M1.(a)

	$^{223}_{88}$Ra	$^{224}_{88}$Ra	$^{225}_{88}$Ra	$^{226}_{88}$Ra
Isotope with smallest mass number	(✓)			
Isotope with most neutrons in nucleus				✓
Isotope with nucleus that has highest specific charge	✓			
Isotope that decays by β^- decay to form $^{225}_{89}$Ac			✓	
Isotope that decays by alpha decay to form $^{220}_{86}$Rn		✓		

one mark for each correct row (ignore first row as already ticked)
allow cross instead of tick and ignore any crossed out ticks
if more than one tick in a row then no mark

4

(b) (i) the atom has lost <u>two electrons</u>✓

1

(ii) (*use of specific charge = charge ÷ mass*)
mass = $3.2 \times 10^{-19} \div 8.57 \times 10^{5} = 3.734 \times 10^{-25}$ (kg)
mass number = $3.734 \times 10^{-25} \div 1.66 \times 10^{-27}$ ✓(= 225)
hence $^{225}_{(88)}$Ra OR 225✓✓
OR
calculate specific charge for each isotope✓
hence $^{225}_{(88)}$Ra OR 225✓✓

ignore any reference to electrons
first mark for deduction
bald correct answer scores 2 marks

don't need radium symbol or 88
wrong answer scores zero

3

[8]

M2.A

[1]

M3.C

[1]

M4.C

[1]

M5.(a) 95 protons ✓

1

241 – 95 = 146 neutrons ✓

1

(b) Beta minus decay. ✓

Marks can be given for a correct equation

1

There is no change in the number of nucleons.

The number of protons increases by 1. ✓

Ignore omitted antineutrino.

1

(c) $^{241}_{95}\text{Am} \rightarrow {}^{A}_{Z}\text{X} + {}^{4}_{2}\alpha$ ✓

1

Nucleon number = A = 241 – 4 = 237 ✓

1

Proton number = Z = 95 – 2 = 93 ✓

1

(d) Ionisation is the removal (or addition) of electrons from (to) an atom or molecule ✓

1

(e) Only a small quantity of material is needed ✓

1

The particles it emits do not travel more than a few centimetres ✓

Alternative for 2nd mark: Would be stopped before reaching the outside of the detector

1

[10]

M6.C

[1]

M7.(a) (i) Q / boron / B ✓

1

(ii) P and R / R and P ✓

1

(iii) R ✓

6 / 14 is smallest fraction / 0.43 smallest ratio / 4.13×10^{7} C / kg ✓

Cannot get second mark if not awarded first mark

2

(iv) $^{14}_{6}R \rightarrow {}^{14}_{7}X + {}^{0}_{-1}e + \overline{\nu_{(e)}}$ ✓✓✓

One mark for each correct symbol on rhs
Ignore −ve sign on e.
Can have neutrino with 0,0 on answer lines
Ignore any subscript on neutrino

3

(b) (i) repulsive below / at 0.5 fm (accept any value less or equal to 1 fm) ✓
attractive up to / at 3 fm (accept any value between 0.5 and 10 fm) ✓
short range OR becomes zero OR no effect ✓

Can get marks from labelled graph
Don't accept negligible for 3rd mark

3

(ii) interaction: electromagnetic / em ✓

(virtual) photon/ γ ✓

2

[12]

M8.(a) (i) protons = 20 ✓
neutrons = 28 ✓
electrons = 18 ✓

3

(ii) $2 \times 1.6 \times 10^{-19} = 3.2 \times 10^{-19}$ ✓(C)

-ve sign loses mark

1

(iii) specific charge = 3.2×10^{-19} / (48 ×; 1.67×10^{-27} +18 × 9.11×10^{-31}) ✓

specific charge = 4.0×10^{6} C kg^{-1} ✓

Allow 1.66
Allow CE from (ii)
First mark is for mass if miss out electron mass and do not justify lose first mark

2

[6]

M9.(a) (i) neutron ✓

accept symbols
symbols e.g. n

1

(ii) electron ✓

accept symbols

1

(iii) neutron ✓

accept symbols

1

(b) (i) antineutrino ✓

$V_{(e)}$

1

(ii) A=99 ✓
Z= 44 ✓

2

(iii) specific charge = $43 \times 1.6 \times 10^{-19}$ ✓ / $99 \times 1.66 \times 10^{-27}$ ✓
specific charge = 4.2×10^{7} ✓C kg^{-1} ✓

Correct answer no working −1
If include mass of electrons lose 2 and 3 mark

4

[10]