OCR
Oxford Cambridge and RSA

GCSE (9-1)

Physics B (Twenty First Century)

Unit **J259H/04**: Higher Tier – Depth in physics

General Certificate of Secondary Education

Mark Scheme for June 2018

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 B:

	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.

Question			Answer	Marks	AO element	Guidance
1	(a)	(i)	As the illuminance increases, the change in resistance becomes less and less. (3rd option) ✓	1	1.2	
	(a)	(ii)	**FIRST CHECK THE ANSWER ON THE ANSWER LINE. If answer is between 14.0 & 16.0 (kΩ) award 2 marks** *R* (at 10 lux) = 20 (kΩ) **OR** *R* (at 70 lux) = {5 ± 1} (kΩ) ✓ Second *R* and ΔR = 20 (kΩ) – {5 ± 1}(kΩ) = 14.0 – 16.0 (kΩ) ✓	2	2.2 × 2	**ALLOW** + or – for ΔR as this is a decrease
	(b)	(i)	**FIRST CHECK THE ANSWER ON THE ANSWER LINE. If answer= 0.000 20(5)/2.0(5) x10 $^{-4}$ (A) award 3 marks** current = *V*/*R* ✓ = 4.5 (V) / 22 000 (Ω) ✓ = 0.000 20(5) / 2.0(5) x 10^{-4} (A) ✓	3	1.2 2.1 2.1	**IGNORE** significant figure errors or rounding errors **ALLOW** any form of equation for mp1 and mp 2 Incorrect *R* loses mp2 **ECF** own values but penalise for power of ten errors
	(b)	(ii)	**FIRST CHECK THE ANSWER ON THE ANSWER LINE. If answer = 2.0(5) (V) award 3 marks** Unit conversion 10 k(Ω) = 10000 (Ω) ✓ p.d. = 0.000 20(5) (A) × 10 000 (Ω) ✓ = 2.0(5) (V) ✓ **OR** p.d. = 4.5 (V) × {R/R_{total}} ✓ = 4.5 (V) × 10 000 (Ω) ÷ 22 000 (Ω) ✓ = 2.0(5) (V) ✓	3	1.2 1.2 2.1	**ECF** from (b)(i)

Question			Answer	Marks	AO element	Guidance
		(iii)	(As illuminance increases) resistance decreases /current increases ✓ p.d. (across 10 k Ω resistor) increases. ✓ Resistance changes get smaller / less as illuminance increases, so change in p.d. becomes smaller ✓	3	2.2 3.1a × 2	**ALLOW** potential divider argument for mp2 & mp3

Question			Answer	Marks	AO element	Guidance
2	(a)*		*Please refer to the marking instructions on page 5 of this mark scheme for guidance on how to mark this question.* **Level 3 (5–6 marks)** Correct calculation to check whether the value of SLH is greater than 2300 J/g **AND** specific evaluation / development. *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)** Correct calculation to check whether the value of SLH is greater than 2300 J/g **OR** Identifies at least one shortcoming of Sarah's experiment **OR** suggests at least one valid improvement. *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)** May attempt to use data to check statement **OR** Makes generic suggestion(s) to improve the procedure, e.g. repeat readings, use a more accurate balance. *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.*	**6**	**2.2 × 2** **3.1b × 2** **3.3a × 2**	**Indicative scientific points may include:** **AO2.2 Calculation of SLH** • P = 3.0 A × 12 V = 36 W • $\Delta E = Pt$ = 36 W × 150 s = 5400 J • Δm = {185.3 g – 184.3 g} = 1.0 g • $L = \Delta E/\Delta m$ = 5400 J/1.0 g = 5400 J/g **AO3.1b Evaluation of experiment** • Heat losses constitute the (most) significant shortcomings • Not all of heater in the water • Thermal energy will dissipate through sides and bottom of beaker • Thermal energy will dissipate from the water surface • Relatively low mass of water evaporated **AO3.3a Development of experimental procedure** • Ensure water level is above top of heater. • Surround beaker sides and bottom with insulating material • Cover top of beaker to limit convection losses (but still allow water vapour to escape) • Use higher powered heater to evaporate more water in the same time • Make sure water is boiling before starting measurements. • Longer time/higher current/voltage to evaporate more water.

Question			Answer	Marks	AO element	Guidance
	(b)		**Any three from:** Force between particles in water are stronger than those in alcohol / AW ✓ Bonds must be broken to change state ✓ (from table) *L* for alcohol < *L* for water ✓ Alcohol is more volatile than water ✓ Water is denser than alcohol ✓ Water molecules are smaller/closer together than alcohol molecules ✓ More molecules in 1g of water than in 1g of alcohol ✓ More intermolecular bonds to be broken ✓	**3**	**1.1** **1.1** **3.2a**	**ALLOW** atoms/molecules for particles

Question			Answer	Marks	AO element	Guidance
3	(a)	(i)	Alpha has A = 4 **AND** Z = 2 ✓ Uranium has A = 234 ✓ Uranium has Z = 92 ✓	3	1.2 × 3	**ALLOW ECF** **ALLOW ECF**
	(a)	(ii)	**FIRST CHECK THE ANSWER LINE.** **If answer = 1440 (W) award 3 marks** $P = E$ /t ✓ $= 1.6\times10^{15} \times 9.0\times10^{-13}$ (J) ✓ = 1400 / 1440 (W) (=approx 1500 W) ✓	3	1.2 2.1 2.1	In any form e.g. $E = Pt$
	(a)	(iii)	Correct $\Delta\theta$ = (37 – 20) °C (= 17 °C) ✓ $E = mc\Delta\theta$ = 100 (kg) × 4200 (J/kg °C) × 17 (°C) ✓ = 7 140 000 (J) ✓ $P = E/t \Rightarrow t = E/P$ ✓ = 7 140 000 (J)/1500 (W) = 4800 (s) (> 3600 s) ✓	5	1.2 2.1 2.1 1.2 2.2	**ECF** own value of P from (a)(ii) Using 1440 W gives 5100 (s) **ECF** incorrect E from mp3 **ORA** $P = E/t \Rightarrow$ 7 140 000 (J)/ 3600 (s) = ✓ $\Rightarrow t$ = 7 140 000 (J)/1500 (W) = 4800 (s) (> 3600 s)✓

Question			Answer	Marks	AO element	Guidance
	(b)	(i)	**FIRST CHECK THE ANSWER ON THE ANSWER LINE. If answer = 36 (days) award 4 marks** Driving time per day = 18 (kWh) / 5 (kW) = 3.6 (h) ✓ Distance / day of travel= 25 (km/h) × 3.6 (h)= 90 (km) ✓ Number of travelling days = 3200 (km)/90 (km) ✓ = 35.6 = 36 (days) ✓ **OR** Travelling time = 3200(km)/25(km/h) = 128 (hours) ✓ 128 hours at 5kW gives 128 × 5 = 640(kWh) needed from battery ✓ 18kWh per battery charge per day gives 640/18 = 35.6 (days) ✓	**4**	**2.2** **1.2** **1.2** **1.2**	**ECF**. mp1
		(ii)	**Any one from:** solar cell not charging enough (due to dust/angle to Sun/day length change) ✓ mean speed reduced by rough terrain/going round hills/going up hills ✓ may break down and need repair✓	**1**	**3.1b**	A sensible suggestion for why extra time is needed

Question			Answer	Marks	AO element	Guidance
4	(a)	(i)	**FIRST CHECK THE ANSWER ON THE ANSWER LINE. If answer = 0.43 (s) award 3 marks** $T^2 = kL$ = 4.02 (s^2 /m) × 0.046 (m) ✓ = 0.185 (s^2) ✓ T= √{0.185 (s^2)} = 0.43 (s) ✓	**3**	**1.2** **2.1** **2.1**	
	(a)	(ii)	**FIRST CHECK THE ANSWER ON THE ANSWER LINE. If answer = 298 or 300 (m/s) award 3 marks** s = 2 × 64 (m) = 128 (m) ✓ $v = s/t$ ✓ = 128 (m) / 0.43 (s) = 298 (m/s) (= 300 m/s) ✓	**3**	**1.2** **1.2** **2.1**	 **ECF**. own t from (a)(i) **ALLOW** s = 64 (m) here if incorrectly quoted for mp1
	(b)	(i)	Measuring t is harder **because** time is very short/not easy to match pendulum to sound / pendulum is very short /easy to measure distance (accurately) ✓	**1**	**3.1b**	
		(ii)	(v is too small) t is too large ✓ Using $v = s/t$ / his reaction time will extend timing ✓	**2**	**3.2a** **3.2b**	 **ALLOW** discussion of inaccurate actual length of oscillating pendulum for mp2

Question			Answer	Marks	AO element	Guidance
5	(a)	(i)	**Any two from:** Use of 20 cm (instead of 0.20 m) ✓ Use of 800 g (instead of 0.80 kg) ✓ Not measuring *h* correctly ✓	**2**	**1.2** **3.2a**	e.g. used cm instead of m e.g. used g instead of kg e.g. 'distance fallen by trolley is less than shown'
	(a)	(ii)	Measure actual change in vertical height ✓ From centre of (mass of) trolley at starting point ✓ To position of centre (of mass) on the test surface ✓	**3**	**3.3b × 3**	
	(b)	(i)	If trolley has not fallen any distance, there is no potential energy to transfer to kinetic energy. ✓	**1**	**1.1**	**ALLOW** (At the start) trolley has not moved and so KE and distance are both 0 AW
	(b)	(ii)	All three points correctly plotted (± 1 a small division) ✓ Best-fit smooth curve ✓	**2**	**2.2 × 2**	**ECF** own misplotting
	(c)		**Any four from:** Graph is levelling out/AW ✓ checks maximum value from graph ✓ Greater range of data (would indicate if this is true) ✓ Faster motion involves greater friction/ AW ✓ Higher KE gives greater distance travelled ✓	**4**	**2.2** **3.3b** **2.1** **3.1b**	Needs indication on or with reference to graph

Question			Answer	Marks	AO element	Guidance
6	(a)		**Any three from:** Molecules collide with wall ✓ rebound/reflect/bounce back ✓ momentum change results in force (on the wall) ✓ Pressure is *F*/*A* ✓	3	**1.1** **2.1** **1.1**	
	(b)		**Any three from:** Atmosphere gets cooler (with height) ✓ molecules travel slower / less KE ✓ Density of atmosphere drops/ molecules are further apart (with height) ✓ fewer molecules strike a surface (per second) ✓ smaller force (per unit area) exerted on a surface (so pressure is less)✓	3	**1.1** **2.1** **2.1**	**ORA**
7	(a)		**FIRST CHECK THE ANSWER ON THE ANSWER LINE. If answer = 32/32.4 (MW) award 3 marks** Total *P* input (maximum) = 1000 (W/m^2) × 216 000 (m^2) = 216 000 000 (W) ✓ Maximum electrical power output = {15/100} × 216 000 000 (W) = 32 400 000 (W) ✓ = 32.4 (MW) ✓	3	**2.2 × 3**	

Question			Answer	Marks	AO element	Guidance
7	(b) *		*Please refer to the marking instructions on page 5 of this mark scheme for guidance on how to mark this question.* **Level 3 (5–6 marks)** Detailed, balanced discussion of the advantages and disadvantages of solar farms and gas-burning power stations not restricted to statement as made by Jane. May query Jane's source for PV pollutions. *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)** Describes one advantage AND one disadvantage of BOTH solar farms and gas-burning power stations. Discusses points mentioned by Jane and with some evaluation. **OR** Describes more than one advantage /disadvantage of BOTH solar farms and gas-burning power stations. *There is a basic line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.* **Level 1 (1–2 marks)** Largely quotes material from Jane's statement. Describes an advantage or disadvantage of BOTH solar farms and gas-burning power stations. OR Describes one advantage AND one disadvantage of one type of power station. *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.*	**6**	**2 × 1.1** **2.2** **3 × 3.2b**	**AO1.1 Renewable vs. Non-renewable energy resources** For example: • Gas is non – renewable so will run out • Solar is renewable • A renewable energy resource will not run out **AO2.2** Compare the ways in which the main energy resources are used to generate electricity **AO3.2b Advantages and disadvantages** • CO_2 contributes to global warming • solar power stations don't produce CO_2 (once built) • solar output is about 300 × smaller than gas [e.c.f part **(a)**] • gas produces CO_2 • solar doesn't produce CO_2 at the point of electricity generation • solar panel production is polluting • solar farms take up farming/building land • but some may be used, e.g. grazing sheep

Question			Answer	Marks	AO element	Guidance
8	(a)		Graph marking/references show two points of activity ratio 2:1 ✓ 400 years ≤ *T*½ ≤ 450 years ✓	2	1.2 3.1b	One may be (0, 800)
	(b)		**Any four from:** (Alpha particles are highly) ionising ✓ This can damage cells/DNA/cause cancer ✓ (After 10 years the) activity will still be very high (due to long half-life) ✓ Am-241 may escape from a discarded detector ✓ Can be ingested by animals/absorbed by plants / enter the food webs ✓	4	1.1 2.1 × 3	Alpha radiation is in the stem, so 'this ionising radiation can damage cells' gets mp2 & mp3
	(c)	(i)	Number of radioactive nuclei (remaining) ✓	1	2.1	**ALLOW** atoms for nuclei
	(c)	(ii)	(Number of) nuclei decaying / (number of) alpha particles emitted AW / activity (of sample) ✓	1	2.1	
	(c)	(iii)	**Any three from:** 48 is roughly half of 100 ✓ 'Number of sixes' dice should be one-sixth of previous 'number of dice left' ✓ It's random ✓ the sample is very small ✓	3	2.2 × 3	

Question			Answer	Marks	AO element	Guidance
9	(a)		Red light and violet light both slow down when going from air into glass. ✓ When they go from glass into air, violet light speeds up more than red light. ✓	2	2.1 × 2	Top and bottom boxes
	(b)	(i)	Refraction/bending (towards normal) ✓ waves slower in core than in mantle ✓	2	1.1 2.1	**ALLOW** 'change direction' for refracted here
	(b)	(ii)	Refracted other way from (b)(i) ✓ Wave speed faster lower in the mantle ✓	2	1.2 2.1	**ECF** mp2 reversed in (b)(i)

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