(a).

$$\Delta G = -\frac{4}{3}\pi r^3 \, \Delta G_v + 4\pi r^2 \cdot \gamma.$$

$$n\cdot v = \frac{4}{3}\pi r^3 \rightarrow r = \left(\frac{3}{4\pi}\cdot n\cdot v\right)^{\frac{1}{3}}$$

$$\rightarrow \Delta G = -n\cdot v\cdot \Delta G_v + (36\pi)^{\frac{1}{3}}\cdot n^{\frac{2}{3}}\cdot v^{\frac{2}{3}}\cdot \gamma.$$

$$= -n\cdot \Delta G_a + (36\pi)^{\frac{1}{3}}\cdot n^{\frac{2}{3}}\cdot v^{\frac{2}{3}}\cdot \gamma. //$$

(b).

$$\frac{\partial G}{\partial n} = -\Delta G_a + \frac{2}{3}\cdot(36\pi)^{\frac{1}{3}}\cdot n^{-\frac{1}{3}}\cdot v^{\frac{2}{3}}\cdot\gamma$$

n^* 에서 $\frac{\partial G}{\partial n} = 0 \rightarrow \Delta G_a = \frac{2}{3}(36\pi)^{\frac{1}{3}}\cdot n^{*-\frac{1}{3}}\, v^{\frac{2}{3}}\cdot\gamma$

$$\rightarrow n^* = \left(\frac{\Delta G_a}{\frac{2}{3}(36\pi)^{\frac{1}{3}}\cdot v^{\frac{2}{3}}\cdot\gamma}\right)^{-3}$$

$$= \frac{\frac{8}{27}\cdot 36\pi\cdot v^2\cdot\gamma^3}{\Delta G_a^3} = \frac{32}{3}\cdot\frac{\pi\cdot v^2\cdot\gamma^3}{\Delta G_a^3} //$$

$$\Delta G^* = -\left(\frac{32}{3}\cdot\frac{\pi v^2\gamma^3}{\Delta G_a^3}\right)\cdot\Delta G_a + (36\pi)^{\frac{1}{3}}\cdot\left(\frac{32}{3}\cdot\frac{\pi v^2\gamma^3}{\Delta G_a^3}\right)^{\frac{2}{3}}\cdot v^{\frac{2}{3}}\cdot\gamma$$

$$= -\frac{32}{3}\cdot\frac{\pi v^2\gamma^3}{\Delta G_a^2} + \left(\overset{2}{\cancel{6}}\cdot\frac{\overset{2^6}{32}}{\cancel{3}}\cdot\frac{\pi^{\frac{3}{2}}\cdot v^3\cdot\gamma^3}{\Delta G_a^3}\right)^{\frac{2}{3}}\cdot\gamma$$

$$= -\frac{32}{3}\cdot\frac{\pi v^2\gamma^3}{\Delta G_a^2} + 2^4\cdot\frac{\pi v^2\gamma^3}{\Delta G_a^2}$$

$$= \frac{16}{3}\cdot\frac{\pi v^2\gamma^3}{\Delta G_a^2} //$$

(c)

$$\Delta G_{gr} = -n\cdot({}^{o}G_{v} - {}^{o}G_{gr}) + (36\pi)^{\frac{1}{3}}\, n^{\frac{2}{3}}\cdot V_{gr}^{\frac{2}{3}}\cdot \gamma_{gr}$$

$$\Delta G_{dia} = -n\cdot({}^{o}G_{v} - {}^{o}G_{dia}) + (36\pi)^{\frac{1}{3}}\, n^{\frac{2}{3}}\, V_{dia}^{\frac{2}{3}}\cdot \gamma_{dia}$$

$$\Delta G_{gr} = \Delta G_{dia}.$$

$$\rightarrow -n({}^{o}G_{dia} - {}^{o}G_{gr}) + (36\pi)^{\frac{1}{3}}\cdot n^{\frac{2}{3}}\cdot (V_{gr}^{\frac{2}{3}}\cdot \gamma_{gr} - V_{dia}^{\frac{2}{3}}\cdot \gamma_{dia}) = 0.$$

$$\rightarrow 0.02 n^{\frac{1}{3}} = (36\pi)^{\frac{1}{3}}\cdot \left((8\cdot 10^{-30})^{\frac{2}{3}}\cdot 3.1 - (6\cdot 10^{-30})^{\frac{2}{3}}\cdot \gamma_{dia}\right)$$

$$\rightarrow n = \left((36\pi)^{\frac{1}{3}}\cdot \frac{(8\cdot 10^{-30}\ m^3/atom)^{\frac{2}{3}}\cdot 3.1\ J/m^2 - (6\cdot 10^{-30})^{\frac{2}{3}}\cdot \gamma_{dia}}{0.02\ eV/atom\cdot 1.6\cdot 10^{-19}\ J/eV}\right)^3.$$

$$\rightarrow \gamma_{dia} = 3.6\ J/m^2,\quad n \approx 466.$$

$$\gamma_{dia} = 3.65\ J/m^2,\quad n \approx 145.$$

$$\gamma_{dia} = 3.7\ J/m^2,\quad n \approx 21.$$

(d)

$$\Delta G_{dia} < \Delta G_{gr}.$$

$$\rightarrow n({}^{o}G_{dia} - {}^{o}G_{gr}) < (36\pi)^{\frac{1}{3}}\cdot n^{\frac{2}{3}}(V_{gr}^{\frac{2}{3}}\cdot \gamma_{gr} - V_{dia}^{\frac{2}{3}}\cdot \gamma_{dia})$$

$$\rightarrow n < \left[(36\pi)^{\frac{1}{3}}\cdot \frac{V_{gr}^{\frac{2}{3}}\cdot \gamma_{gr} - V_{dia}^{\frac{2}{3}}\cdot \gamma_{dia}}{{}^{o}G_{dia} - {}^{o}G_{gr}}\right]^3$$

(e) (b)에서 $n^{*} = \frac{32}{3}\cdot \frac{\pi v^2 \gamma^3}{\Delta G_a^3} = 100$

$$\rightarrow \Delta G_a = \left(\frac{\pi v^2 \gamma^3}{100}\right)^{\frac{1}{3}} = 8.6129\cdot 10^{-20}\ J$$

$$\Delta G_v = \frac{\Delta G_a}{V} = 1.0766\cdot 10^{10}\ J/m^3$$