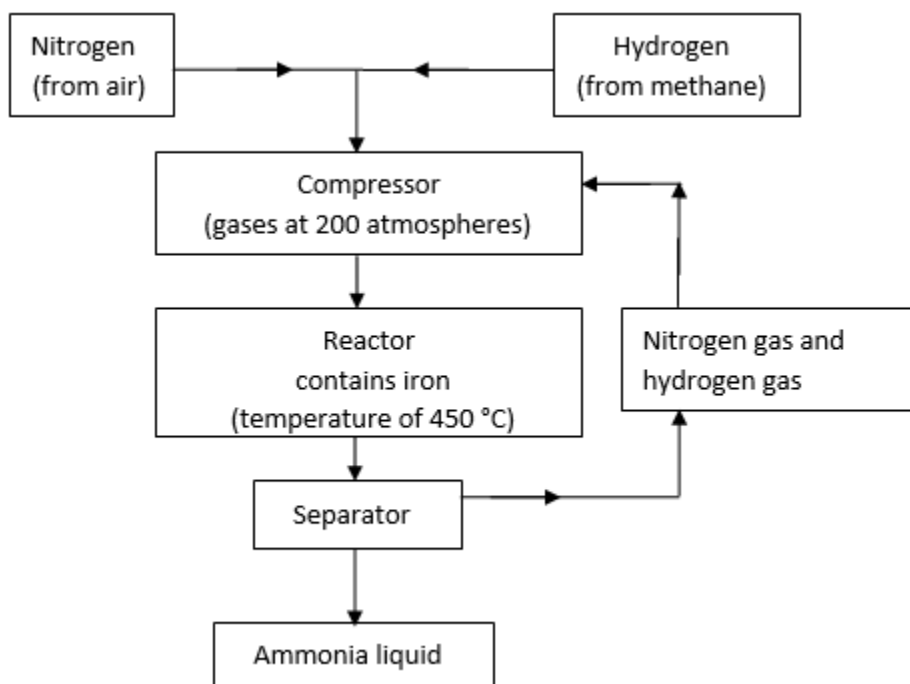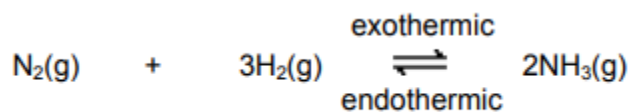# REVERSIBLE REACTIONS

&

LE CHATELIER'S PRINCIPLE 1

Q1. Ammonia is used in the production of fertilisers. The flow diagram shows the main stages in the manufacture of ammonia.

Study the flow diagram and then answer the questions.

In the reactor the equation to produce ammonia is:

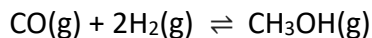$$N_2(g) \quad + \quad 3H_2(g) \quad \underset{\text{endothermic}}{\overset{\text{exothermic}}{\rightleftharpoons}} \quad 2NH_3(g)$$

The equation shows that the reaction is reversible. Explain how the reaction reaches an equilibrium.

_____

(1 mark)

Q2. Methanol is a fuel that is used in some racing cars instead of petrol.

Methanol can be made from carbon monoxide and hydrogen. The equation for this reaction is shown below.

$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$$

The forward reaction is exothermic.

(a) A high pressure (between 50 and 100 atmospheres) is used in this process.

Explain why the highest equilibrium yield of methanol is obtained at high pressure.

_____

_____

(1 mark)

(b) The temperature used in this process is about 250 °C.

It has been stated that, 'the use of this temperature is a compromise between the equilibrium yield of product and the rate of reaction'.

Explain this statement.

_____

_____

_____

_____

(3 marks)

Q3. The equation for a reaction to produce hydrogen is:

$$CO(g) \quad + \quad H_2O(g) \quad \rightleftharpoons \quad CO_2(g) \quad + \quad H_2(g)$$

(a) Explain why changing the pressure does not affect the yield of hydrogen at equilibrium.

_____

(1 mark)

(b) Suggest why the best yield of hydrogen at equilibrium is obtained at low temperatures.

_____

_____

Q4. Hand warmers use chemical reactions.

(a) The table shows temperature changes for chemical reactions A, B and C.

Reaction	Starting temperature in °C	Final temperature in °C	Change in temperature in °C
A	18	25	+ 7
B	17	....	+ 5
C	18	27	+ 9

What is the final temperature for reaction B? Write your answer in the table.

(1 mark)

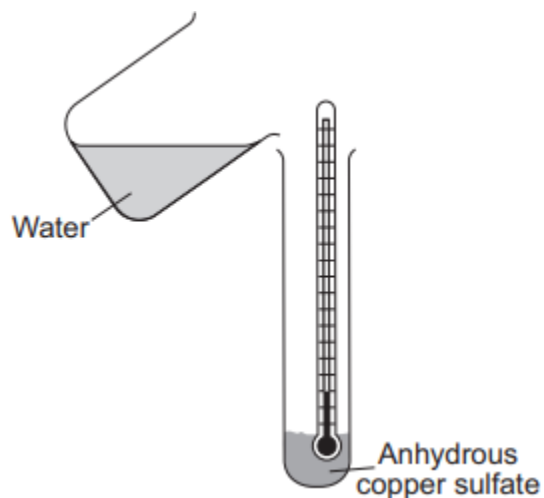**(b)(i)** What name is given to reactions that heat the surroundings?

_____

(1 mark)

(ii) Which reaction, A, B or C, would be best to use in a hand warmer?

Give a reason why you chose this reaction.

_____

_____

_____
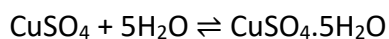
(2 marks)

(c) A student added water to some anhydrous copper sulfate.

The equation for the reaction is shown.

anhydrous copper sulfate + water ⇌ hydrated copper sulfate

$$CuSO_4 + 5H_2O \rightleftharpoons CuSO_4.5H_2O$$

The student measured the temperature before and after the reaction.

(i) The measurements showed that this reaction can be used for a hand warmer.

Draw a ring around the correct answer to complete the sentence.

When water is added to anhydrous copper sulfate the temperature

of the mixture	increases.
	decreases.
	stays the same.

(1 mark)

(ii) Anhydrous copper sulfate is white.

What colour is seen after water is added to the anhydrous copper sulfate?

_____

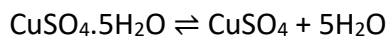(1 mark)

(iii) What does the symbol $\rightleftharpoons$ mean?

_____

(1 mark)

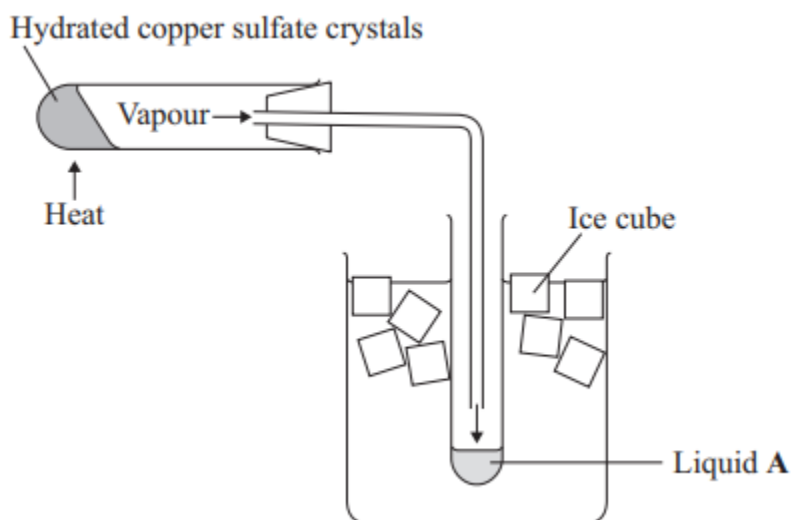**(iv)** The student heated a tube containing hydrated copper sulfate.

Name the solid substance produced.

_____

(1 mark)

Q5. A student heated some hydrated copper sulfate crystals. The equation for this reaction is shown below.

$$CuSO_4.5H_2O \rightleftharpoons CuSO_4 + 5H_2O$$

The diagram shows the apparatus used.

(a) Name liquid A _____.

(1 mark)

(b) What helped the vapour to condense into liquid A?

_____

(1 mark)

(c) The student weighed the copper sulfate before and after it was heated.

The experiment was repeated and the two sets of results are shown in the table.

Mass of copper sulfate before heating in grams	Mass of copper sulfate after heating in grams	Mass lost in grams
2.50	1.65	0.85
2.50	1.61	0.89

(i) Draw a ring around the average mass lost for these two sets of results.

0.85g   0.87g   0.89g

(1 mark)

(ii) The student used the same mass of copper sulfate each time but the mass lost was

different. Put a tick (✓) next to the two reasons which could explain why the mass lost is different.

Reason	(✓)
The student used different test tubes for the two experiments.	
The student made errors in weighing during the experiments.	
The student used more ice in one of the experiments.	
The student did not heat the copper sulfate for long enough in one of the experiments.	

(2 marks)

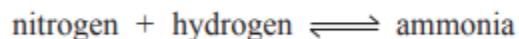**(d)** Anhydrous copper sulfate is used to test for water.

Use words from the box to complete the sentence.

blue   green   red   white

Water changes the colour of anhydrous copper sulfate from _____ to _____.

(2 marks)

Q6. Ammonia is made using the Haber process. The word equation for this reaction is shown below.

$$\text{nitrogen} + \text{hydrogen} \rightleftharpoons \text{ammonia}$$

(i) Which two of the statements in the table do you know are true only by looking at the word equation?

Put a tick (✓) next to these two true statements.

Put a tick (✓) next to these **two** true statements.

| Statement	(✓)
The reaction is very fast.	
Ammonia can break up to form nitrogen and hydrogen.	
Ammonia is made from nitrogen and hydrogen.	
The reaction that makes ammonia is endothermic.	

(2 marks)

(ii) Draw a ring around the name of the raw material from which nitrogen is obtained.
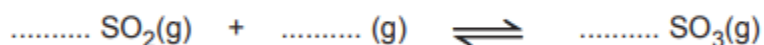
air   methane   oil   water

(1 mark)

Q7. The figure represents a reaction in the production of sulfuric acid.

Oxygen

Sulfur dioxide ⟶ Reactor ⟶ Sulfur trioxide
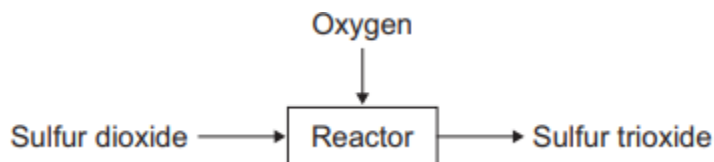
(a) Complete and balance the equation for the reaction.

.... $SO_2(g)$ + ... (g) $\rightleftharpoons$ .... $SO_3(g)$

(b) The pressure of the reacting gases was increased. State the effect of increasing the pressure on the rate of reaction. Explain your answer in terms of particles.

_____

_____

_____

_____

_____

_____

(3 marks)

Total marks (30)