Cambridge Assessment International Education

Cambridge IGCSE™

PHYSICS **0625/41**

Paper 4 Extended Theory **October/November 2021**

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 October/November 2021 series for most Cambridge IGCSE™, Cambridge International A and AS Level components and some Cambridge O Level components.

© UCLES 2021

[Turn over

PUBLISHED

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.

© UCLES 2021

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.

© UCLES 2021

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.

© UCLES 2021

Examples of how to apply the list rule
State **three** reasons…. [3]

A

1	Correct	✓	**2**
2	Correct	✓	
3	Wrong	×	

B
(4 responses)

1	Correct, Correct	✓, ✓	**3**
2	Correct	✓	
3	Wrong	ignore	

C
(4 responses)

1	Correct	✓	**2**
2	Correct, Wrong	✓, ×	
3	Correct	ignore	

D
(4 responses)

1	Correct	✓	**2**
2	Correct, CON (of 2.)	×, (discount 2)	
3	Correct	✓	

E
(4 responses)

1	Correct	✓	**3**
2	Correct	✓	
3	Correct, Wrong	✓	

F
(4 responses)

1	Correct	✓	**2**
2	Correct	✓	
3	Correct CON (of 3.)	× (discount 3)	

G
(5 responses)

1	Correct	✓	**3**
2	Correct	✓	
3	Correct Correct CON (of 4.)	✓ ignore ignore	

H
(4 responses)

1	Correct	✓	**2**
2	Correct	×	
3	CON (of 2.) Correct	(discount 2) ✓	

I
(4 responses)

1	Correct	✓	**2**
2	Correct	×	
3	Correct CON (of 2.)	✓ (discount 2)	

© UCLES 2021

PUBLISHED

RM Assessor 3 annotations:

annotation	suggested use
tick	mark awarded (note the ticks are added up next to the tick annotation, check the total you enter agrees)
cross	no mark awarded
SEEN	indicates page seen
BOD	benefit of doubt given
NBOD	no benefit of doubt given
on page comment	gives a text box to write comment –much easier to use than in the previous version of RM assessor
ECF	error carried forward
^	omission mark
?	unclear
U UU	unit penalty applied unit penalty not applied because already applied earlier in same question

annotation	suggested use
wavy line (horizontal or vertical)	used to highlight a particular point
CON	contradiction
NAQ	not answered question
PD	poor diagram
SF SFSF	error in number of significant figures significant figure error not penalized.
POT POT POT	power-of-ten error POT penalty not applied as already applied
TV	too vague
I	ignore
SC	special case

© UCLES 2021

NOTES ABOUT MARK SCHEME SYMBOLS AND OTHER MATTERS

B marks	are independent marks, which do not depend on other marks. For a B mark to be scored, the point to which it refers must be seen specifically in the candidate's answer.
M marks	are method marks upon which further marks depend. For an M mark to be scored, the point to which it refers **must** be seen in a candidate's answer. If a candidate fails to score a particular M mark, then none of the dependent marks can be scored.
C marks	are compensatory marks in general applicable to numerical questions. These can be scored even if the point to which they refer are not written down by the candidate, **provided subsequent working gives evidence that they must have known it.** For example, if an equation carries a C mark and the candidate does not write down the actual equation but does correct substitution or working which shows he knew the equation, then the C mark is scored. A C mark is not awarded if a candidate makes two points which contradict each other. Points which are wrong but irrelevant are ignored.
A marks	In general, A marks are awarded for final answers to numerical questions. If a final numerical answer, eligible for A marks, is correct, with the correct unit and an acceptable number of significant figures, all the marks for that question are normally awarded.
Brackets ( )	Brackets around words or units in the mark scheme are intended to indicate wording used to clarify the mark scheme, but the marks do not depend on seeing the words or units in brackets, e.g. 10 (J) means that the mark is scored for 10, regardless of the unit given. However, if a word in brackets is replaced with another word that is clearly wrong then the mark should not be awarded.
Underlining	Underlining indicates that this **must** be seen in the answer offered, or something very similar.
OR / or	This indicates alternative answers, any one of which is satisfactory for scoring the marks.
eeoo.	This means "each error or omission".
owtte.	This means "or words to that effect".
Ignore	This indicates that something which is not correct or irrelevant i.e. it is not a contradiction (CON) is to be disregarded and does not incur a penalty.
Spelling	Be generous about spelling and use of English. If an answer can be understood to mean what we want, give credit. However, do not allow ambiguities, e.g. spelling which suggests confusion between reflection / refraction / diffraction or thermistor / transistor / transformer.

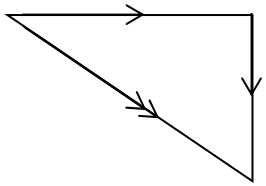
© UCLES 2021

Not/NOT	This indicates that an incorrect answer is not to be disregarded, but cancels another otherwise correct alternative offered by the candidate, i.e. right plus wrong penalty applies.
ecf	meaning "error carried forward" is mainly applicable to numerical questions, but may in particular circumstances be applied in non-numerical questions. This indicates that if a candidate has made an earlier mistake and has carried an incorrect value forward to subsequent stages of working, marks indicated by ecf may be awarded, provided the subsequent working is correct, bearing in mind the earlier mistake. This prevents a candidate from being penalised more than once for a particular mistake, but **only** applies to marks annotated ecf in the mark scheme. **Always annotate ecf if applied.**
cao	correct answer only
Significant Figures	Answers are normally acceptable to any number of significant figures $\geqslant 2$. Any exceptions to this general rule will be specified in the mark scheme. Annotate with SF from the toolbar. A second (or further) sig. fig. error in a single question is not penalised; annotate with SF SF. It is normally acceptable to quote just 1 s.f. for answers, which are exact to 1 s.f
Units	Deduct one mark for each incorrect or missing unit from an answer that would otherwise gain all the marks available for that answer: **maximum 1 per question**. No deduction is incurred if the unit is missing from the final answer but is shown correctly in the working. Annotate with U. For more than one unit error in a question, annotate UU to indicate an error which has not been penalised. Unless listed here or stated in the mark scheme for the question, do not accept derived units e.g. kg m s^{-2} for N is NOT acceptable. The following are acceptable alternatives: Nm for J, Js^{-1} or Nms^{-1} for W, Nm^{-2} for Pa, Ns and kg m s^{-1} are both acceptable for both momentum and impulse. Beware : J NOT acceptable for moments. Condone wrong use of upper and lower case symbols, e.g. pA for Pa.
Arithmetic errors	If the **only** error in arriving at a final answer is clearly an arithmetic one, then the mark awarded will be one mark lower than the maximum mark. Regard a power-of-ten error as an arithmetic error unless otherwise specified in the mark scheme. Annotate with POT. Do not penalise the same POT error more than once. Annotate POT POT. However if the power-of-ten error is due to the wrong omission or inclusion of g (= 10 N / kg) this rule does not apply. The use of a wrong SI prefix in the final answer is counted as a power-of-ten error rather than a unit error.
Transcription errors	If the only error in arriving at a final answer is because previously calculated data has clearly been misread, but used correctly, then for that part question the mark will be one less than the maximum mark.
Fractions	Allow these only where specified in the mark scheme; they are a form of sig. fig. error; annotate with SF. Consequently, when a sig. fig. error and a fraction is used in the same question, the second answer may still be awarded full marks.

© UCLES 2021

Crossed out	Work which has been crossed out **and not replaced but can easily be read**, should be marked as if it had not been crossed out. Look to see if it has been replaced on a blank page or another part of the same page.
Use of **NR**	(# or / key on the keyboard). Use this if the answer space for a question is completely blank or contains no readable words, figures or symbols.

© UCLES 2021

Question	Answer	Marks
1(a)	it / a vector has a direction	**B1**
1(b)	two / three vectors **and** no more than one other quantity underlined	**C1**
	acceleration **and** momentum **and** velocity underlined **and** no others	**A1**
1(c)(i)	5.5 N	**B1**
1(c)(ii)	correct right-angled triangle / rectangle / intersecting arcs seen e.g. 	**B1**
	(magnitude from) 9.6 to 10.0 N	**B1**
	(angle to vertical from) 54.0 to 57.5°	**B1**
1(c)(iii)	any **two** of: equal (in magnitude) opposite (in direction) the ring is in equilibrium **or** no resultant force on ring **or** forces on ring balance	**B2**

© UCLES 2021

Question	Answer	Marks
2(a)	(quantity of thermal) energy **or** energy (to increase temperature) **or** energy (transferred by heating)	**C1**
	energy to increase temperature (of an object) per degree Celsius 1 °C	**A1**
2(b)(i)	(internal energy) depends on kinetic energy (of molecules)	**B1**
	kinetic energy (of molecules) decreases **or** potential energy (of molecules) decreases	**B1**
2(b)(ii)	(ΔE =) $mc\Delta T$ in any form **or** $0.24 \times 4200 \times 17$	**C1**
	1.7×10^4 J	**A1**
2(c)(i)	k.e. of molecules / (thermal) energy absorbed (from water / surroundings) **or** energy absorbed from (cooling) water	**B1**
	supplies latent heat **or** energy used to overcome intermolecular forces / to break bonds	**B1**
2(c)(ii)	any determination of mass	**B1**
	determine change in mass (of ice) / increase in mass of water **or** dry the ice **or** ensure water is at 0 °C / equilibrium is established **or** insulate the beaker	**B1**
	use (l_f =) E / m in any form	**B1**

Question	Answer	Marks
3(a)	any **three** of: they / molecules collide with inner surface momentum (of a molecule) changes / reverses force exerted / impulse force spread over area / surface **or** $p = F / A$	**B3**
3(b)(i)	(V_2 =) p_1V_1 / p_2 in any form **or** $630 \times 1.0 \times 10^5 / 1.4 \times 10^5$	**C1**
	450 cm^3 **or** 4.5×10^{-4} cm^3 **or** 0.45 dm^3	**A1**
3(b)(ii)	any **two** of: molecules move more slowly / have less kinetic energy pressure (inside balloon) decreases **or** pressure is directly proportional to temperature **or** $p \propto T$ volume is directly proportional to temperature **or** $V \propto T$ molecular collisions less frequent molecular collisions less violent / hard / exert smaller impulse water / external pressure compresses balloon **or** water pressure greater (and balloon compressed)	**B2**

© UCLES 2021

Question	Answer	Marks
4(a)(i)	straight line begins at (15 s, 120 m) **and** continues to end of given line	**B1**
4(a)(ii)	curve with increasing gradient from origin to beginning of candidate's **(a)(i)**	**B1**
4(b)	(E_k =) $\frac{1}{2}mv^2$ in any form	**C1**
	$\frac{1}{2} \times 1.8 \times 10^5 \times 20^2$	**C1**
	3.6×10^7 J	**A1**
4(c)(i)	(work done =) force × distance (moved in the direction of the force)	**C1**
	(work done =) force × distance moved in the direction of the force	**A1**
4(c)(ii)	240 m **c.a.o.**	**B1**
4(c)(iii)	3.6×10^7 / 240 **or** kinetic energy / distance **or** (a =) 20 / 24 **or** $\Delta v / t$ in any form **or** 0.83 **or** (F =) ma in any form	**C1**
	1.5×10^5 N	**A1**

© UCLES 2021

Question	Answer	Marks
5(a)	(point) where (parallel) rays (of light) meet (after passing through lens)	**C1**
	point) where parallel rays (of light) meet / are focussed (after passing through lens) **or** (point) through which rays (of light) that emerge parallel pass (before reaching lens)	**A1**
5(b)	distance between principal focus / focal point and optical centre / lens	**B1**
5(c)(i)	vertical line labelled L 4.0 (± 0.2*)* cm to the right of O	**B1**
5(c)(ii)	paraxial ray from tip of O to candidate's lens **and** from lens to tip of I **or** paraxial ray from lens to tip of I **and** from tip of O to candidate's lens	**C1**
	3.0 (± 0.2*)* cm	**A1**
5(c)(iii)	fourth box ticked i.e: 	**B1**
	reversed / inverted	**B1**

Question	Answer	Marks
6(a)(i)	(J) ultraviolet (radiation) (K) infrared (radiation) (L) radio (waves)	
	two correct	**C1**
	all three correct	**A1**
6(a)(ii)	L **or** radio (waves)	**B1**
6(b)	(c =) 3.0×10^8 (m / s) seen	**C1**
	(f =) v / λ in any form **or** $3.0 \times 10^8 / 1.2 \times 10^{-9}$	**C1**
	2.5×10^{17} Hz	**A1**
6(c)(i)	stated <u>medical</u> use (e.g. treating cancer / X-ray shadowgraph / sterilising equipment)	**B1**
	statement of what happens to the X-rays (e.g. absorbed by tumour / bones / bacteria)	**B1**
	stated consequence (e.g. tumour killed **or** image / picture / shadow / photograph produced)	**B1**
6(c)(ii)	can cause burns / (cell) mutation / cell damage / tumours / cancer / damages DNA etc.	**B1**

© UCLES 2021

Question	Answer	Marks
7(a)	electrons mentioned	**B1**
	negative charges / electrons move from cloth **or** move to rod	**B1**
7(b)(i)	electrons / negative charge(s) repelled to earth **or** ball charged by induction	**B1**
	ball positively charged	**B1**
	opposite charges attract	**B1**
7(b)(ii)	negatively charged (by rod) **or** ball discharges / becomes neutral	**B1**
	repelled by rod **or** pulled down by gravity / its weight	**B1**

Question	Answer	Marks
8(a)	Q / t **or** (rate of) flow of (electric) charge / electrons	**B1**
8(b)	(current in the 450 Ω resistor =) $I_2 - I_1$	**B1**
8(c)	($V_{450\ \Omega}$ =) IR **or** 0.012 × 450 **or** 5.4 (V) **or** 9.0 – 5.4 **or** 3.6 (V) seen	**C1**
	(I =) 3.6 / 800 **or** 0.0045 (A)	**C1**
	(P =) VI **or** 3.6 × 0.0045 **or** 3.6^2 / 800	**C1**
	1.6×10^{-2} W **or** 16 mW	**A1**
8(d)	resistance (of LDR) decreases	**B1**
	current (in circuit) increases **or** resistance of parallel pair decreases	**C1**
	p.d. across 800 Ω resistor increases **and** p.d. across 450 Ω resistor decreases **or** resistance of parallel pair a smaller fraction of total resistance **and** p.d. across 450 Ω resistor decreases	**A1**

© UCLES 2021

Question	Answer	Marks
9(a)	(very small) nucleus **and** surrounded by electrons (in orbit / shells)	**B1**
	92 protons **or** 92 electrons **or** number of protons = number of electrons	**B1**
	protons and neutrons in nucleus	**B1**
	143 neutrons	**B1**
9(b)	(uranium-238 has) three more neutrons (in nucleus)	**B1**
9(c)	$^{94}_{(38)}$(E)	**B1**
	$^{(94)}_{38}$(E)	**B1**
9(d)(i)	55	**B1**
9(d)(ii)	140	**B1**

© UCLES 2021