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 **March 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.

Cambridge International is publishing the mark schemes for the March 2018 series for most Cambridge IGCSE®, Cambridge International A and AS Level components and some Cambridge O Level components.

Cambridge Assessment International Education

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)	*either* direction of force on a (small test) mass *or* direction of acceleration of a (small test) mass	**B1**
1(a)(ii)	Any three from: • the lines are radial • near the surface the lines are (approximately) parallel • parallel lines so constant field strength • constant field strength hence constant acceleration of free fall	**B3**
1(b)(i)	$g = GM / R^2$ $g = (6.67 \times 10^{-11} \times 7.35 \times 10^{22}) / (1.74 \times 10^3 \times 10^3)^2$	**C1**
	$g =$ **1.62 N kg^{-1}**	**A1**
1(b)(ii)	*either* $x\omega^2 = GM / x^2$ <u>and</u> $\omega = 2\pi / T$ *or* $v^2 / x = GM / x^2$ <u>and</u> $v = 2\pi r / T$	**C1**
	$(1.74 \times 10^6 + 320 \times 10^3)^3 \times 4\pi^2 / T^2 = (6.67 \times 10^{-11} \times 7.35 \times 10^{22})$	**C1**
	$T^2 = 7.04 \times 10^7$ $T =$ **8400 s** (8390)	**A1**

Question	Answer	Marks
2(a)	$pV = nRT$ $T = (5.60 \times 10^5 \times 3.80 \times 10^{-2}) / (5.12 \times 8.31)$	**C1**
	T = **500 K**	**A1**
2(b)(i)	V / T is constant $V = (3.80 \times 10^4) \times (500 + 125) / 500$	**C1**
	V = $\mathbf{4.75 \times 10^4}$ cm^3	**A1**
2(b)(ii)	(for ideal gas,) change in internal energy is change in (total) kinetic energy (of molecules)	**B1**
	$\Delta U = 3 / 2 \times 1.38 \times 10^{-23} \times 125 \times 5.12 \times 6.02 \times 10^{23}$	**C1**
	= **7980** J	**A1**
2(c)(i)	$w = p\Delta V$ $= 5.60 \times 10^5 \times (4.75 – 3.80) \times 10^{-2}$	**C1**
	= **5320** J	**A1**
2(c)(ii)	total = 7980 + 5320 = **13300** J	**A1**

Question	Answer	Marks
3(a)	reasonably shaped circle or oval surrounding the origin	**B1**
	closed loop passing through $(0,\pm v_0)$ and $(\pm x_0,0)$	**B1**
3(b)	line from (0,0) to $(90, F_0)$	**B1**
	curve with decreasing positive gradient, zero gradient at θ = 90	**B1**
3(c)	reasonable sinusoidal wave, one cycle, period 4.0 ms	**B1**
	amplitude at 4.0 V	**B1**
3(d)	U near right-hand end of line with Ba between U and peak of graph	**B1**
	Ba on right hand side of peak and Kr between Ba and peak of graph	**B1**

Question	Answer	Marks
4(a)	frequency at which body will vibrate when there is no (resultant external) resistive force acting on it OR frequency at which body will vibrate when there is no driving force / external force acting on it	**B1**
4(b)(i)	resonance	**B1**
4(b)(ii)	peak is not sharp / peak not infinite height	**M1**
	so damped	**A1**
4(c)	e.g. (quartz crystal) to produce ultrasound (quartz crystal) in watch to keep timing NMR / MRI microwave ovens tuning circuits	**B1**

Question	Answer	Marks
5(a)	<u>pulses</u> of ultrasound	**B1**
	reflected at boundaries (between media)	**B1**
	reflected pulses detected by (ultrasound) generator	**B1**
	Any three from:	
	(reflected signal) processed and displayed	**(B1)**
	time delay (between transmission and receipt) gives information about depth (of boundary)	**(B1)**
	intensity of reflected pulse gives information about (nature of) <u>boundary</u>	**(B1)**
	gel used to minimise reflection at skin / maximise transmission into skin	**(B1)**
	degree of reflection depends upon impedances of two media (at boundary)	**(B1)**
		B3
5(b)(i)	product of density and speed	**M1**
	of sound in the medium	**A1**
5(b)(ii)	(Z_1 about equal to Z_2,) coefficient very small / nearly 0	**B1**
	(Z_1 very different to Z_2,) coefficient nearly 1	**B1**

Question	Answer	Marks
6(a)(i)	0101	A1
6(a)(ii)	1000	A1
6(b)	sketch: series of steps	B1
	changes every 0.25 ms	B1
	correct heights 0, 5, 10, 12, 15, 8 at correct times Two marks for all levels correct One mark if one mistake	B2

Question	Answer	Marks
7(a)	work done per unit charge	B1
	(work done) moving positive charge from infinity (to the point)	B1
7(b)(i)	potential always same sign / potential is always positive so same sign of charge	B1

Question	Answer	Marks
7(b)(ii)	1 *from x = 12 cm to x = 25 cm:* speed increases and *from x = 27 cm to x = 31 cm*: speed decreases	**B1**
	(*from x = 12 cm to x = 25 cm:* speed increases) at decreasing rate or (*from x = 27 cm to x = 31 cm*: speed decreases) at increasing rate	**B1**
	at x = 26 cm: speed maximum	**B1**
	at 32 cm: speed still decreasing	**B1**
	2 $q\,\Delta V = ½mv^2$ $3.2 \times 10^{-19} \times (2.14 - 1.43) \times 10^4 = ½ \times 6.6 \times 10^{-27} \times v^2$ $v^2 = 6.88 \times 10^{11}$	**C1**
	v = **8.3** × **10**$^{\mathbf{5}}$ m s^{-1} (8.30)	**A1**

Question	Answer	Marks
8(a)(i)	all frequencies have the same gain	**B1**
8(a)(ii)	output changes at the same time as input changes	**B1**
8(b)(i)	$R_T / 800 = 1.8 / 1.2$ R_T = **1200** Ω	**A1**
8(b)(ii)	stepped from –9 V to +9 V or v.v.	**B1**
	V_{out} negative < R_T and V_{out} positive > R_T	**B1**
8(b)(iii)	correct LED symbol with connection between V_{OUT} and earth	**B1**
	diode pointing upwards	**B1**

Question	Answer	Marks
9(a)(i)	PSYV <u>and</u> QRXW	B1
9(a)(ii)	electron moving in magnetic field deflected towards face QRXW	M1
	so face PSYV is more positive	A1
9(b)(i)	PV *or* SY *or* RX *or* QW	B1
9(b)(ii)	number of charge carriers per unit volume	B1
9(b)(iii)	negative and positive charge (carriers) would deflect in opposite directions	M1
	so no change in polarity	A1

Question	Answer	Marks
10(a)(i)	*either* product of flux density and area	M1
	direction of flux normal to area	A1
	or flux density × area × sin θ	(M1)
	where θ is angle between direction of flux and area	(A1)
10(a)(ii)	(induced) e.m.f. proportional to rate	M1
	of change of (magnetic) flux linkage	A1
10(b)	e.m.f. $= \Delta(\phi N) / \Delta t$ $= (6.8 \times 10^{-6} \times 2 \times 3.5 \times 96) / (2.4 \times 10^{-3})$	C1
	$=$ **1.9** V	A1

Question	Answer	Marks
10(c)	alternating	**C1**
	with same frequency as supply	**A1**

Question	Answer	Marks
11(a)	no forbidden band / valence and conduction bands overlap	**B1**
	no change in number of charge carriers (as temperature rises)	**B1**
	increased lattice vibrations so resistance increases	**B1**
11(b)	photons captured / absorbed by electrons in valence band	**B1**
	electrons promoted to conduction band	**B1**
	leaving holes in the valence band	**B1**
	more holes and / or electrons so resistance decreases	**B1**

Question	Answer	Marks
12(a)	Any 2 from: scattering of X-ray beam / no lead grid lack of collimation of beam / aperture large anode area large beam p.d. low / photon energy low / X-ray soft	**B2**
12(b)(i)	$0.81 = (e^{-1.5 \times 0.32}) / (e^{-1.5 \times x})$	**C1**
	x = **1.8** mm	**A1**

Question	Answer	Marks
12(b)(ii)	ratio/dB = 10 lg(0.81)	**C1**
	= (–) **0.92** dB	**A1**

Question	Answer	Marks
13(a)(i)	probability of decay (of a nucleus)	**M1**
	per unit time	**A1**
13(a)(ii)	$A = A_0\,e^{-\lambda t}$ after one half-life, $\frac{1}{2}A_0 = A_0\,e^{-\lambda t1/2}$	**M1**
	$\frac{1}{2} = \exp(-\lambda t_{½})$ and hence taking logs, $\ln 2 = \lambda t_{½}$	**A1**
13(b)	activity = $3.8 \times 10^4 \exp(-\ln 2 \times 36 / 15)$	**C1**
	= 7200 Bq	**C1**
	or activity = $3.8 \times 10^4 / 2^{2.4}$	**(C1)**
	= 7200 Bq	**(C1)**
	volume = $(7200 / 1.2) \times 5.0$	**C1**
	= $3.0 \times 10^4\ cm^3$	**A1**
	OR activity of 5.0 cm^3 = $1.2 \times 2^{2.4}$	**(C1)**
	= 6.3336 Bq	**(C1)**
	volume = $(3.8 \times 10^4 / 6.3336) \times 5.0$	**(C1)**
	= $3.0 \times 10^4\ cm^3$	**(A1)**