Worksheet 6.4: Solutions

The Ostwald process

No.	Answer
1	**a** $2KNO_3(s) + H_2SO_4(l) \rightarrow K_2SO_4(aq) + 2HNO_3(l)$ **b** Nitric acid has a much lower boiling point than sulfuric acid; therefore it can be distilled off. **c** Large deposits of nitrates are not common.
2	$4NH_3(g) + 5O_2(g) \rightleftharpoons 4NO(g) + 6H_2O(g)$: $\Delta H = -907$ kJ
3	Increased pressure, increased temperature, use of a catalyst and increased concentration of reactants would all increase the rate.
4	Decreased pressure, decreased temperature, increased concentration of reactants and decreased concentration of product would all increase the yield.
5	Temperature: 820–930°C; pressure: 4–10 atm; rapid pass over electrically heated catalyst, low percentage of ammonia in mixture These conditions are chosen to increase yield while maintaining an acceptable rate, and to limit side reactions. Electrically heating the catalyst and the rapid pass over the catalyst means that the gases themselves are not held at high temperatures for long periods.
6	**a** $2NO(g) \rightleftharpoons N_2(g) + O_2(g)$ **b** High temperatures increase *K* for this reaction; therefore low temperatures are desirable.
7	**a** $2NH_3(g) \rightleftharpoons N_2(g) + 3H_2(g)$ **b** Again, a low temperature is desirable to limit this reaction.
8	**a** $2NO(g) + O_2(g) \rightleftharpoons 2NO_2(g)$; $\Delta H = -114$ kJ **b** This is a reversible reaction. As it is exothermic, a low temperature improves the yield. Unusually, this reaction is faster at lower temperatures. Thus, lower temperatures are used to increase both rate and yield.
9	**a** $3NO_2(g) + H_2O(l) \rightarrow 2HNO_3(aq) + NO(g)$ **b** The nitrogen monoxide can be recycled to form more nitrogen dioxide.
10	–3, +2, +4 and +5
11	See Figure 6.29 on page 189 of the textbook.