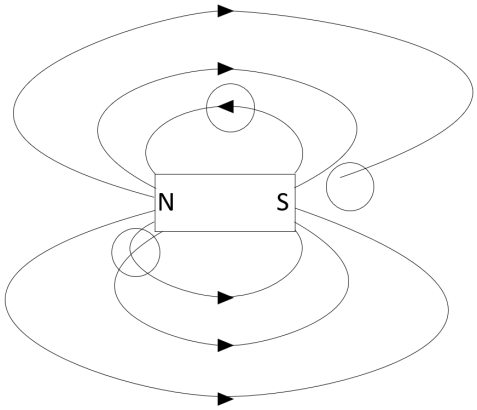
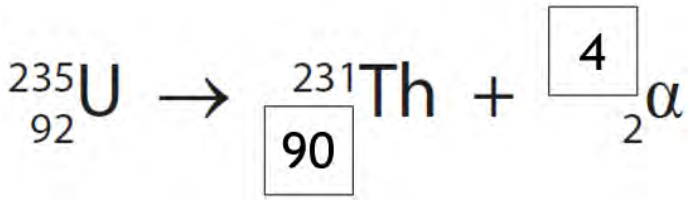
Question number	Answer	Notes	Marks
2 (a)	(plotting) compass(es);	allow **suspended** magnet, magnetometer allow higher level responses e.g. Hall probe, search coil	1
(b)	one mark for each correct indication;;;  	2 marks max. if more than three indications given	3
(c)	any two from: difficult to magnetise; difficult to demagnetise; idea that it retains its magnetism;	 allow idea of taking a long time to magnetise allow idea of taking a long time to demagnetise	2

Total for Question 2 = 6 marks

Question number	Answer	Notes	Marks
4 (a) (i)	use of acceleration = change in velocity / time; substitution; evaluation; e.g. acceleration = change in velocity / time acceleration = (-)30 / 6.2 (acceleration =) (-)4.8 (m/s^2)	seen anywhere in working allow clear indication that acceleration is gradient ignore minus sign allow (-)4.8 to (-)5.0 (m/s^2)	3
(ii)	clear indication that distance is area under line; understanding braking distance is area of triangle section only; evaluation; e.g. distance = area distance = 0.5 × 30 × 6.2 (distance =) 93 (m)	 54 (m) = 1 mark 147 (m) = 2 marks accept alternative method using ecf answer from (a)(i) and $v^2 = u^2 + 2as$ giving 93.75 (m)	3
(iii)	thinking distance: increase in thinking distance; (due to) increased reaction time; braking distance: no effect on braking distance; (due to) no effect on braking time / braking force;	 allow idea that braking distance does not depend on human factors	4
(b)	A; B is incorrect because it does not show deceleration C is incorrect because the distance cannot change abruptly and the car is moving throughout D is incorrect because the first portion shows that the car is not moving		1

Total for Question 4 = 11 marks

Question number	Answer	Notes	Marks
7 (a)	any two from: MP1. alphas do not penetrate as far; MP2. alphas are more ionizing; MP3. alphas are more likely to collide (with material); MP4. alphas have more mass / move slower;	 allow RA allow RA allow RA allow RA	2
(b) (i)	(nuclei with) same numbers of protons; (nuclei with) different numbers of neutrons;	allow (nuclei with) same atomic number allow (nuclei with) different mass number	2
(ii)	one mark for each correct number;; 		2
(iii)	any indication that 2100 million years is 3 half-lives; evaluation of number of uranium nuclei after 1 half-life; (after 2100 million years) there are 800 million uranium nuclei; (after 2100 million years) there are 5600 million thorium nuclei; 5600 (million) / 800 (million) = 7;	 3200 (million) uranium nuclei after one half-life scores first three marks allow total number of nuclei is constant allow 7 × 800 = 5600	5

Total for Question 7 = 11 marks

Question number	Answer	Notes	Marks
9 (a)	use of $v^2 = u^2 + 2as$; substitution; rearrangement; evaluation; e.g. $v^2 = u^2 + 2as$ $v^2 = (0) + 2 \times 10 \times 2.2$ $v = \sqrt{44}$ (v =) 6.6 (m/s)	seen anywhere in working allow use of g=9.8, 9.81 allow alternative method using $mgh = {}^1/_2mv^2$ final answer of 44 (m/s) is 2 marks only allow 6.63…(m/s), 6.56…(m/s) 6.5 scores 3 marks only	4
(b) (i)	vertical arrow drawn upwards;	ignore labels reject if more than one arrow drawn unless resultant force is clearly labelled	1
(ii)	substitution into F = ma; rearrangement; evaluation; e.g. 18 000 = 4100 × a a = 18 000 / 4100 (a =) 4.4 (m/s^2)	 -1 for POT error allow 4.39…(m/s^2)	3

Total for Question 9 = 8 marks

Question number	Answer	Notes	Marks
11 (a) (i)	line drawn in top-right quadrant; correct angle by eye;	accept if drawn on diagram 1 instead of diagram 2 DOP	2
(ii)	32 (degrees);	allow in range 31-33 (degrees)	1
(iii)	refractive index = sin(angle of incidence) / sin(angle of refraction);	allow standard symbols and rearrangements e.g. 'i' for angle of incidence 'r' for angle of refraction 'n' for refractive index	1
(iv)	substitution; evaluation to at least 3s.f.; e.g. n = sin(64) / sin (32) n = 1.70	allow ecf from (ii) allow 1.696…	2
(v)	sin(c) = 1 / n;	allow standard symbols and rearrangements	1
(vi)	substitution OR rearrangement; evaluation; e.g. sin(c) = 1/1.7 OR c = $\sin^{-1}(1/n)$ (c =) 36 (degrees)	allow ecf from (iv) allow 36.03…(degrees)	2
(b)	light undergoes total internal reflection; angle of incidence is above the critical angle; light (would be) going from more (optically) dense to less (optically) dense;	allow TIR for 'total internal reflection' allow idea that light would speed up if it travelled through the boundary / light travels faster in air than in material	3

Total for Question 11 = 12 marks