Cambridge Assessment International Education

Cambridge O Level

PHYSICS **5054/21**

Paper 2 Theory **October/November 2023**

MARK SCHEME

Maximum Mark: 75

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

Cambridge International is publishing the mark schemes for the October/November 2023 series for most Cambridge IGCSE, Cambridge International A and AS Level components, and some Cambridge O Level components.

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Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptors for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently, e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

GENERIC MARKING PRINCIPLE 5: Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).
GENERIC MARKING PRINCIPLE 6: Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

Science-Specific Marking Principles

1	Examiners should consider the context and scientific use of any keywords when awarding marks. Although keywords may be present, marks should not be awarded if the keywords are used incorrectly.
2	The examiner should not choose between contradictory statements given in the same question part, and credit should not be awarded for any correct statement that is contradicted within the same question part. Wrong science that is irrelevant to the question should be ignored.
3	Although spellings do not have to be correct, spellings of syllabus terms must allow for clear and unambiguous separation from other syllabus terms with which they may be confused (e.g. ethane / ethene, glucagon / glycogen, refraction / reflection).
4	The error carried forward (ecf) principle should be applied, where appropriate. If an incorrect answer is subsequently used in a scientifically correct way, the candidate should be awarded these subsequent marking points. Further guidance will be included in the mark scheme where necessary and any exceptions to this general principle will be noted.
5	'List rule' guidance For questions that require ***n*** responses (e.g. State **two** reasons …): • The response should be read as continuous prose, even when numbered answer spaces are provided. • Any response marked *ignore* in the mark scheme should not count towards ***n***. • Incorrect responses should not be awarded credit but will still count towards ***n***. • Read the entire response to check for any responses that contradict those that would otherwise be credited. Credit should **not** be awarded for any responses that are contradicted within the rest of the response. Where two responses contradict one another, this should be treated as a single incorrect response. • Non-contradictory responses after the first ***n*** responses may be ignored even if they include incorrect science.

6 Calculation specific guidance

Correct answers to calculations should be given full credit even if there is no working or incorrect working, **unless** the question states 'show your working'.

For questions in which the number of significant figures required is not stated, credit should be awarded for correct answers when rounded by the examiner to the number of significant figures given in the mark scheme. This may not apply to measured values.

For answers given in standard form (e.g. $a \times 10^n$) in which the convention of restricting the value of the coefficient (a) to a value between 1 and 10 is not followed, credit may still be awarded if the answer can be converted to the answer given in the mark scheme.

Unless a separate mark is given for a unit, a missing or incorrect unit will normally mean that the final calculation mark is not awarded. Exceptions to this general principle will be noted in the mark scheme.

7 Guidance for chemical equations

Multiples / fractions of coefficients used in chemical equations are acceptable unless stated otherwise in the mark scheme.

State symbols given in an equation should be ignored unless asked for in the question or stated otherwise in the mark scheme.

Acronyms and shorthand in the mark scheme.

acronym / shorthand	explanation
A marks	Final answer marks which are awarded for correct final answers to numerical questions.
C marks	Compensatory marks which may be scored to give partial credit when final answer (A) marks have not been scored.
B marks	Independent marks which do not depend on other marks.
M marks	Method marks which must be scored before any subsequent final answer (A) marks can be scored.
Brackets ( )	Words not explicitly needed in an answer however if a contradictory word/phrase/unit to that in the brackets is seen the mark cannot be scored.
Underlining	The underlined word (or a synonym) must be present for the mark to be scored. If the word is a technical scientific term, the word must be there.
owtte	Or words to that effect
ignore	If seen, this incorrect or irrelevant point may be disregarded, i.e. it is not to be treated as contradictory.
not/NOT	An incorrect point which contradicts any correct point and means the mark cannot be scored.
ecf [question part]	Indicates that a candidate using an erroneous value from the stated question part must be given credit here if the erroneous value is used correctly here. i.e. their error is carried forward to this question and they are not penalised a second time for one error.
cao	correct answer only

Question	Answer	Marks
1(a)(i)	particles move / collide / hit	**B1**
	particles collide with (inner) walls (of rocket)	**B1**
	force exerted by collisions over / on an area	**B1**
1(a)(ii)	more collisions per unit time	**B1**
1(b)	(expelled) water gains / has (downward) momentum	**B1**
	momentum conserved	**B1**
	rocket gains (upward) momentum (and accelerates)	**B1**
1(c)	any **two** from: mass (of water and rocket) decreases / changes pressure (of air) decreases (air) resistance (acts) gravitational field strength decreases (with height) less water expelled per second / water expelled at slower speed	**B2**

Question	Answer	Marks
2(a)	change / increase of velocity (with time)	**B1**
	change / increase of velocity per unit time **or** rate of change / increase of velocity	**B1**
2(b)(i)	force × distance moved <u>in the direction of the force</u> / <u>forwards</u>	**B1**
2(b)(ii)	(work done =) $5.4 \times 10^4 \times 280$	**C1**
	1.5×10^7 (J)	**A1**

Question	Answer	Marks
2(b)(iii)	$E_k = ½mv^2$ **or** (m =) $2 \times E_k / v^2$	**C1**
	(m =) $2 \times 3.2 \times 10^6 / 12^2$ **or** $2 \times 3.2 \times 10^6 / 144$	**C1**
	4.4×10^4 (kg)	**A1**

Question	Answer	Marks
3(a)	particles move apart **or** distance between particles increases	**B1**
	particles able to move further against the forces (of attraction) **or** forces (of attraction) less effective against faster moving particles **or** particles collide harder (with neighbours)	**B1**
3(b)(i)	conduction	**B1**
3(b)(ii)	density of heated water decreases	**B1**
	less dense / heated water rises	**B1**
	cold water sinks / convection current established	**B1**
3(b)(iii)	100 °C **or** 373 K	**B1**
3(b)(iv)	(ΔT =) 100 – 17 **or** 83 (°C)	**C1**
	(ΔE =) $mc\Delta T$ **or** $2.5 \times 4200 \times (100 – 17)$ **or** $2.5 \times 4200 \times 83$	**C1**
	8.7×10^5 (J)	**A1**

Question	Answer	Marks
4(a)	(λ =) v / f **or** 3.0×10^8 / 4.7×10^{14}	**C1**
	6.4×10^N (m) or 3 / 4.7×10^6	**C1**
	6.4×10^{-7} (m)	**A1**
4(b)(i)	speed: decreases frequency: stays the same wavelength: decreases	**B2**
4(b)(ii)	i = 45° **and** r = 30°	**C1**
	(n =) sin(i) / sin(r) **or** sin(45°) / sin(30°)	**C1**
	1.4	**A1**
4(b)(iii)	straight continuation of ray in block **and** refraction away from normal in air	**B1**
	emergent ray parallel to initial incident ray	**B1**

Question	Answer	Marks
5(a)(i)	infrared (radiation) **and** visible (light) **and** ultraviolet (radiation)	**B1**
	infrared (radiation) **and** visible (light) **and** ultraviolet (radiation) **and** in this order	**B1**
5(a)(ii)	damaging effect: (skin) cancer / cataracts	**B1**
	property: it / ultraviolet radiation is ionising	**B1**

Question	Answer	Marks
5(b)	in a transverse wave, the vibration direction is perpendicular / at right angles to the propagation direction	**B1**
	in a longitudinal wave, the vibration direction is parallel to the propagation direction	**B1**

Question	Answer	Marks
6(a)	(because) the current at every point in a series circuit is the same	**B1**
6(b)(i)	(R =) V / I **or** 1.5 / 0.20 **or** 7.5 (Ω)	**C1**
	(R_T =) 7.5 – 1.5 –3.5	**C1**
	2.5 (Ω)	**A1**
6(b)(ii)	resistance (of T / thermistor) decreases (as the temperature increases)	**B1**
	current in circuit increases **or** smaller fraction of total resistance	**B1**
	p.d. across R and S increases **or** (p.d. is) smaller fraction of e.m.f.	**B1**

Question	Answer	Marks
7(a)(i)	P: (carbon) brush **and** Q: slip ring(s)	**B1**
7(a)(ii)	to connect the output terminal(s) and the (rotating) coil/brushes	**B1**
	without wires twisting	**B1**
7(b)(i)	at least one of the five positions when the output e.m.f. is zero indicated with X **and** no indications elsewhere	**B1**

Question	Answer	Marks
7(b)(ii)	(amplitude ≡) 3.6 (cm) **or** (E_{max} =) 5.0 × 3.6 **or** 36 (V) seen	**C1**
	18 (V)	**A1**
7(b)(iii)	(T =) 8.0 (m s)	**B1**
7(b)(iv)	(f =) 1 / T **or** 1 / 8.0 **or** 1 / (4.0 × 2.0) **or** 1 / 0.0080	**C1**
	130 (Hz)	**A1**

Question	Answer	Marks
8(a)	it / uranium-235 has (3) fewer neutrons (in the nucleus)	**B1**
8(b)(i)	the nucleus splits (and releases more neutrons)	**B1**
8(b)(ii)	neutrons released (when nucleus splits)	**B1**
	neutrons absorbed by other (uranium-235) nuclei	**B1**
	these nuclei split **and** release neutrons	**B1**
	this process continues (using released neutrons)	**B1**
8(b)(iii)	to slow down the neutrons (emitted by fission)	**B1**
8(b)(iv)	they / control rods absorb neutrons (without further fission)	**B1**
	to slow down / stop / control the chain reaction / limit the number of fissions	**B1**

Question	Answer	Marks
9(a)	(T =) $2\pi r / v$ **or** $2\pi \times 1.1 \times 10^{11} / 3.5 \times 10^{4}$	**C1**
	2.0×10^{7} (s)	**A1**
9(b)	it / speed does not have a direction	**B1**
9(c)(i)	it / velocity changes	**M1**
	(because) its direction changes	**A1**
9(c)(ii)	to change the velocity **or** to keep Venus in a circular orbit **or** to accelerate Venus towards the centre of the orbit / Sun	**B1**
9(c)(iii)	arrow towards Sun **and** on Venus	**B1**
9(c)(iv)	it / Venus is in the gravitational field **or** the gravitational attraction	**M1**
	of the Sun	**A1**
9(d)(i)	Mercury	**B1**
9(d)(ii)	time taken is less **and** orbital speed is greater / circumference of orbit is less / closer to the Sun	**B1**
	circumference of orbit is less **and** orbital speed is greater.	**B1**