H

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

Oxford Cambridge and RSA Examinations

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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
BOD	Benefit of doubt given
CON	Contradiction
RE	Rounding error
SF	Error in number of significant figures
ECF	Error carried forward
L1	Level 1
L2	Level 2
L3	Level 3
NBOD	Benefit of doubt not given
SEEN	Noted but no credit given
I	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 (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. *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)** 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. *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)** 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 CO_2 emissions • which cause global warming • coal fired power stations / mines are being closed • coal fired stations produce SO_2 • nuclear does not cause CO_2 emissions • renewables increasingly used as more sustainable

Question			Answer	Marks	AO element	Guidance
			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.*			• renewables increasingly used as no CO_2 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 x 10⁻⁴ (m) award 4 marks**	4		Answer in standard form = 4.4×10^x (m) where x is not -4 from incorrect conversion scores 3 marks.
			Substitution 1540 m/s = 3.5MHz $\times \lambda$ ✓		1.2	
			Conversion 3.5 MHz = 3.5×10^6 (Hz) ✓		1.2	
			Rearrangement λ = 1540 ÷ (3.5×10^6) ✓		2.1x2	
			Answer in standard form = 4.4×10^{-4} (m) ✓			**DO NOT ALLOW** 0.00044 (m)
		(ii)	Centre of one reflection i.e.99 (µs) **OR** 44(µs) correctly identified ✓ [99– 44] = 55 (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**	5		**ALLOW** other methods such as working out distance travelled by wave reflected at **A** and wave reflected at **B** and subtracting
			Recall speed = distance ÷ time ✓		1.2	**ALLOW** any subject of the equation
			Substitution 1540 m/s = distance ÷ 55 (µs) ✓		2.1	**ECF** time from 5bii [51(µs) gives 0.0393 (m);59(µs) gives 0.0454 (m)]
			Conversion 55 µs = 55×10^{-6} (s) ✓		1.2	Answer from incorrect conversion can score max 4 marks
			Rearrangement and evaluation distance = $1540 \times 55 \times 10^{-6}$ = 0.0847(m) ✓		2.1	**ALLOW** 0.085 (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) ✓		2.1	**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**	4		
			Recall work done = force × distance ✓		1.2	**ALLOW** any subject of the equation
			Substitution $4.6 \times 10^7 = 2.3 \times 10^5 \times s$ ✓		2.1x3	
			Rearrangement and evaluation $s = 4.6 \times 10^7 \div 2.3 \times 10^5 = 200$ (m) ✓			
			$d = 200 - 130 = 70$ (m) ✓			**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) ✓	2	1.1 x 2	
			to thermal energy (store) of brakes/train/surroundings ✓			**ALLOW** of air/tunnel walls **IGNORE** sound
	(b)		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 360 000 (N) award 5 marks**	5		**ALLOW** answers with more sf that round correctly to this value. **ALLOW** answers in standard form or using prefixes
			Calculation $KE = (\frac{1}{2} \times 280\,000 \times 12^2) = 2.016 \times 10^7$ (J) ✓		2.1	**ALLOW if** $KE = 2.016 \times 10^7$ (J) seen anywhere in response
			KE = work done by force ✓		1.1	
			Recall and rearrange work done = force × distance ✓		1.2	
			force = $2.016 \times 10^7 \div 56$ ✓		2.1	**ALLOW** $\frac{1}{2} \times 280\,000 \times 12^2$ for 2.016×10^7 **ECF** wrong value of KE
			force = 360 000 (N) ✓		2.1	
	(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**	3		**ALLOW** 31 m/s and all answers that round correctly to 31 m/s
			110 x 1000 ÷(60 x 60) ✓		1.2	**ALLOW** 110000 ÷ 3600
			= 30.5(5) (m/s) ✓		2.1	
			= 31 (m/s) ✓		1.2	
	(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 I**GNORE** examples
		(ii)	✓ acceleration ✓ displacement ✓ distance ✓ ✓ speed ✓ velocity	1	1.1	All must be correct to award the mark
	(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/s²) ✓	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/s²)

Question			Answer	Marks	AO element	Guidance
		(ii)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 108 (m) or 110 (m) award 3 marks**	3		**ALLOW** counting squares method **ALLOW** for counting squares, answers that round to 110 (m) **IGNORE** distance = speed x time
			Identifies stopping distance = area under negative slope line ✓		1.2	
			Recall area of triangle = ½ base x height ✓		2.2x2	**ALLOW** ½ x 12 x 18 **ECF** height and/or base from 9ci
			Stopping distance = 108 (m) ✓			**ALLOW** 110 (m) to 2sf
	(d)	(i)	Straight lines drawn on graph:	3	2.2 x 3	With a ruler and ± ½ small square
			(0, 0) to (1-24, 26) ✓			Must start from (0, 0)
			(1-24, 26) to (21-44, 20) ✓			**ECF** first point (x, y), 2nd point (x + 20, y - 6)
			(21-44, 20) to (45, 0) ✓			**ECF** 2nd 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 × current × length of conductor 0.63 = 1.8 × *I* × 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)✓		2.2	
			Recall and rearrange to energy = power x time ✓		1.2	
			E = 120 × 125 **OR** 15000 (J) ✓		2.1x3	
			Select and apply energy = mass x specific latent heat $E = 100 \times 10^{-3}$ x SLH ✓			**ALLOW ECF** from their calculated value of E using energy = power x time
			SLH = 15000 ÷ [100 x 10⁻³] = 150 000 (J/kg) ✓			150 (J/kg) scores 4 marks

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