OCR
Oxford Cambridge and RSA

Foundation

GCSE

Physics B Twenty First Century Science

J259/04: Depth in physics (Higher Tier)

General Certificate of Secondary Education

Mark Scheme for June 2023

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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.

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 stamp ‘seen’ 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.

Level of response questions on this paper are **2b** and **7**

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 element	Guidance
1	(a)		Line showing refraction away from the normal on leaving the prism ✓	1	1.2	Ray down by eye
	(b)		Angle of refraction between 15° and 35° inclusive ✓	1	2.2	
	(c)		Line showing less refraction than blue on entering the prism✓ Line showing less refraction than blue on leaving the prism✓	2	1.2	View by eye ray of red light refracted towards the normal but above blue light **ALLOW** the red light parallel to incident beam of white light entering the prism at a different point **IGNORE** any incident rays at the same point on the LHS of the prism View refracted ray leaving the prism by eye **IGNORE** unlabelled emerging rays from the point where the blue light is incident on the boundary of the right side of the prism

Question			Answer	Marks	AO element	Guidance
2	(a)		Increase stretch/extension of the spring ✓ **Either** (providing) more elastic potential energy ✓ (so) providing more KE ✓ **OR** Providing more force/tension/force is proportional to the extension/$F=kx$ ✓ Force is proportional to acceleration/Force = mass x acceleration/$F=ma$ ✓	3	3.3a	**ALLOW** pull the trolley back further (to the right) **ALLOW** potential energy for elastic potential energy **IGNORE** ref. to reducing friction and air resistance **IGNORE** ref. to changing the number of coils or mass of the aeroplane **ALLOW** the greater force the greater the acceleration (for the same mass of aeroplane)
	(b)	(i)*	Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question. **Level 3 (5–6 marks)** Description of how to safely use apparatus to get results for force and extension **AND** Description of a graphical/tabular method to calculate the work done/energy stored in the spring or a correct calculation *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)** Description of how to safely use apparatus to get results for force and extension **OR**	6	1.2	**Demonstration of knowledge and understanding of how to safely get data for *F-x* for the spring** • Hang spring on a clamp stand with hook attached and with clamp to ensure apparatus is stable • Measure spring's length using a ruler • Weigh masses • Add one mass to hook • Measure new length of spring, making sure spring isn't moving • Calculate extension by subtracting new length minus original length • A precaution (e.g. safe distance or safety goggles) away from masses if they fall or in case the spring snaps

Question			Answer	Marks	AO element	Guidance
			Description of a graphical/tabular method to calculate the work done/energy stored in the spring or attempt at a correct calculation *There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.* **Level 1 (1–2 marks)** Limited description of how to safely use apparatus to get results for force and extension **OR** Limited description of a graphical/tabular method to calculate the work done/energy stored in the spring or simple attempt at a calculation *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.* **0 marks** *No response or no response worthy of credit.*			• make sure you're at eye level when measuring length of spring • add a pointer to help measure length of spring • keep the extension small **Calculation of work done** • Plot graph of force against extension • draw a line of best fit • work done = total area under the graph or by counting squares • work done = ½ x 20 x 0.32 = 3.2J • energy stored = work done • energy stored in a stretched spring (J) = ½ × spring constant (N/m) × (extension (m))^2 = ½ x 62.5 x (0.32)^2 = 3.2J • shape is a triangle, so height x base / 2 gives work done • graph is straight line so can calculate work done in stretching the spring up to maximum force used by student • straight line graph, so limit of proportionality not exceeded

Question			Answer	Marks	AO element	Guidance
		(ii)	(Jamal's conclusion is wrong because): (10 x 0.16)/2 = ✓ 0.8(J) work done in stretching spring by 0.16m (not minimum of 1J required) ✓ **OR** Spring constant k = 62.5 (N/m) ✓ $E = ½ kx^2 = 0.5 \times 62.5 \times 0.16^2 = 0.8$(J) (not minimum of 1J required) ✓	**2**	**3.2b**	Answer of 0.8(J) gets 2 marks
	(c)		**Any three from:** Use a single light gate (at bottom of ramp) ✓ (Use a ruler to) measure the length of trolley/card (attached to top of model aeroplane) ✓ Timer/datalogger records time whilst blocked ✓ Speed calculated by length of trolley/card divided by time ✓ **OR** Method of measuring distance (between light gates/start and finish) ✓ Timer/datalogger/video/light gates records time (start and finish) ✓ Method of calculating speed at the bottom of ramp ✓	**3**	**2.2**	**DO NOT ALLOW** speed = distance / time marking point in isolation unless there is reference to how distance and time is calculated Speed at bottom calculated by 2 x distance divided by time

Question			Answer	Marks	AO element	Guidance
3	(a)		**Any two from:** green light is the only colour that is transmitted ✓ other colours of white light are absorbed (by the filter) ✓ yellow ball scatters/reflects the green light (as yellow is a combination of red and green)✓	2	2.1	**ALLOW** pass though/emit for transmitted **ALLOW** blocked for absorbed
	(b)		It has a shorter wavelength than red light ✓ It has a lower energy than violet light ✓	2	2.1	
	(c)		Light is an electromagnetic wave ✓ (So) it can pass through the vacuum/light does not need a medium (to transfer energy) ✓	2	2.1	

Question			Answer	Marks	AO element	Guidance
4	(a)		They have 89/equal number of protons ✓ Ac-225 has 136 neutrons **AND** Ac-227 has 138 neutron/Ac-227 has 2 more neutrons (than Ac-225) ORA✓	2	2.1	**DO NOT ALLOW** different number of protons **IGNORE** ref. to electrons **ALLOW** isotope have different number of neutrons. For one mark if no other mark awarded **IGNORE** ref. to atomic and mass number
	(b)	(i)	It is unstable/not stable/to become stable ✓	1	1.1	
		(ii)	Gamma ✓	1	1.1	
		(iii)	Alpha ✓ Beta ✓	2	3.2b	

Question			Answer	Marks	AO element	Guidance
5	(a)		30 mph: 9 **and** 23✓ 60 mph: 56 **and** 74 ✓	2	3.1a	
	(b)		Between 74÷23 = 3.2/23 x 3 = 69/74÷3=24.7m Therefore at least triple ✓	1	3.1b	**ALLOW ECF** from 5(a)
	(c)		**First check the answer on answer line** **If answer = 17.9 (m/s) award 2 marks** 40 x 1609 = 64360 (m) ✓ 64360 / 3600 = 17.88 (m/s) ✓	2	2.2	 **ALLOW** 17.87 (7 recurring) m/s
	(d)		Range of 5 – 9 (m/s)✓	1	1.2	

Question			Answer	Marks	AO element	Guidance
6	(a)		(It will align with the) Earth's magnetic field ✓ (with) the north pole of the magnet seeking/pointing towards the magnetic north (pole of Earth) ✓	2	2.1	**ALLOW** the Earth has magnetic poles **DO NOT ALLOW** magnet repelled (by the Earth's magnetic field)
	(b)		(known) N-pole of magnet repels N-pole of bar or attracts S-pole ✓ (as) like poles repel and opposite poles attract ✓	2	2.1	**ALLOW** correct argument for known S-pole Must see ref. to poles **IGNORE** ref. to charges
	(c)	(i)	Use (plotting) compass ✓ Mark position and direction of (compass) needle✓ Repeat (until compass returns to original position) and join dots ✓ **OR** Use Iron filings/powder✓ Sprinkle (iron filings) around the wire✓ (Tap the card) and record shape ✓	3	1.2	**ALLOW** the idea of observing or tracing the pattern of field lines
		(ii)	Arrow showing anti-clockwise direction ✓	1	3.1a	**ALLOW** any correct arrow drawn showing anti-clockwise direction
		(iii)	gap between field lines increases (as distance from wire increases) ORA AW✓	1	2.1	
		(iv)	(Field lines) get closer together AW ✓ Showing <u>strength</u> of field increases (at a particular distance) ✓	2	1.1	
	(d)		**First check the answer on answer line**	4		

Question			Answer	Marks	AO element	Guidance
			If answer = 10(m) award 4 marks Select and rearrange length = F/BI ✓ 20mT = 0.020 T ✓ Length = 0.3/(0.020 x 1.5) ✓ = 10 (m)✓		**1.2 x 2** **2.1 x 2**	**ALLOW** 1.0 x 10^n for incorrect conversion of B from a correct rearrangement of F=BIL for 3 marks
	(e)	**(i)**	(Sara) rotates/spins the coil (in the magnetic field so a potential difference is induced) ✓	**1**	**2.2**	Idea that something is making it spin by mechanical work
		(ii)	Changes to a.c. (from d.c.) ✓	**1**	**2.2**	

Question			Answer	Marks	AO element	Guidance
7*			Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question. **Level 3 (5–6 marks)** Detailed comparison of the two processes including an explanation of how energy is released *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)** Comparison of the two process *There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.* **Level 1 (1–2 marks)** Limited comparison of the two processes *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.* **0 marks** *No response or no response worthy of credit.*	**6**	**1.1**	**AO 1.1 Description of processes and energy released** • Fission - Nuclear fuels are radioactive materials that release energy during changes in the nucleus. • a neutron splits a large and unstable nucleus into two smaller parts, roughly equal in size, releasing more neutrons, which may go on to make further collisions. • Fusion - If brought close enough together using high temperature and pressures, hydrogen nuclei can fuse into helium nuclei • Both can generate electricity, produce neutrons, use radioactive isotopes • Uranium mined – Hydrogen obtained from (sea) water • Fusion requires very high temperatures and pressures compared to fission • Fusion is still in development whereas fission is reliable and widely used • In fusion nuclei combine in fission single nuclei splits • Neutron needed to start fission reaction • Fission produces radioactive waste, fusion produces stable Helium • More energy is released from nuclear fusion than fission • Mass of products less than reactants in fission/fusion so energy must be released which radiates away • $E=mc^2$ where m is mass difference/loss of mass • Energy is released from the nucleus, carried away as kinetic energy of the particles and also by gamma radiation in fission

Question			Answer	Marks	AO element	Guidance
8	(a)		**First check the answer on answer line** **If answer = 86 N/m award 5 marks** (0.050 + 0.050 + 0.040) / 3 = 0.046 (6 recurring) ✓ Select F = kx ✓ k = 4/0.046 (6 recurring) ✓ k = 85.71428571 ✓ = 86 (N/m) (to 2sf) ✓	**5**	**1.2 x 2** **2.1 x 2** **1.2**	**ALLOW** reasoned discard of 0.04m **ALLOW ECF** for incorrect average extension but subsequent k calculated correctly **ALLOW** 85(N/m) for rounding 0.046(6 recurring) to use 0.047 **ALLOW** 87(N/m) from (80+80+100)/3 to give 86.6(6 recurring) **ALLOW** an answer to 2sf if a calculation is shown
	(b)		**First check the answer on answer line** **If answer is in range of 3.5 – 3.7 (N) award 3 marks** Both forces drawn to scale (4cm:6cm) ✓ Hypotenuse drawn and measured ✓ Length of hypotenuse converted to force using scale giving answer between 3.5 and 3.7 (N) ✓	**3**	**3.1a**	**ALLOW** use of Pythagoras to give 3.6N
	(c)		**Any two from:** The forces are acting in opposite directions (on either side of the centre/pivot) ✓ (produce) a turning effect/moment/torque ✓	**2**	**3.2a**	

Question			Answer	Marks	AO element	Guidance
			There is a resultant (turning effect/moment) clockwise about the pivot/centre ✓			

Question			Answer	Marks	AO element	Guidance
9	(a)	(i)	**Any two pairs from:** Stopwatch/timer ✓ Time needed to calculate power/energy supplied/E=Pt (from power supply)✓ Scales/(top pan) balance ✓ To measure mass (of wax) ✓ Voltmeter✓ To measure potential difference to calculate power/P=IV/energy (from power supply)✓ Ammeter✓ To measure current to calculate power/P=IV/energy (from power supply)✓ Joulemeter✓ To measure energy supplied (from power supply)✓	**4**	**2.2**	**ALLOW** weighing scale but not weighing balance
		(ii)	It would be higher✓ Thermal energy transferred to surroundings (rather than into the wax) ✓	**2**	**3.2b**	**ALLOW** heat is lost/dissipated to surroundings
		(iii)	The <u>energy</u> would be going into changing state/solid to a liquid/melting ✓ (So) calculating (specific) latent heat (causing incorrect answers) ✓	**2**	**3.2a**	**IGNORE** ref to boiling

Question			Answer	Marks	AO element	Guidance
		(iv)	**First check the answer on answer line** **If answer = 0.7225 (A) award 4 marks** E = 2890 x 0.02 x 18 = 1040.4 (J) ✓ E/t = IV to give I=E/(Vt) or P=E/t = 1040.4/120 = 8.67(W) ✓ I = 1040.4 / (12 x 120) or I=P/V = 8.67/12 ✓ = 0.7225 (A) ✓	**4**	**2.1**	**ALLOW ECF** for a correct calculation of I from an incorrect E for 3 marks **ALLOW** answer to 2sf and 3sf. 1sf only if calculation shown
	(b)	**(i)**	Circuit diagram including power supply, wire, voltmeter and ammeter in correct places. ✓ (For various lengths of wire) record values of voltage and current (to calculate resistance)✓ Resistance is calculated from voltage ÷ current/R = V/I ✓	**3**	**2.2**	**ALLOW** measurements**/**readings from voltmeter and ammeter
		(ii)	To prevent the wire getting hot ✓ (Because) resistance increases with temperature (for heating elements) ✓	**2**	**2.2**	**ALLOW** the wire to cool so at the same (starting/room) temperature
		(iii)	**First check the answer on answer line** **If answer = 0.36m award 4 marks** Select P = I^2R ✓ R = $20/2.5^2$ = 20/6.25 = 3.2 (Ω) ✓ **OR** Select P=IV and V=IR ✓ V=20/2.5=8V and R=8/2.5 ✓ = 3.2 (Ω) L = 0.36 (m) ✓	**4**	**1.2** **2.1 x 2** **3.2b**	**ALLOW ECF** from calculated value of R✓

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