

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

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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.

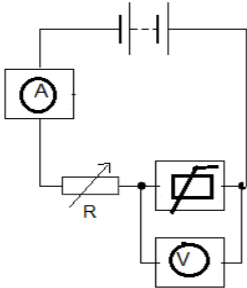
The breakdown of Assessment Objectives for GCSE (9-1) in Physics B:

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

Question	Answer	Marks	AO element	Guidance
2*	<p>Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.</p> <p>Level 3 (5–6 marks) Correctly explains the acceleration before during and after take off AND Correctly applies Newton’s I and II Laws <i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i></p> <p>Level 2 (3–4 marks) Some explanation of acceleration before and during take off AND Attempts to apply Newton’s I and II Laws <i>There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.</i></p> <p>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 <i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.</i></p> <p>0 marks <i>No response or no response worthy of credit.</i></p>	6	1 x 1.1 3x 2.1 2 x 3.1a	<p>AO 1.1 Demonstrates knowledge of weight and Newton’s first law</p> <ul style="list-style-type: none"> 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 <p>AO 2.1 Application of Newton’s Laws</p> <ul style="list-style-type: none"> Application of Newtons first law Application of $F=ma$ /Newton’s 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 = $8800000 / 1420\ 000 = 6.2\ \text{m/s}^2$ <p>AO 3.1a analyse ideas to interpret how the forces and acceleration change before during and after lift-off</p> <ul style="list-style-type: none"> 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)	 <p>Correct symbol for Thermistor in correct place ✓ Correct voltmeter and ammeter symbols in correct place ✓</p>	2	1.2	<p>ALLOW thermistor and voltmeter swapped round</p> <p>ALLOW correct symbols drawn but not a complete circuit i.e. not connected to the wires in the circuit</p>
		(ii)	<p>Current (in circuit/thermistor) increased ✓</p> <p>AND any two from: (Because) the resistance of the thermistor decreases (when the temperature increases) ✓</p> <p>(So) <u>total</u> resistance in circuit decreases (as resistance of variable resistor is not changing) ✓</p> <p>(And) the potential difference is the same ✓</p>	3	1.1	
	(b)		<p>FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 8.1 Ω award 4 marks</p> <p>Reading values of current at 0.4V and 1.2V ✓</p> <p>Calculating resistance correctly for both values at 0.4V and 1.2V and therefore difference in resistance = 8.1 ✓✓</p> <p>Ω ✓</p>	4	<p>3.1a</p> <p>2.1 x 2</p> <p>1.2</p>	<p>ALLOW current of 0.02 A to 0.04A at 0.4V</p> <p>$R = 0.4/0.04 = 10.0\Omega$ and $R = 1.2/0.64 = 1.88\Omega$</p> <p>ALLOW 2 marks for ECF of 1 incorrect current reading but all subsequent steps correct</p> <p>ALLOW 1 mark for ECF of 2 incorrect current readings but all subsequent steps correct</p>

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

Question		Answer	Marks	AO element	Guidance
5	(a)*	<p>Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.</p> <p>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 <i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i></p> <p>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 <i>There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.</i></p> <p>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 <i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.</i></p> <p>0 marks <i>No response or no response worthy of credit.</i></p>	6	1x 1.2 3x 2.1 2 x3.2a	<p>AO 1.2 Demonstrates knowledge of energy transfer, specific heat capacity and the particle model</p> <ul style="list-style-type: none"> Recalls $E = \text{Power} \times \text{time}$ Description of the arrangement and behaviour of molecules in solid and liquid wax <p>AO 2.1 Application of energy transfer, specific heat capacity and the particle model</p> <ul style="list-style-type: none"> Calculation of energy transferred to heat the wax - Solid wax = $36 \times 500 = 18000\text{J}$ and Liquid wax $36 \times 150 = 5400\text{ J}$ Calculation of gradient for solid and liquid wax e.g. Solid = $36/500 = 0.072^\circ\text{C}$ per second and Liquid $38/150 = 0.25^\circ\text{C}$ per second Calculation of energy transferred to raise the temperature by 1°C – Solid required $18000\text{J}/36^\circ\text{C} = 500\text{J per }^\circ\text{C}$ and Liquid required $5400/38 = 142\text{J per }^\circ\text{C}$ Calculation of SHC – Solid $c = 2500\text{J/Kg}^\circ\text{C}$ and Liquid $c = 711\text{J/Kg}^\circ\text{C}$ – 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 <p>AO3.2a Analysing information and using the particle model to explain the difference in the solid and liquid wax</p> <ul style="list-style-type: none"> 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 = 8.6×10^2 (kg/m³) award 4 marks Recall and apply density = mass / volume ✓ $= \frac{0.043}{0.00005}$ ✓ $= 860$ (kg/m ³) ✓ Density = 8.6×10^2 (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)	<p>(Nina is not correct because)</p> <p>To be inversely proportional doubling the depth would halve the circumference ✓</p> <p>Supporting calculation e.g. at depths 0.4m and 0.8m circumference at 0.8m should be $28 \div 2 = 14$ (rather than 23) ✓</p> <p>OR</p> <p>Circumference x depth = constant ✓</p> <p>Supporting calculations e.g. $30 \times 0.2 = 6$ and $28 \times 0.4 = 11.2$ (not constant as different values) ✓</p>	2	3.2b	
		(ii)	<p>(Description of an alternative method e.g.)</p> <p>Alternative container for gas e.g. Gas syringe (to measure the volume of gas) ✓</p> <p>Description of method to change pressure e.g. Pump (with pressure gauge)/weights added on syringe/different depths of water ✓</p>	2	3.3a	Description of Boyle's law investigation 2 marks
	(b)	(i)	<p>FIRST CHECK THE ANSWER ON ANSWER LINE</p> <p>If answer = 8000 (N / m²) award 2 marks</p> <p>Pressure = $1000 \times 10 \times 0.8$ ✓</p> <p>= 8000 (N/m²) ✓</p>	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)	<p>FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 7200 (N) award 3 marks</p> <p>$21600 = F \times 3.0$ ✓ $F = 21\,600 / 3.0$ ✓ $= 7200 \text{ (N)}$ ✓</p>	3	2.2	
		(ii)	<p>Use the area under the graph to find the distance – by calculation or counting squares ✓</p> <p>Distance = 27 m ✓</p> <p>(No) Ben does not hit the obstacle as the distance he travels is less than 30.0m ✓</p>	3	2.2 x 2 3.2b	<p>ALLOW use of $v^2 - u^2 = 2as$ and $a = \frac{\Delta v}{\Delta t}$</p> <p>ALLOW use of $s = \frac{1}{2}(u + v)t$</p> <p>ALLOW Counting squares with a tolerance of +/-2m</p> <p>ALLOW 1 mark for calculation of distance without speed conversion (40mph gives distance of 60(m)) and correct evaluation</p>
	(b)	(i)	<p>Any three from: (Reducing speed) momentum is reduced ✓</p> <p>Force = rate of change in momentum ✓</p> <p>(Which means) smaller change in momentum on impact ✓</p> <p>(So) results in a smaller (resultant) force (on impact) ✓</p>	3	1.1	
		(ii)	<p>Thinking distance will double (increase) when travelling at 40mph (compared to 20 mph) ✓</p> <p>When speed doubles the kinetic energy increases by a factor of four AW ✓</p> <p>(So) braking distance will quadruple ✓</p> <p>(So) stopping distance will more than double (as stopping distance = thinking distance + braking distance) ✓</p>	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)	1	1.1	IGNORE reference to compression and rarefaction
		(ii)	4	1.1	ALLOW 1 mark if current is produced by electromagnetic induction

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