1. 1 (i) protons and neutrons **(1)**
6p , 8n / **(1)**
[**o**r u and d quarks **(1)**, 20u and 22d **(1)**]
6 electrons **(1)**

(ii) electron **(1)**

(iii) atoms with identical numbers of protons but different numbers of neutrons **(1)** 6

[6]

2. (a) 90 (protons) **(1)**

(232 – 90 gives) 142(neutrons), 90(electrons) **(1)** 2

(b) X = 90 **(1)**

Y = (any value between) 212 and 252 **(1)**

Z = 90 **(1)** 3

[5]

3. (a) 27 (protons) and 27 (electrons) **(1)**
32 (neutrons) **(1)** 2

(b) $^{60}_{27}\text{Co}$ **(2)**

(correct nucleon number **(1)** correct symbol and proton number **(1)**) 2

(c) (i) $^{3}_{1}\text{H}$ (or $^{3}_{1}\text{T}$) **(1)**

(ii) charge/unit mass = $\dfrac{1.60\times10^{-19}}{3\times1.67\times10^{-27}}$ [or $\frac{1}{3}$ e/m_p) **(1)**

= 3.19×10^{7} (C kg^{-1}) **(1)** (allow C.E. from (i)) 3

[7]

4. (a) 18 (protons) **(1)**
(37 – 18 gives) 19 (neutrons **(1)** 2

(b) (charge) = 2^{+} or 2^{-} **(1)**
$Q = 2 \times 1.60 \times 10^{-19} = 3.2 \times 10^{-19}$ (C) **(1)** 2

(c) (i) neutron **(1)**

(ii) electron **(1)** 2

(d) (%) = $\dfrac{16 \times 9.11 \times 10^{-31}}{1.67 \times 10^{-27} \times 37}$ **(2)** (for correct nuclear mass and substitution)
(= 2.36×10^{-4}) = 2.36×10^{-2}(%) **(1)** 3

[9]

5. (a) $^{12}_{6}\text{C}$ **(1)** 1

(b) 2e **(1)**

$= (2 \times 1.6 \times 10^{-19}) = 3.2 \times 10^{-19}$ C **(1)** 2

(c) $\left(\frac{Q}{m}\right) = \frac{6 \times 1.6 \times 10^{-19}}{14 \times 1.67 \times 10^{-27}}$ **(1)**

$= 4.1$**(1)** $\times 10^{7}$ C kg^{-1} **(1)** 2

[5]

6. (a) 6 (protons) and 6 (electrons) **(1)**
8 (neutrons) **(1)** 2

(b) (i) $(2 \times 1.6 \times 10^{-19}) = 3.2 \times 10^{-19}$ (C) **(1)**

(ii) 14 **(1)**

(iii) $m = 14 \times 1.67 \times 10^{-27}$ (kg) **(1)**

$\frac{Q}{m} = \left(\frac{3.2 \times 10^{-19}}{14 \times 1.67 \times 10^{-27}}\right) = 1.4 \times 10^{7}$ (C kg^{-1}) **(1)** (1.37×10^{7} (C kg^{-1}))

(allow C.E for values from (i) and (ii)) 4

[6]

7. (a) (i) 94 (protons) **(1)**

(ii) 145 (neutrons) **(1)**

(iii) 93 (electrons) **(1)** 3

(b) same number of protons
[or same atomic number] **(1)**

different number of neutrons/nucleons
[or different mass number] **(1)** 2

[5]

8. (a) (i) neutron **(1)**

(ii) electron **(1)**

(iii) neutron **(1)** 3

(b) (i) (X =) 225 **(1)**
(Y =) 88 **(1)**

(ii) $\left(\frac{\text{mass of } {}^{225}_{88}\text{Ra}}{\text{mass of } \alpha \text{ particle}} = \frac{225}{4}\right) = 56(.3)$ **(1)**

(allow C.E. for value of X from (i)) 3

[6]

9. (a) number of protons = number of electrons (e.g.14) **(1)**
number of protons + number of neutrons = 28 **(1)** 2

(b) (i) nuclei with the same number of protons **(1)**
but different number of neutrons/nucleons **(1)**

(ii) (137 – 55) = 82 **(1)**

(iii) $\frac{Q}{m} = \frac{92 \times 1.60 \times 10^{-19}}{236 \times 1.67 \times 10^{-27}}$ **(1)**

$= 3.73 \times 10^{7}$ (C kg^{-1}) **(1)**

(iv) X (= 236 – 137 – 4) = 95 **(1)** 6

[8]

10. (a) 22 (nucleons) **(1)**
11 (electrons) **(1)** 2

(b) charge: $+\frac{2}{3} = -\frac{1}{3} + 1 + 0$ **(1)**

lepton number: 0 = 0 – 1 + 1 **(1)**

baryon number: $\frac{1}{3} = \frac{1}{3} + 0 + 0$ **(1)** 3

(c) the electron and the positron are annihilated **(1)**
γ photon(s)/ γ ray(s) are produced **(1)**
specifying two (γ) photons/rays **(1)**
masses converted into energy **(1)** max 2

[7]

11. (a) (i) (charge) = 92 × 1.60 × 10^{-19}
= 1.47 × 10^{-17} (C) **(1)**

(ii) (magnitude of ion charge) = 3(*e*) **(1)**
number of electrons (= 92 – 3) = 89 **(1)** 4

(b) X: number of nucleons [or number of neutrons plus protons or mass number] **(1)**
239 **(1)**
Y: number of protons [or atomic number] **(1)**
94 **(1)** 4

[8]