CAMBRIDGE
International Education

Cambridge IGCSE™ (9–1)

PHYSICS (9–1) **0972/41**

Paper 4 Theory (Extended) **May/June 2024**

MARK SCHEME

Maximum Mark: 80

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 May/June 2024 series for most Cambridge IGCSE, Cambridge International A and AS Level and Cambridge Pre-U 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 descriptions 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 mark	Final answer mark which is awarded for fully correct final answers including the unit.
C mark	Compensatory mark which may be scored when the final answer (A) mark for a question has not been awarded.
B mark	Independent mark which does not depend on any other mark.
M mark	Method mark which must be scored before any subsequent final answer (A) mark 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 is not awarded.
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.
/ or **OR**	Alternative answers any one of which gains the credit for that mark.
owtte	Or words to that effect.
ignore	Indicates either an incorrect or irrelevant point which may be disregarded, i.e., not treated as contradictory.
insufficient	An answer not worthy of credit on its own.
CON	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.
cao	Correct answer only.
ORA	Or reverse argument.

Question	Answer	Marks
1(a)	(acceleration is) rate of change in velocity **OR** change in velocity per unit time **OR** (a =) $\Delta v / \Delta t$	**B1**
1(b)	0.021 N	**A2**
	$F = ma$ **OR** (F =) ma **OR** 0.0075×2.8	C1
1(c)(i)	any **four** from: • (acceleration) decreases • (acceleration decreases) to zero (at approximately 0.03 s) • resistive force increases / resistance increases (as speed / velocity increases) • resultant force (downwards) decreases • (until) terminal velocity / constant speed (is reached) • (when) resistive force = weight **OR** resultant force is zero **OR** forces are balanced	**B4**
1(c)(ii)	tangent drawn at t = 0.010 s	**M1**
	1.2 m / s^2 $\leqslant$ acceleration $\leqslant$ 1.8 m / s^2	**A2**
	(a =) gradient of tangent **OR** (a =) {$\Delta y / \Delta x$}	C1

Question	Answer	Marks
2(a)(i)	0.16 m / s	**A3**
	conservation of momentum **OR** $m_P v_P = m_Q v_Q$ **OR** $2.7 \times v_P = 1.2 \times 0.36$ **OR** ($m_Q v_Q$ =) 0.432 seen	C1
	(v_P =) $m_Q v_Q / m_P$ **OR** $1.2 \times 0.36 / 2.7$	C1
2(a)(ii)	0.078 J	**A3**
	(k.e. =) $\frac{1}{2}mv^2$ **OR** (k.e. =) $\frac{1}{2} \times 1.2 \times 0.36^2$	C1
	(k.e. =) $\frac{1}{2} \times 1.2 \times 0.36^2$	C1
2(b)	(from) elastic (energy store in the compressed spring)	**B1**
	to kinetic (as final energy store of trolleys)	**B1**

Question	Answer	Marks
3(a)	(they / particles in ice) vibrate (about a fixed position) **OR** particles in water move throughout the liquid	**B1**
3(b)(i)	conduction	**B1**
3(b)(ii)	2.6×10^4 J	**A2**
	$c = (\Delta)E / m\Delta\theta$ **OR** (ΔE =) $mc\Delta\theta$ **OR** $0.34 \times 4200 \times 18$ **OR** 2.6×10^N (J)	C1
3(b)(iii)	density (of water next to the ice) increases	**B1**
	cold(er) water sinks	**B1**
	warm(er) water replaces cold water **OR** warm(er) water rises **OR** making a convection current	**B1**

Question	Answer	Marks
3(b)(iv)	internal energy decreases **AND** (average) kinetic energy (of particles) decreases	**A2**
	kinetic energy decreases	C1

Question	Answer	Marks
4(a)(i)	(point on principal axis) where rays of light parallel (to the principal axis, incident on converging lens)	**B1**
	(rays) meet / converge after passing through lens / refraction	**B1**
4(a)(ii)	X marked between one of the focal points and the lens **AND** E marked on other side of lens	**B1**
4(a)(iii)	virtual **AND** upright	**B1**
4(b)(i)	2.0×10^8 m / s	**A2**
	$n = c / v_g$ **OR** (v_g =) c / n **OR** (v_g =) $3(.0) \times 10^8 / 1.5$	C1
4(b)(ii)	(wavelength) decreases	**B1**
4(c)	long-sightedness	**B1**
	it moves the image towards the lens / back of the eye / retina **OR** reduces / shortens focal length of (combined lens)	**B1**
	(converging lens) focuses image on back of eye / retina	**B1**

Question	Answer	Marks
5(a)	any **two** from: • (longitudinal) vibration / oscillation in wave parallel to propagation direction / direction of travel • transverse wave vibrates / oscillates perpendicular to propagation direction / direction of travel • (longitudinal) consists of compressions and rarefactions • transverse wave consists of crests / peaks and troughs • (longitudinal) needs a medium (to travel)	**B2**
5(b)(i)	P-wave **AND** it is longitudinal	**B1**
5(b)(ii)	1.8×10^4 m **OR** 18 km	**A2**
	1.5λ **OR** $1.5 \times 1.2 \times 10^4$ **OR** 1.8×10^N	C1
5(b)(iii)	$v = f\lambda$ **OR** $v = \lambda / t$ **OR** (t =) λ / v **OR** $f = 4600 / 1.2 \times 10^4$ **OR** ($t / 5$ =) $1.2 \times 10^4 / 4600$ **OR** (t =) $6(.0) \times 10^4 / 4600$	**M1**
	13 s	**A2**
	$t = 1 / f$ **OR** (time for one wave =) 2.6 (s)	C1

Question	Answer	Marks
6(a)(i)	(region) where (an electric) charge experiences a force **OR** (region) where a force acts on a (an electric) charge	**B1**
6(a)(ii)	at least four straight radial lines **AND** evenly spaced (by eye) surrounding sphere	**B1**
	four lines touching sphere **AND** no lines inside sphere	**B1**
	at least **one** arrowhead towards sphere **AND** no incorrect arrowheads	**B1**

Question	Answer	Marks
6(b)(i)	electrons move (through the wire) from the sphere **OR** electrons move (through the wire) to(wards) the Earth	**A2**
	electrons move (in the wire)	C1
6(b)(ii)	2.5 A	**A3**
	$I = Q / t$ **OR** (I =) Q / t **OR** $3.5 \times 10^{-10} / 1.4 \times 10^{-10}$	C1
	2.5×10^{N}	C1

Question	Answer	Marks
7(a)	(electrical) work done moving a unit charge around a (complete) circuit	**A2**
	work done **AND** moving a charge (in a circuit)	C1
7(b)(i)	correct symbols for five cells in series	**B1**
	correct symbols for variable resistor **AND** fixed resistor	**B1**
	cells, variable resistor and fixed resistor connected in series	**B1**
7(b)(ii)	curve with negative gradient of decreasing magnitude from 0 Ω to 150 Ω **AND** does not reach the x-axis	**A2**
	curve / line with negative gradient from 0 Ω to 150 Ω	C1
	y-axis labelled 0.25 where candidate's line meets the y-axis **OR** the mark on the y-axis labelled 0.25	**A2**
	$R = V / I$ **OR** (I_{max} =) V / R **OR** 7.5 / 30	C1

Question	Answer	Marks
8(a)(i)	$^{0}_{-1}\beta$	**B1**
	$^{208}_{.....}Pb$	**B1**
	$^{.....}_{82}Pb$	**B1**
8(a)(ii)	γ-emission / it consists of waves / rays **OR** γ-emission has no mass / charge	**B1**
8(a)(iii)	(it contains) too many / excess of neutrons **OR** (nucleus is) <u>too</u> heavy	**B1**
8(b)	smooth curve (through magnetic field) **AND** labelled β	**B1**
	path towards bottom of page **AND** no upward component **AND** labelled β	**B1**
	(continuation of beam along) horizontal line through magnetic field **AND** labelled γ	**B1**

Question	Answer	Marks
9(a)	ultraviolet **AND** visible light **AND** infrared **only**	**A2**
	any **two** from: ultraviolet; visible light; infrared **and** no more than **one** incorrect addition	C1
9(b)	1.5×10^{11} m	**A2**
	$v = s / t$ **OR** (s =) vt **OR** $3.0 \times 10^{8} \times 500$ **OR** 1.5×10^{N}	C1
9(c)(i)	any **two** from: • cloud / nebula / it collapses • due to (internal) gravitational attraction • (internal) temperature increases	**B2**

Question	Answer	Marks
9(c)(ii)	any **three** from: • (nuclear) fusion / nuclear reactions (in the star) • forces are balanced • gravitational force is inwards • outwards force is due to high temperature	**B3**