

GCSE (9–1)

**Combined Science B (Twenty First Century
Science)**

J260/07: Physics (Higher Tier)

General Certificate of Secondary Education

Mark Scheme for June 2019

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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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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
—	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 Combined Science 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)		transformers ✓	1	1.1	ALLOW transformer IGNORE step up, step down
	(b)		increased decreased ✓	1	1.1	DO NOT ALLOW answers in incorrect order (must have both answers in this order)
	(c)	(i)	230 (V) ✓	1	1.1	ALLOW values in range 220-240 (V)
		(ii)	(The high voltage/p.d.) may cause a high current ✓ Which may overheat wires /cause fires OR may cause electric shock/stop heart ✓ OR (The high voltage/p.d.) is a.c. ✓ can affect muscles / so you can't let go OR may cause electric shock/stop heart✓	2	1.1x2	ALLOW electrocution ALLOW electrocution

Question			Answer	Marks	AO element	Guidance
2	(a)		Safety (max. 2 from): Don't boil the liquid OR Suggestion of sensible max temperature. ✓ Take care not to touch hot parts ✓ Allow apparatus to cool before dismantling ✓ Measurements (max. 2 from): Measure initial and final temperature of liquid/oil/water ✓ Measure mass of liquid/oil/water ✓ Record energy on joulemeter ✓ Stir before taking temperature readings ✓	3	1.2 x 3	ALLOW goggles or other sensible safety precaution e.g. heat proof gloves IGNORE gloves unqualified, apron IGNORE measure temperature IGNORE measure temperature difference ALLOW measure energy used ALLOW measure time to heat and power of heater ALLOW measure time to heat, p.d. and current in heater. ALLOW one mark (in measurements) for idea of substitution of measurements in the specific heat capacity equation
	(b)		FIRST CHECK ANSWER ON ANSWER LINE If answer = 2.05 (kJ/kg °C) $(1.94 + 2.23 + 1.98) / 3$ ✓ $= 2.05 \text{ (kJ/kg °C)}$ ✓	2	1.2 x 2	ALLOW any answer that rounds to 2.05 ALLOW one mark for 1.96 if 2.23 is explicitly identified as an outlier
	(c)		(accurate value is) lower ✓ (Because) energy is required to heat up apparatus and/or surroundings ✓ Lag the container OR add a lid ✓	3	3.1a 3.1b 3.3b	ECF ORA ALLOW only improvements that reduce the energy transfer to apparatus/surroundings

Question	Answer	Marks	AO element	Guidance
3	* 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) Interprets the charts to describe trends in detail. AND Gives an explanation for the trends including a reference to renewables and coal. <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) Interprets the charts to describe a trend in detail. OR Gives an explanation for the trend in renewables and coal. OR States a basic trend shown in the charts and explain a trend by referring to either coal decreasing or renewables increasing. <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) States a basic trend shown in the charts OR Explains a trend by referring to either coal decreasing or renewables increasing.	6	3.1a x 4 2.1 x 2	AO3.1a Analyse information and ideas to interpret For example: Basic trend: • coal use has fallen • gas use not much changed /no clear trend /up and down • nuclear not much changed /no clear trend /up and down • renewables increased • other and oil not much changed /no clear trend /up and down/unchanged overall • quoting data e.g. coal from 36.5% to 22.0% More detail: • coal use falling every year • renewables increasing every year • the increase in renewables is increasing every year • using data for coal e.g. coal fell by $(36.5 - 22.0 =) 14.5\%$ • using data for renewables AO2.1 Application of knowledge and understanding For example: Explains that: • coal/gas result in CO₂ emissions • which cause global warming • coal fired power stations / mines are being closed • coal fired stations produce SO₂ • nuclear does not cause CO₂ emissions • renewables increasingly used as more sustainable

Question			Answer	Marks	AO element	Guidance
			<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>			• renewables increasingly used as no CO₂ emissions when generating • lots of wind farms and offshore wind farms have been built • lots of solar farms have been built.

Question			Answer	Marks	AO element	Guidance
4	(a)	(i)	An induced magnet becomes a magnet in a magnetic field. A permanent magnet keeps its magnetism when it is not in a magnetic field/has its own magnetic field always ✓	1	1.1	Both statements required for the mark ALLOW an induced magnet has temporary magnetism but a permanent always has its magnetism.
		(ii)	1. they attract 2. they repel ✓	1	1.1	Both required for the mark AW applies to both
		(iii)	Field is stronger near the poles ✓ Field direction is from north to south ✓	2	1.1x2	This can be in words (even if nothing on diagram) OR by field pattern showing lines closer together [or by labels e.g. 'field stronger here'] at poles and arrowheads on field lines (even if no words). ALLOW for poor drawing skills i.e. words take priority e.g. allow If field lines parallel and words say 'stronger at poles' e.g. allow if arrow heads contradict each other and words say N to S. DO NOT ALLOW if arrowheads contradict (even if words correct) IGNORE crossing field lines
	(b)		(The metal bar in the boat) is a permanent magnet ✓ The Earth's magnetic field is in the direction left to right or right to left ✓ OR (Magnet) lines up with Earth's magnetic field ✓	2	3.2bx2	ALLOW bar magnet for permanent magnet ALLOW (magnetic) north/south is to right/left
	(c)		(The core of the Earth) is a permanent magnet. ✓	1	1.1	ALLOW the Earth behaves as if it has a bar magnet (at the centre/core). ALLOW (the core) creates/has a magnetic field

Question			Answer	Marks	AO element	Guidance
5	(a)		The number of waves/cycles/oscillations (made by the source) each second ✓	1	1.1	ALLOW vibration for oscillation
	(b)	(i)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 4.4×10^{-4} (m) award 4 marks Substitution $1540 \text{ m/s} = 3.5\text{MHz} \times \lambda$ ✓ Conversion $3.5 \text{ MHz} = 3.5 \times 10^6 \text{ (Hz)}$ ✓ Rearrangement $\lambda = 1540 \div (3.5 \times 10^6)$ ✓ Answer in standard form = $4.4 \times 10^{-4} \text{ (m)}$ ✓	4	1.2 1.2 2.1x2	Answer in standard form = $4.4 \times 10^x \text{ (m)}$ where x is not -4 from incorrect conversion scores 3 marks. DO NOT ALLOW 0.00044 (m)
		(ii)	Centre of one reflection i.e. 99 (μs) OR 44(μs) correctly identified ✓ $[99 - 44] = 55 \text{ (μs)}$ ✓	2	2.2x2	ALLOW for 44 (μs) value in range 42 to 46 (μs) ALLOW for 99(μs) value in range 97 to 101 (μs) ALLOW for 55 (μs) value in range 51 to 59(μs) Delay in correct range with no working scores 2 marks
		(iii)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.042 (m) or 0.043 (m) award 5 marks Recall speed = distance ÷ time ✓ Substitution $1540 \text{ m/s} = \text{distance} \div 55 \text{ (μs)}$ ✓ Conversion $55 \text{ μs} = 55 \times 10^{-6} \text{ (s)}$ ✓ Rearrangement and evaluation $\text{distance} = 1540 \times 55 \times 10^{-6} = 0.0847 \text{ (m)}$ ✓ Recognition that distance travelled by reflected beam from B is = 2 x distance AB greater than the reflected beam from A so = 0.042 (m) ✓	5	1.2 2.1 1.2 2.1 2.1	ALLOW other methods such as working out distance travelled by wave reflected at A and wave reflected at B and subtracting ALLOW any subject of the equation ECF time from 5bii [51(μs) gives 0.0393 (m); 59(μs) gives 0.0454 (m)] Answer from incorrect conversion can score max 4 marks ALLOW 0.085 (m) ALLOW answers that round to 0.042 or 0.43(m) ALLOW an independent mark for recognition that the distance should be halved, i.e. award this mark if candidate has halved their distance or time but not both

Question			Answer	Marks	AO element	Guidance
6	(a)	(i)	Top line 237 ✓ Bottom line 93 ✓	2	1.2 x 2	
		(ii)	For e: top 0 and bottom -1 ✓ For Sm: top line 147 ✓ For Sm: bottom line 62 ✓	3	1.1 1.2x2	Both required for this mark
	(b)		Idea that Pm-147 emits β AND Am-241 emits α ✓ Idea that radiation from Am-241/alpha radiation will be completely absorbed/stopped ✓ Idea that radiation from Pm-147/beta radiation will be only partially absorbed/stopped (depending on thickness) ✓	3	2.1x3	DO NOT ALLOW Pm-147 without some attempt at valid explanation ALLOW no alpha will get through Only award this mark if Pm-147 is the chosen isotope ALLOW some beta will get through.
	(c)		To avoid irradiation of people AW ✓ Because it is ionising radiation OR damages cells/tissues/DNA OR can cause cell mutation ✓	2	2.1x2	IGNORE avoid harming/damaging/killing people IGNORE causes cancer / causes radiation poisoning

Question			Answer	Marks	AO element	Guidance
7	(a)	(i)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 70 (m) award 4 marks Recall work done = force $\times$ distance ✓ Substitution $4.6 \times 10^7 = 2.3 \times 10^5 \times s$ ✓ Rearrangement and evaluation $s = 4.6 \times 10^7 \div 2.3 \times 10^5 = 200$ (m) ✓ $d = 200 - 130 = 70$ (m) ✓	4	1.2 2.1x3	ALLOW any subject of the equation ALLOW an independent mark for recognition that the distance d is their value of s minus 130, as long as $s > 130$ and d correctly calculated
		(ii)	(Energy transferred) from kinetic (energy store of train) ✓ to thermal energy (store) of brakes/train/surroundings ✓	2	1.1 x 2	ALLOW of air/tunnel walls IGNORE sound
	(b)		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 360 000 (N) award 5 marks Calculation $KE = (\frac{1}{2} \times 280\,000 \times 12^2) = 2.016 \times 10^7$ (J) ✓ $KE = \text{work done by force}$ ✓ Recall and rearrange work done = force $\times$ distance ✓ force = $2.016 \times 10^7 \div 56$ ✓ force = 360 000 (N) ✓	5	2.1 1.1 1.2 2.1 2.1	ALLOW answers with more sf that round correctly to this value. ALLOW answers in standard form or using prefixes ALLOW if $KE = 2.016 \times 10^7$ (J) seen anywhere in response ALLOW $\frac{1}{2} \times 280\,000 \times 12^2$ for 2.016×10^7 ECF wrong value of KE
	(c)		The KE of the trains is transferred by heating (and the	2	1.1	

Question			Answer	Marks	AO element	Guidance
			thermal store of the surroundings is increased). ✓ AND any one from: idea that: There are now more trains ✓ More people/passengers (transfer energy by heating surroundings) ✓ Not all of energy from motors/engines is transferred to KE of train as they are not 100% efficient. ✓		2.1	ALLOW (tunnels) used more frequently/often

Question			Answer	Marks	AO element	Guidance
8	(a)		It changes speed as it enters and leaves the prism ✓ OR It slows down as it enters (the glass/prism) / It speeds up as it leaves (the glass/prism) ✓ it changes direction/bends. ✓	2	1.1 x 2	ALLOW angle changes on entering/leaving
	(b)		Red light has the lowest frequency ✓ Violet light is refracted most moving from air to glass ✓	2	1.1 2.1	

Question			Answer	Marks	AO element	Guidance										
9	(a)		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 31 (m/s) award 3 marks 110 x 1000 ÷(60 x 60) ✓ = 30.5(5) (m/s) ✓ = 31 (m/s) ✓	3	 1.2 2.1 1.2	ALLOW 31 m/s and all answers that round correctly to 31 m/s ALLOW 110000 ÷ 3600										
	(b)	(i)	A scalar has magnitude only. A vector has magnitude and direction. ✓	1	1.1	Must have both to be awarded the mark ALLOW size for magnitude IGNORE examples										
		(ii)	<table><tr><td>✓ acceleration</td><td></td></tr><tr><td>✓ displacement</td><td></td></tr><tr><td></td><td>✓ distance</td></tr><tr><td></td><td>✓ speed</td></tr><tr><td>✓ velocity</td><td></td></tr></table> ✓	✓ acceleration		✓ displacement			✓ distance		✓ speed	✓ velocity		1	1.1	All must be correct to award the mark
✓ acceleration																
✓ displacement																
	✓ distance															
	✓ speed															
✓ velocity																
	(c)	(i)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 1.5 (m/s²) award 3 marks Attempt to calculate gradient of negative slope ✓ Uses a correct pair of values e.g. (-) (18-0)/(47-35) ✓ Deceleration = 1.5 (m/s ²) ✓	3	2.2x3	IGNORE sign ALLOW 18/(47-35) and other correct pairs where zero omitted. ALLOW any correct fraction eg 18/12 IGNORE negative sign of gradient ALLOW correctly calculated answers that round to 1.5 (m/s ²)										

Question			Answer	Marks	AO element	Guidance
		(ii)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 108 (m) or 110 (m) award 3 marks Identifies stopping distance = area under negative slope line ✓ Recall area of triangle = $\frac{1}{2}$ base x height ✓ Stopping distance = 108 (m) ✓	3	1.2 2.2x2	ALLOW counting squares method ALLOW for counting squares, answers that round to 110 (m) IGNORE distance = speed x time ALLOW $\frac{1}{2} \times 12 \times 18$ ECF height and/or base from 9ci ALLOW 110 (m) to 2sf
	(d)	(i)	Straight lines drawn on graph: (0, 0) to (1-24, 26) ✓ (1-24, 26) to (21-44, 20) ✓ (21-44, 20) to (45, 0) ✓	3	2.2 x 3	With a ruler and $\pm \frac{1}{2}$ small square Must start from (0, 0) ECF first point (x, y), 2 nd point (x + 20, y - 6) ECF 2 nd point to (45, 0)
		(ii)	(second gazelle because) The area (under the curve) is larger ✓	1	3.2a	

Question			Answer	Marks	AO element	Guidance
10			FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 1.4 (A) award 2 marks Substitution into force = magnetic flux density $\times$ current $\times$ length of conductor $0.63 = 1.8 \times I \times 0.25$ ✓ Current = 1.4 (A) ✓	2	2.1x2	ALLOW calculation of 1.4 A and a final answer slightly more (to allow for lifting the rod)

Question			Answer	Marks	AO element	Guidance
11	(a)		particles gain kinetic energy/move faster (when heated/ as temperature rises) ✓ particles move further apart (when heated/change state) ✓ particles escape from liquid (as they enter gaseous state) ✓	3	1.1 x 3	ALLOW atoms, molecules for 'particles' throughout DO NOT ALLOW vibrate faster/more for 'move faster'
	(b)		Idea that (for a fixed mass) latent heat is greater than specific heat. ✓ energy from water is transferred to the solid PCM by heating OR energy from liquid PCM is transferred to water/night air by heating ✓ energy from water melts the solid PCM by heating OR the liquid PCM freezes by heating the night air/water ✓	3	2.1 3.1ax2	
	(c)	(i)	(A because) Any two from: Melting point of A (temperature of 16°C) is lower than required/22°C so it will have a greater cooling effect ✓ Melting point of B (temperature of 28°C) is higher than required so it will not melt below that temperature ✓ The time to melt A is greater so more energy/heating is required to melt it or A has higher specific latent heat ✓ The gradient of the slopes for A is lower so more energy/heating is required to increase its temperature or it has higher specific heat capacity) ORA ✓	2	3.2ax2	DO NOT ALLOW just A without justification
		(ii)	FIRST CHECK THE ANSWER ON ANSWER LINE	5		

Question			Answer	Marks	AO element	Guidance
			If answer = 150 000 (J/kg) award 5 marks Deduce time required from graph = [160-35] OR 125 (s) ✓ Recall and rearrange to energy = power x time ✓ $E = 120 \times 125$ OR 15000 (J) ✓ Select and apply energy = mass x specific latent heat $E = 100 \times 10^{-3} \times \text{SLH}$ ✓ $\text{SLH} = 15000 \div [100 \times 10^{-3}] = 150\,000 \text{ (J/kg)}$ ✓		2.2 1.2 2.1x3	ALLOW ECF from their calculated value of E using energy = power x time 150 (J/kg) scores 4 marks

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