Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

PHYSICS **9702/42**

Paper 4 A Level Structured Questions **May/June 2016**

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 will not enter into discussions about these mark schemes.

Cambridge is publishing the mark schemes for the May/June 2016 series for most Cambridge IGCSE®, Cambridge International A and AS Level components and some Cambridge O Level components.

1	(a) (i)	gravitational force provides/is the centripetal force	B1	
		same gravitational force (by Newton III)	B1	[2]
	(ii)	$\omega = 2\pi / T$ $= 2\pi / (4.0 \times 365 \times 24 \times 3600)$	C1	
		$= 5.0\ (4.98) \times 10^{-8}\ \text{rad s}^{-1}$	A1	[2]
	(b) (i)	(centripetal force =) $M_A d\omega^2 = M_B(2.8 \times 10^8 - d)\omega^2$ *or* $M_A d_A = M_B d_B$	C1	
		$M_A / M_B = 3.0 = (2.8 \times 10^8 - d) / d$	C1	
		$d = 7.0 \times 10^7\ \text{km}$	A1	[3]
	(ii)	$GM_AM_B / (2.8 \times 10^{11})^2 = M_A d\omega^2$	B1	
		$M_B = (2.8 \times 10^{11})^2 \times d\omega^2 / G$ $= (2.8 \times 10^{11})^2 \times (7.0 \times 10^{10}) \times (4.98 \times 10^{-8})^2 / (6.67 \times 10^{-11})$	C1	
		$= 2.0 \times 10^{29}\ \text{kg}$	A1	[3]
2	(a) (i)	number of <u>atoms/nuclei</u> in 12 g of carbon-12	B1	[1]
	(ii)	amount of substance	M1	
		containing N_A (or 6.02×10^{23}) particles/molecules/atoms *or* which contains the same number of particles/atoms/molecules as there are atoms in 12 g of carbon-12	A1	[2]
	(b)	$pV = nRT$		
		$2.0 \times 10^7 \times 1.8 \times 10^4 \times 10^{-6} = n \times 8.31 \times 290$, so $n = 149\ \text{mol}$ or $150\ \text{mol}$	A1	[1]
	(c) (i)	V and T constant and so pressure reduced by 5.0% pressure $= 0.95 \times 2.0 \times 10^7$	C1	
		or		
		calculation of new n (= 142.5 mol) and correct substitution into $pV = nRT$	(C1)	
		pressure $= 1.9 \times 10^7\ \text{Pa}$	A1	[2]

	(ii)	loss is 5 / 100 × 150 mol = 7.5 mol *or* $\Delta N = 4.52 \times 10^{24}$	C1	
		$t = (7.5 \times 6.02 \times 10^{23}) / 1.5 \times 10^{19}$ *or* $t = 4.52 \times 10^{24} / 1.5 \times 10^{19}$	C1	
		$= 3.0 \times 10^{5}$ s	A1	[3]
3	**(a)**	no <u>net</u> energy transfer between the bodies *or* bodies are at the same temperature	B1	[1]
	(b) (i)	thermocouple, platinum/metal resistance thermometer, pyrometer	B1	[1]
	(ii)	thermistor, thermocouple	B1	[1]
	(c) (i)	change = 11.5 K	B1	[1]
	(ii)	final temperature = 311.2 K	B1	[1]
4	**(a) (i)**	$T = 0.60$ s <u>and</u> $\omega = 2\pi / T$	C1	
		$\omega = 10\,(10.47)$ rad s^{-1}	A1	[2]
	(ii)	energy $= \frac{1}{2} m\omega^2 x_0^2$ or $\frac{1}{2} mv^2$ <u>and</u> $v = \omega x_0$	C1	
		$= \frac{1}{2} \times 120 \times 10^{-3} \times (10.5)^2 \times (2.0 \times 10^{-2})^2$		
		$= 2.6 \times 10^{-3}$ J	A1	[2]
	(b)	sketch: smooth curve in correct directions	B1	
		peak at *f*	M1	
		amplitude never zero and line extends from 0.7*f* to 1.3*f*	A1	[3]
	(c)	sketch: peaked line always below a peaked line A	M1	
		peak not as sharp <u>and</u> at (or slightly less than) frequency of peak in line A	A1	[2]

5	**(a)**	amplitude of the carrier wave varies	M1	
		in synchrony with displacement of the information/audio signal	A1	[2]
	(b) (i)	10 kHz	A1	[1]
	(ii)	5 kHz	A1	[1]
	(c) (i)	$24 = 10 \lg (P_{MIN} / \{5.0 \times 10^{-13}\})$	C1	
		$P_{MIN} = 1.3\ (1.26) \times 10^{-10}$ W	A1	[2]
	(ii)	$45 \times 2 = 10 \lg (\{500 \times 10^{-3}\} / P)$		
		$P = 5.0 \times 10^{-10}$ (W)	M1	
		$P > P_{MIN}$ so yes	A1	
		or		
		maximum attenuation calculated to be 96 (dB) 96 dB > 2 × 45 dB so yes	(M1) (A1)	
		or		
		maximum length of wire calculated to be 48 (km) actual length 45 km < 48 km so yes	(M1) (A1)	
		or		
		maximum attenuation per unit length calculated to be 2.2 dB km^{-1} 2.2 dB km^{-1} > 2.0 dB km^{-1} so yes	(M1) (A1)	[2]
6	**(a)**	lines perpendicular to surface *or* lines are radial	M1	
		lines <u>appear</u> to come from centre	A1	[2]
	(b) (i)	$F_E = (1.6 \times 10^{-19})^2 / 4\pi\varepsilon_0 x^2$	C1	
		$F_G = G \times (1.67 \times 10^{-27})^2 / x^2$	C1	
		$F_E / F_G = (1.6 \times 10^{-19})^2 \times (8.99 \times 10^9) / [(1.67 \times 10^{-27})^2 \times (6.67 \times 10^{-11})]$ $= 1.2\ (1.24) \times 10^{36}$	A1	[3]
	(ii)	$F_E \gg F_G$	B1	[1]

7	(a)	e.g. storing energy blocking d.c. in oscillator circuits in tuning circuits in timing circuits			
		any two		B2	[2]
	(b) (i)	$1/6 + 1/C + 1/C = 1/4$		C1	
		$C = 24\,\mu F$		A1	[2]
	(ii)	$Q = CV$ $= 4.0 \times 10^{-6} \times 12$		C1	
		$= 48\,\mu C$		A1	[2]
	(iii)	**1.** 48 μC		A1	
		2. 24 μC		A1	[2]
8	(a) (i)	gain = voltage output / voltage input		B1	[1]
	(ii)	changes in V_{OUT} occur immediately when V_{IN} changes		M1 A1	
		or			
		changes in V_{IN} result in immediate changes to V_{OUT}		(M1) (A1)	[2]
	(b)	$12 = 1 + R/(1.5 \times 10^3)$		C1	
		$R = 16.5\,k\Omega$		A1	[2]
	(c)	straight line from (0,0) to ($0.75t_1$, 9.0 V)		B1	
		horizontal line from endpoint of straight line to t_1		B1	
		+9 V to –9 V (or *v.v.*) at t_1		B1	
		correct line to t_2		B1	[4]

9	**(a)**	**(i)**	number density of charge carriers/free electrons *or* number per unit volume of charge carriers/free electrons	B1	[1]
		(ii)	PX or QY or RZ	B1	[1]
	(b)	**(i)**	V_H is inversely proportional to n	B1	
			for semiconductors, n is (much) smaller than for metals	B1	[2]
		(ii)	magnetic field would deflect holes and electrons in same direction	B1	
			(because) electrons are (–)ve, holes are (+)ve	M1	
			so V_H has opposite polarity/opposite sign	A1	[3]
10	**(a)**		iron rod changes flux (density)/field	B1	
			change of flux in coil Q causes induced e.m.f.	B1	[2]
	(b)		constant reading (either polarity) from time zero to near t_1	B1	
			spike in one direction near t_1 clearly showing a larger voltage	M1	
			of opposite polarity	A1	
			zero reading from near t_1 to t_2	B1	[4]
11	**(a)**		point P shown at 'lower end' of load	B1	[1]
	(b)		$V_{r.m.s.} = 6.0 / \sqrt{2} = 4.24\,V$	C1	
			$I_{r.m.s.} = 4.24 / (2.4 \times 10^3)$ $= 1.8 \times 10^{-3}\,A$	A1	[2]
	(c)	**(i)**	capacitor in parallel with load	B1	[1]
		(ii)	line from peak to curve at 3.0 V for either half- or full-wave rectified	M1	
			correct curvature on line (gradient becoming more shallow)	A1	
			line drawn as for full-wave rectified	A1	[3]

12	**(a)**	**(i)**	(X–ray) photon produced when electron/charged particle is stopped/accelerated (suddenly)	B1	
			range of accelerations (in target)	M1	
			hence distribution of wavelengths	A1	[3]
		(ii)	electron gives all its energy to one photon	B1	
			electron stopped in single collision	B1	[2]
		(iii)	de-excitation of (orbital) electrons in target/anode/metal	B1	[1]
	(b)	**(i)**	aluminium sheet/filter/foil (placed in beam from tube)	B1	[1]
		(ii)	(long wavelength X-rays) do not pass through the body	B1	[1]
13	**(a)**		(photons of) electromagnetic radiation	M1	
			emitted from nuclei	A1	[2]
	(b)		line of best fit drawn	B1	
			recognises μ as given by the gradient of best-fit line *or* $\ln C = \ln C_0 - \mu x$	B1	
			$\mu = 0.061\,\text{mm}^{-1}$ (within $\pm 0.004\,\text{mm}^{-1}$, 1 mark; within $\pm 0.002\,\text{mm}^{-1}$, 2 marks)	A2	[4]
	(c)		aluminium is less absorbing (than lead) *or* gradient of graph would be less	M1	
			so μ is smaller	A1	[2]