Assess Quizzes from the o-book – Explanations for the answers.

Chapter 5 Review – Support

Q	Reason
1	The question says 'penetrating' not anything else. See page 160. The order from least to most is alpha, beta, gamma. Others not listed in the options would be neutrons, and neutrinos following on after gamma.
2	An excess of neutrons means it wants to get rid of one by converting it to a proton (see page 166): $^{1}_{0}n \rightarrow {}^{1}_{1}p + {}^{0}_{-1}e + \overline{\nu}_e$. So, this is beta negative decay. Get in the habit of putting the electron antineutrinos in with beta negative decay and electron neutrinos in with beta positive decay (page 167, 168) because you may be asked this in a test. More importantly though, you will absolutely need it for Unit 4 work on the Standard Model for the EA.
3	$^{14}_{6}C \rightarrow {}^{14}_{7}N + {}^{0}_{-1}e + \overline{\nu}_e$ because that's how a nuclide with an excess of neutrons decays. You can see how it starts with 6p, 8n and finishes with 7p and 7n. That is, lost a neutron but gained a proton. See page 166.
4	Beta positive decay produces a beta positive particle (positron $^{0}_{+1}e$) and an electron neutrino (ν_e). If you write out what you know so far you will see that to balance it you need the Na-23 nuclide as well: $^{23}_{12}Mg \rightarrow {}^{0}_{+1}e + \nu_e + {}^{23}_{11}N$. What a great question.
5	Notice that the bottom number (atomic number or charge on the particle) of the reactants is 11, so we need another +1 on the other side. But the top numbers (mass numbers) are equal already. This can only mean a particle that has a top number of 0, and a bottom number of +1. Hence, a positron $^{0}_{+1}e$. But always associated with positron decay is an electron neutrino ν_e. Thus, the full equation. Note that I have not allowed for the neutrino in the options. I was just checking if you could work out the type of decay. In a short answer question you'd need to say the electron neutrino as well.
6	Alpha decay produces $^{4}_{2}He$ so to balance you need a $^{234}_{90}Th$. Be careful with this. You balance the bottom numbers (atomic number, or charge) first. That says a 90 is needed. Then you work out that the symbol for a nuclide with an atomic number of 90 is Th. Then you work out the top (mass) number to find out which particular isotope of Th it is.
7	$n = \frac{t}{t_{1/2}} = \frac{9}{4.5} = 2$ $N = N_0(\frac{1}{2})^n$ $= 25(\frac{1}{2})^2$ Note that N can represent no. of particles in nuclide, or mass of nuclide.

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8	$n = \frac{t}{t_{1/2}} = \frac{18}{6} = 3$ $N = N_0(\frac{1}{2})^n$ $= 24(\frac{1}{2})^3$ $= 3\,\mu g$ The symbol N is usually thought of as the number of particles, but can be used to represent mass as well (as that is proportional to the number of particle of a particular nuclide. The chemists among you would have learnt that N (no. of particles) = (mass in grams)/(6.02 × 10^{24}).
9	Activity is defined as the average number of radioactive disintegrations per second (page 493). It is not a syllabus term but, boy, you should learn it anyway. If we have 8000 counts (disintegrations) in 2 minutes (2 × 60) seconds, the number per second is 8000/(2× 60).
10	$N = N_0(\frac{1}{2})^n$ $1 = N_0(\frac{1}{2})^4$ $N_0 = \frac{1}{(\frac{1}{2})^4} = \frac{1}{\frac{1}{16}}$ $= 4$

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Chapter 5 Review – Consolidate

Q	Reason
1	The bottom numbers have to be equal so that means a particle with a 2. Note that it says ‘other particle’ so that means there is just one. If it didn’t say anything there could be two positrons to consider. The top number has to be 4, so the particle is ${}^{4}_{2}X$ where you then look up the atomic number to see what the symbol is – and it must be He, hence ${}^{4}_{2}He.$ It couldn’t be two positrons as the mass number for a positron is 0.
2	The only way the equation balances is: ${}^{137}_{55}Cs \rightarrow {}^{137}_{56}Ba + {}^{0}_{-1}e + \overline{\nu}_e$
3	The only way the equation balances is: ${}^{240}_{94}Pu \rightarrow {}^{236}_{92}U + {}^{4}_{2}He$
4	$N_0 = 1200, N = 300, t = 106\,d$ $1200 \xrightarrow{t_{1/2}} 600 \xrightarrow{t_{1/2}} 300$ $2\,\text{half-lives} = 106\text{ d}$ $1\,\text{half-life} = 106/2 = 53\,\text{d}$ Alternatively: $N = N_0(\frac{1}{2})^n$ $n = \log_{\frac{1}{2}}(\frac{N}{N_0})$ [use your graphing calculator] $n = 2$ $2\,\text{half-lives} = 106\text{ d}$ $1\,\text{half-life} = 106/2 = 53\,\text{d}$
5	$n = \frac{t}{t_{1/2}} = \frac{3.25\times10^5}{3.25\times10^4} = 10$ $N = N_0(\frac{1}{2})^n$ $= 10.40\mu g \times (\frac{1}{2})^{10}$ $= 10.40\mu g \times 9.765\times10^{-4}$ $= 0.0102\mu g$

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Chapter 5 Review – Extend

Q	Reason
1	Lead is a better shield than aluminium for the same thickness as it allows less beta radiation through. So, it would reduce the activity more than Al, hence graph 2. It would not be Graph 3 as the initial activity is different and so is not a fair test. For gamma radiation, the penetration would be greater than for beta, so Graph 1 it is.
2	$A = A_0(\frac{1}{2})^n$ $10 = 15(\frac{1}{2})^n$ $n = \log_{\frac{1}{2}}(\frac{10}{15})$ [use your graphing calculator] $n = 0.585$ [n is the number of half-lives] $n = \frac{t}{t_{1/2}}$ $t = t_{1/2} \times n = 5730\,y \times 0.585$ $= 3350\,y$
3	$A = A_0(\frac{1}{2})^n$ $n = \log_{\frac{1}{2}}(\frac{A}{A_0})$ [use your graphing calculator] $n = \log_{\frac{1}{2}}(\frac{281}{1000})$ $= 1.831\,\text{half-lives}$ $n = \frac{t}{t_{1/2}}$ $t_{1/2} = \frac{t}{n} = \frac{5 \times 60}{1.831}$ $= 164\,s$

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4	$A = A_0(\frac{1}{2})^n$ $n = \log_{\frac{1}{2}}(\frac{A}{A_0})$ [use your graphing calculator] $n = \log_{\frac{1}{2}}(\frac{25}{100})$ $= 2\,\text{half-lives}$ $n = \frac{t}{t_{1/2}}$ $t = t_{1/2} \times n = 12.5 \times 2$ $= 25\ y$
5	Too much mass means alpha decay: ${}^{222}_{86}Rn \rightarrow {}^{4}_{2}He + {}^{218}_{84}Po$