Oxford Cambridge and RSA

H

GCSE (9–1)

Physics A (Gateway Science)

J249/04: Paper 4 (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
	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**.

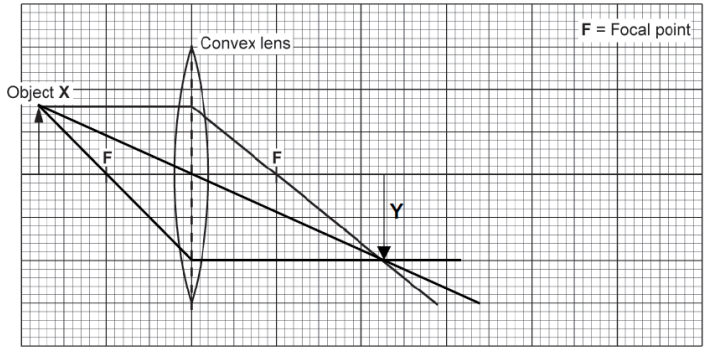
Please ask for help or guidance whenever you need it. Your first point of contact is your Team Leader.

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

Question			Answer	Marks	AO element	Guidance
16	(a)		**Either** ray (centre ray or focal ray) drawn as indicated below ✓  Image upside down **AND** in the correct place ✓	**2**	**2 × 2.2**	**ALLOW** just one ray drawn If no rays drawn (or incorrect) but image is inverted, slightly larger and roughly in the correct place then award this mark **IGNORE** position of Y (if arrow is in the correct place) **ALLOW** tolerance of +/- 2 squares for image position
	(b)		A (red) filter is needed ✓ (The red filter) absorbs all colours/frequencies/wavelengths except red (light) ✓	**2**	**2 × 2.1**	**ALLOW** The red filter absorbs blue and green (light/frequency/wavelength) (but not red) **ALLOW** the filter transmits red light <u>only</u> / <u>only</u> lets red (light/frequency/wavelength) through
	(c)	**(i)**	230 (V) ✓	**1**	**1.1**	

Question			Answer	Marks	AO element	Guidance
		(ii)	(Earth wire together with fuse) prevents user from getting electric shock (if there is a fault) ✓ Plastic case is an insulator (so earth wire not required) ✓	**2**	**2 × 1.1**	**ALLOW** metal case could cause electric shock if no earth wire / AW **ALLOW i**dea of earth wire carries current to Earth / AW **ALLOW** prevents projector becoming live / AW **ALLOW** plastic case is not a conductor / does not conduct electricity/current **ALLOW** appliance is double insulated

Question			Answer	Marks	AO element	Guidance
17	(a)		Change the thickness of the cardboard (and repeat) ✓ **Any 2 from**: (Control variable) Same volume of water / same starting temperature of water ✓ Measure temperature with thermometer **/** time with stopwatch ✓ Calculate the rate using change in temperature / time ✓ Repeat results (and calculate the mean) ✓	**3**	**3 × 3.3a**	**ALLOW** use different boxes with different thicknesses / line the box with an insulator **ALLOW** same beaker / both beakers (don't) have a lid / same room temperature **ALLOW** a specified amount of water in the beaker / a specified starting temperature
	(b)	**(i)**	5 or 4 points correctly plotted to within ½ small square ✓✓	**2**	**2 × 2.2**	3 or 2 correctly plotted points gains 1 mark **IGNORE** 'blobs' more than ½ square diameter
		(ii)	Smooth curved line of best fit through most points ✓	**1**	**1.2**	**DO NOT ALLOW** a straight line of best fit
		(iii)	Temperature decreases (with time) ✓ At a decreasing rate / by a smaller change in temperature for each increase in time ✓	**2**	**2 × 3.1a**	**IGNORE** non-linear relationship / positive/negative correlation **ALLOW** inverse proportion for this mark only **ALLOW** gradient decreases / temperature decreases more quickly at the start (than at the end) **ALLOW** use of data from the graph to show decreasing rate

Question			Answer	Marks	AO element	Guidance
		(iv)	Line starts at 90°C and decreases but remains <u>above</u> their LOBF ✓	**1**	**3.2b**	**IGNORE** shape of the line but no mark for a horizontal line **ALLOW** 90 +/- 2 °C
		(v)	**Any one from:** Repeat (and find a mean) / check reproducibility/repeatability ✓ Use smaller time intervals ✓ Use more precise timer/thermometer ✓	**1**	**3.3b**	**ALLOW** any sensible suggestion **IGNORE** a longer time / use more thicknesses **ALLOW** use equipment with higher resolution / data logger **IGNORE** better equipment unless qualified
	(c)		Thermal conductivity of metal is higher (so rate of cooling is greater) / ORA ✓	**1**	**3.2a**	**ALLOW** metal is a (better thermal) conductor / ORA

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 evaluation of the advantages and disadvantages of wind power **AND** Analysis of Fig. 18.1 and Fig. 18.2 **AND** An attempt to give a conclusion about the use of wind power *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)** Evaluation of the advantages and disadvantages of wind power **AND** Analysis of Fig. 18.1 and Fig. 18.2 **OR** Evaluation of the advantages and disadvantages of wind power **AND** An attempt to give a conclusion about the use of wind power **OR** Analysis of Fig. 18.1 and Fig. 18.2 **AND** An attempt to give a conclusion about the use of wind power	**6**	**2 × 1.1** **2 × 3.1a** **3 × 3.2b**	**AO1.1 Demonstrates knowledge and understanding of advantages and disadvantages of wind power** Advantages • Wind is renewable • Does not create greenhouse gases (CO_2) • Does not contribute to global warming/climate change • Cheap to run (once built) • Less fossil fuels used Disadvantages • Unreliable – when wind drops so does power output / turbines switched off if it is too windy • Takes up lots of land • Some people think they are unsightly/noisy • Expensive to build **AO3.1a Analyses information by interpreting graphs of power output and use** • Wind pattern/power generated does not follow demand • Power generation is (always) below that of demand • Demand peaks at 17.00, lowest at ~5.00 • Peak demand is ~48000MW or Lowest demand is ~27000MW • Greatest power generation is ~11000MW or lowest power generation is ~5300MW • Power generation fluctuates

Question			Answer	Marks	AO element	Guidance
			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)** Evaluation of the advantages or disadvantages of wind power **OR** Analysis of Fig. 18.1 or Fig. 18.2 **OR** An attempt to give a basic conclusion about the use of wind power *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.*			**AO3.2b Analyses information to draw conclusions about use of wind power** • Current wind power cannot meet the demand for the UK • To meet the demand lots more wind turbines need to be built • Even more land/sea will be taken up with wind turbines • Expensive to build as so many wind turbines required • There will still be some days when wind cannot meet the demand requirements • There will need to be other power generation systems (examples given) • We need to be able to store the energy generated

Question			Answer	Marks	AO element	Guidance
19	(a)		Ultrasound waves are <u>longitudinal</u> ✓ **OR** Ripples are <u>transverse</u> ✓ Oscillations/vibrations (of particles) in ultrasound/longitudinal waves are <u>parallel</u> to the direction of energy transfer / ultrasound has compressions and rarefactions ✓ **OR** Oscillations/vibrations (of particles) in the ripples/transverse waves are <u>perpendicular</u> to the direction of energy transfer ✓	**2**	**2 × 1.1**	**ALLOW** direction of travel/propagation for energy transfer **IGNORE** direction of wave motion
	(b)	**(i)**	0.0022 (m) ✓	**1**	**2.2**	
		(ii)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 2.0 × 10^6 (Hz) award 4 marks** (Rearrange: frequency =) speed / wavelength **OR** (f =) 4500 / 0.0022 ✓ (f =) 2 045 455 (Hz) ✓ (f =) 2 000 000 (Hz) ✓ (f =) 2.0 × 10^6 (Hz) ✓	**4**	**1.2** **2 x 2.1** **1.2**	**ALLOW** ecf from **(b)(i)** **ALLOW** three marks for 2.0 MHz **ALLOW** a mark for their answer to 2 significant figures **ALLOW** a mark for their answer in standard form
	(c)		Decreases ✓ Stays the same ✓	**2**	**2 × 2.1**	

Question			Answer	Marks	AO element	Guidance
	(d)	**(i)**	(Partial) reflection/absorption at the front of the kidney ✓ (Partial) reflection at the back of the kidney ✓	**2**	**2 × 2.1**	Both of the marking points can be awarded by a suitably clear diagram (or additional drawings on the given diagram) **ALLOW** 1 mark maximum for just reflection/bounces back
		(ii)	Measure the <u>time</u> between reflections ✓ Use distance = ½ x speed x time (to find the size) ✓	**2**	**2 × 2.2**	 **ALLOW** distance = speed x time and mention of time halved
	(e)		There is no (known) risk associated with ultrasound / ultrasounds are safer than X-rays / X-rays pass through soft tissue (so would not detect the kidney) / X-rays are ionising (radiation) ✓	**1**	**1.1**	**ALLOW** X-rays used to detect bones/pass through kidney **ALLOW** ultrasound detects soft tissue/organs

Question			Answer	Marks	AO element	Guidance
20	(a)		(The nucleus contains) 95 protons ✓ (and) 146 neutrons ✓	2	2 × 1.1	**IGNORE** references to electrons **ALLOW** the nucleus has a charge of (+) 95
	(b)		237 ✓ 93 ✓ He / α ✓	3	2 × 2.2 1 × 1.1	
	(c)		Beta and gamma would not be absorbed/stopped (by smoke) ✓	1	1.1	**ALLOW** beta and gamma would pass straight through / are too penetrating / penetrate further / less ionising
	(d)	(i)	The time it takes the number of (undecayed/radioactive) nuclei to halve ✓	1	1.1	**ALLOW** count-rate or activity for number of undecayed nuclei **ALLOW** the time it takes for half of the (radioactive) nuclei to decay **ALLOW** atoms for nuclei
		(ii)	It is long enough so the activity does not change significantly / source will not need to be replaced ✓	1	2.1	**ALLOW** it will last a long time
		(iii)	Thorium (is greatest risk to begin with) / ORA ✓ As thorium will have a higher activity/count-rate (at the beginning) / ORA ✓	2	2 × 3.2a	**ALLOW** thorium decays faster / ORA

Question			Answer	Marks	AO element	Guidance
	(e)		**Any two from:** (Agree) Smoke alarms use small amounts of americium-241 ✓ Mainly emits alpha particles which are stopped by skin/soil ✓ Americium-241 is contained within the foil / AW ✓ Americium-241 cannot move out of materials in detector / be inhaled ✓ Soil emits more radiation ✓ **Or** **Any two from:** (Disagree) Smoke alarm contains an isotope with a long half-life ✓ The smoke alarm/foil could be damaged ✓ Americium-241 may contaminate objects (in the waste) ✓ Americium-241 also emits gamma rays (which are more penetrating that alpha particles) ✓ Soil may not absorb all radiation ✓	**2**	**2 × 3.2a**	**IGNORE** vague answers such as 'bad for the environment' **ALLOW** gamma is not stopped by the foil

Question			Answer	Marks	AO element	Guidance
21	(a)	(i)	(From) Chemical energy (store) ✓ (To) Thermal energy (store of the water in the kettle) ✓	2	2 × 2.1	**ALLOW** chemical energy store decreases **ALLOW** thermal energy store increases **ALLOW** heat / internal energy for thermal **IGNORE** sound/electrical energy **IGNORE** intermediate energy transfers/stores and any energy transfers/stores after thermal (store of the water)
		(ii)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 138 000 (J) award 4 marks** (Recall: energy transferred =) power x time ✓ (Power = 5.0 x 230 =) 1150✓ (Time = 2 x 60 =) 120✓ (Energy transferred =) 1150 × 120 = 138 000 (J) ✓	4	 1.2 2.1 2.1 2.1	 **ALLOW** equation in any form **ALLOW** ecf for incorrect power calculated **ALLOW** ecf for incorrect/no conversion of time

Question			Answer	Marks	AO element	Guidance
	(b)	(i)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 72 (%) award 5 marks** Select from data sheet: change in thermal energy = mass × specific heat capacity × change in temperature (no mark) (change in thermal energy =) 1.2 × 4200 × 75 ✓ (change in thermal energy =) 378 000 (J) ✓ (Recall: efficiency =) useful output energy transfer / input energy transfer **OR** (Efficiency =) 378 000 / 525 000 ✓ (Efficiency =) 0.72 ✓ (Efficiency =) 72 (%) ✓	**5**	**1.2** **2.1** **1.2** **2.1** **1.2**	**ALLOW** ecf for incorrect thermal energy calculated **ALLOW** 4 marks for answer of 0.72 (%)
	(b)	(ii)	some energy is transferred to the (thermal energy store of the) kettle/surroundings/air ✓	**1**	**2.1**	**IGNORE** sound
	(c)		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 0.9 (A) award 2 marks** (Rearrangement: I_p =) $I_s \times V_s / V_p$ ✓ **OR** (I_p =) 12 × 9.0 / 120 ✓ (I_p =) 0.9 (A) ✓	**2**	**1.2** **2.1**	

Question			Answer	Marks	AO element	Guidance
22	(a)		(All galaxies) showed <u>red-shift</u> ✓ (Hubble measured the) wavelength/frequency of <u>light</u> (from the galaxy) ✓	2	2 × 1.1	**ALLOW** (all galaxies) showed <u>light</u> with a longer wavelength/lower frequency for 2 marks
	(b)	(i)	Readings of speed taken for two different values of distance ✓ Working to show that the factor increase in speed is the same as distance ✓	2	2 × 3.1a	**ALLOW** +/- ½ a small square **ALLOW** a statement for the second mark e.g. as the distance doubles so does the speed. <u>Example:</u> At 20 Mpc, speed = 1400 km/s At 40 Mpc, speed = 2800 km/s 40/20 = 2 = 2800/1400 **ALLOW** 1 mark maximum for it is a (straight) line of best fit through the origin (therefore it is proportional)
		(ii)	**Any one from:** The more distant galaxies are travelling faster ✓ The evidence suggests the universe is expanding ✓ The universe was smaller in the past ✓	1	1.1	**ALLOW** galaxies are moving away from each other

Question			Answer	Marks	AO element	Guidance
	(c)		To ensure results are reproducible / check the work is of high enough quality / claims are not false / for new theories to be accepted / to develop theories / AW ✓	1	1.1	**ALLOW** check validity / for mistakes/anomalies / AW **ALLOW** check that it's not biased / AW
	(d)	(i)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 5 800 000 (m/s) award 2 marks** (Reads off speed from graph =) 5800 (km/s) ✓ Speed = 5800 × 1000 = 5 800 000 (m/s) ✓	2	 2.2 1.2	**ALLOW** 5.8×10^6 (m/s) **ALLOW** ecf for their speed from graph x 1000
		(ii)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 4.36×10^{17} (s) award 3 marks** time = distance / speed ✓ (time =) 2.53×10^{24} / 5 800 000 ✓ (time =) 4.36×10^{17} (s) ✓	3	 1.2 2.1 2.1	**ALLOW** ecf from **(d)(i)** **ALLOW** 4.4×10^{17} (s) **ALLOW** equation in any form

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