OCR
Oxford Cambridge and RSA

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GCSE (9–1)

Physics B (Twenty First Century Science)

J259/03: Breadth 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.

It is also responsible for developing new specifications to meet national requirements and the needs of students and teachers. OCR is a not-for-profit organisation; any surplus made is invested back into the establishment to help towards the development of qualifications and support, which keep pace with the changing needs of today's society.

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
	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)		**Any three from:** Sundip holds ruler vertically ✓ zero mark at bottom ✓ Alex holds fingers at bottom of ruler ✓ Sundip drops ruler ✓ Alex catches ruler ✓ read off value and use table to convert to reaction time ✓	3	1.2	
	(b)		very few humans have reaction time shorter than 0.15 s / reaction time (probably) won't be this short / (probably) won't catch ruler this fast ✓	1	2.1	
	(c)		**Any one from:** many people will have longer/slower reaction times (than 0.24 s) ✓ a few people many have shorter reaction times (than 0.15 s) ✓ **Any one from:** use a longer ruler / 50 cm ruler / metre ruler (and extend the table) ✓ calculate reaction times for smaller/larger readings (than 12 cm) ✓	2	3.2b x 1 3.3b x 1	**ALLOW** answers explaining that people with visual impairment or physical disability of hands/arms would not be able to measure reaction time in this way.

Question			Answer	Marks	AO element	Guidance
2	(a)		negative correlation / as wind output increases, gas output decreases / AW ✓ wind speed varies ✓ need to burn more gas when wind speed is low / gas is used to balance the load / gas power stations switched on when it is not windy / AW ✓	3	3.1a 3.2a x 2	
	(b)	(i)	**Any one from:** (burning gas emits) carbon dioxide ✓ (burning gas causes) climate change / greenhouse effect / global warming ✓ drilling for gas may damage ecosystems / habitats / AW ✓	1	1.1	**ALLOW** greenhouse gases (released)
		(ii)	on some days wind turbines generate very little energy / even with more wind turbines they will not always supply enough energy ✓ **AND any one from:** will always need gas / fuel power stations as backup ✓ could use biomass / hydroelectric / nuclear / coal / storage as backup instead of gas ✓ another energy resource will be needed ✓	2	3.1b	

Question			Answer	Marks	AO element	Guidance
3	(a)		electrons ✓ change distance from nucleus / lose energy / emit photons ✓	2	1.1	
	(b)		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 0.0326(4417845) (m) award 3 marks** recall / rearrange wavelength = speed ÷ frequency ✓ $3 \times 10^8 \div 9.19 \times 10^9$ ✓ = 0.0326(4417845) (m) ✓	3	1.2 2.1 × 2	**ALLOW** v = fλ **ALLOW** answers that make a suitable rounding, e.g. 0.033 or 0.03
	(c)		**Any one from:** faster response of emergency services / more efficient delivery of parcels / other sensible suggestions/ easier to find addresses / easier to locate services / easier to locate people from their phone signals / ✓	1	1.1	**IGNORE** to find your way

Question			Answer	Marks	AO element	Guidance
4	(a)		energy is transferred (from source to absorber) ✓	1	1.1	
	(b)	(i)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 1.4×10^{14} award 3 marks** 2×10^{10} km = 2×10^{13} m **and** 14 cm = 0.14 m ✓ $2 \times 10^{13} \div 0.14$ ✓ 1.4 (285714…) $\times 10^{14}$ ✓	3	 1.2 2.1 × 2	**ALLOW** any answer that rounds to 1.4×10^{14} **ALLOW** 2 marks for correct calculation with incorrect unit conversion, i.e. 1.4×10^{n}, $n \neq 14$
		(ii)	distance ✓ from one crest/trough to the next / between two identical points on adjacent waves ✓	2	1.1	**ALLOW** use of diagram with wavelength clearly labelled from one crest to the next (or alternative)
	(c)		wavelength is longer ✓ it is redshifted / stretched ✓	2	2.1	

Question			Answer	Marks	AO element	Guidance
5	(a)		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 1.4 × 10^{10} (kg) award 3 marks** recall / rearrange mass = density × volume ✓ 1000 × (50 × 350 × 800) **or** 14 000 000 ✓ = 1.4 × 10^{10} (kg) ✓	3	**1.2** **2.1 × 2**	
	(b)		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 3.2 × 10^{13} (J) award 3 marks** recall GPE = mgh ✓ = 8.0 × 10^{9} × 10 × 400 ✓ = 3.2 × 10^{13} (J) ✓	3	**1.2** **2.1 × 2**	
	(c)		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 6.72 × 10^{11} (J) award 4 marks** recall efficiency = useful out / total in ✓ 140 MW = 140 × 10^{6} W and 1 hour = 3600 s ✓ ((140 × 10^{6}) × 3600)/0.75 ✓ = 6.72 × 10^{11} (J) ✓	4	**1.2 × 2** **2.1 × 2**	**ALLOW** 3 marks for 1.87 × 10^{8} (did not convert hours to seconds) **ALLOW** 3 marks for 6.72 × 10^{5} (did not convert MW to W) **ALLOW** 2 marks for 187 (no unit conversions)

Question			Answer	Marks	AO element	Guidance
6	(a)		**Any two from:** medical scans to see inside the body ✓ radiotherapy to kill cancer cells ✓ airport security scans to look inside luggage ✓	**2**	**1.1**	**ALLOW** (scans for) broken bones **ALLOW** to see a shadow image (of the inside of the body)
	(b)	**(i)**	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 8.0×10^{-15} (J) award 3 marks** recall / rearrange W = VQ ✓ $50\,000 \times 1.6 \times 10^{-19}$ ✓ $8(.0) \times 10^{-15}$ (J) ✓	**3**	 **1.2** **2.1 × 2**	
		(ii)	use a higher p.d. / voltage ✓	**1**	**2.1**	
	(c)		(all) are <u>absorbed</u> by lead ✓ (all) pass through / penetrate (through) beryllium ✓ shorter wavelengths pass through copper / longer wavelength absorbed by copper ✓	**3**	**1.1**	

Question			Answer	Marks	AO element	Guidance
7	(a)		the ratio of force over acceleration / force ÷ acceleration / m = f/a / AW ✓ a measure of how difficult it is to change the <u>velocity</u> of an object ✓	2	1.1	 **IGNORE** acceleration
	(b)	(i)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 1.2 (m/s²) award 3 marks** recall acceleration = change in velocity ÷ time / attempt to calculate gradient of graph ✓ 6 ÷ 5 ✓ = 1.2 (m/s²) ✓	3	 1.2 2.1 × 2	**ALLOW** 2 marks for correct calculation of gradient of a tangent drawn anywhere on the curve.
		(ii)	resultant force/it is constant ✓ **and any one from:** (because) acceleration/gradient constant ✓ mass is constant ✓ force is proportional to acceleration ✓	2	2.1	
		(iii)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 3472 (kg) award 2 marks** 40 000 = 0.5 × mass × 4.8² ✓ = 3472 (kg) ✓	2	2.1	**ALLOW** answer to the number of significant figures given by the candidate **ALLOW** 4.8± ½ small square; 4.7 gives 3622 kg, 4.8 gives 3472 kg, 4.9 gives 3332 kg

Question			Answer	Marks	AO element	Guidance
8	(a)		all three rays converge at a point ✓ focus labelled where any two rays cross ✓	2	1.1	Rays of light should be straight by eye. **ALLOW** second mark if only two rays drawn
	(b)		B is a converging/(plano)convex lens / AW ✓ because it is thicker/wider in the middle / AW ✓	2	2.1	
	(c)		**Any two from:** some sound waves will reflect ✓ waves need to slow down to converge / AW ✓ it will act as a diverging/concave lens ✓	2	3.2b	

Question			Answer	Marks	AO element	Guidance
9	(a)		biofuels are made from plants / are renewable / are carbon neutral ✓ fossil fuels are made from <u>fossilised</u> plants or animals / are non-renewable / cause CO_2 emissions ✓ both are burnt / combusted to release thermal energy ✓	3	1.1	
	(b)		**Any one from:** energy density of oil is 2 times wood pellets ✓ density of oil is 1.25 times wood pellets ✓ cost of oil is 2.2 times wood pellets ✓ **AND** cost per MJ is 1.25 for pellets and 1.375 for oil / 1.1 times larger for oil / 10% larger for oil ✓ **<u>so</u>** overall wood pellets are slightly cheaper ✓ **OR** MJ per m^3 is 15 200 for pellets and 38 000 for oil / 2.5 times bigger for oil ✓ **<u>so</u>** oil needs less storage space ✓	3	3.2a	**DO NOT ALLOW** third marking point (conclusion) unless it is justified with a calculation

Question			Answer	Marks	AO element	Guidance
10	(a)	(i)	specific heat capacity relates to change in temperature / AW ✓ specific latent heat relates to change in state / AW ✓	2	1.1	
		(ii)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 2.85 326087 award 3 marks** 52-20 = 32(°C) ✓ 210 000 x 1 / (2300 × 32 x 1) ✓ = 2.85326087 ✓	3	2.1	**ALLOW** answers that round to 2.85
	(b)		**Any two from:** temperature of wax decreases / ✓ thermal store of wax decreases ✓ energy is transferred by conduction / convection / radiation ✓ (as wax solidifies) latent heat is transferred to surroundings ✓	2	1.1	**ALLOW** any correct response that is in relation to energy transfers

Question			Answer	Marks	AO element	Guidance
11	(a)	(i)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 0.1875 award 3 marks** recall average speed = distance ÷ time ✓ 0.12 ÷ 0.64 ✓ = 0.1875 (m) ✓	3	**1.2** **2.1 × 2**	**ALLOW** 0.19, 0.188
		(ii)	there is a resultant force on the block / friction (acts on the block) ✓ so there is an acceleration / deceleration **OR** the **velocity** changes ✓	2	1.1	**IGNORE** slows down / speed changes (stem)
	(b)		vary mass / put slotted masses on top of block ✓ control/same material / surface area / use the same block **or** control/same (initial) velocity of block / launch using a spring ✓ measure distance travelled (with a ruler) ✓	3	3.3a	**ALLOW** add weight

Question			Answer	Marks	AO element	Guidance
12	(a)		A ✓ it is a straight line ✓	2	1.1	**ALLOW** Force is proportional to extension here
	(b)		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 0.82 (J) award 3 marks** attempt to calculate any area on graph ✓ 82 squares ✓ = 82 x 10^{-2} = 0.82 (J) ✓	3	2.2	
	(c)	(i)	elastic deformation ✓ **AND any one from:** particles become further apart (but remain in structure) ✓ particles remain attracted to one another ✓	2	1.1	**ALLOW** bonds stretch **ALLOW** bonds do not break / do not permanently stretch **ALLOW** bonds can go back to original size
		(ii)	plastic deformation ✓ **AND any one from:** permanent increase in particles separation / bonds are broken ✓ rows or planes of atoms slide over one another ✓	2	1.1	

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