OCR
Oxford Cambridge and RSA

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GCSE (9–1)

Physics B (Twenty First Century Science)

J259/02: Depth in physics (Foundation 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)		B✓	1	1.1	
	(b)	(i)	X ✓	1	1.1	
		(ii)	W ✓	1	1.1	

Question			Answer	Marks	AO element	Guidance
2	(a)		The wax is melting - B ✓ The wax is a liquid - C ✓ The particles of the wax are closest together - A ✓	3	2.1	
	(b)		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 6000 (J) award 2 marks** = 0.25x 24000 ✓ = 6000(J) ✓	2	2.1	

Question			Answer	Marks	AO element	Guidance
3	(a)		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 4 (m/s) award 3 marks** Recall Speed = distance ÷ time✓ = 500 ÷ 125✓ = 4 (m/s) ✓	3	**1.2** **2.1 x 2**	
	(b)		It has size but not direction ✓	**1**	**1.1**	

Question			Answer	Marks	AO element	Guidance
4	(a)	(i)	Variable resistor ✓	1	1.1	
		(ii)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 4.8 (Ω) award 3 marks** Recall p.d. = current × resistance✓ Resistance = 3.6 ÷ 0.75 ✓ = 4.8 (Ω)✓	3	 1.2 2.1 x 2	
	(b)	(i)	voltmeter✓ ammeter✓	2	1.2	either order
		(ii)	As brightness increases resistance decreases✓ At a decreasing rate/non-linear/AW✓	2	3.1a 3.2b	 **ALLOW** inversely proportional

Question			Answer	Marks	AO element	Guidance
5	*		Please refer to the marking instructions on page 5of this mark scheme for guidance on how to mark this question. **Level 3 (5–6 marks)** Describes in detail how to calculate pressure they exert on the floor **AND** Explains using ideas about forces why their hypothesis is wrong *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 how to calculate pressure they exert on the floor with some detail **AND** Explains using ideas about forces why their hypothesis is wrong **OR** Describes in detail how to calculate pressure they exert on the floor **AND** Gives a basic explanation of why their hypothesis is wrong *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 some basic steps of how to calculate pressure **OR** Gives a basic explanation of why the hypothesis is wrong *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	**2×1.1** **2×2.1** **2×3.2a**	**AO1.1 Demonstrate knowledge of pressure = force/area** • Recalling of pressure = force/area • Recalling that weight is a force • Recalling of weight = mass / gravitational field strength • Demonstrating that area should be measured in metres squared **AO2.1 Applies knowledge of P = F/A to calculating force and area from Ben and Alex's investigation** • Counting squares method • Combining partial squares together • Converting area of 1 square into metres squared • Calculating pressure by dividing weight by double the area of one foot **AO3.2a Analysing information to make judgement about why their hypothesis is wrong** • Even though they have the same shoe size, Alex exerts a lesser force on floor as greater surface area means less pressure exerted on the floor • Force is spread out over greater area ORA

Question			Answer	Marks	AO element	Guidance
6	(a)	(i)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 9.3 (cm^3) award 2 marks** Volume = 2.1 x 2.1 x 2.1 = 9.261 ✓ Volume = 9.3 (cm^3) ✓	**2**	**2.1** **1.2**	**ALLOW** one mark for incorrect answer to correct number of significant figures
		(ii)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 8 (g/cm^3) award 2 marks** 74.4 / 9.3 ✓ = 8 ✓	**2**	**2.1**	**ALLOW** ECF from 6a(i) **ALLOW** 8.2667, 8.0346, 8.0337 or correct rounding of these to any sf for 2 marks
	(b)		Use a balance to) measure the mass of a measuring cylinder ✓ (Use a balance to) measure the mass of the measuring cylinder with water ✓ The mass of the water = (mass of water + measuring cylinder) – (mass of measuring cylinder) ✓ Use the measuring cylinder to measure the volume (of water) ✓	**4**	**2.2**	**ALLOW** (Use a balance to) measure the mass of the water and glass (Use a balance to) measure the mass of the glass (without water) The mass of the water = (mass of water + glass) – (mass of glass) Use of measuring cylinder to measure the volume (of water) **ALLOW** some/all the water
	(c)		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 0.25 (g/cm^3) award 2 marks** = 1.0 ÷ 4 or $\frac{D_{poly}}{D_{water}} = \frac{V_{water}}{V_{poly}} = 1 / 4$ ✓ = 0.25 (g/cm^3) ✓	**2**	**2.1**	

Question			Answer	Marks	AO element	Guidance
7	(a)		short half-life (of 6 hours, but long enough to get results) **OR** emits gamma radiation ✓ **AND any one from:** After 24 hours there will only be a small amount (1/8) of the tracer left AW ✓ can penetrate the skin so detected outside the body ✓ least ionising so least damaging to cells ✓	**2**	**3.2a** **2.1**	**ALLOW** 'only 6 hours' **ALLOW** idea 'so it doesn't linger in the body'
	(b)		**(Precaution):** prepare the tracer: several metres away **OR** behind a (lead) screen **AND** **(Explanation):** Reduces risk (due to irradiation) OR reduces exposure ✓	**1**	**2.1**	**IGNORE** any reference to lead apron
	(c)		Cobalt-60 ✓ **AND any one from:** Idea of no appreciable loss in activity when in use ✓ It will not need to be replaced often as it has a long half-life ✓ Gamma radiation so will penetrate the body and reach the tumour ✓	**2**	**3.2a** **2.1**	e.g. It has a long enough half life to be used many times. **ALLOW** half-life long, but short enough to see results **DO NOT ALLOW** gamma radiation so will leave the body

Question			Answer	Marks	AO element	Guidance
8	(a)	(i)	Measure distance across several wave fronts ✓ divide by number of waves / 11 cm / 5 wave fronts ✓ Wavelength = 2.2 cm ✓	3	1.2	Must indicate several, i.e. 3 ≤ number of wavefronts ≤ 6 **ALLOW** a few **ALLOW** range 11 to 11.25 **ALLOW** 2 to 2.25 cm
		(ii)	Stopwatch✓ Time a wave front (to move a measured distance) ✓ Divide the distance by the time✓ **OR** Calculate the frequency ✓ number of waves divided by time ✓ Multiply wavelength by frequency ✓	3	1.2	**ALLOW** use a frequency generator set to known frequency to drive dipper **AND** multiply the wavelength by frequency **ALLOW** use the equation $v = f \times \lambda$
	(b)	(i)	Suitable scale on X-axis ✓ All points plotted correctly✓ Suitable line through candidates plotted points ✓	3	1.2	1 small square = 2 +/- 1 square
		(ii)	(yes because) It is not a straight line / It is a curve **OR** The wavelength does increase with depth (but the increases get smaller as depth increases) ✓ Use of data from the graph or table to show the above ✓	2	3.2a	e.g. from 20 cm to 40 cm it increases by 0.05 m but from 80 cm to 100 cm it increases by 0.01 m **ALLOW** answer written on the table or graph

Question			Answer	Marks	AO element	Guidance
9	(a)	(i)	Use (plotting) compass✓ mark direction of plotting compass needle✓ **OR** Use iron filings✓ Sprinkle on and draw the pattern✓	**2**	**1.2**	
		(ii)	Cardboard is not a magnetic material✓ An iron core/increase in current/more turns of the coil of wire (to increase the strength of the electromagnet)✓	**2**	**3.2a** **2.1**	
	(b)	**(i)**	Magnetic field gets stronger at smaller distance ✓ Increases the force of attraction between the block and the electromagnet ✓	**2**	**3.2a**	**ALLOW** higher level answers e.g. field lines closer together
		(ii)	**Any two from:** Clockwise moment increases (due to the increased load) ✓ (In equilibrium) clockwise moment = anticlockwise moment ✓ moment is greater for loads further from pivot ✓ increase the anticlockwise moment by increasing distance from pivot ✓	**2**	**2.1**	

Question			Answer	Marks	AO element	Guidance
10	(a)		**Any two (errors) from:** Ambient light from the window ✓ Ruler in the wrong place ✓ Light meter should be underneath the solar panel ✓ Heat from lamp ✓ Systematic error in light meter reading ✓ **AND any two (how to reduce errors) from:** Cover the window to prevent ambient light coming in ✓ Place ruler between the lamp and the solar panel ✓ Move the light meter to solar panel ✓ Checking that lamp isn't getting too hot/using halogen lamp ✓ Adjusting to zero when reading is zero/take multiple readings of light with lamp off, calculate mean, and subtract from readings ✓	**4**	**2.2×2** **3.3b×2**	**ALLOW** movement of light meter to underneath lamp as candidates may not be familiar with light intensity
	(b)	**(i)**	**FIRST CHECK THE ANSWER IN THE TABLE** **If answer = 1.8 (J) award 2 marks** 0.06 x 30 ✓ = 1.8 (J) ✓	**2**	**2.1**	
		(ii)	A calculation of efficiency at one distance ✓ A comparison with calculated efficiency at a second distance ✓ Conclusion that efficiency does not halve ✓	**3**	**2.1×2** **3.2b**	**Calculations** 10.0 cm – 71%, 20.0 cm – 63%, 30.0 cm – 64% 40.0cm – 55%, 60.0 cm – 47%
		(iii)	As distance increases the electrical energy/power **OR** intensity/energy of Sun/light decreases ✓ Examples given from the data ✓	**2**	**3.1a** **2.1**	

Question			Answer	Marks	AO element	Guidance
11	(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
12*			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

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