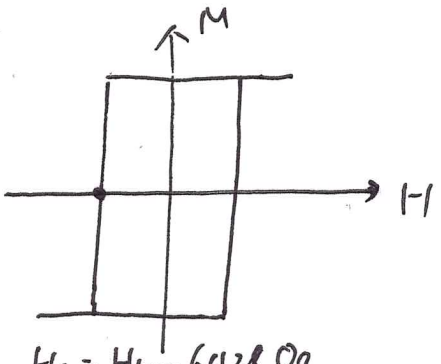
Magnetiz , Solution

(1) $H_K = \frac{2K_u}{M_s} = \frac{2 \times 24.5 \times 10^6}{1400} = 6428\ (Oe)$

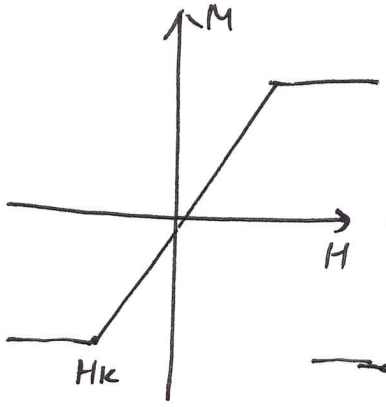
20 nm Co disk is in single domain region.



$H_c = H_K = 6428\ Oe$

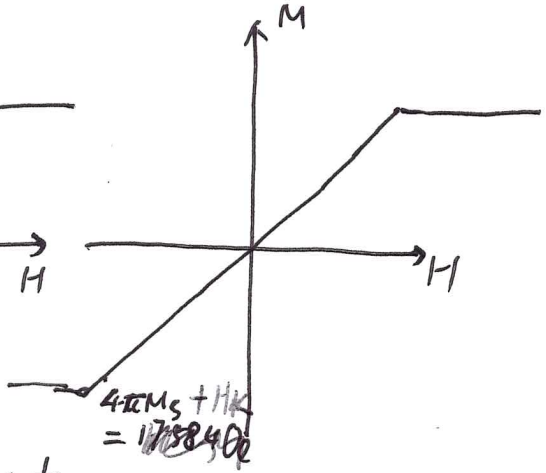
H along C-axis

(0.5 point)



H perpendicular to C-axis

(0.3 point)



H out-of-plane

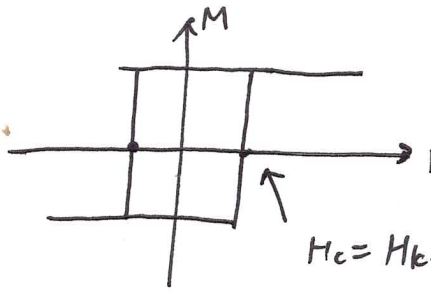
(0.2 point)

(2) $K_u^{eff} V_{total} = K_u^{Co} V_{Co} + K_u^{FeNi} V_{FeNi}$

(0.4) $K_u^{eff} = \frac{K_u^{Co} V_{Co} + K_u^{FeNi} V_{FeNi}}{V_{total}} = \frac{10 \times K_u^{Co}}{12} = 3.75 \times 10^6 \left(erg/cc\right)$

(0.3) $M_s^{eff} = \frac{M_s^{Co} \cdot V_{Co} + M_s^{FeNi} V_{FeNi}}{V_{total}} = \frac{10 \times 1400 + 2 \times 800}{12} = 1300 \left(emu/cc\right)$

$H_K = \frac{2K_u^{eff}}{M_s^{eff}} = 5769\ (Oe)$



$H_c = H_K = 5769\ (Oe)$

(0.3 point)

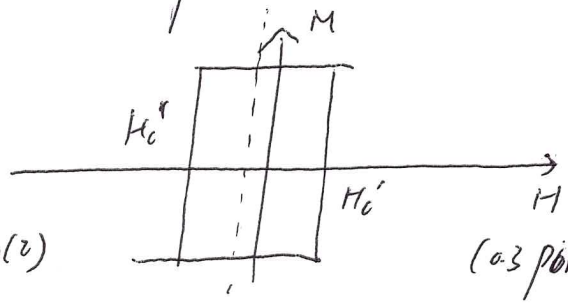
Magnetic Solution

(3) CoO/Co forms an exchange bias structural.

CoO generates an exchange bias field on Co layer, which shifts the M-H loop and enhance the coercivity.

$$\frac{H_c' + H_c''}{2} \rightarrow H_c$$

(0.2 points) H_c: coercivity in problem(2)



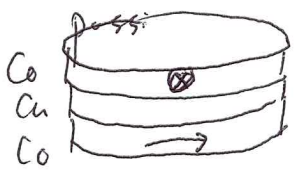
(0.3 points)

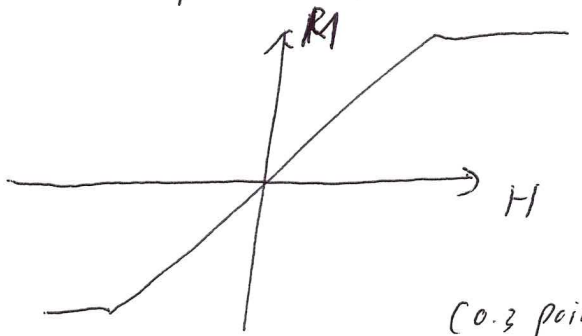
(4) $\frac{K_u \cdot V}{k_B \cdot T} = 25$, $V = \pi \cdot r^2 \cdot t = \frac{25 k_B T}{K_u}$

$r = 2.7 \times 10^{-7}$ cm $= 2.7$(nm); $D = 5.4$(nm)

$D < 5.4$(nm), thermally unstable $\rightarrow$ superparamagnetism.

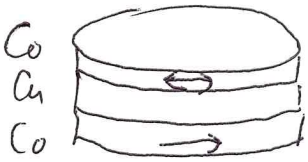
(5) large linear range case, 90° arrangement between two layers.

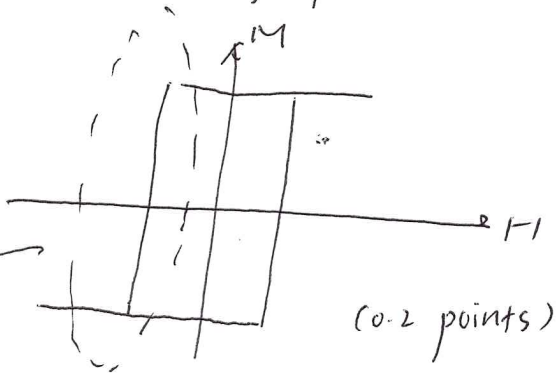




(0.3 points)

possible short linear range case, parallel arrangement between two layers





transfer curve.

(0.2 points)