

GCSE (9–1)

Physics A (Gateway Science)

J249/03: Paper 3 (Higher 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).

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

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

Question			Answer	Marks	AO element	Guidance
16	(a)	(i)	(Ruler has) equal numbers of protons and electrons / ORA ✓ So (effects of positive charges and negative charges) cancel out / AW / ORA ✓	2	2 x 1.1	ALLOW equal numbers of positive and negative charges/opposite charges / ORA ALLOW ruler has not lost/gained electrons / ORA ALLOW ruler is/atoms are neutral unless there is a loss/gain of electrons / ORA ALLOW if the ruler had been charged, movement of electrons (to/from the air) would discharge it ALLOW overall/net charge is zero/neutral / ORA IGNORE just charge is neutral
		(ii)	Electrons are transferred (from/to the ruler or from/to the cloth) / ORA ✓ And any one from: Charges are no longer equal / AW ✓ Different numbers of protons and electrons / AW ✓ Effects no longer cancel out / AW ✓	2	2 x 1.1	ALLOW electrons are lost/gained DO NOT ALLOW protons/positive charges move ALLOW ruler becomes negative/positive with correct movement of electrons ✓✓
	(b)	(i)	They must be opposite/unlike charges / one is positive and one is negative / one is a proton and one is an electron ✓ And any two from: They are being attracted ✓ The arrows show a force on the positive (charge)/(charge) B ✓ Forces/field (lines) go from positive to negative ✓ (Charge) A is negative AND (charge) B is positive ✓	3	3 x 1.2	ALLOW A is positive and B is negative for this mark only ALLOW forces/field (lines) go from B to A ALLOW maximum of 1 mark if described as opposite poles / positive and negative poles

Question		Answer	Marks	AO element	Guidance
	(ii)	<p>Any one from:</p> <p>North and South (poles) (replace positive and negative charges) ✓</p> <p>The arrows/field lines go from North to South (as opposed to positive to negative) ✓</p> <p>They have similar shape field (patterns) ✓</p> <p>Closeness of field lines represents strength of field (in each case) ✓</p> <p>Opposite <u>poles</u> (and opposite charges) attract ✓</p> <p>Both show direction of field (lines)/forces ✓</p>	1	1.1	
	(c)	<p>FIRST CHECK THE ANSWER ON ANSWER LINE</p> <p>If answer = 5(.00) (C) award 3 marks</p> <p>(Rearrange equation) (charge =) energy transferred / potential difference ✓</p> <p>(charge =) $200 / 40$ ✓</p> <p>(charge =) 5 (C) ✓</p>	3	1.2 2.1 2.1	

Question		Answer	Marks	AO element	Guidance
17	(a)	Tape measure / metre rule(r)/stick AND Stop clock/watch ✓	1	1.2	IGNORE just ruler ALLOW light gates
	(b) (i)	Mean = 2(.00) ✓ Median = 2.02 ✓ Mode = 2.08 ✓	3	1.2 x 3	ALLOW 2.04 for mean (for ignoring 1.84) ALLOW 2.06 for median if 2.04 calculated for the mean
	(ii)	(They have a) wide spread/range / AW ✓	1	3.2a	ALLOW (they are) not all close together / don't have a small difference / not similar / AW ALLOW they are too different / have a big gap / not concordant / 0.24 gap / attempt 1 is very different / AW IGNORE not consistent
	(iii)	Improvement must be linked to error Error: Reaction time / difficulty in starting/stopping timer at exact time / AW ✓ Improvement: Video/record the drop (and replay using timings from the recording) / use an electronic timing method / use light gates / AW ✓ OR Error: Not dropping ball from exact height / AW Improvement: Indication of marking the point from where the ball should be dropped from / AW	2	3.3b 3.3a	Marks can be awarded for errors/improvements in either section IGNORE difficulty in timing without a reason IGNORE human error unless qualified ALLOW use larger distances (so that % error in time is reduced)

Question		Answer	Marks	AO element	Guidance
18	*	<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) Detailed explanation about why speed and velocity are different from each other AND Calculations of speed and velocity completed and are correct</p> <p><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) Detailed explanation about why speed and velocity are different from each other AND Calculation of speed OR velocity completed and is correct OR both equations stated/implied</p> <p>OR</p> <p>Explanation about why speed and velocity are different from each other AND Calculations of speed and velocity completed and are correct</p> <p><i>There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.</i></p>	6	1.1x4 2.1x2	<p>AO1.1 Demonstrate knowledge and understanding of the difference between speed and velocity For example:</p> <ul style="list-style-type: none"> • speed is a scalar • velocity is a vector • speed has magnitude only • velocity has magnitude and direction • speed depends on distance • velocity depends on displacement • speed is rate of change of distance • velocity is rate of change of displacement <p>AO1.2 Recall of speed and velocity equations</p> <ul style="list-style-type: none"> • speed = distance / time • velocity = displacement / time <p>AO2.1 Apply knowledge and understanding of calculating speed and velocity For example:</p> <ul style="list-style-type: none"> • speed = 3.0 / (0.5x60) • speed = 0.10 (m/s) • velocity = 0.6 / (0.5x60) • velocity = 0.02 (m/s)

Question	Answer	Marks	AO element	Guidance
	<p>Level 1 (1–2 marks) Explanation about why speed and velocity are different from each other. OR Calculation of speed or velocity completed and is correct OR Both equations stated/implied</p> <p><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>			

Question		Answer	Marks	AO element	Guidance
19	(a)	<p>(Circuit) A - the total resistance is half the value of one of the resistors / less than the smallest resistor value ✓</p> <p>(Circuit) B - the total resistance is double the value of one of the resistors / adding the two resistances together ✓</p>	2	2x2.1	<p>Assume answer refers to circuit A unless indicated otherwise</p> <p>ALLOW (Circuit A) is parallel and has 2 loops/paths (for the current to flow through) / AW ALLOW higher level response i.e. correct equation for resistors in parallel</p> <p>ALLOW (Circuit) B is series and has only 1 loop/path (for the current to flow through) / AW</p> <p>ALLOW maximum of 1 mark for (circuit) A is parallel/has two loops/paths and (circuit) B is series/has one loop/path</p>
	(b)	(i)	2	2x1.1	<p>ALLOW atoms/particles/molecules for ions</p> <p>Any two from: (more current means) ions vibrate more / AW ✓ (more current means) more electrons collide with ions (in the lattice) / AW ✓ (more collisions mean) harder for electrons to pass (through wire/lamp) / AW ✓ (which) increases temperature (and therefore resistance) / AW ✓</p> <p>ALLOW (lamp) heats up / high(er) temperature</p>
		(ii)	2	2x2.2	<p>Lamp, cell, ammeter and variable resistor in series ✓</p> <p>Voltmeter in parallel with the lamp ✓</p> <p>IGNORE voltmeter in series for this mark</p> <p>ALLOW voltmeter in parallel with ammeter and lamp but not variable resistor</p>

Question		Answer	Marks	AO element	Guidance
	(iii)	Measure current and potential difference/voltage ✓ Any two from: Change current/variable resistor/pd (value) ✓ Take at least 3 sets of different V and I readings ✓ Calculate the resistance using V/I or using the current and pd values / plot a graph of V against I ✓	3	3x1.2	ALLOW take readings on ammeter and voltmeter IGNORE repeating same V and I readings ALLOW graph of I against V / graph of I against R

Question			Answer	Marks	AO element	Guidance
20	(a)	(i)	<p>FIRST CHECK THE ANSWER ON ANSWER LINE If answer = $0.001 / 1 \times 10^{-3} \text{ (m}^3\text{)}$ award 2 marks</p> <p>$0.1 \times 0.1 \times 0.1 \checkmark$ $= 0.001 / 1 \times 10^{-3} \text{ (m}^3\text{)} \checkmark$</p>	2	2x2.2	
		(ii)	<p>Density = mass/volume / density is proportional to mass \checkmark</p> <p>(Cube B has 10 x mass of cube A, so) density of cube B is 10 x density of cube A \checkmark</p>	2	1.2 2.2	<p>ALLOW density is 10 times larger ALLOW numerical values used to show density of cube B is 10 x density of cube A</p>
	(b)		As temperature increases, density decreases / ORA \checkmark	1	3.1a	IGNORE negative correlation / inversely proportional
	(c)		Particles (in solid) are close(r) together / (more) compact / ORA / AW \checkmark	1	1.1	Assume answer refers to a solid unless indicated otherwise
	(d)		<p>Any three from:</p> <p>Boat has bigger upthrust/buoyancy force (compared to weight of lump) / ORA / AW \checkmark</p> <p>Upthrust on boat is equal to weight of boat / resultant force is zero / AW \checkmark</p> <p>Weight of water displaced by the boat is equal to the weight of the boat / AW \checkmark</p> <p>(Overall) density of the boat includes the air / ORA / AW \checkmark</p> <p>(Overall) density of the boat (and air) is less than the density of the water / ORA / AW \checkmark</p>	3	3x2.1	<p>ALLOW upthrust on lump is less than weight of lump / there is a resultant force (acting downwards)</p> <p>ALLOW weight of water displaced by lump is less than weight of lump / AW</p> <p>ALLOW hollow for air</p> <p>ALLOW maximum of 1 mark for boat is hollow / contains air / ORA / AW</p>

Question		Answer	Marks	AO element	Guidance	
21	(a)	<p>Mistake 1: Unit for acceleration is missing ✓ Correction 1: Unit should be m/s/s or m/s² or ms⁻² ✓</p> <p>Mistake 2: Acceleration at 3.0 N is only recorded to 1 significant figure ✓ Correction 2: Acceleration should be recorded to 2 significant figures /4.0 (m/s²) ✓</p>	4	<p>3.2a 3.3b</p> <p>3.2a 3.3b</p>	<p>ALLOW sig. fig. for d.p. throughout ALLOW answers in any order</p> <p>ALLOW include units for acceleration</p> <p>ALLOW not recorded to 1 decimal place (like the others) ALLOW should be recorded to 1 d.p./same number of d.p.</p>	
	(b)	(i)	1	2.2	Point correctly plotted at (5.7 m/s ² , 4N) within ½ a small square ✓	
		(ii)	2	2x3.1a	<p>Force is (directly) proportional to acceleration ✓✓</p> <p>OR</p> <p>Maximum of one mark from:</p> <p>Linear relationship (through the origin)✓</p> <p>As force increases, acceleration increases / ORA ✓</p>	<p>ALLOW (directly) proportional to each other / they are (directly) proportional</p> <p>ALLOW $y = mx + c$, $c = 0$ so $y = mx$</p> <p>IGNORE positive correlation</p>
		(iii)	2	<p>2.2</p> <p>2.2</p>	<p>FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.7, 0.71 or 0.72 (kg) award 2 marks</p> <p>Change in y / change in x or 5(.0)/7(.0) ✓</p> <p>(mass =) 0.7(0) / 0.71 / 0.72 (kg) ✓</p> <p>ALLOW eg 4.3/6.0, 4.0/5.6 etc. to within +/- ½ small square</p>	

Question			Answer	Marks	AO element	Guidance
						ALLOW other answers between 0.65 and 0.75 only if workings shown using correct values read from the graph to within $\pm \frac{1}{2}$ small square ✓✓
		(iv)	<p>Any two from:</p> <p>Not all of the energy is transferred to the trolley / energy is transferred/lost to other stores</p> <p>It assumes all of the force on the trolley is equal to the weight added on the string ✓</p> <p>Friction on the pulley / between the wheels and the surface ✓</p> <p>Mass of the string/card is ignored ✓</p> <p>The card on the trolley was not measured properly ✓</p> <p>The card on the trolley did not pass through the light gates vertically/at 90° ✓</p>	2	2x3.2a	<p>ALLOW energy is transferred/lost to the surroundings/due to friction/air resistance ✓</p> <p>ALLOW table is not smooth / friction in the wheels</p>

Question		Answer	Marks	AO element	Guidance
	(v)	<p>Any two from:</p> <p>Compensate for/reduce friction, e.g. by raising the ramp / use a linear air-track / oil/grease pulley ✓</p> <p>Repeat the experiment and calculate the mean ✓</p> <p>Measure the acceleration between two points which are further apart ✓</p> <p>Use different equipment (to check if it produces similar results) ✓</p> <p>Use equipment with higher resolution/precision ✓</p> <p>Use string/card with less mass/weight ✓</p>	2	2x3.3b	<p>ALLOW repeat to remove/identify anomalies</p> <p>ALLOW use lighter string/card / subtract mass of card/string (from measurements)</p> <p>ALLOW use a pulley with less mass to reduce energy wasted when turning pulley / AW</p>
	(c) (i)	Gravitational (potential energy store) to kinetic (energy store) ✓	1	2.1	<p>ALLOW kinetic (energy store) to thermal (energy store) / gravitational (potential energy) to thermal (energy)</p> <p>ALLOW KE for kinetic energy / GPE for gravitational (potential) energy / heat for thermal</p> <p>IGNORE just potential energy / PE</p>
	(ii)	<p>FIRST CHECK THE ANSWER ON ANSWER LINE</p> <p>If answer = 2.6 (J) award 4 marks</p> <p>86cm = 0.86 m ✓</p> <p>(Work done =) $3(.0) \times 0.86$ ✓</p> <p>(Work done =) 2.58 (J) ✓</p> <p>(Work done =) 2.6 (J) ✓</p>	4	<p>1.2</p> <p>2.1</p> <p>2.1</p> <p>1.2</p>	<p>ALLOW ecf for missing or incorrect unit conversion e.g. 260 (J) for 3 marks, 258 (J) for 2 marks</p>

Question		Answer	Marks	AO element	Guidance
22	(a)	<p>FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 1260 or 1300 (Nm) award 4 marks</p> <p>(Force = $70 \times 10 =$) 700 (N) ✓ (Moment =) force x distance ✓ (Moment =) 700×1.8 ✓ (Moment =) 1260 (Nm) ✓</p>	4	2.1 1.2 2.1 2.1	<p>ALLOW ecf for using mass not weight e.g. 3 marks for an answer of 126 (Nm), 2 marks for 70×1.8 ALLOW ecf for incorrect calculation of force ALLOW ecf for converting 1.8m to 180cm e.g. 3 marks for 126 000 (Nm)</p>
	(b)	<p>FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 8 (m/s) award 4 marks</p> <p>$u = 0$ or $v^2 = (u^2 +) 2as$ ✓ $v^2 = 2 \times 10 \times 3.2$ or $v = \sqrt{(2 \times 10 \times 3.2)}$ ✓ $v^2 = 64$ ✓ $v = 8$ (m/s) ✓</p> <p>OR alternative method:</p> <p>$mgh = \frac{1}{2} mv^2$ ✓ $(70 \times) 10 \times 3.2 = \frac{1}{2} (x 70) \times v^2$ ✓ $64 = v^2$ ✓ $v = 8$ (m/s) ✓</p>	4	1.2 2.1 2.1 2.1	<p>$v^2 - u^2 = 2as$ does not score a mark</p>

Question		Answer	Marks	AO element	Guidance
23	(a)	<p>FIRST CHECK THE ANSWERS ON ANSWER LINES If answer = 385 (J/kg°C) AND material = zinc award 5 marks</p> <p>$c = (E / m\theta)$ ✓ $(\theta = 900 - 420 =) 480$ (°C) ✓ $(c =) 462000 / (2.5) \times 480$ ✓ $(c =) 385$ (J/kg°C) ✓</p> <p>(substance is) zinc ✓</p>	5	<p>1.2 2.2 2.2 2.2</p> <p>3.2b</p>	<p>ALLOW ecf for missing or incorrect unit conversion e.g. 0.385 (J/kg°C) for 3 marks</p> <p>(E = mcθ does not score a mark)</p> <p>ALLOW ecf for closest material to the answer calculated for shc if answer is incorrect. IGNORE another material quoted with its value from the table given as the answer unless workings shown</p>
	(b)	<p>Any two from: Not all substances are shown in the table / it could be a substance not in the table ✓</p> <p>Named uncertainties/errors in the experiment ✓</p> <p>It assumes all of the energy went to heat the material ✓</p> <p>The value is (very) close to other values ✓</p> <p>It assumes the substance is pure/not a mixture ✓</p>	2	2x3.1b	<p>ALLOW there could be more than one substance with the same shc</p> <p>ALLOW assumes no energy transferred to other stores / no energy/heat loss</p> <p>ALLOW ecf from 23(a)</p> <p>ALLOW maximum of 1 mark for idea of results not repeated/reproduced</p>

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