

**GCSE (9–1)**

**Physics A (Gateway)**

**J249/02: Paper 2 (Foundation Tier)**

General Certificate of Secondary Education

**Mark Scheme for November 2020**

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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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## Annotations

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

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

**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:

	<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.

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		A ✓	1	1.2	
2		B ✓	1	1.1	
3		C ✓	1	2.1	
4		D ✓	1	2.2	
5		A ✓	1	2.2	
6		C ✓	1	2.2	
7		D ✓	1	1.2	
8		A ✓	1	1.1	
9		C ✓	1	1.2	
10		B ✓	1	1.1	
11		B ✓	1	2.1	
12		D ✓	1	2.1	
13		C ✓	1	2.1	
14		C ✓	1	1.1	
15		C ✓	1	1.2	

Question		Answer	Marks	AO element	Guidance	
16	(a)	<p><b>Any one from:</b>            Similarity            Both transverse waves ✓            Both electromagnetic waves ✓            Both travel at the same speed/speed of light (in a vacuum) ✓            Both can travel through space / vacuum ✓</p> <p><b>Any one from:</b>            Difference            X-ray has higher frequency / shorter wavelength / ORA ✓            X-rays have higher energy / ORA ✓            X-rays are more penetrating / ORA ✓</p>	2	2 × 1.1	1  <b>DO NOT ALLOW</b> we can see visible light/we cannot see X-rays	
	(b)	(i)	86 (%) ✓	1	2.2	<b>ALLOW</b> 85-87 %
		(ii)	<p><b>FIRST CHECK THE ANSWER ON ANSWER LINE</b>  <b>If answer = 14 (%) award 2 marks</b></p> <p>100 – 86 ✓            = 14 (%) ✓</p>	2	2 × 2.2	<b>ALLOW ECF</b> from (b)(i)
	(c)		Big Bang ✓ Red shift ✓ Expanding ✓	3	3 × 1.1	



Question			Answer	Marks	AO element	Guidance
17	(a)	(i)	<u>Transverse</u> ✓	1	1.1	
		(ii)	Molecules/Particles move <u>perpendicular/ right angles</u> (to the direction of energy transfer/water surface) ✓	1	1.1	<b>ACCEPT</b> at right angles/ 90° (to direction of travel) <b>ACCEPT</b> up and down 1
		(iii)	<b>FIRST CHECK THE ANSWER ON ANSWER LINE</b> <b>If answer = 0.5 (Hz) award 2 marks</b>  Frequency = number of waves per second / = $10 \div 20$ ✓ $f = 0.5$ (Hz) ✓	2	2 × 2.1	<b>ACCEPT</b> ½
	(b)	(i)	<b>FIRST CHECK THE ANSWER ON ANSWER LINE</b> <b>If answer = 0.06 (m / s) award 3 marks</b>  Speed = $0.6 \times 0.1$ ✓ Speed = 0.06 (m / s) ✓	2	2 × 2.1	
		(ii)	Distance is measured with a metre-rule <b>OR</b> tape measure ✓  Time is measured with a stop-watch ✓	2	2 × 1.2	<b>ACCEPT</b> metre-ruler <b>DO NOT ALLOW</b> ruler
		(iii)	<b>FIRST CHECK THE ANSWER ON ANSWER LINE</b> <b>If answer = 0.08 (m / s) award 3 marks</b>  Speed = distance ÷ time ✓ = $2.4 \div 30$ ✓ = 0.08 (m / s) ✓	3	1 × 1.2 2 × 2.1	
		(iv)	Uncertainty/difficulty in measuring distance ✓ <b>OR</b> Human reaction time in starting/stopping stopwatch ✓	1	3.2a	<b>ALLOW AW</b>

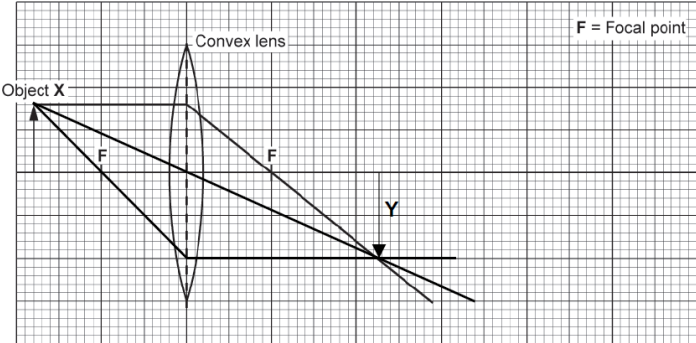
Question			Answer	Marks	AO element	Guidance
18	(a)	(i)	27 ✓	1	1.1	
		(ii)	The same number of protons / atomic number / they both have 27 protons ✓  Co-60 has 3 more neutrons <b>ORA</b> / Co-60 has 33 neutrons and Co-57 has 30 neutrons / mass number is different ✓	2	2 × 1.1	<b>ALLOW</b> Co-57 has 27 neutrons 0
	(b)	(i)	Radioactivity is a random process ✓	1	1.1	<b>ALLOW</b> background radiation fluctuates
		(ii)	<b>FIRST CHECK THE ANSWER ON ANSWER LINE</b> <b>If answer = 209 (counts per minute) award 2 marks</b>  (191 + 224 + 212) ÷ 3 ✓ = 209 (counts per minute) ✓	2	2 × 1.2	
		(iii)	The count-rate stays the same ✓	1	2.1	<b>ALLOW</b> the count-rate goes down slightly <b>DO NOT ALLOW</b> the count-rate goes down
	(c)	(i)	The time it takes the number of undecayed/radioactive nuclei to halve ✓	1	1.1	<b>ALLOW</b> count-rate or activity for number of undecayed nuclei
		(ii)	<b>FIRST CHECK THE ANSWER ON ANSWER LINE</b> <b>If answer = 40 (counts per minute) award 3 marks</b>  10y = 2 half lives ✓ 160 / 2 = 80 (counts per minute) ✓ 80 / 2 = 40 (counts per minute) ✓	3	2 × 2.1	
	(d)	(i)	So (most of) the radioactivity / gamma rays are absorbed by the lead/do not get to the doctor. ✓  So the doctor is not irradiated/to prevent the doctor's cells being damaged. ✓	2	2 × 1.1	<b>ALLOW</b> will absorb alpha and beta radiation  <b>ALLOW</b> to stop the doctor getting cancer

Question			Answer	Marks	AO element	Guidance
18	(d)	(ii)	<p>Iodine-131 ✓</p> <p>Gamma can pass through the body to the detector / alpha cannot pass through the body. ✓</p> <p>Use a short half-life so patient's cells are less damaged. ✓</p>	3	<p>3.2</p> <p>2.2</p> <p>2.2</p>	<p><b>ALLOW</b> this mark if Cobalt-60 or Iodine-131 is chosen</p> <p><b>ALLOW</b> this mark if Radon-222 or Iodine-131 is chosen.</p> <p>1</p>
19	(a)	(i)	<p><b>Any two from:</b></p> <p>First student drops the ruler and second student catches as quick as possible ✓</p> <p>Measure the distance on the ruler where it was caught ✓</p> <p>Use look-up table/equation to find time to travel this distance ✓</p>	2	2 × 1.2	1
		(ii)	<p><b>Any one from:</b></p> <p>To check the precision or repeatability of the readings ✓</p> <p>to find the uncertainty in the measurement ✓</p> <p>to find an average or mean ✓</p>	1	3.3a	
		(iii)	Student B's reaction times will be longer / increases ✓	1	3.2a	<b>ALLOW</b> B will be slower
	(b)	(i)	$(9 + 14) = 23$ (m) ✓	1	2.2	
		(ii)	<p>Stopping distance at 50 mph = 53 m ✓</p> <p>Stopping distance is greater than 40 m / Car hits the barrier ✓</p>	2	<p>3.1a</p> <p>3.2a</p>	<b>ALLOW</b> 52-54m

Question			Answer	Marks	AO element	Guidance
19	(b)	(iii)	<p>Factor: larger mass (of car) ✓  Reason: Braking distance is increased ✓  because deceleration is less / larger KE to dissipate ✓</p> <p><b>OR</b></p> <p>Factor: Poor quality brakes / tyres ✓  Reason: Braking distance is increased ✓  Less friction / smaller deceleration ✓</p> <p><b>OR</b></p> <p>Factor: Icy / wet / slippery road ✓  Reason: Braking distance is increased ✓  Less friction / smaller deceleration ✓</p> <p><b>OR</b></p> <p>Factor: Going uphill ✓  Reason: Braking distance is decreased ✓  Weight of car increases deceleration ✓</p> <p><b>OR</b></p> <p>Factor: Going downhill ✓  Reason: Braking distance is decreased ✓  Weight of car decreases deceleration ✓</p>	3	1.1 2 × 2.1  1.1 2 × 2.1  1.1 2 × 2.1  1.1 2 × 2.1	<p><b>DO NOT ALLOW</b> distance for braking/thinking distance</p> <p><b>DO NOT ALLOW</b> stopping distance</p>

Question			Answer	Marks	AO element	Guidance
19	(c)	(i)	<p><b>FIRST CHECK THE ANSWER ON ANSWER LINE</b>  <b>If answer = 3.25/3.3 (m/s<sup>2</sup>) award 2 marks</b></p> <p>13 ÷ 4 ✓            = 3.3 (m/s<sup>2</sup>) ✓</p>	2	2 × 2.1	ALLOW 3.25 (m/s <sup>2</sup> )
		(ii)	<p><b>Any two from:</b>            Yes / No (no mark)</p> <p>(agree with driver)            stopping distance is shorter ✓</p> <p>Less likely to hit obstacles / safer ✓</p> <p>Attempt to quantify, e.g. 4 s / 0.4 s = 10 ✓</p> <p><b>OR</b></p> <p>(disagree with driver)            (<math>F = ma</math> / so) the force (acting on the people in the car) is            10x greater ✓</p> <p>This can lead to injury / 10× more dangerous ✓</p> <p>Other factors involved (so cannot quantify) ✓</p>	2	2.1  2 × 3.1b   2.1 2 × 3.1b	1
		(iii)	Seat belt / airbag / crumple zone ✓	1	1.1	

20	*	<p>Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.</p> <p><b>Level 3 (5–6 marks)</b> States that greater orbital distance goes with a longer time period but that the relationship is not proportional. Attempts to explain orbital motion in terms of gravity. <b>AND</b> Relates data from the graph to at least two named planets. <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><b>Level 2 (3–4 marks)</b> States that greater orbital distance goes with a longer time period. <b>AND</b> Relates the curve to different named planets in the solar system. <b>OR</b> Reads data from the graph. <i>There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.</i></p> <p><b>Level 1 (1–2 marks)</b> States that greater orbital distance goes with a longer time period. <b>OR</b> Relates the curve to the properties of at least one planet in the solar system. <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><b>0 marks</b> <i>No response or no response worthy of credit.</i></p>	6	<p><b>3 × 2.1</b> <b>3 × 3.1a</b></p>	<p><b>AO3.1a Analyses information and ideas by interpreting graph</b></p> <ul style="list-style-type: none"> <li>• As distance increases, orbit time increases.</li> <li>• Time read correctly for a specific distance.</li> <li>• Comparison of two data points.</li> <li>• Recognises that the data for the Earth is very close to the origin</li> <li>• Outermost planets have periods of over a century</li> <li>• Time is <b>not</b> proportional to distance.</li> <li>• Time increases faster than distance.</li> <li>• Gradient of line increases.</li> <li>• Calculation using data to show non-proportionality, e.g. when distance doubles from 1 to 2, time more than doubles.</li> </ul> <p><b>AO2.1 Applies knowledge and understanding of the solar system</b></p> <ul style="list-style-type: none"> <li>• Inner planets are Mercury, Venus, Earth and Mars.</li> <li>• Outer planets are Jupiter, Saturn, Uranus and Neptune.</li> <li>• As distance from Sun increases, orbital period of planet increases.</li> <li>• Period of Earth's orbit is 1 year</li> <li>• Distance planet travels in one orbit increases with distance from the Sun.</li> <li>• If distance is larger, time will be greater (for same speed)</li> <li>• As speed is smaller, time will be greater by a greater factor.</li> </ul>
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Question		Answer	Marks	AO element	Guidance
21	(a)	<p>Either ray (centre ray or focal ray) drawn as indicated below ✓</p>  <p>Image upside down <b>AND</b> in the correct place ✓</p>	2	2 × 2.2	<p><b>ALLOW</b> just one ray drawn</p> <p>If no rays drawn (or incorrect) but image is inverted, slightly larger and roughly in the correct place then award this mark  <b>IGNORE</b> position of Y (if arrow is in the correct place)  <b>ALLOW</b> tolerance of +/- 2 squares for image position</p>
	(b)	<p>A (red) filter is needed ✓</p> <p>(The red filter) absorbs all colours/frequencies/wavelengths except red (light) ✓</p>	2	2 × 2.1	<p><b>ALLOW</b> The red filter absorbs blue and green (light/frequency/wavelength) (but not red)  <b>ALLOW</b> the filter transmits red light <u>only</u> / <u>only</u> lets red (light/frequency/wavelength) through</p>
	(c) (i)	230 (V) ✓	1	1.1	

Question			Answer	Marks	AO element	Guidance
21	(c)	(ii)	<p>(Earth wire together with fuse) prevents user from getting electric shock (if there is a fault) ✓</p> <p>Plastic case is an insulator (so earth wire not required) ✓</p>	2	2 x 1.1	<p><b>ALLOW</b> metal case could cause electric shock if no earth wire / AW</p> <p><b>ALLOW</b> idea of earth wire carries current to Earth / AW</p> <p><b>ALLOW</b> prevents projector becoming live / AW</p> <p><b>ALLOW</b> plastic case is not a conductor / does not conduct electricity/current</p> <p><b>ALLOW</b> appliance is double insulated</p>
22	(a)		<p>Change the thickness of the cardboard (and repeat) ✓</p> <p><b>Any 2 from:</b></p> <p>(Control variable) Same volume of water / same starting temperature of water ✓</p> <p>Measure temperature with thermometer / time with stopwatch ✓</p> <p>Calculate the rate using change in temperature / time ✓</p> <p>Repeat results (and calculate the mean) ✓</p>	3	3 x 3.3a	<p><b>ALLOW</b> use different boxes with different thicknesses / line the box with an insulator</p> <p><b>ALLOW</b> same beaker / both beakers (don't) have a lid / same room temperature</p> <p><b>ALLOW</b> a specified amount of water in the beaker / a specified starting temperature</p>



Question			Answer	Marks	AO element	Guidance
22	(b)	(i)	5 or 4 points correctly plotted to within $\frac{1}{2}$ small square ✓✓	2	2 × 2.2	3 or 2 correctly plotted points gains 1 mark <b>IGNORE</b> 'blobs' more than $\frac{1}{2}$ square diameter
		(ii)	Smooth curved line of best fit through most points ✓	1	1.2	<b>DO NOT ALLOW</b> a straight line of best fit
		(iii)	Temperature decreases (with time) ✓  At a decreasing rate / by a smaller change in temperature for each increase in time ✓	2	2 × 3.1a	<b>IGNORE</b> non-linear relationship / positive/negative correlation  <b>ALLOW</b> inverse proportion for this mark only  <b>ALLOW</b> gradient decreases / temperature decreases more quickly at the start (than at the end) <b>ALLOW</b> use of data from the graph to show decreasing rate
		(iv)	Line starts at 90°C and decreases but remains <u>above</u> their LOBF ✓	1	3.2b	<b>IGNORE</b> shape of the line but no mark for a horizontal line <b>ALLOW</b> 90 +/- 2 °C
		(v)	<b>Any one from:</b> Repeat (and find a mean) / check reproducibility/repeatability ✓  Use smaller time intervals ✓  Use more precise timer/thermometer ✓	1	3.3b	<b>ALLOW</b> any sensible suggestion <b>IGNORE</b> a longer time / use more thicknesses  <b>ALLOW</b> use equipment with higher resolution / data logger <b>IGNORE</b> better equipment unless qualified
	(c)		Thermal conductivity of metal is higher (so rate of cooling is greater) / ORA ✓	1	3.2a	<b>ALLOW</b> metal is a (better thermal) conductor / ORA

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