F

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.

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 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.

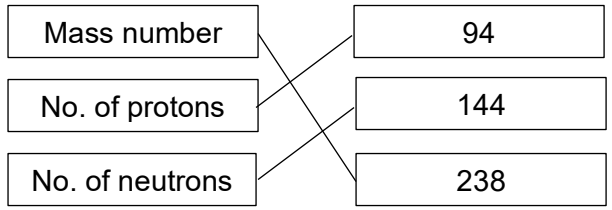
Question			Answer	Marks	AO element	Guidance
1			B ✓	1	1.1	
2			B ✓	1	1.1	
3			C ✓	1	1.1	
4			B ✓	1	2.1	
5			B ✓	1	1.2	
6			B ✓	1	1.2	
7			B ✓	1	1.2	
8			D ✓	1	2.1	
9			A ✓	1	1.2	
10			D ✓	1	2.1	
11			C ✓	1	1.1	
12			D ✓	1	1.1	
13			A ✓	1	1.1	
14			C ✓	1	2.1	
15			C ✓	1	2.1	

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)**	Mark with **(b)(ii)** Arrow drawn from **P** pointing to the centre of the Sun, labelled **F** ✓	**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)	Arrow from **P** pointing away from the centre of the Sun, labelled **R** ✓	**1**	**1.1**	**IGNORE** relative lengths of arrows
		(iii)	(**F** and **R** are) equal (in size) ✓ And opposite in direction so (resultant / overall force is zero) ✓	**2**	**2 × 2.1**	**ALLOW F** and **R** are balanced for two marks
		(iv)	Red giant ✓ Planetary nebula ✓ White dwarf ✓	**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 × g × h ✓ (Gravitational potential energy =) 20 × 10 × 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 ÷ 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)	Any **two** from: (Oil) provides lubrication / is a lubricant ✓ This reduces friction ✓ Reduces transfer to thermal store / Less energy is wasted / less energy transferred to surroundings ✓ So efficiency is increased ✓	**2**	**2 × 2.1**	**ALLOW** heat for thermal energy

Question			Answer	Marks	AO element	Guidance
18	(a)		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer is 0.75 (m) award 3 marks** Rearrangement: Wavelength = wave speed ÷ frequency ✓ (Wavelength =) 330 ÷ 440 ✓ (Wavelength =) 0.75 (m) ✓	**3**	**1 × 1.2** **2 × 2.1**	**ALLOW** ¾ (m)
	(b)		Any **two** from: (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 ✓	**2**	**2 × 1.1**	
	(c)		Wavelength < 100 cm ✓ Amplitude stays at 1mm ✓	**2**	**2 × 2.2**	

Question			Answer	Marks	AO element	Guidance
19	(a)		 ✓ ✓	2	2 × 1.1	**1 mark** for one correct connection
	(b)	**(i)**	(Mode =) 227 (GBq) ✓	1	1.2	
		(ii)	(mass number of alpha =) 4 ✓ (atomic number of U =) 92 ✓	2	2 × 2.1	
		(iii)	**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) ✓	2	2 × 3.1b	
	(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	

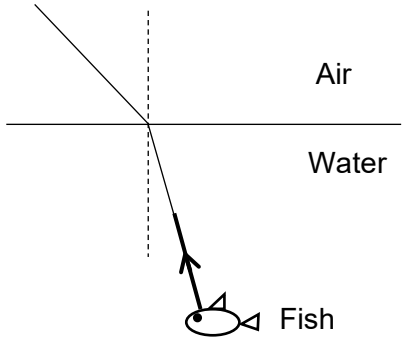
Question			Answer	Marks	AO element	Guidance
	(d)	**(i)**	820 (grams) ✓	**1**	**2.2**	**ALLOW** 810-830
		(ii)	Any **two** from: Neptune is far away / the furthest planet from the Sun / it would take a long time to get to Neptune ✓ (So) electricity needs to be generated for a long time / power source needs to last a long time ✓ Pu-238 would still be generating (lots of) power/half-life is (much) longer than the time to get to Neptune ✓	**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)		**Any one from:** (Ensure the same) volume / mass of water (in each kettle) ✓ Ensure the water (in the kettles) has the same starting temperature ✓	1	3.3a	 **DO NOT ALLOW** amount / quantity **DO NOT ALLOW** Use the same kettle/power of kettle/efficiency/time

Question			Answer	Marks	AO element	Guidance
20	(b)*		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)** Uses data to describe detailed relationship between energy and time **AND** calculates power **AND** draws a conclusion *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 relationship between energy and time **AND** calculates power **OR** draws a conclusion in terms of power *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 simple relationship between energy and time described **OR** calculates a power **OR** draws a conclusion *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 × 2.1** **2 × 3.1a** **2 × 3.2b**	**AO3 – Analyses graph to describe how the change in thermal energy varies with time** • (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 **AO3 – Analyses information to draw conclusions about power of kettles** • Power of A > B > C / ORA • Higher power means more energy transferred in the same time / ORA **AO2.1 – Applies knowledge of power as rate of energy transfer** • P = E ÷ 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**	

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

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

Question			Answer	Marks	AO element	Guidance
23	(a)	(i)	2 or 3 correctly plotted points to within ½ small square ✓ 4 points correctly plotted to within ½ 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)	Maximum **two** from: (24 ÷ 1.6 =) 15 panels ✓ (15 × 26 =) 390 MJ / maximum energy he could generate > energy required / maximum energy is 26 MJ greater ✓ **OR** (364 ÷ 26 =) 14 panels ✓ (14 × 1.6 =)22.4 m^2 / area of panels required < area of roof / area of panels is 1.6 m^2 greater ✓ And any **one** from: 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 ✓	**3**	**3 × 3.1b**	**ALLOW** 390 MJ / maximum energy is 26 MJ greater for 2 marks **ALLOW** 22.4 m^2 / area of panels is 1.6 m^2 greater for 2 marks

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