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CAMBRIDGE
International Education

Cambridge O Level

PHYSICS **5054/21**

Paper 2 Theory **October/November 2025**

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 2025 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 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.

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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	<u>'List rule' guidance</u> 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.

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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.

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Annotations guidance for centres

Examiners use a system of annotations as a shorthand for communicating their marking decisions to one another. Examiners are trained during the standardisation process on how and when to use annotations. The purpose of annotations is to inform the standard isation and monitoring processes and guide the supervising examiners when they are checking the work of examiners within their team. The meaning of annotations and how they are used is specific to each component and is understood by all examiners who mark the component.

We publish annotations in our mark schemes to help centres understand the annotations they may see on copies of scripts. Note that there may not be a direct correlation between the number of annotations on a script and the mark awarded. Similarly, the use of an annotation may not be an indication of the quality of the response.

The annotations listed below were available to examiners marking this component in this series.

Annotations

Annotation	Meaning
	unclear response
	information missing or insufficient for credit
	evaluation attempted
	benefit of the doubt given
	contradiction in response or mark not awarded
	incorrect point or mark not awarded
	error carried forward applied
	used to highlight parts of an extended response
	highlight
	incorrect or insufficient point ignored while marking the rest of the response

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Annotation	Meaning
LNK	two statements are linked
MO	mandatory mark not awarded
POT	power of ten error
RE	rounding error
SC	special case
SEEN	point has been noted, but no credit has been given or blank page seen
SF	error in number of significant figures
T	answer outside the tolerance of the mark scheme
TV	response is too vague or there is insufficient detail in response
	correct point or mark awarded
	used to highlight parts of an extended response
U	incorrect unit

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Mark Scheme Abbreviations:

;	separates marking points
/	alternative responses for the same marking point
R	reject the response
A	accept the response
I	ignore the response
ecf	error carried forward
AVP	any valid point
ora	or reverse argument
AW	alternative wording
underline	actual word given must be used by candidate (grammatical variants excepted)
( )	the word / phrase in brackets is not required but sets the context
max	indicates the maximum number of marks that can be given
mp	marking point
cao	Correct answer only

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Question	Answer	Marks
1(a)	(change in momentum / momentum =) 18 000 (kg m / s)	C1
	(force =) $\frac{\text{change in momentum}}{\text{time taken}}$ **or** $\frac{18\,000}{1.5}$	C1
	12 000 (N)	A1
1(b)(i)	$\left(\frac{p^2}{2m} =\right) \frac{m^2v^2}{2m}$	B1
	shown to be $½mv^2$ (and equal to E_k / kinetic energy) $E_k = ½mv^2$ seen	B1
1(b)(ii)	39 000 seen	B1
	$(m =) \frac{39\,000^2}{2 \times 5.4 \times 105}$	C1
	1400 (kg)	A1

Question	Answer	Marks
2(a)(i)	360 (N)	B1
2(a)(ii)	(work done =) Fx **or** 360×13	C1
	4700 (J)	A1
2(b)(i)	(energy =) VIt **or** $230 \times 5.6 \times 11$	C1
	1.4×10^4 (J)	A1
2(b)(ii)	0.33 **or** 33%	B1

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Question	Answer	Marks
2(c)	any **two** from: (work done / GPE) to lift the cage / cable (energy transferred) thermally in motor (coils) (work done) overcoming friction / air resistance	**B2**

Question	Answer	Marks
3(a)	water molecules collide with molecules in ice	**B1**
	molecules in ice vibrate faster / with more energy / more vigorously / with greater amplitude **or** molecules knocked out of solid lattice / bonds are broken / forces of attraction are overcome	**B1**
3(b)(i)	(energy =) $mc\Delta\theta$ **or** $0.24 \times 4200 \times (22 - 6)$ **or** $0.24 \times 4200 \times 16$	**C1**
	1.6×10^4 (J)	**A1**
3(b)(ii)	any **two** from: (molecules of water have) no orderly arrangement (molecules of water) move within the water's volume (molecules of water are) closer together (molecules of water) slide over each other	**B2**
3(b)(iii)	plastic is a bad (thermal) conductor) **or** a good (thermal) insulator **or** no delocalised electrons in plastic	**B1**

Question	Answer	Marks
4(a)	any **two** from: (in glass) light / it travels more slowly / at a different speed enters (an optically) denser medium / medium with different refractive index wavelength changes (and frequency stays the same) angle of incidence is greater than 0	**B2**

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Question	Answer	Marks
4(b)(i)	(point) where parallel rays meet (after refraction)	C1
	(point) where rays parallel to principal axis meet (after refraction) **or** (point) where paraxial rays meet (after refraction)	A1
4(b)(ii)	distance between principal focus / focal point and (centre of) lens	B1
4(c)(i)	arrow of height 1.8 cm **and** 2.2 cm **and** on left of the centre of the lens	B1
4(c)(ii)	any **two** from: paraxial ray from tip of O to lens **and** from lens to F_2 straight ray through centre of lens ray that seems to come from F_1 from tip of O to lens **and** emerges paraxially from lens	M2
	two rays traced back to image (labelled I)	A1
4(c)(iii)	virtual **and** rays (merely) seem to come from I / do not pass through the image / object distance less than focal length / the image is upright	B1

Question	Answer			Marks
5(a)	fast(est) moving particles (more likely to) escape / molecules with high(er) (kinetic) energy escape?)	**or**	work done / energy needed to remove particles (from liquid)	B1
	(average kinetic) energy of molecules remaining decreases	**or**	energy transferred from internal energy of liquid / (kinetic) energy of particles	B1
5(b)(i)	magnetic field (of coil) mentioned			B1
	magnetic field (due to a.c.) is changing / alternating / reversing			B1
	e.m.f. in (base of) container			B1

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Question	Answer	Marks
5(b)(ii)	speed of particles increases	**B1**
	particles push each other apart	**B1**
	volume of liquid increases	**B1**
5(b)(iii)	less dense / heated liquid rises	**B1**
	denser / cooler liquid sinks **or** liquid near surface sinks **or** convection (current) established	**B1**

Question	Answer	Marks
6(a)	potential difference / p.d. (across a component) is directly proportional to the current (in the component)	**B1**
	at constant temperature / physical conditions	**B1**
6(b)(i)	(ammeter reading =) V/R **or** $\frac{E}{R_P + R_Q}$ **or** $\frac{9.0}{8.0 + 4.0}$	**C1**
	0.75 (A)	**A1**
6(b)(ii)	(power transferred =) IV **or** $0.75 \times (0.75 \times 8.0)$ **or** 0.75×6.0	**C1**
	4.5 (W)	**A1**
6(c)(i)	(length halves and so cross-sectional) area doubles **or** (new resistance =) $\frac{8.0 \times 0.50}{2.0}$	**C1**
	2.0 (Ω)	**A1**

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Question	Answer	Marks
6(c)(ii)	(voltmeter reading =) $\frac{E \times R_Q}{R_{new} + R_Q}$ **or** $\frac{9.0 \times 4.0}{2.0 + 4.0}$ **or** (I =) 1.5 A	**B1**
	6.0 (V)	**B1**

Question	Answer	Marks
7(a)	electrons mentioned **or** movement of negative charge mentioned	**C1**
	<u>electrons</u> move (from cloth) to rod	**A1**
7(b)(i)	(in conductors) <u>electrons</u> are free to move	**B1**
7(b)(ii)	like charges repel	**B1**
	negative charges / electrons move away from the rod / to the right	**B1**
	positive charges / protons do not move **or** left-hand side (of ball) becomes positively charged	**B1**
7(b)(iii)	unlike / opposite charges attract	**B1**
	attractive force stronger (than repulsive force on negative charges) / positive charges closer to the rod.	**B1**

Question	Answer	Marks
8(a)	different numbers of neutrons / nucleons	**C1**
	radon-222 / it has two fewer neutrons (in the nucleus) / radon-222 has 136 neutrons <u>and</u> radon-224 has 138 neutrons	**A1**

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Question	Answer	Marks
8(b)(i)	$^{4}_{2}$(a)	**B1**
	$^{218}_{.....}$(Po)	**B1**
	$^{.....}_{84}$(Po)	**B1**
8(c)(i)	count rate at detector J is not zero / is small **or** some alpha particles are deflected through large angles	**B1**
	detector K has larger / very large detection rate **or** most / nearly all alpha particles pass straight the gold sheet / are undeflected by the gold sheet	**B1**
8(c)(ii)	there is a concentration of charge in the atom	**B1**
	most of the mass of an atom is concentrated into a very small volume **or** most of the (volume of an) atom is empty space **or** atom has a dense nucleus	**B1**

Question	Answer	Marks
9(a)	speed is constant	**B1**
	(motion is) in a straight line	**B1**
9(b)(i)	to change the direction of the motion / velocity (of Venus) / otherwise it would move in a straight line	**B1**
9(b)(ii)	gravitational field / gravitational attraction / gravity	**B1**
	(gravitational field) of Sun	**B1**
	towards centre of circle / Sun / inward	**B1**

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Question	Answer	Marks
9(b)(iii)	(speed =) $\frac{2\pi r}{T}$ **or** $\frac{(2\times\pi)\times 1.1\times 1011}{5400\times(3600)}$	**C1**
	$3.6\times10^{4}\,(\text{m/s})$	**A1**
9(b)(iv)	Mercury	**B1**
	(its speed is) greater (than that of Venus)	**B1**

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