

M1. (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]

- M2.** (a) alpha particles **cannot** pass through...  
*do not accept gamma particles...*  
**or**  
 alpha particles can pass through a very thin sheet of **paper / card**  
*credit answers where correct amendments are made to boxed statement*
- 1
- (b) (i) horizontal and vertical line drawn at correct positions on the graph  
*accept a cross drawn at 4500 / 500 on the curve*  
**or**  
*two pairs of lines drawn, for example, at 600 and 300*  
*accept a horizontal line drawn at 500 on its own*  
*do not accept vertical lines only*
- 1
- (ii) 4500 million years
- 1
- (iii) half-life too long  
*do not accept simply its half-life is 4500 million years*
- 1
- no (measurable) change in count rate  
*do not accept have not got the equipment*  
*do not accept it's harmful (to children)*  
*if neither of the above points scored, accept not enough time to measure it for 1 mark*
- 1

[5]

**M3.** (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

(d) Marks awarded for this answer will be determined by the quality of communication as well as the standard of the scientific response. Examiners should apply a best-fit approach to the marking.

**0 marks**

No relevant content

**Level 1 (1 – 2 marks)**

There is a basic description of at least **one** of the particles in terms of its characteristics.

**Level 2 (3 – 4 marks)**

There is a clear description of the characteristics of **both** particles  
**or**  
a full description of either alpha **or** beta particles in terms of their characteristics.

**Level 3 (5 – 6 marks)**

There is a clear and detailed description of **both** alpha and beta particles in terms of their characteristics.

**examples of the physics points made in the response:****structure**

- alpha particle consists of a helium nucleus
- alpha particle consists of 2 protons and 2 neutrons
- a beta particle is an electron
- a beta particle comes from the nucleus

**penetration**

- alpha particles are very poorly penetrating
- alpha particles can penetrate a few cm in air
- alpha particles are absorbed by skin
- alpha particles are absorbed by thin paper
- beta particles can penetrate several metres of air
- beta particles can pass through thin metal plate / foil
- beta particles can travel further than alpha particles in air
- beta particles can travel further than alpha particles in materials eg metals

**deflection**

- alpha particles and beta particles are deflected in opposite directions in an electric field
  - beta particles are deflected more than alpha particles
  - alpha particles have a greater charge than beta particles but beta particles have much less mass
- or**
- beta particles have a greater specific charge than alpha particles

6

[13]

**M4. (a) (i) L**

**1**

**(ii) M**

**1**

**(b) To make a smoke detector work.**

**1**

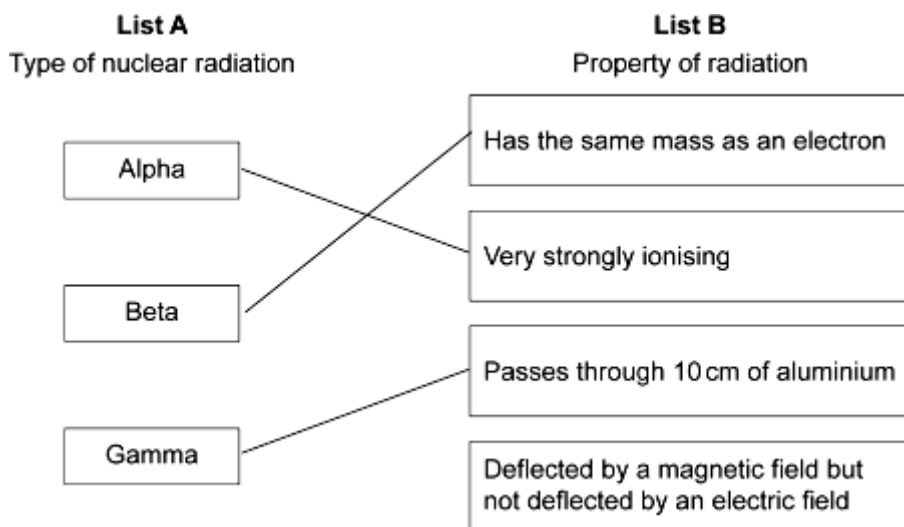
**(c) 40**

*no tolerance*

**1**

**[4]**

M5. (a) 1 mark for each correct line



*if more than 1 line is drawn from any box in List A, none of those lines gain any credit*

3

(b) (i) (the detector) reading had gone down

*'it' equals detector reading*

*accept the reading in the table is the smallest*

*accept 101 is (much) lower than other readings / a specific value eg 150*

*do **not** accept this answer if it indicates the readings are the thickness*

1

more beta (particles / radiation) is being absorbed / stopped

*accept radiation for beta particles / radiation*

*accept fewer particles being detected*

1

(ii) six years

1

(iii) alpha would not penetrate the cardboard

*accept the basic property – alpha (particles) cannot pass through paper / card*

*accept alpha (particles) are less penetrating (than beta)  
range in air is neutral*

1

[7]

- M6.** (a) nucleus  
do **not** accept core / centre / middle 1
- (b) radiation damages our cells  
accept radiation is dangerous / poisonous / harmful / toxic  
accept radiation can cause cancer / kills cells / change DNA /  
cause mutations / harm health  
accept so precautions can be taken  
accept so they know they may be exposed to / harmed by  
radiation it refers to radiation (source)  
to stop people being harmed is insufficient 1
- (c) **C** 1
- (d) gamma 1
- gamma will pass through the lead  
reason only scores if gamma chosen  
**or**  
alpha and beta will not pass through lead  
accept correct symbols for alpha, beta and gamma 1
- (e) (i) range of alpha too short  
accept alpha would not reach detector  
**or**  
alpha absorbed whether box is full or empty  
accept alpha (always) absorbed by box / card  
accept alpha will not pass through the box / card  
alphas cannot pass through objects / solids is insufficient  
alpha not strong enough is insufficient 1



(ii) **M**

*reason only scores if M chosen*

1

less radiation / beta (particles) absorbed

*accept more radiation / beta particles pass through*

**or**

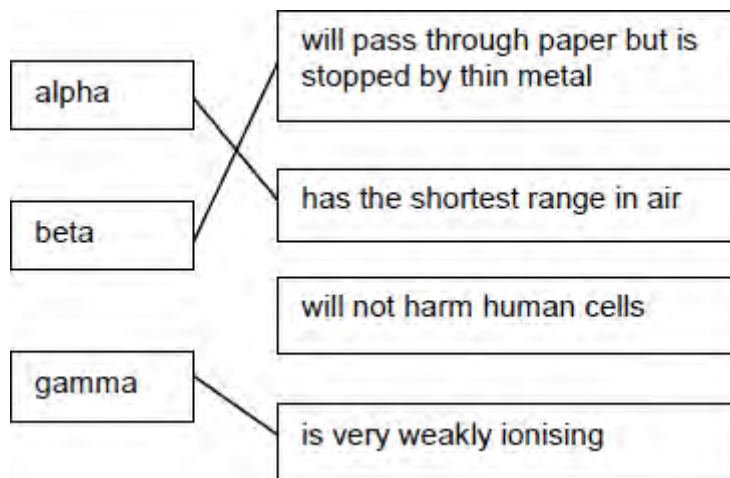
more radiation absorbed by full boxes

*accept reading is higher*

1

**[8]**

M7. (a) 3 lines correct



*allow 1 mark for each correct line  
if more than one line is drawn from any type of radiation box  
then all of those lines are wrong*

3

(b) Gamma radiation will pass through the body

1

(c) half

1

(d) protons

1

[6]