CAMBRIDGE
International Education

Cambridge International AS & A Level

PHYSICS **9702/42**

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.

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
AE	arithmetic error
BOD	benefit of the doubt given
CON	contradiction in response, mark not awarded
	correct point or mark awarded
ECF	error carried forward applied
SF	error in number of significant figures
I	incorrect or insufficient point ignored while marking the rest of the response
XP	incorrect physics
	incorrect point or mark not awarded
^	information missing or insufficient for credit

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

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 independent 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 mandatory 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 compensatory 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 answer marks. They may depend on an **M** mark or allow a **C** mark to be awarded by implication.

Question	Answer	Marks
1(a)(i)	radius = $6.37 \times 10^6 \times \cos 52.2° = 3.90 \times 10^6$ m	**A1**
1(a)(ii)	period = 24 hours	**C1**
	$v = 2\pi r / T$ **or** $v = r\omega$ **and** $\omega = 2\pi / T$	**C1**
	$v = (2\pi \times 3.90 \times 10^6) / (24 \times 60 \times 60)$ $= 280$ m s^{-1}	**A1**
1(b)(i)	$F = mv^2 / r$	**C1**
	$= (58.6 \times 280^2) / (3.90 \times 10^6)$ $= 1.2$ N	**A1**
1(b)(ii)	arrow pointing horizontally to the left	**B1**
1(b)(iii)	arrow from student pointing along the dotted line, labelled 'weight'	**B1**
	upwards arrow from student pointing in a direction to the left of normal and above the tangent to the Earth, labelled 'contact force'	**B1**

Question	Answer	Marks
2(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**
2(b)	*Any two points from*: • molecules are in <u>continuous</u> random motion • molecules have negligible volume compared with volume of gas • collisions (involving molecules) are (perfectly) elastic • collisions (of molecules) are instantaneous	**B2**
2(c)(i)	$pV = nRT$	**C1**
	$p = (0.0160 \times 8.31 \times 282) / (1.87 \times 10^{-4})$ $= 2.01 \times 10^{5}$ Pa	**A1**
2(c)(ii)	number of molecules = $0.0160 \times 6.02 \times 10^{23}$	**C1**
	separation $= \sqrt[3]{[(1.87 \times 10^{-4}) / (0.0160 \times 6.02 \times 10^{23})]}$ $= 2.7 \times 10^{-9}$ m (*allow any answer that is 3 × 10⁻⁹ m to one significant figure*)	**A1**
2(d)(i)	$F = 6.67 \times 10^{-11} \times (3.34 \times 10^{-27})^2 / (2.7 \times 10^{-9})^2$	**C1**
	$= 1.0 \times 10^{-46}$ N	**A1**
2(d)(ii)	numerical comparison between 10^{-46} N (F) and 10^{-26} N (the weight of molecule) leading to a conclusion that the assumption is supported	**B1**

Question	Answer	Marks
3(a)	same temperature	**B1**
	no <u>net</u> transfer of thermal energy (between them)	**B1**
3(b)(i)	density	**B1**
3(b)(ii)	*Any two points from:* • large response time / large time to reach equilibrium **or** cannot measure rapidly changing temperatures • reaching equilibrium requires (significant) transfer of energy **or** changes temperature of environment being measured **or** cannot measure temperature of small objects • bulky / difficult to set up **or** difficult to take readings / scale not calibrated to read temperature **or** cannot measure temperature of solid objects	**B2**
3(b)(iii)	substance with large mass **or** temperature that is constant (over time) **or** to calibrate other thermometers (in a laboratory)	**B1**

Question	Answer	Marks
3(b)(iv)	0 °C = 273 K	**C1**
	T = 273 × (7.83 – 2.31) / (8.69 – 2.31) (= 236 K)	**C1**
	θ = 236 – 273 = – 37 °C	**A1**

Question	Answer	Marks
4(a)	change in internal energy = work done + energy transfer by heating	**C1**
	increase in internal energy = work done on system + energy transferred to the system by heating	**A1**
4(b)(i)	$U = (3 / 2)\ pV$	**A1**
4(b)(ii)	$pV = NkT$ and k identified as Boltzmann constant	**B1**
	$U = (3 / 2)\ NkT$	**A1**
4(c)(i)	$W = (+)8XY$	**A1**
4(c)(ii)	$W = –20XY$	**A1**
4(d)	work done during stages BC and DA = 0	**B1**
	change in internal energy (over complete cycle) = 0	**C1**
	thermal energy supplied = $20XY – 8XY$ = $(+)12XY$	**A1**

Question	Answer	Marks
5(a)(i)	straight line through the origin shows that a is proportional to x	**B1**
	negative gradient shows that a is always in the opposite direction to x	**B1**
5(a)(ii)	$a_0 = \omega^2 x_0$	**C1**
	$\omega = 2\pi / T$	**C1**
	$T = 2\pi \sqrt{(x_0 / a_0)}$ $= 2\pi \sqrt{(1.2 / 13)}$ $= 1.9$ s	**A1**
5(b)(i)	loss of energy of oscillations	**B1**
	due to <u>resistive</u> force(s)	**B1**
5(b)(ii)	line starting from $x = \pm 1.2$ cm at $t = 0$	**B1**
	line starting from non-zero value of x from $t = 0$ to $t = 2T$ that is entirely either above or below the t-axis	**B1**
	curve from $t = 0$ starting from non-zero x value, with both magnitude of x value and magnitude of gradient continuously decreasing	**B1**

Question	Answer	Marks
6(a)	force per unit positive charge	**B1**
6(b)(i)	radial lines	**B1**
	arrows pointing away from the sphere	**B1**
6(b)(ii)	$C = Q / V$	**C1**
	$V = 83 / 69$ $= (+)1.2$ V	**A1**
6(b)(iii)	$V = Q / 4\pi\varepsilon_0 r$ $r = (83 \times 10^{-12}) / (4\pi \times 8.85 \times 10^{-12} \times 1.2)$	**C1**
	$= 0.62$ m	**A1**
6(b)(iv)	$E = Q / 4\pi\varepsilon_0 r^2$	**C1**
	$= (83 \times 10^{-12}) / (4\pi \times 8.85 \times 10^{-12} \times 0.62^2)$ $= 1.9$ N C^{-1}	**A1**
6(c)	$26 = 83 \exp [- t / (120 \times 10^6 \times 69 \times 10^{-12})]$	**C1**
	$t = 9.6 \times 10^{-3}$ s	**A1**

Question	Answer	Marks
7(a)(i)	$T = 2\pi / 40\pi = 0.050$ s	**A1**
7(a)(ii)	$V_{r.m.s.} = 18 / \sqrt{2}$ $= 13$ V	**A1**
7(b)	sinusoidal curve of period 50 ms from $t = 0$ to $t = 100$ ms	**B1**
	correct phase (V_{MAX} at $t = 0$, 50, 100 ms and $-V_{MAX}$ at 25, 75 ms etc.)	**B1**
	maximum and minimum voltages shown as ± 18 V	**B1**
7(c)	*Any three points from*: • rectification is full-wave • mean power = 14 W • resistance of R = 12 Ω • peak current in R = 1.6 A **or** r.m.s. current in R = 1.1 A • period of <u>output</u> voltage / power = 25 ms ***or*** frequency of <u>output</u> voltage / power = 40 Hz **or** angular frequency of <u>output</u> voltage / power = 250 rad s^{-1}	**B3**

Question	Answer	Marks
8(a)	*Any three points from*: • electrons moving between levels emit a single photon • energy of photon = difference between energy levels • energy of photon depends on frequency • discrete frequencies (in spectrum) so differences between electron energies must be discrete • discrete differences between electron energies means energy levels must be discrete	**B3**
8(b)(i)	energy $= -(13.6 \times 1.60 \times 10^{-19})$ $= -2.18 \times 10^{-18}$ J	**A1**
8(b)(ii)	$\Delta E = hf$	**C1**
	$= (6.63 \times 10^{-34} \times 2.47 \times 10^{15}) / (1.60 \times 10^{-19}) = 10.2$ eV	**A1**
8(b)(iii)	$n = 2$ energy level = – 3.4 eV	**A1**
	$n = 3$ energy difference = 12.1 eV	**A1**
	$n = 4$ energy difference = 12.8 eV	**A1**
	$n = 3$ energy level = – 1.5 eV **and** $n = 4$ energy level = – 0.8 eV	**A1**

Question	Answer	Marks
9(a)	difference between mass of nucleus and mass of (constituent) nucleons	**M1**
	when nucleons are separated to infinity	**A1**
9(b)	$\Delta m = (2 \times 2.013553) - (4.001505)$ (u) $(= 0.025601$ u)	**C1**
	$E = c^2 \Delta m$	**C1**
	energy from one He-4 nucleus= $0.025601 \times 1.66 \times 10^{-27} \times (3.00 \times 10^8)^2$ $(= 3.82 \times 10^{-12}$ J)	**C1**
	energy to form 1.00 mol= $3.82 \times 10^{-12} \times 6.02 \times 10^{23}$ $= 2.30 \times 10^{12}$ J	**A1**
9(c)(i)	$L = 1.09 \times 10^{11} \times (3.00 \times 10^8)^2$	**C1**
	$= 9.81 \times 10^{27}$ W	**A1**
9(c)(ii)	$L = 4\pi\sigma r^2 T^4$ $9.81 \times 10^{27} = 4\pi \times 5.67 \times 10^{-8} \times (1.19 \times 10^9)^2 \times T^4$	**C1**
	$T = 9930$ K	**A1**
9(d)	standard candles have known luminosity	**B1**
	radiant flux intensity (from star) measured (on the Earth)	**B1**
	distance found from $F = L / (4\pi d^2)$	**B1**

Question	Answer	Marks
10(a)	<u>difference</u> in degrees of blackening	**B1**
10(b)(i)	$I = I_0 \exp(-\mu x)$ $= I_0 \exp(-5.8 \times 0.35) = 0.13\ I_0$	**A1**
10(b)(ii)	use of $\exp\{-(0.35 \times 3.7)\}$ factor	**C1**
	$0.053 I_0 = I_0 \exp\{-[(0.35 \times 3.7) + 2.1\mu]\}$	**C1**
	$\mu = 0.78\ \text{cm}^{-1}$	**A1**
10(b)(iii)	factor of only 2.5 between the (detected) <u>intensities</u> (so not good contrast)	**B1**
10(c)	(structure) scanned in (thin) sections	**B1**
	(many) scans (of each section) taken from different angles	**B1**
	scanning repeated for all sections and (data) compiled (to form 3D image)	**B1**