OCR
Oxford Cambridge and RSA

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GCSE (9–1)

Combined Science B (Twenty First Century Science)

J260/03: Physics (Foundation Tier)

General Certificate of Secondary Education

Mark Scheme for November 2020

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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

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.

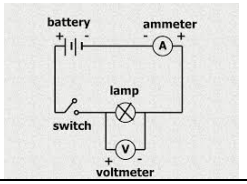
You should ensure also that you are familiar with the administrative procedures related to the marking process. These are set out in the OCR booklet **Instructions for Examiners**. If you are examining for the first time, please read carefully **Appendix 5 Introduction to Script Marking: Notes for New 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)		Microwaves have a longer wavelength than light ✓	1	1.1	2nd box
	(b)		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 3720 (m/s) award 2 marks** Substitution: wave speed = 15 × 248 ✓ wave speed = 3720 (m/s) ✓	 1 1	2x2.1	

Question			Answer	Marks	AO element	Guidance
2	(a)		Bulb/lamp/light Switch (Battery) Ammeter Voltmeter ✓✓	2	2x1.2	Two marks for 4 correct, one mark for 2 or 3 correct, zero marks for 1 or 0 correct. **DO NOT ALLOW** Ampmeter
	(b)	(i)	A circuit diagram containing a battery connected in series with an ammeter and a switch, ✓ **AND** A bulb with a voltmeter connected in parallel. ✓  **OR** ✓✓	2	2x1.2	**DO NOT ALLOW** gaps in the circuits **IGNORE** extra/other components
		(ii)	record the initial brightness of bulb, e.g. bright/dim (and readings from ammeter and voltmeter) ✓ add second bulb in parallel and record brightness (and readings from ammeter and voltmeter) ✓	2	2x1.1	
		(iii)	To have a more valid comparison / To ensure his investigation is repeatable/reproducible/accurate ✓	1	3.1a	**ALLOW** Fair test
		(iv)	Stay the same ✓ Decrease ✓	2	2x1.1	
	(c)	(i)	Any **one** from: Overheating components - hot bulb ✓ Heating of wires and bulbs ✓ Blown/exploded/broken bulb ✓	1	3.3a	
		(ii)	Any **one** from: Use a heatproof mat ✓ Switch off between readings (to ensure components don't get too hot) ✓ Don't exceed maximum supply voltage to lamps ✓	1	3.3a	

Question			Answer	Marks	AO element	Guidance
3	(a)		circular pattern centred on wire ✓ weaker/lines wider spacing away from wire ✓ anticlockwise direction ✓	3	3 x 1.1	All 3 marks can be scored by drawing on diagram if they explicitly show the three marking points **DO NOT ALLOW** one circle drawn
	(b)		Increase the current in the wire ✓ Move the pin closer to the wire ✓	2	2 x 2.1	2nd and 5th boxes ticked

Question			Answer	Marks	AO element	Guidance
4	(a)		Transverse ✓ Longitudinal ✓	2	2 x 1.1	**ALLOW** examples of transverse and longitudinal for each mark
	(b)		observe that it only moves up and down ✓ stays in the same place / is not pushed along the lake by the waves ✓	2	2 x 1.2	
	(c)	(i)	**Any three from:** **Measurements** How to measure time - method of making sound that can be seen (cymbals, large blocks of wood, firework, flare), measure time (with a stopwatch) from when sound made to return of echo **OR** clap hands in time with echo and count 'n' times. ✓ How to measure distance e.g. trundle wheel, tape measure. ✓ **Accuracy of Measurement** **MAX one** from: A detail of how to measure accurately e.g. Repeat and calculate mean **OR** use 10 or more echoes (as above) ✓	3	3 x 1.2	**ALLOW** any method that will work and is suitable Must imply a suitable distance for sound to travel **IGNORE** metre rule **IGNORE** detail of **ensuring accuracy of** distance between sound source and cliff – whether by measuring one two or many times.
		(ii)	(speed =) $\frac{\text{distance travelled by sound}}{\text{time taken}}$ ✓	1	1.1	

Question			Answer	Marks	AO element	Guidance
5	(a)	(i)	$^{14}_{6}C$ ✓	1	1.2	last choice ringed
		(ii)	They have different numbers of neutrons ✓	1	1.1	**ALLOW** they have different mass number **DO NOT ALLOW** 'more neutrons' or 'less neutrons', because insufficient for different
	(b)		(charge of nucleus) decreases ✓ (mass of nucleus) decreases ✓	2	2 x 1.1	

Question	Answer	Marks	AO element	Guidance
(c)*	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)** Detailed explanation as to why shellfish are safe to eat but sheep are not by comparing half-life from the table **AND** Explanation of contamination and irradiation in the context of the shellfish and the sheep. *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)** Partial explanation as to why shellfish are safe to eat but sheep are not **AND** Explanation of contamination and irradiation *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)** Basic/limited explanation as to why shellfish are safe to eat but sheep are not **AND** Description of difference between contamination and irradiation **OR** Uses the table to compare the half-life *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.*	**6**	**1 x 1.1** **3 x 3.1b** **2 x 3.2a**	**AO1.1 Demonstrate knowledge and understanding that** • contamination is a greater hazard than irradiation • because the source continues to radiate the body from inside • demonstrates differences between contamination and irradiation **AO3.1b Analyse information and ideas to evaluate** • Both emit gamma radiation • Both are made in a reactor • Cs 137 has a longer half-life than Co 60 • γ rays will kill bacteria • γ rays can harm/mutate cells/DNA • γ rays can cause cancer • Shellfish is irradiated – has not been contaminated with Co 60 • Sheep were contaminated by eating grass containing Cs 137 **AO3.2a Analyse information and ideas to make judgements** • The Cs 137 inside the body continues to emit radiation for a long time. • The Co 60 has not touched the shellfish so a person eating it will not be exposed to radiation from Co 60. • (If there were) bacteria on the shellfish (they) will have been killed. • The shellfish is safe to eat

Question			Answer	Marks	AO element	Guidance
6	(a)		the gravitational force on the elephant ✓	1	1.1	2nd box ticked
	(b)		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 300 000 (J) award 2 marks** Substitution: GPE = weight × height = 60 000 × 5 ✓ GPE = 300 000 (J) ✓	2	2 x 2.1	
	(c)		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 40 (%) award 2 marks** Substitution: efficiency = $\frac{300\,000}{750\,000}$ × 100 ✓ efficiency = 40 (%) ✓	2	2 x 2.1	**ECF** from **(b)**
	(d)		Dissipated as thermal energy **OR** dissipated as heat **OR** lost to the surroundings **OR** lost as heat **OR** lost as thermal energy ✓	1	1.1	**IGNORE** lost unless indicated where energy has been transferred to.

Question			Answer	Marks	AO element	Guidance
7	(a)		Magnetic gravitational✓	1	3.2a	
	(b)	(i)	450 (kN) ✓	1	2.2	
		(ii)	(A straight arrow): pointing in opposite direction to existing arrow ✓ 4.5 squares in length ✓	2	2 x 2.2	**ALLOW** arrow to start from any point on grid
	(c)		Any **3** from: a force from the ground (upwards on him) ✓ a force from him downwards on the ground ✓ the two forces of the same type✓ the two forces are equal and in opposite directions ✓ correct idea about Newton's 3rd law✓	3	1 x 2.1 2 x 1.1	 **ALLOW** (normal) reaction force **DO NOT ALLOW** idea that the upward force is the interaction pair to his weight

Question			Answer	Marks	AO element	Guidance
8	(a)		**ONE MARK** acceleration increases when accelerating force increases ✓ **OR** there is a positive correlation between acceleration and accelerating force ✓ **TWO MARKS** acceleration doubles when accelerating force doubles ✓✓ **OR** acceleration is proportional to accelerating force ✓✓	**2**	**2 x 2.1**	
	(b)	**(i)**	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 3000 (N) award 3 marks** Recall force = mass x acceleration Substitution: force = 1200 × 2.5 ✓ force = 3000 (N) ✓	**3**	 **1.2** **2.1** **2.1**	
		(ii)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 81 (km/h) award 4 marks** Substitution: [final speed – 0] = 2.5 × 9 ✓ Final speed = (2.5 × 9) = 22.5 (m/s) ✓ (22.5/1000 =) 0.0225km/s ✓ (0.0225 x 60 x 60 =) 81km/h ✓	**4**	 **2.1** **2.1** **1.2** **1.2**	 **ALLOW (**22.5 x 60 x 60 =) 81 000 (m/h) **ALLOW** (81 000/1000 =) 81 (km/h)

Question			Answer	Marks	AO element	Guidance
9	(a)		192 (J) ✓	1	2.1	
	(b)		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 21 (hours) award 3 marks**			
			convert 240 W to 0.24 kW **OR** 5.04 kWh to 5040 Wh ✓	1	1.2	**ALLOW** before or after calculation
			rearrange and substitute: time = 5.04 ÷ 0.24 **OR** 5040 ÷ 240 ✓	1	2.1	**ALLOW** 5.04 ÷ 240
			time = 21 (hours) ✓	1	2.1	0.021 (hours) i.e. no conversion = 2 marks
	(c)		1st box = reactor 2nd box = turbine 3rd box = generator ✓ ✓	2	2x1.1	three correct = 2 marks two correct = 1 mark zero or one correct = 0 marks

Question			Answer	Marks	AO element	Guidance
10	(a)		transferred to (thermal store of) surroundings ✓ Energy is conserved OR total energy stays the same ✓	2	2x2.1	 **ALLOW** Energy cannot be created or destroyed
	(b)	(i)	density = $\frac{\text{mass}}{\text{volume}}$ ✓	1	1.1	centre equation ringed
		(ii)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 0.73 (g/cm^3) and to 2sf award 3 marks** Substitution: density = 66 ÷ 90 ✓ density = 0.7333 (g/cm^3) ✓ density = 0.73 (g/cm^3) ✓ to 2sf	 1 1 1	 2.1 2.1 1.2	 **ALLOW** value given to 2 or more sf **ALLOW ECF** incorrect value given to 2sf gets this mark.
	(c)		Jane ✓ (It is the increase in internal energy that increases the temperature of 1kg of a material by 1°C.)	1	3.1a	**ALLOW** answer on the diagram e.g. ringed or ticked
	(d)		0.4 × 2740 × (20 – 4) ✓	1	2.1	3rd answer ticked
	(e)		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 81 600 (J) award 3 marks** select and apply: energy to cause a change of state = mass × SLH *E* = 0.4 kg × 204 kJ ✓ = 81.6 kJ = 81 600 (J) ✓	 1 1 1	 2.1 2.1 1.2	 **ALLOW** 0.4 x 204 000

Question			Answer	Marks	AO element	Guidance
11	(a)	(i)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer =** 4.5 x 10^5 (J) **in standard form award 4 marks**			
			Recall Work done (energy transferred) = force × distance ✓	**1**	**1.1**	**ALLOW** GPE=weight×height **ALLOW** GPE=mass×g×height OR mgh
			= 9000 N × 50 m ✓	**1**	**2.1**	
			= 450 000 (J) ✓	**1**	**2.1**	
			= 4.5 x 10^5 (J) ✓	**1**	**1.2**	
		(ii)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 30000 (W) award 3 marks**			**ECF** from **(a)(i)**
			Recall Power = Energy transferred ÷ time ✓	**1**	**1.1**	
			= 450 000 J ÷ 15 s ✓	**1**	**2.1**	
			= 30000 (W) ✓	**1**	**2.1**	**ALLOW 30 <u>kW</u>**
	(b)		Rate Mechanically Kinetic Thermal ✓ ✓	**1** **1**	**1.1** **2.1**	Four correct = 2 marks Three or Two correct = 1 mark One or none correct = 0 marks

Question			Answer	Marks	AO element	Guidance
12	(a)	(i)	Both points plotted to within ±0.5 small square ✓	1	2.2	Points are: (1.4, 8) and (1.8, 11)
		(ii)	Suitable straight line of best fit through most of the points ✓	1	2.2	**ALLOW** points as plotted by candidate
		(iii)	Current is (directly) proportional to potential difference/pd/voltage **OR** the relationship is linear ✓	1	3.1a	**ALLOW** component is linear **IGNORE** just they both increase / as one increases so does the other
		(iv)	(fixed) resistor ✓	1	2.1	**ALLOW** resistance (wire) or Ohmic conductor
		(v)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 160 OR 170 (Ω) award 4 marks** Read current = 12 mA from graph ✓ Convert mA to A: Resistance = 12 mA = 12 × 10^{-3} A ✓ Rearrange equation and substitute: Resistance = 2.0 V ÷ 12 × 10^{-3} A ✓ = 160 or 170 (Ω) ✓	 1 1 1 1	 2.2 1.2 2.1 2.1	 **ALLOW** current = 11.8 – 12.2 mA **ECF** from line drawn on graph **ALLOW** 3 marks for correct calculation with no conversion = 0.16 or 0.17 (Ω) **ALLOW** 2 marks for substitution with an incorrect or no conversion and incorrect or no evaluation, e.g. for Resistance = 2.0 ÷ 12 **ALLOW** answers of more than 2 s.f. that round to 160 or 170
	(b)	(i)	Current is not (directly) proportional to potential difference/pd/voltage **OR** the relationship is non-linear ✓	1	3.1a	**ALLOW** component is non-linear **ALLOW** description of what the graph shows e.g.: No current when p.d. negative **AND** then current increases as p.d. increases **OR** No current when potential difference less than 0.5 V **AND** then current increases as p.d. increases
		(ii)	To allow current to pass in only one direction ✓	1	3.2b	**ALLOW** convert a.c. to d.c.

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