1 a) $Z(A) = \frac{A}{2} \frac{81}{80 + 0.6A^{2/3}} = \frac{100 * 81}{2*(80 + 0.6(100)^{2/3})}$

$= 43.08 \sim 44$

b) $^{50}_{25}Mn_{25} \longrightarrow {}^{50}_{24}Cr^{(-)} + \beta^+ + \nu + Q_{\beta^+}$

or $^{50}_{24}Cr + e^- + \beta^+ + \nu + Q_{\beta^+}$

c) $\frac{A}{A_0} = e^{-\lambda t} = e^{-\frac{\ln 2}{0.28\,h} \times 1\,h} = e^{-2.476} = 8.41 \times 10^{-2}$

d) $^{46}_{22}Ti + {}^{6}_{3}Li \longrightarrow {}^{50}_{25}Mn + 2n + Q$

e) $\sigma_{Geo} \sim \pi R^2 = \pi \left(1.2(46)^{1/3} + 1.2(6)^{1/3}\right)^2 fm^2$

$= \pi (4.30 + 2.18)^2 = 132.\ fm^2$

$= 1.32$ barnes

f) $V_{coul}^{CNS} = \frac{1.439\,MeV \cdot fm\ Z_1 Z_2}{R} = \frac{1.439\,MeV \cdot fm \times 3 \times 22}{(4.30 + 2.18)\,fm}$

$= 14.7$ MeV

g) The cross section for slow neutrons increases w/ $\frac{1}{velocity}$ due to the deBroglie wavelength increase of slow moving particles

h) ${}^{4}_{2}He_2$ has $\pi(s_{1/2}^2)\,\nu(s_{1/2}^2)$

which is a doubly-magic or doubly closed shell → like noble gases in atoms → increased stability

i) $A_{fission} \sim \frac{236}{92} \times Z_{fission} \rightarrow \frac{236}{92} \times 36 = 92.3$

so "92"

j) • all fissile nuclei are even-odd (Z / N) and capture of neutron gives more excitation energy when E-E product is formed

• 238U is E-E and produces E-O 239U with less excitation energy than fissile nuclei

2) A ${}^{201}Tl \xrightarrow{ec} {}^{201}Hg^{*}\ I = 1/2^- \xrightarrow{IT} {}^{201}Hg\ I = 3/2^-$

γ_{IT} has $\Delta l_{MIN} = 3/2 - 1/2 = 1\ \hbar$ $\quad \Delta\pi = \oplus \rightarrow \oplus = No$

therefore M1

B $\quad \lambda_{sp}(a^{-1}) = 3.15 \times 10^{13} \underbrace{(0.167)^3}_{4.66\times10^{-3}} = 1.47 \times 10^{11}/s$

3) A $\quad \frac{\text{fission}}{\text{Rate}} = \frac{MWe}{\epsilon ffic} \frac{1}{\Delta E/\text{fission}} = \frac{1100 \times 10^6\ W}{0.30} \left(\frac{1\ J/s}{W}\right) \frac{1}{\Delta E/fis}$

$$f.\ Rate = \frac{3.66 \times 10^9\ \frac{J}{s}}{\underbrace{195\ \frac{MeV}{fission} \times 10^6\ \frac{eV}{MeV} \times 1.602 \times 10^{-19}\ J/eV}_{3.124\times10^{-11}\ J/f}} = 1.17 \times 10^{20}\ \frac{fission}{sec}$$

3) B $\frac{\text{Mass}}{\text{yr}} = 1.17\times10^{20}\frac{\text{fissions}}{\text{sec}} \times 3.15\times10^{7}\frac{\text{s}}{\text{yr}} \times 235\frac{\text{g}}{\text{mol}} \times \frac{1}{N_A/\text{mol}}$

$= 1.44\times10^{6}\ \text{g/yr} = 1.44\times10^{3}\frac{\text{kg}}{\text{yr}} = 1.44\ \text{metric ton/yr}$

4) a True Net Rxn $4(p^+) \rightarrow {}^{4}He^{2+} + 2\beta^+ + 2\nu + Q$

b False, smaller makes He

c False, several very different processes must have taken place

d True, ${}^{209}Bi + n \rightarrow {}^{210}Bi^{*} \rightarrow {}^{210}Po \searrow {}^{206}Pb + \alpha \ldots$

e True, can't go above A=210

several examples given in lecture & homework