OCR
Oxford Cambridge and RSA

H

GCSE (9–1)

Combined Science B (Twenty First Century Science)

J260/07: Physics (Higher Tier)

General Certificate of Secondary Education

Mark Scheme for Autumn 2021

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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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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1. 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

2. 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

3. **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 = 52.5 (kW h) award 3 marks** Recall: Energy = power × time ✓ Substitution: E = 7 kW × 7.5 h ✓ = 52.5 (kW h) ✓	3	 **1.2** **2.1 x 2**	
		(ii)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 92 (%) award 3 marks** Recall: Efficiency = $\frac{\text{useful energy output}}{\text{total energy input}}$ × 100% ✓ Substitution: Efficiency = $\frac{48.3}{52.5}$ × 100% ✓ = 92 (%) ✓	3	 **1.2** **2.1 x 2**	 **ALLOW** ECF from (a)(i) **ALLOW** answer of 0.92 for 2 marks
		(iii)	Alternating (voltage) changes direction **AND** Direct (voltage) always in same direction ✓	1	**1.1**	**DO NOT ALLOW** idea that it changes without idea that direction changes/alternates **ALLOW** constant **ALLOW** graphs showing direct = negative **or** positive voltage against time **and** alternating = positive **and** negative voltage against time
	(b)	(i)	Curve of best fit through points ✓	1	**2.2**	**DO NOT ALLOW** straight line or lines

Question			Answer	Marks	AO element	Guidance
		(ii)	Value shown by drawn line at 2019 **OR** If no drawn line at 2019, answer between 270,000 and 330,000 ✓	1	3.2b	**ECF** from (c)(i)
	(c)	(i)	(people want to) reduce CO_2 emissions/ reduce carbon footprint/ reduce global warming / environmentally more friendly / environmentally safer **OR** (people want to) reduce pollution/ NOx / particulates/incidence of asthma **OR** government incentives **OR** Becoming cheaper to buy **OR** Charging points more readily available ✓	1	2.1	e.g. tax cuts, subsidies
		(ii)	**Any two from:** Not enough power stations **OR** Not enough generating capacity ✓ High peak demand when all being charged at the same time ✓ Distribution network would need to deliver more energy/power or have higher current/higher voltage or more cables ✓	2	2.1	**ALLOW** not enough electricity

Question			Answer	Marks	AO element	Guidance
2	(a)		weigh the pan (without the stone) ✓ Subtract (the weight of the pan from the total weight) ✓	2	3.3b	If no other mark scored **ALLOW** check for zero error on forcemeter for 1 mark **DO NOT ALLOW** use a top pan balance unless also states × *g* or × 10 for 2 marks
	(b)	(i)	Jupiter ✓	1	1.1	
		(ii)	**Any four from:** Identifies Jupiter as not fitting the pattern of increasing density and increasing gravitational field strength ✓ The gravitational field strength increases as the mass of the planet increases **OR** There is a correlation between the gravitational field strength and the mass. ✓ Use of data from the table to justify suggested relationship ✓ g increases with density for first three planets ✓ g of Jupiter larger than other planets but doesn't fit pattern between density and mass ✓	4	3.2b	

Question			Answer	Marks	AO element	Guidance
3	(a)		(5) 3 1 2 4 ✓✓✓	3	2.1	3 before 1 = 1 mark 1 before 2 = 1 mark 2 before 4 = 1 mark
	(b)	(i)	Reason: will not reach camera **/** won't be detected outside body✓ Explanation: (beta has) shorter range ✓ **OR** Reason: more harmful ✓ Explanation: more ionising ✓ **OR** Reason: higher dose needed for enough decay in time of scan **/** body will remain contaminated for longer ✓ Explanation: longer to decay ✓	2	2.1	Reason must match explanation **ALLOW** 2 marks for: higher dose needed for enough decay in time of scan because (beta has) a longer half life **OR** body will remain contaminated for longer because (beta has) a longer half life
		(ii)	Destroy tissue **OR** kill cancer cells/tumours ✓	1	2.1	
	(c)	(i)	(contamination) **Any one from:** body irradiated for longer time **OR** body irradiated continuously **OR** exposed to radiation at closer range **OR** greater irradiation of internal organs ✓ (irradiation) **Any one from:** can move away from source (so exposure will be for a shorter time) **OR** some of radiation will not penetrate far into body **OR** some may be stopped by clothes or air before it reaches body ✓ (so) contamination is more hazardous **OR** contamination (usually) results in a higher dose ✓	3	1.1	

Question			Answer	Marks	AO element	Guidance
		(ii)	**Any two from:** damages/kills cells ✓ mutation/cancer ✓ ionises DNA molecules ✓ change way cell behaves/heat cell ✓	**2**	**1.1**	
		(iii)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 0.0625 OR 1/16 award 2 marks** 24 hours = 4 half-lives **OR** 1/2 ×1/2 ×1/2 ×1/2 **OR** $[1/2]^4$ ✓ = 0.0625 **OR** 1/16 ✓	**2**	**1.2**	

Question			Answer	Marks	AO element	Guidance
4	(a)		Closed circuit with correct symbols for battery/cell/power supply **AND** ammeter **AND** voltmeter ✓ correct symbol for thermistor ✓ ammeter in series **AND** voltmeter in parallel (with thermistor) ✓ correct symbol for variable resistor in series with thermistor ✓	4	1.2	**IGNORE** switch **ALLOW** variable power supply **ALLOW** higher level answers using a potentiometer
	(b)		measure the potential difference and the current. ✓ change the potential difference across thermistor **OR** change the resistance of the variable resistor ✓ Measure a range of values of potential difference and current (after changing potential difference across the thermistor). ✓	3	1.2	**ALLOW** readings from voltmeter and ammeter **ALLOW** any method of changing the potential difference across the thermistor.
	(c)		From 0 to 5 V / 0 to 0.5 A the resistance is constant ✓ (because) straight line **OR** current proportional to potential difference ✓ Above 5V the resistance decreases ✓ (because) gradient increases or potential difference÷ current deceases ✓	4	3.1a	**ALLOW** at low potential difference the resistance is constant **ALLOW** explanations in terms of gradient is 1/*R*

Question			Answer	Marks	AO element	Guidance
5	(a)	(i)	580 (kN) ✓	1	2.2	**ALLOW** Answer in range 570 – 590 (kN)
		(ii)	Arrow is downward arrow starting at either end of tug A vector arrow AND 2.4cm in length ✓ 3rd side of triangle joined **AND** (double headed) arrow down and right ✓	2	2.2	**ALLOW** half a small square tolerance **ALLOW** Force down at LH end of tug A vector **AND** completed rectangle showing diagonal as resultant with double headed arrow.
		(iii)	(6.3 cm =) 630 (kN) ✓	1	2.2	**ALLOW** 620 to 640
	(b)		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 0.11 (m/s^2) award 3 marks** Select & apply: final speed ^{2} – initial speed ^{2} = 2 × acceleration × distance substitution: $(3.8)^2 – (0.4)^2$ = 2 × acceleration × 65 ✓ = 0.1098461538 (m/s^2) ✓ = 0.11 (m/s^2) ✓	3	**2.1 x 2** **1.2**	
	(c)		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 5.12 (m) award 3 marks** frequency = 10 ÷ 16 **OR** 0.625 (Hz) ✓ substitute: 3.2 = 0.625 × wavelength ✓ wavelength = 5.12 (m) ✓	3	2.1	**ALLOW** correct substitution and evaluation using their value of frequency for MP2 and MP3 **ALLOW** answer of 0.32(m) for 2 marks

Question			Answer	Marks	AO element	Guidance
6	(a)	(i)	acceleration (directly) proportional to force ✓ (yes because) straight line graph through origin **OR** as acceleration doubles force doubles **OR** acceleration = constant × force ✓	2	2.2	
		(ii)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 2.0 or 2.1 (kg) award 3 marks** Candidate states they are using gradient **OR** attempt to calculate gradient or [1 ÷ gradient] ✓ mass in range 2.0 to 2.1 (kg) ✓ Correct use of m=F/a **AND** Answer given to 1 decimal place ✓	3	1.2	May be shown by triangle drawn or correct answer **DO NOT ALLOW** this mark if a point is used to calculate mass **ALLOW** use of gradient and then 1/gradient **OR** direct use of change in F ÷ change in a **OR** a point on the line. **DO NOT ALLOW** use of one of the plotted points that is not on the line. If answer is in the range of: 2 ≤ mass < 2.1 (kg) award 2 marks
	(b)*		Please refer to the marking instructions on page 4 of this	6	4 x 1.2	**AO1.1** Demonstrate knowledge and understanding

Question			Answer	Marks	AO element	Guidance
			mark scheme for guidance on how to mark this question. **Level 3 (5–6 marks)** Clearly describes how to do experiment and how to calculate acceleration. Develops experimental procedure by including some extra detail to ensure accuracy or safety. *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)** Describes details of how to do experiment and how to calculate acceleration but some details may be unclear or missing. *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)** Describes by diagram or writing that a trolley will be accelerated **AND** times measured **OR** how to calculate acceleration. *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.*		**2 x 3.3a**	**For example:** • equipment needed: trolley, string, pulley, masses and 2 light gates. • diagram of set-up • initial speed = 0, final speed from light gate • time from start to final light gate • increase force by adding mass to hanger • keep total mass the same by moving this mass from trolley to the hanger • acceleration = [final speed – initial speed] ÷ time **AO3.3a** Develop experimental procedures **For example:** • Tilt ramp to friction compensate. • Repeat for each force and take the mean • Use a tray of foam under weight to prevent damage to floor as weight drops • other valid methods e.g. measuring time to travel from start and last 30 cm with a stopwatch and calculating final speed.

Question			Answer	Marks	AO element	Guidance
7	(a)	(i)	**Any two from:** radio has longer wavelength ✓ microwave has longer wavelength ✓ infrared **OR** ir has longer wavelength ✓ ultraviolet **OR** uv has shorter wavelength ✓ X-rays have shorter wavelength ✓ gamma rays **OR** γ rays have shorter wavelength ✓	2	1.1	**ALLOW** other size indicators e.g. higher, lower, bigger, smaller
		(ii)	idea that Sun is the source and electromagnetic radiation transfers energy **OR** EM radiation does not need a medium to travel in ✓ **AND** idea that skin/eyes/body absorbs ✓	2	2.1	**ALLOW** Store of thermal/nuclear energy **ALLOW** EM radiation can travel through vacuum/space **ALLOW** increases thermal store
	(b)	(i)	vertical arrow pointing downwards ✓	1	1.2	
		(ii)	Fleming's left hand rule ✓ Thumb = force/movement **AND** fore/first/index finger = field **AND** middle/second finger = current **OR** field is left to right **AND** current is into page **OR** All 3 are perpendicular **OR** at right angles ✓	2	1.2	**ALLOW** FLHR **ALLOW** marks for points shown on a labelled diagram **ALLOW** this mark if Right Hand rule used
	(c)		Force upwards on one side of coil and down on the other ✓ because current is in opposite directions on opposite sides of coil ✓	2	1.1	**ALLOW** arrow up on one side of coil and down on the other.

Question			Answer	Marks	AO element	Guidance
8	(a)		Less energy transferred heating the cables **OR** lower power loss in cables due to heating ✓ (because if voltage is greater) current can be less (for same energy transfer) ✓	2	1.1	
	(b)		Radio waves with a frequency of 50 Hz are produced by the overhead power lines ✓	1	3.1a	
	(c)		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 3 award 2 marks** 11479 ~ 10000 or 10^4 **AND** 33 ~10 or 10^1 **OR** 10000 ÷ 10 =1000 **OR** 10^{4-1} =10^3 ✓ = 3 orders of magnitude ✓	2	2.1	

Question			Answer	Marks	AO element	Guidance
9	(a)	(i)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 1.92 x 10^{-3} (s) award 3 marks** Select and apply: Change of momentum = resultant force x time for which it acts Substitution: 1.53 = 795 ÷ time ✓ = 1.924528302 x 10^{-3} (s) ✓ = 1.92 x 10^{-3} (s) ✓	3	**2.1 x 2** **1.2**	**ALLOW** any number of sf Must be to 3sf
		(ii)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 9 (m/s) award 3 marks** Conversion: 170 g = 0.17 kg ✓ Recall and apply: momentum = mass x velocity ✓ velocity = (1.53 ÷ 0.17) = 9 (m/s) ✓	3	**1.2 x 2** **2.1**	**ALLOW** 1 mark for 1.53 = 170 × velocity with incorrect answer to calculation. **ALLOW** 0.009 (m/s) for 2 marks
	(b)		momentum is shared between the two balls ✓ momentum is conserved ✓	2	**2.1**	**ALLOW** cue ball momentum decreases other ball increases

Question			Answer	Marks	AO element	Guidance
10	(a)		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 750 (J/kg °C) award 4 marks** temperature change: 22 °C – 8 °C = 14 °C ✓ Aluminium: E = 13 × 900 × [22 – 8] **OR** 163 800 (J) ✓ Energy from heater = increase in internal energy of aluminium + increase in internal energy of air **OR** 189000 = 163 800 + 2.4 × C × 14 ✓ C = [189000 -163 800] ÷ [2.4 ×14] = 750 (J/kg °C) ✓	4	2.1	If temperature incorrect all other marks may still be awarded **ALLOW** this mark if some rearrangement already done correctly.
	(b)	(i)	molecules move faster ✓ because they gain kinetic energy ✓	2	1.1	**ALLOW** particles
		(ii)	(faster molecules) will have greater (change in) momentum (when they collide with walls) **OR** Collide with walls more often/frequently ✓ (Exert) greater force on tank/container walls ✓ Idea that this increase in force causes increase in pressure ✓	3	1.1	**ALLOW** ECF for RA if molecules moving slower in (b)(i)

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