CAMBRIDGE INTERNATIONAL EXAMINATIONS

Pre-U Certificate

MARK SCHEME for the May/June 2013 series

9792 PHYSICS

9792/02 Paper 2 (Part A Written), 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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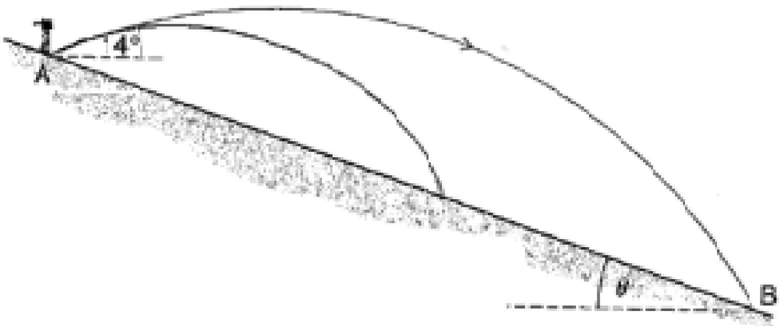
1 **(a)** **(i)** horizontal component at A = 63 cos 14 = 61.1 ($m\,s^{-1}$) (1)
vertical component at A = 63 sin 14 = 15.2 ($m\,s^{-1}$) (1) [2]

(ii) horizontal displacement = 61.1 × 4.9 = 300 (m)
accept 299 (m) (1) [1]

(iii) vertical displacement = $ut + ½at^2 = (15.2 \times 4.9) – (½ \times 9.81 \times 4.9^2)$ (1)
= 74.5 – 117.8 = (–)43.0 to 43.3 (m)
accept 44 (m), **ignore** sign (1) [2]

(iv) the angle of the slope tan θ = 43.3 / 300 (1)
θ = 8.2° (1) [2]

(b) **(i)**



at least 3 mm along original path **and** then new path under present curve (1) [1]

(ii) 1. path determined by movement of club **or** caused by same force in same direction **or** air resistance has acted for short time
not if path stated to be different (1)

2. (air resistance) reduces upward velocity / deceleration
allow WD against air resistance; **not** if height is greater (1)
(air resistance) reduces forward velocity
not if maximum height is later (1)

3. forward/horizontal velocity (much) reduced
not if angle smaller (1) [4]

[Total: 12]

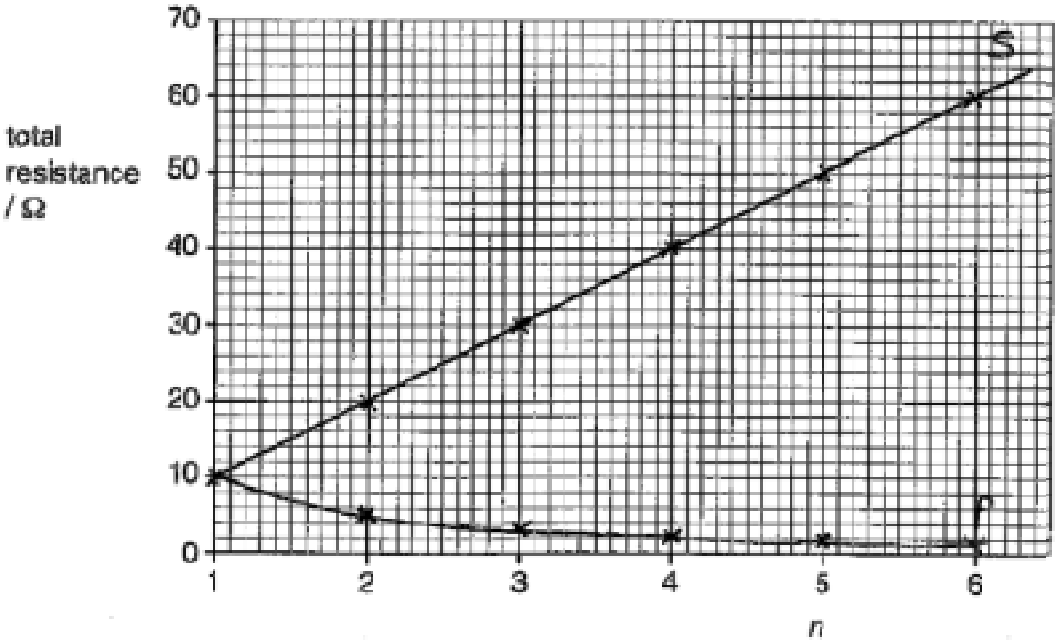
2	**(a)**	**(i)**	mgh = 6.0 × 9.81 × 1.64	(1)	
			96.5 (J)	(1)	
			kinetic energy = 96.5 + 134 = 231 (J)	(1)	[3]
		(ii)	½mv^2 = 231 so v^2 = 461 / 6	(1)	
			v = √(460 / 6.0) = 8.77 (m s^{-1})	(1)	
			momentum = 8.77 × 6 = 52.6 (52.596) (N s)	(1)	[3]
	(b)		force = momentum / time =	(1)	
			= 52.6 / 0.013 = 4046 (N)		
			accept 4050 / 4060	(1)	[2]
	(c)		(because of the small time) the force is very large	(1)	
			constant impulse / change of momentum **or** greater rate of change of momentum	(1)	[2]
					[Total: 10]
3	**(a)**	**(i)**	heat energy for raising temperature = mcΔθ = 65 × 4200 × 77	(1)	
			= 2.10 × 10^7 (J)	(1)	
			heat energy for conversion to steam = 65 × 2.26 × 10^6 = 1.47 × 10^8 (J)	(1)	
			total heat required = 1.68 × 10^8 (J)	(1)	[4]
		(ii)	power = 1.68 × 10^8 / time	(1)	
			= 1.68 × 10^8 / 1200 = 140 000 (W)	(1)	[2]
	(b)	**(i)**	power output = force x speed	(1)	
			= 1800 × 3.2 = 5760 (W)	(1)	[2]
		(ii)	efficiency = 5760 / 140000 = 4.1 (%) **or** 0.041		
			NOT 0.041%	(1)	[1]
					[Total: 9]

4 **(a) (i)** electromotive force is the energy per unit charge (or power per unit current) (1)
(converted from other forms of energy or power) into electrical energy (or power) (1) [2]

(ii) resistance is potential difference per unit current (1) [1]

(b) (i) 1. total resistance = 10n (Ω) (1) [1]

2. resistances 10, 20, 30, 40, 50 and 60 Ω (1)
plotted as straight line graph (1) [2]



(ii) 1. resistance = 10 / n (Ω) (1)

2. resistances = 10, 5, 3.3, 2.5, 2.0 and 1.7 Ω (1)
graph plotted correctly (for values stated) (1) [3]

(c) (i) 4 lines of 40 (Ω) (1)
total resistance 10 (Ω) (1) [2]

(ii) (always) 10 Ω (1) [1]

(iii) smaller current through each resistor (1) so capable of handling more power output (1)
if one resistor faulty/inaccurate (1), total resistance close to 10 Ω (1)
(*R* unchanged 1/2 only)
basic sensible suggestion (1); elaboration (1) (2) [2]

[Total: 14]

5	**(a)**	radio waves, microwaves and UV are transverse waves **and** ultrasound is a longitudinal wave (-1 e.e.o.o.)	(2)	[2]
	(b)	a (transverse) wave in which all the oscillations take place in one plane **ignore** direction	(1)	
		diagram showing this (in contrast to a non-polarised wave)	(1)	[2]
	(c) (i)	amplitude = $A \cos 30 = 0.87A$ **ignore** √3/2	(1)	[1]
	(ii)	30° to the vertical	(1)	[1]
	(iii)	amplitude = $A \cos 30 \times \cos 30 = 0.75A$	(1)	
		intensity ∝ amplitude^2	(1)	
		intensity = $I \times 0.75^2 = 0.56(25)\ I$ **not** A^2 penalise fractions only once	(1)	[3]
				[Total: 9]
6	**(a) (i)**	132 to 135 mm	(1)	[1]
	(ii)	phase difference = 180 degrees or π radians	(1)	[1]
	(iii)	actual value of $s = 2 \times 25$ mm = 49 to 51 mm	(1)	
		(D = 132 mm, a = 22 mm, $s = 8 \times 132/22$ =) 48.4 mm	(1)	
		percentage difference = (1.6 in 50 ×100 =) 3.2%	(1)	[3]
	(iv)	any **two** from: the intensity of the wave from B will be less than that from A B is further from X than A the slit widths are not negligible (so situation is more complex than assumed) small angle approximation has been made **or** $\sin\theta \approx \theta$	(2)	[2]
	(b)	the amplitude of one high frequency wave, the carrier, varies in a manner determined by the amplitude of another wave (the modulating wave, the signal)	(1)	
		constant period of carrier wave **or** period much less for carrier wave	(1)	
		modulated amplitude	(1)	[3]
	(c)	lowest frequency = 200 Hz	(1)	
		middle frequency = 3 times lowest frequency (allow 4 times / 800 Hz) = 600 Hz	(1)	
		highest frequency = 11 – 14 times lowest frequency = 2500 ± 300 Hz	(1)	[3]
				[Total: 13]

7	**(a)**	**(i)**	$E = hc/\lambda$ (and knowing what the terms mean)	(1)	
			$= 6.63 \times 10^{-34} \times 3.0 \times 10^{8} / 6.44 \times 10^{-7} = 3.09 \times 10^{-19}$ (J)	(1)	[2]
			$= 3.09 \times 10^{-19} / e$	(1)	
			$= 3.09 \times 10^{-19} / 1.60 \times 10^{-19} = 1.93$ (eV)	(1)	[2]
		(ii)	7.87 W / 3.09×10^{-19} (J)	(1)	
			2.55×10^{19} (s^{-1})	(1)	[2]
	(b)		(too) low energy photons / (too) long wavelength / (too) low frequency	(1)	
			electrons in most metals (except sodium and potassium) require UV radiation / work function in metals high / work function low / below threshold frequency	(1)	[2]
					[Total: 8]
8	**(a)**	**(i)**	(total no. of atoms =) number of atoms of isotope / abundance ratio **or** $1.82 \times 10^{22} / 0.00718$ **or** $1.82 \times 10^{22} / 0.0000718$ **or** 2.53 (4818942) $\times 10^{n}$	(1)	
			2.53 (4818942) $\times 10^{24}$	(1)	
		(ii)	$2.13 \times 10^{9} / 7.10 \times 10^{8}$ **or** 3 half-lives **or** 2^3 **or** $1/2^3$ **or** $8 \times 1.82 \times 10^{22}$	(1)	
			1.46 (1.456) $\times 10^{23}$	(1)	
		(iii)	0.039890410964.00 **or** 0.0400 **or** 3.989041096% **or** 4.00% **allow** 0.04 from $1.46 \times 10^{23} / 3.65 \times 10^{24}$	(1)	
		(iv)	too few uranium-235 atoms (in naturally occurring uranium) **or** atomic abundance ratio too low (in naturally occurring uranium)	(1)	
			chance of further fission , 1 **or** chance of 1 neutron hitting another (U-235) nucleus too low **or** not enough neutrons emitted	(1)	[7]
	(b)	**(i)**	at least one β emission **or** ${}^{234}_{91}X$ **or** ${}^{234}_{91}Pa$	(1)	
			two β emissions	(1)	
		(ii)	new uranium-234 **atoms** created (somehow /by decaying uranium-238)	(1)	
			in equilibrium with uranium-238 **or** decay at same rate as produced **or** as number of uranium-238 atoms decreases, so does number of uranium-234 atoms	(1)	[4]
	(c)	**(i)**	**1.** 57	(1)	
			2. 89	(1)	
		(ii)	**1.** $0.181 \times 1.66 \times 10^{-27} \times (3.00 \times 10^{8})^2$ **or** $0.181 \times (3.00 \times 10^{8})^2$ **or** 1.63 / 1.629×10^{16}	(1)	
			2.70(414) $\times 10^{-11}$ (J)	(1)	
			2. 4.92(15348) $\times 10^{11}$ (J) (do not penalise J / kg as wrong unit)	(1)	[5]

(d) **(i)** all uranium atoms undergo the same chemical reactions / behaviour / properties ignore chemical means (1)

(ii) more liberated neutrons can escape through the sides of the rod before hitting another uranium-235 nucleus **or** large surface area to volume ratio (1) [2]

(e) **social**

political / 'nimby' opposition (1)
terrorist target / dirty bomb (1)
accidents unlikely (1)
built away from population centres (1)
unattractive (in rural / coastal areas) (1)
jobs created (1)
operate continuously (1)
large power output (1)
(public perception of) leading to nuclear weapons (1)

environmental

no CO_2 emitted / small carbon footprint / no greenhouse gases emitted / less global warming (1)
radioactive waste long lasting (1)
radioactive waste dangerous (1)
land uninhabitable due to accidents (1)
radiation escape to surroundings (1)
danger of tsunami / earthquake (1)
volume of waste small (1)
small area (1)
mining for uranium dirty (1)
long term storage needed (1)

economic

expensive to build (1)
expensive maintenance (1)
difficult / expensive disposal of waste (1)
not easily switched on/off (1)
creates jobs (do not credit twice) (1)
decommissioning costs (1)
fuel cheap / power station cheap to run (1)
fuel abundant (1)
easy to transport (1)

at least two from each category [max 7]

[Total: 25]