

# Atoms and Nuclear Radiation

## Mark Scheme 1

<b>Level</b>	GCSE (9-1)
<b>Subject</b>	Combined Science: Trilogy - Physics
<b>Exam Board</b>	AQA
<b>Topic</b>	6.4 Atomic Structure
<b>Sub-Topic</b>	Atoms and Nuclear Radiation
<b>Difficulty Level</b>	Bronze Level
<b>Booklet</b>	Mark Scheme 1

**Time Allowed:** 59 minutes

**Score:** /58

**Percentage:** /100

**Grade Boundaries:**

**M1.(a)** The nucleus will emit a neutron.

1

(b) **Similarity**

same mass number

*allow same number of nucleons (protons + neutrons)*

1

**difference**

different atomic number

*allow different number of protons*

1

(c) Radioactive decay is random.

1

(d) 1.3 (billion years)

*allow 1.2-1.4 (billion years)*

2

*allow 1 mark for horizontal line drawn from ~ 550*

(e) alpha

1

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**M2.(a)** (mass number) 231

1

(protons) 92

1

(neutrons) 141

1

(b) 2 / two (hours)

1

(because) count rate halves in that time

1

(c) A high-speed electron

1

(d) uncontrolled

1

benign

1

[8]

**M3.(a)** gamma

*allow 1 mark for 1 or 2 correct*

beta

alpha

2

(b) any **two** from:

- do not point (radioactive) source at students
- keep (radioactive) source outside the box for minimum time necessary
- wear safety glasses **or** eye protection **or** do not look at source
- wear gloves

- hold (radioactive) source away from body
- hold (radioactive) source with tongs / forceps

2

- (c) as time increases count rate decreases

1

count rate halves every 80 seconds

1

- (d) half-life is 80 seconds

1

so after 200 seconds count rate = 113

1

- (e) because a very small amount of radiation will be emitted **or** will be similar to / same as background radiation

1

[9]

**M4.(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

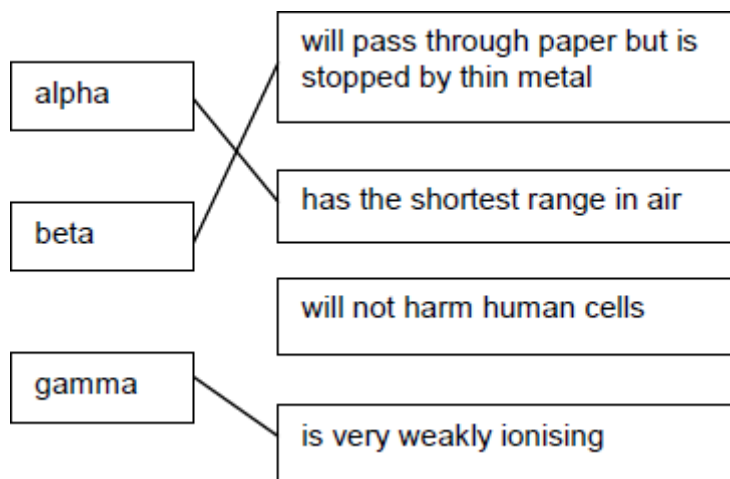
## deflection

- 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]

**M5.(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]

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**

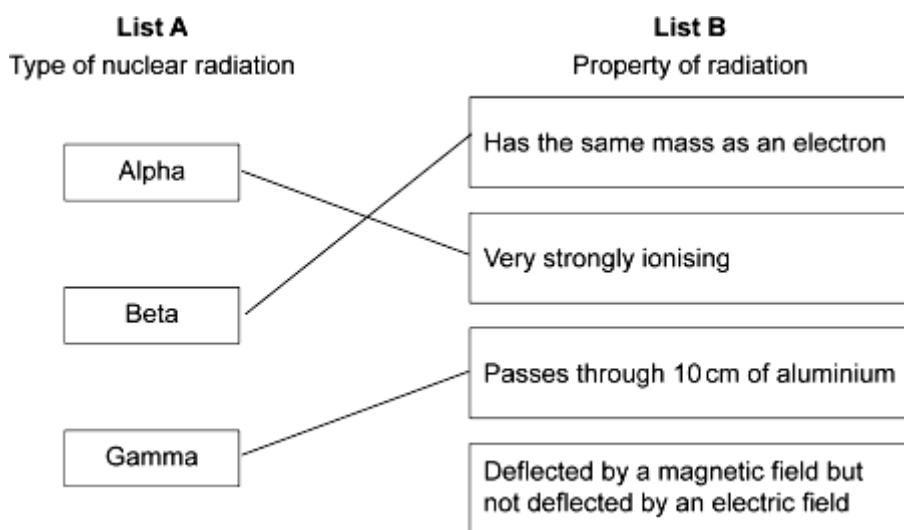
more radiation absorbed by full boxes

*accept reading is higher*

1

[8]

**M7.** (a) 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]