1. (a) most alpha particles pass straight through the atom

1

which shows that the atom is mostly empty space

1

very few alpha particles are deflected through a large angle

1

which shows the atom contains a nucleus where the mass / charge of the atom is concentrated

1

(b) electron may absorb electromagnetic radiation

full credit may be scored for a description of an electron emitting electromagnetic radiation

1

(and) move further from the nucleus

1

to a higher energy level

1

[7]

2. (a) Alpha – two protons and two neutrons

1

Beta – electron from the nucleus

1

Gamma – electromagnetic radiation

1

(b) Gamma

Beta

Alpha

*allow **1** mark for 1 or 2 correct*

2

(c) any **two** from:

- (radioactive) source not pointed at students
- (radioactive) source outside the box for minimum time necessary
- safety glasses **or** eye protection **or** do not look at source
- gloves
- (radioactive) source held away from body
- (radioactive) source held with tongs / forceps

accept any other sensible and practical suggestion

2

(d) half-life = 80 s **1**

counts / s after 200 s = 71

accept an answer of 70

1

(e) very small amount of radiation emitted

accept similar / same level as background radiation

1

[10]

3. (a) 2 protons and 2 neutrons

accept 2p and 2n

accept (the same as a) helium <u>nucleus</u>

symbol is insufficient

do not accept 2 protons and neutrons

1

(b) (i) gamma rays

1

(ii) loses/gains (one or more) <u>electron(s)</u>

1

(c) any **one** from:

- wear protective clothing
- work behind lead/concrete/glass shielding
- limit time of exposure
- use remote handling

accept wear mask/gloves

wear goggles is insufficient

wear protective equipment/gear is insufficient

accept wear a film badge

accept handle with (long) tongs

accept maintain a safe distance

accept avoid direct contact

1

[4]

4. (a) (i) (atoms with the) same number of protons

allow same atomic number

or *same proton number*

1

(atoms with) different number of neutrons

allow different mass number

1

(ii) 82

1

(iii) 124

1

(b) (i) $^{58}_{26}Fe + {}^{208}_{82}Pb$

1 *mark for each correct box*

3

(ii) (a) neutron

1

(iii) 4.0×10^{-4} (s)

or

0.0004

$3.00 \times 10^{8} \times 0.1 = 12\,000 / t$

gains ***1*** *mark*

2

(iv) particles need to travel a large distance

1

equipment would have to be very long

1

with circular paths long distances can be accommodated in a smaller space

1

(c) (i) the average time for the number of nuclei to halve **1**

the time for count rate to halve **1**

(ii) $^{261}_{106}Sg + {}^{4}_{2}\alpha$

1 *mark if top boxes total = 265*
and *bottom boxes total = 108*
1 *mark for 4 and 2 for alpha* **2**

(d) (i) 3 plotted points
± ½ small square **1**

best line through points **1**

(ii) 190−205 (pm)
or correct from student's line **1**

[20]

5. (a) neutrons and protons **1**

(b) 0 **1**

(+)1 **1**

(c) (i) total positive charge = total negative charge
accept protons and electrons have an equal opposite charge **1**

(because) no of protons = no of electrons **1**

(ii) ion **1**

positive **1**

[7]

6. (a) (i) neutron **1**

(ii) neutron
proton
both required, either order
1

(iii) 2
1

number of <u>protons</u>
do not accept number of electrons
1

(b) (i) any **one** from:

- beta
- gamma

accept correct symbols
accept positron / neutrino / neutron
cosmic rays is insufficient
1

(ii) electrons
1

(iii) are highly ionising
1

(c) (i) mutate / destroy / kill / damage / change / ionise
Harm is insufficient
1

(ii) much smaller than
1

[9]