UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

# MARK SCHEME for the October/November 2006 question paper

# 9702 PHYSICS

**9702/04** Paper 4 (Core), 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.

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|---|---|---|---|---|---|
| 1 | (a) | | *either* ratio of work done to mass/charge<br>*or* work done moving unit mass/charge from infinity<br>*or* both have zero potential at infinity | B1 | |
| | (b) | | gravitational forces are (always attractive)<br>electric forces can be attractive or repulsive<br>for gravitational, work got out as masses come together /mass moves from infinity<br>for electric, work done on charges if same sign, work got out if opposite sign as charges come together | B1<br>B1<br>B1<br>B1 | [4] |
| 2 | (a) | (i) | idea of heat lost (by oil) = heat gained (by thermometer)<br>32 x 1.4 x (54 – $t$) = 12 x 0.18 x ($t$ – 19)<br>$t$ = 52.4°C | C1<br>C1<br>A1 | [3] |
| | | (ii) | *either* ratio (= 1.6/54) = 0.030 *or* (=1.6/327) = 0.0049 | A1 | [1] |
| | (b) | | thermistor thermometer (allow 'resistance thermometer')<br>because small mass/thermal capacity | B1<br>B1 | [2] |
| | (c) | | boiling point temperature is constant<br>further comment<br>e.g. heating of bulb would affect only rate of boiling | M1<br><br>A1 | [2] |
| 3 | (a) | | use of $a = -\omega^2 x$ clear<br>*either* $\omega = \sqrt{(2k/m)}$ *or* $\omega^2 = (2k/m)$<br>$\omega = 2\pi f$<br>$f = (1/2\pi)\sqrt{(2 \times 300)/0.240)}$<br>= 7.96 ≈ 8 Hz | C1<br>B1<br>C1<br>B1<br>A0 | [4] |
| | (b) | (i) | resonance | B1 | [1] |
| | | (ii) | 8 Hz | B1 | [1] |
| | (c) | | (increase amount of) damping<br>without altering ($k$ or) $m$ …(some indirect reference is acceptable)<br>sensible suggestion | B1<br>B1<br>B1 | [3] |
| 4 | (a) | (i) | $GMm\,\{(R + h_1)^{-1} - (R + h_2)^{-1}\}$<br>$\frac{1}{2}m\,\{v_1^2 - v_2^2\}$ | B1<br>B1 | [2] |
| | (b) | | $2M \times 6.67 \times 10^{-11}\,\{(26.28 \times 10^6)^{-1} - (29.08 \times 10^6)^{-1}\} = 5370^2 - 5090^2$<br>$M \times 4.888 \times 10^{-19} = 2.929 \times 10^6$<br>$M = 6.00 \times 10^{24}$ kg<br>*(If equation in* **(a)** *is dimensionally unsound, then 0/3 marks in* **(b)***, if dimensionally sound but incorrect, treat as e.c.f.)* | B1<br>C1<br>A1 | [3] |
| 5 | (a) | (i) | (induced) e.m.f proportional/equal to rate of change of flux (linkage)<br>*(allow 'induced voltage, induced p.d.)*<br>flux is cust as the disc moves<br>hence inducing an e.m.f | B1<br><br>M1<br>A0 | [2] |
| | | (ii) | field in disc is not uniform/rate of cutting not same/speed of disc not same (over whole disc)<br>so different e.m.f.'s in different parts of disc<br>lead to eddy currents | B1<br>M1<br>A0 | [2] |
| | (b) | | eddy currents dissipate thermal energy in disc<br>energy derived from oscillation of disc<br>energy of disc depends on amplitude of oscillations | B1<br>B1<br>B1 | [3] |

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| 6 | (a) | (i) | peak voltage = $6\sqrt{2}$<br>peak voltage = 8.48 V | | |
| | | (ii) | zero because *either* no current in circuit (and $V = IR$)<br>*or* all p.d. across diode | B1 | |
| | (b) | | waveform: half-wave rectification<br>peak height at about 4.25 cm<br>half-period spacing of 2.0 cm<br>*(allow ±¼ square for height and half-period)* | B1<br>B1<br>B1 | <br><br>[3] |
| | (c) | (i) | *capacitor shown in parallel with resistor* | B1 | [1] |
| | | (ii) | *either* energy = $\frac{1}{2}CV^2$ or = $\frac{1}{2}QV$ <u>and</u> $Q = CV$<br>$= \frac{1}{2} \times 180 \times 10^{-6} \times (6\sqrt{2})^2$<br>$= 6.48 \times 10^{-3}$ J | C1<br>C1<br>A1 | <br><br>[3] |
| | | (iii) | *either* fraction = $0.43^2$ or final energy = 1.2 mJ<br>fraction = 0.18 | C1<br>A1 | <br>[2] |
| 7 | (a) | (i) | quantum/packet/discrete amount of energy<br>electromagnetic mentioned | M1<br>A1 | <br>[2] |
| | | (ii) | max. k.e. corresponds to electron emitted from surface<br>energy is required to bring electron to surface | B1<br>B1 | <br>[2] |
| | (b) | | at higher frequency, fewer photons (per second) for same intensity<br>so rate of emission decreases<br>(allow argument based on photoelectric efficiency) | M1<br>A1 | <br>[2] |
| 8 | (a) | (i) | *either* number = $6.02 \times 10^{23} \times (\{2.65 \times 10^{-6}\}/234)$<br>*or* number = $(2.65 \times 10^{-9})/(234 \times 1.66 \times 10^{-27})$<br>$= 6.82 \times 10^{15}$ | <br>C1<br>A1 | <br><br>[2] |
| | | (ii) | $A = \lambda N$<br>$604 = \lambda \times 6.82 \times 10^{15}$<br>$\lambda = 8.86 \times 10^{-14}\ \text{s}^{-1}$ | C1<br><br>A1 | <br><br>[2] |
| | | (iii) | $T_{½} = \ln 2/\lambda$<br>$= 7.82 \times 10^{12}$ s<br>$= 2.48 \times 10^{5}$ years | <br>C1<br>A1 | <br><br>[2] |
| | (b) | | half-life is (very) long (compared with time of counting) | B1 | [1] |
| | (c) | | there would be appreciable decay of source during the taking of measurements | B1 | [1] |