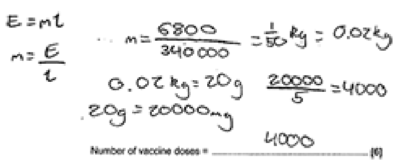
Mark scheme

Question			Answer/Indicative content	Marks	Guidance
1			C	1 (AO 2.1)	**Examiner's Comments** This question was generally well answered. One common error was selecting D, perhaps confused by the quantities, the other common error was selecting A with a power of ten error.
			Total	**1**	
2			A	1 (AO 1.1)	**Examiner's Comments** Most candidates answered that most of the mass is in the nucleus. A small minority of candidates gaveanswer C, perhaps indicating either a misunderstanding between the terms atom and nucleus or a misunderstanding between the terms nucleus and neutron.
			Total	**1**	
3		i	**Any two from:** Energy is needed to change the state of a material ✓ Energy is needed to break / weaken the bonds (between molecules / particles) or overcome attractive forces (between solid (vaccine) molecules) ✓ Some heat transfer with the surroundings / container ✓	2 (2 ×AO 1.2)	**ALLOW** ideas about energy needed to increase separation of molecules **Examiner's Comments** Many candidates scored 1 of the 2 marks for stating the energy is needed for a change in state.
		ii	**First check the answer on answer line** **If answer = 4000 (doses) award 6 marks** m = E ÷ L ✓ m = 6800 ÷ 340000 ✓ m = 0.02 kg ✓ 0.02 kg = 20 000 mg✓	6 (AO 1.2) (AO 2.1) (AO 2.1) (AO 1.2) (AO 2.1) (AO 3.1b)	Rearrangement of the equation **ALLOW** 0.02 ÷ 5 ×10^n (missing or incorrect conversion from mg to kg) for 4 marks

			(number of doses =) $0.02 \div 5\text{x}10^{-6}$ OR 20 000 ÷ 5 ✓ (number of doses =) 4000 ✓ **Or** 5 mg = 5×10^{-6} kg ✓ energy of one dose 5 (mg) × 340000 ✓✓ energy of one does = 1.7 J ✓ (number of doses =) 6800 ÷ 1.7 ✓ (number of doses =) 4000 ✓		**ALLOW** 4×10^{n} doses for 5 marks **ALLOW** $5 \times 10^{n} \times 340000$ for 2 marks **ALLOW** 1.7×10^{n} (power of ten error) for 3 marks **ALLOW** 4×10^{n} doses for 5 marks **<u>Examiner's Comments</u>** This question enabled candidates to decide on their own approach to a multi-stage calculation. Clear working should be encouraged. High scoring candidates rearranged the equation before substituting the numbers from the question. Many candidates struggled with the conversion between kg. Some candidates correctly determined the energy needed to melt one dose and then went on to indicate that this worked out to be 4000 doses. This alternative method was correct physics, and thus full credit was given. Exemplar 2  The candidate clearly rearranges the equation and substitutes in the correct numbers from the question to determine the mass of vaccine melted (0.02 kg). The candidate then indicates how the mass of 0.02 kg is changed initially to a mass of 20 g before changing it to a mass 20 000 mg.

					The final calculation is then shown giving the answer of 4000 doses.
			Total	**8**	
4			**A**	1 (AO 1.1)	**<u>Examiner's Comments</u>** This question was very well answered. The common incorrect response was D where perhaps candidates had not understood 'increasing' density.
			Total	**1**	
5			**B**	1 (AO 1.1)	**<u>Examiner's Comments</u>** The majority of candidates correctly realised that a new theory should be peer reviewed.
			Total	**1**	
6	a	i	**Any three from:** small / tiny nucleus ✓ positively charged nucleus ✓ mass is concentrated in the nucleus ✓ most of atom is empty space ✓	3 (3 × AO1.1)	**IGNORE** reference to electrons **ALLOW** maximum 2 marks for implying nucleus but not stating nucleus **ALLOW** atom has empty space **<u>Examiner's Comments</u>** It was expected that candidates would state that since most of the alpha particles passed straight through, most of the atom is empty space. Since a very small number of alpha particles were reflected straight back, this gave the idea of a small, positive nucleus where the mass of the atom is concentrated. A number of candidates did not mention "nucleus"
		ii	Previous models could not explain new observations / new evidence disproves old model / AW ✓	1 (AO1.2)	**ALLOW** (idea of) previous/plum pudding/Thomson's model did not fit with these observations **ALLOW** shows there is a nucleus / empty space **IGNORE** reference to neutrons (1932) **<u>Examiner's Comments</u>** Many candidates correctly explained that the results from the alpha

					scattering experiment did not support the plum pudding model. Some candidates enhanced the answers by explaining the differences in terms of positive charge.
	b	i	(3 × 8 × 8 =) 192 (m^3) ✓)	1 (AO2.1)	**Examiner's Comments** This question was answered well. High scoring candidates often showed their working.
		ii	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 2.3 / 2.30 / 2.304 award 3 marks** mass = density × volume ✓ 0.012 × 192 ✓ 2.3 / 2.30 / 2.304 (kg) ✓	3 (AO1.2) (AO2.1) (AO2.1)	Possible ECF from 19(b)(i) Correct re-arrangement Correct substitution **Examiner's Comments** This question was answered well. High scoring candidates often showed their working. Candidates should show the rearrangement of the equation and the data correctly substituted.
			Total	**8**	