CAMBRIDGE
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Cambridge International AS & A Level

PHYSICS **9702/43**

Paper 4 A Level Structured Questions **May/June 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 May/June 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)	work done per unit mass	**B1**
	work (done in) moving mass from infinity (to the point)	**B1**
1(b)(i)	evidence of addition of 3.4×10^6 to 1.7×10^6 **or** 6.8×10^6	**C1**
	$GM \times 122 / (5.1 \times 10^6)$ **or** $GM \times 122 / (10.2 \times 10^6)$	**C1**
	$6.67 \times 10^{-11} \times M \times 122 \times [(5.1 \times 10^6)^{-1} - (10.2 \times 10^6)^{-1}] = 5.1 \times 10^8$ leading to $M = 6.4 \times 10^{23}$ kg	**A1**
1(b)(ii)	$\phi = (-)(6.67 \times 10^{-11} \times 6.4 \times 10^{23}) / (3.4 \times 10^6)$	**C1**
	$= -1.3 \times 10^7$ J kg^{-1}	**A1**
1(c)(i)	Mars takes (just under) 25 hours to rotate once on its axis	**B1**
1(c)(ii)	orbit is equatorial **or** orbit is in same direction as direction of rotation of Mars	**B1**

Question	Answer	Marks
2(a)	(electric) force is (directly) proportional to product of charges	**B1**
	force (between point charges) is inversely proportional to the square of their separation	**B1**
2(b)(i)	charge = (+)2*e*	**A1**
2(b)(ii)	$F = 2 \times (1.60 \times 10^{-19})^2 / [4\pi \times 8.85 \times 10^{-12} \times (170 \times 10^{-12})^2] = 1.6 \times 10^{-8}$ N	**A1**
2(c)(i)	$F = mv^2 / r$	**C1**
	$v = [\ (1.6 \times 10^{-8} \times 170 \times 10^{-12}) / (9.11 \times 10^{-31})\ ]^{½}$ $= 1.7 \times 10^6$ m s^{-1}	**A1**
2(c)(ii)	$F = mr\omega^2$ **and** $\omega = 2\pi / T$ $F = 4\pi^2 mr / T^2$	**C1**
	$T = [\ (4\pi^2 \times 9.11 \times 10^{-31} \times 170 \times 10^{-12}) / (1.6 \times 10^{-8})\ ]^{½}$ $= 6.2 \times 10^{-16}$ s	**A1**
	or	
	$v = 2\pi r / T$	**(C1)**
	$T = (2\pi \times 170 \times 10^{-12}) / (1.73 \times 10^6)$ $= 6.2 \times 10^{-16}$ s	**(A1)**

Question	Answer	Marks
2(d)(i)	$E \propto Q / r^2$	**C1**
	ratio = $[1.60 \times 10^{-19} \times (170 \times 10^{-12})^2] / [3.2 \times 10^{-19} \times (340 \times 10^{-12})^2]$ = 0.13	**A1**
2(d)(ii)	resultant force slightly less (than 1.6×10^{-8} N) so speed lower **or** resultant force slightly less (than 1.6×10^{-8} N) so period greater	**B1**

Question	Answer	Marks
3(a)	(thermal) energy per unit mass (to cause state change)	**B1**
	(thermal) energy to change state at constant temperature	**B1**
3(b)	(for vaporisation): involves greater change in volume (of substance) **or** involves greater increase in separation of molecules	**B1**
	more work has to be done by molecules (to separate) **or** greater increase in potential energy of molecules	**M1**
	kinetic energy of molecules unchanged, so more thermal energy needed	**A1**
3(c)	$Q = mc\Delta\theta$ **and** $Q = mL$	**C1**
	$\Delta\theta$ for the water = 26.4 – 10.3	**C1**
	$(37.0 \times L) + (37.0 \times 4.18 \times 10.3) = (208 \times 4.18 \times 16.1)$	**C1**
	$L = 335\ \text{J g}^{-1}$	**A1**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>4(a)(i)</td><td>sum of potential energy and kinetic energy</td><td>B1</td></tr>
<tr><td></td><td>(total) energy of random motion of particles</td><td>B1</td></tr>
<tr><td>4(a)(ii)</td><td>potential energy (of molecules) (in an ideal gas) is zero, so the internal energy of the gas is equal to the total kinetic energy (of molecules)</td><td>B1</td></tr>
<tr><td></td><td>kinetic energy of molecules is proportional to (thermodynamic) temperature (so internal energy is proportional to (thermodynamic) temperature))</td><td>B1</td></tr>
<tr><td>4(b)</td><td>cooling work done = 0</td><td>B1</td></tr>
<tr><td></td><td>compression increase in internal energy = +2U</td><td>B1</td></tr>
<tr><td></td><td>cooling change in internal energy = –U</td><td>B1</td></tr>
<tr><td></td><td>both rows: thermal energy adds to work to give increase in internal energy in terms of U and/or W

(if fully correct, thermal energy for compression = 2U – W and thermal energy for cooling = –U:

<table><tr><td>compression</td><td>+W</td><td>2U – W</td><td>+2U</td></tr><tr><td>cooling</td><td>0</td><td>–U</td><td>–U</td></tr></table>)</td><td>B1</td></tr>
</table>

Question	Answer	Marks
5(a)(i)	amplitude = 0.60 m	**A1**
5(a)(ii)	oscillations are simple harmonic	**B1**
5(b)	*Any three points from:* • mean / equilibrium position is at h = 1.4 m • total energy of oscillations = 9.0 J • angular frequency of oscillations = 1.2 rad s^{-1} **or** period of oscillations = 5.1 s **or** frequency of oscillation = 0.19 Hz • maximum speed of block = 0.73 m s^{-1} • mass of block = 33 kg	**B3**
5(c)	U-shaped curve resting on h axis (with minimum at $E_P = 0$)	**B1**
	curve from h = 0.8 m to h = 2.0 m, with minimum E_P shown at h = 1.4 m	**B1**
	both end-points of curve shown at E_P = 9.0 J	**B1**

Question	Answer	Marks
6(a)(i)	conversion from a.c. to d.c.	**B1**
6(a)(ii)	smoothing	**B1**
6(b)(i)	$A = 12$ V	**A1**
	$B = 2\pi / (20 \times 10^{-3})$ $= 310$ rad s^{-1}	**A1**
6(b)(ii)	full-wave (rectification)	**B1**
6(b)(iii)	four diodes shown, with correct circuit symbols	**B1**
	four diodes correctly connected to form a bridge rectifier	**B1**
6(b)(iv)	$V = V_0 \exp(-t / \tau)$ **or** $V = V_0 \exp(-t / RC)$ **and** $\tau = RC$	**C1**
	$8.0 = 12 \exp(-7.3 \times 10^{-3} / \tau)$	**C1**
	$\tau = 0.018$ s	**A1**
6(c)	time constant $= RC$	**C1**
	$R = (0.018 / 570 \times 10^{-6})$ $= 32\ \Omega$	**A1**

Question	Answer	Marks
7(a)	• force per unit length • force per unit current • length / current perpendicular to field *1 mark for any two points, 2 marks for all three points.*	**B2**
7(b)(i)	$F = BQv$	**B1**
7(b)(ii)	arrow at Y pointing vertically upwards	**B1**
7(b)(iii)	upwards deflection showing circular path	**B1**
7(c)(i)	electric field applied vertically downwards (may be shown on a labelled diagram)	**B1**
	electric force on particle in opposite direction to magnetic force (may be shown on a labelled diagram)	**B1**
	particle undeflected when magnitudes of electric and magnetic forces are equal	**B1**
7(c)(ii)	$EQ = BQv$	**B1**
	$v = E / B$	**A1**

Question	Answer	Marks
8(a)	wavelength associated with a moving particle	**B1**
8(b)	$\lambda = h / p$	**C1**
	$= (6.63 \times 10^{-34}) / (9.11 \times 10^{-31} \times 4.9 \times 10^{7})$ $= 1.5 \times 10^{-11}$ m	**A1**
8(c)	similarity: *any one point from*: • same mass • same magnitude of charge • both leptons	**B1**
	difference: *any one point from*: • electron has negative charge, positron has positive charge • positron is anti-particle of electron • electron is a particle, positron is an anti-particle	**B1**
8(d)(i)	(pair) annihilation	**B1**
8(d)(ii)	their mass gets converted into energy	**B1**
	(their mass–energy) becomes the energy of the gamma photons	**B1**
8(d)(iii)	they travel in opposite directions to conserve momentum	**B1**
8(d)(iv)	kinetic energy $= ½ \times 9.11 \times 10^{-31} \times (4.9 \times 10^{7})^2 = 1.1 \times 10^{-15}$ J	**A1**

Question	Answer	Marks
8(d)(v)	$E = mc^2$	**C1**
	$E = hc / \lambda$ **or** $E = hf$ **and** $c = f\lambda$	**C1**
	$(1.1 \times 10^{-15}) + (9.11 \times 10^{-31} \times (3.00 \times 10^8)^2) = (6.63 \times 10^{-34} \times 3.00 \times 10^8) / \lambda$ $\lambda = 2.39 \times 10^{-12}$ m	**A1**

Question	Answer	Marks
9(a)	number of nuclear disintegrations per unit time	**B1**
9(b)	activity is proportional to the number of undecayed nuclei	**B1**
	activity = (–) rate of change of number of undecayed nuclei	**B1**
	N is proportional to the rate of change of N (so exponential variation)	**B1**
9(c)(i)	$120 = 180 \exp(-\lambda \times 8.4)$	**C1**
	$\lambda = 0.048\ \text{min}^{-1}$	**A1**
9(c)(ii)	half-life = ln 2 / 0.048 = 14 min	**A1**
9(c)(iii)	line with negative gradient throughout, starting at (0, 180)	**B1**
	curve with negative gradient passing through (8.4, 120)	**B1**
	curve with decreasing negative gradient, from $t = 0$ to $t = 24$ min, passing through (14, 90)	**B1**

Question	Answer	Marks
10(a)	speed is (directly) proportional to distance	**M1**
	speed is speed of recession of galaxy from an observer, and distance is the distance of the galaxy from the observer	**A1**
10(b)(i)	galaxy is receding from the Earth	**B1**
	observed wavelength is redshifted from emitted wavelength	**B1**
10(b)(ii)	$\Delta\lambda / \lambda = v / c$ $(4.91 - 4.62) / 4.62 = v / (3.00 \times 10^8)$	**C1**
	$v = 1.9 \times 10^7$ m s^{-1}	**A1**
10(b)(iii)	wavelength (of maximum intensity) is inversely proportional to temperature	**B1**
	observed wavelength too high, so determined temperature too low	**B1**
10(c)	$v = H_0 d$	**C1**
	$d = (1.9 \times 10^7) / (2.3 \times 10^{-18})$ $= 8.3 \times 10^{24}$ m	**A1**