Cambridge Assessment International Education

Cambridge IGCSE™ (9–1)

PHYSICS (9–1) **0972/41**

Paper 4 Extended Theory **May/June 2023**

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 2023 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 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 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)(i)	(magnitude of velocity =) 0.90 m / s	**A2**
	use of Pythagoras' theorem e.g. $a^2 + b^2 = c^2$ OR (speed =) $\sqrt{\left(0.54^2 + 0.72^2\right)}$ **OR** correct vector triangle or rectangle drawn	C1
	(direction of velocity =) 53° (to riverbank)	**A2**
	use of trigonometry to find angle e.g. $\tan\theta = 0.72 / 0.54$ **OR** (only) angle with horizontal identified on the diagram	C1
1(a)(ii)	(distance =) 81 m	**A3**
	$v = s / t$ **OR** (s =) vt **OR** (s =) $0.9(0) \times 90$	C1
	(time =) 1.5×60 (= 90) **OR** (time =) 90	C1
1(b)	friction (of water backwards) **OR** resistance (on swimmer backwards)	**B1**
	(friction / resistance) balances forward force **OR** (there is) no resultant force	**B1**

Question	Answer	Marks
2(a)(i)	(speed =) 38 m / s	**A2**
	$a = \Delta v / \Delta t$ **OR** (Δv =) $a\Delta t$ **OR** (Δv =) 7.2×5.3	C1
2(a)(ii)	(resultant force =) 1 700 N	**A2**
	$F = ma$ **OR** (F =) ma **OR** (F =) 240×7.2	C1
2(b)(i)	(vector) has direction (as well as magnitude) **OR** scalar does not have direction	**B1**

Question	Answer	Marks
2(b)(ii)	(velocity) changes (as direction of motion changes) **OR** direction (of velocity) changes	**B1**
2(b)(iii)	any **two** from: • because there is an acceleration / change in velocity / change in direction / change in momentum (which needs a resultant force) • motorcyclist accelerates / changes momentum (because velocity / direction changes) • (resultant) force is perpendicular to the motion (of the motorcycle) **OR** $a \propto F$	**B2**

Question	Answer	Marks
3(a)	heated / hot(ter) / warm(er) air is less dense **OR** cool(er) air is more dense	**B1**
	heated / hot(ter) / warm(er) air rises (to ceiling displacing cooler air) **OR** cool(er) air falls (displaced by warm(er) air)	**B1**
3(b)(i)	speed / velocity (of particles) increases **OR** (they) move faster	**B1**
3(b)(ii)	(higher temperature means) particles collide (with rubber) harder / with more force / with greater momentum (change)	**B1**
	(larger volume means) particles collide (with rubber) less frequently **OR** (larger volume means) larger (surface) area (for particle collisions)	**B1**
	effect of larger volume cancels effect of increased temperature / owtte **OR** the effect of larger area cancels the effect of larger force / owtte **OR** $P = F / A$ so the two changes cancel each other / owtte	**B1**

Question	Answer	Marks
4(a)(i)	c = (Δ)E / $m\Delta\theta$ **OR** (ΔE =) $mc\Delta\theta$	**B1**
	($\Delta\theta$ =) 21.5 – 19 OR ($\Delta\theta$ =) 2.5 (°C)	**B1**
	(ΔE =) 0.6(0) × 4200 × 2.5 **OR** (ΔE =) 0.6(0) × 4200 × {21.5 – 19}	**B1**
4(a)(ii)	(maximum possible efficiency =) 3.1% or 0.031	**A4**
	E = Pt **OR** (E =) Pt **OR** (E =) 13 × 500 **OR** (E =) 6500	C1
	(useful energy output =) 6500 – 6300 **OR** (useful energy output =) 200	C1
	efficiency = useful energy (output) / total energy (input) (× 100%) **OR** (efficiency =) useful energy (output) / total energy (input) (× 100%) **OR** (efficiency =) {6500 – 6300} / 6500 **OR** (efficiency =) 200 / 6500 (× 100%)	C1
	OR	
	P = E/t **OR** (P =) E / t **OR** (P =) 6 300 / 500 OR (P =) 12.6 (W)	(C1)
	(useful power output =) total power (output) – wasted power (output) **OR** (useful power output =) 13 – {6300 / 500} **OR** (useful power output =) 13–12.6	(C1)
	efficiency = useful power (output) / total power (input) (× 100%) **OR** (efficiency =) useful power (output) / total power (input) (× 100%) **OR** (efficiency =) 0.4 / 13 (× 100%)	(C1)
4(b)	any **one** from: • temperature change is an underestimate (due to thermal energy losses) • (thermal energy is) transferred from the water (to air / beaker / bench) • energy (other than light) transferred in lamp (filament / glass / internal structure) • (some) water evaporates	**B1**

Question	Answer	Marks
5(a)	(light / electromagnetic radiation) of a single frequency	**B1**
5(b)	angle of incidence / i = 0 **OR** incident ray along normal **OR** all of wavefront enters block at same time	**B1**
	angle of refraction / r = 0 **OR** no refraction **OR** whole wavefront slows down at same time	**B1**
5(c)	(c =) $\sin^{-}1\{1/1.5\}$ (= 42°) **OR** (c =) $\sin^{-1}\{1/n\}$ = 41.8°	**A2**
	n = 1 / sin c **OR** (c =) $\sin^{-1}\{1/n\}$ **OR** (c =) 41.8°	C1
5(d)(i)	<u>all</u> light is reflected	**B1**
	θ / angle of incidence > c / critical angle	**B1**
5(d)(ii)	<u>all</u> light is reflected **OR** reflected ray at 90° to incident ray **OR** reflected ray is parallel to original ray	**B1**

Question	Answer	Marks
6(a)	(wavelength =) 0.16 m	**A2**
	$v = f\lambda$ **OR** (λ =) v / f **OR** (λ =) $3 \times 10^8 / 1.9 \times 10^9$	C1
6(b)	(microwaves) only need short aerials / antennas	**B1**
	(microwaves) penetrate (some) walls	**B1**

Question	Answer	Marks
6(c)(i)	labelled diagram of digital (signal) with blocks of high (1) and low (0) **AND** labelled diagram of analogue with continuously variable signal	**B1**
	digital (signal) consists of <u>two</u> values owtte	**B1**
	analogue (signal) varies over a range (of values) owtte	**B1**
6(c)(ii)	any **two** from: • faster (data) transmission rate **OR** data can be compressed • data / signal transmitted over long(er) distances (as signal can be regenerated) • noise easily removed (from signal / data) **OR** signal can be regenerated	**B2**

Question	Answer	Marks
7(a)	any **two** from: • (potential divider) splits / shares / divides the e.m.f. / voltage / potential difference / p.d. (of a power source / in a circuit) • (e.m.f. is) split between (two) resistors / components (connected in series to power source) • (potential divider shares e.m.f.) in proportion to the resistances (of the resistors / components)	**B2**
7(b)(i)	(e.m.f. =) 15 V	**B1**
7(b)(ii)	(resistance =) 60 Ω	**A3**
	($R_{\|\|}$ =) R_2R_3 / (R_2 + R_3) **OR** ($R_{\|\|}$ =) 40 × 40 / (40 + 40) **OR** ($R_{\|\|}$ =) 1600 / 80 **OR** 1 / $R_{\|\|}$ = 1 / R_2 + 1 / R_3 **OR** 1 / $R_{\|\|}$ = 1 / 40 + 1 / 40 **OR** ($R_{\|\|}$ =) (1 / 40 + 1 / 40)$^{-1}$ **OR** ($R_{\|\|}$ =) 20 (Ω)	C1
	(resistance =) 40 + (candidate's value for combined resistance of R_2 and R_3)	C1

Question	Answer	Marks
7(c)	(reading =) 10 V	**A2**
	emf shared in same proportion as resistance **OR** e.g. $R_1 / R_{II} = V_1 / V_{II}$ **OR** (reading =) $15 \times 40 / 60$ **OR** (reading =) 0.25×40	C1

Question	Answer	Marks
8(a)	any **four** from: • alternating current in (primary coil) • (current in primary generates) changing magnetic field • iron core concentrates (magnetic) field **OR** iron core transfers (magnetic) field (to secondary coil) • secondary coil is in alternating / changing (magnetic) field **OR** secondary coil cuts (magnetic) field • e.m.f. induced (in secondary coil)	**B4**
8(b)(i)	(number of turns =) 3000	**A2**
	$N_p / N_s = V_p / V_s$ **OR** (N_p =) $N_s V_p / V_s$ **OR** (N_p =) $450 \times 220\,000 / 33\,000$	C1
8(b)(ii)	(current =) 350 A	**A3**
	$P = IV$ **OR** (I =) P / V **OR** (I =) $7.7 \times 10^7 / 220\,000$	C1
	(I =) 3.5×10^N	C1

Question	Answer	Marks
9(a)	(number of neutrons =) 7	**B1**
	any **one** from: • number of electrons = number of protons • white dots are protons / there are 5 protons • grey dots are neutrons • (number of neutrons) = 12 – 5	**B1**
9(b)(i)	(X2 has) one more proton more and one fewer neutron (than X1) **OR** (X2 has) 6 protons and 6 neutrons	**A2**
	(X2 has) one neutron fewer / one more proton (than X1) **OR** (X2 has) 6 protons / 6 neutrons	C1
9(b)(ii)	(X2) has fewer (excess) neutrons (in its nucleus) ORA	**B1**
9(c)(i)	time (taken)	**M1**
	for number of (radioactive) nuclei / atoms (in a sample of X1) to halve **OR** for rate of decay to halve	**A1**
9(c)(ii)	large number of particles produced in short time **OR** high / large decay rate **OR** high dose (of radiation) in short time	**B1**

Question	Answer	Marks
10(a)(i)	(speed) decreases (from X to Y) and then increases (from Y to X)	**B1**

Question	Answer	Marks
10(a)(ii)	any **three** from: • gravitational (potential) energy (GPE) transfers to kinetic energy (KE) or vice versa • KE transfers to GPE from X to Y **AND** GPE transfers to KE from Y to X • speed decreases as KE decreases / ORA • most GPE at Y **OR** least GPE at X • total (of GPE + KE) energy is constant	**B3**
10(b)(i)	–230 (°C)	**B1**
10(b)(ii)	(white surface) is a poor absorber / good reflector / poor emitter of IR / radiation **OR** black / other surface is a good absorber / poor reflector / good emitter of IR / radiation	**B1**
	any **one** from: • (the white surface) increases in temperature **less** when facing the Sun • (the white surface) decreases in temperature **less** when facing away (from Sun) • the black / other surfaces increases in temperature **more** when facing the Sun • the black / other surface decreases in temperature **more** when facing away (from Sun) • less variation in temperature on white surface (during one whole rotation)	**B1**