20. $\Delta H^{\circ} = +93$ kJ

@ equilibrium at 25°C

solid NH_4HS still in container

a) 2 pts
The equilibrium pressure of NH_3 would be unaffected

$$K_p = (P_{NH3})(P_{H2S})$$

The amount of solid NH_4HS present does not affect the equilibrium.

b) 2 pts
The equilibrium pressure of NH_3 would decrease. In order for the pressure equilibrium constant, Kp, to remain constant, the equilibrium pressure of NH_3 must decrease when the pressure of H_2S is increases.

c) 2 pts
The mass of NH_4HS increases. A decrease in volume causes the pressure of each gas to increase. To maintain the value of the pressure equilibrium constant, Kp, the pressure of each of the gases must decrease. That decrease is realized by the formation of more NH_4HS (a complete explanation of LeChatelier's Principle is also acceptable)

d) 2 pts
The mass of NH_4HS decreases because the endothermic reaction absorbs heat and goes nearer to completion (to the right) as the temperature increases.

21) $NH_4HS_{(s)} \longrightarrow NH_{3(g)} + H_2S_{(g)}$

a) NH_4HS @ 25°C

$P_T = 0.659$ atm @ equilibrium

$K_p = (P_{NH_3})(P_{H_2S})$

$P_{NH_3} = P_{H_2S} = \frac{0.659}{2} = 0.330$ atm

$K_p = (0.330 \text{ atm})(0.330 \text{ atm}) = $ **0.109 atm^2**

b) added NH_3

at equilibrium $P_{NH_3} = 2P_{H_2S}$

$(2x)(x) = 0.109$

$x = 0.233 \text{ atm} = P_{H_2S}$

$2x = 0.466 \text{ atm} = P_{NH_3}$

c) $NH_{3(g)}$ + $H_2S_{(g)}$

1.00 L

25°C

P_{NH_3} = 0.5 atm

P_{H_2S} = 0.5 atm

equilibrium pressure of NH_3 = equilibrium pressure H_2S = 0.330 atm

P_{NH_3} that has reacted = P_{H_2S}

= 0.500 atm - 0.330 atm = 0.170 atm

$$n = \frac{PV}{RT} = \frac{(0.170\,atm)(1.00\,L)}{(0.0821\,\frac{atm \cdot L}{mol \cdot K})(298K)} = 6.95 \times 10^{-3}\ moles$$

22) $NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$

$$K_b = \frac{[NH_4^+][OH^-]}{[NH_3]} = 1.8 \times 10^{-5}$$

a) $1.8 \times 10^{-5} = \frac{x^2}{0.150 - x}$ insignificant

$x = 1.64 \times 10^{-3}\ M = [OH^-]$

5% rule $\frac{1.64 \times 10^{-3}}{0.150} \times 100 = 1.1\%$ ✓

% dissociation = 1.1%

b) $[NH_4Cl] = \frac{0.0500\ mol}{0.100\ L} = 0.500\ M$

$NH_4Cl \longrightarrow NH_4^+ + Cl^-$

[0.500 M] [0.500 M]

	NH_3	+	H_2O	$\rightleftharpoons$	NH_4^+	+	OH^-
I	0.150				0.500		0
C	$-x$				$+x$		x
E	$0.150 - x$				$0.500 + x$		x

$$1.8 \times 10^{-5} = \frac{(0.500 + x)(x)}{(0.150 - x)}$$

$x = 5.4 \times 10^{-6}\ M = [OH^-]$

5% rule $\frac{5.4 \times 10^{-6}}{0.150} \times 100$

0.0036% ✓

$pOH = -\log(5.4 \times 10^{-6}) = 5.27$

$14 - 5.27 = 8.73 = pH$

d) $Mg(OH)_2 \rightleftharpoons Mg^{+2} + 2OH^-$

$K_{sp} = [Mg^{+2}][OH^-]^2$

actual $K_{sp} = 1.5 \times 10^{-11}$

$[MgCl_2] = \frac{0.0800\text{ mol}}{0.100\text{ L}} = 0.800\text{ M}$

$MgCl_2 \longrightarrow Mg^{+2} + Cl^-$

0.800M   0.800M

$K_{sp} = (0.800)(5.4 \times 10^{-6})^2$

2.3×10^{-11}

larger than actual Ksp

yes- ppt will form

23)

(a) two points

Calculated Mm (HA) too low

M(NaOH) => V(NaOH) => n(NaOH) => n(HA) => Mm(HA)

(M = n ÷ V) and (Mm = m÷ n)

(b) two points

Calculated Mm(HA) not affected

Any one of the following reasons. Water: does not change n(HA) OR changes only

M(HA) -- sense of dilution OR is not a reactant

(c) two points

Calculated Mm(HA) too high

equivalence point => n(NaOH) => n(HA) => Mm(HA) (expected pH higher)

Note: "no effect if NaOH standardized with same indicator" earns 2 points; no credit

earned if pH=7

or neutral

(d) two points

Calculated Mm(HA) too low

V(NaOH) => n(NaOH) => n(HA) => Mm(HA)

Note: point earned for V(NaOH) only if:

(i) no explanation point is earned in (a)

(ii) explanation in (a) also includes V(NaOH)