29) $K_p = \dfrac{(P_{NO})^2 (P_{O_2})}{(P_{NO_2})^2} = \dfrac{(6.5 \times 10^{-5})^2 (4.5 \times 10^{-5})}{(0.53)^2} = 6.3 \times 10^{-13}$

31) $K_p = K(RT)^{\Delta n}$

$CH_3OH \rightleftharpoons CO + 2H_2$

$K = \dfrac{[CO][H_2]^2}{[CH_3OH]} = \dfrac{(0.24)(1.1)^2}{(0.15)} = 1.9$

$K_p = (1.9)[(0.0821)(600)]^{3-1} = 4.6 \times 10^3$

33) a) $K = \dfrac{[H_2O]}{[NH_3]^2[CO_2]}$ $\quad K_p = \dfrac{P_{H_2O}}{(P_{NH_3})^2 (P_{CO_2})}$

b) $K = [N_2][Br_2]^3$ $\quad K_p = (P_{N_2})(P_{Br_2})^3$

c) $K = [O_2]^3$ $\quad K_p = (P_{O_2})^3$

d) $K = \dfrac{[H_2O]}{[H_2]}$ $\quad K_p = \dfrac{P_{H_2O}}{P_{H_2}}$

4) $CaCO_3 \rightleftharpoons CaO + CO_2$

$K_p = P_{CO_2} = 1.04$

a) $Q = 2.55$ $\quad Q > K_p$ $\leftarrow$

mass of CaO decreases

b) $Q = 1.04$ $\quad Q = K_p$

mass of CaO will not change

c) $Q = 1.04$ $\quad Q = K_p$

mass of CaO will not change

d) $Q = 0.211$ $\quad Q < K_p$ $\rightarrow$

mass of CaO will increase

53)

$$N_{2(g)} + O_{2(g)} \rightleftharpoons 2NO_{(g)}$$

$$K_p = \frac{(P_{NO})^2}{(P_{N_2})(P_{O_2})} = 0.050$$

	N_2	O_2	NO
I	0.80	0.20	0
C	$-x$	$-x$	$+2x$
E	$0.80-x$	$0.20-x$	$2x$

$$\frac{(2x)^2}{(0.80-x)(0.20-x)} = 0.050$$

$$\frac{4x^2}{0.16-1.00x+x^2} = 0.050$$

$$4x^2 = 8.0\times10^{-3} - 0.050x + 0.050x^2$$

$$3.95x^2 + 0.050x - 8.0\times10^{-3} = 0$$

$$x = \frac{-b \pm \sqrt{b^2-4ac}}{2a} = \frac{-0.050 \pm \sqrt{(0.050)^2-4(3.95)(-8.0\times10^{-3})}}{2(3.95)}$$

$x = 3.9\times10^{-2}$ atm or $x = -5.2\times10^{-2}$ atm

$$P_{NO} = 2x = 2(3.9\times10^{-2}) = 7.8\times10^{-2} \text{ atm}$$