CAMBRIDGE
International Education

Cambridge International AS & A Level

PHYSICS **9702/21**

Paper 2 AS Level Structured Questions **May/June 2024**

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	Marks
1(a)	units of F_D: kg m s^{-2}	**M1**
	units of ρ: kg m^{-3} **and** units of A: m^2 **and** units of v: m s^{-1} **or** units of v^2: m^2 s^{-2}	**M1**
	kg m s^{-2} = C kg m s^{-2} **and** comment '(so) C has no units' / unit terms cancelled **or** C = kg m s^{-2} / (kg m^{-3} m^2 m^2 s^{-2}) **and** comment '(so) C has no units' / unit terms cancelled	**A1**
1(b)	one arrow vertically downward labelled weight to within 10° of the vertical	**B1**
	one arrow vertically upwards labelled drag / drag force / F_D / air resistance / viscous force to within 10° of the vertical	**B1**
1(c)	(at terminal velocity) $F_D = mg$	**C1**
	$F_D = 0.049 \times 9.81$ $= 0.48$ N	**A1**
1(d)	area = $\pi \times (0.060 / 2)^2$	**C1**
	$0.48 = ½ \times C \times 1.2 \times \pi \times (0.060 / 2)^2 \times 25^2$	**C1**
	$C = 0.45$	**A1**

Question	Answer	Marks
2(a)	change in displacement / time (taken)	**B1**
2(b)(i)	horizontal velocity = $22 \times \cos 40°$	**C1**
	time taken $= 36 / (22 \times \cos 40°)$ $= 2.1$ s	**A1**
2(b)(ii)	$u = 22 \times \sin 40°$ $= 14$ m s^{-1}	**A1**
2(b)(iii)	$s = ut + \frac{1}{2} at^2$ $= (14 \times 2.1) + (\frac{1}{2} \times -9.81 \times 2.1^2)$	**C1**
	$= 7.8$ (m)	**C1**
	(therefore) height of wall $= 7.8 + 1.2$ $= 9.0$ m	**A1**

Question	Answer	Marks
2(b)(iii)	**or**	
	other methods possible e.g. time to maximum height = (0 – 14) / –9.81 (= 1.43 s) time from maximum height to wall = 2.1 – 1.43 (= 0.67 s) maximum height above release = $(14 \times 1.43) + (½ \times -9.81 \times 1.43^2)$ = 9.99 (m)	**(C1)**
	height from maximum to wall = $0.5 \times 9.81 \times 0.67^2$ (= 2.2 m) height above release = 9.99 – 2.2 = 7.8 (m)	**(C1)**
	height of wall = 1.2 + 7.8 = 9.0 m	**(A1)**

Question	Answer	Marks
3(a)	sum / total momentum before (a collision) = sum / total momentum after (a collision) **or** sum / total momentum (of a system) is constant	**M1**
	if no (resultant) external force (acts) / for an isolated system	**A1**
3(b)	along direction of motion: $10m = 2mv \cos 30° + 3mw \cos 30°$	**C1**
	perpendicular to direction of motion: $2mv \cos 60° = 3mw \cos 60°$ $(v = 3w / 2)$	**C1**
	$v = 2.9\ \text{m s}^{-1}$	**A1**
	$w = 1.9\ \text{m s}^{-1}$	**A1**
3(c)	$E_K = ½ \times m \times v^2$ $(= ½ \times 4.2 \times 6.0^2)$ (= 76 J)	**C1**
	force = work done / distance	**C1**
	force = 76 / 0.050 = 1500 N	**A1**

Question	Answer	Marks
3(c)	**or**	
	$a = (-)u^2 / 2s$ $= (-)6.0^2 / (2 \times 0.050)$ $(= (-)360 \text{ m s}^{-2})$	**(C1)**
	$F = ma$	**(C1)**
	$F = 4.2 \times 360$ $= 1500 \text{ N}$	**(A1)**
	or	
	$a = (-)u^2 / 2s$ $= (-)6.0^2 / (2 \times 0.050)$ $(= (-)360 \text{ m s}^{-2})$	**(C1)**
	$t = -u / a$ $= -6.0 / -360 \ (= 0.017 \text{ s})$ $F = \Delta p / t$	**(C1)**
	$F = (0 - 4.2 \times 6) / 0.017$ $= 1500 \text{ N}$	**(A1)**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>4(a)</td><td>extension / <u>original</u> length</td><td>B1</td></tr>
<tr><td rowspan="3">4(b)(i)</td><td>Young modulus = stress / strain</td><td>C1</td></tr>
<tr><td>= $(18 / 4.5 \times 10^{-7}) / (1.4 \times 10^{-3} / 4.0)$</td><td>C1</td></tr>
<tr><td>= $(4.0 \times 10^{7}) / (3.5 \times 10^{-4})$
= 1.1×10^{11} Pa</td><td>A1</td></tr>
<tr><td rowspan="2">4(b)(ii)</td><td>straight line through the origin</td><td>B1</td></tr>
<tr><td>ending at the point (3.5, 4.0)</td><td>B1</td></tr>
<tr><td>4(c)</td><td>
<table>
<tr><th></th><th>greater in second wire</th><th>less in second wire</th><th>the same in both wires</th></tr>
<tr><td>stress</td><td></td><td>✓</td><td></td></tr>
<tr><td>strain</td><td></td><td>✓</td><td></td></tr>
</table>
</td><td>B2</td></tr>
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Question	Answer	Marks
5(a)	wave(s) (travel along string and) reflect at fixed point / wall / Q / end / vibration generator / P	**B1**
	incident and reflected waves superpose	**B1**
5(b)	0.80 m	**A1**
5(c)	same wavelength as original throughout **and** passing through intersection of solid and dashed lines	**B1**
	reflected in dashed line **and** of same amplitude	**B1**
5(d)	180°	**A1**
5(e)	$v = f\lambda$ **and** $f = 1 / T$ **or** $v = \lambda / T$	**C1**
	$v = 6.25 \times 0.80$ **or** $0.80 / 0.16$ $= 5.0\ \text{m s}^{-1}$	**A1**

Question	Answer	Marks
6(a)	sum of current(s) entering a junction = sum of current(s) leaving (the same junction) **or** (algebraic) sum of current (s) at a junction is zero	**B1**
6(b)	(by Kirchhoff's second law) $V = V_1 + V_2$	**B1**
	so $IR_T = IR_1 + IR_2$ (and cancelling I gives) $R_T = R_1 + R_2$ **or** $V / I = V_1 / I + V_2 / I$ (and substituting R gives) $R_T = R_1 + R_2$	**B1**
6(c)	current in circuit = 1.35 / (10 + 15) (= 0.054 A)	**C1**
	r = (E – V) / I	**C1**
	= (1.5 – 1.35) / 0.054 = 2.8 Ω	**A1**
	or	
	by potential divider principle $\frac{0.15}{1.35} = \frac{r}{25}$	**(C2)**
	r = 2.8 Ω	**(A1)**
	or	
	I = 1.35 / (10 + 15) (= 0.054 A)	**(C1)**
	total resistance = 1.50 / 0.054 (= 27.8 Ω) r = 27.8 – 25	**(C1)**
	r = 2.8 Ω	**(A1)**

Question	Answer	Marks
6(d)(i)	the (total) resistance (of the circuit) has decreased (and e.m.f. is unchanged)	**M1**
	(the current (in the cell) will) increase	**A1**
6(d)(ii)	(as the current is greater and so there is a) larger p.d. across the internal resistance	**M1**
	(terminal p.d. will) decrease	**A1**

Question	Answer	Marks
7(a)	$^{66}_{29}Cu$	**B1**
7(b)(i)	the energy of the decay is fixed / constant	**B1**
	the energies of the beta particles have a (continuous) range of values / varies / not constant	**B1**
	another particle / an (anti)neutrino must possess the extra / remaining energy (difference between energy of the decay and the β kinetic energy)	**B1**
7(b)(ii)	(electron) antineutrino	**B1**
7(b)(iii)	$^{66}_{29}Cu \rightarrow {}^{66}_{30}Zn + {}^{0}_{-1}\beta + {}^{0}_{0}\overline{\upsilon}_{e}$ values for Cu and Zn correct with no other extra particles on either side of the equation	**B1**
	second term correct ($^{0}_{-1}\beta$)	**B1**
	third term correct ($^{0}_{0}\overline{\upsilon}_{e}$)	**B1**