(A) Liquid drop model

M(atom) = $ZM_H + (A - Z)M_n - \Delta$
Δ = mass defect
P = (M – A)/A= packing fraction.
1 amu = 1/12 of atomic mass of ^{12}C atom
f = B.E/A
1 amu = 931.5 Mev
1 amu = 1.66×10^{-27} kg

(B) Semiempirical mass formula

$$M = ZM_P + NM_n - a_v A + a_s A^{\frac{2}{3}} + a_c \frac{Z(Z-1)}{A^{\frac{1}{3}}} + a_a \frac{(A-2Z)^2}{A} - a_p A^{\frac{-3}{4}}$$

The various constant found are

$$a_v = 15.5\ MeV$$
$$a_s = 16.8\ MeV$$
$$a_c = 0.7\ MeV$$
$$a_a = 23.0\ MeV$$

$$a_p \begin{cases} = 34\ MeV & for\ even-even\ (Z,N)\ nuclei \\ = 0\ MeV & for\ odd\ \ nuclei \\ = -34\ MeV & for\ odd-odd\ (Z,N)\ nuclei \end{cases}$$

Problem 1. Use the semiempirical mass formula to calculate the binding energy of $^{40}Ca_{20}$. What is the percentage discrepancy between this value and the actual value? (a_v = 15.5 MeV, a_s = 16.8 MeV, a_c = 0.7 MeV, a_a = 23.0 MeV & a_p = 34.0 MeV)

Problem 2. Coulomb energy is given as

$$E_c = \frac{3}{5} \frac{Z(Z-1)e^2}{4\pi\epsilon_o R}$$

For the mirror nuclei such as $^{15}N_7$ & $^{15}O_8$, the difference in mass *m* is due to difference in Coulomb energy & difference between proton & neutron mass. Show whether this value of *m* agrees with the actual value.

Problem 3. Find the energy needed to remove a neutron from ^{81}Kr, ^{82}Kr & ^{83}Kr.

Problem 4. Which isobar of A = 75 does the liquid drop model suggests to be most stable nucleus?

Problem 5. Use the shell model, predict the characteristics of ground sate of $^{15}O_8$, $^{16}O_8$ & $^{17}O_8$.

Problem 6. Use single particle shell model to predict the ground state spin, parities & magnetic moment of nuclei $^{19}Ne_{10}$, $^{20}Ne_{10}$, & $^{21}Ne_{10}$.