Cambridge International AS & A Level

Cambridge Assessment International Education
Cambridge International Advanced Subsidiary and Advanced Level

PHYSICS **9702/42**

Paper 4 A Level Structured Questions **October/November 2018**

MARK SCHEME

Maximum Mark: 100

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)	force per unit mass	**B1**
1(a)(ii)	acceleration = F/m, field strength = F/m, so equal	**B1**
1(b)	smooth curve between R and $4R$ with negative gradient of decreasing magnitude	**B1**
	line passing through (R, 1.00g) and (2R, 0.25g)	**B1**
	line ending at (4R, 0.0625g)	**B1**
1(c)	$M = (4/3 \times \pi R^3)\rho$	**C1**
	$g = GM/(2R)^2$	**C1**
	$g = ⅓ \times 6.67 \times 10^{-11} \times \pi \times 3.4 \times 10^6 \times 4.0 \times 10^3$ $= 0.95\,\text{m}\,\text{s}^{-2}$	**A1**

Question	Answer	Marks
2(a)	gas that obeys equation pV = constant × T	**M1**
	symbols p, V and T explained	**A1**
2(b)(i)	$pV = ⅓ Nm\langle c^2\rangle$ **and** $M = Nm$ (and so) $p = ⅓\rho\langle c^2\rangle$	**C1**
	$2.12 \times 10^7 = ⅓ \times [3.20/(1.84 \times 10^{-2})] \times \langle c^2\rangle$	**C1**
	$c_{r.m.s.} = 605\,m\,s^{-1}$	**A1**
2(b)(ii)	**1.** $pV = nRT$ **and** $T = (22 + 273)\,K$	**C1**
	$n = (2.12 \times 10^7 \times 1.84 \times 10^{-2})/(8.31 \times 295)$ $= 159\,mol$	**A1**
	2. mass $= 3.20/(159 \times 6.02 \times 10^{23})$ **or** mass $= [2 \times (3/2) \times 1.38 \times 10^{-23} \times 295]/605^2$	**C1**
	mass $= 3.34 \times 10^{-26}\,kg$	**A1**
2(c)	$A = (3.34 \times 10^{-26})/(1.66 \times 10^{-27})$ $= 20$	**A1**

Question	Answer	Marks
3(a)	(thermal) energy per unit mass (to cause change of state)	**B1**
	(energy transfer during) change of state between solid and liquid at constant temperature	**B1**
3(b)(i)	Any one from: • rate of increase in mass (of beaker and water) is constant • level of water rises at a constant rate • volume of water (in beaker) increases at a constant rate • constant time between drops • constant rate of dripping	**B1**
3(b)(ii)	(electrical power supplied =) 12.8×4.60 (= 58.9 W)	**C1**
	(rate of transfer to ice =) $[(185.0 - 121.5) \times 332] / [5.00 \times 60]$ (= 70.3 W)	**C1**
	1. rate = 70.3 W	**A1**
	2. rate = 70.3 – 58.9 = 11.4 W	**A1**

Question	Answer	Marks
4(a)	(defining equation of s.h.m. is) $a = -kx$ where k is a constant **or** $a \propto -x$	**B1**
	g and L are constant (so $a \propto -x$ and hence s.h.m.)	**B1**
4(b)	$T = 0.50\,\text{s}$ **and** $T = 2\pi / \omega$	**C1**
	$\omega^2 = 2g / L$	**C1**
	$L = (2 \times 9.81 \times 0.50^2) / 4\pi^2$ $= 0.12\,\text{m}$	**A1**
4(c)(i)	Any one from: • viscosity of liquid • friction within the liquid • viscous drag • friction/resistance between walls of tube and liquid	**B1**
4(c)(ii)	(maximum) KE = $\frac{1}{2}mv_0^2$ **and** $v_0 = \omega x_0$ **or** energy = $\frac{1}{2}m\omega^2 x_0^2$	**C1**
	ratio = $(1.3 / 2.0)^2$ $= 0.42$	**A1**

Question	Answer	Marks
5(a)	amplitude of carrier (wave) varies	B1
	variation in synchrony with displacement of information signal	B1
5(b)(i)	wavelength = $(3.0 \times 10^8) / (900 \times 10^3)$ $= 3.3 \times 10^2$ m	A1
5(b)(ii)	amplitude varies (continuously) between a maximum and a minimum	B1
	variations repeat 5000 times each second **or** variations repeat every 0.2 ms **or** variations above and below 4.0 V	B1
5(b)(iii)	10000 Hz	A1
5(c)(i)	Any two from: • (orbit is) above the Equator • (orbit is) from west to east/same direction as Earth's rotation • orbit is circular/orbit has a particular radius	B2
5(c)(ii)	**1.** minimal reflection/absorption/attenuation by atmosphere **or** maximum penetration of/transmission through atmosphere	B1
	2. uplink signal is greatly attenuated/must be greatly amplified	B1
	prevents downlink signal swamping the uplink signal	B1

Question	Answer	Marks
6(a)(i)	work done per unit charge	**B1**
	work done moving positive charge from infinity (to the point)	**B1**
6(a)(ii)	field strength = potential gradient	**M1**
	negative sign included **or** directions discussed	**A1**
6(b)	horizontal straight lines, at non-zero potential, within the spheres	**B1**
	magnitude of potential greater at surface of sphere A than at surface of sphere B	**B1**
	concave curve between A and B, with a minimum nearer to B	**B1**
	lines show *V* <u>positive</u> all the way from 0 to *D*	**B1**

Question	Answer	Marks
7(a)	$R/R_T = 2.4/1.8$ **or** at 4.0 °C, $R_T = 3.2\,k\Omega$	**C1**
	hence $R/3.2 = 2.4/1.8$ $R = 4.3\,k\Omega$	**A1**
7(b)	$R_T = 3.37\,k\Omega$ **or** R_T is greater (than $3.2\,k\Omega$)	**B1**
	$V^+ > V^-$	**M1**
	hence output is +5.0 V	**A1**

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Question	Answer	Marks
7(c)	correct LED symbol	**B1**
	two diodes shown connected, in parallel and with opposite polarities, between V_{OUT} and earth	**M1**
	diodes labelled to show correct polarities consistent with **(b)** (G pointing from V_{OUT} to earth and B pointing from earth to V_{OUT} if **(b)** correct)	**A1**

Question	Answer	Marks
8(a)	force per unit current	**B1**
	force per unit length (of wire)	**B1**
	current normal to (magnetic) field	**B1**
8(b)(i)	forces (on PQ and RS) are horizontal	**B1**
	(hence they create) no moment about the pivot	**B1**
	or	
	forces (on PQ and RS) are equal and opposite	**(B1)**
	(hence there is) no <u>net</u> force (on the two sections)	**(B1)**
8(b)(ii)	realisation of the need to apply moments	**C1**
	$BILx = mgy$ $B \times 2.7 \times 1.2 \times 10^{-2} \times 7.5 = 45 \times 10^{-6} \times 9.81 \times 8.8$	**C1**
	$B = 1.6 \times 10^{-2}$ T	**A1**

Question	Answer	Marks
9(a)	$0 \rightarrow t_1$ horizontal straight line at non-zero value of V_H **and** $t_3 \rightarrow t_4$ horizontal straight line at different non-zero V_H	**B1**
	$t_1 \rightarrow t_3$ straight diagonal line with negative gradient **and** graph line starts at $(0, V_0)$ and ends at $(t_4, -2V_0)$	**B1**
9(b)	$E = 0$ for $0 \rightarrow t_1$ **and** $t_3 \rightarrow t_4$	**B1**
	E is non-zero at all points between $t_1 \rightarrow t_3$	**M1**
	E has constant magnitude between $t_1 \rightarrow t_3$	**A1**

Question	Answer	Marks
10(a)	$V_0 = \sqrt{2} \times V_{r.m.s.} = \sqrt{2} \times 9.9$ (= 14 V) **and** $\omega = 2\pi f = 2\pi \times 50$ (= 314 rad s^{-1})	**C1**
	$V = 14 \sin 314t$	**A1**
10(b)	enables (resonating) nuclei to be located	**B1**
	resonant frequency depends on magnetic field strength	**B1**
	Any one from: • non-uniform field is (accurately) calibrated • (non-uniform) field may be varied to enable detection in different positions • unique (magnetic) field strength/frequency at each point	**B1**
10(c)	$I = I_0 \exp(-\mu x)$	**C1**
	$I = I_0 [\exp(-\mu x)_{bone} \times \exp(-\mu x)_{soft\ tissue}]$ $I = I_0 [\exp(-2.9 \times 0.40) \times \exp(-0.92 \times 1.4)]$	**C1**
	$I / I_0 = 0.0865$	**C1**
	ratio / dB = 10 lg 0.0865 = –11 dB	**A1**

Question	Answer	Marks
11(a)	discrete amount/quantum/packet of <u>energy</u>	**M1**
	of electromagnetic radiation	**A1**
11(b)	mostly dark/dark background	**B1**
	coloured lines	**B1**
11(c)(i)	6	**A1**
11(c)(ii)	**1.** maximum photon energy = 13.6 – 0.85 (= 12.75 eV)	**C1**
	maximum kinetic energy = (13.6 – 0.85) – 5.6 = 7.2 eV	**A1**
	2. energy = hc/λ	**C1**
	$\lambda = (6.63 \times 10^{-34} \times 3.00 \times 10^{8}) / [(13.6 - 0.85) \times 1.60 \times 10^{-19}]$	**C1**
	$= 9.8 \times 10^{-8}$ m	**A1**

Question	Answer	Marks
12(a)	fusion: two nuclei combine to form a (single) nucleus	**B1**
	fission: a (single) large nucleus divides to form (smaller) nuclei	**B1**
	Any one from: • fusion is initiated by (very) high temperatures • fission is initiated by neutron bombardment • resulting nuclei in fission are of similar size • (both processes) release energy • binding energy per nucleon increases • total binding energy increases • fission involves release of neutrons	**B1**
12(b)(i)	neutron	**B1**
12(b)(ii)	**1.** zero	**A1**
	2. $(4 \times 11.3290 \times 10^{-13}) - (2 \times 1.7813 \times 10^{-13}) - (3 \times 4.5285 \times 10^{-13})$	**C1**
	energy change $= 45.316 \times 10^{-13} - 17.148 \times 10^{-13}$ $= 2.82 \times 10^{-12}$ J	**A1**
12(b)(iii)	1.0 mol or N_A nuclei of each energy $= 2.817 \times 10^{-12} \times 6.02 \times 10^{23}$ $= 1.7 \times 10^{12}$ J	**A1**