CAMBRIDGE
International Education

Cambridge International AS & A Level

PHYSICS **9702/22**

Paper 2 AS Level Structured Questions **October/November 2024**

MARK SCHEME

Maximum Mark: 60

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.

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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.

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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)	a quantity with magnitude and direction	**B1**
1(b)(i)	SI base units of D: kg m s^{-2}	**C1**
	SI base units of r: m **and** v: m s^{-1}	**C1**
	base units of η: kg m s^{-2} / (m × m s^{-1}) = kg m^{-1} s^{-1}	**A1**
1(b)(ii)	$W = U + D$	**A1**
1(b)(iii)	U = 830 × 9.81 × 4.6 × $(10^{-2})^3$ (= 0.037 N)	**C1**
	W = 0.037 + 0.32 = 0.36 N	**A1**

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Question	Answer	Marks
2(a)	product of mass and velocity	**B1**
2(b)	$F = m\Delta v / \Delta t$ $= 16 \times 0.60 / 1.1$	**C1**
	$= 8.7$ N	**A1**
2(c)	$x = ut + ½at^2$ $x = 0.60 \times 3.7 + ½ \times 0.85 \times 3.7^2$	**C1**
	or	
	$v = 0.60 + 0.85 \times 3.7$ (= 3.75 m s^{-1}) $x = 3.75 \times 3.7 – 0.5 \times 0.85 \times 3.7^2$ **or** $x = ½ \times (0.60 + 3.75) \times 3.7$ **or** $x = (3.75^2 – 0.60^2) / (2 \times 0.85)$	**(C1)**
	$x = 8.0$ m	**A1**
2(d)(i)	$F = W / s$	**C1**
	$= 250 / 18$ $= 14$ N	**A1**
2(d)(ii)	any line starting at distance = 0 and a positive non-zero value of kinetic energy	**B1**
	a straight line from distance = 0 to distance = x with positive gradient	**B1**
	a straight horizontal line at a non-zero value of kinetic energy starting at distance = x and ending at distance = x + 18 m that is continuous with the previous line	**B1**

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Question	Answer	Marks
3(a)(i)	$E = \sigma / \varepsilon$ **or** E = gradient	**C1**
	E = e.g. $12 \times 10^7 / 0.0050$ $= 2.4 \times 10^{10}$ Pa	**A1**
3(a)(ii)	cross drawn at (1.0%, 24×10^7 Pa), labelled Q	**B1**
3(b)	resultant force (in any direction) is zero	**B1**
	resultant moment / torque (about any point) is zero	**B1**
3(c)(i)	(moment =) $33 \times 0.65 / 2$ **or** $1.5 \times (0.65 - 0.12)$ **or** $T \sin 50° \times (0.65 / 2)$	**C1**
	sum of clockwise moments = sum of anticlockwise moments $33 \times (0.65 / 2) + 1.5 \times (0.65 - 0.12) = T \sin 50° \times (0.65 / 2)$	**C1**
	tension = 46 N	**A1**
3(c)(ii)	$\sigma = F / A$	**C1**
	$\pi r^2 = 46 / (1.5 \times 10^7)$ $r = 9.9 \times 10^{-4}$ m	**A1**

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Question	Answer	Marks
3(c)(iii)	elastic limit is not reached **or** (new) stress is less than (stress at) elastic limit **or** (new) strain is less than (strain at) elastic limit	**M1**
	(so the wire behaves) elastically	**A1**

Question	Answer	Marks
4(a)	longitudinal waves have oscillations parallel to the (direction of) transfer of energy	**B1**
	transverse waves have oscillations perpendicular to the (direction of) transfer of energy	**B1**
4(b)(i)	A marked at the open end of the pipe	**B1**
4(b)(ii)	$f = v / \lambda$	**C1**
	$\lambda = 4 \times 4.5 \times 10^{-2}$	**C1**
	$f = 340 / (4 \times 4.5 \times 10^{-2})$ $= 1900$ Hz	**A1**
4(b)(iii)	the node–antinode distance is longer **or** the wavelength (of the wave) is longer	**M1**
	(the speed of sound is constant so) the frequency (of the wave) is lower	**A1**

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Question	Answer	Marks
5(a)	energy transferred per unit charge (from electrical to other forms)	**B1**
5(b)(i)	heater	**A1**
5(b)(ii)	(V =) 7.0 × 0.86 = 6.0 (V)	**A1**
5(b)(iii)	I = (230 – 6.0) / 170 (= 1.3 A)	**C1**
	I_1 = 7.0 – 1.3 = 5.7 A	**A1**
5(b)(iv)	V = 230 – 6.0 – (5.7 × 2.4)	**C1**
	= 210 V	**A1**
	or	
	R = ((230 – 6.0) / 5.7) – 2.4 (= 36.9 Ω)	**(C1)**
	V = 5.7 × 36.9 = 210 V	**(A1)**

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Question	Answer	Marks
5(b)(v)	$P = IV$ **or** $P = I^2R$ **or** $P = V^2 / R$	**C1**
	$P = 5.7 \times 210$ **or** $P = 5.7^2 \times (210 / 5.7)$ **or** $P = 210^2 / (210 / 5.7)$ $P = 1200$ W	**A1**
5(b)(vi)	% efficiency = <u>useful</u> power out / (total) power in ($\times$ 100)	**C1**
	= 1200 / (230 $\times$ 7.0) ($\times$100) = 0.75 ($\times$ 100) = 75% or 74% (using 3 s.f. value from **(v)** gives 74%)	**A1**
5(b)(vii)	(current) decreases	**A1**

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Question	Answer	Marks
6(a)	mass of α (particle) is <u>much</u> greater (than β^+ particle)	**B1**
	both particles are positively charged	**B1**
	(magnitude of) charge on α (particle) is twice the charge (on β^+ particle)	**B1**
6(b)(i)	cross labelled Q at (82, 212)	**B1**
6(b)(ii)	particles emitted are: • beta-minus (particle) / electron • (electron) antineutrino either particle named	**B1**
	both particles named and no incorrect particles named	**B1**
6(c)(i)	$212(u) \times 1.3 (\times 10^5) \sin 68°$ **or** $4(u) \times 150 (\times 10^5) \sin \theta$	**C1**
	$4(u) \times 150 (\times 10^5) \times \sin \theta = 212(u) \times 1.3 (\times 10^5) \times \sin 68°$	**C1**
	$\sin \theta = 0.426$ $\theta = 25°$	**A1**
6(c)(ii)	$E = \frac{1}{2}mv^2$	**C1**
	$= \frac{1}{2} \times 4 \text{ u} \times (150 \times 10^5)^2$ $= \frac{1}{2} \times 4 \times 1.66 \times 10^{-27} \times (150 \times 10^5)^2$ $= 7.5 \times 10^{-13}$ J	**A1**

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