Cambridge Assessment International Education

Cambridge International AS & A Level

PHYSICS **9702/22**

Paper 2 AS Level Structured Questions **May/June 2023**

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 2023 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.

Question	Answer	Marks
1(a)(i)	force / area (normal to the force)	**B1**
1(a)(ii)	($p = F / A$ so units are) kg m s^{-2} / m^2 = kg m^{-1} s^{-2}	**A1**
1(b)	unit of R: m **and** unit of t: s **and** unit of L: m	**C1**
	unit of ρ: kg m^{-3} **or** $\rho = m / V$	**C1**
	base units of k: (kg m^{-1} s^{-2} × m^4 × kg m^{-3} × s) / (kg × m) = kg m^{-1} s^{-1}	**A1**
1(c)	R contributes 4 × 2% **or** 8% (and L contributes 2%) so R contributes more (to the percentage uncertainty in k)	**B1**

Question	Answer	Marks
2(a)	the point where (all) the weight (of the object) is taken to act	**B1**
2(b)(i)	(54 × 0.45) **or** (2.4 × 0.95) **or** (T sin 30° × 1.3)	**C1**
	(54 × 0.45) = (2.4 × 0.95) + (T sin 30° × 1.3)	**C1**
	T = 34 N	**A1**
2(b)(ii)	resultant moment = (54 × 0.45) – (2.4 × 0.95) **or** (34 sin 30° × 1.3) = 22 N m	**A1**
2(c)(i)	(∆)E = mg(∆)h **or** W(∆)h	**C1**
	= 2.4 × 1.8 = 4.3 J	**A1**

Question	Answer	Marks
2(c)(ii)	$E = \frac{1}{2}mv^2$	**C1**
	$= \frac{1}{2} \times (2.4 / 9.81) \times 3.4^2$ $= 1.4$ J (at X)	**C1**
	kinetic energy at Y $= 4.3 + 1.4$ $= 5.7$ J	**A1**
	or	
	$\frac{1}{2}mv^2 = \frac{1}{2}mu^2 + mg(\Delta)h$	**(C1)**
	$v^2 = 3.4^2 + 2 \times 9.81 \times 1.8$ $v^2 = 46.9$ so $v = 6.85$ (m s^{-1}) KE $= \frac{1}{2} \times (2.4 / 9.81) \times 6.85^2$	**(C1)**
	$= 5.7$ J	**(A1)**
2(c)(iii)	no variation **or** acceleration is (always) vertically downwards	**B1**
2(c)(iv)	horizontal straight line at a non-zero value of velocity	**B1**

Question	Answer	Marks
3(a)(i)	rate of change of momentum	**B1**
3(a)(ii)	change in momentum = $(1.4 - 0.80) \times 3.0$	**C1**
	$= 1.8\ \text{kg m s}^{-1}$	**A1**
3(b)(i)	resultant force (on block) is zero	**B1**
	(so) velocity is constant	**B1**
3(b)(ii)	$P = Fv$ **or** $P = Fs / t$	**C1**
	$v = 2.0 / 0.80$ $(= 2.5\ \text{m s}^{-1})$	**C1**
	distance $= 2.5 \times 3.0$ $= 7.5\ \text{m}$	**A1**
	or	
	$P = W / t$ **or** $P = Fs / t$	**(C1)**
	$W = 2.0 \times 3.0$ $(= 6.0\ \text{J})$	**(C1)**
	distance $= 6.0 / 0.80$ $= 7.5\ \text{m}$	**(A1)**
3(c)	0 to 3.0 s: upward sloping straight line from the origin.	**B1**
	3.0 to 6.0 s: horizontal line at non-zero value of momentum with no 'step change' in momentum at 3.0 s	**B1**

Question	Answer	Marks
4(a)	Hooke's (law)	**B1**
4(b)	$k = F / x$ **or** k = gradient	**C1**
	= e.g. 12.0 / (0.240 – 0.08) = 75 N m^{-1}	**A1**
4(c)	$E = \frac{1}{2}Fx$ **or** $E = \frac{1}{2}kx^2$ **or** E = area under graph	**C1**
	$E = \frac{1}{2} \times 6.0 \times 0.080$ **or** $\frac{1}{2} \times 75 \times 0.08^2$ = 0.24 J	**A1**

Question	Answer	Marks
5(a)(i)	(they are) perpendicular	**B1**
5(a)(ii)	(they are) parallel	**B1**
5(b)(i)	$\lambda = v / f$	**C1**
	$= 340 / 1700$ $= 0.20\ \text{m}$	**A1**
5(b)(ii)	$L = \frac{3}{4} \times \lambda = \frac{3}{4} \times 0.20$ $= 0.15\ \text{m}$	**A1**
5(b)(iii)	$\lambda = 4 \times 0.15$ **or** 0.20×3 $= 0.60\ \text{m}$	**A1**
5(c)(i)	$(I =)\ 8.5 \times \cos^2 35° = 5.7\ (\text{W m}^{-2})$	**A1**
5(c)(ii)	$5.2 = 5.7 \cos^2 \theta$ $(\theta = 17°)$	**C1**
	$\alpha = 35° + 17°$ $= 52°$	**A1**

Question	Answer	Marks
6(a)	temperature decreases (so) resistance decreases	**B1**
6(b)(i)	current = V / R	**A1**
6(b)(ii)	$I = Anvq$ $n = N / V$ **or** $n = N / AL$	**C1**
	$v = (V / R) / [(V / L) (N / V) e]$ **or** $(V / R) / [A (N / AL) e]$ $= VL / RNe$	**A1**
	or	
	$v = L / t$ $= L / (Q / I)$	**(C1)**
	$= LI / Q$ $= L(V / R) / Ne$ $= VL / RNe$	**(A1)**
6(b)(iii)	time = distance / speed **or** Q / I $= L / (VL / RNe)$ **or** $Ne / (V / R)$ time = RNe / V	**A1**

Question	Answer	Marks
7(a)	V / 9.0 = 1800 / (1800 + 1200)	**C1**
	V = 5.4 V	**A1**
	or	
	I = 9.0 / (1800 + 1200) = 3.0×10^{-3} (A) V = $3.0 \times 10^{-3} \times 1800$	**(C1)**
	= 5.4 V	**(A1)**
7(b)(i)	L / 1.2 = 5.4 / 9.0 **or** XZ / 1.2 = 5.4 / 9.0	**C1**
	L = 0.72 m	**A1**
	or	
	L / 1.2 = 1800 / (1800 + 1200) **or** XZ / 1.2 = 1.8 / (1.8 + 1.2)	**(C1)**
	L = 0.72 m	**(A1)**
7(b)(ii)	• (intensity) increase	**B1**
	• (power) increase	**B1**
	• (length XZ) decrease	**B1**

Question	Answer	Marks
8(a)(i)	number of protons: equal/same	**B1**
	number of neutrons: unequal/different	**B1**
8(a)(ii)	down (quark) changes to up (quark) **or** up down down (quarks) change to up up down (quarks)	**B1**
8(a)(iii)	(electron) antineutrino	**B1**
8(b)	charm (quark charge) is (+)2/3(*e*) **or** 2 charm (quark charges) is (+)4/3(*e*) **or** bottom (quark charge) is –1/3(*e*)	**C1**
	charge = +2/3(*e*) + 2/3(*e*) –1/3(*e*) = (+)1(*e*)	**A1**