

**GCSE (9–1)**

**Physics B (Twenty First Century Science)**

**J259/01: Breadth in physics (Foundation 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).

<b>Annotation</b>	<b>Meaning</b>
/	alternative and acceptable answers for the same marking point
✓	Separates marking points
<b>DO NOT ALLOW</b>	Answers which are not worthy of credit
<b>IGNORE</b>	Statements which are irrelevant
<b>ALLOW</b>	Answers that can be accepted
( )	Words which are not essential to gain credit
—	Underlined words must be present in answer to score a mark
<b>ECF</b>	Error carried forward
<b>AW</b>	Alternative wording
<b>ORA</b>	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:

	<b>Assessment Objective</b>
<b>AO1</b>	<b>Demonstrate knowledge and understanding of scientific ideas and scientific techniques and procedures.</b>
AO1.1	Demonstrate knowledge and understanding of scientific ideas.
AO1.2	Demonstrate knowledge and understanding of scientific techniques and procedures.
<b>AO2</b>	<b>Apply knowledge and understanding of scientific ideas and scientific enquiry, techniques and procedures.</b>
AO2.1	Apply knowledge and understanding of scientific ideas.
AO2.2	Apply knowledge and understanding of scientific enquiry, techniques and procedures.
<b>AO3</b>	<b>Analyse information and ideas to interpret and evaluate, make judgements and draw conclusions and develop and improve experimental procedures.</b>
<b>AO3.1</b>	Analyse information and ideas to interpret and evaluate.
AO3.1a	Analyse information and ideas to interpret.
AO3.1b	Analyse information and ideas to evaluate.
<b>AO3.2</b>	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.
<b>AO3.3</b>	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)	<p><b>FIRST CHECK THE ANSWER ON ANSWER LINE</b>  <b>If answer = 525 000 (J) award 2 marks</b></p> <p><math>70 \times 10 \times 750 \checkmark</math>  <math>= 525\,000 \text{ (J)} \checkmark</math></p>	2	2.1	
	(b)	(i)	1	2.1	First box ticked
		(ii)	2	2.1	Bottom two boxes ticked

Question		Answer	Marks	AO element	Guidance
2	(a)	<p><b>FIRST CHECK THE ANSWER ON ANSWER LINE</b>  <b>If answer = 12.6 award 2 marks</b></p> <p><math>9.0 \times 1.4 \checkmark</math>  <math>= 12.6 \text{ (V)} \checkmark</math></p>	2	2.1	
	(b)	<p><b>FIRST CHECK THE ANSWER ON ANSWER LINE</b>  <b>If answer = 103 award 2 marks</b></p> <p><math>12 \times 8.6 \checkmark</math>  <math>= 103 \text{ (W)} \checkmark</math></p>	2	2.1	<b>ALLOW</b> 103.2 or 100 for 2 marks
	(c)	(resistance will) change/increase $\checkmark$	1	2.1	<b>DO NOT ALLOW</b> decrease



Question		Answer	Marks	AO element	Guidance
3	(a)	40 cm ✓ 2 m ✓	2	1.2	
	(b)	2.0 Hz ✓	1	1.2	
	(c) (i)	motion of rope / vibration / oscillation is at right angles / perpendicular ✓ to the direction of <u>travel/motion/movement</u> of the wave / AW ✓	2	1.1	<b>ALLOW</b> rope moves up and down as the waves move forward for 1 mark.
	(ii)	<b>Any one from:</b> sound waves are longitudinal, ✓ vibration is parallel to motion of wave (for sound), ✓ sound waves have compressions (and rarefactions). ✓	1	1.1	<b>IGNORE</b> references to sound waves travelling through air

Question		Answer	Marks	AO element	Guidance
4	(a)	Visible light waves are transverse ✓ Visible light waves are electromagnetic waves ✓	2	1.1	Top two boxes ticked.
	(b)	Transmits ✓ Absorbs ✓	2	1.1	<b>ALLOW</b> a description of transmission. <b>ALLOW</b> a description of absorption.
	(c)	the information / data / claim has been evaluated ✓ by other scientists / experts ✓	2	1.1	<b>ALLOW</b> checked

Question		Answer	Marks	AO element	Guidance
5	(a)	<p><b>FIRST CHECK THE ANSWER ON ANSWER LINE</b>  <b>If answer = 9.9 (kg) award 3 marks</b></p> <p>recall / rearrange mass = density <math>\times</math> volume <math>\checkmark</math>  <math>0.9 \times 11 \checkmark</math>  <math>= 9.9 \text{ (g)} \checkmark</math></p>	3	1.2 2.1 $\times$ 2	
	(b)	<p><b>FIRST CHECK THE ANSWER ON ANSWER LINE</b>  <b>If answer = 126 (J) award 3 marks</b></p> <p><math>0.6 \text{ g} = 0.0006 \text{ kg} \checkmark</math>  <math>0.0006 \times 210\,000 \checkmark</math>  <math>= 126 \text{ (J)} \checkmark</math></p>	3	1.2 2.1 $\times$ 2	If conversion is omitted or incorrect max 2 marks can be awarded.
	(c)	<p><b>Any two from:</b></p> <p>particles can no longer freely move <math>\checkmark</math>  particles move more slowly <math>\checkmark</math>  particles lose energy <math>\checkmark</math>  (stronger) bonds between particles <math>\checkmark</math>  particles are in fixed positions / lattice <math>\checkmark</math></p>	2	1.1	

Question		Answer	Marks	AO element	Guidance
6	(a)	<p><b>FIRST CHECK THE ANSWER ON ANSWER LINE</b>  <b>If answer = 8.5 award 2 marks</b></p> <p><math>0.85 \times 10 \checkmark</math>  <math>= 8.5 \text{ (N)} \checkmark</math></p>	2	2.1	
	(b)	<p><b>FIRST CHECK THE ANSWER ON ANSWER LINE</b>  <b>If answer = 8600 (Pa) award 3 marks</b></p> <p><math>24 \div 0.0028 \checkmark</math>  <math>= 8571.4 \text{ (Pa)} \checkmark</math>  <math>= 8600 \text{ (Pa)} \checkmark</math></p>	3	2.1 × 2 1.2	
	(c)	<p><b>Any two from:</b>            (greater pressure leads to) greater (net) force on/from particles ✓            more (frequent) collisions ✓            particles collide with one another / the walls of the container ✓            particles travel shorter distance (between collisions) ✓            particles are closer together (hence smaller volume) ✓</p>	2	1.1	<b>ALLOW</b> temperature of air increases ✓ collisions are more energetic/ exert larger forces ✓
	(d)	put the syringe in a water bath ✓	1	3.3b	Second box ticked

Question		Answer	Marks	AO element	Guidance	
7	(a)	<b>Any two from:</b> chemical store (of petrol) decreases ✓ gravitational store of brick increases ✓ kinetic energy store of conveyor or bricks increases ✓ thermal store of surroundings / generator / electric motor / other named component increases ✓	2	2.1		
	(b)	<b>FIRST CHECK THE ANSWER ON ANSWER LINE</b> <b>If answer = 245 award 3 marks</b>  $35 \times 7.0$ ✓ 245 ✓ J ✓	3	2.1 × 2  1.2		
	(c)	(i)	rate of energy transfer / rate of doing work ✓	1	1.1	<b>ALLOW</b> energy (transfer) divided by time or work done divided by time.
		(ii)	lift bricks faster / lift more bricks in the same amount of time / lift heavier bricks at the same rate ✓	1	1.1	

Question			Answer	Marks	AO element	Guidance
8	(a)	(i)	weight or gravitational force ✓ downwards ✓  <b>OR</b>  reaction force ✓ upwards ✓  <b>OR</b>  air resistance / drag ✓ to the left / against the motion ✓	2	1.1	
		(ii)	<b>Any one from:</b> there is a resultant/net force ✓ there is a force acting against the motion ✓ friction / air resistance / drag (acts against the motion) ✓	1	1.1	
	(b)		<b>FIRST CHECK THE ANSWER ON ANSWER LINE</b> <b>If answer = 0.25 (m/s) award 3 marks</b>  15 cm = 0.15 m ✓ 0.15 ÷ 0.60 ✓ = 0.25 (m/s) ✓	3	1.2 2.1 × 2	If conversion is omitted or incorrect max 2 marks can be awarded.
	(c)		<b>Any two from:</b> vary initial speed of block or repeat with different speeds ✓  measure the distance it travels past the light gate ✓ using a metre ruler / tape measure ✓	2	3.3a	

Question		Answer	Marks	AO element	Guidance
9	(a)	(uranium) will run out <b>OR</b> is not replenished) / AW ✓	1	1.1	
	(b)	<b>Any two from:</b> neutron ✓ splits (uranium) nucleus ✓ making more than one (smaller) nuclei ✓ more neutrons released ✓ setting off a chain reaction ✓ mass is converted to energy ✓ ionising radiation emitted ✓ nuclei/neutrons have kinetic energy ✓	2	1.1	
	(c)	<b>FIRST CHECK THE ANSWER ON ANSWER LINE</b> <b>If answer = 40 (%) award 3 marks</b>  1600 ÷ 4000 ✓ = 0.4 ✓ = 40 (%) ✓	3	2.1 × 2  1.2	

Question		Answer	Marks	AO element	Guidance
10	(a)	number within range 40 - 50 (m) ✓	1	1.1	
	(b)	<p><b>Any one from:</b>  less likely to collide / crash ✓  collisions occur at a lower speed ✓  less (kinetic) energy / momentum in collision ✓</p> <p><b>AND</b>  stopping distance reduced from 23 m to 12 m / stopping distance is (roughly) halved / significantly reduced ✓</p>	2	3.2b	
	(c)	<p><b>Any one from:</b>  they are about the same for low speeds / 20 mph ✓  statement is correct for high speeds / any speed over 40 mph ✓</p> <p><b>AND</b>  thinking distance and braking distance values quoted from chart for one speed ✓</p>	2	3.1b	
	(d)	<p>drugs / alcohol / tiredness / distractions ✓  increase reaction time / thinking time / thinking distance ✓</p> <p><b>OR</b>  wet road / icy road / worn tyres / worn brakes ✓  increase braking distance / decrease braking force / reduce friction ✓</p>	2	1.1	



Question		Answer	Marks	AO element	Guidance
11	(a)	repeat experiment (in the same place) without the nuts / use a control ✓	1	3.3b	<b>ALLOW</b> measure background radiation count (and subtract from reading).
	(b)	put a sheet of paper (between the nuts and the detector) ✓ radiation will be blocked / reduced ✓	2	1.1	<b>ALLOW</b> increase the distance of air (to a few cm) between the nuts and the detector.
	(c)	electric current is flow of charge ✓ alpha particles are charged / (positive) ions ✓	2	2.1	
	(d)	<b>Any one from:</b> they can assess the risk / only a small risk ✓ they only eat a small quantity of nuts (so risk is small) ✓ they can decide to take the risk or not eat nuts ✓ nuts are a good source of protein / nuts are a healthy snack ✓	1	2.1	

Question		Answer	Marks	AO element	Guidance
12	(a)	<p><b>Any three from:</b>  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 ✓</p>	3	1.2	
	(b)	<p>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 ✓</p>	1	2.1	
	(c)	<p><b>Any one from:</b>  many people will have longer/slower reaction times (than 0.24 s) ✓  a few people many have shorter reaction times (than 0.15 s) ✓</p> <p><b>Any one from:</b>  use a longer ruler / 50 cm ruler / metre ruler (and extend the table) ✓  calculate reaction times for smaller/larger readings (than 12 cm) ✓</p>	2	<p>3.2b x 1</p> <p>3.3b x 1</p>	<p><b>ALLOW</b> answers explaining that people with visual impairment or physical disability of hands/arms would not be able to measure reaction time in this way.</p>

Question		Answer	Marks	AO element	Guidance
13	(a)	<p>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 ✓</p>	3	<p>3.1a  3.2a x 2</p>	
	(b)	(i) <p><b>Any one from:</b>  (burning gas emits) carbon dioxide ✓  (burning gas causes) climate change / greenhouse effect / global warming ✓  drilling for gas may damage ecosystems / habitats / AW ✓</p>	1	1.1	<b>ALLOW</b> greenhouse gases (released)
		(ii) <p>on some days wind turbines generate very little energy / even with more wind turbines they will not always supply enough energy ✓</p> <p><b>AND any one from:</b>  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 ✓</p>	2	3.1b	

Question		Answer	Marks	AO element	Guidance
14	(a)	electrons ✓ change distance from nucleus / lose energy / emit photons ✓	2	1.1	
	(b)	<b>FIRST CHECK THE ANSWER ON ANSWER LINE</b> <b>If answer = 0.0326(4417845) (m) award 3 marks</b>  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	<b>ALLOW</b> $v = f\lambda$  <b>ALLOW</b> answers that make a suitable rounding, e.g. 0.033 or 0.03
	(c)	<b>Any one from:</b> 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	<b>IGNORE</b> to find your way

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