

# Foundation

## GCSE

### Physics B Twenty First Century Science

#### J259/01: Breadth in physics (Foundation Tier)

General Certificate of Secondary Education

**Mark Scheme for June 2022**

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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 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).

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

	<b>Assessment Objective</b>
<b>AO1</b>	<b>Demonstrate knowledge and understanding of scientific ideas and scientific techniques and procedures.</b>
AO1.1	Demonstrate knowledge and understanding of scientific ideas.
AO1.2	Demonstrate knowledge and understanding of scientific techniques and procedures.
<b>AO2</b>	<b>Apply knowledge and understanding of scientific ideas and scientific enquiry, techniques and procedures.</b>
AO2.1	Apply knowledge and understanding of scientific ideas.
AO2.2	Apply knowledge and understanding of scientific enquiry, techniques and procedures.
<b>AO3</b>	<b>Analyse information and ideas to interpret and evaluate, make judgements and draw conclusions and develop and improve experimental procedures.</b>
<b>AO3.1</b>	Analyse information and ideas to interpret and evaluate.
AO3.1a	Analyse information and ideas to interpret.
AO3.1b	Analyse information and ideas to evaluate.
<b>AO3.2</b>	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.
<b>AO3.3</b>	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)	(i)	chemical ✓	1	1.1	Top box ticked
		(ii)	electrically ✓	1	1.1	Third box ticked
	(b)	(i)	<b>FIRST CHECK THE ANSWER ON ANSWER LINE</b> <b>If answer = 39 J award 2 marks</b>  13 × 3.0 ✓ 39 (J) ✓	2	2.1	
		(ii)	<b>FIRST CHECK THE ANSWER ON ANSWER LINE</b> <b>If answer = 14 W award 2 marks</b>  (13 + 17 + 12) / 42 ✓ (42 ÷ 3 =) 14 (W) ✓	2	1.2	<b>ALLOW</b> one mark for 12.5 (W) [omitting 17 as an anomalous result]. Second mark can be awarded if candidate states that 17 is anomalous.
	(c)		use oil to lubricate the motor ✓	1	1.2	Bottom box ticked

Question			Answer	Marks	AO element	Guidance
2	(a)	(i)	electrons ✓	1	1.1	
		(ii)	mass ✓ nucleus ✓	2	1.1	These are independent marking points.
	(b)		$10^{-10}$ m ✓	1	1.1	Bottom box ticked
	(c)	(i)	isotopes ✓	1	1.1	Second box ticked
		(ii)	the nucleus emits radioactive particles ✓	1	1.1	Second box ticked.

Question		Answer	Marks	AO element	Guidance
3	(a)	It acts at right angles to the surface of the syringe. ✓	1	1.1	Top box ticked
	(b)	(i) <b>FIRST CHECK THE ANSWER ON ANSWER LINE</b> If answer = 2.4 (kg) award 2 marks  24 ÷ 10 ✓ 2.4 (kg) ✓	2	2.1	
		(ii) <b>FIRST CHECK THE ANSWER ON ANSWER LINE</b> If answer = 20 000 (Pa) award 2 marks  24 ÷ 0.0012 ✓ 20 000 (Pa) ✓	2	2.1	
	(c)	particles are closer together ✓ particles collide more often ✓	2	1.1	First and third boxes ticked.

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Question			Answer	Marks	AO element	Guidance
4	(a)	(i)	induced ✓ iron ✓	2	1.1	
		(ii)	Induced magnets lose their magnetism (when magnet is removed) <b>OR</b> Permanent magnets retain their magnetism / stay magnetic (when magnet is removed) ✓	1	1.1	<b>DO NOT ALLOW</b> always attracts.
	(b)	(i)	the repeat readings are very different /widely spaced / wide range ✓	1	1.2	<b>ALLOW</b> numerical response; eg 6 is not close to 9 or 10 (for first row of data).
		(ii)	as the number of sheets of paper increases, the number of paperclips decreases / ORA ✓	1	3.1b	<b>ALLOW</b> thickness of paper/distance from the magnet instead of number of sheets of paper. <b>DO NOT ALLOW</b> 'negative correlation' on its own; candidates need to mention thickness of paper and number of paperclips.
	(c)		Increase the current in the wires ✓	1	1.1	Second box ticked

Question		Answer	Marks	AO element	Guidance
5	(a)	Normal line ✓	1	1.2	Third box ticked
	(b)	<p><b>Any two from:</b>  do the experiment in a dark room / AW ✓  use a narrow beam of light ✓  use a sharp pencil ✓  put crosses as far apart as possible ✓  use a ruler to join the crosses ✓  take a photo ✓</p>	2	1.2	<b>ALLOW</b> put crosses at beginning and end of ray.
	(c)	C ✓	1	1.1	
	(d)	<p><b>Any two from:</b>  each wavelength is a different colour ✓  use a colour filter / coloured lens ✓  only one colour is transmitted through the filter ✓  all the other colours are absorbed by the filter ✓  repeat the experiment ✓</p> <p><b>OR:</b>  Use monochromatic light. ✓✓</p>	2	3.3a	<p><b>ALLOW</b> one mark for suggesting using a prism to separate the colours of the spectrum.  A prism and a narrow slit could get 2 marks.</p> <p><b>ALLOW</b> use a laser for one mark.</p>

Question		Answer	Marks	AO element	Guidance
6	(a)	Chemical energy store in battery decreases ✓ Thermal energy store in room increases ✓	2	2.1	First box ticked Bottom box ticked
	(b)	(i) <b>FIRST CHECK THE ANSWER ON ANSWER LINE</b> <b>If answer = 216 (J) award 2 marks</b>  180 × 1.2 ✓ 216 (J) ✓	2	2.1	
		(ii) <b>FIRST CHECK THE ANSWER ON ANSWER LINE</b> <b>If answer = 0.92 (A) award 3 marks</b>  Rearrangement of equation either in symbols or numbers <b>OR</b> correct substitution into given equation ✓ 1.1 ÷ 1.2 = 0.916... ✓ 0.92 (A) ✓	3	2.1 × 2  1.2	The final mark is for evidence of rounding their value correctly to 2sf.

Question		Answer	Marks	AO element	Guidance
7	(a)	<p><b>FIRST CHECK THE ANSWER ON ANSWER LINE</b>  <b>If answer = 1.8 (N m) award 2 marks</b></p> <p>6.0 cm = 0.06 m ✓            30 × 0.06 ✓            = 1.8 (Nm) ✓</p>	3	1.2 2.1 × 2	If no (or incorrect) unit conversion, allow ecf of distance eg = 6 for other 2 marks.
	(b)	(i)	1	1.1	Second box ticked
		(ii)	2	2.1	<b>ALLOW</b> one mark for correct comparison of any other pair of forces eg R and Q are same size.
	(c)	the (compressed) spring pushes it back up ✓	1	3.2a	

Question			Answer	Marks	AO element	Guidance
8	(a)	(i)	upwards force: normal / contact / reaction force ✓ downwards force: weight / gravitational force ✓	2	1.1	<b>ALLOW</b> gravity / gravitation <b>NOT</b> gravitational potential
		(ii)	<b>FIRST CHECK THE ANSWER ON ANSWER LINE</b> <b>If answer = 1.5 (m/s<sup>2</sup>) award 3 marks</b>  250 - 160 = 90 (N) ✓ 90 ÷ 60 ✓ 1.5 (m/s <sup>2</sup> ) ✓	3	2.1	First mark for calculating net force. <b>ALLOW</b> ecf for incorrect or omitted net force in calculation of acceleration. If F = 250 N, a = 4.2 ms <sup>-2</sup> [2] If F = 160 N, a = 2.7 ms <sup>-2</sup> [2] If F = 410 N, a = 6.8 ms <sup>-2</sup> [2]
	(b)		Velocity is constant <b>OR</b> terminal velocity <b>OR</b> zero acceleration ✓  <b>AND any one from:</b> forwards force = backwards force/air resistance (AW) ✓ resultant force = 0 ✓ forces are in equilibrium or balanced ✓	2	2.1	<b>ALLOW</b> speed instead of velocity. <b>ALLOW</b> velocity faster than Fig 8.2  <b>ALLOW</b> both forces are equal
	(c)		C (because largest diameter) ✓ so larger surface <u>area</u> ✓	2	3.2a	<b>IGNORE</b> reference to largest air resistance as this is in the answer stem. <b>IGNORE</b> reference to mass or cost.

Question			Answer	Marks	AO element	Guidance
9	(a)	(i)	<b>Any one from:</b> use small currents ✓ use a larger resistor ✓ put wire in a water bath / beaker of water ✓ use long lengths of wire. ✓ turn off the power pack immediately after taking readings/leave power pack on for as short a time as possible (AW). ✓	1	3.3b	
		(ii)	<b>Any two from:</b> material / metal of wire ✓ length of wire ✓ current in wire ✓	2	2.2	
	(b)		<b>FIRST CHECK THE ANSWER ON ANSWER LINE</b> <b>If answer = 0.22 (Ω) award 3 marks</b>  Correct substitution into $V=IR$ ✓ Rearrange for R ✓ Final value 0.22 (Ω) ✓	3	1.2 2.1 × 2	$R = V \div I$ or $0.55 \div 2.5$
	(c)	(i)	point plotted at (0.32, 0.22) to within $\frac{1}{2}$ a small square ✓ appropriate line of best fit ✓	2	1.2	Watch out for (0.32, 0.24) Smooth curve close to top and bottom plots. <b>ALLOW</b> a straight line through the curve trend with reasonable balance of plots on both sides of line.
		(ii)	as diameter increases, resistance decreases / AW ✓  <b>AND any one from:</b> non-linear relationship ✓ inverse-square relationship ✓ resistance falls more slowly for higher diameters / AW ✓	2	3.2b	<b>ALLOW</b> inversely proportional <b>IGNORE</b> reference to an outlier (from a straight line).

Question		Answer	Marks	AO element	Guidance
10	(a)	<p><b>(Similarity) Any one from:</b>            electromagnetic ✓            transverse ✓            travel (at same speed) in a vacuum ✓            they both carry information or energy ✓</p> <p><b>(Difference) Any one from:</b>            microwaves lower frequency / ORA ✓            microwaves longer wavelength / ORA ✓            microwaves not visible / ORA ✓</p>	2	1.1	IGNORE reference to medium the waves are travelling through.
	(b)	<p>(i) <b>FIRST CHECK THE ANSWER ON ANSWER LINE</b>  <b>If answer = <math>4.5 \times 10^{-4}</math> / 0.00045 award 4 marks</b></p> <p>conversion 90 km = 90 000 m ✓            Correct substitution into speed = distance ÷ time ✓            rearrange for time = distance ÷ speed or <math>90\,000 \div (2.0 \times 10^8)</math> ✓            = <math>4.5 \times 10^{-4}</math> (s) / 0.00045 (s) ✓</p>	4	1.2 × 2 2.1 × 2	ALLOW 3 marks for $4.5 \times 10^{-7}$ / 0.00000045 (s)
		<p>(ii) <b>Any one from:</b>            time delay is tiny / is negligible / is unimportant / could speed up communications ✓            speeds are similar / both speeds very fast / speed of microwave in air is 1½× speed of light in fibre ✓            distance microwave signal needs to travel will be further (because uses satellites) ✓</p>	1	3.1a	ALLOW a correct calculation of time taken by microwave to travel 90km = 0.0003 s

Question		Answer	Marks	AO element	Guidance
11	(a)	correct symbol for thermistor, in the correct place in the circuit. ✓	1	1.1	
	(b)	(i) <b>Any one from:</b> wait for hot water to cool down ✓ mix hot water and cold water ✓ (use an electric) water bath (with a thermostat) ✓	1	3.3b	<b>IGNORE</b> use a thermometer. <b>ALLOW</b> heat (slowly) on a stove/Bunsen burner/cooker etc., but not boil on a stove.
		(ii) less confident ✓  <b>AND any one from:</b> new data point does not fit pattern / no correlation ✓ new data point is an anomaly / outlier ✓ new data point shows opposite pattern ✓	2	3.1b	<b>ALLOW</b> it should be between 1300 and 1800 <b>ALLOW</b> it is very low compared to the others <b>ALLOW</b> she said it would increase but it decreases / it didn't increase / resistance is higher at 0
	(c)	as temperature increases, resistance decreases ✓  <b>AND any one from:</b> there is an anomaly / outlier (at 80°C) ✓ the data is (slightly) scattered ✓	2	3.1a	<b>DO NOT ALLOW</b> negative correlation on its own – must refer to temperature and resistance  <b>ALLOW</b> non-linear pattern.

Question		Answer	Marks	AO element	Guidance
12	(a)	<p>distance is a scalar / displacement is a vector / displacement is distance with a direction ✓</p> <p>(he changes direction so) the displacement is smaller than the distance / AW ✓</p>	2	1.1  2.1	<b>ALLOW</b> numerical comparison for second mark e.g. distance is (at least) 36m and displacement is 12m. ✓
	(b)	(i)	1	2.1	<b>ALLOW</b> e.g. 16m/s is 57 km/h <b>or</b> 4m/s is 14 km/h <b>ALLOW</b> using a smaller time interval will give a better estimate of initial acceleration.
		(ii)	3	1.2  2.2 × 2	

Question		Answer	Marks	AO element	Guidance
13	(a)	<p>(gamma rays are) ionising ✓            (so) kill (any / cancer) cells ✓</p> <p><b>AND any one from:</b>            penetrating so pass through <b>or</b> pass through tissue /            named tissue / head ✓            the cancer/focal point receives a higher            dose/concentration of /exposure to /absorbs more            radiation ✓            multiple low energy beams minimizes damage to            healthy cells ✓</p>	3	1.1	<p><b>IGNORE</b> more / less  <b>IGNORE</b> kills cancer / damages cells</p>
	(b)	<p>contamination is when radioactive material / source is            inside (or on) / in contact (with the body) ✓            Ben has been irradiated / gamma rays do not make Ben            radioactive ✓</p>	2	2.1	<p><b>ALLOW</b> (most) gamma rays/radiation passes            through the body  <b>IGNORE</b> rays hitting (implies they don't penetrate)</p>
	(c)	<p><b>Any one from:</b>            X-ray energy/intensity/properties can be controlled ✓            X-ray machine can be switched on and off / gamma            rays emitted continuously/randomly ✓            X-ray machine can be used at any time/will not run out /            gamma source will decay and lose its activity ✓            X-ray machines are cheaper/more common/ in most            hospitals. ✓            (Gamma) radiotherapy is a more specialist treatment so            not available in all hospitals. ✓</p>	1	2.1	<p><b>IGNORE</b> less ionising / references to safety / risk</p>

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