H

GCSE (9–1)

Physics A (Gateway Science)

J249/03: Paper 3 (Higher Tier)

General Certificate of Secondary Education

Mark Scheme for Autumn 2021

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

Question			Answer	Marks	AO element	Guidance
16	(a)	(i)	450 m ✓	**1**	2.2	
		(ii)	350 s ✓	**1**	2.2	**ALLOW** 5 minutes 50 s
		(iii)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 1.3 (m/s) award 3 marks** (Rearrangement) Speed = distance / time ✓ 450 / 350 ✓ 1.3 (m / s) ✓	**3**	 1.2 2.2 2.2	**ALLOW** ECF from (a)(i) and(ii) **ALLOW** 1.2857 (m/s) **ALLOW** s = d / t
		(iv)	Section E ✓ Steepest <u>gradient</u> or <u>slope</u> ✓	**2**	2.2 1.1	 **ALLOW** correct speeds calculated (1 m / s) and compared for sloped sections
		(v)	(The student) Stopped✓	**1**	1.1	**ALLOW** any sensible answer related to stopping
	(b)		(Time) Watch / stopwatch / stopclock / timer **AND** (Distance) trundle wheel / (measuring) tape ✓	**1**	2.2	**ALLOW** mobile (phone) <u>timer</u> **IGNORE** mobile (phone) **ALLOW** metre rule **ALLOW** tracking / fitbit app on mobile to measure distance **IGNORE** ruler

Question			Answer	Marks	AO element	Guidance
17	(a)		Ammeter B **AND** Ammeter B does not have a zero error / ammeter A has a zero error ✓ Ammeter B can read a current of 1 A / ammeter A cannot read up to a current of 1 A / only reads to 50 mA ✓	**2**	3.3b x 2	**ALLOW** ammeter A does not start at zero **ALLOW** Ammeter A does not read high enough **DO NOT ALLOW** higher degree of precision / digital
	(b)	(i)	(For a fixed resistor) *V* is (directly) proportional to ***I*** / *V=IR* ✓ And gives a straight-line graph through the origin ✓	**2**	3.2b x 2	**ALLOW** calculation of resistance of 10 Ω from the gradient of the graph for two different points for **1 mark** **ALLOW** constant gradient through the origin
		(ii)	**Any one from:** (Higher current) gives greater heating effect ✓ Apparatus was not left to cool between readings ✓	**1**	3.3b	**ALLOW** the resistor / component had heated up **DO NOT ALLOW** random error
		(iii)	Ask **someone else** to repeat your experiment ✓ Repeat experiment using **different** equipment ✓	**2**	3.3b x 2	**IGNORE** just repeat experiment
	(c)		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 2.5 (W) award 2 marks** 0.5^2 x 10 ✓ 2.5 (W) ✓	**2**	 2.1 2.1	

Question			Answer	Marks	AO element	Guidance
18	(a)	(i)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 67 200 (J) award 2 marks** (Energy = mass x shc x temperature change) 0.2 x 4200 x 80 ✓ 67 200 (J) ✓	2	 2.1 2.1	**ALLOW** 67 000 (J) Note use of 20 or 100 for temperature, scores zero No ECF
		(ii)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 452 000 (J) award 2 marks** (Energy = mass x specific latent heat) 0.2 x 2 260 000 ✓ 452 000 (J) ✓	2	 2.1 2.1	**ALLOW** 450 000 (J) Note inclusion of a temperature, scores zero No ECF
		(iii)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 5.2 x 10^5 (J) award 3 marks** 67 200 + 452 000 = 519 200 ✓ 5.19200 x 10^5 ✓ 5.2 x 10^5 (J) ✓	3	 2.1 2.1 1.2	**ALLOW** ECF from 18(a)(i) and 18(a)(ii) **ALLOW** ECF for wrong calculation **ALLOW** 520 000 (J) for 2 marks
	(b)	(i)	**Any two from:** Some of the energy was used to heat the container ✓ Heat/energy lost to the environment ✓	2	3.2a 3.3a	**ALLOW** 1 mark maximum for any general 'energy losses' response
		(ii)	**Any one from:** Reduces random errors ✓ Helps identify anomalies ✓ Allows checks for precision ✓	1	3.3b	**ALLOW** improves accuracy

Question			Answer	Marks	AO element	Guidance
19*			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)** A detailed description **AND** explanation of the behaviour of both springs, including correct calculation of spring constant or work done. *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)** A basic description **and** explanation of the behaviour of both springs including correct calculation of spring constant or work done **OR** A detailed description **and** explanation of the behaviour of both springs. *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)** A basic description **or** explanation of both springs **OR** A detailed description **or** explanation of one spring. *The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear.*	**6**	1.1x1 2.2x1 3.1bx2 3.2bx2	**AO1.1 Demonstrate knowledge of Hooke's Law to describe the springs** For example: • spring A obeys Hooke's law until 5N / 0.20 m • spring B obeys Hooke's law until 4N / 0.32 m • up to the elastic limit both springs obey Hooke's law • after the elastic limit both springs are permanently deformed **AO3.2b Analyse and draw conclusions from the graphs to describe the behaviour of both springs** For example: • spring A has a higher spring constant • spring B has a lower spring constant • both springs have a linear section • both springs have a non-linear section • more work is done stretching spring A up to elastic limit • less work is done stretching spring B up to elastic limit • breaking force comparison **AO3.1b Evaluate the graphs using data and calculations** For example • spring A has a spring constant of 25N/m • spring B has a spring constant of 12.5 N/m • attempt at calculating the work done in stretching the springs, using $E = ½\ k\ x^2$ or $E = ½\ Fx$ in specific regions

Question			Answer	Marks	AO element	Guidance
			0 marks *No response or no response worthy of credit.*			**AO2.2 Apply understanding of the shape of the graphs to explain the behaviour of the springs** For example • up to the elastic limit both springs exhibit elastic behaviour • after the elastic limit Hooke's law is not obeyed • up to the elastic limit the extension is reversible • after the elastic limit the extension is plastic • plastic deformation cannot to reversed • linear section demonstrates Hooke's law being obeyed

Question			Answer	Marks	AO element	Guidance
20	(a)		**Any two from:** the magnet will exert a force on the wire ORA OR the wire will move ✓ (current in the wire) creates a magnetic field ✓ the magnetic fields of the magnet and wire interact / AW✓	**2**	1.2 x 2	 **ALLOW** attracted / repelled for force
	(b)		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 0.12 (T) award 3 marks** (F = BIL) B = F / (IL) ✓ = 0.15 / (5.0 x 0.25) ✓ = 0.12 (T) ✓	**3**	 1.2 2.1 2.1	
	(c)	(i)	**Maximum two from:** Both rotate (on an axis) ✓ Both have a (fixed) magnet surrounding a coil / AW ✓ **Maximum two from:** In the motor energy is transferred from the electrical energy store to the kinetic energy store ✓ In the generator energy is transferred from the kinetic energy store to the electrical energy store ✓ In the motor the current (and magnetic field) causes motion ✓	**3**	1.1 x 3	 **IGNORE** Thermal energy store **IGNORE** Thermal energy store

Question			Answer	Marks	AO element	Guidance
			In the generator motion (and magnetic field) causes current (in the wire) ✓ (the generator) has slip rings and the (motor) a split ring commutator ✓			
		(ii)	Alternator output is <u>alternating current</u> / <u>a.c.</u> ✓ Dynamo output is <u>direct current</u> / <u>d.c</u>. ✓	**2**	1.1 x 2	

Question			Answer	Marks	AO element	Guidance
21	(a)	(i)	The effort force is further from the pivot ✓ The effort force has to move further ✓	2	1.1 x 2	
		(ii)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 650 (N) award 4 marks** Moment = force x (perpendicular) distance (from pivot) ✓ Clockwise moment = anticlockwise moment ✓ 0.2F = 100 x 1.3 or F = 130 / 0.2 ✓ F = 650 (N) ✓	4	 1.2 1.2 2.1 2.1	 **ALLOW** in any form e.g. 100 x 1.3, 130 (N), F x 0.2
	(b)	(i)	The force of the mug on the table ✓ The force of the table on the mug ✓	2	1.1 x 2	**ALLOW** gravity / force due to gravity / gravitational force **ALLOW** normal contact force
		(ii)	Upwards force arrow and downwards force arrow ✓ Arrows drawn of equal length ✓ Upwards force arrow labelled normal contact force and downwards force arrow labelled weight ✓ Arrows drawn of equal length ✓	3	1.1 2.1 1.1	**DO NOT ALLOW** more than two arrows **ALLOW** gravity / force due to gravity / gravitational force

Question			Answer	Marks	AO element	Guidance
22	(a)		direction / displacement is changing / AW ✓	1	1.1	
	(b)		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 50 (W) award 3 marks** Power = energy / time ✓ 3000 / 60 ✓ 50 (W) ✓	3	 1.2 2.1 2.1	
	(c)		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 10 (s) award 3 marks** (Rearrangement) t = change in velocity / a ✓ t = (1-5) / (-0.4) ✓ t = 10 (s) ✓	3	 1.2 2.1 2.1	 **IGNORE** negative signs

Question			Answer	Marks	AO element	Guidance
23	(a)		**Any four from:** Increase in temperature is because driving does work (on the tyre) / energy transfer (to molecules) due to friction (between tyre and road) ✓ (Higher temperature means) higher (average) speed of the gas molecules ✓ More (frequent) collisions <u>with the walls / sides (</u>of the tyre) / <u>with the tyre</u>✓ Increase the force (over a certain area) ✓ A larger force over the same area increases the pressure / area✓	4	1 x 2.1 3 x 1.1	**ALLOW** particles / atoms for molecules **ALLOW** higher <u>kinetic</u> energy
	(b)		**Mistake:** (The thickness of the atmosphere is) large (compared to the diameter of the Earth) ✓ **Correction linked to correct mistake:** (The thickness of the atmosphere is very) small / AW (compared to the diameter of the Earth) ✓	2	3.2a 2.1	

Question			Answer	Marks	AO element	Guidance
24	(a)		A sensible curve drawn from (0,0) ✓	1	2.2	**DO NOT ALLOW** a straight line
	(b)		As current increases, power increases ✓ **But** As current increases power increases at a faster / increasing rate ✓✓	2	2 x 3.1a	**ALLOW** As power increases, current increases **DO NOT ALLOW** Power is (directly) proportional to current squared (since the data does not support this proposal) for the second mark
	(c)		Current read-off to less than half a small square from candidate's graph for a power of 3.0 W ✓	1	2.2	
	(d)		Any sensible reference to $P=I^2R$ / $P=IV$ and $R=V\div I$✓ One calculation of resistance from graph ✓ Second calculation of resistance from the graph and conclusion drawn (showing increase) ✓	3	1.2 2.2 3.2b	**ALLOW** ECF from candidate's line Numerical examples using plotted data points: 0.9W and 0.10A: $0.9\div0.10^2 = 90\Omega$ 2.2W and 0.15A : $2.2\div0.15^2 = 98\Omega$ 4W and 0.20A: $4\div0.20^2 = 100\Omega$ 7W and 0.25A: $6\div0.25^2 = 112\Omega$ 11W and 0.30A: $11\div0.30^2 = 122\Omega$

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