CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the May/June 2014 series

9702 PHYSICS

9702/22 Paper 2 (AS Structured Questions), maximum raw mark 60

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.

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1 **(a)** power = energy / time *or* work done / time B1
force: kg m s^{-2} (including from *mg* in *mgh* or *Fv*)
or kinetic energy ($\frac{1}{2}mv^2$): kg (m s^{-1})^2 B1
(distance: m and (time)$^{-1}$: s^{-1}) and hence power: kg m s^{-2} m s^{-1} = kg m^2 s^{-3} B1 [3]

(b) Q/t : kg m^2 s^{-3} C1
A: m^2 and x: m and T: K C1
correct substitution into $C = (Qx)/tAT$ or equivalent, or with cancellation C1
units of C : kg m s^{-3} K^{-1} A1 [4]

2 **(a)** $\rho = m/V$ C1
$V = (\pi d^2/4) \times t = 7.67 \times 10^{-7}$ m^3
$\rho = (9.6 \times 10^{-3})/[\pi(22.1/2 \times 10^{-3})^2 \times 2.00 \times 10^{-3}]$ C1
$\rho = 12513$ kg m^{-3} (allow 2 or more s.f.) A1 [3]

(b) **(i)** $\Delta\rho/\rho = \Delta m/m + \Delta t/t + 2\Delta d/d$ C1

= 5.21% + 0.50% + 0.905% [or correct fractional uncertainties] C1

= 6.6% (6.61%) A1 [3]

(ii) $\rho = 12500 \pm 800$ kg m^{-3} A1 [1]

3 **(a)** a body / mass / object continues (at rest or) at constant / uniform velocity unless acted on by a <u>resultant</u> force B1 [1]

(b) **(i)** weight <u>vertically</u> down B1
normal / reaction / contact (force) perpendicular / normal <u>to the slope</u> B1 [2]

(ii) **1.** acceleration = gradient *or* $(v - u)/t$ *or* $\Delta v/t$ C1
= (6.0 – 0.8)/(2.0 – 0.0) = 2.6 m s^{-2} M1 [2]

2. $F = ma$
= 65 × 2.6
= 169 N (allow to 2 or 3 s.f.) A1 [1]

3. weight component seen: mg sinθ (218 N) C1
218 – R = 169 C1
R = 49 N (require 2 s.f.) A1 [3]

4 **(a)** GPE: energy of a mass due to its position in a gravitational field B1
KE: energy (a mass has) due to its motion / speed / velocity B1 [2]

(b) **(i)** **1.** KE $= \frac{1}{2} mv^2$ C1

$= \frac{1}{2} \times 0.4 \times (30)^2$ C1

$= 180\,\text{J}$ A1 [3]

2. $s = 0 + \frac{1}{2} \times 9.81 \times (2.16)^2$ *or* $s = (30 \sin 45°)^2 / (2 \times 9.81)$ C1

$= 22.88\ (22.9)\,\text{m}$ $= 22.94\ (22.9)\,\text{m}$ A1 [2]

3. GPE $= mgh$ C1
$= 0.4 \times 9.81 \times 22.88 = 89.8\ (90)\,\text{J}$ A1 [2]

(ii) **1.** KE = initial KE – GPE = 180 – 90 = 90 J A1 [1]

2. (horizontal) velocity is not zero / (object) is still moving / answer explained in terms of conservation of energy B1 [1]

5 **(a)** (Young modulus / E =) stress / strain B1 [1]

(b) **(i)** stress $= F/A$
or $= F/(\pi d^2/4)$
or $= F/(\pi d^2)$ M1

ratio = 4 (or 4:1) A1 [2]

(ii) E is the same for both wires (as same material) [e.g. $E_P = E_Q$] M1
strain = stress / E
ratio = 4 (or 4:1) [*must be same as* ***(i)***] A1 [2]

6 **(a)** there are no lost volts / energy lost in the battery
or there are no lost volts / energy lost in the internal resistance B1 [1]

(b) the current / I decreases (as R increases) M1
p.d. decreases (as R increases) A1

or

the parallel resistance (of X and R) increases M1
p.d. across parallel resistors increases, so p.d. (across Y) decreases A1 [2]

(c) (i) current = 2.4 (A) C1
p.d. across AB = 24 – 2.4 × 6 = 9.6 V M1

or

total resistance = 10 Ω (= 24 V / 2.4 A) C1
(parallel resistance = 4 Ω), p.d. = 24 × (4 / 10) = 9.6 V M1 [2]

(ii) R (AB) = 9.6 / 2.4 = 4.0 Ω C1
1 / 6 + 1 / X = 1 / 4 [must correctly substitute for R] C1
X = 12 Ω A1

or

I_R = 9.6 / 6.0 = 1.6 (A) (C1)
I_X = 2.4 – 1.6 = 0.8 (A) (C1)
X (= 9.6 / 0.8) = 12 Ω (A1) [3]

(iii) power = VI *or* EI *or* V^2/R *or* E^2/R *or* I^2R C1
= 24 × 2.4 *or* $(24)^2/10$ *or* $(2.4)^2 \times 10$
= 57.6 W (allow 2 or more s.f.) A1 [2]

(d) power decreases M0

e.m.f. constant or power = 24 × current, and current decreases
or e.m.f. constant or power = 24^2 / resistance, and resistance increases A1 [1]

7 (a) waves from the double slit are coherent / constant phase difference B1

waves (from each slit) overlap / superpose / meet (**not** interfere) B1

maximum / bright fringe where path difference is $n\lambda$
or phase difference is $n360°$ / $2\pi n$ rad
or minimum / dark fringe where path difference is $(n + \frac{1}{2})\lambda$
or phase difference is $(2n + 1)\,180°$ / $(2n + 1)\pi$ rad B1 [3]

(b) $v = f\lambda$ C1
$\lambda = (3 \times 10^8) / 670 \times 10^{12}$ = 448 (or 450) (nm) M1 [2]

(c) w = 12 / 9 C1
a (= $D\lambda / w$) = $(2.8 \times 450 \times 10^{-9}) / (12 / 9 \times 10^{-3})$ [allow nm, mm] C1
= 9.5×10^{-4} m [9.4×10^{-4} m using λ = 448 nm] A1 [3]

(d) (red light has) larger / higher / longer wavelength (must be comparison) M1
fringes further apart / larger separation A1 [2]