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

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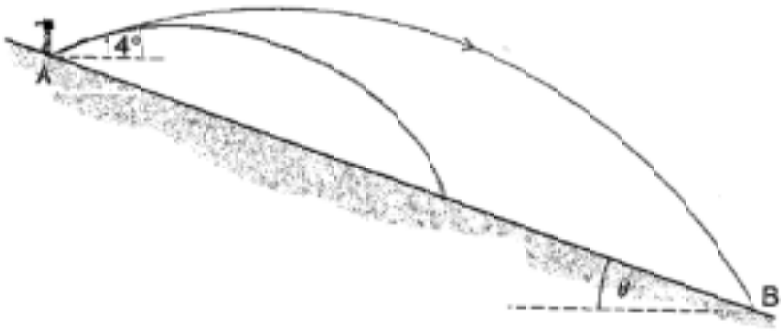
1 (a) (i) horizontal component at A = 63 cos 14 = 61.1 ($m\,s^{-1}$) (1)
vertical component at A = 63 sin 14 = 15.2 ($m\,s^{-1}$) (1) [2]

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

(iii) vertical displacement = $ut + \frac{1}{2}at^2$ = (15.2 × 4.9) – (½ x 9.81 × 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]

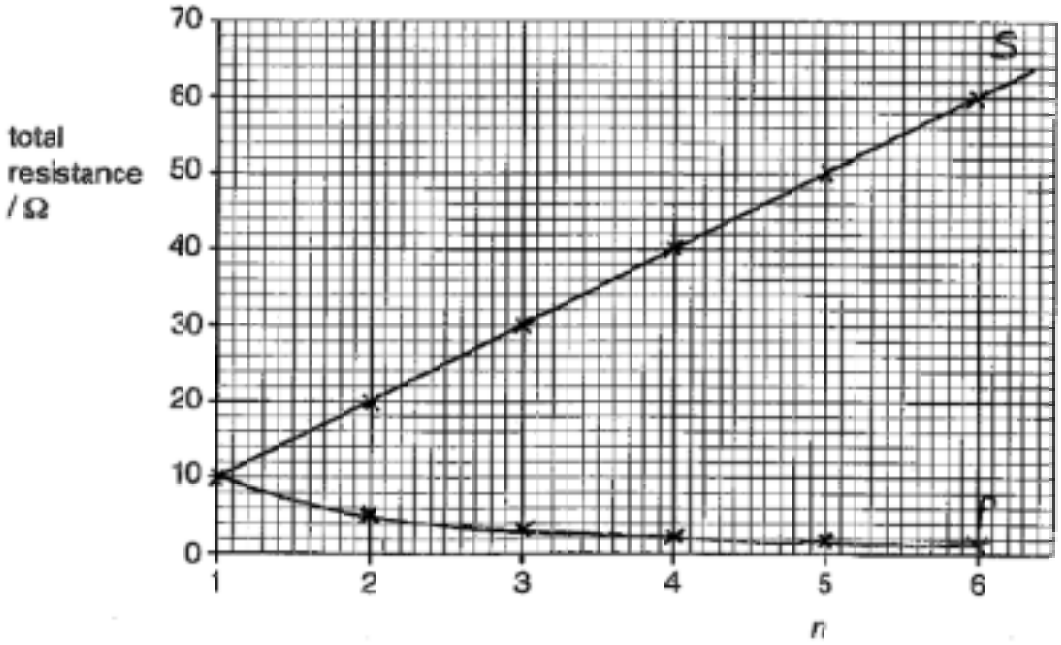
[Total: 9]

4 (a) (i) electromotive force is the energy per unit charge (or power per unit current) (converted from other forms of energy or power) into electrical energy (or power) (1) (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 $\sqrt{3}/2$ (1) [1]

(ii) 30° to the vertical (1) [1]

(iii) amplitude = $A \cos 30 \times \cos 30 = 0.75A$ (1)
intensity $\propto$ 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 $\times$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 $\pm$ 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**
$1.63 / 1.629 \times 10^{16}$ (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]