

GCSE (9–1)

Physics B (Twenty First Century Science)

J259/04: Depth in physics (Higher Tier)

General Certificate of Secondary Education

Mark Scheme for June 2019

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.

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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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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

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
<u>—</u>	Underlined words must be present in answer to score a mark
ECF	Error carried forward
AW	Alternative wording
ORA	Or reverse argument

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.

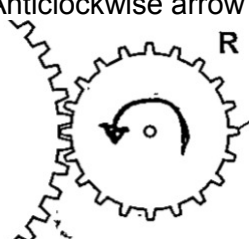
You should ensure that you have copies of these materials.

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)	(i)	Anticlockwise arrow ✓ 	1	2.1	ALLOW word anticlockwise
		(ii)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 12 (per minute) award 2 marks $40 / 20 = 2$ ✓ $6 \times 2 = 12$ (per minute) ✓	2	2.2 × 2	
	(b)		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 6.4 (N m) award 3 marks Recall and apply: moment of a force = force × distance ✓ (moment =) 32×0.20 ✓ (moment =) 6.4 (N m) ✓	3	1.2 2.1 × 2	

Question	Answer	Marks	AO element	Guidance
2*	<i>Please refer to the marking instructions on page 5 of this mark scheme for guidance on how to mark this question.</i> Level 3 (5–6 marks) Correct density of both liquids determined AND Qualitative comparison of graphs of which at least one idea is interpretation and one is evaluation <i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i> Level 2 (3–4 marks) A valid attempt made to determine density of both liquids AND Some comparison of graphs at least one idea of which must be an interpretation or an evaluation <i>There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.</i> Level 1 (1–2 marks) A valid attempt made to determine density of one liquid OR Limited comparisons of graphs and densities <i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.</i> 0 marks <i>No response or no response worthy of credit.</i>	6	1.1 2.1 × 2 3.1a × 2 3.1b	AO3.1a Interpreting information from the graph For example: • Straight-line graphs • Linear relationship between mass and volume • Graph does not go through origin because of the mass of the beaker • Gradient of line for E is greater • Gradient is density • Intercept is mass of beaker AO3.1b Evaluation of information from the graph For example: • Mass of cylinder = 60 g (allow ± 5 g) • Density of E is greater than that of F AO1.1 – Demonstration of ideas about density For example: • Correct use of density equation for any point taken from the graph AO2.1 Apply knowledge and understanding of scientific ideas • Line(s) extended to determine y-intercept • Density of E is about 1.4 (g/cm³) or 1400kg/m³ • Density of F is about 1.0 (g/cm³) or 1000kg/m³

Question			Answer	Marks	AO element	Guidance
3	(a)		More sheets means less light / intensity (for LDR) ORA ✓ Resistance of LDR increases with less light / intensity ORA ✓	2	3.2a 3.2b	ALLOW more light (intensity) less resistance ALLOW more resistance with more sheets 1 mark max
	(b)		Ammeter connected in series ✓ Voltmeter connected across the cell / LDR ✓	2	1.2 × 2	Candidates must have correct symbols for each device and complete circuit IGNORE other extra symbols / minor gaps DO NOT ALLOW continuous line through ammeter or voltmeter IGNORE continuous line through second meter in a correct circuit
	(c)	(i)	Any one from: Use the same light source ✓ Keep the distance between the LDR and light source the same ✓ Keep the same background light ✓	1	3.3a	 ALLOW any suggestions that keep the ambient light the same
		(ii)	Any one from: Work in a darkroom ✓ Keep the same background light ✓ Put a box around the LDR (and light source) ✓ Use the same light source ✓ Keep the distance between the LDR and light source the same ✓	1	3.3b	ALLOW any suggestions that keep the ambient light the same

Question			Answer	Marks	AO element	Guidance
4	(a)	(i)	Pressure (inside the syringe/marshmallow) decreases ✓ <u>Volume</u> of trapped air increases / air inside marshmallow ✓	2	2.1 × 2	
		(ii)	Measure the (length of) marshmallow <u>and</u> measure the volume of air in the syringe AW ✓ Take several readings ✓ A graph of length against volume should be a straight-line graph through the origin AW / length ÷ volume = constant AW ✓	3	3.3a × 2 2.1	
	(b)		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 8 (mm³) or 8.0 (mm³) award 3 marks Recall and apply: pressure × volume = constant ✓ $100\,000 \times 8.8 = 110\,000 \times \text{volume}$ ✓ (volume =) 8 (mm ³) or 8.0 (mm ³) ✓	3	1.2 2.1 × 2	ALLOW correct answer written in table ALLOW $P_1 \times V_1 = P_2 \times V_2$ ALLOW $P_1 / P_2 = 0.91$ or $P_2 / P_1 = 1.1$ for 1 mark

Question			Answer	Marks	AO element	Guidance
5	(a)		Speed increases ✓ Frequency does not change ✓ Wavelength increases ✓	3	1.1 × 3	
	(b)		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.022 (m) award 4 marks Recall and rearrange to give: distance = speed × time ✓ = $1100 \times 4.0 \times 10^{-5}$ ✓ = 0.044 (m) ✓ length of eyeball = $0.044 \div 2 = 0.022$ (m) ✓	4	1.2 2.1 2.1 1.2	Alternative method: $4.0 \times 10^{-5} / 2 = 2.0 \times 10^{-5}$ Distance = $1100 \times 2.0 \times 10^{-5}$ = 0.022 (m)
	(c)		The (smaller) pulses at due to reflections ✓ at the (eye) lens ✓	2	3.2a 3.2b	 ALLOW cornea

Question			Answer	Marks	AO element	Guidance
6	(a)		(Yes the) LED bulb is the most efficient because of its low/least power / 8 (W) AW ✓ AND (Yes saves the environment because) LED bulb produce the least CO₂ AW ✓ OR LED Longest life span so less waste produced (landfill) AW ✓	2	3.2a × 2	
	(b)		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 25 award 2 marks number of bulbs = $50000 \div 2000$ ✓ number of bulbs = 25 ✓	2	2.2 × 2	
	(c)		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 5200 (pence) award 4 marks Recall and apply: energy transferred (kW h) = power (kW) × time (h) ✓ Conversion: 8 (W) = 0.008 (kW) ✓ energy transferred = 0.008×50000 or 400 ✓ cost = $400 \times 13\text{p} = 5200$ (pence) ✓	4	1.2 1.2 2.1 2.2	ALLOW 3 marks for calculating cost for 1 hour $0.008 \times 1 \times 13\text{p} = 0.104\text{p}$ ALLOW 2 marks for calculating cost for 1 hour with incorrect conversion of 8 W ALLOW 1 mark for a value of energy (kW h) in cost calculation ALLOW £52 on the answer line ALLOW 3 marks for 5200000 (pence); 8 used instead of 0.008 or any incorrect conversion of 8 W

Question			Answer	Marks	AO element	Guidance
7	(a)	(i)	Out of plane of paper ✓	1	3.1a	
		(ii)	Thumb indicates direction (of movement of wire), first/index finger in direction of field and middle/second in direction of current ✓	1	1.2	ALLOW a labelled diagram showing Fleming's Left-Hand rule ALLOW pointed finger for first/index finger
	(b)		(Current-carrying) wire has a magnetic field (around it) ✓ The (magnetic) fields of the wire and magnet <u>interact</u> ✓	2	1.1 × 2	ALLOW 'motor effect' / wire and magnet exert a force on each other
	(c)		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.0054 (N) or 5.4×10^{-3} (N) award 4 marks Select and apply: force = magnetic flux density × current × length ✓ Conversion: 4.5 (cm) = 0.045 (m) ✓ (force =) $0.060 \times 0.045 \times 2.0$ ✓ (force =) 0.0054 (N) or 5.4×10^{-3} (N) ✓	4	1.2 1.2 2.1 × 2	ALLOW 3 marks for any incorrect conversion of 4.5 cm e.g. 0.54 (N); 4.5 cm used instead of 0.045 m
	(d)		The force doubles / becomes 0.0108 (N) ✓ Because the force is proportional to the current AW ✓	2	2.1 × 2	ALLOW ECF from (c) – doubled force should be 1.08N if answer to part (c) is 0.54N

Question	Answer	Marks	AO element	Guidance
8*	<i>Please refer to the marking instructions on page 5 of this mark scheme for guidance on how to mark this question.</i> Level 3 (5–6 marks) Detailed description of transformers AND Detailed explanation of the transmission of electrical power. <i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i> Level 2 (3–4 marks) Partial description of transformers. AND Partial explanation of the transmission of electrical power. <i>There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.</i> Level 1 (1–2 marks) Basic description of transformers. AND Basic explanation of high-voltage transmission. <i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.</i> 0 marks <i>No response or no response worthy of credit.</i>	6	1.1 × 4 2.1 × 2	AO1.1 Knowledge and understanding of transformers For example • Diagram showing two coils • Diagram labelled showing primary/input coil, output/secondary coil and iron (ring) • Step-up increases voltage, step down decreases • Output is high(er) with more turns on the output/secondary coil (ORA) • Alternating current applied to input/primary coil • Changing field/flux induces voltage (at output/secondary coil) • The output voltage depends on the ratio of turns (on the coils) / $V_s/V_p = N_s/N_p$ AO2.1 Applying knowledge and understanding of transformers For example • At power station, output voltage is stepped up • The voltage is stepped down for safe home use • High voltage means low(er) current in the transmission cables/ Power = voltage x current / Power = current² x resistance • Lower current implies less power / energy / heat / thermal loss in cables • More power / energy gets to the homes from the power stations (as minimum lost in cables)

Question			Answer	Marks	AO element	Guidance
9	(a)		(Speed is the same but) velocity is different/changes (because of change in direction) or telescope accelerates ✓ (NO), the force is perpendicular to direction of velocity / towards the Sun / centre of circle / centripetal force ✓	2	3.1b 3.2b	IGNORE Centrifugal force
	(b)	(i)	Gravity pulls particles together / gravitational collapse / compress ✓ OR Work done on gas / dust cloud ✓ AND Temperature of gas / dust cloud increases resulting in fusion ✓	2	1.1 × 2	ALLOW gas / dust cloud is heated / warmed up resulting in fusion
		(ii)	Red-shift (of light) ✓ Any one from: Galaxies are moving away / space is expanding ✓ The more distant galaxies move faster (so at one time the galaxies must have been closer) AW ✓	2	1.1 × 2	ALLOW Cosmic Microwave Background Radiation / CMBR
	(c)		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 5.5 (m/s²) award 4 marks Recall and rearrange to give: acceleration = Force ÷ mass ✓ (resultant force =) $3.1 \times 10^7 - 2.0 \times 10^7$ or 1.1×10^7 (N) ✓ acceleration = $1.1 \times 10^7 \div 2.0 \times 10^6$ ✓ (acceleration =) 5.5 (m/s ²) ✓	4	1.2 2.2 2.1 × 2	ALLOW 1 mark for acceleration = 15.5 (m/s ²) if resultant force $F = 3.1 \times 10^7$ N / 25.5 (m/s ²) if resultant force $F = 5.1 \times 10^7$ N

Question			Answer	Marks	AO element	Guidance
10	(a)	(i)	A: (Constant) deceleration ✓ B: Constant / same / steady velocity / zero acceleration ✓ C: (Constant) acceleration ✓	3	2.1 × 3	ALLOW slowing down ALLOW speed for velocity ALLOW speeding up
		(ii)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 4.0 (m/s²) or 4 (m/s²) award 3 marks acceleration = gradient (of line) ✓ (acceleration =) $[30 - 10] \div 5$ or $20 \div 5$ ✓ (acceleration =) 4.0 (m/s ²) or 4 (m/s ²) ✓	3	1.2 2.1 × 2	ALLOW $a = (v - u) / t$ or $a = (v^2 - u^2) / 2s$
	(b)	(i)	Momentum is conserved AW (in the collision) ✓ Momentum of car = 15000 – 9000 (= 6000 kg m/s) ✓	2	1.1 2.1	
		(ii)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 6.0 / 6 (m/s) award 3 marks Recall and rearrange to give: velocity = momentum ÷ mass ✓ = $6000 \div 1000$ ✓ speed = 6.0/6 (m/s) ✓	3	1.2 2.1 × 2	IGNORE speed = momentum / mass

Question			Answer	Marks	AO element	Guidance
11	(a)		(gamma) the exposure time / length of treatment is less AW ✓ gamma is irradiation (because it is external) ORA ✓	2	3.2a 3.2b	
	(b)	(i)	Graph starts at 2.0×10^7 (counts per second) ✓ Activity = 1.0×10^7 (counts per second) at 74 days <u>and</u> activity = 0.5×10^7 (counts per second) at 148 days ✓ A curve of decreasing gradient ✓	3	2.1 × 2 3.1a	
		(ii)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 1/8 award 3 marks Activity is halved after (each) half-life or fraction = 1/2 after first half life ✓ Fraction = 1/4 after 2 half-lives ✓ Fraction = 1/8 (after 3 half-lives) ✓	3	2.2 × 3	ALLOW activity = 1.0×10^7 (after 1 half-life) ALLOW activity = 0.5×10^7 (after 2 half-lives) ALLOW 0.125
	(c)		(Amaya is correct) The activity (of low-level waste) decreases rapidly (due to short half-life) AW ORA ✓ (so after some years no longer dangerous) so no need for permanent burial ORA ✓	2	3.2a × 2	

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