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

OCR (Oxford Cambridge and RSA) is a leading UK awarding body, providing a wide range of qualifications to meet the needs of candidates of all ages and abilities. OCR qualifications include AS/A Levels, Diplomas, GCSEs, Cambridge Nationals, Cambridge Technicals, Functional Skills, Key Skills, Entry Level qualifications, NVQs and vocational qualifications in areas such as IT, business, languages, teaching/training, administration and secretarial skills.

It is also responsible for developing new specifications to meet national requirements and the needs of students and teachers. OCR is a not-for-profit organisation; any surplus made is invested back into the establishment to help towards the development of qualifications and support, which keep pace with the changing needs of today's society.

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.

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.

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.

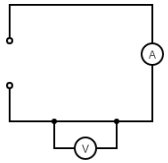
You should ensure that you have copies of these materials.

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 ✓	3	1 × 1.1	**ALLOW** lines through meters 
			Wire and power supply and ammeter in series ✓		2 × 1.2	**ALLOW** a resistor symbol for wire / a cell symbol for power supply **IGNORE** additional components / short circuits
			Voltmeter in parallel around the wire ✓			**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.

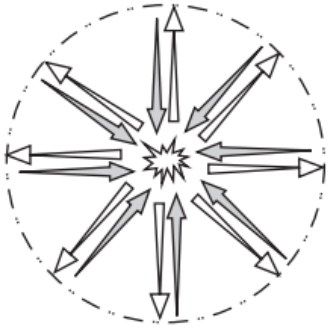
	(b)	**(i)**	Both Plotted to within ½ small square ✓ (0.65, 3.2) and (0.98, 4.8)	**1**	**1.2**	Use overlay
		(ii)	Straight LOBF ✓	**1**	**2.2**	All points within 1 small square of the line vertically. **ALLOW** one anomalous point identified **or** clearly anomalous **IGNORE** minor errors e.g. feathering / 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. Δy ÷ Δx **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 ÷ 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**		

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>AO</th><th>Guidance</th></tr>
<tr><td>2</td><td>(a)</td><td></td><td>star / comet / (artificial) satellite / asteroid / meteor ✓</td><td>1</td><td>1.1</td><td>IGNORE other named planets, the Sun / moons / dust / rocks / gases</td></tr>
<tr><td></td><td>(b)</td><td></td><td>Any one calculation ✓

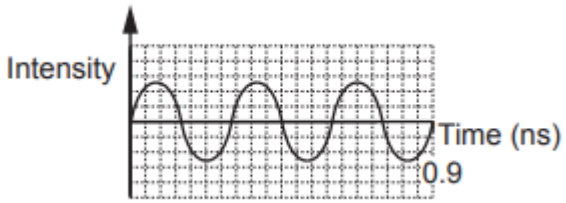
and corresponding comparison ✓</td><td>2</td><td>3.2a</td><td>ALLOW for max 1 mark rough estimate e.g. 3480 is about a third/quarter of Earth’s diameter or e.g. moon is much less than diameter of Earth
ALLOW ≠ or is not as AW for < or >
ALLOW any correct MP2 also gains MP1
ALLOW for 2 marks the student 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></td></tr>
</table>

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 that 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

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 friction / a contact force (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 = mcθ ✓ E = 0.2 x 500 x 60 ✓ = 6 000 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

	(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 CO_2 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 × t ✓ Substitution (any subject) E = 40000 × 30 ✓ Evaluation E = 1 200 000 (J) ✓	**4**	**1 x 1.1** **1 x 1.2** **2 x 2.1**	**ALLOW** *E* = *P* x *t* in any form **ALLOW** 1.2 x 10^n where n ≠ 6 (no, or incorrect kW to W conversion) = 3 marks **ALLOW** for 3 marks no conversion of kW: (30 x 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 x 10 x 40) = 800 ✓ v = 28.3 m/s ✓	**4**	**1 x 1.1** **3 x 2.1**	2nd mark must have 40 m as height. **ALLOW** for MP1 and MP2: 2 x 10 x 40 = v^2 but **NOT** if u^2 is in the equation e.g. $v^2 - u^2$ = 800 **ALLOW** for 3 marks v = √800 or 20√2 etc.
	(c)		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 730 000 J award 3 marks** Select KE = ½ mv^2 ✓ Substitution: KE = 0.5 × (1500 + 840) × 25^2 ✓ Evaluation = 731 250 J ✓	**3**	**1.1** **2 x 2.1**	**ALLOW** as evidence of formula ½ x *their* mass x 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 ÷ 12 ✓ = 2.5 (m/s^2) ✓	**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 × 30 ✓ = 28 500 (kg m s^{-1}) ✓	**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 ÷ 3 ✓ = 4750 (N) ✓	**3**	**1.1** **2 x 2.1**	**ALLOW** MP2 also gains MP1
				10		

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 $F = k\,x$ ✓ 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 ÷ 0.005 = 50 (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 ÷ (their compression ÷ 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 x10^{-3} award 3 marks** Energy stored = area under graph **or** ½ b x h ✓ Substitution E = ½ x 0.01 x 1.2 ✓ Evaluation E = 0.006 J ✓	3	 1.1 2 x 2.2	**IGNORE** POT errors as there are no unit conversions Alternative approach: **M1** $E = ½ kx^2$ **or** $k = 120$ **M2** substitution $E = ½ \times 120 \times 0.01^2$ **M3** Evaluation E = 0.006 (J)

Question			Answer	Marks	AO	Guidance
		(ii)	A straight line with a shallower gradient, passing through the origin ✓	1	3.2a	
	(e)		**Maximum 3 from below including:** Annika / plastic deformation (max 2): • particles slide over each other • particles spacing changes permanently • permanent shape change • occurs above limit of proportionality / elastic limit • force needed depends on area • force needed depends on strength of material • force needed depends on temperature Tom / elastic deformation (max 2): • stretching increases distance between particles **or** compression decreases distance between particles • particle spacing returns to original when force is removed • material returns to original shape / state • particles do not stretch/compress ✓✓✓	3	2.1	**MAX 2** if no reference to particle explanations **IGNORE** particles/material becomes deformed **ALLOW** bonds between particles broken permanently **ALLOW** stretched as AW for tension **ALLOW** squashed as AW for compression
				13		

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 ÷ 11.5 = 20 **or** 2000 ÷ 100 = 20 and both calculations = 2 marks **ALLOW** for one mark substitution of ratio e.g. 2000 ÷ 20 = 100 (turns) **or** 230 ÷ 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 / $P = I^2R$ ✓ 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	$^{12}_{4}Be$
		(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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