Name of the Student:_____
Max. Marks : 27 Marks **Time : 27 Minutes**

Mark Schemes

Q1.

(a) (i) $\lambda = \frac{0.693}{t_{1/2}} = \frac{0.693}{3420 \times 365 \times 24 \times 3600}$ **(1)**

$= 6.43 \times 10^{-12}$ (s^{-1}) **(1)**

(ii) $N = \frac{1}{\lambda}\frac{dN}{dt} = \frac{450 \times 10^3}{6.43 \times 10^{-12}}$ **(1)**

$= 7.0 \times 10^{16}$ **(1)**

(4)

(b) (i) pass through with no [or very small] deflection **(1)**

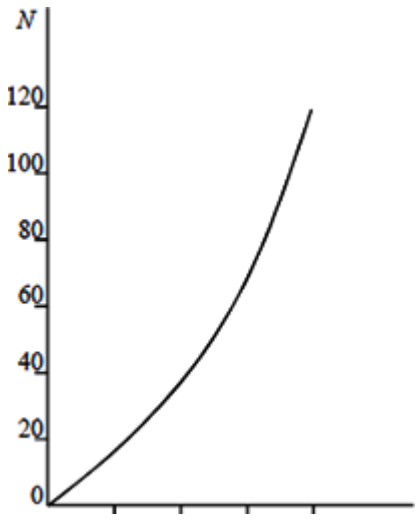
(ii) volume of nucleus << volume of atom (*)
[or nucleus small and atom mostly empty space] (*)
most of mass in nucleus (*)
nucleus has positive charge (*)
size of nucleus << separation (*)
(*) any two **(1) (1)**

(3)

[7]

Q2.

(a)



straight line between (Z = 0, N = 0) to (Z = 20, N = 20) **(1)**
curving upwards to Z = 80; N = 110 – 130 **(1)**

(2)

(b) (i) A = any region below the line of stability
but N > 80 and Z > 60

(ii) B = any region above and close to the line of stability **(1)**

(iii) C = any region below and close to the line of stability **(1)**

(3)

(c)

mode of decay	change in proton number, Z	change in neutron number, N
α emission	–2	–2
β^- emission	+1	–1
β^+ emission	–1	+1
e capture	–1	+1
p emission	–1	0
n emission	0	–1

(1)(1) (1) – lose one mark for each row in error

(3)

[8]

Q3.

(a) $(R^3 = R_0^3 A)$

plot R^3 against A with axes labelled **(1)**

units on axes **(1)**
scales chosen to use more than 50% of page **(1)**

element	$R/10^{-15}$ m	A	$R^3/10^{-45}$ m^3
carbon	2.66	12	18.8
silicon	3.43	28	40.4
iron	4.35	56	82.3
tin	5.49	120	165.5
lead	6.66	208	295

calculate data for table **(1)**
plot data **(1)(1)** lose one mark for each error
calculation of gradient

e.g. gradient = $\frac{1}{3}$ **(1)** (= 1.41×10^{-45} m^3)

r_0 (= gradient)$^{\frac{1}{3}}$ **(1)**

= $(1.41 \times 10^{-45})^{\frac{1}{3}} = 1.1(2) \times 10^{-15}$ m **(1)**

alternative:

plot R against $A^{1/3}$ with axes labelled **(1)**
units on axes **(1)**
scales chosen to use more than 50% of page **(1)**

element	$R/10^{-15}$ m	A	$A^{1/3}$
carbon	2.66	12	2.29
silicon	3.43	28	3.04
iron	4.35	56	3.83
tin	5.49	120	4.93
lead	6.66	208	5.93

calculate data for table **(1)**
plot data **(1)(1)** lose one mark for each error
calculation of gradient

e.g. gradient = $\frac{6.72 \times 10^{-15}}{6.0}$ **(1)** = $(1.1(2) \times 10^{-45}$ m$^3)$

r_0 = gradient **(1)**
= $1.1(2) \times 10^{-15}$ m **(1)**
[or plot ln$R$ against ln$A$...]

(max 8)

(b) assuming the nucleus is spherical
ignoring the gaps between nucleons
assuming all nuclei have same density
assuming total mass is equal to mass of constituent nucleus
any one assumption **(1)**

$M = \frac{4}{3}\pi R^3 \rho$ **(1)**

$\left(\therefore M = \frac{4}{3}\pi R_0^3 a\rho\right)$

$\left(\therefore \rho = \frac{3m}{4\pi R_0^3}\right) = \frac{3 \times 1.67 \times 10^{-27}}{4\pi \times (1.12 \times 10^{-15})^3}$ **(1)**

$= 2.8 \times 10^{17}$ kg m^{-3} **(1)**

(4)

[12]