Cambridge International AS & A Level

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PHYSICS **9702/42**

Paper 4 A Level Structured Questions **March 2019**

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.

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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)	work done per unit mass	B1
	idea of work done moving mass from infinity (to the point)	B1
1(a)(ii)	(gravitational) force is attractive	B1
	(gravitational) potential at infinity is zero	B1
	decrease in potential energy as masses approach *or* displacement and force in opposite directions	B1
1(b)(i)	*Either* $mv^2 / R = GMm / R^2$ *Or* $v = \sqrt{(GM / R)}$ $v^2 = (6.67 \times 10^{-11} \times 6.00 \times 10^{24}) / (7.30 \times 10^6)$	C1
	giving $v = 7.4 \times 10^3\ \text{m s}^{-1}$	A1
1(b)(ii)	$V_P = -GMm / R$	C1
	$= -(6.67 \times 10^{-11} \times 6.00 \times 10^{24} \times 340) / (7.30 \times 10^6)$	C1
	$V_P = -1.9 \times 10^{10}\ \text{J}$	A1
1(c)	$v^2 \propto 1 / r$, (r smaller) so v greater	M1
	and E_K greater	A1

Question	Answer	Marks
2(a)(i)	gas obeys formula pV / T = constant	**M1**
	symbols V and T explained	**A1**
2(a)(ii)	mean-square-speed (of atoms / molecules)	**B1**
2(b)(i)	use of $T = 393$	**C1**
	$pV = nRT$	**C1**
	$2.4 \times 10^5 \times 6.8 \times 10^{-3} = n \times 8.31 \times 393$ and $N = n \times 6.02 \times 10^{23} = 3.0 \times 10^{23}$	**A1**
	or $pV = NkT$	**(C1)**
	$2.4 \times 10^5 \times 6.8 \times 10^{-3} = N \times 1.38 \text{ x } 10^{-23} \times 393$ hence $N = 3.0 \times 10^{23}$	**(A1)**
2(b)(ii)	volume of one atom = $4 / 3\pi r^3$	**C1**
	volume occupied $= 3.0 \times 10^{23} \times 4 / 3 \times \pi \times (3.2 \times 10^{-11})^3$ $= 4 \times 10^{-8}$ m^3	**A1**
2(b)(iii)	assumption: volume of atoms negligible compared to volume of container / cylinder	**B1**
	4×10^{-8} (m^3) << 6.8×10^{-3} (m^3) so yes	**B1**

Question	Answer	Marks
3(a)(i)	mention of upthrust and weight	**B1**
3(a)(ii)	upthrust is greater than the weight	**B1**
	(resultant force is) upwards	**B1**
3(b)	A, ρ, g *and* M are constant	**B1**
	either acceleration $\propto$ – displacement *or* acceleration $\propto$ displacement <u>and</u> (– sign indicates) a and x in opposite directions	**B1**
3(c)(i)	*either* $\omega = 2\pi / T$ *or* $\omega = 2\pi f$ <u>and</u> $f = 1 / T$	**C1**
	$\omega = 2\pi / 1.3$ $= 4.8\ \text{rad s}^{-1}$	**A1**
3(c)(ii)	$\omega^2 = A\rho g / m$	**C1**
	$4.83^2 = (4.5 \times 10^{-4} \times \rho \times 9.81) / 0.17$	**C1**
	$\rho = 900\ \text{kg m}^{-3}$	**A1**

Question	Answer	Marks
4(a)	Any three from: above the Equator period 24 hours orbits west to east one particular orbital radius	B3
4(b)	attenuation = 10 lg(P_1 / P_2) 194 = 10 lg (3.2 × 10^3 / P_2)	C1
	P_2 = 1.3 × 10^{-16} W	A1
4(c)	advantage: e.g. no tracking required	B1
	disadvantage: e.g. longer time delay	B1

Question	Answer	Marks
5(a)	region where charge experiences an (electric) force	B1
5(b)	graph: field strength zero from x = 0 to x = R	B1
	curve with negative gradient, decreasing from x = R to x = 3R	B1
	line passes through field strength E at x = R,	B1
	line passes through field strength 0.25E at x = 2R and field strength 0.11E at x = 3R	B1

Question	Answer	Marks
5(c)	field strength = $q / 4\pi\epsilon_0 x^2$	**C1**
	$2.0 \times 10^6 = q / (4 \times \pi \times 8.85 \times 10^{-12} \times 0.26^2)$	**C1**
	$q = 1.5 \times 10^{-5}$ C	**A1**

Question	Answer	Marks
6(a)	charge / potential (difference)	**M1**
	charge on one plate, p.d. between the plates	**A1**
6(b)(i)	all three capacitors connected in series	**B1**
6(b)(ii)	8 (μF) in parallel with the two 4 (μF) capacitors connected in series	**B1**
6(c)	discharge from 7.0 V to 4.0 V	**C1**
	Either energy = $\frac{1}{2}CV^2$ *or* energy = $\frac{1}{2}QV$ <u>and</u> $C = Q / V$	**C1**
	energy $= \frac{1}{2} \times 47 \times 10^{-6} \times (7^2 - 4^2)$ $= 7.8 \times 10^{-4}$ J	**A1**

Question	Answer	Marks
7(a)(i)	output voltage / input voltage	**B1**
7(a)(ii)	no time delay between input and output	**B1**
	clear reference to <u>change</u>(s) in input and / or output	**B1**
7(b)(i)	V_{IN} only connected to non-inverting input	**B1**
	midpoint between R_1 and R_2 only connected to inverting input	**B1**

Question	Answer	Marks
7(b)(ii)	gain = 1 + (R_1 / R_2) 25 = 1 + (12 × 10^3) / R_2	C1
	R_2 = 500 Ω	A1
7(b)(iii)	V_{MAX} = 9/25 = 0.36 V	C1
	range is –0.36 V to + 0.36 V	A1

Question	Answer	Marks
8(a)(i)	*Either* Newton's third law *or* equal and opposite forces	B1
	force on magnet is upwards	B1
	so force on wire downwards	B1
8(a)(ii)	using (Fleming's) left-hand rule	M1
	current from B to A	A1
8(b)	sinusoidal wave with at least 1 cycle	B1
	peaks at +6.4 mN and –6.4 mN	B1
	time period 25 ms	B1

Question	Answer	Marks
9	X-rays (are used)	**B1**
	(object is) scanned in sections / slices	**B1**
	either: scans taken at many angles / directions *or* images of each section / slice are 2-dimensional	**B1**
	scans of many sections / slices are combined	**B1**
	(to give) 3-dimensional image (of whole structure)	**B1**

Question	Answer	Marks
10(a)	single straight line along full length of solenoid	**B1**
	at least two more parallel lines along full length of solenoid	**B1**
	correct direction – right to left	**B1**
10(b)	(induced) e.m.f. proportional / equal to <u>rate</u>	**M1**
	of change of (magnetic) flux (linkage)	**A1**
10(c)	increasing current causes increasing flux	**B1**
	increasing flux induces e.m.f. in coil	**B1**
	(induced) e.m.f. opposes growth of current	**B1**

Question	Answer	Marks
11(a)	quantum / packet / discrete amount of <u>energy</u>	M1
	of electromagnetic radiation	A1
11(b)	$E = hc / \lambda$	C1
	$= (6.63 \times 10^{-34} \times 3.0 \times 10^{8}) / (540 \times 10^{-9})$	C1
	$= (3.68 \times 10^{-19}) / (1.6 \times 10^{-19})$ $= 2.3$ eV	A1
11(c)	Any 4 from: photon absorbed by electron in valence band (1) photon energy > energy of forbidden band (1) electron promoted to conduction band (1) hole left in valence band (1) more charge carriers so lower resistance (1)	B4

Question	Answer	Marks
12(a)(i)	fission	B1
12(a)(ii)	*either* ${}^{0}_{-1}$e *or* ${}^{0}_{-1}\beta$	M1
	7	A1
12(b)(i)	energy $= c^2 \Delta m$ $= 0.223 \times 1.66 \times 10^{-27} \times (3.00 \times 10^{8})^2$	C1
	$= 3.33 \times 10^{-11}$ J	A1

Question	Answer	Marks
12(b)(ii)	Any 2 from: kinetic energy of products gamma photons neutrinos	**B2**