Worksheet 6.5: Solutions

The contact process

No.	Answer
1	It was named for its corrosiveness and extremely sour, or 'vitriolic', taste. In these times it was common for the alchemists to taste the chemicals that they had discovered or produced!
2	SO_2 is produced as a: • by-product of the desulfurisation of petroleum in the petrochemical industries • waste product generated in the smelting of the sulfide ores of non-ferrous metals such as copper, zinc and lead. For example: $2PbS(s) + 3O_2(g) \rightarrow 2PbO(s) + 2SO_2(g)$
3	$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$; $\Delta H = -197$ kJ
4	It is necessary to prevent 'poisoning' of the catalyst. (This term indicates that the catalyst is rendered ineffective by dust or contaminants coating its surface.)
5	According to Le Châtelier's principle an increased yield can be achieved by: • increasing the gas pressure (3 moles of reactant gases produce only 2 moles of product gases, so an increase in pressure would enhance the forward reaction) • decreasing the temperature, as the forward reaction is exothermic.
6	Low temperatures ensure a significant yield of sulfur trioxide is formed, but slowly. At high temperatures, the equilibrium yield is poor, but it forms quickly. A compromise in temperature must be reached to achieve acceptable yields quickly. A temperature of about 440°C for the incoming gases is appropriate, and atmospheric pressure is used to save money on the costs associated with high pressure equipment.
7	**a** Vanadium(V) oxide or vanadium pentoxide **b** By using trays of pellets, the surface area of the catalyst is increased, and so is its effectiveness. Length of time for contact is carefully controlled because the temperature increases due to the exothermic reaction. At higher temperatures the SO_3 would quickly decompose to SO_2 and O_2.
8	$SO_3(g) + H_2O(l) \rightarrow H_2SO_4(aq)$ While this direct hydrolysis of SO_3 would be more straightforward, it is highly exothermic and would result in the production of a 'fog' of sulfuric acid droplets. Oleum ($H_2S_2O_7$) is produced by reacting preformed sulfuric acid with SO_3. The oleum is then reacted with water: $SO_3(g) + H_2SO_4(l) \rightarrow H_2S_2O_7(l)$ $H_2S_2O_7(l) + H_2O(l) \rightarrow 2H_2SO_4(aq)$

No.	Answer
9	Both of these gases readily hydrolyse in rainwater to produce sulfurous and sulfuric acids respectively, which are major contributors to acid rain. Relevant equations are: $SO_2(g) + H_2O(l) \rightarrow H_2SO_3(aq)$ $SO_3(g) + H_2O(l) \rightarrow H_2SO_4(aq)$
10	See Figure 6.30 on page 191 of the textbook.