

GCSE (9–1)

Physics A (Gateway)

J249/02: Paper 2 (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
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 A:

	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.

For answers to Section A if an answer box is blank ALLOW correct indication of answer e.g. circled or underlined.

Question		Answer	Marks	AO element	Guidance
1		B ✓	1	1.1	
2		B ✓	1	1.1	
3		C ✓	1	1.1	
4		B ✓	1	2.1	
5		B ✓	1	1.2	
6		B ✓	1	1.2	
7		B ✓	1	1.2	
8		D ✓	1	2.1	
9		A ✓	1	1.2	
10		D ✓	1	2.1	
11		C ✓	1	1.1	
12		D ✓	1	1.1	
13		A ✓	1	1.1	
14		C ✓	1	2.1	
15		C ✓	1	2.1	

Question		Answer	Marks	AO element	Guidance
16	(a)	A moon orbits a planet ✓ Planets orbit the sun / a star ✓	2	2 × 1.1	
	(b)	(i)	1	1.1	For both marks at least one of the forces must be labelled correctly. If no labels, award 1 mark if both arrows are in the correct direction
		(ii)	1	1.1	IGNORE relative lengths of arrows
		(iii)	2	2 × 2.1	ALLOW F and R are balanced for two marks
		(iv)	3	3 × 1.1	Must be in the correct order

Question			Answer	Marks	AO element	Guidance
17	(a)	(i)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer is 0.9 (J) award 2 marks (Kinetic energy =) $0.5 \times 20 \times 0.3^2$ ✓ (Kinetic energy =) 0.9 (J) ✓	2	2 × 2.1	
		(ii)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer is 3200 (J) award 3 marks Gravitational potential energy = $m \times g \times h$ ✓ (Gravitational potential energy =) $20 \times 10 \times 16$ ✓ (Gravitational potential energy =) 3200 (J) ✓	3	1 × 1.2 2 × 2.1	
	(b)	(i)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer is 0.4 award 2 marks (Efficiency =) $0.6 \div 1.5$ ✓ (Efficiency =) 0.4 / 40 % ✓	2	2 × 2.1	ALLOW 2 marks for 40 % ALLOW 1 mark for 40 (without % sign) ALLOW 1 mark for 0.4% IGNORE attempt of conversion of energy to joules
		(ii)	Any two from: Friction occurs / Resistance in wires / coil ✓ Energy transferred to <u>thermal energy</u> (store) ✓ of cable / winch / coil / motor / wires / surroundings ✓	2	2 × 2.1	ALLOW heat for thermal energy

Question		Answer	Marks	AO element	Guidance
	(iii)	<p>Any two from:</p> <p>(Oil) provides <u>lubrication</u> / is a <u>lubricant</u> ✓</p> <p>This reduces friction ✓</p> <p>Reduces transfer to thermal store / Less energy is wasted / less energy transferred to surroundings ✓</p> <p>So efficiency is increased ✓</p>	2	2 × 2.1	ALLOW heat for thermal energy

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Question		Answer	Marks	AO element	Guidance
18	(a)	<p>FIRST CHECK THE ANSWER ON ANSWER LINE If answer is 0.75 (m) award 3 marks</p> <p>Rearrangement: Wavelength = wave speed \div frequency ✓ (Wavelength =) $330 \div 440$ ✓ (Wavelength =) 0.75 (m) ✓</p>	3	<p>1 \times 1.2 2 \times 2.1</p>	<p>ALLOW $\frac{3}{4}$ (m)</p>
	(b)	<p>Any two from:</p> <p>(Sound) travels as a <u>longitudinal</u> wave ✓ (air) particles / molecules / atoms vibrate / oscillate ✓ <u>parallel</u> to the direction of energy transfer / wave travel / sound travel ✓</p>	2	2 \times 1.1	
	(c)	<p>Wavelength < 100 cm ✓ Amplitude stays at 1mm ✓</p>	2	2 \times 2.2	

Question		Answer	Marks	AO element	Guidance
19	(a)	<p>Mass number → 238 No. of protons → 94 No. of neutrons → 144</p> <p>✓ ✓</p>	2	2 × 1.1	1 mark for one correct connection
	(b)	(i)	1	1.2	(Mode =) 227 (GBq) ✓
		(ii)	2	2 × 2.1	(mass number of alpha =) 4 ✓ (atomic number of U =) 92 ✓
		(iii)	2	2 × 3.1b	Either: Yes AND alpha is less penetrating / more easily absorbed (than beta) / ORA ✓ So, cannot get into the body / get through the skin (so less likely to damage cells) ORA ✓ Or: No AND alpha is more ionising than beta ✓ So can cause more damage to cells (if inside the body) ✓
	(c)	Any two from: They have some of the radioactive source on them ✓ So, they are (still) being irradiated (AW) ✓ So, their cells could (continue to) be damaged ✓	2	2 × 2.1	

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Question		Answer	Marks	AO element	Guidance
	(d) (i)	820 (grams) ✓	1	2.2	ALLOW 810-830
	(ii)	<p>Any two from: Neptune is far away / the furthest planet from the Sun / it would take a long time to get to Neptune ✓</p> <p>(So) electricity needs to be generated for a long time / power source needs to last a long time ✓</p> <p>Pu-238 would still be generating (lots of) power/half-life is (much) longer than the time to get to Neptune ✓</p>	2	2 × 3.1b	ALLOW batteries would have run out / Solar panels would not get enough sunlight

Question		Answer	Marks	AO element	Guidance
20	(a)	<p>Any one from:</p> <p>(Ensure the same) volume / mass of water (in each kettle) ✓</p> <p>Ensure the water (in the kettles) has the same starting temperature ✓</p>	1	3.3a	<p>DO NOT ALLOW amount / quantity</p> <p>DO NOT ALLOW Use the same kettle/power of kettle/efficiency/time</p>

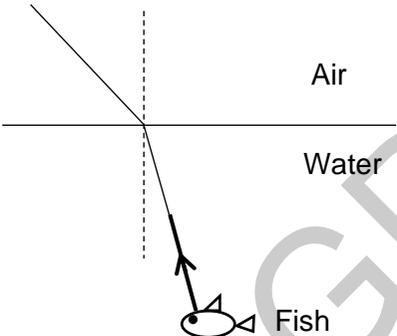
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Question		Answer	Marks	AO element	Guidance
20	(b)*	<p>Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.</p> <p>Level 3 (5–6 marks)</p> <p>Uses data to describe detailed relationship between energy and time AND calculates power AND draws a conclusion <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)</p> <p>Describes relationship between energy and time AND calculates power OR draws a conclusion in terms of power <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)</p> <p>Describes simple relationship between energy and time described OR calculates a power OR draws a conclusion <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	2 × 2.1 2 × 3.1a 2 × 3.2b	<p>AO3 – Analyses graph to describe how the change in thermal energy varies with time</p> <ul style="list-style-type: none"> • (Thermal) energy (store) increases (with time) • Increase is proportional / As one doubles the other doubles / AW • Straight line graph through origin • Some data used to show this relationship E.g. for Kettle A, Energy at 50 s = 60000J. Energy at 100s = 120000 J • Rate for each kettle is constant • Energy of A (is always) > B > C / ORA • Rate of increase of Energy of A > B > C / ORA <p>AO3 – Analyses information to draw conclusions about power of kettles</p> <ul style="list-style-type: none"> • Power of A > B > C / ORA • Higher power means more energy transferred in the same time / ORA <p>AO2.1 – Applies knowledge of power as rate of energy transfer</p> <ul style="list-style-type: none"> • $P = E \div t$ • Attempt at calculating power of kettles • E.g. Power of A = 120 000 / 100 = 1200 W • Power of B = 80000/100 = 800 W Power of C = 40000/100 = 400 W

Question		Answer	Marks	AO element	Guidance
20	(c)	Energy is transferred from the mains / via National grid / via transformers / via power lines ✓ Using a.c. / AW ✓	2	2 × 1.2	

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Question		Answer	Marks	AO element	Guidance
21	(a)	<p>FIRST CHECK THE ANSWER ON ANSWER LINE If answer is 6.6 (s) award 2 marks</p> <p>Mean = $(6.7 + 6.3 + 6.7 + 6.6) \div 4$ ✓ (Mean =) 6.6 (ms) ✓</p>	2	2 × 1.2	<p>ALLOW one mark for 6.575 (ms) ALLOW candidate's average roundly correctly to 2 s.f. for one mark</p>
	(b)	<p>Any one from:</p> <p>The timer would start and stop at (roughly) the same time ✓</p> <p>The time would not be the time for the sound to travel from mic 1 to mic 2 ✓</p>	1	2.2	<p>ALLOW the time measurement would be incorrect</p>
	(c) (i)	<p>FIRST CHECK THE ANSWER ON ANSWER LINE If answer is 320 (m / s) award 4 marks</p> <p>7.5 ms = 0.0075 s ✓ Rearrangement: speed = distance ÷ time ✓ (Speed =) $2.4 \div 0.0075$ ✓ (Speed =) 320 (m / s) ✓</p>	4	<p>1.2 1.2 2 × 2.1</p>	
	(ii)	<p>With a tape measure / (several) metre-rule(s) ✓</p>	1	1.2	<p>DO NOT ALLOW with a ruler</p>
	(iii)	<p>Any one from:</p> <p>Errors / Uncertainty in measuring time ✓</p> <p>Errors / Uncertainty in measuring distance ✓</p> <p>Value on the website might be for different conditions (air temperature etc) ✓</p>	1	3.2a	<p>DO NOT ALLOW the value on the website could be incorrect.</p>

Question			Answer	Marks	AO element	Guidance
22	(a)	(i)	<p>Any one from: It is refracted ✓ It changes direction/bends (away from the normal) ✓ The speed <u>increases</u> ✓ The wavelength <u>increases</u> ✓</p>	1	1.1	<p>DO NOT ALLOW bends towards the normal</p> <p>IGNORE speed/wavelength changes DO NOT ALLOW the speed/wavelength decreases</p>
		(ii)	<p>Ray continues in a straight line AND normal line drawn (90° by eye relative to interface) where incident ray meets the interface ✓</p> <p>Ray enters the air AND is to the left of the normal line ✓</p> <p>angle of refraction > angle of incidence AND angle of incidence < 90° ✓</p> 	3	3 × 1.2	<p>DO NOT ALLOW if the ray emerges vertically or to the right-hand side of the normal</p> <p>IGNORE any reflected rays IGNORE direction of any arrows</p> <p>ALLOW marking points 2 and 3 to be awarded if the ray does not come from the fish</p>
	(b)		<p>At least two of the rays are reflected in different directions ✓</p>	1	1 × 1.2	IGNORE any normal lines
	(c)		<p>The fish <u>absorbs</u> the green (light) / <u>does not reflect</u> the green (light) / the fish reflects red (light) <u>only</u> ✓</p> <p>There is no red (light) (to reflect) / the (green) light contains no red (light) / no light is reflected ✓</p>	2	2 × 2.1	

Question			Answer	Marks	AO element	Guidance
23	(a)	(i)	2 or 3 correctly plotted points to within $\frac{1}{2}$ small square ✓ 4 points correctly plotted to within $\frac{1}{2}$ small square ✓ Smooth curved line of best fit through most points ✓	3	3 × 2.2	DO NOT ALLOW a straight line of best fit ALLOW ECF from incorrectly plotted points
		(ii)	Candidate's line of best fit extended to 2.00 AND their value of p.d. is correct for their graph ✓ Value of p.d. = 2.55 – 2.70 ✓	2	2 × 3.2b	IGNORE line of best fit past 2.00
		(iii)	Any one from: Repeat readings and calculate the mean/discard anomalies ✓ Carry out investigation in the dark / reduce ambient light ✓ Use a greater range / more values of light intensity ✓ Use higher light intensities ✓ Use a light meter to check light intensity ✓	1	3.3b	
	(b)	(i)	Any two from: To reduce energy bills / sell electricity (back to national grid) ✓ People are more aware of environmental issues / they are better for the environment ✓ To reduce reliance on/use of fossil fuels / fossil fuels are running out ✓ To reduce CO ₂ / greenhouse emissions / global warming ✓ They are cheaper (than 20 years ago) ✓ The government has encouraged people to install them / grants available to fit them ✓ More efficient / better/newer panels/technologies are now available ✓	2	2 × 3.2a	IGNORE people are more environmentally friendly/green. ALLOW they use a renewable energy resource IGNORE they weren't available twenty years ago.

Question		Answer	Marks	AO element	Guidance
23	(ii)	<p>Maximum two from:</p> <p>($24 \div 1.6 =$) 15 panels ✓ ($15 \times 26 =$) 390 MJ / maximum energy he could generate > energy required / maximum energy is 26 MJ greater ✓</p> <p>OR</p> <p>($364 \div 26 =$) 14 panels ✓ ($14 \times 1.6 =$) 22.4 m² / area of panels required < area of roof / area of panels is 1.6 m² greater ✓</p> <p>And any one from:</p> <p>When it is night/cloudy/dark/sun not at highest point energy output would/could be too low ✓ Would need (batteries) to store energy / to obtain energy at night / may need back-up power/generator ✓ Amount of energy generated can change with weather/seasons so may be less ✓</p>	3	3 × 3.1b	<p>ALLOW 390 MJ / maximum energy is 26 MJ greater for 2 marks</p> <p>ALLOW 22.4 m² / area of panels is 1.6 m² greater for 2 marks</p>

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