Cume Exam Key, Jan 2014

I.

a) $Z_{CN} = 20 + 95$

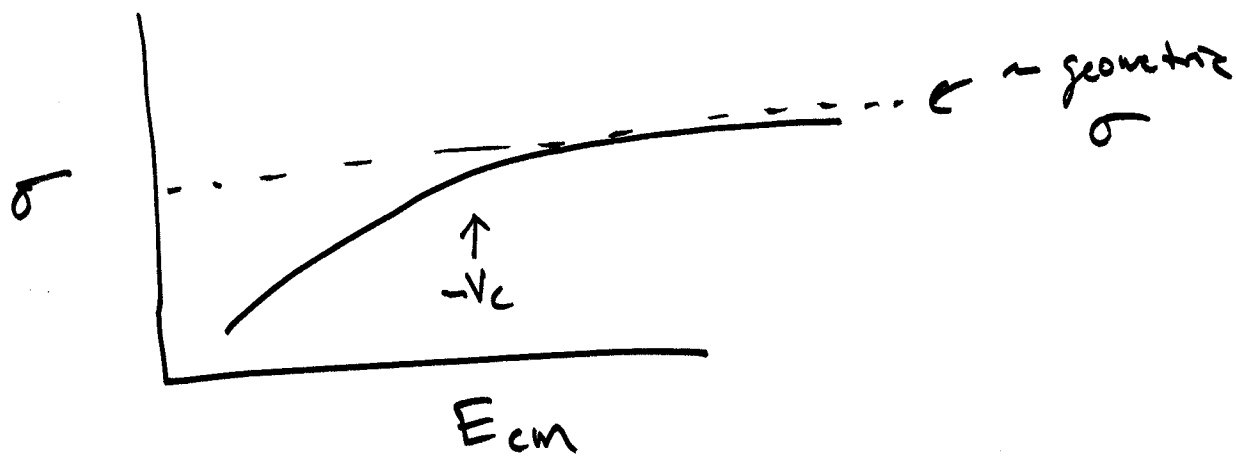
$A_{CN} = 48 + 243$

CN is $^{291}115$

b) $V_c = 1.44\ fm \cdot MeV \left(\frac{20 \cdot 95}{R}\right) = 230.9\ MeV$

$R = 1.2\ fm \left(48^{1/3} + 243^{1/3}\right) = 11.84\ fm$

c)



d) $\sigma = \pi R^2 \left(1 - \frac{B}{T_P}\right)$ max at $\sigma = \pi R^2$

$\sigma = \pi (11.84\ fm)^2 = 440.41\ fm^2$

↑ from b) $= 4.40 \times 10^{-24}\ cm^2$

$= 4.4$ barns

e) ^{48}Ca $T_{lab} = 260$ MeV

$$E_{cm} = T_p \left(\frac{m_p}{m_p + m_T}\right) = 217.11 \text{ MeV}$$

T_p: 260 MeV

f) $Q = m_{^{48}Ca} + m_{^{243}Am} - m_{115}$

$= \Delta_{^{48}Ca} + \Delta_{^{234}Am} - \Delta_{115}$

$= -169.82$ MeV

g) $E^* = Q + E_{cm}$

$= 47.30$ MeV

II

a) $^{243}Am_{95} \rightarrow {}^{4}He_{2}^{2+} + {}^{239}Np_{93}^{2-}$

b) Tgt weight $= 0.83 \frac{mg}{cm^2} \cdot 24\ cm^2 = 19.92\ mg$

19.92 mg Am_2O_3

> should use 243.06 & 15.99

$\underbrace{\frac{243\,g}{mol} \cdot 2}_{Am} + 3 \cdot \frac{16\,g}{mol} = \frac{534\,g}{mol}\ Am_2O_3$

Am ($486 \frac{g}{mol}$) is 91.0% weight

c) 19.92 mg $Am_2O_3 \cdot 91.0\% = 18.13$ mg Am

$A = \lambda N = 4.22 \times 10^{15} \frac{decay}{year} = 1.334 \times 10^{8} \frac{decay}{sec}$

$\lambda = \frac{0.693}{7{,}370\ year} = 9.403 \times 10^{-5}\ years^{-1}$

$N = 18.13\ mg\ Am \cdot \frac{mol}{243.06\,g} \cdot \frac{6.022 \times 10^{23}\ atoms}{1\,mol} =$ ~~[illegible]~~ 4.492×10^{19} atoms Am

d) $N_1 = N_0 e^{-\lambda t}$

$\lambda = \frac{0.693}{2691835 \text{ days}} = 2.574 \times 10^{-7} \text{ days}^{-1}$

$t = 15$ days $\quad N_0 = 4.492 \times 10^{19}$ Am atoms

$\frac{N_1}{N_0} = 0.999996139 \quad$ % Am lost $= 0.000386\%$

Since Am corresponds to 91% by weight

then total % lost was 0.000351%

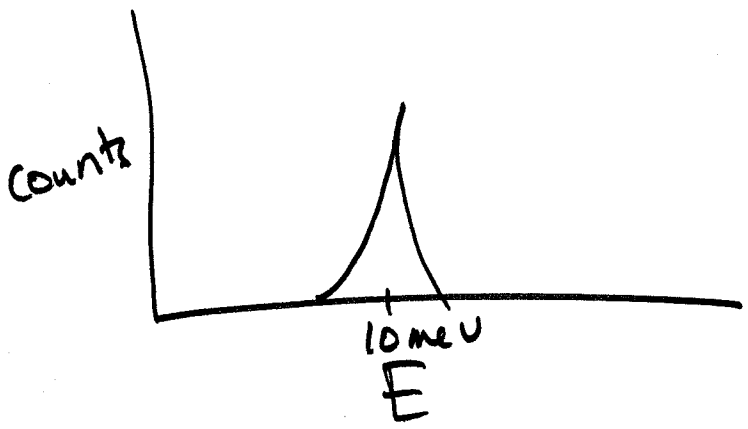
III

a) $\left(\frac{\log t_{1/2} + 46.83}{1.454 \cdot Z}\right)^2 = \frac{1}{Q} \qquad Q = 8.255$ meV

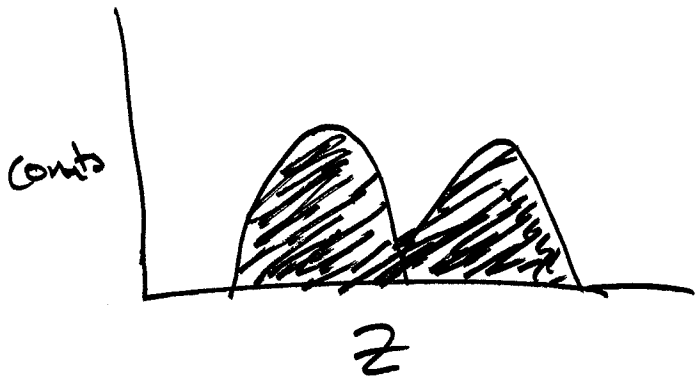
b) 10 meV corresponds $\sim (0.02 \text{ g/cm}^2) / (2.33 \text{ g/cm}^3)$

range $= 0.00858$ cm $= 0.0858$ mm

c)



d)



IV

a) uniquely ID Z of element (not dependent on α-decay chain)

b) High resolution

c) $E_{\alpha}^{K} = \text{Const}\,(Z-1)^2$ from Pb (Const = 0.0110958 keV

$E^{K} = \#144$ keV for $Z = 115$

d) X-ray emission following IC of excited nucleus