Oxford Cambridge and RSA

GCSE (9–1) Physics B (Twenty First Century Science) J259/03 Breadth in Physics (Higher tier)

MARK SCHEME

Duration: 1 hour 45 minutes

MAXIMUM MARK 90

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. 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

11. 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

12. 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)		**Any two from:** planets are not all made of rock / some are made of gas ✓ planets do not orbit in perfect circles / in ellipses ✓ not all planets have moons (e.g. Venus, Mercury) ✓ moons not all rocky/may be icy (e.g. Enceladus) [even though they may all have rocky cores) ✓	**2**	**1.1 x2**	**ALLOW** specific correct examples, e.g. Jupiter not made of rock / made of gas, Venus does not have a moon, Saturn has moon(s) of ice **ALLOW** a correctly identified statement quoted or identified from the report IF more than two examples given apply list rule **IGNORE** attempts to qualify a correctly identified statement with an incorrect example
	(b)		dust and gas ✓ pulled together by gravity ✓	**2**	**1.1 x2**	**ALLOW** dust / gas / matter / nebula Only give credit for responses that describe the formation of the solar system
	(c)		mass is converted into energy (of radiation) ✓	**1**	**1.1**	e.g. quoting $E = mc^2$ **ALLOW** mass is lost in the form of energy **ALLOW** mass is transferred/turned into energy

Question			Answer	Marks	AO element	Guidance
2	(a)		(transferred by) electric current / electrically / electrical working ✓	1	1.1	**ALLOW** by a flow of electrons / current / electricity / **IGNORE** references to National Grid / wires /cables /transformers
	(b)	(i)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 864 (J) award 3 marks** recall **and** rearrange equation: energy = p.d. × charge ✓ substitution 2 × 1.2 × 360 ✓ = 864 (J) ✓	3	 1.2 2.1 2.1	 Equations used to calculate energy must have energy as the subject (accept W for E). **ALLOW** E= ItV **and** Q = It / E = Pt **and** P = VI and Q = It / 360 x 1.2 seen Correct substitutions gain m.p 1 also **DO NOT ALLOW** bald '86400' or '1728' or '432'. Credit can only be given for working
	(b)	(ii)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 3.0 (A) award 4 marks** Recall **and** rearrange: current = charge / time ✓ Convert 2 minutes = 120 s ✓ = 360 / 120 ✓ = 3.0 (A) ✓	4	 1.2 2.1 2.1 2.1	 **ALLOW** 3 marks for 180 (unit conversion omitted) **ALLOW** '3 (A)'

Question			Answer	Marks	AO element	Guidance
3	(a)		**FIRST CHECK THE ANSWER** **If answer = 720 000 (J) award 2 marks** substitution 4.5 × 1600 × (120-20) ✓ = 720 000 (J) ✓	**2**	 **2.1** **2.1**	 **ALLOW** 20 or 120 for ΔT to give 144 000 or 864 000 Does not need comparison with 700 000 for the mark
	(b)	**(i)**	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 480 (s) award 3 marks** recall **and** rearrange: time = energy / power ✓ substitution 720 000 / 1500 ✓ = 480 (s) ✓	**3**	 **1.2** **2.1** **2.1**	**ECF** (a) or energy = 700 000 (J) **ALLOW** for 2 marks '48' or '4800' as a transcription error.
		(ii)	energy transferred to the metal radiator / in the wires ✓	**1**	**1.1**	**ALLOW** 'energy is lost to the surroundings' **IGNORE** it heats up the room / ignore efficiency arguments **DO NOT ALLOW** 'loss' on its own

Question			Answer	Marks	AO element	Guidance
4	(a)		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 89 / 90 / 88.9 (m/s) award 2 marks** 320 × 1000 / 3600 ✓ = 88.9 = 89 (m/s) ✓	**2**	**2.2 x2**	**ALLOW** for 1 mark answers that round to 8.89×10^{n} **ALLOW** answers that round to 88.9
	(b)	**(i)**	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 75 (m) award 3 marks** select **and** rearrange equation: $s = (v^2 - u^2)/2a$ ✓ $= (20^2 - 80^2)/(2 \times -40)$ ✓ = 75 (m) ✓ **OR** Recall and rearrange s = (average) speed x (change in v ÷ acceleration) ✓ = 50 x 1.5 (s) ✓ 75 (m) ✓	**3**	**1.2** **2.1** **2.1**	**ALLOW** one mark for correct substitution before rearrangement $20^2 - 80^2 = 2 \times -40 \times s$ **IGNORE** incorrect signs, but **DO NOT ALLOW** $20^2 + 80^2$ **ALLOW** -75 (m) **ALLOW** if both formulae are seen separately **ALLOW** evaluation of distance using 1.5 x either 80 or 20
	(b)	**(ii)**	velocity has a direction/is a vector ✓ direction is changing (as it turns corner) ✓	**2**	**1.1 x2**	

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>AO element</th><th>Guidance</th></tr>
<tr><td>5</td><td>(a)</td><td></td><td>
<table>
<tr><td></td><td>Increase</td><td>Decrease</td><td>Stay the same</td></tr>
<tr><td>speed</td><td>(✓)</td><td></td><td></td></tr>
<tr><td>frequency</td><td></td><td></td><td>✓</td></tr>
<tr><td>wavelength</td><td>✓</td><td></td><td></td></tr>
</table>
</td><td>2</td><td>1.1 x2</td><td></td></tr>
<tr><td></td><td>(b)</td><td></td><td>FIRST CHECK THE ANSWER ON ANSWER LINE
If answer = 500 (Hz) award 3 marks

select and rearrange: f = v / λ ✓

= 600 / 1.2 ✓
= 500 (Hz) ✓</td><td>3</td><td>1.2

2.2
2.1</td><td>Correct substitution also gains m.p. 1</td></tr>
</table>

Question			Answer	Marks	AO element	Guidance
6	(a)		sound is transmitted/vibrations pass through bones in ear ✓ this works best/more sensitive over a limited range of frequencies/between 1000 to 3000 Hz ✓	2	1.1 x2	**IGNORE** ear drum **IGNORE** pick up / detect **ALLOW** low frequency produce smaller vibrations (in our ears) ORA **ALLOW** e.g. low frequencies produce smaller vibrations in the bones (=2 mks) **ALLOW** higher frequencies are more within our hearing range / lower frequencies are on the edge of our hearing range / we are more/less sensitive to certain frequencies **DO NOT ALLOW** just 'higher frequencies are easier to hear' **DO NOT ALLOW** just 'we are sensitive to certain frequencies'
	(b)	(i)	**Any one from:** distance between phone/James and Mia ✓ background noise ✓ time to listen to each sound ✓ same frequency/ies	1	3.3a	**IGNORE** distance between Mia and wall **IGNORE** the same phone/speaker/app
	(b)	(ii)	waves are transmitted / pass through the wall ✓ but some waves are absorbed / reflected by the wall ✓	2	1.1 x2	**ALLOW** as vibrations / as longitudinal waves / as compressions and rarefactions **ALLOW** a description of absorption e.g. the wave loses energy by vibrating the particles in the wall

Question			Answer	Marks	AO element	Guidance
						ALLOW a description of reflection e.g. the wave echoes off the wall/bounces back from the wall
	(c)		wider range covering frequencies higher than 2 kHz / 2000Hz ✓ more closely spaced frequencies ✓ smaller volume steps / more sensitive volume control ✓	**3**	**3.3b x3**	Or clear ref to table e.g. 'should have a range which went higher than those used in their experiment' **ALLOW** any step less than 880 Hz **ALLOW** volume settings between 0 and 1 **ALLOW** increase distance (between Mia and phone) so volume setting can be higher **IGNORE** repeat and average

Question			Answer	Marks	AO element	Guidance
7	(a)		changing magnetic field (around coil) ✓ induces a p.d. / voltage ✓	2	1.1 x2	**ALLOW** magnetic field is cut (by coil) **ALLOW** produces p.d./voltage
	(b)	(i)	all points plotted correctly at (800, 6.7) (1000, 9.1) (1200,11) ✓ line of best-fit ✓	2	2.2 1.2	To within ± 0.5 small divisions in each direction **IGNORE** lobf below 200 turns
		(ii)	correct value read from candidate's line, to within half a small square ✓	1	2.2	
		(iii)	use motor/machine/electrical device/mechanical device/pendulum (to pull magnet at fixed speed) ✓	1	3.3b	**ALLOW** drop magnet from fixed height
	(c)		current in coil generates a magnetic field ✓ which opposes the change causing it / is a like pole ✓	2	1.1 x2	**DO NOT ALLOW** references to positive / negative / charges

Question			Answer	Marks	AO element	Guidance
8	(a)		correct numbers for neutron (1 over 0) ✓ correct numbers for electron (0 over –1) ✓	2	1.1 x2	
	(b)		**Any two from:** half-life of Tc-99m is short (compared to transport time) ✓ so (almost) all Tc-99m would have decayed ✓ gamma is more penetrating (than beta) so it would be more difficult to shield as it is transported to the hospital ✓	2	3.2b x2	**ALLOW** it only has a half-life of 6 hours **ALLOW** it would have decayed a lot / its activity would be too low
	(c)	(i)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 6.25 (%) award 2 marks** 4 half lives ✓ = 6.25 (%) ✓	2	2.2 x2	**ALLOW** 24 ÷ 6 = 4 seen **ALLOW** evidence of four successive halvings **ALLOW** 93.75(%) (percent of Tc-99m that has decayed)
	(c)	(ii)	longer time for thallium (because it has a longer half-life) / ORA✓ causing greater radiation dose/ risk of cancer / ORA ✓	2	3.1b x2	**ALLOW** more damage to cells **ALLOW** for 2 marks exposure is greater if the patient is exposed for more time

Question			Answer	Marks	AO element	Guidance
9	(a)		The material in the tablet is denser than water **AND** Water is denser than the gas in the bubbles ✓	1	1.1	
	(b)		upwards arrow on tablet labelled reaction ✓ force labelled 18 mN ✓	2	1.1 x2	**ALLOW** contact force / normal reaction force Independent mark, unit required
	(c)	(i)	**Any two from:** pressure (of water) ✓ pressure increases with depth / there is a pressure difference between the top and bottom of the tablet ✓ so **net** force is upwards ✓	2	1.1 x2	**ALLOW** Archimedes principle e.g. water displaced by tablet **ALLOW** the weight of this water is equal to the upthrust **ALLOW more** force upwards
	(c)	(ii)	**Any one from:** tablet has larger volume ✓ tablet has greater thickness ✓ tablet has more pressure difference ✓ tablet has larger area ✓	1	1.1	**DO NOT ALLOW** 'it is bigger' on its own **ALLOW** ORA **DO NOT ALLOW** it is heavier/more mass

Question			Answer	Marks	AO element	Guidance
10	(a)		 ✓	1	1.1	
	(b)	(i)	as temperature increases, potential difference increases ✓ (because) as temperature increases, resistance of thermistor/R_2 decreases ✓ (so) p.d. across thermistor falls (so p.d. across R_1 must increase) ✓	3	3.1a 1.1 1.1	
	(b)	(ii)	at lower temperatures there are smaller changes in p.d. ORA ✓ justified with evidence from graph ✓	2	3.2b x2	**IGNORE** sensitivity **ALLOW** smaller gradient/less steep at lower temperatures ORA **ALLOW** e.g. it goes up 0.1 between 10 and 20 **ALLOW** for 2 marks at lower temperatures there are smaller changes in p.d. for the same change in temperature
	(c)	(i)	systematic ✓	1	1.1	**ALLOW** equipment / zero / apparatus
	(c)	(ii)	current heats the thermistor ✓ use lower current / increase R_1 / decrease voltage / add a heat sink (OWTTE) / measure the effect and take it into account ✓	2	2.1 3.3a	**ALLOW** because of the current

Question			Answer	Marks	AO element	Guidance
11	(a)		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 2.0 (Nm) award 3 marks**	**3**		
			Recall: W = mg ✓		**1.2**	**ALLOW** Force down = 10N = 1kg x 10
			= 1.0 × 10 × 0.2 ✓		**2.1**	Also gains m.p.1 **ALLOW** for 2 marks 1.0 x 10 x 20 = 200
			= 2.0 (Nm) / 200 Ncm ✓		**2.1**	**ALLOW** '2' (Nm)
	(b)	**(i)**	moment due to metre ruler not included ✓	**1**	**3.2a**	**ALLOW** any clear reference to the unbalanced nature of the metre rule e.g the ruler has mass/weight
		(ii)	centre / balance metre ruler on pivot / use ruler made of material with negligible mass /use weights much larger than weight of ruler / use extra weights to balance ruler before checking predictions ✓	**1**	**3.3b**	

Question			Answer	Marks	AO element	Guidance
12	(a)		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 8 (kg m/s) award 2 marks** Recall: momentum = mass × velocity / 5 kg × 1.6 m/s ✓ = 8 (kg m/s) ✓	**2**	**1.2** **2.1**	
	(b)	**(i)**	momentum of **B** = 2.5 kg × 1.6 m/s = (–) 4 (kg m/s) ✓ Total momentum before collision = 8 (kg m/s) – 4 (kg m/s) = 4 (kg m/s) ✓ Total momentum after collision = 4 (kg m/s) **and** total mass × *v* = 7.5 (kg) × *v* = 4 (kg m/s) ✓ *v* = 4 (kg m/s) / 7.5 (kg) = 0.53 (m/s) ✓	**4**	**1.1** **2.1** **2.1** **2.1**	**ALLOW** for 3 marks 1.6 (m/s) with working shown (the candidate has added 8 and 4 to give the total momentum = 12) **ALLOW** bald answer 0.53 only (=2 mks) (candidate may have used only the momentum of trolley B) **ALLOW** if no other mark awarded, 1 mark for 7.5 (= total mass after the collision) **OR** m.p.3 & 4 can be Momentum of joined trolleys = 7.5 (kg) × 0.5 (m/s) = 3.75 (kg m/s) ✓ Which agrees with the momentum before (so speed ≈ 0.5 (m/s) ✓

Question			Answer	Marks	AO element	Guidance
	(b)	(ii)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 27 (N) award 4 marks**	4		**ECF throughout**
			select **and** rearrange to get $F = \Delta p/\Delta t$ ✓		1.1	**ALLOW** F = momentum ÷ time / F = m x Δv÷t
			for **A**, Δp = 5 kg × (0.53 (m/s) – 1.6 (m/s)) **OR** = (-)5.35 (kg m/s) ✓		2.1	Using v_{final} = 0.5 (m/s) gives Δp = 5 .5 (kg m/s)
			F = 5.35 (kg m/s) / 0.20 (s) ✓		2.1	Also gains m.p.2
			= 26.75 (N) = = 27 (N) ✓		2.1	and F = 27.5 (N)

Question			Answer	Marks	AO element	Guidance
13	(a)	(i)	Out of the page ✓	1	1.2	
		(ii)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 1.2 (N) award 4 marks**	4		**ALLOW** 3 marks if 200 turns omitted, 0.0060 N **ALLOW** 3 marks if using 5000mm, 1200N
			select force = magnetic flux density x current x length of conductor ✓		1.2	**ALLOW** 2 marks if 200 turns omitted and no conversion of 25mm to m, 6N
			calculate length correctly, including unit conversion length = 0.025 × 200 = 5 (m) ✓		2.2	**ALLOW** 1 mark for a substitution that shows evidence of the formula
			= 0.40 × 0.60 × 5 ✓		2.1	Also gains m.p.1 and m.p.2
			= 1.2 (N) ✓		2.1	