Report on B1 (2007)

132 candidates, mean 67.00, SD 12.35

Q1. 111 attempts, mean 13.1, SD 4.19 A difficult question, with some very good answers. The places marks were lost were in either/both the last two sections. In the second [5] mark section, many candidates did not realise that 3d4s (i.e. $l_1 = 2$, $l_2 = 0$) has only the single possible total angular momentum, $L = 2$. Often, $L = 0$, 1, 2 were considered. In the last (8 mark) part where the interval rule was required, around 50% of the attempts didn't consider it.

An error was discovered in the first part of the question while the exam was in progress and an announcement made. Magnesium ($Z = 12$) was used rather than Calcium ($Z = 20$), which really does have ground state $4s^2$, and the Z of Sc+ was given as 13 rather than 21; i.e., the wrong row of the periodic table was used for the element names and Z. The question was marked independent of which element was used. The marks of the first two sections was high and the variation in the marks on these two sections low.

Q2. 70 attempts, mean 13.1, SD 3.72 Some excellent answers to both parts. The descriptions of the isotope shift rarely mentioned that the hydrogen atom is usually calculated under the assumption of a fixed central charge, i.e. infinite mass. A common difficulty with the last part was not to realise that there was a transition from F to $F - 1$ that must be calculated for H and then for D.

Q3. 126 attempts, mean 13.7, SD 3.05 A very popular question. Most candidates demonstrated a good working knowledge of both the SEMF and the various forms of beta decay. Often either the first half or the second half was answered very well, but rarely both. The question may have benefitted from removing section (a) as it was a bit long. Only a few candidates didn't notice the table at the bottom and started calculating SEMF binding energies.

Q4. 30 attempts, mean 14.0, SD 3.70 Well done by those who attempted this straightforward (but unfamiliar) alpha decay question. There were a large number of very good answers and a few rushed 'last question' attempts which bought the average down a bit.

Q5. 31 attempts, mean 11.7, SD 3.69 Some good answers here. Many people lost a mark on the first section by calculating the point where 99% were remaining rather than 1%. The main computation was sometimes done very well, consideration of the nuclei decaying during the hour of exposure could either be done approximately or with a differential equation. The last part had scope to describe a lot of features of beta and gamma decays and there were some good answers.

Q6. 114 attempts, mean 14.3, SD 3.33 Another popular one, and pleasingly well done by the vast majority of the candidates. The first part, although simple had never come up before and was dauntingly unfamiliar, but most people had a go anyway and got it. The R bit was done consistently well with almost no mistakes which is what made the average mark high. Although not everyone got the last bits, the guesses were rather innovative and not at all wild.

Q7. 97 attempts, mean 13.6, SD 3.58 Many good answers to this popular question, although frustratingly many neutrino oscillation descriptions mixed up the atmospheric oscillation with solar oscillation, so perhaps a larger hint in the question was required. The question did not make clear that E_τ was the kinetic energy and not total energy so this part was marked leniently for those who attempted it relativistically and got lost. Practicaly noone connected the first part with the last part and said that the reason the ν_μ dissapear is that they oscillate into ν_τ which are below threshold.

Q8. 81 attempts, mean 12.6, SD 3.54 A slightly tricky one, but quite a few people got all 20 marks. The first 9 marks were earned by nearly all attempters. The next part was done well by some by one of the two alternative routes. The last part proved quite difficult despite the hint.