

Cambridge International AS & A Level

PHYSICS

9702/44

Paper 4 A Level Structured Questions

October/November 2025

MARK SCHEME

Maximum Mark: 100

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.

This document consists of **18** printed pages.











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 standardisation 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
	arithmetic error
	benefit of the doubt given
	contradiction in response, mark not awarded
	correct point or mark awarded
	error carried forward applied
	error in number of significant figures
	incorrect or insufficient point ignored while marking the rest of the response
	incorrect physics
	incorrect point or mark not awarded
	information missing or insufficient for credit

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Annotation	Meaning
MO	mandatory mark not awarded
SEEN	point has been noted, but no credit has been given or blank page seen
POT	power of ten error
TE	transcription error

PUBLISHED**Abbreviations**

/	Alternative and acceptable answers for the same marking point.
()	Bracketed content indicates words which do not need to be explicitly seen to gain credit but which indicate the context for an answer. The context does not need to be seen but if a context is given that is incorrect then the mark should not be awarded.
—	Underlined content must be present in answer to award the mark. This means either the exact word or another word that has the same technical meaning.

Mark categories

B marks	These are <u>independent</u> marks, which do not depend on other marks. For a B mark to be awarded, the point to which it refers must be seen specifically in the candidate's answer.
M marks	These are <u>mandatory</u> marks upon which A marks later depend. For an M mark to be awarded, the point to which it refers must be seen specifically in the candidate's answer. If a candidate is not awarded an M mark, then the later A mark cannot be awarded either.
C marks	These are <u>compensatory</u> marks which can be awarded even if the points to which they refer are not written down by the candidate, providing subsequent working gives evidence that they must have known them. For example, if an equation carries a C mark and the candidate does not write down the actual equation but does correct working which shows the candidate knew the equation, then the C mark is awarded. If a correct answer is given to a numerical question, all of the preceding C marks are awarded automatically. It is only necessary to consider each of the C marks in turn when the numerical answer is not correct.
A marks	These are <u>answer</u> marks. They may depend on an M mark or allow a C mark to be awarded by implication.

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Question	Answer	Marks
1(a)	(gravitational) force is (directly) proportional to product of masses	B1
	force (between point masses) is inversely proportional to the square of their separation	B1
1(b)(i)	force = $(6.67 \times 10^{-11} \times 4.0 \times 10^{30} \times 2.0 \times 10^{30}) / (3.3 \times 10^{12})^2$	C1
	= 4.9×10^{25} N	A1
1(b)(ii)	$a = F / m = (4.9 \times 10^{25}) / (4.0 \times 10^{30})$ = 1.2×10^{-5} m s ⁻²	A1
1(b)(iii)	$a = r\omega^2$ and $\omega = 2\pi / T$ or $a = v^2 / r$ and $v = (2\pi r / T)$	C1
	$r = (3.3 \times 10^{12}) / 3$	C1
	$T = 2\pi [(3.3 \times 10^{12}) / (3 \times 1.2 \times 10^{-5})]^{1/2}$ = 1.9×10^9 s	A1
1(b)(iv)	acceleration: B greater than A	B1
	linear speed: B greater than A	B1
	period: B equal to A	B1

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Question	Answer	Marks
2(a)(i)	p = pressure (of gas), V = volume (of gas) and k = Boltzmann constant	B1
	N = number of molecules (in the gas)	B1
	T = thermodynamic temperature (of gas)	B1
2(a)(ii)	$(pV =) NkT = \frac{1}{3}Nm\langle c^2 \rangle$	M1
	$E_K = \frac{1}{2}m\langle c^2 \rangle = \frac{1}{2} \times 3kT = (3/2)kT$	A1
2(b)	(same temperature so) $(\frac{1}{2})m\langle c^2 \rangle$ must be same for both gases	C1
	ratio = $\sqrt{(m_O / m_H)} = \sqrt{(32 / 2)}$ = 4.0	A1

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Question	Answer	Marks
3(a)	total kinetic energy associated with random motion of molecules	B1
	potential energy (of molecules) is zero	B1
3(b)(i)	$pV = NkT$ and $U = (3/2)NkT$	C1
	$U = (3/2)pV$ $= (3/2) \times 2.0 \times 10^5 \times 0.016$ $= 4800 \text{ J}$	A1
3(b)(ii)	temperature = 800 K	A1
3(b)(iii)	volume = 0.032 m ³	A1
3(b)(iv)	straight vertical line labelled X between A and (0.016, 4.0)	B1
	curve from B with continuously decreasing negative gradient, labelled Y	B1
	line labelled Y between (0.016, 4.0) and (0.032, 2.0)	B1

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Question	Answer	Marks
4(a)	<u>number</u> of oscillations per unit time	B1
4(b)(i)	kinetic energy (of object) reaches maximum / minimum / zero twice in a cycle	A1
4(b)(ii)	$\omega = 2\pi / T$ $= 2\pi / 0.80$ <p>or</p> $a_0 = \omega^2 x_0$ $\omega = \sqrt{(1.0 / 0.016)}$	C1
	$\omega = 7.9 \text{ rad s}^{-1}$	A1
4(b)(iii)	<p><i>Any three points from:</i></p> <ul style="list-style-type: none"> • oscillations are simple harmonic • <u>amplitude</u> = 0.016 m • maximum speed = 0.13 m s⁻¹ • total energy of oscillations = 7.0 × 10⁻⁴ J • mass of object = 0.087 kg • maximum momentum = 0.011 kg m s⁻¹ or 0.011 N s 	B3

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Question	Answer	Marks
4(b)(iv)	<p><i>Any two points from:</i></p> <ul style="list-style-type: none"> • kinetic energy is a maximum at zero displacement or kinetic energy is zero at maximum displacement • potential energy is zero at zero displacement or potential energy is a maximum at maximum displacement • kinetic energy is maximum when the potential energy is zero or potential energy is a maximum when the kinetic energy is zero 	B2
	kinetic energy + potential energy is constant	B1

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Question	Answer	Marks
5(a)	potential is (defined as) zero at infinity	B1
	proton has a positive charge and so repels another positive charge	B1
	work is done on two (positive) charges to move them towards each other or work is done by two (positive) charges as they move apart from each other	B1
5(b)(i)	arrow drawn through Q in a WSW direction directly away from the centre of the sphere	B1
5(b)(ii)	curve in at least one quadrant passing through $(\pm R, \pm E_0)$ and $(\pm 2R, \pm \frac{1}{4}E_0)$	B1
	curve between $-3R$ and $-R$ of increasing magnitude of gradient and curve between R and $3R$ of decreasing magnitude of gradient	B1
	two lines drawn, one in the top right quadrant, the other in the bottom left quadrant	B1
5(c)	$E_P = - (1.60 \times 10^{-19})^2 / [4\pi \times 8.85 \times 10^{-12} \times (5.3 \times 10^{-11})]$	C1
	$= -4.3 \times 10^{-18} \text{ J}$	A1

Question	Answer	Marks
6(a)(i)	conversion of a.c. to d.c.	B1
6(a)(ii)	full-wave (rectification)	B1
6(a)(iii)	three diodes with correct symbols connected into the circuit	B1
	lower-left diode shown pointing towards the right and upper-left and lower-right diodes both shown pointing towards the left	B1
6(b)(i)	$\omega = 18 \text{ (rad s}^{-1}\text{)}$	C1
	$T = 2\pi / 18 = 0.35 \text{ s}$	A1

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Question	Answer	Marks
6(b)(ii)	$V_{r.m.s.} = 34 / \sqrt{2}$ $= 24 \text{ V}$	A1
6(b)(iii)	sinusoidal 'humps' with minimum $V_{OUT} = 0$ and non-zero V_{OUT} all same sign	B1
	peak V_{OUT} shown as 34 V or -34 V	B1
	two 'humps' shown, with V_{OUT} always with same sign and $V_{OUT} = 0$ at $t = 0$, $t = 0.175 \text{ s}$ and $t = 0.350 \text{ s}$ and non-zero in between	B1
6(c)(i)	correct circuit symbol for capacitor, connected in parallel with resistor	B1
6(c)(ii)	time constant = RC	C1
	$= 56 \times 10^3 \times 12 \times 10^{-6}$	A1
	$= 0.67 \text{ s}$	
6(c)(iii)	$V_{min} = 34 \exp(-0.14 / 0.67)$	C1
	$= 28 \text{ V}$	A1

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Question	Answer	Marks
7(a)	direction of induced e.m.f.	M1
	such as to (produce effects that) oppose the change that caused it	A1
7(b)(i)	$\Phi = BA$	C1
	$= 0.047 \times 10^{-3} \times \pi \times 12^2$	C1
	$= 0.021 \text{ Wb}$	A1
7(b)(ii)	e.m.f. = flux cut / time	C1
	$= 0.021 / (1 / 85)$	A1
	$= 1.8 \text{ V}$	
7(b)(iii)	force (due to current) cause anticlockwise moment (to oppose rotation)	B1
	(from the LH rule) current is from O to X, so X is at the higher potential	B1

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Question	Answer	Marks
8(a)	(radioactive) substance introduced into the body	B1
	substance absorbed by the tissues being studied	B1
8(b)(i)	$P = 15$ and $R = 0$	A1
	$Q = 7$ and $S = (+)1$	A1
8(b)(ii)	(electron) neutrino	B1
8(c)(i)	<u>number</u> of nuclear disintegrations per unit time	B1
8(c)(ii)	decay constant = $\ln 2 / (2.04 \times 60)$	C1
	$= 5.66 \times 10^{-3} \text{ s}^{-1}$	A1
8(c)(iii)	$N = (2.85 \times 10^{-6}) / (15 \times 1.66 \times 10^{-27})$	C1
	$A = \lambda N$	C1
	rate = $(5.66 \times 10^{-3}) \times (2.85 \times 10^{-6}) / (15 \times 1.66 \times 10^{-27})$	C1
	$= 6.48 \times 10^{17} \text{ s}^{-1}$	A1
8(d)(i)	gamma photons	B1
8(d)(ii)	positron collides with electron (in body)	B1
	annihilation results in their masses becoming photon energy	B1

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Question	Answer	Marks
9(a)	emission of electrons (from a metal surface)	M1
	when electromagnetic radiation is incident (on surface)	A1
9(b)(i)	threshold frequency = $2F$	A1
9(b)(ii)	Planck constant = ϕ / F	A1
9(c)	two diagonal straight lines with positive gradient in the positive E_k region only, starting at non-zero values of f	B1
	line labelled X passing through $(F, 0)$ and line labelled Y passing through $(2F, 0)$ and extending to $3F$ or $+2\phi$	B1
	two diagonal straight lines with equal gradients	B1
	X line extrapolates back to $(0, -\phi)$ and Y line extrapolates back to $(0, -2\phi)$	B1

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Question	Answer	Marks
10(a)	recession of galaxy (from observer) causes emitted light to have	B1
	increase in <u>observed</u> wavelength / decrease in <u>observed</u> frequency	B1
10(b)	(distant) galaxies show redshift <u>so</u> galaxies are moving apart	B1
	galaxies moving apart <u>means</u> universe must be expanding	B1
10(c)	the speed of recession is proportional to the distance of the galaxies from each other or more distant galaxies are receding faster	B1
	<p><i>Any two points from:</i></p> <ul style="list-style-type: none"> • more distant galaxies represent further back in time • a long time ago, all matter in the universe must have been very close together • a long time ago, all matter in the universe must have been moving apart very fast 	B2