CAMBRIDGE
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Cambridge International AS & A Level

PHYSICS **9702/42**

Paper 4 A Level Structured Questions **February/March 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 February/March 2025 series for most Cambridge IGCSE, Cambridge International A and AS Level components, and some Cambridge O Level components.

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.

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.

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	<u>‘List rule’ guidance</u> 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	<u>Calculation specific guidance</u> 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	<u>Guidance for chemical equations</u> 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
AE	arithmetic error
BOD	benefit of the doubt given
CON	contradiction in response, mark not awarded
✗	incorrect point or mark not awarded
ECF	error carried forward applied
I	ignore the response

Annotation	Meaning
MO	mandatory mark not awarded
POT	power of ten error
SEEN	blank page seen
SF	error in number of significant figures
TE	transcription error
✔	correct point or mark awarded
XP	incorrect physics

Question	Answer	Marks
1(a)	arrow vertically downwards labelled 'weight' <u>and</u> arrow perpendicular to cone, inwards and upwards, labelled 'normal contact force'	**B1**
1(b)	vertical component of contact force = weight (so no resultant force vertically)	**B1**
	horizontal component of contact force is resultant force towards centre (of circle)	**B1**
1(c)	$a = v^2 / r$	**C1**
	$a = g \tan 52°$	**C1**
	$9.81 \times \tan 52° = v^2 / 0.15$ leading to $v = 1.4\ \text{m s}^{-1}$	**A1**
1(d)	$v = r\omega$ <u>or</u> $a = r\omega^2$	**C1**
	$\omega = 1.4 / 0.15$ or $\sqrt{(9.81 \times \tan 52° / 0.15)}$ $= 9.3\ \text{rad s}^{-1}$	**A1**
1(e)	same resultant force / same acceleration so v^2 is proportional to r (so if speed increases radius must also increase)	**A1**

Question	Answer	Marks
2(a)	<u>sketch:</u> line from $x = R$ to $x = 4R$ entirely in the negative ϕ region	**B1**
	curve with continuously decreasing magnitude and with gradient of continuously decreasing magnitude, starting at $(R, \pm\phi)$	**B1**
	line passing through $(2R, \pm\frac{1}{2}\phi)$ <u>and</u> $(4R, \pm\frac{1}{4}\phi)$	**B1**
2(b)	horizontal straight line from $t = 0$ to $t = 24$ hours	**B1**
	line starting at $(0, -\phi)$	**B1**

Question	Answer	Marks
2(c)	straight line with non-zero gradient from 0 to *d*	B1
	line with negative gradient from (0, *V*) to (*d*, 0)	B1

Question	Answer	Marks
3(a)(i)	(P and Q are at the) same temperature	B1
	no <u>net</u> transfer of thermal energy (between P and Q)	B1
3(a)(ii)	$Q = mc\Delta T$	C1
	$24 \times 10^3 = (0.54 \times 390 \times \Delta T) + (0.37 \times 910 \times \Delta T)$	C1
	$\Delta T = 44\,\text{K}$	A1
3(b)(i)	work done = $p\Delta V$	C1
	$= (1.6 \times 10^5) \times (0.18 - 0.32)$	C1
	$= -2.2 \times 10^4\,\text{J}$	A1
3(b)(ii)	$pV = NkT$	C1
	$N = (1.6 \times 10^5 \times 0.18) / (1.38 \times 10^{-23} \times 273)$ $= 7.6 \times 10^{24}$	A1
3(b)(iii)	$\frac{1}{2}m\langle c^2\rangle = (3/2)kT$	C1
	r.m.s. speed = $\sqrt{[(3 \times 1.38 \times 10^{-23} \times (210 + 273) / (4.7 \times 10^{-26})]}$ $= 650\,\text{m s}^{-1}$	A1

Question	Answer	Marks
4(a)	$\omega = 2\pi / T$	C1
	$= 2\pi / (0.15 \times 10^{-6}) = 4.2 \times 10^{7}$ rad s^{-1}	A1
4(b)	$a_0 = \omega^2 x_0$	C1
	$= (4.2 \times 10^{7})^2 \times 40 \times 10^{-6}$ $= 7.1 \times 10^{10}$ m s^{-2}	A1
4(c)	$E = ½ m\omega^2 x_0^2$	C1
	$= ½ \times 2.4 \times 10^{-4} \times (4.2 \times 10^{7})^2 \times (40 \times 10^{-6})^2$	C1
	= 340 J	A1
4(d)(i)	apply alternating p.d. (to / across crystal)	B1
	applying p.d. to / across crystal causes it to distort	B1
4(d)(ii)	$Z = \rho c$ $Z_m = 1100 \times 1600$ $(= 1.76 \times 10^6)$ $Z_b = 1900 \times 4100$ $(= 7.79 \times 10^6)$	C1
	intensity reflection co-efficient= $[(7.79 - 1.76) / (7.79 + 1.76)]^2$ = 0.40 or 40%	C1
	percentage transmitted = 60%	A1

Question	Answer	Marks
5(a)	$Q = Q_1 = Q_2$ <u>and</u> $V = V_1 + V_2$	M1
	$V = Q / C$ so: $Q / C = Q / C_1 + Q / C_2$ <u>leading to</u> $1 / C = 1 / C_1 + 1 / C_2$	A1
5(b)	total capacitance = $C + ½C = (3 / 2)C$	C1
	total capacitance = gradient = $400 \times 10^{-6} / 6.0$	C1
	either: $C = (2 \times 400 \times 10^{-6}) / (3 \times 6.0) = 4.4 \times 10^{-5}$ F = 44 μF *or*: $C = (2 \times 400) / (3 \times 6.0) = 44$ μF	A1
5(c)(i)	$\tau = RC$	C1
	$= 54 \times 10^3 \times (3/2) \times 44 \times 10^{-6}$ = 3.6 s	A1
5(c)(ii)	$0.15 = \exp(-t / 3.6)$	C1
	t = 6.8 s	A1

Question	Answer	Marks
6(a)	$F_B = F_E$	B1
	either: $Bqu = qE$ and $E = V / d$ <u>leading to</u> $u = V / Bd$ *or*: $Bqu = qV / d$ <u>leading to</u> $u = V / Bd$	B1

Question	Answer	Marks
6(b)	$E_K = ½mu^2$	C1
	$u = \sqrt{[(2 \times 4.1 \times 10^{-17}) / (3.2 \times 10^{-27})]}$ $= 1.6 \times 10^5 ms^{-1}$	C1
	$B = 980 / (3.6 \times 10^{-2} \times 1.6 \times 10^5)$ $= 0.17$ T	A1
6(c)	expression is independent of mass and charge	A1
6(d)	*either*: electric <u>force</u> is downwards so magnetic force is upwards *or*: no resultant <u>force</u> so magnetic force is upwards	B1
	(positive ions so) current is from left to right	B1
	from (Fleming's) left-hand rule, magnetic field is into the page	B1
6(e)	curved path inside plates with consistent direction of curvature and with no discontinuity at entry or in curvature	B1
	direction of deflection is upwards	B1

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)	(uniform acceleration so) velocity is (directly) proportional to time	M1
	(Fig. 7.2 shows) e.m.f. is (directly) proportional to time so E is proportional to v.	A1

Question	Answer	Marks
7(b)(ii)	($v = at$ so) distance moved in time $\Delta t = at\Delta t$	**C1**
	$\Phi = BA$	**C1**
	$E = (\Delta\Phi / \Delta t) = B \times L \times (at\Delta t) / \Delta t = BLat$	**A1**
7(b)(iii)	$B = (0.30 \times 10^{-3}) / (0.45 \times 7.8 \times 2.0)$	**C1**
	$= 4.3 \times 10^{-5}$ T	**A1**

Question	Answer	Marks
8(a)	• quantum of energy	**M1**
	• of electromagnetic radiation	**A1**
8(b)(i)	$(\Delta)E = hc / \lambda$	**C1**
	$\lambda = (6.63 \times 10^{-34} \times 3.00 \times 10^{8}) / (1.96 \times 1.60 \times 10^{-19})$	**C1**
	$= 6.3 \times 10^{-7}$ m	**A1**
8(b)(ii)	number per unit time = power / energy per photon $= (1.0 \times 10^{-2}) / (1.96 \times 1.60 \times 10^{-19})$ $= 3.2 \times 10^{16}\,s^{-1}$	**A1**

Question	Answer	Marks
8(b)(iii)	*either*: force = rate of change of momentum *or*: $F = \Delta p / t$	C1
	$p = E / c$	C1
	half the photons have change in momentum *p*, the other half have change in momentum 2*p*	C1
	$F = [(1.96 \times 1.60 \times 10^{-19}) / (3.00 \times 10^{8})] \times 3.2 \times 10^{16} \times [(2 + 1) / 2]$ $= 5.0 \times 10^{-11}$ N	A1

Question	Answer	Marks
9(a)(i)	*either*: cannot predict when a (particular) nucleus will decay *or*: cannot predict which nucleus will decay next	B1
9(a)(ii)	not affected by external / environmental factors	B1
9(b)	time for activity to halve	B1
9(c)	energy $= (189 \times 7.826) + (4 \times 7.074) - (193 \times 7.774)$	C1
	$= 7.03$ eV	A1
9(d)(i)	decay constant	A1
9(d)(ii)	decay constant / magnitude of gradient = 1.4 / 0.84	C1
	half-life = ln2 / (1.4 / 0.84) = 0.42 ms	A1
9(e)(i)	positrons collide with electrons and annihilate	B1
9(e)(ii)	long enough to have time to conduct investigation, not so long as to cause patient <u>unnecessary</u> exposure to radiation	B1

Question	Answer	Marks
10(a)(i)	total power of radiation emitted (by the star)	**B1**
10(a)(ii)	standard candle has known luminosity	**B1**
	measure the radiant flux intensity	**B1**
	use $F = L / (4\pi d^2)$ to calculate d	**B1**
10(b)(i)	$v = 2\pi R / T$	**C1**
	$v = 3.00 \times 10^8 \times (656.2877 - 656.2831) / 656.2831$	**C1**
	$R = [3.00 \times 10^8 \times (656.2877 - 656.2831) / 656.2831] \times (2.07 \times 10^6) / 2\pi = 6.93 \times 10^8\,\text{m}$	**A1**
10(b)(ii)	Z is moving towards Earth	**M1**
	so observed wavelength is less than the emitted wavelength	**A1**
10(b)(iii)	$L = 4\pi\sigma r^2T^4$ $3.8 \times 10^{26} = 4\pi \times 5.67 \times 10^{-8} \times (6.93 \times 10^8)^2 \times T^4$	**C1**
	$T = 5800\,\text{K}$	**A1**