Q1. The word equation shows the reaction between anhydrous cobalt chloride and water.

anhydrous cobalt chloride (blue) + water ⇌ hydrated cobalt chloride (pink)

(a) Name the type of reaction shown by the sign ⇌

.....

(1)

(b) When the student added water to anhydrous cobalt chloride what happened?

.....

(1)

(c) A student measured the temperature rise when anhydrous cobalt chloride was added to water.

The student's results are shown in the table below.

	Trial 1	**Trial 2**	**Trial 3**
Temperature rise in °C	8.5	8.2	8.2

Calculate the mean temperature rise.

.....

Temperature = ... °C

(1)

(d) When water was added to anhydrous cobalt chloride an exothermic reaction took place.

Name the type of reaction when hydrated cobalt chloride reacts to form anhydrous cobalt chloride and water.

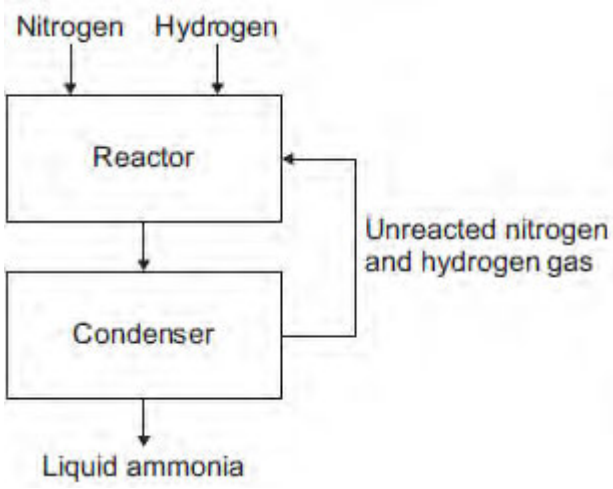
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(1)
(Total 4 marks)

Q2.A flow diagram of the Haber process is shown below.

The Haber process produces ammonia from nitrogen and hydrogen.



(a) Use the correct answer from the box to complete the sentence.

air	**limestone**	**natural gas**

Hydrogen is obtained from ..... .

(1)

(b) In the reactor, nitrogen and hydrogen at a high pressure are heated and passed over a catalyst.

(i) Use the correct answer from the box to complete the sentence.

25	**100**	**450**

The temperature in the reactor is ..... °C

(1)

(ii) Use the correct answer from the box to complete the sentence.

copper	iron	nickel

The catalyst used in the reactor is ..... .

(1)

(iii) How does a catalyst speed up a reaction?

Tick (✓) **one** box.

The catalyst lowers the activation energy. ☐

The catalyst gives the reactants extra energy. ☐

The catalyst increases the pressure in the reactor. ☐

(1)

(c) A mixture of gases leaves the reactor.

The mixture contains ammonia, nitrogen and hydrogen.

Describe what happens to this mixture of gases in the condenser.

Use the flow diagram to help you.

.....

.....

.....

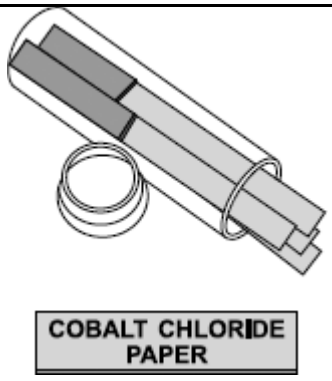
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(3)
(Total 7 marks)

Q3. Read the information and then answer the questions.



Cobalt chloride paper can be used to test for water.

The paper contains anhydrous cobalt chloride.

The jar containing the papers must be kept closed when not being used.

The equation shows the reaction between anhydrous cobalt chloride and water.

$$CoCl_2 + 6\ H_2O \rightleftharpoons CoCl_2.6H_2O$$

anhydrous cobalt chloride (blue) — hydrated cobalt chloride (pink)

(a) Choose **one** word from the box to complete the sentence.

endothermic	**exothermic**	**reversible**

The symbol $\rightleftharpoons$ means that the reaction is .....

(1)

(b) Describe the colour change when water is added to the cobalt chloride paper.

.....

.....

(1)

(c) Suggest why the jar containing the unused cobalt chloride papers must be kept closed.

.....

.....

(1)
(Total 3 marks)

Q4. (a) Ammonia solution is used in cleaning products to remove grease from kitchen surfaces.



Ammonia solution is alkaline.

(i) Draw a ring around the number most likely to be the pH of ammonia solution.

1 **3** **7** **10**

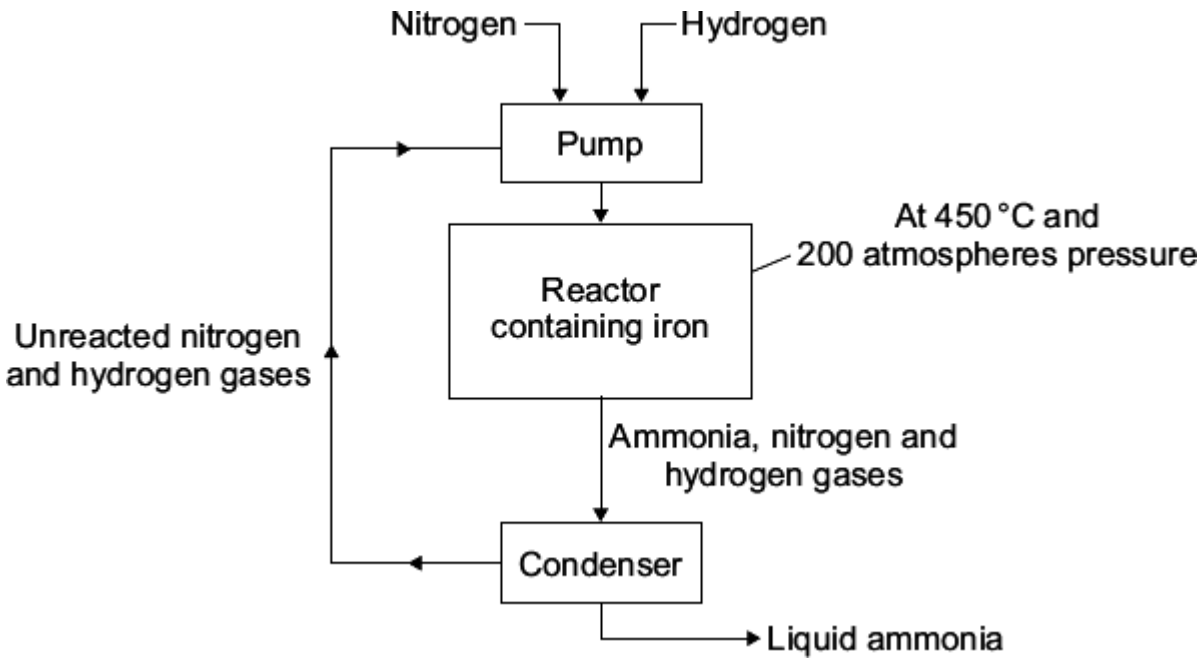
(1)

(ii) Draw a ring around the ion in ammonia solution which makes it alkaline.

Cl^- **H^+** **Na^+** **OH^-**

(1)

(b) Ammonia is made using the Haber process.



(i) Where does the nitrogen used in the Haber process come from?

Draw a ring around your answer.

air **natural gas** **water**

(1)

(ii) A high temperature of 450 °C is used in the reactor.

Tick (✓) **two** reasons in the table which explain why high temperatures make reactions faster.

Reasons	**Tick (✓)**
Particles move faster	
Particles are closer together	
Particles collide more often	
Particles have less energy	

(2)

(iii) The iron in the reactor speeds up the reaction but is not used up.

What is the name given to substances that speed up the chemical reaction but which are not used up during the reaction?

.....

(1)

(c) Complete the sentence.

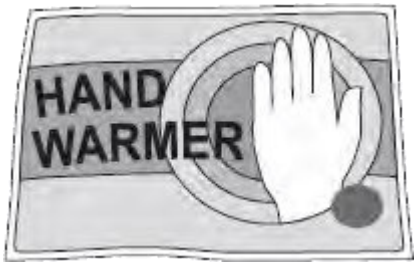
The condenser separates the ammonia from the unreacted nitrogen and hydrogen by

turning the ammonia into a .....

(1)

(Total 7 marks)

Q5. 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)

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

(1)

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

Reaction ☐

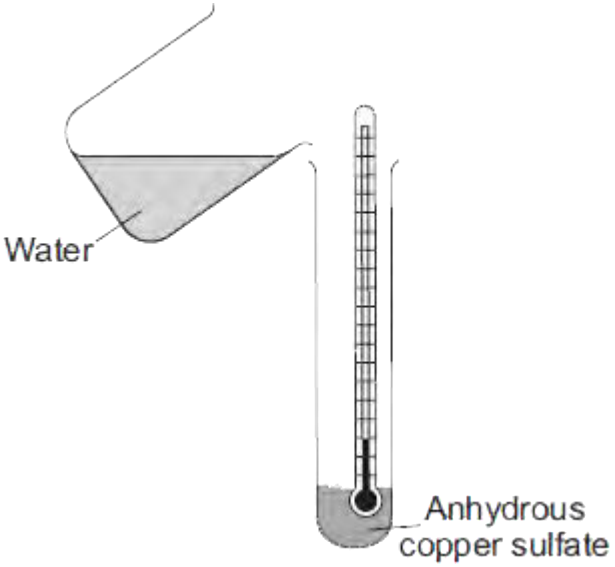
Give a reason why you chose this reaction.

.....

.....

(2)

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



The equation for the reaction is shown.

anhydrous copper sulfate + water ⇌ hydrated copper sulfate

$CuSO_4$ + 5 H_2O ⇌ $CuSO_4.5H_2O$

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)

(ii) Anhydrous copper sulfate is white.

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

.....

(1)

(iii) What does the symbol ⇌ mean?

.....

(1)

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

Name the solid substance produced.

.....

(1)

(Total 8 marks)

Q6. Stage smoke is used for special effects at pop concerts.



By Sam Cockman [CC BY 2.0], via Flickr

Ammonium chloride can be used to make stage smoke.
Ammonium chloride is a white solid.
When heated, ammonium chloride produces white smoke which can be blown onto the stage.

The equation shows what happens when ammonium chloride is heated and cooled.

$NH_4Cl(s)$ $\underset{\text{cooled}}{\overset{\text{heated}}{\rightleftharpoons}}$ $NH_3(g)$ + $HCl(g)$

ammonium chloride (white)	ammonia (colourless)	hydrogen chloride (colourless)

(a) The sentences explain how the smoke is made.

Draw a ring around the correct answer in each box to complete each sentence.

Use the information and the equation to help you.

When heated, ammonium chloride makes two colourless | solids. / liquids. / gases. |

These are blown into the air where they cool and make a | colourless / black | solid. / liquid. |

	white	gas.

which is

ammonia.
ammonium chloride.
hydrogen chloride.

(4)

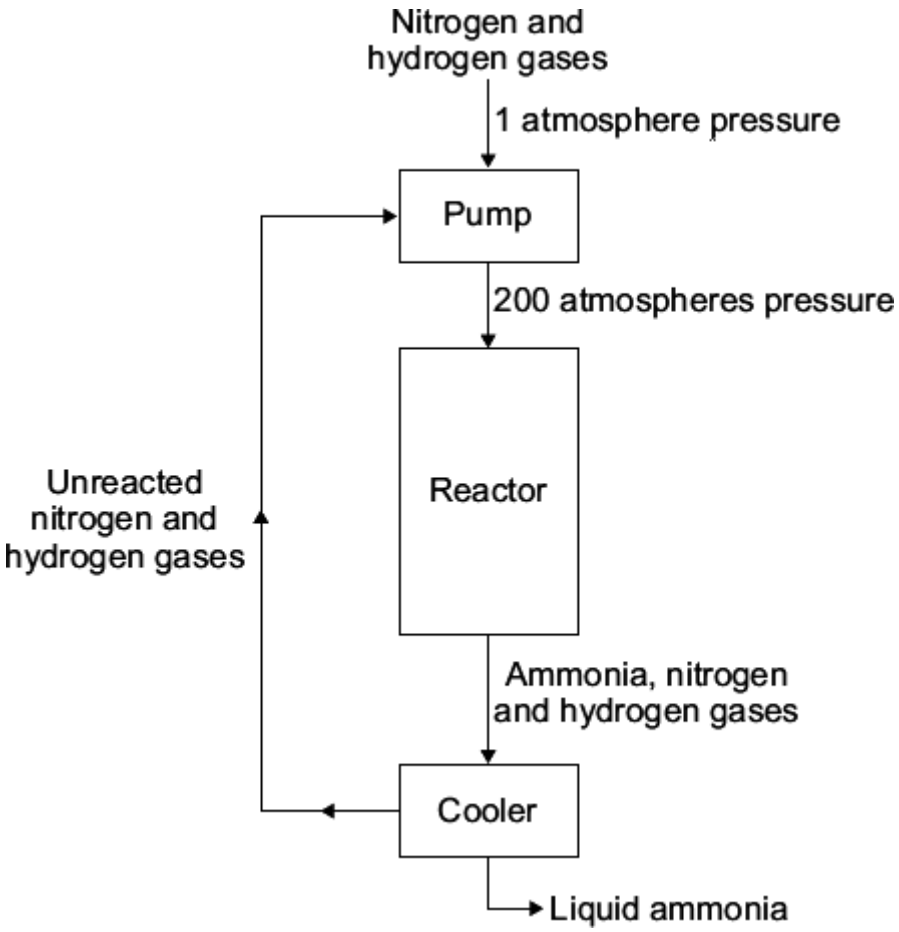
(b) Complete the sentence.

The symbol $\rightleftharpoons$ means that the reaction is .....

(1)

(Total 5 marks)

Q7. The flow diagram shows how ammonia is made.



(a) What effect, if any, does the **pump** have on the pressure of the nitrogen and hydrogen?

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

The pump [decreases / has no effect on / increases] the pressure.

(1)

(b) The word equation for making ammonia is:

nitrogen + hydrogen $\rightleftharpoons$ ammonia

In the **reactor** only a small amount of the nitrogen and hydrogen is changed into ammonia.

Tick (✓) the reason why.

Reason why	Tick (✓)
Ammonia is formed from two elements.	
Nitrogen and hydrogen are gases.	
The reaction is reversible.	

(1)

(c) In the **cooler** the mixture of gases is cooled.

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

The cooler turns the ammonia into

a liquid.

a solid.

an element.

(1)

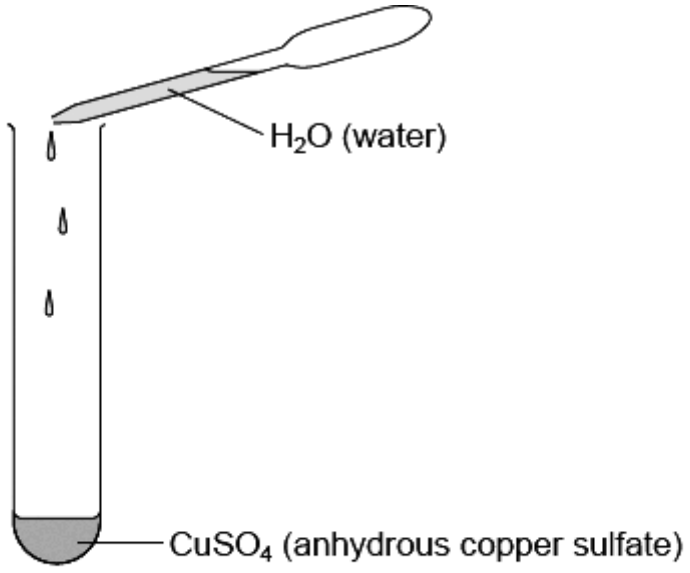
(d) What happens to the unreacted nitrogen and hydrogen from the **reactor**?

.....

.....

(1)
(Total 4 marks)

Q8. The diagram shows how anhydrous copper sulfate can be used to test for water.



$$\underset{\text{white}}{CuSO_4} + \underset{\text{colourless}}{5H_2O} \rightleftharpoons \underset{\text{blue}}{CuSO_4.\,5H_2O}$$

(a) What colour change will you see when water is added to the $CuSO_4$?

Colour changes from ..... to .....

(1)

(b) Draw a ring around the meaning of the symbol $\rightleftharpoons$

endothermic exothermic **reversible**

(1)

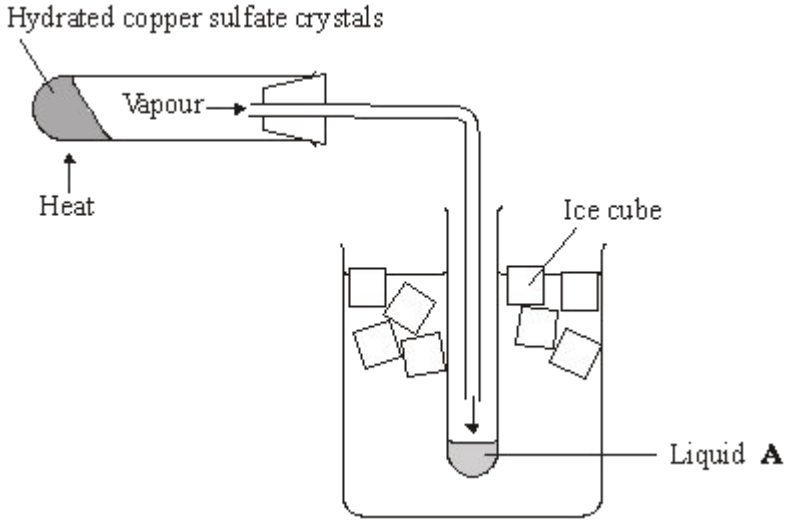
(Total 2 marks)

Q9. A student heated some hydrated copper sulfate crystals.
The equation for this reaction is shown below.

$CuSO_4.5H_2O(s) \rightleftharpoons CuSO_4(s) + 5H_2O(1)$

hydrated copper sulfate crystals — anhydrous copper sulfate — water

The diagram shows the apparatus used.



(a) Name liquid **A** .....

(1)

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

.....

.....

(1)

(c) Put a tick (✓) next to the correct meaning of the symbol $\rightleftharpoons$

Meaning	(✓)
equal amounts of reactants and products	
exothermic reaction	
reversible reaction	

(1)

(d) 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.

0.85 g **0.87 g** **0.89 g**

(1)

(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)

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

Use words from the box to complete the sentence.

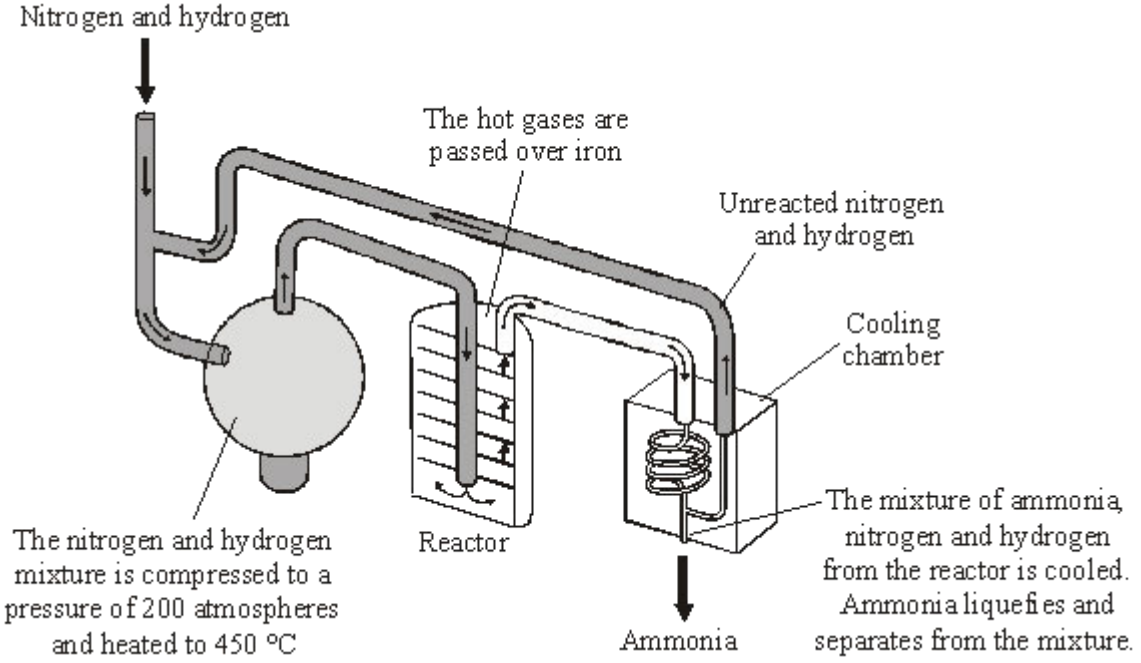
blue	**green**	**red**	**white**

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

to ..... .

(2)
(Total 8 marks)

Q10. The Haber process is named after the German chemist, Fritz Haber.
The diagram shows the main stages in the Haber process.



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(a) Use the diagram to help you to answer these questions.

(i) Complete the word equation for the reaction that takes place in the reactor.

nitrogen + ... ⇌ .....

(1)

(ii) What does the symbol ⇌ mean?

.....

(1)

(iii) What is the purpose of the iron in the reactor?

.....

(1)

(iv) Ammonia is separated from unreacted nitrogen and hydrogen.

Draw a ring around the physical property that allows this separation to take place.

boiling point **density** **melting point**

(1)

(v) What is done with the unreacted nitrogen and hydrogen?

.....

(1)

(b) Some of the products that can be made from ammonia are:

- fertilisers
- dyes
- explosives
- medicines
- plastics

(i) The Haber process was invented a few years before the start of the First World War. It is thought that the First World War would have finished earlier if the Germans had **not** invented the Haber process.

Suggest why.

.....

.....

(1)

(ii) The Haber process has helped to increase food production.

Explain why.

.....

.....

(1)

(c) Factories that make ammonia are very large and operate night and day.

(i) Ammonia factories are often near towns.

Suggest why.

.....

(1)

(ii) Suggest and explain **one** reason why local people might not want an ammonia factory near their town.

.....

.....

.....

.....

(2)

(Total 10 marks)