**Specimen Paper**

GCE A LEVEL

# MARK SCHEME

## MAXIMUM MARK: 100

**SYLLABUS/COMPONENT: 9702/04**

**PHYSICS**
**Paper 4**

## Section A

| | | | | | |
|---|---|---|---|---|---|
| **1** | **(a) (i)** | radial lines | B1 | |
| | | pointing inwards | B1 | |
| | **(ii)** | no difference *OR* lines closer near surface of smaller sphere | B1 | [3] |
| | **(b) (i)** | $F_G = GMm / R^2$ | C1 | |
| | | $= (6.67 \times 10^{-11} \times 5.98 \times 10^{24}) / (6380 \times 10^3)^2$ | | |
| | | $= 9.80$ N | A1 | |
| | **(ii)** | $F_C = mR\omega^2$ | C1 | |
| | | $\omega = 2\pi / T$ | C1 | |
| | | $F_C = (4\pi^2 \times 6380 \times 10^3) / (8.64 \times 10^4)^2$ | | |
| | | $= 0.0337$ N | A1 | |
| | **(iii)** | $F_G. - F_C = 9.77$ N | A1 | [6] |
| | **(c)** | because acceleration (of free fall) is (resultant) force per unit mass | B1 | |
| | | acceleration = 9.77 m $s^{-2}$ | B1 | [2] |
| **2** | **(a) (i)** | $\omega = 2\pi f$ | B1 | |
| | **(ii)** | (-)ve because *a* and *x* in opposite directions *OR* *a* directed towards mean position / centre | B1 | [2] |
| | **(b) (i)** | forces in springs are $k(e + x)$ and $k(e - x)$ | C1 | |
| | | resultant $= k(e + x) - k(e - x)$ | M1 | |
| | | $= 2kx$ | A0 | [2] |
| | **(ii)** | $F = ma$ | B1 | |
| | | $a = -2kx / m$ | A0 | |
| | | (-)ve sign explained | B1 | [2] |
| | **(iii)** | $\omega^2 = 2k / m$ | C1 | |
| | | $(2\pi f)^2 = (2 \times 120) / 0.90$ | C1 | |
| | | $f = 2.6$ Hz | A1 | [3] |

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| **3** | **(a)** | single diode | | M1 | |
| | | in series with R *OR* in series with a.c. supply | | A1 | [2] |
| | **(b) (i) 1** | 5.4 V (allow ±0.1 V) | | A1 | |
| | **(i) 2** | $V = iR$ | | | |
| | | $I = 5.4 / 1.5 \times 10^3$ | | C1 | |
| | | $= 3.6 \times 10^{-3}$ A | | A1 | |
| | **(i) 3** | time = 0.027 s | | A1 | [4] |
| | **(ii) 1** | $Q = it$ | | | |
| | | $= 3.6 \times 10^{-3} \times 0.027$ | | C1 | |
| | | $= 9.72 \times 10^{-5}$ C | | A1 | |
| | **(ii) 2** | $C = \Delta Q / \Delta V$ (allow $C = Q/V$ for this mark) | | C1 | |
| | | $= (9.72 \times 10^{-5}) / 1.2$ | | | |
| | | $= 8.1 \times 10^{-5}$ F | | A1 | [4] |
| | **(c)** | line: reasonable shape with less ripple | | B1 | [1] |
| **4** | **(a) (i)** | 50 mT | | A1 | |
| | **(ii)** | flux linkage $= BAN$ | | C1 | |
| | | $= 50 \times 10^{-3} \times 0.4 \times 10^{-4} \times 150 = 3.0 \times 10^{-4}$ Wb | | A1 | [3] |
| | | (*allow 49 mT → $2.94 \times 10^{-4}$ Wb or 51 mT → $3.06 \times 10^{-4}$ Wb*) | | | |
| | **(b)** | e.m.f. / induced voltage (*do not allow current*) | | | |
| | | proportional/equal to | | B1 | |
| | | rate of change/cutting of flux (linkage) | | B1 | [2] |
| | **(c) (i)** | new flux linkage $= 8.0 \times 10^{-3} \times 0.4 \times 10^{-4} \times 150$ | | | |
| | | $= 4.8 \times 10^{-5}$ Wb | | C1 | |
| | | change $= 2.52 \times 10^{-4}$ Wb | | A1 | [2] |
| | **(ii)** | e.m.f. $= (2.52 \times 10^{-4}) / 0.30$ | | C1 | |
| | | $= 8.4 \times 10^{-4}$ V | | A1 | [2] |
| | **(d)** | *either* | flux linkage decreases as distance increases | B1 | |
| | | | so speed must increase to keep rate of change constant | B1 | [2] |
| | | *or* | at constant speed, e.m.f. / flux linkage decreases as *x* increases | (B1) | |
| | | | so increase speed to keep rate constant | (B1) | |

| | | | | |
|---|---|---|---|---|
| **5** | **(a)** | into (plane of) paper / downwards | B1 | [1] |
| | **(b) (i)** | the <u>centripetal force</u> = $mv^2 / r$ | B1 | |
| | | $mv^2/r = Bqv$ <u>hence</u> $q/m = v/rB$ (*some algebra essential*) | B1 | [2] |
| | **(ii)** | $q/m = (8.2 \times 10^6) / (23 \times 10^{-2} \times 0.74)$ | C1 | |
| | | $= 4.82 \times 10^7$ C kg$^{-1}$ | A1 | [2] |
| | **(c) (i)** | mass $= (1.6 \times 10^{-19}) / (4.82 \times 10^7 \times 1.66 \times 10^{-27})$ | C1 | |
| | | $= 2u$ | | [2] |
| | **(ii)** | proton + neutron | B1 | [1] |
| **6** | **(a)** | $pV / T$ = constant | C1 | |
| | | $T = (6.5 \times 10^6 \times 30 \times 300) / (1.1 \times 10^5 \times 540)$ | C1 | |
| | | = 985 K | A1 | [3] |
| | | (*if uses ℃, allow 1/3 marks for clear formula)* | | |
| | **(b) (i)** | $\Delta U = q + w$ | | |
| | | symbols identified correctly | M1 | |
| | | directions correct | A1 | [2] |
| | **(ii)** | $q$ is zero | B1 | |
| | | is positive *OR* $\Delta U = w$ and $U$ increases | B1 | |
| | | $\Delta U$ is rise in kinetic energy of <u>atoms</u> | M1 | |
| | | and mean kinetic energy $\propto T$ | A1 | [4] |
| | | (*allow 1 of the last two marks if states 'U increases so T rises'*) | | |
| **7** | **(a) (i)** | *either* probability of decay per unit time *or* d$N$/d$t$ = (-)$\lambda N$ OR $A$ = (-)$\lambda N$ | M1 | |
| | | with symbols explained | A1 | [2] |
| | **(ii)** | greater energy of $\alpha$-particle means | M0 | |
| | | (parent) nucleus less stable | A1 | |
| | | nucleus more likely to decay | A1 | |
| | | hence Radium-224 | A1 | [3] |
| | **(b) (i)** | *either* $\lambda$ = ln2 / 3.6 *or* $\lambda$ = ln2 / 3.6 × 24 × 3600 | | |
| | | = 0.193    = $2.23 \times 10^{-6}$ | A1 | |
| | | unit day$^{-1}$    s$^{-1}$ | A1 | [2] |
| | | (*one sig.fig., -1, allow $\lambda$ in hr$^{-1}$*) | | |
| | **(ii)** | $N = \{(2.24 \times 10^{-3}) / 224\} \times 6.02 \times 10^{23}$ | C1 | |
| | | $= 6.02 \times 10^{18}$ | C1 | |
| | | activity = $\lambda N$ | | |
| | | $= 2.23 \times 10^{-6} \times 6.02 \times 10^{18}$ | C1 | |
| | | $= 1.3 \times 10^{13}$ Bq | A1 | [4] |

## Section B

| | | | | |
|---|---|---|---|---|
| **8** | **(a)** + – | | B1 | [1] |
| | **(b) (i)** | **1.** 4.5 V | B1 | |
| | | **2.** Use of potential divider formula 9 × 800 / (800 + 2200) | C1 | |
| | | 2.4 V | A1 | |
| | | **3.** – 9.0 V | B1 | [4] |
| | **(ii)** | green (*e.c.f. from (a) and (i)3*) | B1 | [1] |
| | **(c)** as temperature rises, potential/voltage at B increases | | M1 | |
| | at 60 °C, green goes out, red comes on | | A1 | [2] |
| **9** | **(a) (i)** | clear distinction of boundaries between regions | B1 | |
| | **(ii)** | significant difference in blackening of different regions | B1 | [2] |
| | **(b) (i)** | ½ = $e^{-\mu}$ | C1 | |
| | | $\mu$ = 0.693 $mm^{-1}$ | A1 | [2] |
| | **(ii)** | X-ray (photons) are more penetrating | M1 | |
| | | $\mu$ is smaller | A1 | [2] |
| **10** | **(a)** amplitude of carrier wave varies | | M1 | |
| | in synchrony with (displacement of information) signal | | A1 | [2] |
| | **(b)** three vertical lines | | B1 | |
| | symmetrical with smaller sidebands | | B1 | |
| | at frequencies 70, 75 and 80 kHz | | B1 | [3] |
| | **(c)** bandwidth = 10 kHz | | B1 | [1] |
| **11** | **(a)** unwanted energy / power that is random or that covers whole spectrum | | B1 | [1] |
| | **(b)** number of dB = 10 lg($P_{OUT}$ / $P_{IN}$) | | C1 | |
| | 63 = 10 lg ($P_{OUT}$ / (2.5 × $10^{-6}$)) | | C1 | |
| | $P_{OUT}$ = 5.0 W | | A1 | [3] |
| | **(c)** attenuation = 10 lg(5 / 3.5 × $10^{-8}$) = 81.5 dB | | C1 | |
| | length = 81.5 / 12 = 6.8 km | | A1 | [2] |
| **12** | e.g. permits entry to PSTN | | | |
| | selects base station for any handset | | | |
| | allocates a carrier frequency/channel | | | |
| | monitors handset signal to re-allocate base station | | | |
| | allocates time slot for multiplexing etc | | | |
| | (*any four sensible suggestions, 1 each to max 4)* | | B4 | [4] |