

B.1 a) diamagnetic susceptibility  $\chi_m = \frac{\mu_0 \frac{1}{2} Z r^2}{4 m_e V}$  (eq. B.15) from book

Using  $r = 10^{-10} \text{ m}$   
 $V = r^3$  (GAS)  
 $m = 9.11 \times 10^{-31} \text{ kg}$

$\chi_m \approx 10^{-4}$

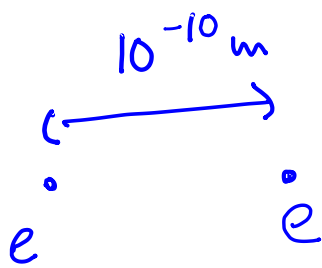
b) From book,  $F = -V \mu_0 \chi_m H \frac{dH}{dz}$   
 force needed to hold frog = weight  
 i.e.  $0.1 \text{ kg} \times g$   
 $\frac{dH}{dz} \approx \frac{H}{d}$  ← size of frog

$\therefore 0.1 \times 9.8 = (0.1)^3 \times 4\pi \times 10^{-7} \times 10^{-4} \times \frac{H^2}{0.1 \text{ m}}$   
 frog is 10 cm

$\Rightarrow H \approx 10^6$

$\Rightarrow B \approx 1 \text{ T}$

13.2



electrostatic energy  $U_{\text{electro}} = \frac{q^2}{4\pi\epsilon_0} \approx 10^{-18} \text{ J}$

magnetic energy  $U_{\text{mag}} = \mu_B B$  (from book very hidden!)  
 from book,  $9.274 \times 10^{-24} \text{ J/T}$

$\Rightarrow U_{\text{mag}} = \mu_B \left[ \frac{\mu_0}{4\pi} \frac{3\hat{x}(\hat{x} \cdot \vec{m}) - \vec{m}}{|\vec{x}|^3} \right]$   
 $= \frac{\mu_B \mu_0}{4\pi |\vec{x}|^3} \times \text{??}$

$$13.3 / a) \quad U = \frac{1}{2} \int \vec{B} \cdot \vec{H} dV = \frac{1}{2\mu} \int B^2 dV$$

$\mu$  in ferromagnet core ( $\mu_r \sim 10^4$ )

$$F = -\frac{dU}{dz} \quad ?$$

$$b) \quad B = \mu_0 (H + m)$$

$$U = \frac{1}{2} \int \vec{B} \cdot \vec{H} dV \quad ?$$

$$13. / \quad M = \mu_B^2 B \sim (E_F) \quad ?$$

$$13.5 / a) \quad U = \int H \cdot B \, dV$$

13.6











