Equilibrium and experimental design

A chemist is tasked with investigating the yield of ammonia at different temperatures.

The equilibrium system is given below.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \quad \Delta H = -92 \text{ kJ/mol or kJ}$$

Three different trials were set up in a 1 litre reaction vessel.
Each trial had an initial mixture of 1.00 mol of N_2 and 3.00 mol of H_2. The temperatures that were used for each mixture were 100 ^oC , 300 ^oC and 500 ^oC. After 30 seconds the scientist measured the concentration of NH_3 present at each trial.

1. Using Le Chatelier's principle, explain how the mixture will respond at each temperature?

   _____
   _____
   _____
   _____
   _____
   _____ 2 marks

2. Identify one flaw in the experimental design that could impact on the validity of the scientist's conclusion on the relationship between temperature and yield.

   _____
   _____ 1 mark

3. Suggest a change in the procedure that would overcome the flaw stated in question 2. above and explain why this will lead to a conclusion with high validity.

   _____
   _____
   _____
   _____
   _____
   _____ 2 marks

4. Suggest one other variable that must be kept constant if the relationship between temperature and yield is to be properly investigated. Explain why this is important.

   _____
   _____
   _____
   _____
   _____
   _____
   _____
   _____ 3 marks

5. What is the scientist really measuring in this experiment over the three trials.

_____

_____ 1 mark

6. Consider the graph shown in figure 1. It shows the concentration of NH_3 over time as graphed by the scientist during trial 1 using a temperature of 300 °C.

   a. Draw the graph you expect would be produced at 100 °c and at 500 °C. Clearly label each graph. 2 marks

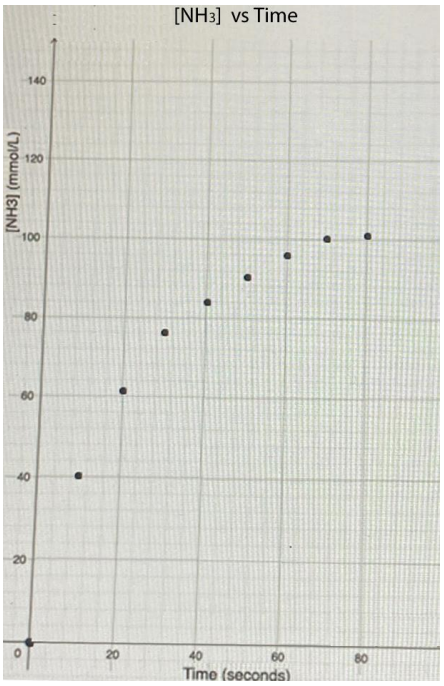

Figure 1

   b. Give an explanation for each graph.

   i. _____

_____

_____

_____

_____ 2 marks

   ii. _____

_____

_____

_____

_____ 2 marks