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| Description: Vertical full colour positive | Safety Bay Senior High School | | | | |
| **CHEMISTRY UNIT 3 & 4** | | | | | |
| **Extended Response #1:** | | | | | |
| **Industrial Applications of Equilibrium** | | | | | |
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| **NAME:** | | |  | | |
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| **Time allowed for this paper** | | | | | |
| Planning time: | | 10 minutes *Use spare paper provided* | | | |
| Working time: | | 50 minutes | | | |
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| **Structure of this paper:** | | | | | |
| Section | | | Number of questions | Marks available | Marks achieved |
| Written response | | | 1 | 40 | \_\_\_\_\_\_ |

**METHANOL**

Methanol (CH3OH) is a colourless liquid that is completely miscible in water. It melts at -97 °C and boils at 65 °C. It is used as an antifreeze, fuel and solvent, and is added to ethanol to make methylated spirits.

Several methods can be used to produce methanol commercially. One of these methods of production involves two steps.

**Step 1: Steam reforming**In the first step there is a reaction between methane and steam to produce carbon monoxide and hydrogen gas. This process occurs at pressures of 10-20 atmospheres (1000 to 2000 kPa) and 850 °C on a nickel catalyst. The reaction is reversible and endothermic.

**Step 2: Synthesis of methanol**In the second step, carbon monoxide and hydrogen are converted into methanol. This step is carried out at a higher pressure of 50-100 atmospheres (5000 to 10,000 kPa) and a temperature of 250 °C using a Cu/ZnO/Al2O3 catalyst. The reaction is reversible and exothermic, and the heat produced is used to provide energy for the first step.

**AMMONIA**

Ammonia (NH3) is a colourless gas. It has a melting point of -78 °C and a boiling point of -33 °C. Its primary use is as a nitrogen source in fertilisers. Ammonia is also used in household cleaners, as an antimicrobial agent in food products and as a precursor compound in the synthesis of a range of nitrogen-containing compounds.

Prior to the 1900s, the main source of ammonia was from guano fields off the coast of South America (guano refers to bird droppings). In 1909 a method for synthesising ammonia from nitrogen and hydrogen was developed by German scientist Fritz Haber. The hydrogen required for the reaction is now generated by steam reforming, an identical process to that described for Step 1 of the production of methanol.

Using the information provided:

* discuss the conditions used in the process of **steam reforming**
* compare and contrast the conditions used in the **synthesis of methanol** and the **Haber process**

Your answer should demonstrate your understanding of theories related to reaction rates and equilibrium.

Your answer should be approximately 2 pages in length. Your answer should take the form of a structured written response. In addition to content, marks will be awarded for structure and clarity. Include chemical equations, diagrams and tables where appropriate.