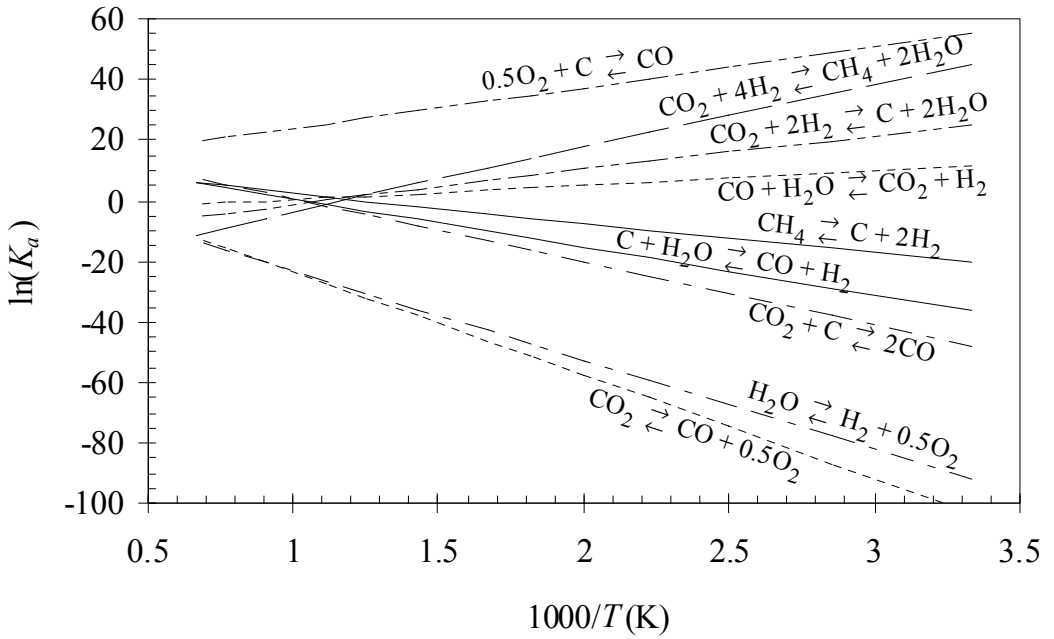

Figure 17.2 *Graphical analysis of competing reactions.*

Reaction	Name	
$CH_{4(g)} \rightleftarrows C_{(s)} + 2H_{2(g)}$	Methane pyrolysis	17.35
$CO_{2(g)} + 2H_{2(g)} \rightleftarrows C_{(s)} + 2H_2O_{(g)}$	Bosch	17.36
$H_2O_{(g)} \rightleftarrows H_{2(g)} + 0.5O_{2(g)}$	Water decomposition	17.37
$CO_{2(g)} \rightleftarrows CO_{(g)} + 0.5O_{2(g)}$	CO oxidation	17.38

To illustrate interpretation of the graph, consider an application of the above reactions to material management in space station gas management, where an objective is to remove CO_2 and provide O_2. There are many ways that the reactions could be combined. On a space station sunlight is relatively abundant. Therefore, high temperatures and solar cells are available, but food must be imported. Note that the Sabatier reaction would convert waste CO_2 to fuel but requires H_2. Fig. 17.2 shows that the equilibrium constant is favorable below 900 K. The Bosch reaction also favors products at temperatures below 900 K. The Bosch reaction produces graphitic carbon, which can be collected in dense form and conveniently disposed. The hydrogen required for the Bosch reaction could be generated by water decomposition, which could be achieved with electrolysis or pyrolysis, with the benefit of co-producing oxygen for respiration. A small extrapolation of Fig. 17.2 shows that water pyrolysis is favorable above 2300 K.[2] Coupling the Sabatier reaction with methane pyrolysis has been suggested. Methane pyrolysis is favorable above 700 K. This would produce hydrogen for other use. Hydrogen production could also be achieved by the syngas reaction, if graphitic carbon was available. H_2 could be enhanced and CO removed by the water-gas shift. Catalysts can selectively alter the kinetics to minimize undesired products, although they cannot alter

2. By comparison, CO pyrolysis is less favored above 700 K, owing to its smaller heat of reaction.