1. \[ ^{210}_{84}\text{Po} \rightarrow ^{206}_{82}\text{Pb} + ^{4}_{2}\text{He} \]

\[ Q = 931.4943 \text{ MeV/amu} \ (M_{\text{Po-210}} - M_{\text{Pb-206}} - M_{\text{He-4}}) \]

also

\[ Q = \frac{M_{\text{Pb-206}} + M_{\text{He-4}}}{M_{\text{Pb-206}}} \quad E_a = \frac{205.974449 \text{ amu} + 4.00260325 \text{ amu}}{205.974449 \text{ amu}} \ (5.3044 \text{ MeV}) = 5.4074_6 \text{ MeV} \]

\[ M_{\text{Po-210}} = \frac{5.4074_6 \text{ MeV}}{931.4943 \text{ MeV/amu}} + 205.974449 \text{ amu} + 4.00260325 \text{ amu} = 209.9828_6 \text{ amu} \]

2. The decay series is:

\[ ^{232}\text{Th} \rightarrow ^{228}\text{Ra} \rightarrow ^{228}\text{Ac} \rightarrow ^{228}\text{Th} \rightarrow ^{224}\text{Ra} \rightarrow ^{220}\text{Rn} \rightarrow ^{216}\text{Po} \rightarrow ^{212}\text{Pb} \]

\[ ^{212}\text{Pb} \rightarrow ^{212}\text{Bi} \rightarrow ^{212}\text{Po (or } ^{208}\text{Tl) } \rightarrow ^{208}\text{Pb} \]

3. a) \[ ^{60}_{29}\text{Cu} \rightarrow ^{60}_{28}\text{Ni} + ^{0}_{1}\text{e}^+ + ^{0}_{0}\text{v}_e \]

b) \[ ^{41}_{20}\text{Ca} \rightarrow ^{41}_{19}\text{K} + ^{0}_{0}\text{v}_e + \text{x-rays} + \text{Auger e}^- \]

c) \[ ^{76}_{33}\text{As} \rightarrow ^{76}_{34}\text{Se} + ^{0}_{-1}\text{e}^- + ^{0}_{0}\text{v}_e \]

4. \[ ^{136}_{56}\text{La} \text{ should be radioactive since it has an odd number of both protons and neutrons.} \]

Since \[ ^{139}_{56}\text{Ba} \text{ is an adjacent isobar to stable } ^{139}_{56}\text{La}, \text{ and since adjacent isobars are not stable unless they have exactly the same mass, } ^{139}_{56}\text{Ba should be unstable with respect to beta decay ( } \beta^- \text{ in this case).} \]
5. see Chart of the Nuclides for data (transitions shown as ....... are there, but presence is not obvious from Chart data)

\[ ^{51}\text{Cr} \rightarrow ^{51}\text{V} \] from Chart
\[ \gamma \quad 0.3201 \text{ MeV} \]
\[ Q_{\text{EC}} \quad 0.7527 \text{ MeV} \]

\[ ^{25}\text{Al} \rightarrow ^{25}\text{Mg} \] from Chart
\[ \beta^+ \quad 3.26 \text{ MeV} \]
\[ Q \quad 4.277 \text{ MeV} \]
\[ \gamma \quad 1.6117 \text{ MeV} \]

\[ ^{38}\text{Cl} \rightarrow ^{38}\text{Ar} \] from Chart
\[ \beta^- \quad 4.91, 1.11 \text{ MeV} \]
\[ Q_b \quad 4.917 \text{ MeV} \]
\[ \gamma \quad 2.1677, 1.6424 \text{ MeV} \]

(You need not show 2.750 \( \beta^- \) transition - this is not obvious from Chart - but you must indicate the cascade of gammas - the correct order is shown)
5. $\beta^-$ $^{46}$Sc $\rightarrow$ $^{46}$Ti and $\beta^-$ $^{46m}$Sc $\rightarrow$ $^{46}$Sc from Chart

Q$_\beta$ = 2.367 MeV
\gamma = 1.1205, 0.8893 MeV
IT = 0.1425 MeV

(order of gamma cascade is not obvious from Chart)