

Cambridge International AS & A Level

PHYSICS

9702/41

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 **17** 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)	velocity and acceleration both have constant magnitude	B1
	velocity is (always) perpendicular to acceleration	B1
1(b)(i)	$v = R\omega$	A1
1(b)(ii)	$a = R\omega^2$ or $a = v^2 / R$	C1
	$a = v\omega$	A1
1(c)(i)	$x = R \sin \theta$	A1
1(c)(ii)	$\theta = \omega t$	A1
1(c)(iii)	clear substitution of $\theta = \omega t$ into $x = R \sin \theta$ leading to $x = R \sin \omega t$	A1
1(c)(iv)	equation is of the form $x = x_0 \sin \omega t$ (so simple harmonic motion)	B1
1(d)(i)	amplitude = $0.46 / 2$ = 0.23 m	A1
1(d)(ii)	$\omega = 2\pi / T$	C1
	period = $2\pi / 1.9$ = 3.3 s	A1

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Question	Answer	Marks
1(d)(iii)	$a_0 = \omega^2 x_0$	C1
	$= 1.9^2 \times 0.23$	A1
	$= 0.83 \text{ m s}^{-2}$	
1(e)	shadow on screen, labelled A, above left-hand edge of the circular path	B1

Question	Answer	Marks
2(a)	work done on / by system	B1
	thermal energy supplied to / removed from system	B1
2(b)(i)	no thermal energy transferred to / from system (due to lack of time)	B1
	work is done on the gas to compress it / to decrease its volume	B1
	internal energy increases so temperature increases	B1
2(b)(ii)	(during vaporisation) molecular separation increases	B1
	(heating causes) potential energy of molecules to increase	B1
	kinetic energy of molecules unchanged so temperature unchanged	B1

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Question	Answer	Marks
3(a)	force per unit mass	B1
3(b)(i)	$F = GMm / x^2$	C1
	$g = F / m$	A1
	$g = [GMm / x^2] / m = GM / x^2$ and $G =$ gravitational constant	
3(b)(ii)	arrow drawn at P pointing directly towards the point mass	B1
3(b)(iii)	fields are in opposite directions	B1
	field strength at Q is four times the field strength at P	B1
3(c)	line starting at $(R, -g_0)$ and ending at $(L - R, +g_0)$	B1
	line passing through $(L / 2, 0)$	B1
	curve becoming shallower from R to $(L / 2)$ and then steeper from $(L / 2)$ to $(L - R)$	B1

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Question	Answer	Marks
4(a)(i)	temperature = $-273.15\text{ }^{\circ}\text{C}$	A1
4(a)(ii)	temperature = 0 K	A1
4(b)(i)	gas is ideal	B1
4(b)(ii)	$pV = NkT$	C1
	$N = 270 / (8.0 \times 10^{-21})$ $= 3.4 \times 10^{22}$	A1
4(b)(iii)	$n = (3.4 \times 10^{22}) / (6.02 \times 10^{23})$ $= 0.056\text{ mol}$	A1
4(c)	$\frac{1}{2} m\langle c^2 \rangle = (3 / 2) kT$	C1
	$\frac{1}{2} \times m \times 1900^2 = 1.5 \times 8.0 \times 10^{-21}$	C1
	$(m = 6.65 \times 10^{-27}\text{ kg})$	
	$m = (6.65 \times 10^{-27}) / (1.66 \times 10^{-27})$	C1
	$= 4.0\text{ u}$	A1

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Question	Answer	Marks
5(a)	work done per unit charge	B1
	work (done) moving positive charge from infinity (to the point)	B1
5(b)(i)	potential (due to proton) = $(1.60 \times 10^{-19}) / (4\pi \times 8.85 \times 10^{-12} \times 10 \times 10^{-12})$	C1
	or	
	potential (due to electron) = $(-1.60 \times 10^{-19}) / (4\pi \times 8.85 \times 10^{-12} \times 110 \times 10^{-12})$	
	$V = [(1.60 \times 10^{-19}) / (4\pi \times 8.85 \times 10^{-12})] \times [(10^{-1} - 110^{-1}) \times 10^{12}] = 130 \text{ V}$	A1
5(b)(ii)	$V = [(1.60 \times 10^{-19}) / (4\pi \times 8.85 \times 10^{-12})] \times [(30^{-1} - 90^{-1}) \times 10^{12}]$	C1
	= (+) 32 V	A1
5(b)(iii)	cross drawn midway between the electron and the proton	B1
5(b)(iv)	line from (10, +130) to (110, -130)	B1
	curve getting shallower until $x = 60 \text{ pm}$, crossing $V = 0$ at (60, 0) and then getting steeper after $x = 60 \text{ pm}$	B1
	curve passing through (30, ±32) and (90, ±32)	B1

Question	Answer	Marks
6(a)	series charges: $Q_s = Q_1 = Q_2$	B1
	series p.d.s: $V_s = V_1 + V_2$	B1
	parallel charges: $Q_s = Q_1 + Q_2$	B1
	parallel p.d.s: $V_s = V_1 = V_2$	B1
6(b)(i)	$E = \frac{1}{2} CV^2$	C1
	p.d. = $[(2 \times 19 \times 10^{-3}) / (470 \times 10^{-6})]^{1/2}$ $= 9.0 \text{ V}$	A1
6(b)(ii)	$E = Q^2 / 2C$ or $C = Q / V$	C1
	$Q = (19 \times 10^{-3} \times 2 \times 470 \times 10^{-6})^{1/2}$ or $Q = 470 \times 10^{-6} \times 9.0$ $Q = 4.2 \times 10^{-3} \text{ C}$	A1
	total charge unchanged	C1
6(b)(iii)	total capacitance = $(470 + 180) \times 10^{-6} \text{ (F)}$	C1
	$E = Q^2 / 2C = (4.23 \times 10^{-3})^2 / (2 \times 650 \times 10^{-6})$ (= 0.014 J)	A1
	$E = 14 \text{ mJ}$	

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Question	Answer	Marks
7(a)	(induced) e.m.f. is (directly) proportional to rate	M1
	of change of (magnetic) flux (linkage)	A1
7(b)(i)	flux = e.m.f. \times time	C1
	flux = 0.54×15 = 8.1 Wb	A1
7(b)(ii)	$\Phi = BA$	C1
	area = $8.1 / (38 \times 10^{-6})$ = $2.1 \times 10^5 \text{ m}^2$	A1
7(b)(iii)	area = speed \times time \times width	C1
	$v = (2.1 \times 10^5) / (15 \times 68)$ = 210 m s^{-1}	A1
7(b)(iv)	opposing force (due to current in wings) must be backwards	B1
	from Fleming's left-hand rule, current (in wings) must be from Q to P	B1
	current is from – to + inside an e.m.f. source so P is at higher potential	B1

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Question	Answer	Marks
8(a)	packet / quantum of <u>energy</u>	M1
	of electromagnetic radiation	A1
8(b)(i)	$E = c^2\Delta m$	C1
	$\Delta m = (4.274 \times 10^6 \times 1.60 \times 10^{-19}) / (1.66 \times 10^{-27} \times (3.00 \times 10^8)^2)$ (= 0.00458 u)	C1
	$m = 233.915174 + 4.000407 + 0.00458$ = 237.92016 u	A1
8(b)(ii)	$E = hc / \lambda$ or $E = hf$ and $c = f\lambda$	C1
	$(4.274 - 4.200) \times 1.60 \times 10^{-13} = (6.63 \times 10^{-34} \times 3.00 \times 10^8) / \lambda$	C1
	$\lambda = 1.7 \times 10^{-11} \text{ m}$	A1
8(b)(iii)	(true) energy of gamma photon is smaller so (true) wavelength is larger	B1
8(c)	(anti)neutrinos are emitted during beta decay	B1
	particles emitted during beta decay carry varying amounts of energy, so energy of gamma photon is also variable (between decays)	B1

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Question	Answer	Marks
9(a)	temperature inversely proportional to wavelength	M1
	temperature is thermodynamic temperature of surface of star and wavelength is the wavelength at which maximum emission rate from star occurs	A1
9(b)	<p><i>Any three points from:</i></p> <ul style="list-style-type: none"> • (surface) temperature of star X = 7000 K or star X has a higher temperature than the Sun • star X has a higher luminosity than the Sun • luminosity of star X = 2.7×10^{27} W • radius of star X = 1.3×10^9 m 	B3
9(c)	light (from star X) is redshifted	B1
	wavelength of peak emission rate would be greater (using observed data)	B1

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Question	Answer	Marks
10(a)	product of density and speed	M1
	speed of sound in medium (and density of the medium)	A1
10(b)	ultrasound waves cause crystal to vibrate	B1
	vibrations (of crystal) cause induced e.m.f. (across crystal)	B1
10(c)(i)	intensity reflection coefficient= $(40.4 - 1.48)^2 / (40.4 + 1.48)^2$	C1
	= 0.86	A1
10(c)(ii)	Z values are very similar	B1
	(almost) all the ultrasound will be transmitted or (almost) none of the ultrasound will be reflected	B1