Exemplar exam question – Option C

1 Catalysts are important in many industrial processes.

a State a chemical equation for a reaction in an industrial process that uses a heterogeneous catalyst and name the catalyst used. [2]

b Explain one advantage and one disadvantage of using a heterogeneous catalyst as opposed to a homogeneous catalyst. [2]

c Explain **three** factors, other than those already mentioned in part **b** and cost, that must be taken into account when choosing a catalyst for a particular reaction. [3]

Commentary

a This part of the question uses the word 'state' and therefore this is all that must be done. There are many equations that can be used, for example:

$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$ or $2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$ [1]

Although the question does not specifically ask for state symbols it is probably safer to put them in as the question is about heterogeneous catalysts and the definition of a heterogeneous catalyst depends on the physical state of the reactants and the catalyst.

The second part of this question requires the **name** of the catalyst and it is important that the name is given and not the symbol/formula. For example:

iron or vanadium(V) oxide [1]

Other names, such as vanadium pentoxide, may be accepted for the catalyst in the Contact process, but 'vanadium oxide' without the oxidation number will probably not be accepted.

b Advantage: can be easily removed/separated from the reaction mixture. [1]

Disadvantage: only effective on the surface. [1]

The answer to part **b** should be set out so that it is clear which factor is an advantage and which is a disadvantage.

Although the question includes the word 'explain', the answer given here is probably sufficient explanation for a two-mark question.

c Any three of the following would be suitable as answers. [3]

- The efficiency of the catalyst must be considered, i.e. to what extent it speeds up the reaction or what proportion of the reactants are converted into products.
- The conditions under which the catalyst can be used, i.e. does it require very high temperature to function properly?
- The selectivity of the catalyst – does it only catalyse the required reaction?
- The environmental impact of using the catalyst, i.e. are there issues with disposing of the catalyst after use?
- Could the catalyst be poisoned by impurities in the reaction mixture? Heterogeneous catalysts can be prone to poisoning.

Again, the question asks for an explanation but the mark scheme is likely to just consist of a series of points. The question is probably best answered as a series of bullet points or short, sharp sentences.