H

GCSE (9–1)

Combined Science B (Twenty First Century Science)

J260/07: Physics (Higher 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.

Annotations

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

Question			Answer	Marks	AO element	Guidance
2	(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) ✓	4	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.

Question			Answer	Marks	AO element	Guidance
3	(a)	(i)	Any **two** from: Ultraviolet/UV, X-rays, gamma/γ rays, alpha/α (particle), betaβ(particle) ✓✓	2	1.1	
		(ii)	kill/damage living cells **or** body tissue ✓ **OR** cause living cells to become cancerous ✓	1	1.1	**ALLOW** cause cancer/mutate cells
	(b)		increases faster temperature increases ✓✓✓	3	1.1	**DO NOT ALLOW** in any other order Four correct = 3 marks Three correct = 2 mark Two correct = 1 mark One or none correct = 0 mark

Question			Answer	Marks	AO element	Guidance
4	(a)		the mass per 1 m^3 of the material. ✓	1	1.1	Tick in 2nd box
	(b)		11.5 ± 0.5 (g/cm^3) ✓	1	2.2	
	(c)		Zinc shows increasing trend **OR** fits pattern ✓ Platinum higher than gold so does not fit pattern **OR** Platinum higher than gold but expected variations away from the line so still fits the pattern broadly ✓ Zinc would increase confidence **AND** but platinum decreases/increases confidence ✓	3	2.2x2 3.2a	**ALLOW** the points are not on the straight line – so relationship is not proportional **ALLOW** plotted points and reference to them in answer for 2 marks

Question			Answer	Marks	AO element	Guidance
5	(a)	(i)	Darken room / lower ripple tank / increase amplitude of waves. ✓	1	3.3b	**ALLOW** any sensible suggestion e.g. switch off lights **OR** draw blinds **OR** shield from light other than lamp **OR** use a brighter lamp
		(ii)	Switch on the motor **OR** adjust speed to give low frequency waves. ✓ **OR** Place a ruler on the paper **OR** use paper with grid lines ✓ **OR** Take a photo/video of the waves **OR** use a stroboscope to make the pattern appear stationary ✓ **AND** Measure length of a number of waves (on photograph or video frame) and divide length by the number of waves to get the wavelength. ✓ **AND** Repeat and take a mean ✓	3	1.2	**DO NOT ALLOW** description of how to generate waves by hand, as this is not accurate
		(iii)	(Fill with) water at a different temperature & measure temperature with thermometer ✓ repeat experiment at different temperatures ✓	2	3.3a	**DO NOT ALLOW** put a heater in the ripple tank 'Different temperatures' may be shown by examples
	(b)	(i)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 2.2 OR 2.3 (Hz) award 2 marks** Calculate frequency = 27 ÷ 12 ✓ = 2.2 or 2.3 (Hz) ✓	2	1.2 1.2	**ALLOW** answers of more than 2 s.f. that round to 2.2 or 2.3
	(b)	(ii)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 0.053 OR 0.055 (m/s) award 3 marks** Convert 2.4 cm to 0.024 m ✓ substitute: wave speed = 0.024 × 2.2 **OR** 0.024 × 2.3 ✓ = 0.053 **OR** 0.055 (m/s) ✓	3	1.2 2.1 2.1	**ECF** from part b(i) ALLOW 2 marks for substitution with an incorrect answer or no conversion **ALLOW** answers of more than 2 s.f. that round to 0.053 or 0.055

Question			Answer	Marks	AO element	Guidance
6	(a)	(i)	The current at W is <u>LOWER</u> than the current at Y ✓ The potential difference measured by voltmeter X is <u>LOWER</u> than the potential difference measured by Z ✓	2	2.1	
		(ii)	The current increases **OR** ammeter reading is higher ✓ The p.d./voltage decreases **OR** voltmeter reading is lower ✓	2	1.1	
	(b)		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 0.45 (J) award 4 marks** Convert 300 mC to 0.3 C ✓ Recall and rearrange: work done = potential difference × charge ✓ Substitute: work done = 1.5 × 0.3 ✓ Work done = 0.45 (J) ✓	4 1.2 1.1 2.1 2.1		No conversion or incorrect conversion scores 3 marks. **ALLOW** 450 <u>mJ</u> **ALLOW** 3 marks for correct answer with no conversion =450 (J)

Question			Answer	Marks	AO element	Guidance
7	(a)		Power rating increases which causes the change in stored energy to increase **AND** time increases causes stored energy to increase ✓ Recognising that one or both changes is proportional ✓ 2 or more examples from the table used to show this ✓	3	3.1a	For example: 'Change in stored energy proportional to power rating' or 'Change in stored energy proportional to time used' **ALLOW** 2 marks for change in stored energy = power rating × time **ALLOW** Examples: shower & kettle to show power rating: 7500 ÷1500 = 600 ÷ 3000. vacuum cleaner & television to show time: 125 ÷ 1.0 = 50 ÷ 0.4 Any two to show power × time
	(b)	(i)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 45 (W h) award 3 marks** 90/100 = 0.9 ✓ Substitututon: 0.9 = useful energy output / 50 ✓ = 45 (W h) ✓	3	 1.2 2.1 2.1	
	(b)	(ii)	Shape of Sankey diagram correct ✓ Sankey diagram: 5 scale divisions wide going to two arrows; one arrow that is 4.5 scale divisions wide and the other arrow that is 0.5 scale divisions wide ✓ Wider arrow labelled: kinetic energy **OR** useful energy (output) ✓ Other arrow labelled: thermal energy **OR** energy lost to surroundings **OR** energy dissipated **OR** energy wasted ✓	4	1.2 2.2 2.2 2.2	**ECF** part b(i) **ALLOW** one mark maximum of these two label marks if arrows are the same size. **ALLOW** indication that useful energy also finally transferred to thermal store of surroundings. **ALLOW** energy wasted **IGNORE** other energies/arrows e.g. sound
	(c)		1st gap chemical/nuclear/gpe/kinetic/thermal ✓ 2nd gap (electric) current (doing work) ✓ **OR** electrical working 3rd gap thermal (energy store) ✓	3	1.1	**DO NOT ALLOW** sources such as coal, uranium, hydroelectric, wind, solar

Question			Answer	Marks	AO element	Guidance
8	(a)	(i)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 1/8 award 3 marks** Number of half-lives = $\dfrac{2076 - 1986}{30} = \dfrac{90}{30} = 3$ ✓ Fraction = ½ × ½ × ½ **OR** $(½)^3$ ✓ = 1/8 ✓	3	2.1	
		(ii)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 2166 award 3 marks** 1/64 = ½ × ½ × ½ × ½ × ½ × ½ **OR** $(½)^6$ ✓ 6 half-lives = 6 × 30 years = 180 years ✓ Year = 1986 + 180 = 2166 ✓	3	2.1	
	(b)		Any **two** from: To inform people of hazards / risks ✓ To inform people of benefits / costs / ethical issues, ✓ To enable (informed) decision making ✓ To increase understanding and so speed up further research ✓	2	1.1	**ALLOW** different examples from one marking point e.g. To inform the public of the risks so they can avoid them and to inform politicians of the risks so they can make laws to protect people.

Question			Answer	Marks	AO element	Guidance
9	(a)		Velocity has direction **OR** velocity is a vector **AND** speed has magnitude only **OR** speed does not have direction ✓ Direction is changing (so velocity changes)✓	2	1.1	
	(b)		Idea of how difficult it is to change the velocity/acceleration ✓ **OR** (Inertial Mass) = Force ÷ acceleration ✓	1	1.1	
	(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)** Explains motion of space probe as it travels towards the star, and explains why it then crashes into the star, using first law and second law *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)** Explains motion of space probe as it travels towards the star, using first and second law **OR** Explains why the space probe crashes into the star, using first and second law *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)** Explains motion of space probe as it travels towards the star, with use of only first law **OR** Explains why the space probe crashes into the star, with use of only first law. *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	2.1 x 2 3.1b x 3 3.2a x 1	**Indicative scientific points may include:** **AO2.1** Apply knowledge and understanding **For example:** Probe: • At first no (resultant) force on probe • Later force of gravity from star **AO3.1b** Evaluate information and ideas **For example:** Probe: At first: due to Newton's first law • will continue at constant speed • will not change direction As approaches star: due to Newton's second law (+ gravity) • accelerates probe/increases speed • towards centre of star **AO3.2a** Make judgements • space probe will continue on path towards star • speed/velocity will not change (until it gets close to star) • space probe will crash into star • **ALLOW** Star is also moving and outcome that probe may/will miss star, or other sensible reason for outcome that probe may/will miss star

Question			Answer	Marks	AO element	Guidance
10	(a)	(i)	Any **one** from: increasing its thermal store ✓ **OR** So the internal energy of the milk has increased ✓	1	1.1	**IGNORE** gets hot
		(ii)	They have different specific heat capacities ✓ **OR** Need different energy to raise the temperature of the same mass by the same temperature ✓	1	1.1	
	(b)	(i)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 1250000 (J) to 3 s.f. award 3 marks** Conversion: 560 g = 0.56 kg ✓ Select and apply: energy = mass × specific latent heat $E = 2.23 \times 10^6 \times 0.56$ (=1248800) ✓ $E = 1250\,000$ (J) ✓	3	 1.2 2.1 1.2	 **ALLOW** this mark for correct answer to 3 or more s.f **ALLOW** this mark for attempt at calculation with incorrect answer correctly given to 3 s.f. (calculation must be attempted)
		(ii)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 2970 OR 2980 (W) award 3 marks** conversion 7 minutes = 7 x 60 s = 420 s ✓ Sub & rearrange: 1248800 or 1250000 $= P \times 7 \times 60$ OR $P \times 420$ ✓ $P = 2970$ or 2980 (W) ✓	3	 1.2 2.1 2.1	**ALLOW** energy value 1248800 J or 1250000 J from **(bi)** **ALLOW ECF** from energy value in **(bi)** **ALLOW** This mark if incorrect or no conversion **ALLOW** answers to more than 3 s.f. that round to 2970 or 2980 W

Question			Answer	Marks	AO element	Guidance
11	(a)		Action and reaction are equal **AND** opposite ✓ **OR** Forces occur in interaction pairs which are the same size **AND** oppose each other. ✓	1	1.1	**DO NOT ALLOW** forces acting on the same object e.g. example of weight and normal reaction given or reference to balanced forces on one object.
	(b)		Any **three** from: The wire experiences a force/moves ✓ Direction of force/movement is down/into page on wire (and up/out of page on magnet) ✓ Magnetic field around wire (field on wire) interacts with field of magnet ✓ Further detail: Field (on wire) out of page on side of N pole and into page on side of S pole. ✓	3	1.2	**ALLOW** points made by annotating diagram
	(c)		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 2.9 × 10^{-2} (T) in standard form to 2sf award 4 marks** Select and apply: force = magnetic flux density × current × length 0.072 = magnetic flux density × 0.45 × 5.6 ✓ flux density =($\frac{0.072}{0.45 × 5.6}$) = 0.02857.. (T) 0.029 (T) ✓ Answer in standard form and to 2sf : 2.9 × 10^{-2} (T) ✓ ✓	4	2.1 2.1 2x1.2	Correct answer but not in standard form to 2sf = 2 marks Any number of significant figures – must round to 0.029 Must be of form a.b × 10^c where a b and are digits and c is a positive or negative number. **ALLOW** one or both of these marks for an incorrect answer in standard form or/and 2sf

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