Cambridge International AS & A Level

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PHYSICS **9702/42**

Paper 4 A Level Structured Questions **May/June 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 May/June 2018 series for most Cambridge IGCSE™, Cambridge International A and AS Level and Cambridge Pre-U components, and some Cambridge O Level components.

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)	direction of force on a (small test) mass **or** path in which a (small test) mass will move	**B1**
1(a)(ii)	(at surface,) lines (of force) are radial	**B1**
	Earth has large radius/height above surface is small so lines are (approximately) parallel	**B1**
	parallel lines → constant field strength	**B1**
1(b)	(change in) KE of rock = (change in) PE **or** $½mv^2 = GMm/R$	**C1**
	$(m)v^2 = (m)(2 \times 6.67 \times 10^{-11} \times 7.4 \times 10^{22}) / (1.7 \times 10^3 \times 10^3)$	**C1**
	$v = 2.4 \times 10^3\,\text{m s}^{-1}$	**A1**
	correct conclusion based on comparison of v with $2.8\,\text{km s}^{-1}$	**B1**
	or	
	(change in) KE of rock = (change in) PE	**(C1)**
	(at infinity) $E_P = (6.67 \times 10^{-11} \times 7.4 \times 10^{22} \times m) / (1.7 \times 10^3 \times 10^3)$ $= 2.9 \times 10^6\,m$	**(C1)**
	E_K of rock $= ½ \times m \times (2.8 \times 10^3)^2 = 3.9 \times 10^6\,m$	**(A1)**
	correct conclusion based on comparison of E_K and E_P values	**(B1)**
	or	

Question	Answer	Marks
	(change in) KE of rock = (change in) PE **or** $\frac{1}{2}mv^2 = GMm/R$	**(C1)**
	$(m)\ (2800)^2 = (m)\ (2 \times 6.67 \times 10^{-11} \times 7.4 \times 10^{22}) / R$	**(C1)**
	$R = 1.3 \times 10^3$ km	**(A1)**
	correct conclusion based on <u>comparison</u> of R with 1.7×10^3 km	**(B1)**
	or	
	(change in) KE of rock = (change in) PE **or** $\frac{1}{2}mv^2 = GMm/R$	**(C1)**
	$(m)\ (2800)^2 = (m)\ (2 \times 6.67 \times 10^{-11} \times M) / (1.7 \times 10^6)$	**(C1)**
	$M = 1.0 \times 10^{23}$ kg	**(A1)**
	correct conclusion based on <u>comparison</u> of M with 7.4×10^{22} kg	**(B1)**

Question	Answer	Marks
2(a)	no intermolecular forces (so no potential energy)	**B1**
2(b)(i)	mean square speed (of molecule(s))	**B1**
2(b)(ii)	kelvin/thermodynamic/absolute <u>temperature</u>	**B1**
2(c)(i)1.	$pV = NkT$	**C1**
	$4.7 \times 10^{-2} \times 2.6 \times 10^{5} = N \times 1.38 \times 10^{-23} \times 446$	**C1**
	or	
	$pV = nRT$ **and** $N = nN_A$ $4.7 \times 10^{-2} \times 2.6 \times 10^{5} = n \times 8.31 \times 446$ $n = 3.3$ (mol)	**(C1)**
	$N = 3.3 \times 6.02 \times 10^{23}$	**(C1)**
	$N = 2.0 \times 10^{24}$	**A1**
2(c)(i)2.	average increase $= 2900 / (2.0 \times 10^{24})$ $= 1.5 \times 10^{-21}$ J	**A1**
2(c)(ii)	$\Delta E_K = (3/2)k(\Delta)T$ $1.5 \times 10^{-21} = (3/2) \times 1.38 \times 10^{-23} \times (\Delta)T$	**C1**
	$(\Delta)T$ in range 70–72 K	**C1**
	$T = 173 + 273 + 70$ $= 520$ K	**A1**

Question	Answer	Marks
3(a)	(during melting,) bonds between atoms/molecules are broken	**B1**
	potential energy of atoms/molecules is increased	**B1**
	no/little work done so required input of energy is thermal	**B1**
3(b)(i)	(ΔQ =) $mc\Delta\theta$	**C1**
	loss = $(160 \times 0.910 \times 15) + (330 \times 4.18 \times 15)$ = 2.3×10^4 J	**A1**
3(b)(ii)	$2.3 \times 10^4 = (48 \times 2.10 \times 18) + 48L + (48 \times 4.18 \times 23)$	**C1**
	$48L = 1.66 \times 10^4$ $L = 350\ \text{J g}^{-1}$	**A1**

Question	Answer	Marks
4(a)	acceleration proportional to displacement	**B1**
	acceleration <u>directed</u> towards fixed point **or** displacement and acceleration in opposite <u>directions</u>	**B1**
4(b)(i)	**1.** amplitude decreases gradually so light damping **or** oscillations continue so light damping	**B1**
	2. loss of energy	**B1**
	due to friction in wheels **or** due to friction between wheels and surface (during slipping) **or** due to air resistance (on trolley)	**B1**
4(b)(ii)1.	$\omega^2 = 2k/m$	**C1**
	$= (2 \times 230) / 0.950$	**C1**
	$\omega = 22 \text{ rad s}^{-1}$	**A1**
4(b)(ii)2.	$T = 2\pi / \omega$	**C1**
	$T = (2\pi / 22) = 0.286 \text{ s}$ time $= 1.5T$ $= 0.43 \text{ s}$	**A1**

Question	Answer	Marks
5(a)(i)	range of frequencies (of signal)	B1
5(a)(ii)	advantage: e.g. better quality (of reproduction) greater rate of transfer of data less distortion	B1
	disadvantage: e.g. fewer stations (in any frequency range)	B1
5(b)(i)	5.0 V	A1
5(b)(ii)	maximum: 674 kHz	A1
	minimum: 626 kHz	A1
5(b)(iii)	$T = 1 / (10 \times 10^3) = 1.0 \times 10^{-4}$ s minimum time = $T / 2$ $= 5.0 \times 10^{-5}$ s	A1

Question	Answer	Marks
6(a)	capacitance = charge / potential	**M1**
	charge is (numerically equal to) charge on one plate	**A1**
	potential is potential difference between plates	**A1**
6(b)(i)	two in series, in parallel with the other (correct symbols)	**A1**
6(b)(ii)	two in parallel connected to one in series (correct symbols)	**A1**
6(c)(i)	capacitance = 1.2 μF	**A1**
6(c)(ii)	**1.** $Q = CV$	**C1**
	$= 1.2 \times 8.0$ $= 9.6\ \mu C$	**A1**
	2. $E = ½QV$ **and** $V = Q/C$ **or** $E = ½CV^2$ **and** $V = Q/C$ **or** $E = ½Q^2/C$	**C1**
	$E = ½(9.6 \times 10^{-6})^2 / (3.0 \times 10^{-6})$ $= 1.5 \times 10^{-5}$ J	**A1**

Question	Answer	Marks
7(a)(i)	(fraction of) output is combined with the input	**M1**
	output (fraction) <u>subtracted/deducted</u> from input	**A1**
7(a)(ii)	Any two valid points e.g. • greater bandwidth/gain constant over a larger range of frequencies • smaller gain	**B2**
7(b)(i)	gain = 1 + (6400 / 800) = 9.0	**A1**
7(b)(ii)	**1.** (+)5.4 V	**A1**
	2. –9.0 V	**A1**
7(b)(iii)	replace the 6400 Ω resistor with a thermistor	**B1**

Question	Answer	Marks
8(a)	electric and magnetic fields at right-angles to one another *(may be shown on a clearly labelled diagram)*	**B1**
	particle enters fields (with velocity) normal to the (two) fields *(may be shown on a clearly labelled diagram)*	**B1**
	no deviation for particles with selected velocity	**B1**
8(b)	magnetic force equals/is the centripetal force	**C1**
	$Bqv = mv^2 / r$	**C1**
	$M = Bqr / v$ $= (94 \times 10^{-3} \times 1.6 \times 10^{-19} \times 0.075) / (3.4 \times 10^{4})$	**M1**
	<u>division</u> by 1.66×10^{-27} shown, to give m = 20 u	**A1**
8(c)	sketch: semicircle clear (in same direction)	**B1**
	with larger radius	**B1**

Question	Answer	Marks
9(a)	(magnetic) flux density × area	**B1**
	magnetic flux density normal to area **or** reference to cross-sectional area **or** × sin (angle between *B* and *A*)	**B1**
	× number of turns on coil	**B1**
9(b)	e.m.f. = *BAN* / *t* **or** e.m.f = rate of change of flux <u>linkage</u>	**C1**
	$= (7.5 \times 10^{-3} \times \pi \times \{1.2 \times 10^{-2}\}^2 \times 160) / 0.15$ $= 3.6 \times 10^{-3}$ V	**A1**
9(c)	sketch: zero for 0–0.10 s, 0.25–0.35 s, and 0.425–0.55 s, and non-zero outside these ranges	**B1**
	two horizontal steps, with zero voltage either side	**B1**
	with same polarity	**B1**
	correct values (1st step 3.6 mV and 2nd step 7.2 mV)	**B1**

Question	Answer	Marks
10(a)	emission of electron	**B1**
	when electromagnetic radiation incident (on surface)	**B1**
10(b)(i)	packet/quantum/discrete amount of energy	**M1**
	of electromagnetic radiation	**A1**
10(b)(ii)	$E = hc/\lambda$	**C1**
	$= (6.63 \times 10^{-34} \times 3.00 \times 10^{8}) / (420 \times 10^{-9})$ $= 4.7 \times 10^{-19}$ J	**A1**
10(b)(iii)	sodium: yes zinc: no	**B1**

Question	Answer	Marks
11(a)	X-ray image(s) taken of one slice	M1
	(many images) taken from different angles	A1
	(computer) produces 2D image of slice	B1
	(this is) repeated for (many) slices	M1
	to build up a 3D image (of structure)	A1
11(b)(i)	combining of images involves (very) large number of calculations	B1
11(b)(ii)	CT scan consists of (very) many (single X-ray) images	B1

Question	Answer	Marks
12(a)	emission of particles/radiation by unstable nucleus	**B1**
	spontaneous emission	**B1**
12(b)(i)	P – the curve that starts with a high number D – the curve with the peak S – the curve that increases from zero throughout *(one correct 1 mark, all three correct 2 marks)*	**B2**
12(b)(ii)	$\lambda t_{½} = 0.693$ $\lambda = 0.693 / (60.0 \times 60)$	**C1**
	$= 1.93 \times 10^{-4}\ s^{-1}$	**A1**
12(c)	half-life of F is much shorter than half-life of E	**B1**
	nuclei of F decay (almost) as soon as they are produced	**B1**