Cambridge International AS & A Level

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PHYSICS **9702/21**

Paper 2 AS Level Structured Questions **October/November 2019**

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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Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptors for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1: Marks must be awarded in line with: • the specific content of the mark scheme or the generic level descriptors for the question • the specific skills defined in the mark scheme or in the generic level descriptors for the question • the standard of response required by a candidate as exemplified by the standardisation scripts.
GENERIC MARKING PRINCIPLE 2: Marks awarded are always **whole marks** (not half marks, or other fractions).
GENERIC MARKING PRINCIPLE 3: Marks must be awarded **positively**: • marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate • marks are awarded when candidates clearly demonstrate what they know and can do • marks are not deducted for errors • marks are not deducted for omissions • answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.
GENERIC MARKING PRINCIPLE 4: Rules must be applied consistently e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

GENERIC MARKING PRINCIPLE 5: Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).
GENERIC MARKING PRINCIPLE 6: Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

Question	Answer	Marks
1(a)(i)	mass in range 1–20 g	**A1**
1(a)(ii)	wavelength in range 1×10^{-8} m to 4×10^{-7} m	**A1**
1(b)(i)	$T = 2\pi \times (200 \times 10^{-3} / 25)^{0.5}$ = 0.56 s	**A1**
1(b)(ii)	percentage uncertainty = (2% + 8%) / 2 (= 5%) **or** fractional uncertainty = (0.02+0.08) / 2 (= 0.05)	**C1**
	ΔT = 0.56 × 0.05 = 0.028 (s)	**C1**
	T = (0.56 ± 0.03) s	**A1**

Question	Answer	Marks
2(a)	the (two) plates are <u>vertical</u> (and separated)	**B1**
	left plate positively charged **and** right plate negatively charged/earthed **or** right plate negatively charged **and** left plate positively charged/earthed	**B1**
2(b)	$F = Eq$	**C1**
	$= 1.3 \times 10^{4} \times 3.7 \times 10^{-9}$ $= 4.8 \times 10^{-5}$ N	**A1**
2(c)	$F^2 = (4.8 \times 10^{-5})^2 + (5.4 \times 10^{-5})^2$ so $F = 7.2 \times 10^{-5}$ N **or** $F = [(4.8 \times 10^{-5})^2 + (5.4 \times 10^{-5})^2]^{0.5}$ so $F = 7.2 \times 10^{-5}$ N	**A1**
2(d)	electric force is constant (because field strength/E is constant)	**B1**
	weight is constant (and so resultant force constant)	**B1**
2(e)(i)	$m = 5.4 \times 10^{-5} / 9.81$ $(= 5.5 \times 10^{-6})$	**C1**
	$a = 7.2 \times 10^{-5} / (5.5 \times 10^{-6})$ $= 13$ m s^{-2}	**A1**
2(e)(ii)	$v^2 = u^2 + 2as$ $v^2 = 2 \times 13 \times 0.58$	**C1**
	$v = 3.9$ m s^{-1}	**A1**

Question	Answer	Marks
3(a)	$\rho = m / V$	C1
	$V = \pi \times (0.16 / 2)^2 \times 7.6 \times 3.0$ (= 0.458 m^3)	C1
	$m = \pi \times (0.16 / 2)^2 \times 7.6 \times 3.0 \times 1.2 = 0.55$ kg	A1
3(b)(i)	$\Delta p = 0.55 \times 7.6$ = 4.2 N s	A1
3(b)(ii)	F = 4.2 / 3.0 **or** 0.55 × 7.6 / 3.0 = 1.4 N	A1
3(c)(i)	F = 1.4 N	A1
3(c)(ii)	Newton's third law (of motion)	B1
3(d)	$2 \times 1.4 = m \times 9.81$ m = 0.29 kg	A1
3(e)	the density of air is less at high altitude	B1
3(f)	$f_o = f_s v / (v - v_s)$ = 3000 × 340 / (340 – 22)	C1
	= 3200 Hz	A1

Question	Answer	Marks
4(a)	$k = F / x$ **or** k = gradient	**C1**
	e.g. $k = 4.0 / 0.050$ $k = 80\ \text{N m}^{-1}$	**A1**
4(b)	$E = ½Fx$ **or** $E = ½kx^2$ **or** E = area under graph	**C1**
	$(\Delta)E = (½ \times 3.2 \times 0.040) – (½ \times 1.2 \times 0.015) = 0.055$ J **or** $(\Delta)E = (½ \times 80 \times 0.040^2) – (½ \times 80 \times 0.015^2) = 0.055$ J **or** $(\Delta)E = ½ \times (1.2 + 3.2) \times 0.025 = 0.055$ J	**A1**
4(c)	$(\Delta)E = mg(\Delta)h$	**C1**
	$= 0.122 \times 9.81 \times (0.120 – 0.095)$ $= 0.030$ J	**A1**
	or	
	$(\Delta)E = W \times (\Delta)h$	**(C1)**
	$= 1.2 \times 0.025$ $= 0.030$ J	**(A1)**

Question	Answer	Marks
4(d)(i)	$E = 0.055 – 0.030$ $= 0.025$ J	**A1**
4(d)(ii)	$E = ½mv^2$	**C1**
	$v = [(2 \times 0.025) / 0.122]^{0.5}$ $= 0.64$ m s$^{–1}$	**A1**

Question	Answer	Marks
5(a)(i)	the dippers are connected to the same vibrator/motor	**B1**
5(a)(ii)	(the overlapping waves have) similar/same amplitude	**B1**
5(b)	any means of 'freezing' the pattern e.g. use a stroboscope/strobe	**B1**
5(c)	$vT = \lambda$ **or** $v = f\lambda$ **and** $f = 1 / T$	**C1**
	$T = 0.060 / 0.40$ $= 0.15$ s	**A1**
5(d)(i)	path difference = 3.0 cm	**A1**
5(d)(ii)	phase difference = 180°	**A1**
5(e)	line drawn joining points where only maxima are observed (i.e. through points where wavefronts intersect) of length at least 4 cm	**B1**

Question	Answer	Marks
6(a)	work done / charge **or** energy (transferred from electrical to other forms) / charge	**B1**
6(b)	for V < 0.25 V resistance is infinite/very high (as current is zero)	**B1**
	for V > 0.25 V resistance decreases (as V increases)	**B1**
6(c)(i)	$R = V / I$	**C1**
	$= 0.75 / (15 \times 10^{-3})$	**C1**
	$= 50\ \Omega$	**A1**

Question	Answer	Marks
6(c)(ii)	**1.** $V_Y = 15 \times 10^{-3} \times 60$ (= 0.90 V)	C1
	$V_X = 2.0 - 0.90 - 0.75$ (= 0.35 V)	C1
	$R_X = 0.35 / (15 \times 10^{-3})$ = 23 Ω	A1
	or	
	total $R = 60 + 50 + R_X$	(C1)
	$60 + 50 + R_X = 2.0 / (15 \times 10^{-3})$	(C1)
	R_X = 23 Ω	(A1)
	2. $P = VI$ **or** $P = EI$ **or** $P = I^2R$ **or** $P = V^2 / R$	C1
	ratio = $\frac{(15 \times 10^{-3})^2 \times 60}{2.0 \times 15 \times 10^{-3}}$ **or** $\frac{0.90 \times 15 \times 10^{-3}}{2.0 \times 15 \times 10^{-3}}$ **or** $\frac{(0.90^2 / 60)}{2.0 \times 15 \times 10^{-3}}$ = 0.45	A1

Question	Answer	Marks
7(a)(i)	proton number = 17 **and** nucleon number = 35	**A1**
7(a)(ii)	(electron) neutrino	**B1**
7(b)	d/down (quark charge) is $-\frac{1}{3}(e)$ **or** <u>two</u> d/down (quark charges) is $-\frac{2}{3}(e)$ **or** s/strange (quark charge) is $-\frac{1}{3}(e)$	**C1**
	charge = $-\frac{1}{3}(e) - \frac{1}{3}(e) - \frac{1}{3}(e)$ $= -1(e)$	**A1**