

$$1) \text{ B.E.} = a_v A - a_s A^{2/3} - a_c \frac{Z^2}{A^{1/3}} - a \left( \frac{Z-2Z}{A} \right)^2 + 0$$

$$\text{BE}(^{31}\text{P}) = 15.56(31) - 17.23(31)^{2/3} - 0.7 \frac{15^2}{(31)^{1/3}} - 23.285 \frac{(8-15)^2}{31}$$

$$\text{BE}(^{31}\text{P}) = 261.44 \text{ MeV}$$

$$\text{BE}(^{31}\text{S}) = 15.56(31) - 17.23(31)^{2/3} - 0.7 \frac{16^2}{(31)^{1/3}} - 23.285 \frac{(31-16)^2}{31}$$

$$\text{BE}(^{31}\text{S}) = 254.53 \text{ MeV} \quad (\text{only difference is Coulomb term})$$

$$2) \text{ BE} = (Z m_H + N m_n - m_A) c^2 \quad \Delta_H = 7288.97 \text{ keV}$$

$$\text{BE} = Z \Delta_H + N \Delta_n - \Delta_A \quad \Delta_n = 8671.32 \text{ keV}$$

$$\text{BE}(^{31}\text{P}) = 15 * 7.28897 + 16 * 8.67132 - (-24.44088) \text{ MeV}$$

$$\text{BE}(^{31}\text{P}) = 262.917 \text{ MeV}$$

$$\text{BE}(^{31}\text{S}) = 16 * \Delta_H + 15 \Delta_n - 19.6446 \text{ MeV}$$

$$\text{BE}(^{31}\text{S}) = 256.739$$

$$3) \text{ Difference measured } \text{BE}(^{31}\text{P}) - \text{BE}(^{31}\text{S}) = 6.18 \text{ MeV}$$

$$\text{Difference calc in (1)} = 6.91 \text{ MeV}$$

is slightly larger as seen in lecture for other mirror nuclei

$$4) \begin{matrix} ^{31}_{16}\text{S} \\ (a) \end{matrix} \pi \left( \Delta_{1/2}^2 P_{3/2}^4 P_{1/2}^2 d_{5/2}^6 \Delta_{1/2}^2 \right) \rightarrow \left( \Delta_{1/2}^2 P_{3/2}^4 P_{1/2}^2 d_{5/2}^6 \Delta_{1/2}^1 \right)$$

$$\text{or } \pi \left[ \begin{smallmatrix} 16 & 0 \\ 8 & 8 \end{smallmatrix} \right] (d_{5/2}^6 \Delta_{1/2}^2) \rightarrow \left[ \begin{smallmatrix} 16 & 0 \\ 8 & 8 \end{smallmatrix} \right] (d_{5/2}^6 \Delta_{1/2}^1)$$

$$(b) \begin{matrix} ^{31}\text{P} \\ 15/16 \end{matrix} \text{ ground state odd proton } \pi(\Delta_{1/2}^1) \rightarrow j = \frac{1}{2} \text{ Parity} = \text{even}$$