Cambridge Assessment International Education

Cambridge International AS & A Level

PHYSICS **9702/02**

Paper 2 AS Level Structured Questions **For examination from 2022**

MARK SCHEME

Maximum Mark: 60

Specimen

This document has **10** pages. Blank pages are indicated.

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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 descriptors 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	‘List rule’ guidance (see examples below) 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.

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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.

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Abbreviations used in the Mark Scheme

/ alternative answers for the same marking point
underline actual word given must be used by candidate (grammatical variants accepted)
(brackets) the word or phrase in brackets is not required, but sets the context

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 method 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.

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Examples of how to apply the list rule

State **three** reasons ... [3]

A

1. Correct	✓	**2**
2. Correct	✓	
3. Wrong	×	

B (4 responses)

1. Correct, Correct	✓, ✓	**3**
2. Correct	✓	
3. Wrong	ignore	

C (4 responses)

1. Correct	✓	**2**
2. Correct, Wrong	✓, ×	
3. Correct	ignore	

D (4 responses)

1. Correct	✓	**2**
2. Correct, CON (of 2.)	×, (discount 2)	
3. Correct	✓	

E (4 responses)

1. Correct	✓	**3**
2. Correct	✓	
3. Correct, Wrong	✓	

F (4 responses)

1. Correct	✓	**2**
2. Correct	✓	
3. Correct CON (of 3.)	× (discount 3)	

G (5 responses)

1. Correct	✓	**3**
2. Correct	✓	
3. Correct Correct CON (of 4.)	✓ ignore ignore	

H (4 responses)

1. Correct	✓	**2**
2. Correct	×	
3. CON (of 2.) Correct	(discount 2) ✓	

I (4 responses)

1. Correct	✓	**2**
2. Correct	×	
3. Correct CON (of 2.)	✓ (discount 2)	

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Question	Answer	Marks
1(a)	$v = [(1.8 \times 126 \times 10^{-2}) / 5.1 \times 10^{-3}]^{1/2}$	**C1**
	$v = 21\ \text{m s}^{-1}$	**A1**
1(b)	percentage uncertainty = 4% (allow fractional uncertainty = 0.04)	**C1**
	absolute uncertainty = 0.04×21 $= 0.8\ \text{m s}^{-1}$	**A1**

Question	Answer	Marks
2(a)	rate of change of velocity **or** change in velocity / time (taken)	**B1**
2(b)(i)	$v_X = 24 / 1.5$ $= 16\ \text{m s}^{-1}$	**A1**
2(b)(ii)	$\tan 28° = v_Y / v_X$ **or** $v_X = v \cos 28°$ **and** $v_Y = v \sin 28°$	**C1**
	$v_Y = 16 \tan 28°$ **or** $v_Y = 16 \times (\sin 28° / \cos 28°)$ so $v_Y = 8.5\ \text{m s}^{-1}$	**A1**
2(b)(iii)	$v = u + at$	**C1**
	$t = 8.5 / 9.81$ $= 0.87\ \text{s}$	**A1**
2(b)(iv)	straight line from positive v_Y at $t = 0$ to negative v_Y at $t = 1.5\ \text{s}$	**M1**
	line starts at (0, 8.5) and crosses t-axis at (0.87, 0) and continues to $t = 1.5\ \text{s}$	**A1**
2(c)(i)	$(v^2 = u^2 + 2as)$ $\quad 0 = 8.5^2 + 2(-9.81)s$ **or** $(s = ut + \frac{1}{2}at^2)$ $\quad s = 8.5 \times 0.87 + \frac{1}{2} \times (-9.81) \times 0.87^2$ **or** $(s = vt - \frac{1}{2}at^2)$ $\quad s = 0 - \frac{1}{2} \times (-9.81) \times 0.87^2$ **or** $(s = \frac{1}{2}(u + v)t$ or area under graph) $s = 0.5 \times 8.5 \times 0.87$	**C1**
	$s = 3.7\ \text{m}$	**A1**

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Question	Answer	Marks
2(c)(ii)	$(\Delta)E = mg(\Delta)h$	**C1**
	$m = 22 / (9.81 \times 3.7)$ $= 0.61$ kg	**A1**
2(d)	acceleration (of free fall) is unchanged **or** not dependent on mass, and so no effect (on time taken)	**A1**

Question	Answer	Marks
3(a)(i)	rate of change of momentum **or** change in momentum / time (taken)	**B1**
3(a)(ii)	(work =) force × displacement in the direction of the force.	**B1**
3(b)(i)	$E_K = \frac{1}{2}mv^2$	**C1**
	$E_K = 0.5 \times 0.40 \times 0.30^2$ $E_K = 1.8 \times 10^{-2}$ J	**A1**
3(b)(ii)	$1.8 \times 10^{-2} = \frac{1}{2} \times F \times 0.080$ **or** $1.8 \times 10^{-2} = \frac{1}{2} \times k \times (0.080)^2$ **and** $F = k \times 0.080$	**C1**
	$F_{MAX} = 0.45$ N	**A1**
3(b)(iii)	$F = ma$	**C1**
	$a = 0.45 / 0.40$ $= 1.1$ m s^{-2}	**A1**
3(b)(iv)	• constant velocity / resultant force is zero, so in equilibrium	**B1**
	• decelerating / resultant force not zero, so not in equilibrium	**B1**
3(b)(v)	$p = mv$ **or** 0.40×0.25 **or** 0.40×0.15	**C1**
	$\Delta p = (0.40 \times 0.25) + (0.40 \times 0.15)$ $= 0.16$ N s	**A1**

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Question	Answer	Marks
4(a)(i)	vibrations (of particles) are perpendicular to direction of energy transfer	**B1**
4(a)(ii)	waves meet / overlap (at a point)	**B1**
	(resultant) displacement is sum of the individual displacements	**B1**
4(b)(i)	$\lambda = v / f$	**C1**
	$\lambda = 4.0 \times 1.5$ $\lambda = 6.0$ cm	**A1**
4(b)(ii)	path difference = (44 – 29) / 6 $= 2.5\lambda$	**A1**
4(b)(iii)	waves have phase difference = 180° or 900° **or** path difference is an odd number of half wavelengths	**M1**
	particles are at rest / no motion	**A1**

Question	Answer	Marks
5(a)	angle = 90°	**A1**
5(b)(i)	$\cos^2\theta = 0.75$	**C1**
	$\theta = 30°$	**A1**
5(b)(ii)	$I \propto A^2$	**C1**
	ratio = $(0.75)^{0.5}$ = 0.87	**A1**

Question	Answer	Marks
6(a)	$I = I_1 + I_2 + I_3$	**B1**
	$(V / R) = (V / R_1) + (V / R_2) + (V / R_3)$ **or** $(I / V) = (I_1 / V) + (I_2 / V) + (I_3 / V)$ **and** (so) $1 / R = 1 / R_1 + 1 / R_2 + 1 / R_3$	**A1**

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Question	Answer	Marks
6(b)(i)	energy is dissipated in the internal resistance	**B1**
6(b)(ii)	• energy = EQ	**C1**
	$= 6.0 \times 2.5 \times 10^3$ $= 1.5 \times 10^4$ J	**A1**
	• number = $2.5 \times 10^3 / 1.6 \times 10^{-19}$ $= 1.6 \times 10^{22}$	**A1**
6(b)(iii)	$1 / 4.8 = 1 / 12 + 1 / R_X$ $R_X = 8.0\,\Omega$	**A1**
6(b)(iv)	$P = V^2 / R$ **or** $P = VI$ **and** $V = IR$	**C1**
	ratio = $(V^2 / 8) / (V^2 / 12) = 12 / 8$ $= 1.5$	**A1**
6(b)(v)	(as temperature decreases) resistance of thermistor / X increases	**B1**
	<u>total</u> (circuit) resistance increases / current (in battery) decreases	**M1**
	(so) power decreases	**A1**

Question	Answer	Marks
7(a)	number of protons = 12	**A1**
	number of neutrons = 11	**A1**
7(b)	same / equal (rest) mass **or** equal (magnitude of) charge	**B1**
7(c)	a quark and an antiquark	**B1**
7(d)	down / d (quark) = $-\frac{1}{3}(e)$ and charm / c (quark) = $(+)\frac{2}{3}(e)$	**C1**
	charge = $-\frac{1}{3} -\frac{1}{3} +\frac{2}{3} = 0$	**A1**

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