



## Cambridge International AS & A Level

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**PHYSICS**

**9702/21**

Paper 2 AS Level Structured Questions

**May/June 2022**

**MARK SCHEME**

Maximum Mark: 60

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<p><b>Published</b></p>
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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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This document consists of **13** printed pages.

**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 <b>context</b> 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>B</b> marks	These are <u>independent</u> marks, which do not depend on other marks. For a <b>B</b> mark to be awarded, the point to which it refers must be seen specifically in the candidate's answer.
<b>M</b> marks	These are <u>method</u> marks upon which <b>A</b> marks later depend. For an <b>M</b> 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 <b>M</b> mark, then the later <b>A</b> mark cannot be awarded either.
<b>C</b> marks	These are <u>compensatory</u> 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 <b>C</b> mark and the candidate does not write down the actual equation but does correct working which shows the candidate knew the equation, then the <b>C</b> mark is awarded. If a correct answer is given to a numerical question, all of the preceding <b>C</b> marks are awarded automatically. It is only necessary to consider each of the <b>C</b> marks in turn when the numerical answer is not correct.
<b>A</b> marks	These are <u>answer</u> marks. They may depend on an <b>M</b> mark or allow a <b>C</b> 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.

<b>ECF</b>	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. <u>Within</u> a section of a numerical question, ECF can be given after AE, TE and POT errors, but <b>not</b> after XP.
<b>AE</b>	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.
<b>POT</b>	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.
<b>TE</b>	Indicates incorrect transcription of the correct data from the question, a graph, data sheet or a previous answer. For example, the value of $1.6 \times 10^{-19}$ has been written down as $6.1 \times 10^{-19}$ or $1.6 \times 10^{19}$ . 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.
<b>SF</b>	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.
<b>BOD</b>	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').
<b>CON</b>	Indicates that a response is contradictory.
<b>I</b>	Indicates parts of a response that have been seen but disregarded as irrelevant.
<b>M0</b>	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.
<b>^</b>	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.
<b>SEEN</b>	Indicates that a page has been seen.

Question	Answer	Marks
1(a)	change in displacement / time (taken)	<b>B1</b>
1(b)(i)	(displacement =) area under graph	<b>C1</b>
	(at $t = 4.0$ s) $v = (-) 2.4$	<b>C1</b>
	height = $\frac{1}{2} \times 2.5 \times 4.0 - \frac{1}{2} \times 1.5 \times 2.4$ = 3.2 m	<b>A1</b>
1(b)(ii)	change in momentum = $7.5 (-4.0 - 2.4)$	<b>C1</b>
	= $(-) 48$ N s	<b>A1</b>
1(b)(iii)	$W = \Delta p / (\Delta)t$ or $\Delta mv / (\Delta)t$	<b>C1</b>
	= $48 / 4.0$	<b>A1</b>
	= 12 N	
	<b>or</b>	
	$W = ma$ or $mg$ or $m(v - u) / t$	<b>(C1)</b>
	= $7.5 \times 1.6$ or $7.5 \times (4 + 2.4) / 4.0$ = 12 N	<b>(A1)</b>
1(c)	speed/velocity decreases so viscous force decreases	<b>B1</b>
	viscous force decreases (and weight constant) so resultant force decreases	<b>B1</b>

Question	Answer	Marks
2(a)	point where (all) the weight (of the object) is taken to act	<b>B1</b>
2(b)(i)	moments about P are: $(F \times 1.10)$ , $(44.0 \times 0.60)$ and $(3.0 \times 2.90)$ <i>1 mark for any one correct moment and 2 marks for two correct moments</i>	<b>C2</b>
	$(F \times 1.10) = (44.0 \times 0.60) + (3.0 \times 2.90)$ $F = 32 \text{ N}$	<b>A1</b>
2(b)(ii)	force = $32 + 44 + 3$ $= 79 \text{ N}$	<b>A1</b>
2(c)(i)	$(F = \rho g V)$ $V = 2.5 / (1100 \times 9.81) (= 2.32 \times 10^{-4})$	<b>C1</b>
	$V = (4/3)\pi r^3$	<b>C1</b>
	$r = [(3 \times 2.32 \times 10^{-4}) / 4\pi]^{1/3}$ $r = 0.038 \text{ m}$	<b>A1</b>
2(c)(ii)	resultant moment = $2.5 \times 2.9$ $= 7.3 \text{ N m}$  <b>or</b> resultant moment = $F \times 1.1 - (44 \times 0.6 + 0.5 \times 2.9)$ $= 7.3 \text{ N m}$ (allow 7.2 N m or 7.4 N m from rounded values of $F$ )	<b>A1</b>
	direction: anticlockwise	<b>A1</b>

Question	Answer	Marks
3(a)(i)	work (done) / time (taken)	<b>B1</b>
3(a)(ii)	$W = Fx$ <b>or</b> $E = Fx$	<b>B1</b>
	$(P =) Fx / t = Fv$ <b>or</b> $P = Fvt / t = Fv$	<b>B1</b>
3(b)(i)	$T = 430 \sin 11^\circ$ <b>or</b> $430 \cos 79^\circ$	<b>C1</b>
	$= 82 \text{ N}$	<b>A1</b>
3(b)(ii)	speed = $56 / 82$ $= 0.68 \text{ m s}^{-1}$	<b>A1</b>
3(b)(iii)	no change in kinetic energy (of block)	<b>B1</b>
3(b)(iv)	(input power) = $56 / 0.80$ ( = 70 W)	<b>C1</b>
	time taken = $1.2 \times 10^3 / 70$ $= 17 \text{ s}$	<b>A1</b>
	<b>or</b>	
	(useful energy) = $1200 \times 80 / 100$ ( = 960 J)	<b>(C1)</b>
	time taken = $960 / 56$ $= 17 \text{ s}$	<b>(A1)</b>

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Question	Answer	Marks
4(a)	$k = F / \Delta L$ or $F / x$ or gradient	<b>C1</b>
	= e.g. $30 / (0.60 - 0.20)$	<b>A1</b>
	= $75 \text{ N m}^{-1}$	
4(b)	$E = \frac{1}{2} F \Delta L$ or $\frac{1}{2} Fx$ or $\frac{1}{2} k (\Delta L)^2$ or $\frac{1}{2} kx^2$ or area under graph	<b>C1</b>
	= $\frac{1}{2} \times 15 \times 0.20$ or $\frac{1}{2} \times 75 \times 0.20^2$	<b>C1</b>
	= 1.5 J	<b>A1</b>

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Question	Answer	Marks
5(a)	wave(s) (travel along string and) reflect at fixed point / A / B / end	<b>B1</b>
	incident and reflected waves superpose / interfere <b>or</b> two waves travelling / with speed in opposite directions superpose / interfere	<b>B1</b>
5(b)	line has an approximate sinusoidal shape with maximum downward displacement at P and zero displacement at each node	<b>B1</b>
5(c)	$v = \lambda / T$ <b>or</b> $v = f\lambda$ <b>and</b> $f = 1 / T$	<b>C1</b>
	$\lambda = 35 \times 0.040$ <b>or</b> $35 / 25$  ( = 1.4 m)	<b>C1</b>
	distance = $1.4 \times 2.5$  = 3.5 m	<b>A1</b>
5(d)	(number of periods / cycles) ( $= t / T$ ) = $0.060 / 0.040$  ( = 1.5)	<b>C1</b>
	amplitude = $72 / 6$  = 12 mm	<b>A1</b>



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Question	Answer	Marks
6(a)	sum of current(s) into junction = sum of current(s) out of junction <b>or</b> (algebraic) sum of current(s) at a junction is zero	<b>B1</b>
6(b)(i)	same potential difference (across X and Y as in parallel)	<b>B1</b>
	power = $V^2 / R$ (and $R_X > R_Y$ ) <b>or</b> power = $VI$ and $I_X < I_Y$	<b>M1</b>
	(so) Y (dissipates more power)	<b>A1</b>
6(b)(ii)	$R = \rho L / A$ (and $R_X > R_Y$ )	<b>M1</b>
	(so) Y (has the larger (cross-sectional) area)	<b>A1</b>
6(c)(i)	current = $5.4 / 1800$  $= 3.0 \times 10^{-3} \text{ A}$	<b>A1</b>
6(c)(ii)	$5.4 / 9.0 = 1800 / (1800 + R_L)$  <b>or</b> $R_L = (9.0 - 5.4) / 3.0 \times 10^{-3}$	<b>C1</b>
	$R_L = 1200 \Omega$	<b>A1</b>
6(c)(iii)	resistance of LDR / $R_L$ decreases	<b>B1</b>
	current (in the circuit) increases (so) voltmeter reading increases	<b>B1</b>

Question	Answer	Marks
7(a)(i)	change in $A = 0$	<b>A1</b>
	change in $Z = (+)1$	<b>A1</b>
7(a)(ii)	(electron) <u>anti</u> neutrino	<b>B1</b>
7(b)(i)	up / u (charge) = $(+)\frac{2}{3}e$ <b>or</b> antidown / $\bar{d} = (+)\frac{1}{3}e$ <b>or</b> $(q) = \frac{2}{3}e + \frac{1}{3}e$	<b>M1</b>
	$q = (+)1e$	<b>A1</b>
7(b)(ii)	hadron(s)	<b>B1</b>
	meson(s)	<b>B1</b>