**UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS**

**GCE Advanced Subsidiary Level and GCE Advanced Level**

**MARK SCHEME for the October/November 2006 question paper**

# 9702 PHYSICS

**9702/02** Paper 2 (Structured), maximum raw mark 60

This mark scheme is published as an aid to teachers and students, 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.

All Examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes must be read in conjunction with the question papers and the report on the examination.

The grade thresholds for various grades are published in the report on the examination for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level syllabuses.

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| | | | | | |
|---|---|---|---|---|---|
| **1** | **(a)** | **(i)** | product of force and distance <u>moved</u> | | |
| | | | (by force) in the direction of the force | | |
| | | **(ii)** | work (done) per unit time (*idea of ratio needed*) | | |
| | **(b)** | | *either* work/time *or* power = (force × distance)/time | M1 | |
| | | | to give power = force × velocity | A1 | [2] |
| | **(c)** | **(i)** | kinetic energy (= $\frac{1}{2}mv^2$) = ½ × 1900 × $27^2$ | C1 | |
| | | | power = 692550 / 8.1 = $8.55 \times 10^4$ W | A1 | [2] |
| | | **(ii)** | *either* for equal increments of speed, increments of $E_K$ are different | M1 | |
| | | | so longer time (to increase speed) at high speeds | A1 | [2] |
| | | | *or* air resistance increases with speed (M1) | | |
| | | | so driving force (and acceleration) reduced (A1) | | |
| | | | *or* $P$ (= $Fv$) = $mav$ (M1) | | |
| | | | ($P$ and $m$ constant) so when $v$ increases, $a$ decreases (A1) | | |
| **2** | **(a)** | | uses a tangent (anywhere), not a single point | C1 | |
| | | | draws tangent at correct position | B1 | |
| | | | acceleration = 1.7 ± 0.1 | A2 | [4] |
| | | | (*outside 1.6 → 1.8 but within 1.5 → 1.9, allow 1 mark*) | | |
| | **(b)** | **(i)** | because slope (of tangent of graph) is decreasing | M1 | |
| | | | acceleration is decreasing | A1 | [2] |
| | | **(ii)** | e.g. air resistance increases (with speed) | | |
| | | | (angle of) slope of ramp decreases | B1 | [1] |
| | **(c)** | **(i)** | scatter of points about <u>line</u> | B1 | [1] |
| | | **(ii)** | intercept / line does not go through origin | B1 | [1] |
| **3** | **(a)** | | helium nucleus OR contains two protons and two neutrons | B1 | [1] |
| | **(b)** | | kinetic energy = $\frac{1}{2}mv^2$ | C1 | |
| | | | ½ × 4 × 1.66 × $10^{-27}$ × $v^2$ = 1.07 × $10^{-12}$ | A1 | |
| | | | $v$ = 1.8 × $10^7$ m s$^{-1}$ | A0 | [2] |
| | **(c)** | **(i)** | sum of momenta (in any direction) is constant | | |
| | | | / total momemtum is constant | M1 | |
| | | | in a closed system / no external force | A1 | [2] |
| | | **(ii)** | momentum of francium (= 0) = momentum of $\alpha$ + momentum of astatine | C1 | |
| | | | 204 × $V$ = 4 × 1.8 × $10^7$ | C1 | |
| | | | $V$ = 3.5 × $10^5$ m s$^{-1}$ | A1 | [3] |
| | | | (*nuclei incorrectly identified, 0/3* | | |
| | | | *nuclei correctly identified but incorrect masses, -1 each error*) | | |
| | **(d)** | | another particle / photon is emitted | M1 | |
| | | | at an angle to the direction of the $\alpha$-particle | A1 | [2] |
| | | | (allow 1 mark for ‘Francium nucleus is not stationary’) | | |

| | | | | | |
|---|---|---|---|---|---|
| **4** | **(a)** | **(i)** | when two (or more) waves meet (at a point)<br>there is a change in overall intensity / displacement | | |
| | | **(ii)** | constant phase difference (between waves) | | |
| | **(b)** | **(i)** | *d*sin*θ* = *nλ* | B1 | |
| | | | $(10^{-3} / 550)$ sin90 = $n \times 644 \times 10^{-9}$ | C1 | |
| | | | *n* = 2.8 | C1 | |
| | | | so two orders | A1 | [4] |
| | | | (*power-of-ten error giving 2800 orders, allow 1/3 only for calculation of n*) | | |
| | | **(ii)** | **1.** *d*sin*θ* = *nλ* (*either here or in **(i)** – not both*) | | |
| | | | <u>*θ* is greater so</u> *λ* is greater | B1 | [1] |
| | | | **2.** when *n* is larger, <u>Δ*θ*</u> is larger | M1 | |
| | | | so greater in second order | A1 | [2] |
| **5** | **(a)** | | metal: crystalline / lattice / atoms in regular pattern | B1 | |
| | | | (atoms in regular) pattern that repeats itself (within crystal) | B1 | [2] |
| | | | polymer: long chains of atoms / molecules | B1 | |
| | | | chain consists of 'units' that repeat themselves | B1 | [2] |
| | **(b)** | **(i)** | e.g. latex is soft / not strong / flows / ductile | B1 | |
| | | | elastic limit easily exceeded | B1 | [2] |
| | | | (*allow any two sensible comments, 1 each*) | | |
| | | **(ii)** | more solid / does not flow / stronger / higher ultimate tensile stress<br>more brittle<br>elastic limit much higher<br>increased toughness | | |
| | | | (*any two, 1 each*) | B2 | [2] |
| **6** | **(a)** | **(i)** | $R = \rho L / A$ | B1 | |
| | | **(ii)** | strain = $\Delta L / L$ | B1 | |
| | | | *either* $\Delta R = \rho \Delta L / A$ *or* $R \propto L$ with $\rho$ and $A$ constant | B1 | |
| | | | dividing, $\Delta R / R = \Delta L / L$ | A0 | [3] |
| | **(b)** | | Young modulus = stress / strain | C1 | |
| | | | strain = $72.0 / (1.20 \times 10^{-7} \times 2.10 \times 10^{11})$ | C1 | |
| | | | = $2.86 \times 10^{-3}$ (*allow 1/350* | A1 | |
| | | | $\Delta R = 2.86 \times 10^{-3} \times 4.17 = 1.19 \times 10^{-2}\ \Omega$ | A1 | |
| | | | answer given to 3 sig. fig | B1 | [5] |
| **7** | **(a)** | | both measure (energy / work) / charge | B1 | |
| | | | for e.m.f., transfer of chemical energy to electrical energy | B1 | |
| | | | for p.d., transfer of electrical energy to thermal energy / other forms | B1 | [3] |
| | **(b)** | **(i)** | $I_1 + I_2 = I_3$ | B1 | [1] |
| | | **(ii)** | **1.** $E_2 = I_2R_2 + I_3R_3$ | B1 | [1] |
| | | | **2.** $E_1 - E_2 = I_1R_1 - I_2R_2$ | B1 | [1] |