.07604 \times 10^{-18}$ J $\Delta E(4 \to n) = hf \Rightarrow f = \frac{0.07604 \times 10^{-18}}{6.63 \times 10^{-34}}$ $= 1.14691 \times 10^{14}$ $= \mathbf{1.15 \times 10^{14}\ Hz}$	[1] *A correct answer implies knowledge of concepts.* [2] *Correct intermediate energy level calculated OR correct energy of first photon ($= 0.07604 \times 10^{-18}$)*		[2] Correct answer. (Note: 1.14 if found intermediate energy level =6, incorrect if fractional energy levels used)
3(a)	Electrons are released when light shines on the metal.	[1] Correct idea. (Light releases electrons from anode is incorrect – but allow photons release electrons from anode.)		
3(b)	Changing the brightness of the light changes the number of photons hitting the metal per second. As each photon can release only one electron, as the brightness increases, more electrons are released per second. The greater rate of flow of electrons means a greater current is flowing.	[1] Brighter light linked to either more photons or more electrons. (accept Changing brightness increases number of electrons.)	[1] Brighter light linked to more photons and hence more electrons.	
3(c)	frequency intercept = 1.05×10^{15} Hz	[2] Correct answer (must include $\times 10^{15}$, do not allow 1 or 1.1)		

3(d)	$E_K = hf - \phi \Rightarrow$ gradient of the graph is h provided E_K is changed to joules. $\Rightarrow h = \frac{(8.0-0)\times1.6\times10^{-19}}{(3.00-1.05)\times10^{15}}$ $= 6.5641 \times 10^{-34}$ **$= 6.6 \times 10^{-34}$**	[2] *Correct answer without changing eV to joule OR conversion to Joules incorrect. Calculation shows understanding of how to obtain Plancks' constant from the graph.*	[2] Correct answer consistent with **data from graph**	
3(e)	$\phi = hf_o$, and $\phi = hf - E_K$ and $c = f\lambda$ $\Rightarrow f = \frac{3.00\times10^{8}}{4.01\times10^{-7}} = 7.48130 \times 10^{14}$ Hz $\Rightarrow \phi = 6.63\times10^{-34} \times 7.48130 \times 10^{14} - 3.94\times10^{-20}$ $= 4.56610 \times 10^{-19}$ J $\Rightarrow f_o = \frac{4.56610\times10^{-19}}{6.63\times10^{-34}}$ $= 6.88703 \times 10^{14}$ **$= 6.89 \times 10^{14}$ Hz**	[1] *A correct answer implies knowledge of concepts.*	[2] *Correct answer consistent with incorrectly calculated frequency or work function.*	[2] Correct answer

Judgement Statement

	Achievement	Achievement with Merit	Achievement with Excellence
Criterion 1	3 × A1	2 × A1 + 2 × M1	2 × A1 + 1 × M1 + 1 × E1
Criterion 2	2 × A2	2 × A2 + 2 × M2	2 × A2 + 2 × M2 + 1 × E2