| Mark Scheme | Unit Code | Session | Year | Final version |
|---|---|---|---|---|
| | 2824 | January | 2006 | |
| Page 1 of 3 | | | | |

**Abbreviations, annotations and conventions used in the Mark Scheme**

| | |
|---|---|
| / | = alternative and acceptable answers for the same marking point |
| ; | = separates marking points |
| () | = words which are not essential to gain credit |
| ecf | = error carried forward |
| AW | = alternative wording |

| Question | | | Expected Answers | Marks | |
|---|---|---|---|---|---|
| 1 | a | i | 3.8 ± 0.3 (N s) | 1 | |
| | | ii | momentum (of the ball) *accept impulse* | 1 | |
| | | iii | mv = 3.8 or v = 3.8/0.16; = 23 (m $s^{-1}$) *ecf a* | 2 | |
| | | iv | use F = ma giving 24 = 0.16a; a = 150 (m $s^{-2}$) | 2 | 6 |
| | b | i | exponential | 1 | |
| | | ii | e.g. $h_1/h_2 = e^k$ = 2.1(5) ; giving k = 0.74 to 0.76 | | |
| | | | **or** substitution from a line of table; gives 0.748, 0.757 or 0.746 | 2 | |
| | | iii | 1.5 (m) | 1 | |
| | | iv | Δk.e. = mgΔh; = 0.16 x 9.8 x 0.38 ( = 0.60 J) | 2 | 6 |
| | | | **Total** | | **12** |
| 2 | a | i | Fig. 2.1 : x and a in opposite directions/acceleration towards equilibrium | 1 | |
| | | | point/AW; Fig. 2.2 : proportional graph between x and a/AW | 1 | |
| | | | *Figures not identified max. of 1 mark* | | |
| | | ii | $a = 4\pi^2 f^2 x$; $50 = 4\pi^2 f^2 .50 \times 10^{-3}$ ; giving $f^2$ = 25 and f = 5.0 Hz | 3 | |
| | | iii | cosine wave with initial amplitude 25 mm; decreasing amplitude; | 2 | |
| | | | correct period of 0.2 s (for minimum of 2.5 periods); | 1 | 8 |
| | b | i | the acceleration towards A/centripetal acceleration or force; is constant | 2 | |
| | | ii | $a = v^2/r$; so $50 = v^2/10$; $v^2 = 500$ giving v = 22.4 m $s^{-1}$ | 3 | 5 |
| | | | Total | | **13** |
| 3 | a | | appropriate shape; lines perpendicular to and touching plate and sphere; arrows | 2 | |
| | | | towards negative sphere | 1 | 3 |
| | b | i | By moments, e.g F cos 20 = W sin 20 / by triangle of forces / by resolution of | | |
| | | | forces / other suitable method; *i.e. justification needed* | 1 | |
| | | | F = 1.0 x $10^{-5}$ tan 20 ; = 1.0 x $10^{-5}$ x 0.364; (= 3.64 x $10^{-6}$ N) | 2 | |
| | | | triangle of forces gives W/F = tan 70, etc | | |
| | | ii | E = F/Q ; = 3.64 x $10^{-6}$ / 1.2 x $10^{-9}$ = 3.0 x $10^3$ ;N $C^{-1}$ / V $m^{-1}$ | 3 | 6 |
| | c | | $E = (1/4\pi\varepsilon_o)Q/r^2$ ; 3.0 x $10^3$ = 9 x $10^9$ x 1.2 x $10^{-9}/r^2$ ; | 2 | |
| | | | or use $F = (1/4\pi\varepsilon_o)Q^2/r^2$ ; | | |
| | | | $r^2$ = 3.6 x $10^{-3}$ giving r = 6 x $10^{-2}$ (m) | 1 | 3 |
| | d | | field line sketch *minimum of 5 lines symmetrical about line joining centres with* | 1 | |
| | | | *arrows* ; Fig 3.1 sketch matches RHS of Fig 3.2/plate analogous to mirror/AW | 1 | 2 |
| | | | relating to symmetry | | |
| | | | Total | | **14** |

| **Mark Scheme** | **Unit Code** | **Session** | **Year** | **Final version** |
|---|---|---|---|---|
| | **2824** | **January** | **2006** | |

**Page 2 of 3**

| **Question** | | | **Expected Answers** | **Marks** | |
|---|---|---|---|---|---|
| **4** | **a** | | 29; 34 | | **2** |
| | **b** | | $\lambda$ = 0.693/T = 0.693/(120 x 3.2 x $10^7$) = (1.8 x $10^{-10}$ $s^{-1}$) *accept ln 2* | | **1** |
| | **c** | **i** | Q = CV = 1.2 x $10^{-12}$ x 90 ; evidence of calculation (= 1.1 x $10^{-10}$ C) | **2** | |
| | | **ii** | n = Q/e = 1.1 x $10^{-10}$/1.6 x $10^{-19}$ ; = 6.9 x $10^8$ *allow sig. fig. variations* | **2** | |
| | | **iii** | A = $\lambda$N ; N =6.9 x $10^8$/1.8 x $10^{-10}$ ; = 3.8 x $10^{18}$ *using 7.0 gives 3.9* | **3** | |
| | | **iv** | 1 y is less than 1% of 120 y so expect to be within 1%/ using $e^{-\lambda t}$ gives exactly 1% fall/ problem of random emission or other relevant statement | **1** | **8** |
| | | | Total | | **11** |
| **5** | **a** | **i** | F is towards 'open' end of tube; using Fleming's L.H.rule | **2** | |
| | | **ii** | F = BIw | **1** | |
| | | **iii** | F = 0.15 x 800 x 0.0025; = 3.0 (N) | **2** | **5** |
| | **b** | **i** | A voltage is induced across moving metal as it cuts lines of flux/AW; | **1** | |
| | | | voltage is proportional to flux change per second/AW; | **1** | |
| | | | the flux change per second is Bwv / is proportional to the area of metal moving through the field per second / is proportional to v | **1** | |
| | | | **or** Faraday's law fully stated; with reasonable attempt to; | **2** | |
| | | | relate flux linkage per second proportionally to speed | **1** | |
| | | **ii** | flux (linkage) doubles; so using Faraday's law V doubles/AW | **2** | **5** |
| | | | **Total** | | **10** |
| **6** | **a** | | Internal energy is the sum of the <u>random</u> kinetic and potential energies of the <u>particles/molecules/atoms</u> in the system/body | **2** | |
| | | | *only 1 mark if random omitted* | | |
| | | | s.h.c. is the change in (internal) energy per unit mass/energy required to heat unit mass/kg per unit rise in temperature/$^{o}$C/K | **1** | **3** |
| | **b** | | Electrical heating of body for given time/ energy input = VIt; | **1** | |
| | | | measurement of mass of body and temperature rise; | **1** | |
| | | | hence VIt = mc$\theta$ with c found; | **1** | |
| | | | comment on heat loss and how avoided/compensated for; | **1** | |
| | | | suitable description of apparatus,etc. *max 4 marks* | **1** | **4** |
| | | | *method of mixtures is an acceptable alternative* | | |
| | **c** | **i** | Q = 2.0 x 920 x 293 ; evidence of calculation (= 540 kJ) | **2** | |
| | | **ii** | 2 kg contains 2/0.027 = 74 moles; | **1** | |
| | | | no. of atoms in 2 kg = 74 x 6.02 x $10^{23}$ = 4.46 x $10^{25}$; | **1** | |
| | | | energy per atom = 5.4 x $10^5$/4.46 x $10^{25}$ (= 1.2 x $10^{-20}$ J) | **1** | |
| | | **iii** | e.g 2 x 920/74;= 24.9 J $mol^{-1}$ $K^{-1}$ **or** alternative methods | | |
| | | | *1 mark for suitable method; 1 mark for correct solution* | **2** | **7** |
| | | | Total | | **14** |

| Mark Scheme | Unit Code | Session | Year | Final version |
|---|---|---|---|---|
| | 2824 | January | 2006 | |

Page 3 of 3

| Question | | Expected Answers | Marks | |
|---|---|---|---|---|
| 7 | a | nature and features: | | |
| | | α-particle is 2p + 2n/ mass 4 u | 1 | |
| | | charge of +2e | 1 | |
| | | very short range/heavily ionizing/absorbed by paper | 1 | |
| | | spontaneous; and random nature of radioactive decay | 2 | |
| | | energetically more favourable to eject four particles together than a single one/other comment about energy minimisation/mainly occurs from higher A nuclei/AW | 1 | |
| | | small mass decrease/loss provides kinetic energy of α-particle | 1 | |
| | | particle energy of a few MeV; particular decay is monoenergetic | 2 | |
| | | α-particle scattering: | | |
| | | suitable diagram **and**/**or** description to illustrate experiment *up to 2 marks* | 2 | |
| | | most particles have little if any deflection | 1 | |
| | | large deflection of very few shows nucleus is small; and very massive | 2 | |
| | | (Coulomb's law enables closest approach to) estimate nuclear size (in case of α-particle back scattering with conservation of energy argument) | 1 | |
| | | *max 7* | | 7 |
| | b | description: | | |
| | | (4) hydrogen or light nuclei/protons are fused together to form a helium/heavier/larger nucleus; | 1 | |
| | | two positrons must also be released; to conserve charge; | 2 | |
| | | the process is more complicated than the summary equation suggests/AW; | | |
| | | mass reduction provides energy release/ $\Delta m = \Delta E/c^2$ | 1 | |
| | | the process requires very high temperatures (to bring the protons together); | 1 | |
| | | normally achieved inside a star; only by man in a bomb so far; | 1 | |
| | | comparison: | 2 | |
| | | Energy release in fusion is much greater than in radioactive decay; | | |
| | | because mass reduction/change in fusion is much greater than in radioactive | 1 | |
| | | decay/AW; | 1 | |
| | | as the helium nucleus is so strongly bound; | 1 | |
| | | also energy release from annihilation of positrons; *max 5* | 1 | 5 |
| | | Quality of Written Communication | | 4 |
| | | Total | | 16 |