H

GCSE (9–1)

Physics A (Gateway Science)

J249/04: Paper 4 (Higher Tier)

General Certificate of Secondary Education

Mark Scheme for June 2019

OCR (Oxford Cambridge and RSA) is a leading UK awarding body, providing a wide range of qualifications to meet the needs of candidates of all ages and abilities. OCR qualifications include AS/A Levels, Diplomas, GCSEs, Cambridge Nationals, Cambridge Technicals, Functional Skills, Key Skills, Entry Level qualifications, NVQs and vocational qualifications in areas such as IT, business, languages, teaching/training, administration and secretarial skills.

It is also responsible for developing new specifications to meet national requirements and the needs of students and teachers. OCR is a not-for-profit organisation; any surplus made is invested back into the establishment to help towards the development of qualifications and support, which keep pace with the changing needs of today's society.

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.

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.

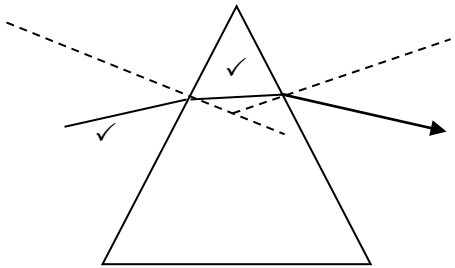
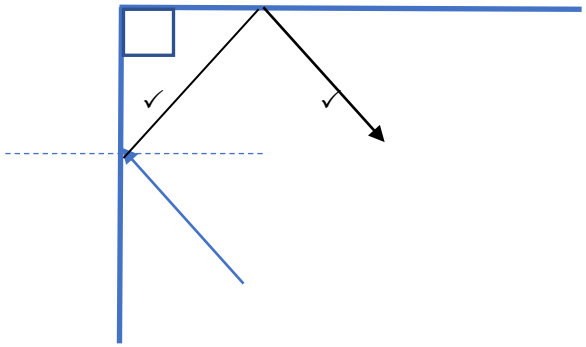
For answers to Section A if an answer box is blank ALLOW correct indication of answer e.g. circled or underlined.

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**	**3**		
			Recall (Energy transferred =) power x time ✓		**1.2**	**ALLOW** correct equation in any form **ALLOW** 200 x 4 or 200 x 4 x 60 x 60 or 200 x14400 or 200 x 4 x 60 or 0.2 x 4 x 60 x 60 or 0.2 x 14400 or 0.2 x 4 x 60 for one mark
			0.2 × 4 ✓		**2.1**	**ALLOW** 800 or 2 880 000 or 2880 or 48 000 or 48 for two marks
			(Energy =) 0.8 (kWh) ✓		**2.1**	
	(b)		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 38.28 (W) award 3 marks**	**3**		
			Recall (Power =) potential difference x current ✓		**1.2**	**ALLOW** correct equation in any form
			12 × 3.19 ✓		**2.1**	
			(P =) 38.28 (W) ✓		**2.1**	**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 =) √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=) √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.** 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)** 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.** 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 of the structure of the Earth. **OR** A basic description of the trends in **Table 22.1.** There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.	**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 No response or no response worthy of credit.			

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 ÷ 0.38 ✓✓✓ **ALLOW** 263 (m/s) ✓✓✓✓ **ALLOW ECF** for 3rd and 4th marking points if incorrect distance is used **ALLOW** 50 ÷ 0.3 or 166.7 ✓✓ **ALLOW** 50 ÷ 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)

OCR (Oxford Cambridge and RSA Examinations)
The Triangle Building
Shaftesbury Road
Cambridge
CB2 8EA

OCR Customer Contact Centre

Education and Learning
Telephone: 01223 553998
Facsimile: 01223 552627
Email: general.qualifications@ocr.org.uk

www.ocr.org.uk

For staff training purposes and as part of our quality assurance programme your call may be recorded or monitored

Oxford Cambridge and RSA Examinations
is a Company Limited by Guarantee
Registered in England
Registered Office; The Triangle Building, Shaftesbury Road, Cambridge, CB2 8EA
Registered Company Number: 3484466
OCR is an exempt Charity

OCR (Oxford Cambridge and RSA Examinations)
Head office
Telephone: 01223 552552
Facsimile: 01223 552553