Assessment Schedule – 2008

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

Evidence Statement

Judgements in italics indicate replacement evidence and so are not counted for sufficiency.

Q	Evidence	Achievement	Achievement with Merit	Achievement with Excellence
ONE (a) P2	This is a **SHOW** question Total be = $[\Sigma m_{\text{nucleons}} - m_{\text{nucleus}}] \times c^2$ $= [61 \times m_p + (147 - 61) \times m_n - m_{Pm}] \times c^2$ $\frac{be}{\text{nucleon}} = \frac{\text{total } be}{147} = 1.32538^{-12}$ J	[2] Correct Mass defect $= 2.167786 \times 10^{-27}$ kg [1] Correct answer shows concept knowledge.	[2] Correct binding energy $= 1.951007 \times 10^{-10}$ J.	[2] Correct binding energy per nucleon
(b) P3	mass deficit / defect	[1] Correct answer.		
(c) P3	This is a **SHOW** question $\Delta m = m_{\text{Nd-146}} + m_n - m_{\text{Nd-147}}$ $= (242.243122 + 1.674929 - 243.908613) \times 10^{-27}$ kg	[2] Complete valid method.		
(d) P3	$\Delta m = (243.908613 - 243.906111 - 0.000911939) \times 10^{-27}$ $= \mathbf{1.590061 \times 10^{-30}}$ $E = \Delta m c^2 = \mathbf{1.43105 \times 10^{-13}}$ **J** $E/e = 8.93293 \times 10^5 = \mathbf{8.93 \times 10^5}$ **eV**	[2] Correct Δm *[1] Correct answer (eV or J) shows concept knowledge.*	*[2] Correct energy in J.*	[2] Correct answer.
(e) P3	The decay products have less mass because energy has been released ($E = \Delta m c^2$). Pm-147 has a greater binding energy per nucleon than Nd-147, hence the decay leads to loss of energy.	[1]Energy has been released so mass is lost.	[1]Pm-147 has a greater binding energy per nucleon than Nd-147.	[1]Complete answer showing understanding and linkage of both concepts.
TWO (a) P4	$v = f\lambda \Rightarrow \lambda = 3.00 \times 10^8 \div 6.250 \times 10^{14}$ $= 4.8000 \times 10^{-7}$ m	[2] Correct answer.		
	$= \mathbf{4.80 \times 10^{-7}}$ **m**	[1] Answer rounded to 3sf plus 3 correct units given.		
(b) P4	UV photons have less energy than X-ray photons, but need more energy than visible photons. Energy cannot be created or destroyed / conservation of energy. So a UV photon cannot provide enough energy to form an X-ray photon, but can provide enough energy to form a visible photon.	[1] Links energy conservation / quantum nature of light concept to visible OR X-ray situation.	[1] Links energy conservation concept and quantum nature of light concept to visible AND X-ray situations.	
(c) P5	$\Delta E = E_f - E_i \Rightarrow E_f = E_i + \Delta E$ $= -8.24 \times 10^{-20} + -4.144 \times 10^{-19}$ J $= -4.968 \times 10^{-19} = \mathbf{-4.97 \times 10^{-19}}$ **J**	[2] Correct answer consistent with incorrect handling of +/–.	[2] Correct answer.	
(d) P5	$E_{\text{heat}} = E_{\text{UV}} - E_{\text{light}}$ $= hf_{\text{UV}} - 4.144 \times 10^{-19}$ $= 6.63 \times 10^{-34} \times 3.86 \times 10^{15} - 4.144 \times 10^{-19}$ $= \mathbf{2.55918 \times 10^{-18}} - 0.4144 \times 10^{-18}$ $= 2.14478 \times 10^{-18} = \mathbf{2.14 \times 10^{-18}}$ **J**	[2] Correct value for E_{UV}.	[2] Correct answer.	

(e) P5	For the T-shirt to look white, the frequencies, and hence energies of the photons emitted from the phosphor, must produce the necessary colours that sum to white. This means the phosphor must have electron energy levels with energy values that have differences that give the required set of values.	[1] One key idea identified.	[1] Two key ideas identified and linked.	[1] Key ideas identified and linked are: Frequencies of emitted photons must produce the colours that add up to white. Frequency of a photon depends on its energy. Number and values of phosphor electron energy levels must allow this.
THREE (a) P6	$E = hf = 6.63 \times 10^{-34} \times 1.32 \times 10^{13}$ $= 8.7516 \times 10^{-21}$ **8.75×10^{-21} J**	[2] Correct answer.		
(b) P6	Photons cause emission of electrons from the emitter. Electrons travel to the collector and hence a current in the circuit.	[1]One point clear.	[1] Both points linked, demonstrating understanding.	
(c) P7	For electrons to be released, the energy of the photon must be greater than the work function energy. As this material has work function energy greater than the photon energy, it is not suitable. If answer to (a) $\geq 8.94 \times 10^{-21} J$, answer should be yes, suitable, etc.	[1] One key idea identified.	[1] Key ideas identified and linked are: Electrons released only if photon energy > work function energy. Material's work function energy is too high for electron release.	
(d) P7	$E_{electron} = E_{photon} - E_{work\ function}$ $E_{work\ function} = hf_o$ $= 6.63 \times 10^{-34} \times 9.85 \times 10^{12}$ = **6.53055×10^{-21}** $\Rightarrow E_{el} = 8.7516 \times 10^{-21} - 6.53055 \times 10^{-21}$ $= 2.22105 \times 10^{-21}$ = **2.22×10^{-21} J** OR $E_k = h(f - f_0)$ $= 6.63 \times 10^{-34} (1.32 \times 10^{13} - 9.85 \times 10^{12})$ = **2.22×10^{-21} J**	[2] Correct work function energy.	[2] Correct answer.	

Judgement Statement

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