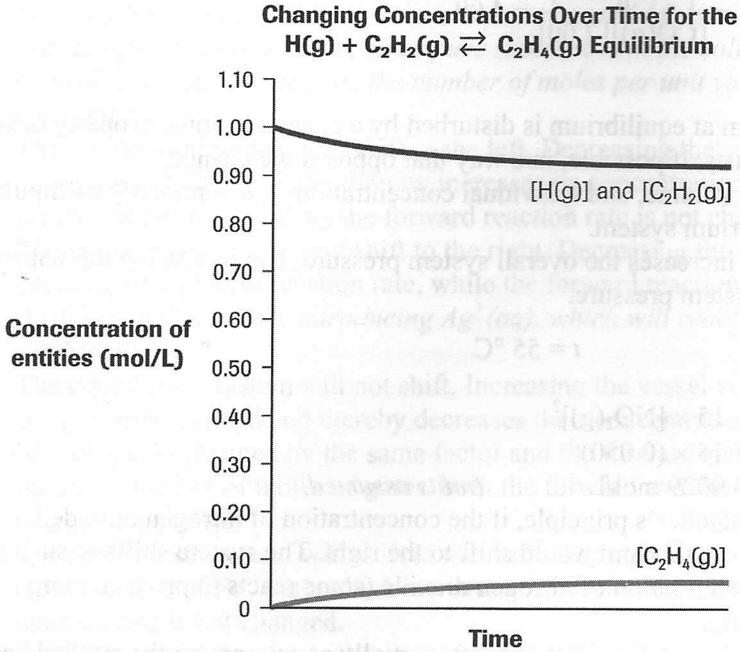
(b)



27. (a)

Concentration	$[H_2(g)]$ (mol/L)	$[Br_2(g)]$ (mol/L)	[HBr(g)] (mol/L)
Initial	4.00	4.00	0.00
Change	$-x$	$-x$	$2x$
Equilibrium	$4.00 - x$	$4.00 - x$	$2x$

$$K_c = \frac{[HBr(g)]^2}{[H_2(g)]\,[Br_2(g)]} = \frac{(2x)^2}{(4.00 - x)^2} = 12.0$$

$$\frac{2x}{4.00 - x} = \sqrt{12.0}$$

$2x = 3.46\,(4.00 - x)$

$x = 2.54$ mol/L

At equilibrium,

$[H_2(g)] = [Br_2(g)] = (4.00 - 2.54)$ mol/L $= 1.46$ mol/L,

$[HBr(g)] = 2 \times 2.54$ mol/L $= 5.07$ mol/L (unrounded value of "x" used)

(b)

Concentration	$[H_2(g)]$ (mol/L)	$[Br_2(g)]$ (mol/L)	[HBr(g)] (mol/L)
Initial	6.00	6.00	0.00
Change	$-x$	$-x$	$2x$
Equilibrium	$6.00 - x$	$6.00 - x$	$2x$

$$K_c = \frac{[HBr(g)]^2}{[H_2(g)]\,[Br_2(g)]} = \frac{(2x)^2}{(6.00 - x)^2} = 12.0$$

$$\frac{2x}{6.00 - x} = \sqrt{12.0}$$

$2x = 3.46\,(6.00 - x)$

$x = 3.80$ mol/L

At equilibrium,

$[H_2(g)] = [Br_2(g)] = (6.00 - 3.80)$ mol/L $= 2.20$ mol/L

$[HBr(g)] = 2 \times 3.80$ mol/L $= 7.60$ mol/L

28. $K_c = \frac{[CO_2(g)][H_2(g)]}{[CO(g)][H_2O(g)]} = \frac{[4.00][2.00]}{[CO(g)][2.00]} = 4.00$

$[CO(g)] = 1.00 \text{ mol/L}$

29. When a chemical system at equilibrium is disturbed by a change in some property of the system, the system adjusts, if possible, in a way that opposes the change.
30. Temperature, container volume, and individual concentrations are commonly manipulated to shift a chemical equilibrium system.
31. Decreasing the volume increases the overall system pressure, and increasing the volume decreases the overall system pressure.
32. (a) $1.15 = \frac{[N_2O_4(g)]}{[NO_2(g)]^2}$ $t = 55\text{ °C}$

(b) $[N_2O_4(g)] = 1.15 \times [NO_2(g)]^2$
$= 1.15 \times (0.050)^2$
$= 0.0029 \text{ mol/L}$ *(units assumed)*

(c) According to Le Châtelier's principle, if the concentration of nitrogen dioxide is increased, then the equilibrium would shift to the right. The system shifts in such a way as to reduce the concentration of nitrogen dioxide (some reacts to produce more dinitrogen tetraoxide).

33. (a) The equilibrium system will shift to the left, partially counteracting the applied heat by undergoing an endothermic reaction.

(b) The equilibrium system will shift to the left, partially counteracting the decreased total pressure by producing more gas phase molecules.

(c) The equilibrium system will shift to the right, partially counteracting the increased concentration of oxygen by reacting it with $HCl(g)$.

(d) The equilibrium position will remain unchanged. Catalysts have no effect on the position of an equilibrium system.

34. (a) high concentration of $C_2H_6(g)$, low concentration of $C_2H_4(g)$ and $H_2(g)$, high temperature, low overall pressure

(b) high concentration of $CO(g)$ and $H_2(g)$, low concentration of $CH_3OH(g)$, low temperature, high overall pressure

35. (a) The equilibrium system will shift to the left, partially counteracting the applied heat by undergoing an endothermic reaction.

(b) The equilibrium system will shift to the left, partially counteracting the decreased total pressure by producing more gas phase molecules.

(c) The equilibrium system will shift to the right, partially counteracting the increased concentration of oxygen by reacting more oxygen with carbon monoxide.

(d) No system shift will occur. Catalysts have no effect on the position of an equilibrium system.

(e) The equilibrium system will shift to the right, partially counteracting the decreased concentration of carbon dioxide by reacting oxygen with carbon monoxide to produce carbon dioxide.

36. (a) The equilibrium system will shift to the right. Dissolving $CuSO_4(s)$ increases the concentration of $Cu^{2+}(aq)$ ions, which initially increases the forward reaction rate, while the reverse reaction rate is not changed.

(b) The equilibrium system will shift to the left. Decreasing the temperature slows down the forward (endothermic) reaction rate more than it slows the reverse (exothermic) reaction rate.

