

Cambridge International AS & A Level

PHYSICS**9702/21**

Paper 2 AS Level Structured Questions

May/June 2025

MARK SCHEME

Maximum Mark: 60

Published

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This document consists of **14** printed pages.

PUBLISHED**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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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.

Science-Specific Marking Principles

- 1 Examiners should consider the context and scientific use of any keywords when awarding marks. Although keywords may be present, marks should not be awarded if the keywords are used incorrectly.
- 2 The examiner should not choose between contradictory statements given in the same question part, and credit should not be awarded for any correct statement that is contradicted within the same question part. Wrong science that is irrelevant to the question should be ignored.
- 3 Although spellings do not have to be correct, spellings of syllabus terms must allow for clear and unambiguous separation from other syllabus terms with which they may be confused (e.g. ethane / ethene, glucagon / glycogen, refraction / reflection).
- 4 The error carried forward (ecf) principle should be applied, where appropriate. If an incorrect answer is subsequently used in a scientifically correct way, the candidate should be awarded these subsequent marking points. Further guidance will be included in the mark scheme where necessary and any exceptions to this general principle will be noted.
- 5 'List rule' guidance

For questions that require ***n*** responses (e.g. State **two** reasons ...):
 - The response should be read as continuous prose, even when numbered answer spaces are provided.
 - Any response marked *ignore* in the mark scheme should not count towards ***n***.
 - Incorrect responses should not be awarded credit but will still count towards ***n***.
 - Read the entire response to check for any responses that contradict those that would otherwise be credited. Credit should **not** be awarded for any responses that are contradicted within the rest of the response. Where two responses contradict one another, this should be treated as a single incorrect response.
 - Non-contradictory responses after the first ***n*** responses may be ignored even if they include incorrect science.

6 Calculation specific guidance

Correct answers to calculations should be given full credit even if there is no working or incorrect working, **unless** the question states 'show your working'.

For questions in which the number of significant figures required is not stated, credit should be awarded for correct answers when rounded by the examiner to the number of significant figures given in the mark scheme. This may not apply to measured values.

For answers given in standard form (e.g. $a \times 10^n$) in which the convention of restricting the value of the coefficient (a) to a value between 1 and 10 is not followed, credit may still be awarded if the answer can be converted to the answer given in the mark scheme.

Unless a separate mark is given for a unit, a missing or incorrect unit will normally mean that the final calculation mark is not awarded. Exceptions to this general principle will be noted in the mark scheme.

7 Guidance for chemical equations

Multiples / fractions of coefficients used in chemical equations are acceptable unless stated otherwise in the mark scheme.

State symbols given in an equation should be ignored unless asked for in the question or stated otherwise in the mark scheme.

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
	Information missing or insufficient for credit
	Arithmetic error
	Benefit of the doubt given
	Contradiction in response, mark not awarded
	Incorrect point or mark not awarded
	Error carried forward applied
	Ignore the response
	Mandatory mark not awarded
	Power of ten error
	Blank page seen
	Error in number of significant figures

Annotation	Meaning
	Transcription error
	Correct point or mark awarded
	Incorrect physics

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>method</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.

Question	Answer	Marks
1(a)	rate of change of velocity	B1
1(b)(i)	$s = ut + \frac{1}{2}at^2$ and $u = 0$ or $s = \frac{1}{2}at^2$ $t = \sqrt{(2 \times 14 / 9.81)}$	C1
	$t = 1.7 \text{ s}$	A1
	OR $v = \sqrt{(0^2 + 2 \times 9.81 \times 14)}$ $v = 17 \text{ (m s}^{-1}\text{)}$ $17 = (0 + 9.81) \times t$ or $17 = 9.81 \times t$ or $14 = \frac{1}{2} \times (0 + 17) \times t$ or $14 = \frac{1}{2} \times 17 \times t$	(C1)
	$t = 1.7 \text{ s}$	(A1)
1(b)(ii)	$s = ut + \frac{1}{2}at^2$ $u = (3.6 - \frac{1}{2} \times 9.81 \times 1.7^2) / 1.7$	C1
	$u = (-) 6.2 \text{ m s}^{-1}$	A1
	OR $v = (3.6 + \frac{1}{2} \times 9.81 \times 1.7^2) / 1.7$ $v = 10 \text{ (m s}^{-1}\text{)}$ $10 = u + 9.81 \times 1.7$ or $10^2 = u^2 + (2 \times 9.81 \times 3.6)$ or $3.6 = \frac{1}{2} \times (u + 10) \times 1.7$	(C1)
	$u = (-) 6.2 \text{ m s}^{-1}$	(A1)

Question	Answer	Marks
1(c)(i)	Less time (as it reaches a lower height)	B1
	(because) the initial <u>vertical</u> (component of the) velocity is smaller (than in part (b))	B1
1(c)(ii)	The (total) initial energy is the same (as in part (b))	B1
	change in gravitational potential energy is same, so speed is the same	B1

Question	Answer	Marks
2(a)	in (rotational) equilibrium	B1
	<u>sum / total</u> of clockwise moments about a point = <u>sum / total</u> of anticlockwise moments about the (same) point.	B1
2(b)	$80 \times 9.81 \times 3$ or $60 \times 9.81 \times 3$ or $45 \times 9.81 \times x$	C1
	$80 \times 9.81 \times 3 = (60 \times 9.81 \times 3) + (45 \times 9.81 \times x)$	C1
	$x = 1.3 \text{ m}$	A1
2(c)(i)	$k = F / x$	C1
	$x = 0.80 - 0.59$ $= 0.21 \text{ m}$	C1
	$k = (60 \times 9.81) / 0.21$ $= 2800 \text{ N m}^{-1}$	A1

Question	Answer	Marks
2(c)(ii)	$E = \frac{1}{2} kx^2$ or $E = \frac{1}{2} Fx$ or $E = \frac{1}{2} F^2/k$ $= \frac{1}{2} \times 2800 \times 0.21^2$ or $= \frac{1}{2} \times 60 \times 9.81 \times 0.21$ or $= \frac{1}{2} \times (60 \times 9.81)^2 / 2800$	C1
	$= 62 \text{ J}$	A1

Question	Answer	Marks
3(a)	work done per unit time	B1
3(b)(i)	$P = F \times v$ $= 1750 \times 35$	C1
	$= 6.1 \times 10^4 \text{ W}$	A1
3(b)(ii)	$W = Fs$ $= 1750 \times 17\,000$	C1
	$= 3.0 \times 10^7 \text{ J}$	A1
	or $W = Pt$ $= 6.1 \times 10^4 \times (17\,000 / 35)$	(C1)
	$= 3.0 \times 10^7 \text{ J}$	(A1)

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Question	Answer	Marks
3(b)(iii)	$P = V \times I$ Power in = $600 \times I$	C1
	Efficiency = $\frac{\text{useful power output}}{\text{(total) power input}}$	C1
	$0.85 = 6.1 \times 10^4 / (600 \times I)$ $I = 120 \text{ A}$	A1
3(c)(i)	Air resistance is the same, as the speed is the same	B1
3(c)(ii)	The motor is producing less power (because of gravitational force / conversion of gravitational potential energy to kinetic energy) so the current will be smaller.	B1

Question	Answer	Marks
4(a)	(when two or more) waves meet / overlap (at a point)	B1
	(resultant) displacement is sum of the individual displacements	B1
4(b)(i)	Fringe width, $x = 3.2 \times 10^{-2} / 8$ $= 4.0 \times 10^{-3} \text{ (m)}$	C1
	$D = ax / \lambda$ $= (4.0 \times 10^{-3} \times 0.16 \times 10^{-3}) / 7.2 \times 10^{-7}$	C1
	$= 0.89 \text{ m}$	A1

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Question	Answer	Marks
4(b)(ii)	Curved line with a negative gradient of decreasing magnitude throughout, from slit separation 0.04 mm to 0.16 mm	B1
	Line of negative gradient ending at (0.16, 0.4), from slit separation 0.04 mm	B1
	Line of negative gradient passing through (0.08, 0.8) <u>and</u> (0.04, 1.6)	B1

Question	Answer	Marks
5(a)	wavelength: - wavelength = distance between successive / adjacent in phase points / wavefronts / crests / troughs $\lambda = d / (\text{number of}) \text{ oscillations}$ frequency: - frequency = (number of) oscillations / cycles crests / troughs / wavefronts (passing a point) per unit time $f = (\text{number of}) \text{ oscillations} / t$ One correct point from either list	B1
	One correct point from both lists and speed = distance / time and one of: - wavelength $\times$ frequency (= distance per unit time) = speed $[(\text{number of}) \text{ oscillations} / t] \times [d / (\text{number of}) \text{ oscillations}] = f\lambda$ $v (= d / t) = \lambda / (1/f) = f\lambda$ or $v (= d / t) = \lambda / T = f\lambda$	B1
5(b)(i)	$T = 4 \times 10^{-3}$ $f = 1 / T = 1 / 0.004$	C1
	$f = 250 \text{ Hz}$	A1

Question	Answer	Marks
5(b)(ii)	$f_o = f_s v / (v - v_s)$ $250 = 236 \times v / (v - 20)$ $v = (250 \times 20) / (250 - 236)$	C1
	$= 360 \text{ m s}^{-1}$	A1

Question	Answer	Marks
6(a)(i)	$I = 1.3 / 1.1$ $= 1.2 \text{ A}$	A1
6(a)(ii)	$v = I / nqA$ $= 1.2 / (8.5 \times 10^{28} \times 1.60 \times 10^{-19} \times 4.7 \times 10^{-7})$	C1
	$= 1.9 \times 10^{-4} \text{ m s}^{-1}$	A1
6(a)(iii)	$\rho = RA / L$	C1
	$= (1.1 \times 4.7 \times 10^{-7}) / 0.45$	C1
	$= 1.1 \times 10^{-6} \Omega \text{ m}$	A1
6(b)(i)	(Total) resistance decreases (and the potential difference stays the same)	M1
	(so the reading on the ammeter) increases	A1
6(b)(ii)	(The average drift speed will be) the same because the current is the same (in X).	B1

Question	Answer	Marks								
7(a)	$^{12}_7\text{N} \rightarrow ^{12}_6\text{C} + ^0_1\beta^+ + ^{(0)}_{(0)}\text{n}$	B1								
	beta-plus shown									
	neutrino shown	B1								
	symbols, nucleon numbers and proton numbers all correct	B1								
7(b)(i)	+1	B1								
7(b)(ii)	Lepton(s)	B1								
7(b)(iii)	<table><tr><td>flavour</td><td>charge / e</td></tr><tr><td>up / u</td><td>$-\frac{2}{3}$</td></tr><tr><td>up / u</td><td>$-\frac{2}{3}$</td></tr><tr><td>down / d</td><td>$(+)\frac{1}{3}$</td></tr></table>	flavour	charge / e	up / u	$-\frac{2}{3}$	up / u	$-\frac{2}{3}$	down / d	$(+)\frac{1}{3}$	
	flavour	charge / e								
	up / u	$-\frac{2}{3}$								
	up / u	$-\frac{2}{3}$								
	down / d	$(+)\frac{1}{3}$								
	3 correct quark flavours	B1								
	Charge on anti-up quark $-\frac{2}{3}(e)$	B1								
Charge on anti-down quark $(+)\frac{1}{3}(e)$	B1									

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	Error carried forward applied
	Ignore the response
	Mandatory mark not awarded
	Power of ten error
	Blank page seen
	Error in number of significant figures

Annotation	Meaning
	Transcription error
	Correct point or mark awarded
	Incorrect physics

Abbreviations

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Question	Answer	Marks
1(a)	acceleration and displacement identified as vectors (and no others)	B1
	speed, temperature and gravitational potential energy identified as scalars (and no others)	B1
1(b)(i)	$W = Fs$ or $W = mas$	B1
	$s = v^2 / 2a$ or $a = v^2 / 2s$ or $as = v^2 / 2$	B1
	$W = ma(v^2 / 2a)$ or $W = m(v^2 / 2s)s$ or $W = m(v^2 / 2)$ and (so E_K) = $\frac{1}{2}mv^2$	B1
	OR	(B1)
	$W = Fs$ or $W = mas$	
	$F = mv / t$ and $s = \frac{1}{2}vt$	(B1)
	$W = mv / t \times \frac{1}{2}vt$ and (so E_K) = $\frac{1}{2}mv^2$	(B1)
	OR	(B1)
	$W = Fs$ or $W = mas$	
	$a = v / t$ and $s = \frac{1}{2}vt$	(B1)
	$W = m(v / t)(\frac{1}{2}vt)$ and (so E_K) = $\frac{1}{2}mv^2$	(B1)
	OR	(B1)
	$W = Fs$ or $W = mas$	
	$a = v / t$ and $s = \frac{1}{2}at^2$	(B1)
	$W = m(v / t)(\frac{1}{2} \times (v / t) \times t^2)$ and (so E_K) = $\frac{1}{2}mv^2$	(B1)

Question	Answer	Marks
1(b)(ii)	kinetic energy $= \frac{1}{2} mv^2$ $= \frac{1}{2} \times 920 \times 17^2$ $= 1.3 \times 10^5 \text{ J}$	A1
1(b)(iii)	$P = W/t$	C1
	$= (4.7 \times 10^4 + 1.3 \times 10^5) / 5.8$	C1
	$= 3.1 \times 10^4 \text{ W}$	A1
1(b)(iv)	(at/after $t = 5.8 \text{ s}$) the kinetic energy (of the car) does not change / work is done only against resistive forces / no work is done to accelerate (the car) so (power output is) less	B1

Question	Answer	Marks
2(a)	force $\times$ <u>perpendicular</u> distance (of line of action of force to / from the point)	B1
2(b)(i)	(moment due to weight $=$) $1.2 \times 270 \times 9.81$	B1
	(moment due to post $=$) $1800 \times (1.6 / \cos \theta)$	B1
	$1.2 \times 270 \times 9.81 = 1800 \times (1.6 / \cos \theta)$ so $\theta = 25^\circ$ or $1.2 \times 270 \times 9.81 - 1800 \times (1.6 / \cos \theta) = 0$ so $\theta = 25^\circ$	B1
2(b)(ii)	A closed tip-to-tail vector triangle	M1
	vector labelled F at an angle of $25^\circ \pm 3^\circ$ anticlockwise from vertical and vector labelled R at an angle of $37^\circ \pm 3^\circ$ clockwise from vertical	A1

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Question	Answer	Marks
2(b)(iii)	$A = F/p$ $= 1800 / (150 \times 10^3)$	C1
	$= 0.012 \text{ m}^2$	A1

Question	Answer	Marks
3(a)	10.0 cm	A1
3(b)(i)	$v = f\lambda$ $= 16 \times 0.40$	C1
	$= 6.4 \text{ m s}^{-1}$	A1
3(b)(ii)	(X and Y have a) <u>constant</u> phase difference (of 180°) so (they are) coherent	B1
3(c)	A single wave of amplitude 10.0 cm	B1
	A single negative sine wave of wavelength 0.40 m	B1
3(d)	$I \propto A^2$ $\frac{I_X}{I_Y} = 10^2 / 20^2$	C1
	ratio = 0.25	A1

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Question	Answer	Marks
4(a)	The (total) <u>kinetic</u> energy changes / decreases so (the collision is) inelastic	B1
	OR (relative) speed of approach not equal to / greater than (relative) speed of separation so (collision is) inelastic	(B1)
4(b)(i)	$p = mv$ or 0.25×3.6 or 0.25×5.2 $\Delta p = 0.25 \times (3.6 + 5.2)$	C1
	$= 2.2 \text{ kg m s}^{-1}$	A1
4(b)(ii)	$F = \Delta p / (\Delta)t$ $= 2.2 / 0.18$	C1
	$= 12 \text{ N}$	A1
	OR $F = ma$ and $a = (v-u) / t$ $= m\Delta v / t$ $= 0.25 \times (3.6 + 5.2) / 0.18$	(C1)
	$= 12 \text{ N}$	(A1)

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Question	Answer	Marks
4(c)	$\frac{1}{2} mv^2 = mg(\Delta)h$	C1
	$\frac{1}{2} \times 0.25 \times 5.2^2 = 0.25 \times g \times h_1$ $h_1 = 5.2^2 / 2g$ $h_1 = 1.38$	
	$\frac{1}{2} \times 0.25 \times 3.6^2 = 0.25 \times g \times h_2$ $h_2 = 3.6^2 / 2g$ $h_2 = 0.66$	C1
	$h_2 / h_1 = 0.66 / 1.38$	
	ratio = 0.48	A1

Question	Answer	Marks
5(a)	the ratio of stress to strain	B1
5(b)(i)	$A = FL / Ex$	C1
	$A = \text{e.g. } (500 \times 0.81) / (95 \times 10^9 \times 4.0 \times 10^{-3})$	C1
	$A = 1.1 \times 10^{-6} \text{ m}^2$	A1
	OR	(C1)
	$A = kL / E$ or $A = \text{gradient} \times L / E$	
	$k = \text{e.g. } 500 / 4.0 \times 10^{-3}$ $k = 1.25 \times 10^5$	
	$A = 1.25 \times 10^5 \times 0.81 / 95 \times 10^9$	(C1)
	$A = 1.1 \times 10^{-6} \text{ m}^2$	(A1)

Question	Answer	Marks
5(b)(ii)	$E = \frac{1}{2} kx^2$ or $E = \frac{1}{2} Fx$ or $E = \text{area (under graph)}$	C1
	$(\Delta)E = \frac{1}{2} \times 1.25 \times 10^5 \times ((3.0 \times 10^{-3})^2 - (2.0 \times 10^{-3})^2)$ or $(\Delta)E = (\frac{1}{2} \times 375 \times 3.0 \times 10^{-3}) - (\frac{1}{2} \times 250 \times 2.0 \times 10^{-3})$ or $(\Delta)E = \frac{1}{2} \times (375 + 250) \times 1.0 \times 10^{-3}$	C1
	work done = 0.31 J	A1

Question	Answer	Marks
6(a)	energy transferred (to the component) per (unit) charge	B1
6(b)(i)	$Q = It$ $= 0.030 \times 4.0 \times 60$	C1
	$= 7.2 \text{ C}$	A1
6(b)(ii)	$I = V / R$ $I_1 = 8.0 / (430 + 240)$	C1
	$= 0.012 \text{ A}$	A1
6(b)(iii)	$I_2 = 0.030 - I_1$ $= 0.030 - 0.012$ $= 0.018 \text{ A}$	A1

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Question	Answer	Marks
6(b)(iv)	$R = V / I_2$ $= (8.0 - (0.018 \times 210)) / 0.018$	C1
	$= 230 \, \Omega$	A1
	OR resistance of top branch = $8.0 / 0.018$ $R = 8.0 / 0.018 - 210$	(C1)
	$= 230 \, \Omega$	(A1)
	OR total circuit resistance = $8.0 / 0.030 = 267$ $1 / 267 = 1 / (210 + R) + 1 / (430 + 240)$ $1 / 267 - 1 / 670 = 1 / (210 + R)$ $210 + R = 443$	(C1)
	$R = 230 \, \Omega$	(A1)
6(c)	(When) the galvanometer reads 0 (A)	M1
	The ratio of the resistances in the top branch will equal the ratio of the resistances in the bottom branch (so the resistance of X can be determined)	A1
	OR The ratio of the left pair of resistances will equal the ratio of the right pair of resistances	(A1)

Question	Answer	Marks
7(a)	(a particle that) cannot be divided/subdivided (into smaller particles)	B1
7(b)(i)	$(p \times e) / (14u) = 4.1 \times 10^7$	C1
	$p = (4.1 \times 10^7 \times 14 \times 1.66 \times 10^{-27}) / (1.60 \times 10^{-19})$	C1
	$p = 6$ (answer should be an integer)	A1
7(b)(ii)	${}^{14}_6\text{X} \rightarrow {}^{14}_7\text{Z}$	B1
	${}^0_{-1}\text{e}^{(-)}$ or ${}^0_{-1}\beta^{(-)}$	B1
	${}^0_0\bar{\nu}_{(e)}$	B1
7(c)	(the nuclei are undergoing) β^+ decay	B1
	A correct explanation in terms of charge and a correct explanation in terms of energy Explanations in terms of charge: • (particles / decay) positively charged so cannot be β^- • (particles / decay) positively charged so could be / is β^+ • β^- (particles / decay) are negatively charged • β^+ (particles / decay) are positively charged Explanations in terms of energy: • range of energies so not α (particles / decay) • range of energies so is β (particles / decay) • β (particles / decay) have a range of energies • α (particles / decay) have discrete energies / not range of energies	B1

Cambridge International AS & A Level

PHYSICS**9702/23**

Paper 2 AS Level Structured Questions

May/June 2025

MARK SCHEME

Maximum Mark: 60

Published

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This document consists of **13** printed pages.

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- 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:

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- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
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GENERIC MARKING PRINCIPLE 4:

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Science-Specific Marking Principles

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- 2 The examiner should not choose between contradictory statements given in the same question part, and credit should not be awarded for any correct statement that is contradicted within the same question part. Wrong science that is irrelevant to the question should be ignored.
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For questions that require ***n*** responses (e.g. State **two** reasons ...):
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6 Calculation specific guidance

Correct answers to calculations should be given full credit even if there is no working or incorrect working, **unless** the question states 'show your working'.

For questions in which the number of significant figures required is not stated, credit should be awarded for correct answers when rounded by the examiner to the number of significant figures given in the mark scheme. This may not apply to measured values.

For answers given in standard form (e.g. $a \times 10^n$) in which the convention of restricting the value of the coefficient (a) to a value between 1 and 10 is not followed, credit may still be awarded if the answer can be converted to the answer given in the mark scheme.

Unless a separate mark is given for a unit, a missing or incorrect unit will normally mean that the final calculation mark is not awarded. Exceptions to this general principle will be noted in the mark scheme.

7 Guidance for chemical equations

Multiples / fractions of coefficients used in chemical equations are acceptable unless stated otherwise in the mark scheme.

State symbols given in an equation should be ignored unless asked for in the question or stated otherwise in the mark scheme.

Annotations guidance for centres

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The annotations listed below were available to examiners marking this component in this series.

Annotations

Annotation	Meaning
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	Benefit of the doubt given
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	Error carried forward applied
	Ignore the response
	Mandatory mark not awarded
	Power of ten error
	Blank page seen
	Error in number of significant figures

Annotation	Meaning
	Transcription error
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	Incorrect physics

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>method</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)	Rate of change of displacement	B1
1(b)	For object A: $s = ut + \frac{1}{2}at^2$ so $t = \sqrt{\frac{2 \times 10}{9.81}}$ = 1.4	C1
	Then for object B: $s = ut + \frac{1}{2}at^2$ $h = -(3 \times 1.4) + (0.5 \times 9.81 \times 1.4^2)$	C1
	= 5.7 m	A1
	OR $h = -(3 \times 1.4) + 10$	(C1)
	= 5.7 m	(A1)
1(c)(i)	time taken (to reach the ground is) same	B1
	The <u>initial vertical</u> (component of the) velocity is the same (as in part (1b))	B1
1(c)(ii)	The (total) initial energy is greater (than in part (1b))	B1
	change in gravitational potential energy is same, so speed is greater	B1

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Question	Answer	Marks
2(a)	force $\times$ <u>perpendicular</u> distance (of line of action of force to / from the point)	B1
2(b)(i)	$150 \times 9.81 \times 4.5$ or $90 \times 9.81 \times 4.5$ or $3.0 \times 9.81 \times m$	C1
	$(150 \times 9.81 \times 4.5) = (90 \times 9.81 \times 4.5) + (3.0 \times 9.81 \times m)$	C1
	$m = 90 \text{ kg}$	A1
2(b)(ii)	Young modulus = σ / ϵ or $F / A\epsilon$ or FL / Ax	C1
	Area of wire = $\pi \times (1.8 \times 10^{-3} / 2)^2$ $= 2.5 \times 10^{-6}$	C1
	So Young modulus = $((90 \times 9.81) / \pi \times (9.0 \times 10^{-4})^2) / 1.2 \times 10^{-3}$ $= 2.9 \times 10^{11} \text{ Pa}$	A1
2(b)(iii)	Moment provided by B will decrease / moment due to wire will increase	B1
	So force acting on wire will increase (Young's modulus and area remain constant) and the strain will increase	B1

Question	Answer	Marks
3(a)	$W = Fd$	B1
	$P = Fd / t = Fv$ or $P = Fvt / t = Fv$	B1
3(b)(i)	$(\Delta)E_{(P)} = mg(\Delta)h$	C1
	increase of gravitational potential energy of car in 1.0 s $= 1500 \times 9.81 \times 30 \times \sin 6.0 = 46\,000 \text{ J}$	A1

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Question	Answer	Marks
3(b)(ii)	(Power to overcome total resistive forces) = 1600×30 = 48 000 W	C1
	power = 48 000 + 46 000 = 9.4×10^4 W	A1
3(c)(i)	Air resistance is the same, as the speed is the same	B1
3(c)(ii)	Mass / weight has increased so (power will) increase	B1

Question	Answer	Marks
4(a)	<u>sum / total</u> momentum (of a system of bodies) is constant or <u>sum / total</u> momentum before = <u>sum / total</u> momentum after	M1
	for an isolated system / no (resultant) <u>external</u> force	A1
4(b)(i)	$p = mv$ or 4.0×6.0 or 2.0×3.0 $(4.0 \times 6.0) + (2.0 \times 3.0) = 6.0 \times v$	C1
	so $v = 5.0 \text{ m s}^{-1}$	A1

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Question	Answer	Marks
4(b)(ii)	KE before = $(0.5 \times 4.0 \times 6.0^2) + (0.5 \times 2.0 \times 3.0^2)$ = 81 J	C1
	KE after = $(0.5 \times 6.0 \times 5.0^2)$ = 75 J	(C1)
	percentage transferred = $[(81 - 75) / 81] \times 100$ = 7%	A1

Question	Answer	Marks
5(a)	sound waves are longitudinal / not transverse (and only transverse waves can be polarised)	B1
5(b)(i)	A periodic curve of at least one period with minimum 0 and maximum I_0	B1
	Smooth continuous $\sin^2 \alpha$ curve	B1
	Peaks at 90° and 270° and troughs at 0, 180° and 360°	B1
5(b)(ii)	$I \propto A^2$	C1
	$I = I_0 \cos^2 \theta$	C1
	At $\alpha = 20^\circ$ the angle between the planes of polarisation of light and filter is 70° (or 110°) $I = I_0 \cos^2 70$ or $I = I_0 \cos^2 110$ ($I = 0.12 I_0$)	C1
	amplitude = $0.34 A_0$	A1

Question	Answer	Marks
6(a)	wave passes (through) an aperture and spreads or wave passes (by / through / around) an edge and spreads	B1
6(b)(i)	$v = f\lambda$	C1
	$f = 3.00 \times 10^8 / 720 \times 10^{-9}$	A1
	$= 4.2 \times 10^{14} \text{ Hz}$	
6(b)(ii)	$d = n\lambda / \sin \theta$	C1
	$d = (2 \times 720 \times 10^{-9}) / \sin 26$	C1
	$(= 3.3 \times 10^{-6} \text{ m})$	A1
	number of lines per m $= 1 / (3.3 \times 10^{-6})$ $= 3.0 \times 10^5 \text{ m}^{-1}$	
6(b)(iii)	$\lambda \times 3 = 720 \times 2 \text{ or } \frac{1}{3.0 \times 10^5} \sin 26 = 3\lambda$	C1
	$\lambda = 480 \text{ nm}$	A1

Question	Answer	Marks
7(a)	$R = \rho L / A$	C1
	$= (1.12 \times 10^{-6} \times 1.5) / 2.45 \times 10^{-7}$	C1
	$= 6.86 \Omega$	A1
7(b)(i)	(A method where the) reading (on the galvanometer) is zero.	B1

Question	Answer	Marks
7(b)(ii)	e.m.f. / 1.2 = 64 / 150	C1
	e.m.f. = (64 / 150) × 1.2 = 0.51 V	A1
7(b)(iii)	(the internal resistance will cause a) drop in p.d. across the wire / the terminal p.d. is lower	B1
	So the null point will move to the right	B1

Question	Answer		Marks
8(a)	flavour	charge / e	
	up / u	$-\frac{2}{3}$	
	down / d	$(+)\frac{1}{3}$	
	down / d	$(+)\frac{1}{3}$	
	3 correct quark flavours		B1
	Charge on anti-up quark $-\frac{2}{3}(e)$		B1
	Charge on anti-down quark $(+)\frac{1}{3}(e)$		B1
8(b)	particle: (electron) neutrino		B1
	antiparticle: positron		B1

Cambridge International AS & A Level

PHYSICS**9702/24**

Paper 2 AS Level Structured Questions

May/June 2025

MARK SCHEME

Maximum Mark: 60

Published

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1(a)	force $\times$ <u>perpendicular</u> distance (of line of action of force to a point) or product of force and perpendicular distance (to a point)	B1
1(b)(i)	in (rotational) equilibrium	B1
	<u>sum / total</u> of CW moments about a point = <u>sum / total</u> of ACW moments about the (same) point.	B1
1(b)(ii)	component of weight = $75 \times \cos 42^\circ$ = 56 N	A1
1(b)(iii)	$F \times 80$ or 56×40 or $F \times 0.8$ or 56×0.4 $F \times 80 = 56 \times 40$	C1
	$F = 28 \text{ N}$	A1

Question	Answer	Marks
2(a)	product of mass and velocity	B1
2(b)	change in momentum = $(-1.4) - (+2.8)$ = $(-) 4.2 \text{ kg m s}^{-1}$	A1
2(c)	$F = \Delta p / (\Delta)t$ or $F = \text{gradient}$ = $4.2 / 12$	C1
	= 0.35 N	A1
2(d)	constant / uniform (rate of) decrease (of speed to zero).	B1

Question	Answer	Marks
2(e)	- The (resultant) force is constant / does not decrease - air resistance would vary / decrease / not constant - the force is not zero when speed / velocity is zero / at 8 s Any two of the above 3 marking points (1 mark each, max 2)	B2
2(f)	line from origin with decreasing positive gradient	B1
	gradient changes from positive to negative at 8.0 s	B1
	after $t = 8.0$ s the line has a negative gradient of increasing magnitude <u>and</u> a positive value of d at $t = 12$ s	B1

Question	Answer	Marks
3(a)	$E_{(K)} = \frac{1}{2}mv^2$ $110 = \frac{1}{2} \times 5.5 \times v^2$	C1
	$v = 6.3 \text{ m s}^{-1}$	A1
3(b)	$(\Delta)E_{(P)} / 20 = mg(\Delta)h$ OR $(\Delta)E_{(P)} / 20 = mgx_0$	C1
	$(x_0 =) 20 / 5.5 \times 9.81 = 0.37 \text{ (m)}$ Allow $(\Delta)h$ for x_0	A1
3(c)	$[\max (E_{(P)})] = 110 + 20 = 130 \text{ J}$	A1

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Question	Answer	Marks
3(d)	$(\max) E_{(P)} / 130 = \frac{1}{2} F_{(0)} x_{(0)}$	C1
	$(F_0 =) 2 \times 130 / 0.37 = 700 \text{ (N)}$	A1
	or $(\max) E_{(P)} / 130 = 1 / 2 k x_{(0)}^2$ $(F_0 =) k x_{(0)}$	(C1)
	$(F_0 =) 2 \times 130 \times 0.37 / (0.37)^2 = 700 \text{ (N)}$	(A1)
3(e)(i)	$(\text{weight}) = 5.5 \times 9.81$	C1
	resultant force = $700 - (5.5 \times 9.81)$ = 650 N	A1
3(e)(ii)	$F = ma$	C1
	$a = 650 / 5.5$ or $(700 / 5.5) - 9.81$ $a = 120 \text{ m s}^{-2}$	A1

Question	Answer	Marks
4(a)(i)	(a wave that) transfers / propagates energy	B1
4(a)(ii)	distance = $n\lambda$	B1
	time $t = n / f$	B1
4(a)(iii)	(v = distance / time) (v) = $n\lambda / (n / f)$ so (v) = $f\lambda$	B1
4(b)(i)	$f = 3 \times 10^8 / 4 \times 10^{-2}$ $= 7.5 \times 10^9$ (Hz) $= 7.5 \times 10^9 / 10^9$ (GHz)	C1
	= 7.5 GHz	A1
4(b)(ii)	(difference in path lengths, $XQ - YQ$) = $\left[72^2 + 30^2\right]^{\frac{1}{2}} - 72 = 6$ (cm)	A1
	Or calculate angle Q using tan and then cos to obtain XQ of 78 $\tan \theta = 30 / 72$ so $\theta = 22.6$ $XQ = 72 / \cos 22.6 = 78$ (cm) path difference $78 - 72 = 6$ (cm)	(A1)
	Or calculate angle X using tan and then cos to obtain XQ of 78 $\tan \theta = 72 / 30$ so $\theta = 67.4$ $XQ = 72 / \sin 67.4 = 78$ (cm) path difference $78 - 72 = 6$ (cm)	(A1)
4(b)(iii)	path difference (= 6 cm / 4 cm) $\lambda = 1.5\lambda$	M1
	(so) phase difference (at Q) = 540° or 180°	M1
	(so) intensity is minimum	A1

Question	Answer	Marks
4(b)(iv)	amplitude changes from maximum (at P) to minimum (at Q)	C1
	amplitude changes from maximum (at P) to minimum to maximum to minimum (at Q)	A1

Question	Answer	Marks
5(a)(i)	temperature decreases, resistance decreases	B1
5(a)(ii)	line from origin with decreasing gradient drawn in first quadrant or line from origin with decreasing gradient drawn in third quadrant	M1
	line drawn in the third or first quadrant of similar composition (straight line from origin followed by correct curve) and similar size as compared by eye to the first line	A1
5(b)(i)	$E = P / I$ $= 18 / 1.5$	C1
	$= 12 \text{ V}$	A1
5(b)(ii)	$I = 3.3 - 1.5$ $= 1.8$	C1
	$I = Anvq$ $1.8 = 1.4 \times 10^{-9} \times 3.4 \times 10^{28} \times v \times 1.6 \times 10^{-19}$	C1
	$v = 0.24 \text{ m s}^{-1}$	A1

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Question	Answer	Marks
6(a)	$2.4 / 6.0 = 8 / (R + 8)$	C1
	$R = 12 \Omega$	A1
	or $I = 2.4 / 8$ $= 0.30$ $R = (6 - 2.4) / 0.3$ or $R = (6 / 0.3) - 8$	(C1)
	$R = 12 \Omega$	(A1)
6(b)	$V = I(\rho L / A)$ or $V = IR$ and $R = (\rho L / A)$	M1
	I, ρ, A are constant (so $V \propto L$)	A1
6(c)(i)	$V_{XP} / V_{XY} = L_{XP} / L_{XY}$ $E / 2.4 = 1.24 / 2.00$	C1
	$E = 1.5 \text{ V}$	A1
6(c)(ii)	p.d. across XY / wire increases / p.d. across XP increases	M1
	so P moved towards X / away from Y / to the left	A1

Question	Answer	Marks
7(a)	• (electron) neutrino • (electron) antineutrino • electron • positron Any two, 1 mark each	B2
7(b)	only meson <u>and</u> neutron are underlined	B1
7(c)	(quark composition is) up, up, down / uud (charge =) $\frac{2}{3}e + \frac{2}{3}e - \frac{1}{3}e = (+1)e = (+) 1.6 \times 10^{-19} \text{ (C)}$	B1
	or (charge =) $1.07 \times 10^{-19} + 1.07 \times 10^{-19} - 5.33 \times 10^{-20} = (+) 1.6 \times 10^{-19} \text{ (C)}$	A1