MARK SCHEME for the May/June 2010 question paper

for the guidance of teachers

9702 PHYSICS

9702/42

Paper 4 (A2 Structured Questions), maximum raw mark 100

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.

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UNIVERSITY of CAMBRIDGE International Examinations

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	Section A										
1		k done moving <u>unit</u> mass n infinity to the point		M1 A1	[2]						
	(b) (i)	at <i>R</i> , $\phi = 6.3 \times 10^7$ J kg ⁻¹ (allow ± 0.1 ± $\phi = GM / R$	× 10 ⁷)	B1							
		$6.3 \times 10^7 = (6.67 \times 10^{-11} \times M) / (6.4 \times M) = 6.0 \times 10^{24} \text{ kg} (\text{allow } 5.95 \rightarrow 6.14)$ Maximum of 2/3 for any value chosen f		C1 A1	[3]						
	(ii)	change in potential = 2.1×10^7 J kg ⁻¹ loss in potential energy = gain in kinet $\frac{1}{2}mv^2 = \phi \text{ m or } \frac{1}{2}mv^2 = GM / 3R$ $\frac{1}{2}v^2 = 2.1 \times 10^7$		C1 B1 C1							
		$v = 6.5 \times 10^3 \text{ m s}^{-1}$ (allo (answer 7.9 × 10 ³ m s ⁻¹ , based on $x = 2$		A1	[4]						
	(iii)	e.g. speed / velocity / acceleration wou deviates / bends from straight path (any sensible ideas, 1 each, max 2)	ld be greater	B1 B1	[2]						
2	(a) (i)	reduction in energy (of the oscillations) reduction in amplitude / energy of oscil due to force (always) opposing motion any two of the above, max 2	ations	(B1) (B1) (B1)	[2]						
	(ii)	amplitude is decreasing (very) graduall continue (for a long time) /many oscilla light damping	-	M1 A1	[2]						
	(b) (i)	frequency = 1 / 0.3 = 3.3 Hz allow points taken from time axis giving	f = 3.45 Hz	A1	[1]						
	(ii)	energy = $\frac{1}{2} mv^2$ and $v = \omega a$ = $\frac{1}{2} \times 0.065 \times (2\pi/0.3)^2 \times (2\pi/0.3)^2$	$1.5 \times 10^{-2})^2$	C1 M1 A0	[2]						
		blitude reduces exponentially / does not vill be not be 0.7 cm	decrease linearly	M1 A1	[2]						

Page 3					Syllabus	Paper	
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3	(a)	(i)		g C corresponds to (3840 – 190) / 100 Ω esistance 2300 Ω , temperature is 100 × (2300 – 3840)	/ (190 – 3840)	C1	
		temperature is 42°C					
		(ii)		er 286 K = $13 \degree C$ or $42 \degree C = 315$ K modynamic scale does not depend on the property of a	a substance	B1 M1	
				hange in resistance (of thermistor) with temperature is		A1	[3]
	(b)	hea	at gair	ned by ice in melting = $0.012 \times 3.3 \times 10^5$ J = 3960 J		C1	
		hea	at lost	by water = $0.095 \times 4.2 \times 10^3 \times (28 - \theta)$		C1	
				$0.012 \times 4.2 \times 10^3 \times \theta = 0.095 \times 4.2 \times 10^3 \times (28 - \theta)$		C1	
			= 16°			A1	[4]
				18°C – melted ice omitted – allow max 2 marks) θ – T) then allow max 1 mark)			
4	(a)			q_1q_2 / $4\pi\varepsilon_0 x^2$		C1	
		= (6.4 ×	10^{-19}) ² / ($4\pi \times 8.85 \times 10^{-12} \times \{12 \times 10^{-6}\}^2$)		C1	101
		= 2	2.56 ×	10 ⁻¹⁷ N		A1	[3]
	(b)	-		at P is same as potential at Q		B1	
				$he = q\Delta V$		M1	101
		ΔV	= 0 s	so zero work done		A0	[2]
	(c)			int, potential is $2 \times (6.4 \times 10^{-19}) / (4\pi\epsilon_0 \times 6 \times 10^{-6})$		C1	
		at F	, pot nae i	ential is $(6.4 \times 10^{-19}) / (4\pi\epsilon_0 \times 3 \times 10^{-6}) + (6.4 \times 10^{-19})$ n potential = $(6.4 \times 10^{-19}) / (4\pi\epsilon_0 \times 9 \times 10^{-6})$	$/ (4\pi\varepsilon_0 \times 9 \times 10^\circ)$) C1	
				$= 1.6 \times 10^{-19} \times (6.4 \times 10^{-19}) / (4\pi\epsilon_0 \times 9 \times 10^{-6})$		C1	
				$= 1.0 \times 10^{-22} \text{ J}$		A1	[4]
5	(a)			age of charge' / storage of energy			
			-	of direct current g of electrical oscillations			
		-	oothir	-			
		(an	y two	, 1 mark each)		B2	[2]
	(b)	(i)		acitance of parallel combination = $60 \mu\text{F}$		C1	[0]
			lolai	capacitance = 20 µF		A1	[2]
		(ii)	•	across parallel combination = $\frac{1}{2} \times p.d.$ across single	capacitor	C1	101
			max	imum is 9V		A1	[2]
	(c)	eith	<i>ier</i> er	nergy = $\frac{1}{2}CV^2$ or energy = $\frac{1}{2}QV$ and Q = CV		C1	
			ergy	$= \frac{1}{2} \times 4700 \times 10^{-6} \times (18^2 - 12^2)$		C1	
			1	= 0.42 J		A1	[3]

	Page 4	1	Mark Scheme: Teachers' version Syllabus		Paper	
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6	(a) (i) straight line through origi		ght line with positive gradient ugh origin		M1 A1	[2]
	(ii)	zero	imum force shown at $\theta = 90^{\circ}$ force shown at $\theta = 0^{\circ}$ onable curve with <i>F</i> about ½ max at 30°		M1 M1 A1	[3]
	(b) (i)		e on electron due to magnetic field e on electron normal to magnetic field and direction of	electron	B1 B1	[2]
	(ii)		e / mention of (Fleming's) left hand rule tron moves towards QR		M1 A1	[2]
7	(a) eith or		the value of steady / constant voltage that produces same power (in a resistor) as the altern if alternating voltage is squared and averaged the r.m.s. value is the square root of this averaged val		M1 A1 (M1) (A1)	[2]
	(b) (i)	220	V		A1	[1]
	(ii)	156	V		A1	[1]
	(iii)	60 H	łz		A1	[1]
	(c) pov	wer = = 156	V _{rms} ² / R 5 ² / 1500		C1	
		16 Ω			A1	[2]
8	(a) (i)	num	ber = $(5.1 \times 10^{-6} \times 6.02 \times 10^{23}) / 241$ = 1.27×10^{16}		C1 A1	[2]
	(ii)		$\times 10^5 = \lambda \times 1.27 \times 10^{16}$		C1	
		λ =	$4.65 \times 10^{-11} \ s^{-1}$		A1	[2]
	(iii)		$5 \times 10^{-11} \times t_{\frac{1}{2}} = \ln 2$		C1	
			= 1.49 × 10 ¹⁰ s = 470 years		A1	[2]

(b) sample / activity would decay appreciably whilst measurements are being made B1 [1]

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	Section B									
9	(a)	(i)		tion of the output (signal) is added to the input (signal) of phase by 180° / π rad / to inverting input		M1 A1	[2]			
		(ii)	incre grea redu	reduces gain eases bandwidth ater stability ices distortion v two, 1 mark each)		B2	[2]			
	(b)	(i)	gain	= 4.4 / 0.062 = 71		A1	[1]			
		(ii)		= $1 + 120/R$ = $1.7 \times 10^3 \Omega$		C1 A1	[2]			
	(c)	ma	ximur	mplifier not to saturate n output is (71 \times 95 \times 10 ⁻³ =) approximately 6.7 V hould be +/– 9 V		B1 M1 A1	[3]			
10	(a)	(i)	strai	in gauge		B1	[1]			
		(ii)	piez	o-electric / quartz crystal / transducer		B1	[1]			
	(b)	circ		coil of relay connected between sensing circuit output switch across terminals of external circuit diode in series with coil with correct polarity for diode second diode with correct polarity	and earth	B1 B1 B1 B1	[4]			
11	<i>either</i> quartz <i>or</i> piezo-electric crystal opposite faces /two sides coated (with silver) to act as electrodes <i>either</i> molecular structure indicated <i>or</i> centres of (+) and (-) charge not coincident potential difference across crystal causes crystal to change shape alternating voltage (in US frequency range) applied across crystal causes crystal to oscillate / vibrate (crystal cut) so that it vibrates at resonant frequency (max 6)									

	Page 6		;	Mark Scheme: Teachers' version	Syllabus	Paper	,
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12	(a)			comes distorted / noisy es power / energy / intensity / is attenuated		B1 B1	[2]
	(b)	(i)	eithei or	 numbers involved are smaller / more manageable / calculations involve addition & subtraction rather th 		•	on [1]
		(ii)	minin signa	10 lg(P_{min} / (6.1 × 10 ⁻¹⁹)) num signal power = 1.93 × 10 ⁻¹⁶ W al loss = 10 lg(6.5 × 10 ⁻³)/(1.93 × 10 ⁻¹⁶) = 135 dB mum cable length = 135 / 1.6 = 85 km so no repeaters necessar	v	C1 C1 C1 C1 A1	[5]