Cambridge Assessment International Education

Cambridge International AS & A Level

PHYSICS **9702/21**

Paper 2 AS Level Structured Questions **October/November 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.

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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	Mark
1(a)	scalar and vector have magnitude	**B1**
	vector has direction (and scalar does not have direction)	**B1**
1(b)(i)	$r = [(3 \times 28) / 4\pi]^{1/3}$ $= 1.9\,\text{cm}$	**A1**
1(b)(ii)	percentage uncertainty in $V = (0.5 / 28) \times 100$ $(= 1.79\%)$	**C1**
	percentage uncertainty in $r = 1.79 / 3$ $= 0.6\%$	**A1**

Question	Answer	Mark
2(a)(i)	arrow upwards (↑) **and** labelled upthrust / U arrow downwards (↓) **and** labelled weight / W / mg arrow downwards (↓) **and** labelled tension / T *1 mark: One or two correctly labelled arrows* *2 marks: Three correctly labelled arrows*	**B2**
2(a)(ii)	$U = T + W$ **or** upthrust = tension + weight	**C1**
	$\rho Vg = T + W$ $V = [(4.00 \times 10^2) + (3.39 \times 10^4)] / (1.23 \times 9.81)$	**C1**
	$V = 2.84 \times 10^3\ \text{m}^3$	**A1**
2(a)(iii)	$m = W / g$ **or** $a = F / m$	**C1**
	$a = (4.00 \times 10^2) / [(3.39 \times 10^4) / 9.81)]$	**C1**
	$a = 0.12\ \text{m s}^{-2}$	**A1**
2(b)	there is air resistance (which increases with speed)	**B1**
	(average) resultant force is less (than weight)	**B1**
	(average) acceleration is less (than g / 9.81, so speed is less than $100\ \text{m s}^{-1}$)	**B1**
2(c)(i)	(extension =) $2.5 \times 2.4 \times 10^{-5} = 6.0 \times 10^{-5}$ (m)	**A1**

Question	Answer	Mark
2(c)(ii)	$E_{(P)} = ½ Fx$ **or** $E_{(P)} = ½ kx^2$ **and** $F = kx$	**C1**
	$E_{(P)} = ½ \times 4.00 \times 10^2 \times 6.0 \times 10^{-5}$ **or** $E_{(P)} = ½ \times 6.7 \times 10^6 \times (6.0 \times 10^{-5})^2$ $E_{(P)} = 0.012$ J	**A1**
2(c)(iii)	longer extension **or** smaller spring constant	**M1**
	elastic potential energy is greater	**A1**

Question	Answer	Mark
3(a)	displacement	**A1**
3(b)(i)	a = gradient **or** $a = \Delta v / (\Delta)t$ **or** $a = (v - u) / t$	**C1**
	e.g. $a = (0.30 - 0.12) / (0.35 - 0.15)$ $a = 0.90\ \text{m s}^{-2}$	**A1**
3(b)(ii)	$(0.25 \times 0.48) + (0.75 \times 0.12) = (0.25\ v) + (0.75 \times 0.30)$ **or** $(0.48 - 0.12) = (0.30 - v)$ **or** $(½ \times 0.25 \times 0.48^2) + (½ \times 0.75 \times 0.12^2) = (½ \times 0.25 \times v^2) + (½ \times 0.75 \times 0.30^2)$	**C1**
	$v = (-)0.060\ \text{m s}^{-1}$	**A1**
	direction: to the left / from the right / opposite to (its) initial velocity / opposite to (initial / final) velocity of B	**B1**
3(c)	sketch: horizontal line from (0, 0.48) to (0.15, 0.48)	**B1**
	horizontal line from (0.35, –0.06) to (0.5, –0.06)	**B1**
	straight line between (0.15, 0.48) and (0.35, –0.06)	**B1**

Question	Answer	Mark
4(a)	(when two or more) waves meet / overlap (at a point)	**B1**
	(resultant) displacement is the sum of the individual displacements	**B1**
4(b)	$\lambda = ax / D$	**C1**
	$\lambda = [(0.65 \times 10^{-3}) \times (1.7 \times 10^{-3})] / 1.9$	**C1**
	$\lambda = 5.8 \times 10^{-7}$ m	**A1**
4(c)(i)	waves are out of phase by a quarter of a cycle / period **or** when one wave has maximum/minimum displacement, the other wave has zero displacement	**B1**
4(c)(ii)	(statement 2 is) not correct (because) waves do not have phase difference of 180° / not in antiphase **or** one wave has some displacement when other has no displacement **or** the displacements of the waves are not always equal and opposite	**B1**
4(d)	more diffraction (of light/waves by slits) **or** light/waves are more spread (by slits) **or** light/waves (from slits) have less intensity	**B1**
	more (bright/dark) fringes **or** bright fringes are less bright / are dimmer / have lower intensity **or** no change to fringe spacing/separation/width	**B1**

Question	Answer	Mark
5(a)	sketch: approximately horizontal line above horizontal dashed line from $t = 0$ to $t = t_1$ **and** approximately horizontal line below horizontal dashed line from $t = t_1$ to $t = t_2$	**A1**
5(b)	$I = P / A$	**C1**
	$A = \pi \times 0.028^2$ **or** $\pi \times 2.8^2$ $(= 2.46 \times 10^{-3}$ **or** 24.6)	**C1**
	$P = 4.7 \times 10^{-3} \times 2.46 \times 10^{-3}$ $= 1.2 \times 10^{-5}$ W	**A1**

Question	Answer	Mark
6(a)(i)	(I =) 16 / 320 = 0.050 (A)	**A1**
6(a)(ii)	R = (25 – 16) / 0.050 **or** R = (9 / 16) × 320 **or** R = (25 / 0.050) – 320	**C1**
	R = 180 (Ω)	**C1**
	$R_{(LDR)}$ = [(1 / 180) – (1 / 240)]$^{-1}$ = 720 Ω	**A1**
	or	
	I = (25 – 16) / 240 (= 0.0375 A)	**(C1)**
	$I_{(LDR)}$ = 0.050 – 0.0375 (= 0.0125 A)	**(C1)**
	$R_{(LDR)}$ = 9.0 / 0.0125 = 720 Ω	**(A1)**

Question	Answer	Mark
6(a)(iii)	$P = V^2 / R$ **or** $P = VI$ **or** $P = I^2R$	**C1**
	ratio = $(9^2 / 720) / (9^2 / 240)$ **or** ratio = $(9 \times 0.0125) / (9 \times 0.0375)$ **or** ratio = $(0.0125^2 \times 720) / (0.0375^2 \times 240)$ ratio = $0.1125 / 0.3375$ = 0.33	**A1**
6(b)	resistance of LDR decreases	**B1**
	resistance of parallel combination decreases **or** total resistance (of circuit) decreases **or** current in resistor of resistance 320 Ω increases **or** potential difference across parallel combination / LDR / 240 Ω resistor decreases	**M1**
	voltmeter reading increases	**A1**

Question	Answer	Mark
7(a)	a (very) small proportion of (alpha) particles are deflected (back) through large angles / angles greater than 90°	**B1**
	a large proportion of (alpha) particles pass straight through / deflected by small angles	**B1**
7(b)	electromagnetic wave / electromagnetic radiation	**A1**
7(c)	neutrino classified as a lepton only and positron classified as a lepton only	**B1**
	neutron classified as a baryon and a hadron and not as a lepton	**B1**
7(d)(i)	1.32 u	**A1**
7(d)(ii)	working states or implies 3 quarks and each quark has a charge of (+) ⅔(*e*)	**B1**
	any combination of 3 quarks comprised of one or more of up / charm / top	**B1**