Cambridge Assessment International Education

Cambridge International AS & A Level

PHYSICS **9702/21**

Paper 2 AS Level Structured Questions **October/November 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 October/November 2022 series for most Cambridge IGCSE™, Cambridge International A and AS Level components and some Cambridge O Level components.

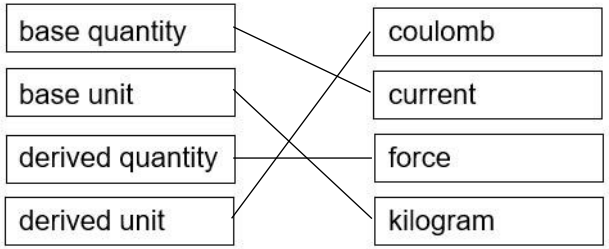
[Turn over

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)	 any two joined correctly	**C1**
	all four joined correctly	**A1**
1(b)(i)	the measurements have a small range	**B1**
1(b)(ii)	(average of the) measurements not close to the true value	**B1**
1(c)(i)	percentage uncertainty = (3 + 5 + 4) / 2	**C1**
	= 6%	**A1**
1(c)(ii)	absolute uncertainty = (6 / 100) × 15.0 = 0.9 m s^{-1}	**A1**

Question	Answer	Marks
2(a)(i)	$t = 1.8 / 4.9$ $= 0.37$ s	**A1**
2(a)(ii)	$v = u + at$ $= 9.81 \times 0.37$	**C1**
	$= 3.6$ m s^{-1}	**A1**
2(a)(iii)	$v^2 = 3.6^2 + 4.9^2$	**C1**
	$v = 6.1$ m s^{-1}	**A1**
	$\theta = \tan^{-1} (3.6 / 4.9)$ $= 36°$	**A1**
2(b)(i)	$\rho = m / V$	**C1**
	$V = \frac{4}{3}\pi r^3$	**C1**
	$\rho = 0.017 / [\frac{4}{3}\pi \times (0.016 / 2)^3]$ $= 7900$ kg m^{-3}	**A1**
2(b)(ii)	$(E =)$ ½mv^2	**C1**
	$(E =)$ ½ $\times$ 0.017 $\times$ 4.9^2 = 0.20 (J)	**A1**

Question	Answer	Marks
2(b)(iii)	$k = F / x$ **or** k = gradient	**C1**
	e.g. $k = 6.4 / 10 \times 10^{-2}$ $= 64\ \text{N m}^{-1}$ (*allow 63–65 N m^{-1}*)	**A1**
2(b)(iv)	$E = ½kx^2$ **or** $E = ½Fx$ **and** $F = kx$	**C1**
	$x_0 = [(2 \times 0.20) / 64]^{0.5}$ $= 0.079\ \text{m}$ or $0.080\ \text{m}$	**A1**
2(c)(i)	same elastic potential energy / same (initial) kinetic energy and (polystyrene ball has) smaller mass (so greater speed) **or** same (average) force and (polystyrene ball has) smaller mass, (so greater average acceleration so greater speed)	**B1**
2(c)(ii)	(for the polystyrene ball there is) less (average vertical) acceleration / smaller (average vertical component of) <u>resultant</u> force (so takes longer time to reach ground)	**B1**

Question	Answer	Marks
3(a)(i)	work done per unit time	**B1**
3(a)(ii)	$W = Fs$	**B1**
	$P = Fs / t$ and (so) $P = Fv$	**B1**
3(b)	(F =) $130 \times 10^3 / 25 = 5200$ (N)	**A1**
3(c)(i)	(component of weight =) $mg \sin\theta$	**A1**
3(c)(ii)	F (along slope due to weight) $= 36\,000 \times 9.81 \times \sin 1.4°$ (= 8600 N)	**C1**
	(total) $F = 5200 + 36\,000 \times 9.81 \times \sin 1.4°$ (= 13 800 N)	**C1**
	$P = 13\,800 \times 25$ $= 350 \times 10^3$ (W) = 350 kW	**A1**

Question	Answer	Marks
4(a)(i)	oscillations are in a single direction, which is perpendicular to the direction of propagation (of the wave) **or** oscillations are in a single plane, which contains the direction of propagation (of the wave)	**B1**
4(a)(ii)	light waves are transverse **and** sound waves are longitudinal	**B1**
4(b)	$I = I_0 \cos^2\theta$	**C1**
	$\cos^2\theta = 1/4$ so $\cos\theta = 1/2$ $\theta = 60°$ or $120°$ or $240°$ or $300°$	**C1**
	angle of rotation $= (120° - 90°)$ or $(240° - 90°)$ or $(300° - 90°)$ $= 30°$ or $150°$ or $210°$ or $330°$	**A1**
4(c)(i)	the waves have different amplitudes	**B1**
	cannot have resultant displacement that is always zero **or** cannot have (complete) destructive interference (at nodes) **or** (at nodes resultant) amplitude is the difference of the amplitudes	**B1**
4(c)(ii)	$I \propto A^2$	**C1**
	$A^2 / A_0^2 = (I_0 / 4) / I_0$ $A = 0.5\,A_0$	**C1**
	maximum amplitude $= A_0 + 0.5\,A_0$ $= 1.5\,A_0$	**A1**

Question	Answer	Marks
5(a)	current (through a conductor is directly) proportional to potential difference (across the conductor)	**M1**
	(provided that) temperature (of conductor remains) constant	**A1**
5(b)(i)	(ratio of) V / I increases (as p.d. increases)	**B1**
5(b)(ii)	(as p.d. increases, current increases so) temperature increases	**B1**
5(c)(i)	$I = 1.55$ A	**A1**
5(c)(ii)	$P = VI$ **or** $P = I^2R$ **or** $P = V^2 / R$	**C1**
	$= 6.0 \times 1.55 \times 2$ **or** $1.55^2 \times 3.87 \times 2$ **or** $(6.0^2 / 3.87) \times 2$ $= 19$ W	**A1**
5(c)(iii)	$I = 1.78 - 1.55$ $(= 0.23$ A)	**C1**
	$R = 12.0 / 0.23$ $= 52\ \Omega$	**A1**
5(d)	lamp P: p.d. across lamp decreases to zero so goes 'out'	**B1**
	lamp Q: p.d. across lamp increases to 12 V so gets brighter	**B1**

Question	Answer	Marks
6(a)	particle with no internal structure / particle which cannot be broken down into anything smaller	**A1**
6(b)	charges: $u = (+)\frac{2}{3}(e)$ **or** $d = -\frac{1}{3}(e)$ **or** $s = -\frac{1}{3}(e)$	**C1**
	$(+)\frac{2}{3}(e) - \frac{1}{3}(e) - \frac{1}{3}(e) = 0(e)$	**A1**
6(c)(i)	• same/equal mass • same/equal (magnitude of) charge • both fundamental (particles) • opposite (sign of) charge • one is matter and the other is antimatter *Any two points, 1 mark each.*	**B2**
6(c)(ii)	neutron/baryon consists of three quarks	**B1**
	pion/meson consists of one quark and one antiquark	**B1**