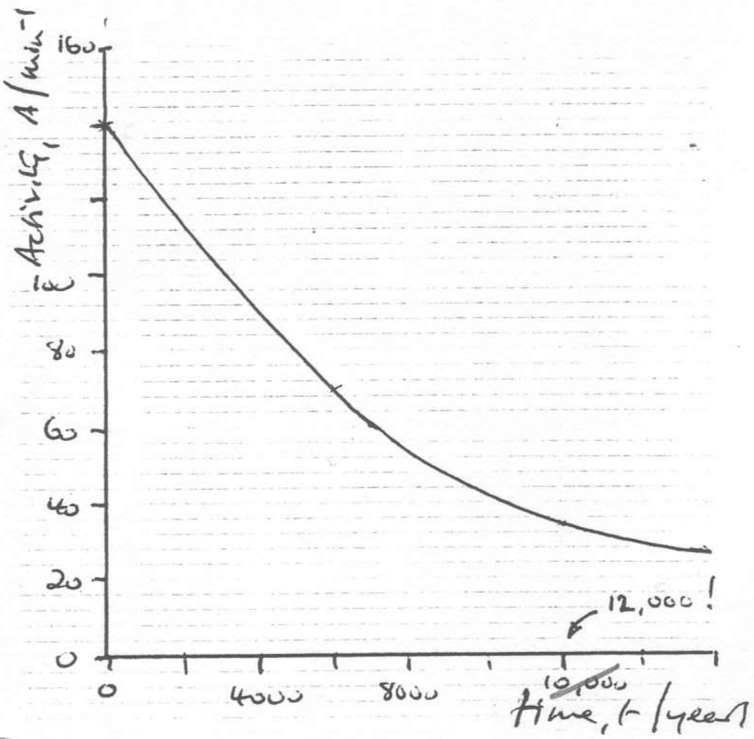
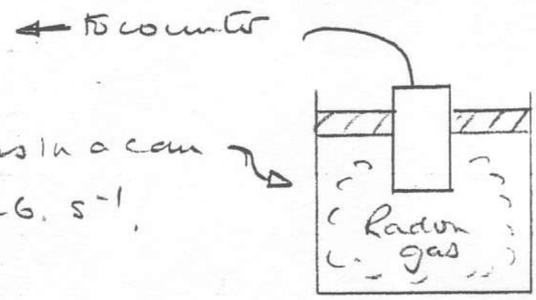
Radioactivity – Questions (1)

A Physics
Radioactivity
Avogadro's No., $N_A = 6 \times 10^{23}$

1. The graph shows the activity of C-14 in 2.0 g of wood plotted against age.
What is… (a) half life? (1)
(b) decay constant? (2)
(c) 0.5 g of carbon from an old sample of wood gave an activity of 22 min^{-1}. How old was the wood? (2)
(d) Estimate the number of C-14 atoms in 2 g of fresh wood. (3)
(e) How many moles of C-14 in this? (1) /9



2. A Physics student starts with 4000 atoms of Radon-220 gas in a can. It's decay constant is 0.0126 s^{-1}.



(a) What is the half life? (2)
(b) What is the initial activity? (2)
(c) Sketch a graph to show the decay. (4)
(d) When is activity (i) 25 s^{-1} (ii) 10 s^{-1}? (3)
(e) Calculate the activity at (i) 30 sec (ii) 2 min. (3) /14

3. In a similar experiment with another gas, the initial activity was 80 s^{-1}, which fell to 10 s^{-1} after 4 minutes.
(a) What is the decay constant of this gas? (3)
(b) How many atoms were present initially? (2)
(c) If the atomic mass of this gas is 150, how many moles were present initially? (2)
(d) What mass of gas does this represent? (2) /9

TJN
3.98
+10.13

MN

Radioactivity — Answers (1) A-Physics

1. (a) $t_{1/2} = 9{,}200 - 4000 = 5{,}200$ y
$= 7{,}200 - 1{,}500 = 5{,}700$ y } $t_{1/2}$ mean value $= \underline{5{,}500}$ y (1)

(b) $t_{1/2} = \ln 2/\lambda \rightarrow \lambda$ (decay constant) $= \underline{1.26 \times 10^{-4}}\ y^{-1}$ (2)

(c) $2g = 4 \times 0.5g \rightarrow$ activity of 2.0g "wood" be 88 min^{-1}!
so age would be about $\underline{4{,}200}$ y (2)

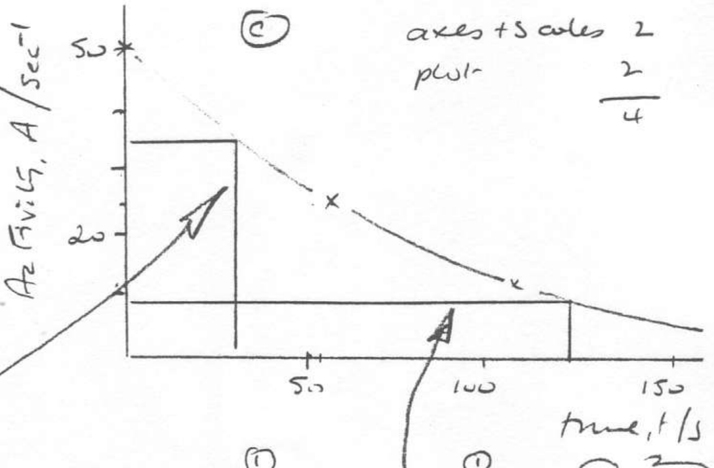
(d) 2g fresh wood has $A = \underline{140\ min^{-1}}$ due to C-14
we need this A in y^{-1} (same units as above)
$A = 140 \times 60 \times 24 \times 365 = \underline{73.6 \times 10^6}$ years^{-1} (1)
(h^{-1}) (day^{-1})
Since Activity $A = \lambda N$ (1) /3
Then No. of C-14 atoms $N = A/\lambda = 73.6 \times 10^6 / 1.26 \times 10^{-4} = \underline{5.8 \times 10^{11}}$ atoms (1)

(e) 1 mole of C-14 is 6×10^{23} atoms — so it's $\underline{9.7 \times 10^{-13}}$ moles (1)
(1 mole of C-14 is 14g — so its 1.36×10^{-11} grams) [9]

2. (a) $t_{1/2} = \ln 2/\lambda = \underline{55\ sec}$ (2)

(b) Initial $A = -\lambda N = \underline{50.4}\ sec^{-1}$ (2)

(c)



axes + scales 2
plot 2
4

(d) Activity is (1) 25 s^{-1} at ...
(i) $t_{1/2} = 55$ sec (easy!) (1)
is (ii) $\underline{10\ s^{-1}}$ use $\ln(A_0/A) = \lambda t$
$\ln(A_0/A) = \ln(\frac{50}{10}) = 1.61 = \lambda t$
so $t = \underline{128\ sec.}$ (2)

(e) use $A = A_0 e^{-\lambda t}$ (1)
so at... (i) $t = 30s$; $A = \underline{34\ sec^{-1}}$ (1) at (ii) $t = 120s$; $A = \underline{11\ sec^{-1}}$ (1) Check with graph [14]

3. (a) 80 → 40 → 20 → 10 in 3 ½ lives
so $t_{1/2} = 4/3 = 1.3$ min $= \underline{80\ sec}$ (2)
so decay constant $\lambda = \ln 2 / t_{1/2} = \underline{8.66 \times 10^{-3}}$ (1) sec^{-1} /3

(b) use $A = -\lambda N \rightarrow N$ initially $= 80/8.66 \times 10^{-3} = \underline{9230}$ atoms (2)

(c) 1 mole of anything is 6×10^{23} items
so 9230 atoms is 1.54×10^{-20} moles (2)

(d) 1 mole of gas has mass of 150g.
so mass is $1.54 \times 10^{-20} \times 150 = \underline{2.3 \times 10^{-18}}$ g. (2)

TN
3.98
+10.13