A-Level Physics: **w25 11**

Question 38 (Answer: **A**)

- Each α removes 4 from the nucleon number and 2 from the proton number, so three remove 12 and 6.
- A β^- leaves the nucleon number alone and *adds* 1 to the proton number.
- $237 - 12 = 225$ and $93 - 6 + 1 = 88$, giving $^{225}_{88}\text{Ra}$.

Question 39 (Answer: **A**)

- The charge is $+e$, so the atom has lost exactly one electron: $94 - 1 = 93$.
- The proton number stays at 94 – removing an electron does not touch the nucleus.
- Neutrons $= 239 - 94 = 145$.

A-Level Physics: **w25 12**

Question 39 (Answer: **D**)

- This is β^+ decay: a proton inside the nucleus becomes a neutron.
- Lepton number must balance, and the emitted positron carries -1.
- So the third particle is a neutrino, with lepton number $+1$ – not an antineutrino.

Question 40 (Answer: **A**)

- The nucleon number falls by $238 - 206 = 32$, and only α decay changes it, by 4 each: $32/4 = 8$ alphas.
- Those 8 alphas alone would take the proton number from 92 to $92 - 16 = 76$.
- The product actually has 82, so $82 - 76 = 6$ β^- decays each added a proton.

A-Level Physics: **w25 14**

Question 38 (Answer: **D**)

- In β^+ decay a proton turns into a neutron, so the left-hand side must be a proton.
- The emitted lepton is a positron.
- Lepton number balance then demands a *neutrino*, not an antineutrino.

Question 39 (Answer: **A**)

- The α gives $^{210}_{82}\text{Pb}$; each β^- then adds a proton without changing the nucleon number.
- After the two betas X has $A = 210$ and $Z = 84$.
- Neutrons $= 210 - 84 = 126$; D is the nucleon number, not the neutron count.

A-Level Physics: **w25 21**

6(a)(i)	numbers of protons and electrons both = 1
	number of neutrons = 2
6(a)(ii)	diagram shows 2 neutrons and 1 proton labelled and forming a nucleus
	diagram shows 1 electron labelled and separated from the nucleus (not touching the proton and neutrons)
6(b)(i)	helium nucleus: top line = 3 **and** bottom line = 2
	beta particle: top line = 0 **and** bottom line = –1
6(b)(ii)	(electron) antineutrino
6(c)	proton: up up down **or** neutron: up down down
	(tritium:) 4 up, 5 down

A-Level Physics: **w25 24**

6(a)(i)	W deflects upwards
	W has deflection that is the mirror image of X
	Y deflects downwards less than X **or** path of Y is parallel to particle Z
6(a)(ii)	nucleus has most of the mass of the atom **or** nucleus is charged
6(a)(iii)	atom is mostly empty space **or** nucleus occupies a <u>very</u> small proportion of the space in the atom
6(b)	mass = 4 u
	charge = (+)2*e*
6(c)(i)	baryon
6(c)(ii)	charge on up quark = $(+)\frac{2}{3}(e)$ **and** charge on down quark = $-\frac{1}{3}(e)$
	(proton is up up down and neutron is up down down) $\left(2\times\frac{2}{3}\right)e-\left(1\times\frac{1}{3}\right)=1e$ **and** $\left(1\times\frac{2}{3}\right)e-\left(2\times\frac{1}{3}\right)e=0$

A-Level Physics: **s25 11**

Question 39 (Answer: **C**)

- Alpha decay is a two-body split, so the energy is shared one fixed way – giving discrete energies.
- Beta decay releases a third particle, a neutrino or antineutrino, alongside the beta particle.
- The available energy is divided between them in any proportion, so the beta energy varies continuously.

A-Level Physics: **s25 12**

Question 38 (Answer: **B**)

- Isotopes of an element share the same number of protons – that is what makes them the same element.
- They differ in their number of neutrons, which is what changes the nucleon number.
- Both atoms are neutral, so each has as many electrons as protons; the electron counts match too.

<table>
<tr><td>7(a)</td><td>$^{12}_{7}\text{N} \rightarrow {}^{12}_{6}\text{C} + {}^{0}_{1}\beta^{+} + {}^{(0)}_{(0)}\text{n}$

beta-plus shown</td></tr>
<tr><td></td><td>neutrino shown</td></tr>
<tr><td></td><td>symbols, nucleon numbers and proton numbers all correct</td></tr>
<tr><td>7(b)(i)</td><td>+1</td></tr>
<tr><td>7(b)(ii)</td><td>Lepton(s)</td></tr>
<tr><td>7(b)(iii)</td><td><table><tr><th>flavour</th><th>charge / e</th></tr><tr><td>up / u</td><td>$-\frac{2}{3}$</td></tr><tr><td>up / u</td><td>$-\frac{2}{3}$</td></tr><tr><td>down / d</td><td>$(+)\frac{1}{3}$</td></tr></table></td></tr>
<tr><td></td><td>3 correct quark flavours</td></tr>
<tr><td></td><td>Charge on anti-up quark –⅔(e)</td></tr>
<tr><td></td><td>Charge on anti-down quark (+)⅓(e)</td></tr>
</table>

5(a)(i)	$P = 40$ **and** $R = 0$
	$Q = 20$ **and** $S = -1$
5(a)(ii)	(electron) antineutrino
5(a)(iii)	leptons
5(b)	(alpha particle consists of) 2 protons and 2 neutrons
	quark composition of proton = up up down **or** quark composition of neutron = up down down
	quark composition (of alpha particle) = 6 up, 6 down