OCR
Oxford Cambridge and RSA

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GCSE (9–1)

Combined Science A (Physics) A (Gateway Science)

J250/12: Paper 12 (Higher Tier)

General Certificate of Secondary Education

Mark Scheme for Autumn 2021

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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.

1. Annotations available in RM Assessor

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

12. 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

13. **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 Combined Science 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.

Question	Answer	Marks	AO element	Guidance
1	A	1	2.1	
2	C	1	1.1	
3	A	1	1.1	
4	A	1	2.1	
5	B	1	1.2	
6	C	1	1.1	
7	A	1	2.1	
8	C	1	2.1	
9	C	1	1.1	
10	A	1	2.1	

Question			Answer	Marks	AO element	Guidance
11	(a)	(i)	Frequency or energy too high / too dangerous / gamma is ionising radiation / can cause cancer / AW ✓	1	1.2	**ALLOW** wavelength too small / can kill cells
		(ii)	Any **one** from: Microwaves ✓ Visible light ✓ Infra-red ✓ UV ✓	1	1.1	**IGNORE** X-rays / gamma rays / radio waves
		(iii)	Any **one** from: Radar ✓ Satellite (TV) ✓ Mobile phones ✓ Remote controls ✓ Optical fibres / optical wireless communications ✓ Morse code ✓ To see/to read CDs or DVDs ✓ Bluetooth ✓	1	1.1	**IGNORE** any use which does **not** involve communications / just 'TV'
	(b)	(i)	As frequency increases, wavelength decreases / ORA ✓ Any two pairs of values of frequency and wavelength that shows this relationship ✓	2	2x3.1a	Possible pairs: f (MHz) λ(m) 562 0.533 571 0.526 578 0.519 586 0.511 594 0.505 691 0.435
		(ii)	Three / 3 ✓	1	1.2	

Question			Answer	Marks	AO element	Guidance
	(b)	(iii)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 299 970 000 (m / s) award 3 marks** 594 MHz = 594 000 000 Hz ✓ (Speed =) 594 000 000 × 0.505 ✓ (Speed =) 299 970 000 (m / s) ✓	3 1 1 1	 1.2 2.1 2.1	**ALLOW** 300 000 000 or 3×10^8 (m / s) with workings shown ✓✓✓ **ALLOW** 2.9997×10^8 (m / s) ✓✓✓ **ALLOW** 299.97 (unit not changed) ✓✓
	(c)		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 0.4 award 3 marks** (efficiency =) useful E output ÷ input E ✓ (efficiency =) 100 ÷ 250 ✓ (efficiency =) 0.4 ✓	3 1 1 1	 1.2 2.1 2.1	 **ALLOW** 40% ✓✓✓ **ALLOW** 0.4% or 0.4 with units or 40 ✓✓

Question			Answer	Marks	AO element	Guidance
12	*		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)** Describes a detailed method of how to determine the reaction time. **AND** Suggests ways to improve the method to produce accurate and precise results. *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 a method of how to determine the reaction time. **AND** Suggests a way to improve the method. *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)** Describes a basic method of how to determine the reaction time **OR** Suggests a way to improve the method. *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 2 x 3.3a 2 × 3.3b	**AO2.2 – Applies knowledge and understanding of how to determine the reaction time measurement.** • Distance gives idea of reaction time • Use of $v^2 = u^2 + 2as$ (a= 10 m / s) to calculate v and acceleration = $\Delta v / \Delta t$ or t = distance / average speed to calculate reaction time t **AO3.3b – Analyses information to develop a method to determine reaction time** • 1st person drops the ruler • 2nd person catches it between fingers • Distance measured / time taken measured **AO3.3b – Analyses information to improve the method** • Repeat each measurement and take a mean • Discard anomalies • Ruler should be dropped without any warning • Vary the time before dropping the ruler • Ruler should be held level with fingers each time / distance should be corrected with height of ruler above hand • Use a ruler with a higher resolution • Ignore readings where there are random errors • Check that there are no systematic errors, e.g. zero errors

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>AO element</th><th>Guidance</th></tr>
<tr><td>13</td><td>(a)</td><td></td><td>Energy cannot be created/destroyed / AW ✓

Energy can only be transferred/changed/shifted (between stores) ✓</td><td>2</td><td>2 × 1.1</td><td></td></tr>
<tr><td></td><td>(b)</td><td></td><td><table><tr><th></th><th>At the bottom of the ramp</th><th>At the top of the ramp</th></tr><tr><td>Magnetic energy store</td><td>MAXIMUM</td><td>MINIMUM</td></tr><tr><td>Gravitational energy store</td><td>MINIMUM</td><td>MAXIMUM</td></tr><tr><td>Thermal energy store</td><td>MINIMUM</td><td>MAXIMUM</td></tr></table></td><td>4</td><td>4 x 2.1</td><td>6 correct ✓✓✓✓
4 or 5 correct ✓✓✓
2 or 3 correct ✓✓
1 correct ✓</td></tr>
<tr><td></td><td>(c)</td><td>(i)</td><td>FIRST CHECK THE ANSWER ON ANSWER LINE
If answer = 4 (m / s) award 3 marks

Rearranges: v^2 = KE / (0.5 × m) ✓
v^2 = 0.024 / (0.5 × 0.003) or v^2 = 16 ✓
v = 4 (m / s) ✓</td><td>3</td><td>

1.2
2.1
2.1</td><td>

ALLOW v = √2KE/m) ✓
ALLOW v = √(2 x 0.024)/0.003 ✓</td></tr>
<tr><td></td><td></td><td>(ii)</td><td>Any two from:

Kinetic energy (store) decreases ✓

Energy would be transferred to a thermal store ✓

(Transferred/dissipated) into the surroundings / ground / air ✓</td><td>2</td><td>2x1.2</td><td></td></tr>
</table>

Question			Answer	Marks	AO element	Guidance
14	(a)		Change in mass of nucleus: – 4 ✓ Change in charge on nucleus: +1 ✓	2	2 × 1.2	**ALLOW** decreases by 4 **ALLOW** increases by 1
	(b)		Radioactive decay is a random process / AW ✓	1	1.1	**ALLOW** answers referring to background radiation
	(c)		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 9 (days) award 2 marks** (Ratio of 1:4 implies) 2 half-lives ✓ (2 half lives = 18 so half-life =) 9 (days) ✓	2	2 × 2.1	
	(d)		(Isotope **X** or beta) Beta radiation penetrates paper / ORA ✓ Beta radiation is blocked by aluminium / AW ✓	2	2 × 2.2	No marks can be scored if isotope **Y** or alpha identified
	(e)		(**Y** is irradiated because) **Y** is exposed to the radiation from **X** / radiation from **X** reaches **Y** / AW ✓ (Not contaminated because) **X** does not touch **Y** / there is not a radioactive source touching **Y** / AW ✓	2	2 × 3.2b	
	(f)		Any **two** from: It is reliable / non-renewables are unreliable ✓ Accidents are rare / still a safe resource ✓ Renewables do not produce enough energy / nuclear power produces more energy for less fuel / AW ✓ There is a plentiful supply of nuclear fuel / nuclear fuel is sustainable ✓ To meet the demand of consumers ✓ No greenhouse gases / no CO_2 produced ✓	2	2 × 3.1b	

Question			Answer	Marks	AO element	Guidance
15	(a)		Gravitational (store decreases/empties) ✓ Kinetic (store increases/fills) **OR** thermal (store increases/fills) ✓	2	2 × 1.1	
	(b)		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 0.25 (Hz) award 2 marks** (Idea that) frequency = number of waves per second ✓ (5 drops in 20s = 5/20 per second =) 0.25 (Hz) ✓	2	 1.2 2.1	
	(c)		(Idea that) the water does **not** move to the side of the bowl / water is left in the bowl / AW ✓	1	1.1	**ALLOW** water (only) moves up and down / a small object/piece of cork (only) moves up and down
	(d)	(i)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 4 × 10^{-8} (°C) award 3 marks** (temperature rise =) E ÷ (m × c) ✓ (temperature rise =) 5.04 × 10^{-4} ÷ (3 × 4200) ✓ (temperature rise =) 4 × 10^{-8} (°C) ✓	3	 1.2 2 × 2.1	
		(ii)	Any **two** from: Temperature rise very small ✓ Requires precise or high resolution thermometer ✓ (idea that) Joule's equipment may not have been precise or good enough ✓ The water "sprays" out so it is difficult to measure accurately / AW ✓	2	2 × 3.2a	 **ALLOW** he only has a simple/normal thermometer

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