

Name: _____

Rates & Equilibrium part 3 AQA Triple Chemistry

Class: _____

Date: _____

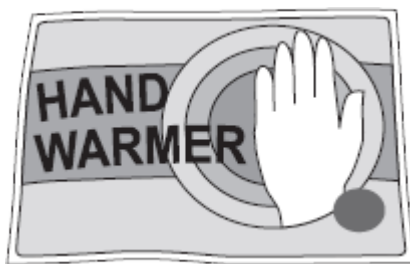
Time: **48 minutes**

Marks: **48 marks**

Comments:

1.

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)

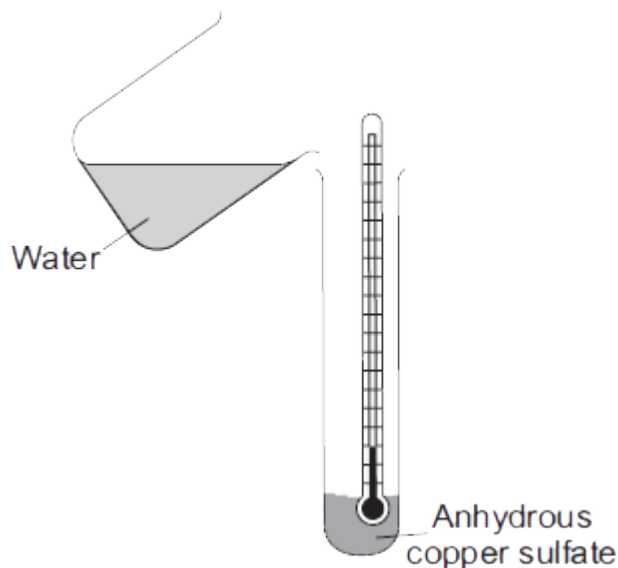
(ii) Which reaction, **A**, **B** or **C**, would be best to use in a hand warmer?

Reaction

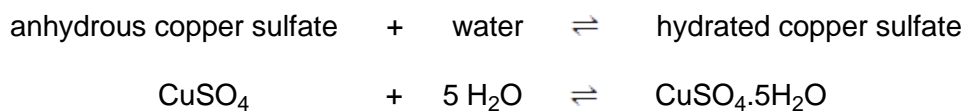
Give a reason why you chose this reaction.

(2)

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



The equation for the reaction is shown.



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 \rightleftharpoons mean?

(1)

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

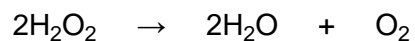
Name the solid substance produced.

(1)

(Total 8 marks)

2.

The symbol equation for the decomposition of hydrogen peroxide is:

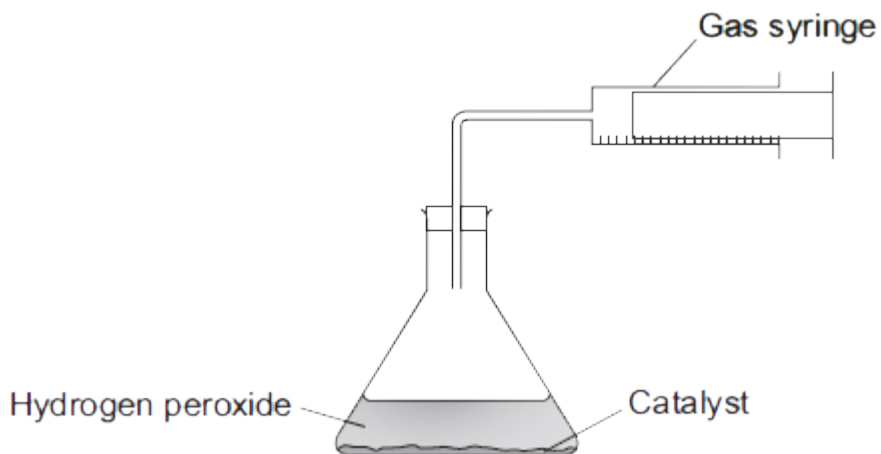


(a) This reaction is *exothermic*.

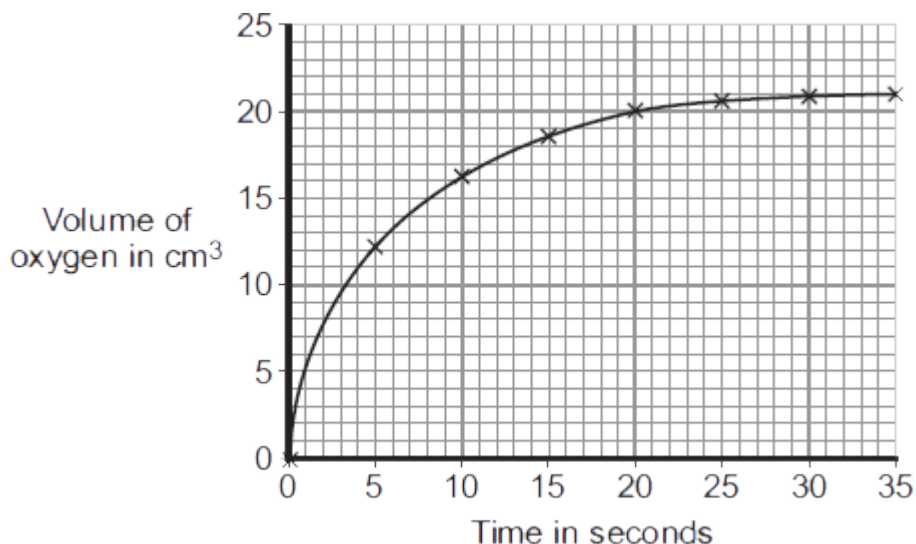
What is an *exothermic* reaction?

(1)

(b) A student measured the volume of oxygen produced by 50 cm³ of hydrogen peroxide.



The graph shows the results.



- (i) Use the graph to describe the changes in the rate of the reaction from 0 to 35 seconds.

(3)

- (ii) What was the total volume of oxygen gas collected?

_____ cm³

(1)

- (iii) The student had calculated that the hydrogen peroxide used should produce 25 cm³ of oxygen.

Calculate the percentage yield of oxygen.

Answer = _____ %

(2)

(c) An increase in the temperature of the hydrogen peroxide increases the rate of the reaction.

Use your knowledge of particles to explain why.

(3)
(Total 10 marks)

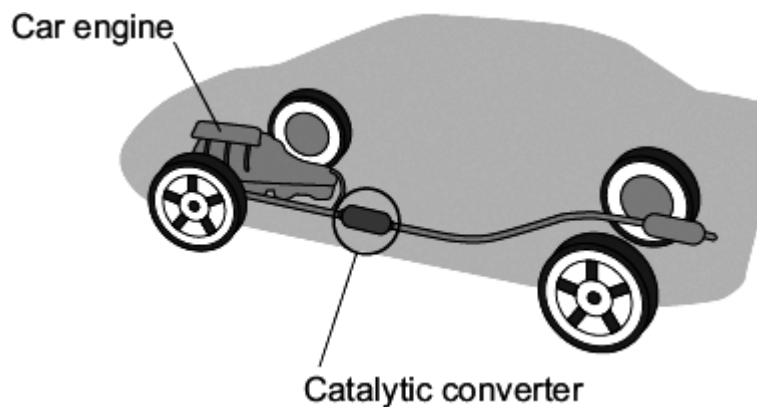
3.

Read the information about car engines.

Burning petrol in air is an *exothermic* reaction. This reaction is used in car engines.

When petrol burns it produces harmful substances such as nitrogen oxides and carbon monoxide.

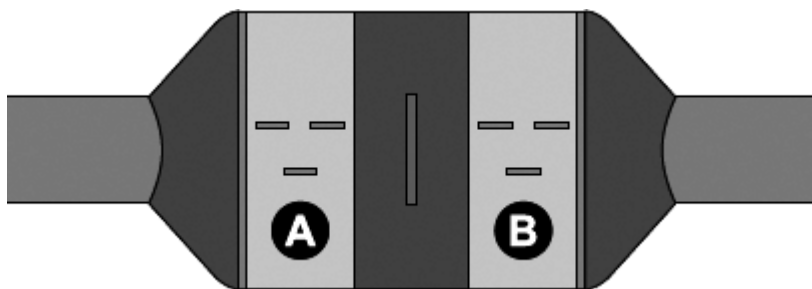
A catalytic converter stops these harmful substances being released into the air.



(a) The reaction is *exothermic*. What is the meaning of *exothermic*?

(1)

(b) The catalytic converter has two parts shown as **A** and **B** in the diagram.



Part **A** contains a catalyst made from platinum and rhodium.

Part **B** contains a catalyst made from platinum and palladium.

(i) Why are catalysts used in chemical reactions?

(1)

(ii) One reaction in part **A** is shown by this equation.

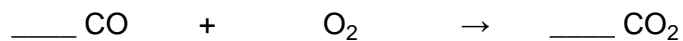


Suggest why this reaction helps the environment.

(1)

(iii) The equation for one of the reactions in part **B** is shown below.

Balance this equation.



(1)

(iv) The catalytic converter works for many years without replacing the catalyst.

Explain why the catalyst does not need to be replaced.

(1)

(v) Suggest why different catalysts are used in parts **A** and **B**.

(1)

(c) Modern catalytic converters contain nanosized particles of catalyst. Using nanosized particles reduces the cost of the catalytic converter.

Suggest and explain why the use of nanosized catalyst particles reduces the cost of the catalytic converter.

Your answer should include information about the size and surface area of the particles.

(3)

(Total 9 marks)

4.

Humberstone was a town in the desert of Northern Chile in South America. It was built for the people who worked in the nearby sodium nitrate mines.

The sodium nitrate was used as a fertiliser.

The sodium nitrate was exported by ship to countries all around the world.

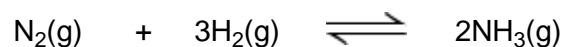
Today the mines have closed and nobody lives in Humberstone.

One of the reasons for the mines closing was the invention of the Haber process.



By Sznegra (Own work) [CC-BY-SA-3.0], via Wikimedia Commons

(a) The Haber process is used to make ammonia (NH_3).



The forward reaction is exothermic.

(i) Name the raw materials that are used to supply the nitrogen and hydrogen.

Nitrogen _____

Hydrogen _____

(2)

(ii) The Haber process uses a temperature of 450 °C.

Explain, as fully as you can, why a temperature of 450 °C is used rather than a much higher temperature or a much lower temperature.

(3)

(iii) Ammonia can be converted to ammonium nitrate by adding an acid.

Name this acid.

(1)

(b) Suggest and explain why the invention of the Haber process caused the closure of the Humberstone mines in Chile.

(2)

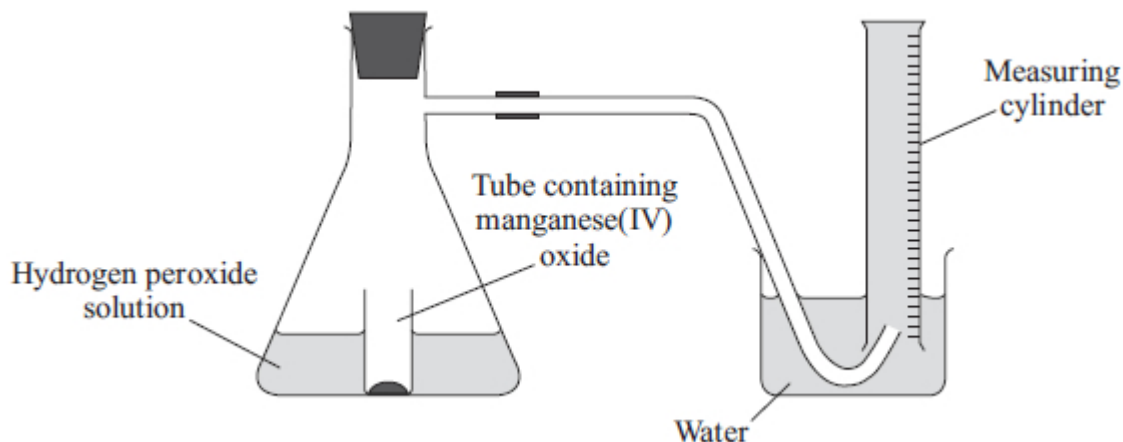
(Total 8 marks)

5.

A student investigated the effect of temperature on the decomposition of hydrogen peroxide. Hydrogen peroxide decomposes to oxygen and water when a manganese(IV) oxide catalyst is added.

The student measured the time taken to collect 5 cm³ of oxygen gas.

The apparatus shown below was used for the investigation. The reaction was started by shaking the flask so that the manganese(IV) oxide and hydrogen peroxide were mixed.



The student did the investigation at two different temperatures. All the other variables were kept constant.

The student's results are shown in the table.

Temperature of the hydrogen peroxide solution in °C	Volume of oxygen collected in cm ³	Time taken to collect the oxygen in seconds	Rate of reaction in cm ³ per second
20	5	40	0.125
25	5	25	

(a) (i) Calculate the rate of reaction at 25 °C.

Rate of reaction = _____ cm³ per second

(2)

(ii) The teacher said that the student should repeat the investigation to get more results. Suggest why.

(1)

(b) The student concluded that:

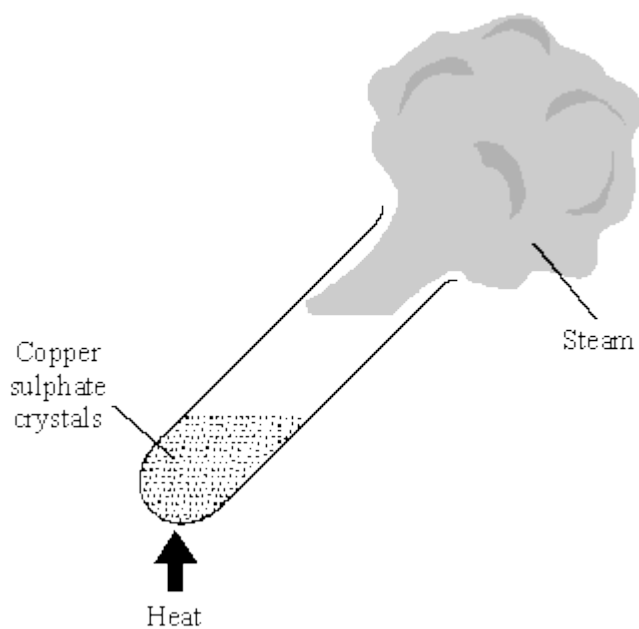
'the rate of reaction increases when the temperature is increased'.

Explain, in terms of particles, why the rate of reaction increases.

(2)
(Total 5 marks)

6.

A student heated some blue copper sulphate crystals. The crystals turned into white copper sulphate.



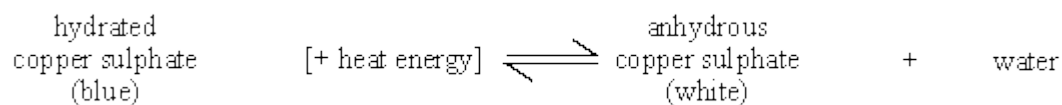
(a) The blue copper sulphate had to be heated to change it into white copper sulphate.

State whether the reaction was exothermic or endothermic. _____

Explain your answer.

(1)

(b) The word equation for this reaction is shown below.



(i) What does the symbol \rightleftharpoons tell you about this reaction?

(1)

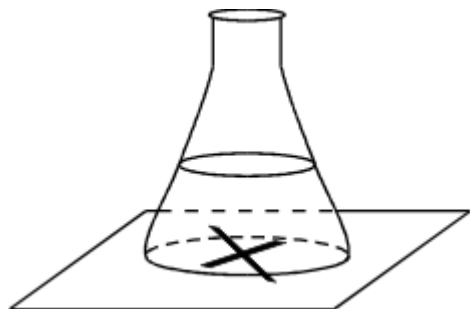
(ii) How could the student turn the white powder back to blue?

(1)

(Total 3 marks)

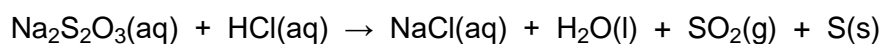
7.

A student studied the effect of temperature on the rate of reaction between hydrochloric acid and sodium thiosulphate.



- The student mixed 50 cm³ of a sodium thiosulphate solution and 5 cm³ of hydrochloric acid in a flask.
- The flask was placed over a cross.
- The student timed how long after mixing the cross could no longer be seen.

(a) (i) Balance the chemical equation for this reaction.

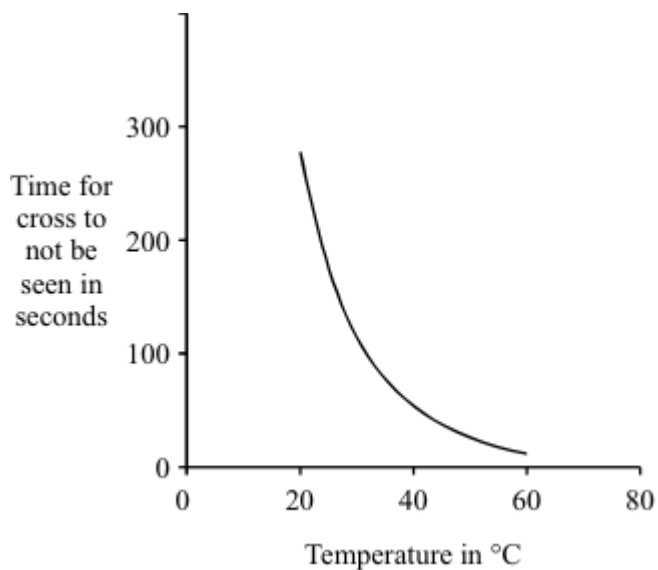


(1)

(ii) What causes the cross to be seen no longer?

(1)

(b) A graph of the results is shown.



(i) What effect does temperature have on the rate of this reaction?

(1)

(ii) Explain why temperature has this effect on the rate of reaction.

(2)

(Total 5 marks)

Mark schemes

1.	(a)	22	1
	(b)	(i) exothermic	1
		(ii) C	1
		gives out most heat energy <i>accept has largest temperature change / increase</i> <i>allow has highest (final) temperature or hottest</i>	1
	(c)	(i) increases	1
		(ii) blue <i>ignore pale / dark etc</i>	1
		(iii) reversible (reaction) <i>allow goes both ways or two / either way</i>	1
		(iv) <u>anhydrous</u> copper sulfate	1
			[8]
2.	(a)	gives out energy or heat	1
	(b)	(i) <i>accept qualified answers in terms of volume of gas related to time</i> fast initially	1
		slows down	1
		reaction stops <i>accept reaction is now very slow</i>	1
	(b)	(ii) 21	1
		(iii) 84 <i>correct answer with or without working = 2 marks</i> <i>allow ecf from (b)(ii) correctly calculated for 2 marks</i> <i>allow evidence of 21/25 or (b)(ii)/25 for 1 mark</i>	2

- (c) because they / particles have more energy / move faster
ignore particles move more / vibrate 1
- (and so) particles collide more often / more frequently **or** particles more likely to collide
ignore collide faster
ignore more collisions 1
- (and) more of the collisions are successful **or** particles collide with more energy / harder **or**
 more of the particles have the activation energy
accept more successful collisions 1

[10]

3.

- (a) gives out heat / energy
allow release / loses
allow the products have less energy
- or**
- energy / heat transferred to the surroundings
ignore temperature rises
allow more energy given out in forming bonds than taken in to break bonds 1
- (b) (i) speed up the reaction (owtte)
accept changes the rate
accept lowers activation energy
accept increases successful collisions
accept allows reaction to take place at a lower temperature 1
- (ii) nitrogen (N₂) / oxygen (O₂) / products are safe **or** not harmful / pollutant /
 toxic / dangerous / damaging
ignore releases nitrogen / oxygen unless qualified
- or**
- (harmful) nitrogen monoxide / NO is not released into the air.
accept prevents / less acid rain
ignore greenhouse gas / ozone layer 1
- (iii) 2 and 2
accept correct multiples or fractions 1

(iv) idea of catalyst not being used up
allow not changed by reaction
ignore catalyst does not take part
ignore catalyst not used in the reaction 1

(v) idea of different reactions (require different catalysts)
accept catalysts work for specific reactions
allow different gases 1

(c) • smaller / very small / or any indication of very small / 1–100 nanometres / a few (hundred) atoms
ignore just small
ignore size of the converter 1

• big(ger) surface area 1

• less (catalyst) needed / small amount of catalyst needed 1

[9]

4.

(a) (i) nitrogen - air
accept atmosphere 1

hydrogen - north sea gas / natural gas / methane / CH₄
accept water / (crude) oil / coal / hydrocarbons / brine 1

(ii) *allow converse throughout*
• high temperature gives a low yield 1

• because reaction is exothermic
must be linked to first bullet point 1

• but at low temperatures the rate is (too) slow
if no other marks awarded accept 450°C is a compromise between yield and rate
or
450°C gives a reasonable yield in a reasonable time for 1 mark 1

(iii) nitric (acid)
accept HNO₃ 1

(b) Ammonia / Haber process can be used to make fertiliser

1

with a specified economical reason
eg raw materials for Haber process readily available
eg transport costs are lower or no need to import
eg Haber process is a continuous process

ignore employment / labour costs

1

[8]

5.

(a) (i) 0.2

correct answer gains 2 marks with or without working

accept answer in table

if answer incorrect 5/25 gains 1 mark

2

(ii) any **one** from:

- wider range of temperatures (owtte)
- (repeat at the same temperature) to improve accuracy / reliability
allow to make it reliable / accurate
- reveal anomalous results (owtte)
allow to eliminate random / human errors / to check results owtte
- so you can get an average / better average
ignore to make it a fair test / to get better results
ignore precision and validity

1

(b) any **two** from:

allow atoms / molecules / they instead of particles throughout

- particles gain energy / have more energy
ignore increases particles activation energy
- particles move faster
ignore move more / vibrate more
- particles collide more
- more of the particles have the activation energy **or** more of the collisions are successful (owtte)
ignore increases / decreases activation energy

or

particles collide with more force / harder / more energy
allow more successful collisions
alone for 1 mark

2

[5]

6.

(a) endothermic **and** because it takes in heat / energy

both for one mark

1

(b) (i) reversible reaction (or explanation)

1

(ii) add water

*do **not** accept cooling **or** reverse the reaction*

1

[3]

7.

(a) (i) $\text{Na}_2\text{S}_2\text{O}_3(\text{aq}) + 2 \text{HCl}(\text{aq}) \rightarrow 2\text{NaCl}(\text{aq}) + \text{H}_2\text{O}(\text{l}) + \text{S}(\text{s}) + \text{SO}_2(\text{g})$

1

(ii) (formation of) sulphur

*accept precipitate **or** solid produced*

*do **not** accept goes cloudy **or** milky*

1

(b) (i) heat \equiv temperature increased temperature increases (the rate of reaction)
or decreased temperature decreases rate of reaction

may be gained in part (ii) if stated and not implied

1

(ii) (these ideas may be given in (i))

particles have more kinetic energy

accept particles move faster

1

more collisions (so more reactions)

more energetic collisions **two marks**

1

[5]