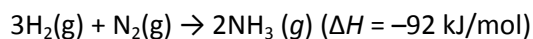


## Ammonia production worksheet 1

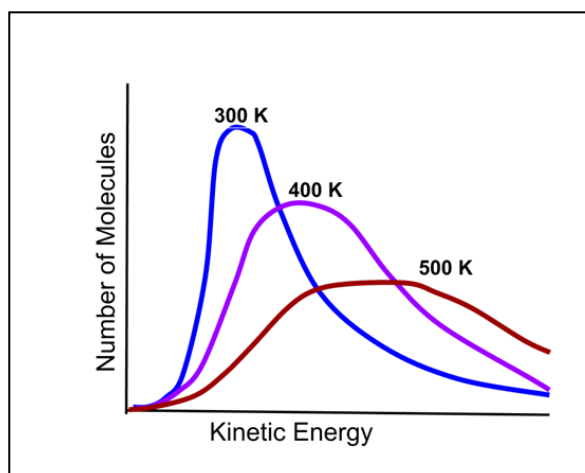
- 1) The Haber process for the formation of ammonia from hydrogen and nitrogen gases is given by the equation below.



- a) What conditions would maximise yield? Describe how these conditions are at odds with the rate of the reaction above?

- b) Explain how an increase in temperature maximises the rate of the reaction. Use the chart on the right

- c) Explain how a catalyst increases the rate of the reaction. Refer to the diagram on the right.



- d) 2.15 litres of hydrogen gas completely reacts with nitrogen gas to form ammonia at STP. The energy given out is used to heat 200.0 grams of water at 20.0 °C. Assuming no energy is lost what is the final temperature of the water?

- e) In a 1.00 litre vessel 1.00 mol of H<sub>2</sub> gas and 1.00 mol of N<sub>2</sub> gas were mixed, at a given temperature and allowed to reach equilibrium. Two minutes after the gases were mixed the reaction mixture had reached equilibrium and it was found that 0.400 mol of NH<sub>3</sub> was present.

At the 6 minute mark the volume was suddenly doubled and the system allowed to reach equilibrium once again. At the 10 minute mark the temperature of the reaction vessel was increased slightly.

- What is the equilibrium expression for this reaction?
- Calculate the value of the equilibrium expression at the 2 minute mark
- What is the value of the equilibrium expression at the 8 minute mark

iv. Use the set of axis, on the right, to graph the concentration vs time graph of each gas present in the mixture. Sketch the graphs and show the general trends of  $[H_2]$ ,  $[N_2]$  and  $[NH_3]$ .

