

Higher

GCSE

Physics B Twenty First Century Science

J259/03: Breadth in physics (Higher Tier)

General Certificate of Secondary Education

Mark Scheme for June 2024

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

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MARKING INSTRUCTIONS

PREPARATION FOR MARKING

RM ASSESSOR

1. Make sure that you have accessed and completed the relevant training packages for on-screen marking: *RM Assessor Online Training*; *OCR Essential Guide to Marking*.
2. Make sure that you have read and understood the mark scheme and the question paper for this unit. These are available in RM Assessor.
3. Log-in to RM Assessor and mark the **required number** of practice responses (“scripts”) and the **required number** of standardisation responses.

MARKING

1. Mark strictly to the mark scheme.
2. Marks awarded must relate directly to the marking criteria.
3. The schedule of dates is very important. It is essential that you meet the RM Assessor 50% and 100% (traditional 50% Batch 1 and 100% Batch 2) deadlines. If you experience problems, you must contact your Team Leader (Supervisor) without delay.
4. If you are in any doubt about applying the mark scheme, consult your Team Leader by telephone, email or via the RM Assessor messaging system.
5. **Crossed Out Responses**
Where a candidate has crossed out a response and provided a clear alternative then the crossed out response is not marked. Where no alternative response has been provided, examiners may give candidates the benefit of the doubt and mark the crossed out response where legible.

Rubric Error Responses – Optional Questions

Where candidates have a choice of question across a whole paper or a whole section and have provided more answers than required, then all responses are marked and the highest mark allowable within the rubric is given. Enter a mark for each question answered into RM assessor, which will select the highest mark from those awarded. *(The underlying assumption is that the candidate has penalised themselves by attempting more questions than necessary in the time allowed.)*

Multiple Choice Question Responses

When a multiple choice question has only a single, correct response and a candidate provides two responses (even if one of these responses is correct), then no mark should be awarded (as it is not possible to determine which was the first response selected by the candidate).

When a question requires candidates to select more than one option/multiple options, then local marking arrangements need to ensure consistency of approach.

Contradictory Responses

When a candidate provides contradictory responses, then no mark should be awarded, even if one of the answers is correct.

Short Answer Questions (requiring only a list by way of a response, usually worth only **one mark per response**)

Where candidates are required to provide a set number of short answer responses then only the set number of responses should be marked. The response space should be marked from left to right on each line and then line by line until the required number of responses have been considered. The remaining responses should not then be marked. Examiners will have to apply judgement as to whether a 'second response' on a line is a development of the 'first response', rather than a separate, discrete response. *(The underlying assumption is that the candidate is attempting to hedge their bets and therefore getting undue benefit rather than engaging with the question and giving the most relevant/correct responses.)*

Short Answer Questions (requiring a more developed response, worth **two or more marks**)

If the candidates are required to provide a description of, say, three items or factors and four items or factors are provided, then mark on a similar basis – that is downwards (as it is unlikely in this situation that a candidate will provide more than one response in each section of the response space.)

Longer Answer Questions (requiring a developed response)

Where candidates have provided two (or more) responses to a medium or high tariff question which only required a single (developed) response and not crossed out the first response, then only the first response should be marked. Examiners will need to apply professional judgement as to whether the second (or a subsequent) response is a 'new start' or simply a poorly expressed continuation of the first response.

6. Always check the pages (and additional objects if present) at the end of the response in case any answers have been continued there. If the candidate has continued an answer there then add a tick to confirm that the work has been seen.

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7. Award No Response (NR) if:
- there is nothing written in the answer space

Award Zero '0' if:

- anything is written in the answer space and is not worthy of credit (this includes text and symbols).

Team Leaders must confirm the correct use of the NR button with their markers before live marking commences and should check this when reviewing scripts.

8. The RM Assessor **comments box** is used by your Team Leader to explain the marking of the practice responses. Please refer to these comments when checking your practice responses. **Do not use the comments box for any other reason.**

If you have any questions or comments for your Team Leader, use the phone, the RM Assessor messaging system, or email.

9. Assistant Examiners will send a brief report on the performance of candidates to their Team Leader (Supervisor) via email by the end of the marking period. The report should contain notes on particular strengths displayed as well as common errors or weaknesses. Constructive criticism of the question paper/mark scheme is also appreciated.

10. For answers marked by levels of response:

Read through the whole answer from start to finish, using the Level descriptors to help you decide whether it is a strong or weak answer. The indicative scientific content in the Guidance column indicates the expected parameters for candidates' answers, but be prepared to recognise and credit unexpected approaches where they show relevance. Using a 'best-fit' approach based on the skills and science content evidenced within the answer, first decide which set of level descriptors, Level 1, Level 2 or Level 3, best describes the overall quality of the answer.

Once the level is located, award the higher or lower mark:

The higher mark should be awarded where the level descriptor has been evidenced and all aspects of the communication statement (in italics) have been met.

The lower mark should be awarded where the level descriptor has been evidenced but aspects of the communication statement (in italics) are missing.

In summary:

The skills and science content determines the level.

The communication statement determines the mark within a level.

11. Annotations available in RM Assessor

Annotation	Meaning
	Correct response
	Incorrect response
	Omission mark
	Benefit of doubt given
	Contradiction
	Rounding error
	Error in number of significant figures
	Error carried forward
	Level 1
	Level 2
	Level 3
	Benefit of doubt not given
	Noted but no credit given
	Ignore

12. Abbreviations, annotations and conventions used in the detailed Mark Scheme (to include abbreviations and subject-specific conventions).

Annotation	Meaning
/	alternative and acceptable answers for the same marking point
✓	Separates marking points
DO NOT ALLOW	Answers which are not worthy of credit
IGNORE	Statements which are irrelevant
ALLOW	Answers that can be accepted
()	Words which are not essential to gain credit
—	Underlined words must be present in answer to score a mark
ECF	Error carried forward
AW	Alternative wording
ORA	Or reverse argument

13. Subject-specific Marking Instructions

INTRODUCTION

Your first task as an Examiner is to become thoroughly familiar with the material on which the examination depends. This material includes:

- the specification, especially the assessment objectives
- the question paper
- the mark scheme.

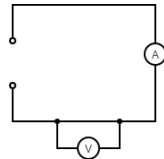
You should ensure that you have copies of these materials.

You should ensure also that you are familiar with the administrative procedures related to the marking process. These are set out in the OCR booklet **Instructions for Examiners**. If you are examining for the first time, please read carefully **Appendix 5 Introduction to Script Marking: Notes for New Examiners**.

Please ask for help or guidance whenever you need it. Your first point of contact is your Team Leader.

The breakdown of Assessment Objectives for GCSE (9-1) in Physics B:

	Assessment Objective
AO1	Demonstrate knowledge and understanding of scientific ideas and scientific techniques and procedures.
AO1.1	Demonstrate knowledge and understanding of scientific ideas.
AO1.2	Demonstrate knowledge and understanding of scientific techniques and procedures.
AO2	Apply knowledge and understanding of scientific ideas and scientific enquiry, techniques and procedures.
AO2.1	Apply knowledge and understanding of scientific ideas.
AO2.2	Apply knowledge and understanding of scientific enquiry, techniques and procedures.
AO3	Analyse information and ideas to interpret and evaluate, make judgements and draw conclusions and develop and improve experimental procedures.
AO3.1	Analyse information and ideas to interpret and evaluate.
AO3.1a	Analyse information and ideas to interpret.
AO3.1b	Analyse information and ideas to evaluate.
AO3.2	Analyse information and ideas to make judgements and draw conclusions.
AO3.2a	Analyse information and ideas to make judgements.
AO3.2b	Analyse information and ideas to draw conclusions.
AO3.3	Analyse information and ideas to develop and improve experimental procedures.
AO3.3a	Analyse information and ideas to develop experimental procedures.
AO3.3b	Analyse information and ideas to improve experimental procedures.

Question			Answer	Marks	AO	Guidance
1	(a)		Use of correct symbols for ammeter and voltmeter ✓ Wire and power supply and ammeter in series ✓ Voltmeter in parallel around the wire ✓	3	1 × 1.1 2 × 1.2	ALLOW lines through meters  ALLOW a resistor symbol for wire / a cell symbol for power supply IGNORE additional components / short circuits ALLOW voltmeter in parallel across the power supply if there are no other components in the circuit other than the ammeter, the power supply and the wire.

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	(b)	(i)	Both Plotted to within $\frac{1}{2}$ small square ✓ (0.65, 3.2) and (0.98, 4.8)	1	1.2	Use overlay
		(ii)	Straight LOBF ✓	1	2.2	All points within 1 small square of the line vertically. ALLOW one anomalous point identified or clearly anomalous IGNORE minor errors e.g. feathering / tramlines DO NOT ALLOW line thickness > 1 small square ALLOW ECF from incorrectly plotted points and judge the line on the balance of points above and below
		(iii)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 5 award 2 marks. Find the gradient of the line from two sets of coordinates taken from the line. e.g. $\frac{6-0}{1.2-0}$ ✓ = 5 ✓	2	2 × 2.2	ALLOW e.g. $\Delta y \div \Delta x$ or rise over run ALLOW any gradient value that rounds to 5 at 1 s.f. ALLOW ECF for 2 marks using their two sets of x and y coordinates (from their line)
		(iv)	5 (Ω) ✓	1	3.2a	ALLOW ECF from part (iii), their gradient rounded to 1 s.f. or better ALLOW any value that rounds to 5 at 1 s.f. If answer out of range: ALLOW correct evaluation of $y \div x$ values from their line of best fit. Working must be seen.
	(c)		The resistance will increase ✓ Double length will double resistance / a statement about resistance being proportional to length ✓	2	2 × 3.2b	ALLOW resistance doubles = 2 marks ALLOW for 2 marks e.g. it will be 10 Ω (instead of 5) or check for use of 2x their value in (b)(iv)
			Total	10		

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Question			Answer	Marks	AO	Guidance																								
2	(a)		star / comet / (artificial) satellite / asteroid / meteor ✓	1	1.1	IGNORE other named planets, the Sun / moons / dust / rocks / gases																								
	(b)		Any one calculation ✓ and corresponding comparison ✓	2	3.2a	ALLOW for max 1 mark rough estimate e.g. 3480 is about a third/quarter of Earth's diameter or e.g. moon is much less than diameter of Earth ALLOW ≠ or is not as AW for < or > ALLOW any correct MP2 also gains MP1 ALLOW for 2 marks the student is correct for Charon:Pluto with correct corresponding calculation <table><tr><td>Moon and Earth</td><td>Pluto and Charon</td></tr><tr><td>3480 ÷ 12700 or 0.274...</td><td>1210 ÷ 2370 or 0.51</td></tr><tr><td>0.274 < 0.5</td><td>0.51 ≈ or > 0.5</td></tr><tr><td>OR</td><td></td></tr><tr><td>12700 ÷ 3480 or 3.6</td><td>2370 ÷ 1210 or 1.96</td></tr><tr><td>3.6 > 2 or 3.6 is ≈ a third</td><td>1.96 ≈ or < 2</td></tr><tr><td>OR</td><td></td></tr><tr><td>12700 ÷ 2 or 6350</td><td>2370 ÷ 2 or 1185</td></tr><tr><td>6350 > 3480</td><td>1185 ≈ or <1210</td></tr><tr><td>OR</td><td></td></tr><tr><td>2 x 3480 or 6960</td><td>2 x 1210 or 2420</td></tr><tr><td>6960 < 12700</td><td>2420 ≈ or > 2370</td></tr></table>	Moon and Earth	Pluto and Charon	3480 ÷ 12700 or 0.274...	1210 ÷ 2370 or 0.51	0.274 < 0.5	0.51 ≈ or > 0.5	OR		12700 ÷ 3480 or 3.6	2370 ÷ 1210 or 1.96	3.6 > 2 or 3.6 is ≈ a third	1.96 ≈ or < 2	OR		12700 ÷ 2 or 6350	2370 ÷ 2 or 1185	6350 > 3480	1185 ≈ or <1210	OR		2 x 3480 or 6960	2 x 1210 or 2420	6960 < 12700	2420 ≈ or > 2370
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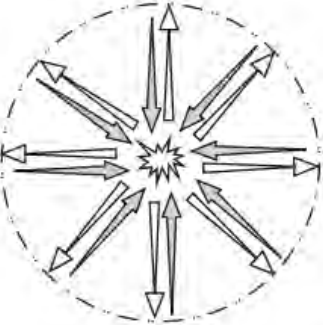
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Question			Answer	Marks	AO	Guidance
	(c)		Pluto has longer orbital time / moves more slowly (than Earth) ORA ✓ Any one from as it is further from the Sun AW ORA ✓ force between Sun and Pluto is less than that between Sun and Earth ORA ✓ Pluto has further to travel / circumference of orbit longer ORA ✓	2	2 × 2.1	Must be a comparison.
	(d)		gravity ✓ fusion ✓	2	1.1	Must be in this order

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Question			Answer	Marks	AO	Guidance
	(e)			1	2.1	Top left box indicated
			TOTAL	8		

Question			Answer	Marks	AO	Guidance
3	(a)		Brake disc ✓	1	3.2b	
	(b)		The brakes apply <u>friction</u> / <u>a contact force</u> (on the brake disc) ✓ does work on the wheel/disc or force in opposite direction (to motion) or brake levers transfer force to brake pads ✓	2	1.1 2.1	IGNORE friction between wheels and road IGNORE deceleration (slow down is in the stem) IGNORE pressure ALLOW backwards / negative / counters as AW for opposite direction / just opposing force IGNORE KE transferred (to thermal) see 3c
	(c)		kinetic ✓ thermal ✓	2	1.1	Must be in this order
	(d)		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 6000 award 3 marks Increase in internal energy = mass x specific heat capacity x change in temperature (selected or use of) / $E = mc\theta$ ✓ $E = 0.2 \times 500 \times 60$ ✓ $= 6\,000 \text{ J}$ ✓	3	1.2 2.1	ALLOW MP2 also gains MP1
				8		

Question		Answer	Marks	AO	Guidance
4	(a)	Vibrations are at right angle / 90° / perpendicular ✓ (perpendicular) to the direction of the wave / energy / travel ✓ OR energy transfer is at a right angle/perpendicular ✓ (perpendicular) to the direction of vibration ✓	2	1.1	ALLOW disturbance / oscillation / goes up and down / has peaks and troughs as AW for vibration ALLOW motion as AW for travel
	(b)	Max displacement or distance from (peak or trough) ✓ (to) mean or equilibrium or rest position ✓	2	1.1	ALLOW amplitude correctly labelled on a sketch of a wave ALLOW zero / equilibrium / mean position labelled IGNORE median / midpoint
	(c)	(i)  ✓	1	2.2	
			5		

Question			Answer	Marks	AO	Guidance
5	(a)		EITHER circuit showing an ammeter in series with lamp(s) or (ammeter to) measure current ✓ at least 2 circuits showing ammeter in series with varying numbers of lamps in series or vary the number of lamps and measure current ✓ OR circuit with a single lamp showing voltmeter across the lamp or (voltmeter to) measure voltage ✓ at least 2 circuits showing voltmeter across a lamp with varying numbers of lamps in series or vary the number of lamps and measure voltage across one lamp ✓	2	3.3b	IGNORE references to light-meters, LDRs IGNORE conclusions or trends IGNORE any other components IGNORE just 'each circuit' – not sufficient for vary the number of lamps
	(b)		brightness decreases ✓ current decreases / voltage per lamp decreases ✓ resistance increases ✓	3	1.2	ALLOW voltage is shared/split/divided (between each lamp) ALLOW less charge transferred as AW for current IGNORE current is divided ALLOW power (produced in each lamp) decreases IGNORE energy decreases

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	(c)	Any three from LED needs replacing less frequently / fewer need to be made / fewer need to be thrown away / less waste ORA ✓ (less replacing so) LED: less use of Earth's resources ✓ Calculation of energy per hour (over lifetime): 18 or 54 or calculation of energy transfer in lifetime of other lamp ✓ comparison: LED use less power than halogen ORA ✓ (The LED operates at lower power), so costs less to run / gives less CO₂ per second ✓	3	3.1b	IGNORE just LED last longer / halogen run out sooner ALLOW LED last 6 x longer or 20 000h more ALLOW 0.018 (kW/h) or 0.054 (kW/h) or 18.5 (h/kW) or 55.6 (h/kW) ALLOW Halogen would use 1296 kWh in 24000 h or LED would use only 72 kWh in 4000 h IGNORE just halogen transfers more energy ALLOW e.g. halogen transfers more energy in its lifetime as AW for power IGNORE just LED cheaper
			8		

Question			Answer	Marks	AO	Guidance
6	(a)		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 1 200 000 J award 4 marks Conversion of 40 kW to 40000 W ✓ Select equation $E = P \times t$ ✓ Substitution (any subject) $E = 40000 \times 30$ ✓ Evaluation $E = 1\,200\,000$ (J) ✓	4	1 x 1.1 1 x 1.2 2 x 2.1	ALLOW $E = P \times t$ in any form ALLOW 1.2×10^n where $n \neq 6$ (no, or incorrect kW to W conversion) = 3 marks ALLOW for 3 marks no conversion of kW: $(30 \times 40) = 1200$
	(b)		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 28(.3) m/s award 4 marks Select $v^2 - u^2 = 2as$ ✓ Substitution of $s = 40$ m and $u = 0$ into equation ✓ $v^2 = (2 \times 10 \times 40) = 800$ ✓ $v = 28.3$ m/s ✓	4	1 x 1.1 3 x 2.1	2 nd mark must have 40 m as height. ALLOW for MP1 and MP2: $2 \times 10 \times 40 = v^2$ but NOT if u^2 is in the equation e.g. $v^2 - u^2 = 800$ ALLOW for 3 marks $v = \sqrt{800}$ or $20\sqrt{2}$ etc.
	(c)		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 730 000 J award 3 marks Select $KE = \frac{1}{2}mv^2$ ✓ Substitution: $KE = 0.5 \times (1500 + 840) \times 25^2$ ✓ Evaluation = 731 250 J ✓	3	1.1 2 x 2.1	ALLOW as evidence of formula $\frac{1}{2} \times \text{their mass} \times 25^2$ (MP1 only)
				11		

Question			Answer	Marks	AO	Guidance
7	(a)	(i)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 2.5 award 3 marks EITHER use of acceleration = gradient OR select and apply equation $a = (v-u)/t$ ✓ Substitution e.g. $30 \div 12$ ✓ $= 2.5 \text{ (m/s}^2\text{)}$ ✓	3	1.2 2 x 2.2	ALLOW any correct gradient calculation. ALLOW just s/t ALLOW if not 2.5, from 2.3 to 2.7 = 2 marks (evidence of formula and minor read-off error)
	(a)	(ii)	Area between the line and the x-axis ✓	1	1.1	
	(a)	(iii)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 28 500 award 3 marks Select: momentum = mass x velocity ✓ $= 950 \times 30$ ✓ $= 28\,500 \text{ (kg m s}^{-1}\text{)}$ ✓	3	1.1 2 x 2.1	Only allow the value 30 m/s read from the graph
	(b)		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 4750 N award 3 marks Select change in momentum = force x time ✓ $F = 14250 \div 3$ ✓ $= 4750 \text{ (N)}$ ✓	3	1.1 2 x 2.1	ALLOW MP2 also gains MP1
				10		

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Question			Answer	Marks	AO	Guidance
8	(a)		Compression (mm) 1 2 3 4 5 All correct ✓	1	2.1	IGNORE whether or not there is a minus sign
	(b)		Compression and the force both increase by the same increment each time ✓	1	3.1b	ALLOW 0.05 N increases compression by 1mm / a graph of force v compression is a straight line / force ÷ compression = a constant IGNORE just compression increases with force
	(c)		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 50 N/m award 4 marks Select $F = kx$ ✓ Substitution of a pair of values from the table into the equation. E.g. $0.25 = k \times 5$ ✓ Conversion from mm to m e.g. 5 mm = 0.005 m ✓ $k = 0.25 \div 0.005 = 50 \text{ (N/m)}$ ✓	4	1.2 2.2 1.1 2.2	ALLOW ECF using their compression value and corresponding force in part (a) for full marks ALLOW 5×10^n where $n \neq 1$ = 3 marks ALLOW e.g. $0.25 \div (\text{their compression} \div 1000)$ ALLOW max 3 for POT (power of ten) errors using their data
	(d)	(i)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.006 (J) or 6×10^{-3} award 3 marks Energy stored = area under graph or $\frac{1}{2} b \times h$ ✓ Substitution $E = \frac{1}{2} \times 0.01 \times 1.2$ ✓ Evaluation $E = 0.006 \text{ J}$ ✓	3	1.1 2 x 2.2	IGNORE POT errors as there are no unit conversions Alternative approach: M1 $E = \frac{1}{2} kx^2$ or $k = 120$ M2 substitution $E = \frac{1}{2} \times 120 \times 0.01^2$ M3 Evaluation $E = 0.006 \text{ (J)}$

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Question			Answer	Marks	AO	Guidance
9	(a)		A battery is d.c. / direct current ✓ A transformer must be a.c or transformers need a changing current/p.d.) ✓ (to produce) a changing magnetic field ✓	3	1.1	ALLOW a battery is d.c. instead of a.c. = 2 marks IGNORE references to induction
	(b)		The ratio of number of turns is the same as the ratio of potential differences / $V_p / V_s = N_p / N_s$ ✓ Use at least one pair of values from the data to calculate the ratio here (20:1 or factor of 20 less) ✓	2	1.1 2.1	ALLOW primary: 20x more turns so 20x more volts = 2 marks ALLOW secondary: 1/20th turns so 1/20th volts = 2 marks ALLOW for one mark $230 \div 11.5 = 20$ or $2000 \div 100 = 20$ and both calculations = 2 marks ALLOW for one mark substitution of ratio e.g. $2000 \div 20 = 100$ (turns) or $230 \div 20 = 11.5V$ and both calculations = 2 marks ALLOW if no other mark, $230/2000 = 0.115$ or $11.5/100 = 0.115$ OR $2000/230 = 8.7$ or $100/11.5 = 8.7$ = 1 mark
	(c)		Energy lost as thermal / power loss / $P = I^2 R$ ✓ Fire risk / wires can overheat ✓	2	1.1	ALLOW heat is produced ALLOW light fitting too hot to touch / risk of burn from touching light fitting IGNORE just 'too hot' unqualified IGNORE risk of explosion / dangerous to touch / lamp blows / fuse blows / power cut
				7		

Question			Answer	Marks	AO	Guidance
10	(a)		A neutron turns/decays into a proton ✓ (and an electron) The sum of protons + neutrons does not change ✓	2	1.1	ALLOW proton/atomic number increases by one or neutron number decreases by one IGNORE electron statements e.g. electrons have 0 mass IGNORE just atomic mass is protons and neutrons
	(b)	(i)	12 ✓ Be ✓	2	1.1	$^{12}_4\text{Be}$
		(ii)	time taken for the activity to halve or time taken to halve original number of unstable nuclei ✓	1	1.1	ALLOW time taken for half of the particles to decay IGNORE e.g. for the material to halve / mass to halve
	(c)	(i)	They are the (more) ionising (than gamma rays) ✓	1	1.1	
		(ii)	Gamma and most penetrating/leaves body ✓	1	1.1	ALLOW (gamma) not absorbed (by patient) / escapes (from patient) IGNORE explanations about alpha
		(iii)	Any one from Wear lead aprons / lead-lined clothes ✓ Stand well away / separate room ✓ Stand behind a screen / wall / use shielding ✓	1	1.1	IGNORE protective clothing / PPE / gloves / radiation suits / exposure time / reference to storage
		(iv)	Before decay: Boron-10 = 10 and Neutron = 1 ✓ After decay: Lithium 7 + 4 (alpha) and before and after mass numbers add up to 11 ✓	2	3.2b	ALLOW B and n have mass 11 MUST see 1 for neutron ALLOW Li and alpha have mass 11 MUST see 4 for alpha ALLOW 11 implied e.g. $10+1 = 7+4 = 2$ marks ALLOW e.g. Bo for boron / L for lithium in nuclear equations / missing or incorrect proton numbers
				10		

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