H

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.

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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

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Question			Answer	Marks	AO element	Guidance
		(ii)	**Any one from:** North and South (poles) (replace positive and negative charges) ✓ The arrows/field lines go from North to South (as opposed to positive to negative) ✓ They have similar shape field (patterns) ✓ Closeness of field lines represents strength of field (in each case) ✓ Opposite <u>poles</u> (and opposite charges) attract ✓ Both show direction of field (lines)/forces ✓	1	1.1	
	(c)		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 5(.00) (C) award 3 marks** (Rearrange equation) (charge =) energy transferred / potential difference ✓ (charge =) 200 / 40 ✓ (charge =) 5 (C) ✓	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	*		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)** Detailed explanation about why speed and velocity are different from each other **AND** Calculations of speed **and** velocity completed and are correct *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)** 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 **OR** Explanation about why speed and velocity are different from each other **AND** Calculations of speed **and** velocity completed and are correct *There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.*	6	1.1x4 2.1x2	**AO1.1 Demonstrate knowledge and understanding of the difference between speed and velocity** For example: • 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 **AO1.2 Recall of speed and velocity equations** • speed = distance / time • velocity = displacement / time **AO2.1 Apply knowledge and understanding of calculating speed and velocity** For example: • 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
			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 *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.*			

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

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)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 0.001 / 1x10^{-3} (m^3) award 2 marks** 0.1 x 0.1 x 0.1 ✓ = 0.001 / 1x10^{-3} (m^3) ✓	2	2x2.2	
		(ii)	Density = mass/volume / density is proportional to mass ✓ (Cube B has 10 x mass of cube A, so) density of cube B is 10 x density of cube A ✓	2	1.2 2.2	**ALLOW** density is 10 times larger **ALLOW** numerical values used to show density of cube B is 10 x density of cube A
	(b)		As temperature increases, density decreases / ORA✓	1	3.1a	**IGNORE** negative correlation / inversely proportional
	(c)		Particles (in solid) are close(r) together / (more) compact / ORA / AW✓	1	1.1	Assume answer refers to a solid unless indicated otherwise
	(d)		**Any three from:** Boat has bigger upthrust/buoyancy force (compared to weight of lump) / ORA / AW ✓ Upthrust on boat is equal to weight of boat / resultant force is zero / AW ✓ Weight of water displaced by the boat is equal to the weight of the boat / AW✓ (Overall) density of the boat includes the air / ORA /AW✓ (Overall) density of the boat (and air) is less than the density of the water / ORA / AW ✓	3	3x2.1	**ALLOW** upthrust on lump is less than weight of lump / there is a resultant force (acting downwards) **ALLOW** weight of water displaced by lump is less than weight of lump / AW **ALLOW** hollow for air **ALLOW** maximum of 1 mark for boat is hollow / contains air / ORA / AW

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

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 +/- ½ small square ✓✓
		(iv)	**Any two from:** Not all of the energy is transferred to the trolley / energy is transferred/lost to other stores It assumes all of the force on the trolley is equal to the weight added on the string ✓ Friction on the pulley / between the wheels and the surface ✓ Mass of the string/card is ignored ✓ The card on the trolley was not measured properly✓ The card on the trolley did not pass through the light gates vertically/at 90˚ ✓	**2**	**2x3.2a**	**ALLOW** energy is transferred/lost to the surroundings/due to friction/air resistance ✓ **ALLOW** table is not smooth / friction in the wheels

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

Question			Answer	Marks	AO element	Guidance
22	(a)		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 1260 or 1300 (Nm) award 4 marks** (Force = 70 x 10 =) 700 (N) ✓ (Moment =) force x distance ✓ (Moment =) 700 x 1.8 ✓ (Moment =) 1260 (Nm) ✓	4	 **2.1** **1.2** **2.1** **2.1**	**ALLOW** ecf for using mass not weight e.g. 3 marks for an answer of 126 (Nm), 2 marks for 70 x 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)
	(b)		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 8 (m/s) award 4 marks** u = 0 **or** v^2 = (u^2 +) 2as ✓ v^2 = 2 x 10 x 3.2 or v = √(2 x 10 x 3.2) ✓ v^2 = 64 ✓ v = 8 (m/s) ✓ **OR alternative method:** mgh = ½ mv^2 ✓ (70 x) 10 x 3.2 = ½ (x 70) x v^2 ✓ 64 = v^2 ✓ v = 8 (m/s) ✓	4	 **1.2** **2.1** **2.1** **2.1**	$v^2 - u^2$ = 2as does not score a mark

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

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