OCR
Oxford Cambridge and RSA

H

GCSE (9–1)

Physics B (Twenty First Century Science)

J259/04: Depth in 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.

1. 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

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.

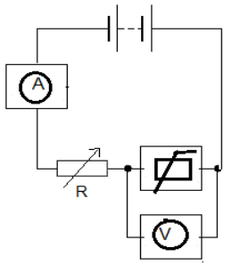
The breakdown of Assessment Objectives for GCSE (9-1) in Physics B:

	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)	the rate of transfer of chemical store of energy ✓✓ **OR** Power = Transfer of chemical store / time ✓✓	2	1.1	**ALLOW** (80kJ of the) Chemical Store transferred (in the battery) 1 mark And per second 1 mark **ALLOW** Power = energy transferred/time 1 mark
		(ii)	How - (energy is dissipated) by heating (in the wires) ✓ Where - thermal store of the surroundings ✓	2	1.1	**ALLOW** description e.g. the wires get hot **ALLOW** Heat/thermal energy (of surroundings)
	(b)	(i)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = £6.72 award 2 marks** 42 x 16 = 672p ✓ = £6.72 ✓	2	2.1 1.2	
		(ii)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 6.0 (hours) award 2 marks** Power / energy = 42 / 7✓ Time = 6.0 (hours)✓	2	2.1	
		(iii)	Maximum range = 42 x 6 = 252km ✓ Amir's range is less/220 so don't agree with manufacturer ✓ **OR** Amir's range per kWh = 220 /42 = 5.2km✓ Which is less than manufacture's claim so don't agree ✓ **OR** Energy manufacturer claims required = 220 ÷ 6 = 36.7 kWh ✓ Which is less than the energy stored by a fully charged battery so don't agree with manufacturer ✓	2	3.1b	**ALLOW** ECF from b(ii) for error in calculation answer if calculation is correct

Question	Answer	Marks	AO element	Guidance
(c)	Add weights/mass to the trolley (to represent more passengers)✓ Measure the power output from the motor ✓	2	3.3a	**ALLOW** calculation of power needed to pull different weights/masses 2 marks Idea of weight must be in reference to adding mass/weight to the trolley **ALLOW** P=IV **ALLOW** Measure GPE for lifting different weights/masses or measure total distance travelled (by the trolley) for different weights/masses 1 mark

Question			Answer	Marks	AO element	Guidance
2*			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)** Correctly explains the acceleration before during and after take off **AND** Correctly applies Newton's I and II Laws *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)** Some explanation of acceleration before and during take off **AND** Attempts to apply Newton's I and II Laws *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)** A partial description of acceleration before or during take off **AND** Basic attempt at applying Newton's I and II Laws *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** **3x 2.1** **2 x 3.1a**	**AO 1.1 Demonstrates knowledge of weight and Newton's first law** • Recall of weight = mass x gravitational field strength • Demonstrate knowledge of forces acting on the rocket e.g. weight acts downwards and up thrust acts upwards – interaction pair of forces **AO 2.1 Application of Newton's Laws** • Application of Newtons first law • Application of F=ma /Newtons second law • Calculation of weight of rocket weight = 14 200 000 N • Description of before take off - Stationary - Weight balanced by reaction force and resultant force = 0 so no acceleration • Description of during take off - Upward thrust greater than weight Resultant force = 23 000 000 – weight) = 8800000 So accelerates upwards Acceleration = 8800000 / 1420 000 = 6.2 m/s^2 **AO 3.1a analyse ideas to interpret how the forces and acceleration change before during and after lift-off** • After take off - Fuel is burnt so mass/weight decreases • This will increase the resultant force increasing the acceleration • Gravitational field strength decreases away from the Earth increasing the acceleration • When fuel is used up rocket will stop accelerating

Question			Answer	Marks	AO element	Guidance
3	(a)	(i)	 Correct symbol for Thermistor in correct place✓ Correct voltmeter and ammeter symbols in correct place✓	2	1.2	**ALLOW** thermistor and voltmeter swapped round **ALLOW** correct symbols drawn but not a complete circuit i.e. not connected to the wires in the circuit
		(ii)	Current (in circuit/thermistor) increased ✓ **AND any two from:** (Because) the resistance of the thermistor decreases (when the temperature increases) ✓ (So) <u>total</u> resistance in circuit decreases (as resistance of variable resistor is not changing) ✓ (And) the potential difference is the same ✓	3	1.1	
	(b)		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 8.1 Ω award 4 marks** Reading values of current at 0.4V and 1.2V ✓ Calculating resistance correctly for both values at 0.4V and 1.2V and therefore difference in resistance = 8.1 ✓✓ Ω ✓	4	 3.1a 2.1 x 2 1.2	**ALLOW** current of 0.02 A to 0.04A at 0.4V R =0.4/0.04=10.0Ω and R=1.2/0.64=1.88 Ω **ALLOW** 2 marks for ECF of 1 incorrect current reading but all subsequent steps correct **ALLOW 1** mark for ECF of 2 incorrect current readings but all subsequent steps correct

Question			Answer	Marks	AO element	Guidance
4	(a)	(i)	Alternating/changing current in the primary coil ✓ Changing/varying magnetic field (in iron core) ✓ Induces a potential difference/current (in the secondary coil) ✓	3	2.1	**ALLOW** (magnetic) field lines cutting secondary coil **ALLOW** for induces wtte
		(ii)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 2.875 (A) award 3 marks** Rearrange $I_s = V_p \times I_p / V_s$ ✓ $I_s = 230 \times 0.25 / 20$ ✓ I_s = 2.875(A) ✓	3	 1.2 2.1 x 2	
	(b)		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 11.5:1 award 3 marks** potential difference across primary coil ÷ potential difference across secondary coil = number of turns in primary coil ÷ number of turns in secondary coil = 230/20 ✓ = 11.5 ✓ Ratio = 11.5:1 ✓	3	 2.1 x 2 1.2	 **ALLOW** 23:2 for 3 marks

Question			Answer	Marks	AO element	Guidance
5	(a)*		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)** Correctly uses the particle model to explain the difference in SHC of solid and liquid wax **AND** Correctly uses calculations to justify the difference in the SHC for solid and liquid wax *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)** Uses the particle model to explain the difference in solid and liquid wax **AND** Uses data or calculations to explain the difference in the SHC for solid and liquid wax *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)** Attempts to use the particle model to describe the difference in SHC of solid and liquid wax **OR** Attempts to use data or make some calculations to justify the difference in the SHC for solid and liquid wax *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	**1x 1.2** **3x 2.1** **2 x3.2a**	**AO 1.2 Demonstrates knowledge of energy transfer, specific heat capacity and the particle model** • Recalls E = Power x time • Description of the arrangement and behaviour of molecules in solid and liquid wax **AO 2.1 Application of energy transfer, specific heat capacity and the particle model** • Calculation of energy transferred to heat the wax - Solid wax = 36 x 500 = 18000J and Liquid wax 36 x 150 = 5400 J • Calculation of gradient for solid and liquid wax e.g. Solid = 36/500 = 0.072°C per second and Liquid 38/150 = 0.25°C per second • Calculation of energy transferred to raise the temperature by 1°C – Solid required 18000J/36°C = 500J per °C and Liquid required 5400/38 = 142J per °C • Calculation of SHC – Solid c = 2500J/Kg°C and Liquid c= 711J/Kg°C – SHC of liquid wax approximately a quarter of solid wax • Use of the particle model to describe how heating the wax changes the energy stored in the solid and liquid wax to raise its temperature **AO3.2a Analysing information and using the particle model to explain the difference in the solid and liquid wax** • Comparison of the energy required to raise the temperature of solid and liquid wax e.g. solid wax requires more energy to raise its temperature • Comparison of the SHC for the solid and liquid wax e.g. solid wax has a higher SHC as it requires more energy per unit mass to raise its temperature • Use of the particle model to explain why the solid wax requires more energy to raise its temperature compared to the liquid wax

Question			Answer	Marks	AO element	Guidance
	(b)		The volume increases (as the density decreases) ✓ (For) the same mass (of 0.2kg)/same number of particles ✓	2	1.1	**ALLOW** idea that particles are further apart compared to a solid
	(c)	(i)	Submerge object in water in a displacement/eureka can/measuring cylinder ✓ Measure volume of displaced water(displacement/eureka can)/change in volume in measuring cylinder ✓	2	1.2	
		(ii)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 8.6 x 10^2 (kg/m^3) award 4 marks** Recall and apply density = mass / volume ✓ = $\frac{0.043}{0.00005}$ ✓ = 860 (kg/m^3) ✓ Density = 8.6 x 10^2 (kg/m^3) ✓	4	 1.2 2.1 x 2 1.2	 **ALLOW** any final answer in standard form

Question			Answer	Marks	AO element	Guidance
6	(a)	(i)	(Nina is not correct because) To be inversely proportional doubling the depth would halve the circumference ✓ Supporting calculation e.g. at depths 0.4m and 0.8m circumference at 0.8m should be 28 ÷ 2 =14 (rather than 23) ✓ **OR** Circumference x depth = constant ✓ Supporting calculations e.g. 30 x 0.2 = 6 and 28 x 0.4 = 11.2 (not constant as different values) ✓	**2**	**3.2b**	
		(ii)	(Description of an alternative method e.g.) Alternative container for gas e.g. Gas syringe (to measure the volume of gas) ✓ Description of method to change pressure e.g. Pump (with pressure gauge)/weights added on syringe/different depths of water✓	**2**	**3.3a**	Description of Boyle's law investigation 2 marks
	(b)	**(i)**	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 8000 (N / m^2) award 2 marks** Pressure = 1000 x 10 x 0.8 ✓ = 8000 (N/m^2) ✓	**2**	**2.1**	
		(ii)	(At increased depth) pressure increases ✓	**3**	**2.1**	

Question			Answer	Marks	AO element	Guidance
			(because) The balloon's surface experiences greater forces (from the water) AW ✓ (due to) the gravitational force/weight from the water increases✓			
	(c)		(Atmospheric) pressure decreases with height ORA✓ (Atmospheric pressure decreases) as there is less gravitational force/weight of air above it ORA✓	**2**	**2.1**	

Question			Answer	Marks	AO element	Guidance
7	(a)	(i)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 7200 (N) award 3 marks** 21600 = F x 3.0 ✓ F = 21 600 / 3.0 ✓ = 7200 (N) ✓	3	2.2	
		(ii)	Use the area under the graph to find the distance – by calculation or counting squares ✓ Distance = 27 m ✓ (No) Ben does not hit the obstacle as the distance he travels is less than 30.0m✓	3	2.2 x 2 3.2b	**ALLOW** use of $v^2 - u^2 = 2as$ and $a = \frac{\Delta v}{\Delta t}$ **ALLOW** use of $s = \frac{1}{2}$(u + v)/t **ALLOW** Counting squares with a tolerance of +/-2m **ALLOW** 1 mark for calculation of distance without speed conversion (40mph gives distance of 60(m)) and correct evaluation
	(b)	(i)	**Any three from:** (Reducing speed) momentum is reduced ✓ Force = rate of change in momentum ✓ (Which means) smaller change in momentum on impact ✓ (So) results in a smaller (resultant) force (on impact) ✓	3	1.1	
		(ii)	Thinking distance will double (increase) when travelling at 40mph (compared to 20 mph) ✓ When speed doubles the kinetic energy increases by a factor of four AW✓ (So) braking distance will quadruple ✓ (So) stopping distance will more than double (as stopping distance = thinking distance + braking distance) ✓	4	3.2a x 2 2.1 3.2b	

Question			Answer	Marks	AO element	Guidance
8	(a)		Galaxies further away have a greater (recessional) velocity AW ✓ Galaxies moving away from one another ✓ (So) Universe is expanding (as must have started from a single point) ✓	3	3.1a x 2 3.2a	
	(b)	(i)	**Any two from:** Can be placed above atmosphere e.g. placed in orbit, on a probe, on a mountain ✓ More regions of the electromagnetic spectrum can be observed/greater range of wavelengths are observable ✓ Better resolution/greater sensitivity/greater magnification ✓	2	1.1	**IGNORE** reference to precision and accuracy **ALLOW** can observe fainter objects/objects at greater distances
		(ii)	**Any one from:** More data points✓ More points closer together✓ Larger range of distance / more distant galaxies have been observed / Larger range of speeds measured✓	1	3.2b	

Question			Answer	Marks	AO element	Guidance
9	(a)		The coil is moving parallel to the field lines/not cutting the (magnetic) field lines ✓ (So) no potential difference/current induced (or words to that effect) ✓	2	2.1	
	(b)		Bulb flashes more frequently/rapidly ✓ Bulb is brighter (due to higher pd/current) ✓	2	2.1	
	(c)		C ✓	1	1.1	
	(d)	(i)	Particles vibrate in the same direction as the travel of the wave/energy AW ✓	1	1.1	**IGNORE** reference to compression and rarefaction
		(ii)	(High frequency) soundwave provides a force/pushes on the diaphragm ✓ (which) causes the diaphragm/magnet/coil to vibrate with the same frequency ✓ The magnetic field lines are cut (with the same frequency) ✓ (Which) <u>induces</u> a changing potential difference/current (with the same high frequency as the sound wave) ✓	4	1.1	**ALLOW** 1 mark if current is produced by electromagnetic induction

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