Q1. $$\left\{-\frac{\hbar^2}{2\mu}\frac{d^2}{dr^2}+V_{np}\right\}u_0=-\frac{\hbar^2\alpha^2}{2\mu}u_0(r)$$

$$u_0=N_0\left[e^{-\alpha r}-e^{-\beta r}\right]$$

$$-\frac{\hbar^2}{2\mu}\left(\cancel{\alpha^2 e^{-\alpha r}}-\beta^2 e^{-\beta r}\right)+V_{np}\left(e^{-\alpha r}-e^{-\beta r}\right)$$
$$=-\frac{\hbar^2\alpha^2}{2\mu}\left(\cancel{e^{-\alpha r}}-e^{-\beta r}\right)$$

$$\underline{V_{np}=-\frac{\hbar^2}{2\mu}(\beta^2-\alpha^2)\frac{e^{-\beta r}}{e^{-\alpha r}-e^{-\beta r}}}$$

$$\therefore V_{np}u_0(r)=-\frac{\hbar^2}{2\mu}N_0(\beta^2-\alpha^2)e^{-\beta r}$$

$$D_0=-\frac{\hbar^2}{2\mu}\cdot N_0\sqrt{4\pi}(\beta^2-\alpha^2)\underbrace{\int dr\, r\, e^{-\beta r}}_{1/\beta^2}$$

$\alpha=0.2316\ \text{fm}^{-1}$ $\qquad$ $\underline{D_0=-126.2\ \text{MeV fm}^{3/2}}$

$N_0=0.8821\ \text{fm}^{-1/2}=\sqrt{2\alpha}\sqrt{6\times7}/5$

$$D_0R^2=-\frac{\hbar^2}{2\mu}N_0\sqrt{4\pi}\frac{(\beta^2-\alpha^2)}{6}\underbrace{\int dr\, r^3 e^{-\beta r}}_{6/\beta^4}$$

$$\underline{=D_0/\beta^2}$$

$\underline{R=1/(6\alpha)}=0.72\,\text{fm}$