Cambridge Assessment International Education

Cambridge International AS & A Level

PHYSICS **9702/23**

Paper 2 AS Level Structured Questions **May/June 2022**

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.

Cambridge International is publishing the mark schemes for the May/June 2022 series for most Cambridge IGCSE, Cambridge International A and AS Level and Cambridge Pre-U components, and some Cambridge O Level components.

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.

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 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.

Annotations

✓	Indicates the point at which a mark has been awarded.
X	Indicates an incorrect answer or a point at which a decision is made not to award a mark.

XP	Indicates a physically incorrect equation ('incorrect physics'). No credit is given for substitution, or subsequent arithmetic, in a physically incorrect equation.
ECF	Indicates 'error carried forward'. Answers to later numerical questions can always be awarded up to full credit provided they are consistent with earlier incorrect answers. Within a section of a numerical question, ECF can be given after AE, TE and POT errors, but **not** after XP.
AE	Indicates an arithmetic error. Do not allow the mark where the error occurs. Then follow through the working / calculation giving full subsequent ECF if there are no further errors.
POT	Indicates a power of ten error. Do not allow the mark where the error occurs. Then follow through the working / calculation giving full subsequent ECF if there are no further errors.
TE	Indicates incorrect transcription of the correct data from the question, a graph, data sheet or a previous answer. For example, the value of 1.6×10^{-19} has been written down as 6.1×10^{-19} or 1.6×10^{19}. Do not allow the mark where the error occurs. Then follow through the working / calculation giving full subsequent ECF if there are no further errors.
SF	Indicates that the correct answer is seen in the working but the final answer is incorrect as it is expressed to too few significant figures.
BOD	Indicates that a mark is awarded where the candidate provides an answer that is not totally satisfactory, but the examiner feels that sufficient work has been done ('benefit of doubt').
CON	Indicates that a response is contradictory.
I	Indicates parts of a response that have been seen but disregarded as irrelevant.
M0	Indicates where an A category mark has not been awarded due to the M category mark upon which it depends not having previously been awarded.
^	Indicates where more is needed for a mark to be awarded (what is written is not wrong, but not enough). May also be used to annotate a response space that has been left completely blank.
SEEN	Indicates that a page has been seen.

Question	Answer	Marks
1(a)	$\rho = m / V$	**C1**
	$V = (4 / 3) \times \pi \times r^3$ $= (4 / 3) \times \pi \times (3.42 / 2)^3$ $(= 20.9\ \text{cm}^3)$	**C1**
	$\rho = 67 / 20.9$ $= 3.2\ \text{g cm}^{-3}$	**A1**
1(b)	$\%\rho = \%m + 3 \times \%d$ $= [(2 / 67) \times 100] + [3 \times (0.02 / 3.42) \times 100]$	**C1**
	$= 3.0\% + 3 \times 0.58\%$ $= 4.7\%$ or 5%	**A1**

Question	Answer	Marks
2(a)	(time =) displacement / velocity	**C1**
	(time =) 70.0 / 65.0 cos 4.30° = 1.08 (s)	**A1**
2(b)	$s = ut + \frac{1}{2}at^2$ $= (65 \times \sin 4.30° \times 1.08) – (0.5 \times 9.81 \times 1.08^2)$	**C1**
	$s = -0.46$ (m)	**C1**
	height above ground = 1.66 − 0.46 = 1.2 m	**A1**
2(c)	GPE has decreased	**M1**
	(total energy conserved so) KE has increased	**A1**

Question	Answer	Marks
3(a)	(velocity =) change in displacement / time	**B1**
3(b)(i)	a = 2400 / 1200 = 2.0 m s^{-2}	**A1**
3(b)(ii)	straight line from the origin with positive gradient (labelled A)	**M1**
	ending at (20, 40)	**A1**
3(c)(i)	line starting at origin (with the same gradient as A) and beneath A at all points	**B1**
	gradient decreasing to zero	**B1**
	straight horizontal line from t = 12 s and ending at t = 20 s (and labelled B)	**B1**
3(c)(ii)	the velocity/speed will increase	**B1**
	to a new terminal/constant/maximum velocity/speed	**B1**
	or	
	the car has an acceleration	**(B1)**
	to a new (higher) terminal/constant/maximum velocity/speed	**(B1)**

Question	Answer	Marks
4(a)	work (done) = force × displacement	**M1**
	(force = mg and distance = Δh) (so) work (done) = $mg\Delta h$ and work = $\Delta E_{(P)}$ (so $\Delta E_{(P)} = mg\Delta h$)	**A1**
4(b)	gravitational potential (energy) to heat/thermal (energy)	**B1**
4(c)(i)	$P = mg(\Delta)h / (\Delta)t$ **or** Fv	**C1**
	$P = (0.60 \times 9.81 \times 1.4) / 4.0$ **or** $0.60 \times 9.81 \times (1.4 / 4.0)$ $= 2.1$ W	**A1**
4(c)(ii)	$P = I^2R$ **or** IV **or** V^2 / R	**C1**
	$= 0.09^2 \times 47$ **or** 0.09×4.23 **or** $4.23^2 / 47$ $= 0.38$ W	**A1**
4(c)(iii)	efficiency $= P_{out} / P_{in}$ (× 100) **or** E_{out} / E_{in} (× 100)	**C1**
	$= 0.38 / 2.1$ (× 100) **or** $0.38 \times 4.0 / 2.1 \times 4.0$ (× 100) $= 0.18$ **or** 18%	**A1**

Question	Answer	Marks
5(a)(i)	power = intensity × area	**C1**
	= $1.3 \times 10^3 \times (\pi \times 0.055^2)$ = 12 W	**A1**
5(a)(ii)	intensity = power / area = $12 / (\pi \times 0.0015^2)$ = 1.7×10^6 W m^{-2}	**A1**
5(b)(i)	(λ =) v / f **or** c / f	**C1**
	(λ =) $3.0 \times 10^8 / 3.7 \times 10^{15} = 8.1 \times 10^{-8}$ (m)	**A1**
5(b)(ii)	ultraviolet	**A1**

Question	Answer	Marks
5(b)(iii)	$d \sin\theta = n\lambda$ **or** $(1 / N) \times \sin\theta = n\lambda$	**C1**
	$d = 1 / 2400 \times 10^3$ (m) $= 4.2 \times 10^{-7}$ (m) **or** $N = 2400 \times 10^3$ (m^{-1})	**C1**
	$n = 4.2 \times 10^{-7} \times \sin 90° / 8.1 \times 10^{-8}$ **or** $\sin 90° / 2400 \times 10^3 \times 8.1 \times 10^{-8}$ $n = 5.2$ or 5.1 **or** when $n = 5$, $\theta = 76.4°$ and when $n = 6$, $\sin\theta > 1$ (so) $n = 5$	**B1**
	number of maxima = $(2 \times 5) + 1$ $= 11$	**A1**
5(b)(iv)	the wavelength has increased	**M1**
	(so) number of maxima decreases	**A1**

Question	Answer	Marks
6(a)(i)	line passes through (0,0) and is in first and third quadrants only	**M1**
	gradient of line becoming less steep in both quadrants and roughly symmetrical	**A1**
6(a)(ii)	(as I increases) the temperature (of the filament wire/lamp) increases	**B1**
	(as I / temperature / V increases) the resistance (of wire/lamp) increases	**B1**
	(as I / temperature / V increases the graph curves because) ratio V / I increases or ratio I / V decreases	**B1**
6(b)	$R = \rho L / A$	**C1**
	$= (5.6 \times 10^{-8} \times 5.8) / 3.4 \times 10^{-8}$ $= 9.6\ \Omega$	**A1**

Question	Answer	Marks
6(c)		**B4**

position of switches		ammeter readings		
S_1	S_2	X / A	Y / A	Z / A
open	open	0	0	0
open	closed	1.0	**0**	**1.0**
closed	open	**2.0**	**2.0**	**0**
closed	closed	**3.0**	**2.0**	**1.0**

second row: both values correct (B1)

third row: all three values correct (B1)

fourth row: $X = Y + Z$ (any values) (B1)

all three values correct (B1)

Question	Answer	Marks
7(a)(i)	$^{18}_{9}F \rightarrow {}^{18}_{8}O + {}^{0}_{(+)1}\beta^{(+)} + {}^{(0)}_{(0)}\nu_{(e)}$ ν **or** neutrino (B1) ${}^{0}_{(+)1}\beta^{(+)}$ (B1) ${}^{18}_{8}O$ (B1)	**B3**
7(a)(ii)	up quark to down quark	**B1**
7(b)(i)	must be three (anti)quarks as largest (negative) quark charge is (–)2/3 (*e*) **or** mesons can only have a charge of 0 or $\pm$1(*e*)	**M1**
	(so hadron is) a baryon	**A1**
7(b)(ii)	any combination of three from: antiup (quark) / up antiquark and/or anticharm (quark) / charm antiquark and/or antitop (quark) / top antiquark	**B1**