

GCSE (9–1)

Physics A (Gateway Science)

J249/04: Paper 4 (Higher Tier)

General Certificate of Secondary Education

Mark Scheme for June 2019

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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 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

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.

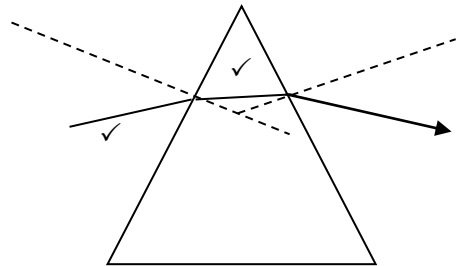
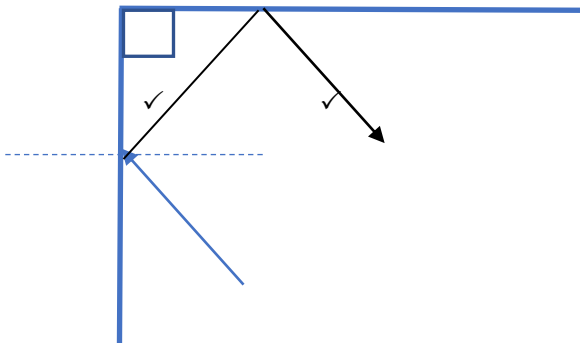
For answers to Section A if an answer box is blank ALLOW correct indication of answer e.g. circled or underlined.

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

Question			Answer	Marks	AO element	Guidance
16	(a)		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.8 (kWh) award 3 marks Recall (Energy transferred =) power x time ✓ 0.2×4 ✓ (Energy =) 0.8 (kWh) ✓	3	1.2 2.1 2.1	ALLOW correct equation in any form ALLOW 200×4 or $200 \times 4 \times 60 \times 60$ or 200×14400 or $200 \times 4 \times 60$ or $0.2 \times 4 \times 60 \times 60$ or 0.2×14400 or $0.2 \times 4 \times 60$ for one mark ALLOW 800 or 2 880 000 or 2880 or 48 000 or 48 for two marks
	(b)		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 38.28 (W) award 3 marks Recall (Power =) potential difference x current ✓ 12×3.19 ✓ (P =) 38.28 (W) ✓	3	1.2 2.1 2.1	ALLOW correct equation in any form ALLOW 38.3 (W) or 38 (W)

Question			Answer	Marks	AO element	Guidance
17	(a)		As speed increases, (thinking) distance increases / ORA ✓ BUT (thinking) distance is (directly) proportional to speed / as speed doubles, (thinking) distance doubles / linear relationship through the origin ✓ ✓	2	3.1a 3.2b	ALLOW numerical values from graph, e.g. at 15 (m/s), td = 10m but at 30 (m/s) td = 20(m). ALLOW numerical values from graph, e.g. at 15 (m/s), td = 10 (m) but at 30 (m/s) td = 2×10 = 20 (m) for 2 marks
	(b)	(i)	16 (m) ✓	1	3.1a	
		(ii)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.67 (s) award 3 marks Rearrangement to give Time = distance / speed ✓ Time = 16 / 24 ✓ Time = 0.67 (s) (2 decimal places) ✓	3	1.2 2.1 2.1	ALLOW ECF from (b)(i) ALLOW 0.6 or 0.7 or 0.66(6...) (s) for 2 marks ALLOW one mark for any calculated answer to 2dp
	(c)	(i)	(Driver under influence of) alcohol / drugs / tired / (named) distraction / ill / <u>old</u> -age / intoxication / high(er) speed ✓	1	1.1	IGNORE just age ALLOW increase in driver's reaction time
		(ii)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 26 (m) award 2 marks (Stopping distance =) braking (distance) + thinking (distance) OR 16 OR 10 ✓ (sd =) 26 (m) ✓	2	2×2.2	

Question			Answer	Marks	AO element	Guidance
	(d)		Maximum 2 marks from: Higher speed increases braking distance ✓ BUT Double speed quadruples braking distance / braking distance is (directly) proportional to the speed squared AW ✓✓ Maximum 2 marks from: (Idea that) higher speed (car has) more KE ✓ BUT Double speed quadruples KE / KE is (directly) proportional to the speed squared / AW ✓✓	3	2.1 3.1a x2 2.1 3.1a x2	ALLOW numerical values from graph, e.g. at 10 (m/s), bd = 7.5 (m) but at 20 (m/s) bd = 30 (m). ALLOW numerical values from graph, e.g. at 10 (m/s), bd = 7.5 (m) but at 20 (m/s) bd = 4×7.5 (= 30m) for 2 marks

Question			Answer	Marks	AO element	Guidance
18	(a)		Diagram showing correct refractions 	2	2×1.2	If diagram is incorrect, maximum of one mark from: any rising line in air before the prism ✓ a line in the prism close to horizontal by eye and joining the exit ray ✓ IGNORE any arrows on rays
	(b)			2	2×1.2	One mark for each correct reflection of about 90° by eye IGNORE any arrows on rays
	(c)	(i)	(Filter X lets through) red, orange and yellow ✓	1	3.2b	DO NOT ALLOW any extra colours
		(ii)	(Filter Y absorbs) orange and yellow ✓	1	3.2b	DO NOT ALLOW any extra colours
	(d)	(i)	Any one from: Red (wall) absorbs all colours (in the light except red) ✓ (The wall) only reflects red light ✓	1	2.1	ALLOW there is no red in the coloured light to reflect / AW ALLOW (wall) cannot reflect other colours (of light)

Question			Answer	Marks	AO element	Guidance
		(ii)	Any two from: green ✓ blue ✓ indigo ✓ violet ✓ cyan ✓	1	2.1	DO NOT ALLOW orange / yellow / magenta
	(e)	(i)	Ray of green light focused between lens and F_R ✓	1	1.2	
		(ii)	green has shorter wavelength or higher frequency (than red) / shorter wavelengths refract more / show a larger change in speed / green light slows down more (than red light) / AW / ORA ✓	1	2.1	IGNORE green (light) refracts more IGNORE just green (light) slows down
		(iii)	long sighted ✓ (Because lens is) convex/focusing/converging ✓	2	3.1a 3.2b	Mark independently

Question			Answer	Marks	AO element	Guidance
19	(a)	(i)	Neutron(s) ✓	1	1.1	IGNORE gamma
		(ii)	Any one from: Gravity ✓ (very) high temperatures ✓ high pressure ✓	1	1.1	ALLOW (high) gravitational field strength ALLOW hot (temperatures) / lots of heat IGNORE just heat
	(b)	(i)	Any one from: Both produce energy ✓ Both convert mass to energy / have a “loss” in mass ✓ Both produce neutrons ✓	1	1.1	
		(ii)	Any one from: In fusion nuclei join / in fission nuclei split/decay/break up / AW ✓ fusion occurs at higher temperatures or pressures / fission occurs at lower temperatures or pressures ✓ larger/heavier nucleus forms in fusion / smaller/lighter/daughter nuclei forms in fission ✓ more energy released in fusion / less energy released in fission ✓ fission causes a chain reaction / fusion does not cause a chain reaction ✓ fusion does not produce (radioactive) waste / fission does produce radioactive waste ✓	1	1.1	ALLOW atom IGNORE molecules / particles / ions ALLOW only fission reactors are used at present to produce electricity

Question			Answer	Marks	AO element	Guidance
	(c)		Advantage - Any one from: no carbon dioxide produced / does not contribute to global warming/climate change/acid rain / no polluting gases ✓ small quantities of fuel needed / (idea of) more energy per unit mass ✓ fuel readily available ✓ will not run out as fast (as fossil fuels) ✓ to preserve fossil fuels ✓ Disadvantage - Any one from: Radioactive/nuclear waste produced ✓ security of transport of fuel / waste ✓ expensive to build ✓ danger of exposure to radiation ✓ decommissioning is expensive ✓ risk of accident (and after-effects)/uncontrollable (chain reaction) ✓ non-renewable ✓	2	2×1.1	ALLOW a named polluting gas IGNORE (idea of) ozone layer ALLOW (idea of) risk from terrorists ALLOW (idea of) explosion IGNORE just dangerous

Question			Answer	Marks	AO element	Guidance
20	(a)		A.C. (transmitted in power lines) / (electrical/electron/particle) oscillations / AW ✓ BUT Alternating currents/(electrical/electron/particle) oscillations produce (radio) waves/electromagnetic radiation ✓✓	2	2×1.1	
	(b)		(High voltage means) lower current ✓ Less heating/heat loss/power loss/energy wasted or more useful energy transmitted / ORA ✓	2	2×1.1	IGNORE no energy losses / prevent energy loss / AW ALLOW more efficient / (wires at) lower temperature
	(c)		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 20 (A) award 5 marks Recall $I^2 = P / R$ ✓ 6.156 kW = 6156 W ✓ ($I^2 =$) 6156 / 15.39 OR ($I^2 =$) 400 ✓ ($I =$) $\sqrt{400}$ ✓ ($I =$) 20 (A) ✓	5	1.2 2.1 2.1 2.1 2.1	ALLOW correct equation in any form DO NOT ALLOW marks to be awarded from incorrect equation e.g. $I = P / R$ Award marks if 6.156kW has not been correctly converted to W E.g. ($I^2 =$) 0.4 or 6.156/15.39 ✓✓ ($I =$) $\sqrt{0.4}$ ✓✓✓ $I = 0.63$ ✓✓✓✓

Question			Answer	Marks	AO element	Guidance
21	(a)	(i)	Area (under line) for thinking (distance) is same as for braking (distance) / area under horizontal line = area under diagonal line / area of rectangle = area of triangle / AW ✓	1	3.1a	ALLOW both areas show 4(m)
		(ii)	A line starting at (0.75, 8) ✓ Diagonal line drawn parallel to original line and finishing at the x axis ✓	2	2×1.2	Mark independently
	(b)	(i)	(Idea of measuring) a length/distance on the ruler ✓	1	1.2	
		(ii)	Any one from: drop ruler from same height above hand ✓ (idea of) change the time taken before dropping the ruler each time ✓ make sure hand of catcher not moving / fingers are the same distance apart ✓	1	1.2	ALLOW suitable answers that refer to reducing named random or systematic errors e.g. measure from same place on the ruler (relative to hand) ALLOW (idea of driver Q being) unaware of when ruler is being dropped ALLOW repeat and calculate mean
	(c)	(i)	(Store of) KE (in moving car) ✓ (transferred thermally) to (store of) thermal energy / heat (in brakes/pads/discs/tyres) ✓	2	2×2.1	
		(ii)	Any one from: (Idea of) heat dissipated/transferred (to air) more quickly ✓ KE is reduced more quickly ✓	1	2.1	IGNORE to thermal energy of road/surroundings

Question	Answer	Marks	AO element	Guidance
22 *	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 description of the structure of the Earth AND Detailed explanation of the trends in Table 22.1. <i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i> Level 2 (3–4 marks) Description of the structure of the Earth. AND Explanation of the trends in Table 22.1. OR Detailed description of the structure of the Earth. OR Detailed explanation of the trends in Table 22.1. <i>There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.</i> Level 1 (1–2 marks) A basic description of the structure of the Earth. OR A basic description of the trends in Table 22.1. <i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.</i>	6	2×3.1a 2×3.2a 2×2.1	AO3.1a Analyse information and ideas to interpret some basic trends in data • density increases as depth increases • speed (of P/S waves) increases as density increases • speed (of P/S waves) increases as depth increases AO2.1 Apply knowledge and understanding of scientific ideas to explain trends in the data • Earth contains layers • velocity changes at a boundary • as density changes at a boundary • particles more tightly packed • P is longitudinal, S is transverse AO3.2a Analyse information and ideas to make judgements about the structure of the Earth • core has highest density • core has highest speed for P waves • S waves do not travel through the core • so the outer core is a liquid • pressure highest in core / $P = \rho gh$ • pressure and so density increase with depth • large change in density between mantle and outer core

Question			Answer	Marks	AO element	Guidance
			0 marks <i>No response or no response worthy of credit.</i>			

Question			Answer	Marks	AO element	Guidance
23	(a)		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 20 (minutes) then award 2 marks Evidence on graph or elsewhere of half of activity indicated ✓ (Half life =) 20 (minutes) ✓	2	2×2.2	ALLOW 19-21 (minutes) ✓✓
	(b)		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 128 (counts per minute) award 2 marks Evidence of halving /doubling using data ✓ (Activity =) 128 (counts per minute) ✓✓	2	2×2.2	e.g. time to go from 64 to 32 (cpm) is 30 (mins) / initial activity = 64×2 If answer is 105 to 127 or 129 to 136 then award a maximum of 1 mark ✓
	(c)		Conclusion 1 (incorrect) Any one from: Idea that activity is a random/unpredictable occurrence / AW ✓ Idea that low numbers of counts amplify relative variations / AW ✓ Conclusion 2 (incorrect) Any one from: (All radioactive isotopes) have a half-life / AW ✓ changes in activity will be small if half-life is long ✓	2	2×3.1b	ALLOW correct answers referring to background radiation/readings

Question			Answer	Marks	AO element	Guidance
24	(a)	(i)	Mean = $(0.28 + 0.32) = 0.30$ (s) ✓	1	1.2	ALLOW 0.3 (s) DO NOT ALLOW answers with all 3 readings used giving a mean of $(0.28+0.32+0.54) / 3 = 0.38$ (s)
		(ii)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 333 (m/s) award 4 marks Use of distance = 100 m ✓ Recall $(s =) d / t$ ✓ $100 / 0.3$ ✓ $(s =) 333$ (m/s) (3 sig. figs.) ✓	4	2.1 1.2 2.1 2.1	ALLOW ECF from 24(a)(i) ALLOW $100 \div 0.38$ ✓✓✓ ALLOW 263 (m/s) ✓✓✓✓ ALLOW ECF for 3 rd and 4 th marking points if incorrect distance is used ALLOW $50 \div 0.3$ or 166.7 ✓✓ ALLOW $50 \div 0.38$ or 131.6 ✓✓ ALLOW 132 ✓✓✓ ALLOW 167 ✓✓✓
		(iii)	Any two from: Inconsistent results should be repeated ✓ More readings of time should be done and the mean calculated ✓ (Explanation of) clap-echo method ✓ Larger/different distances used ✓	2	2×3.3b	Clap-echo method effectively may gain 2 marks as it also uses the idea of multiple readings.

Question			Answer	Marks	AO element	Guidance
	(b)		idea of 3 echoes/reflections/returning pulses (from each pulse) / AW✓ takes different times to travel (there and back) through different layers/distances/thicknesses / time (interval) between echoes is different/not regular / AW ✓ BUT the thicker the layer/the longer the distance, the bigger the time interval/takes longer to travel (there and back) / AW ✓✓	3	3×2.1	ALLOW (idea of measuring) the time taken for the wave to be reflected back (for different layers)

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