



ST PAUL'S SCHOOL  
Est. 1509

# **JUNIOR SCHOLARSHIP EXAMINATION**

**MAY 2018**

**CHEMISTRY**

**30 minutes**

**Answer the questions in the spaces provided**

**Name.....**

**This question is all about iron, a common metal, which is used to make nails, amongst other things.**

- a) Give one property of iron that makes it suitable for use as a nail.

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[1]

- b) Iron has a density of  $7.88\text{g/cm}^3$ .  
Calculate the mass of an iron nail that has a volume of  $2\text{cm}^3$ .

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[1]

- c) Pure iron can rust very quickly.  
i) What conditions are needed for iron to rust?

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[1]

- ii) Describe and explain how one method of preventing rusting works.

Method: .....

Explanation:.....

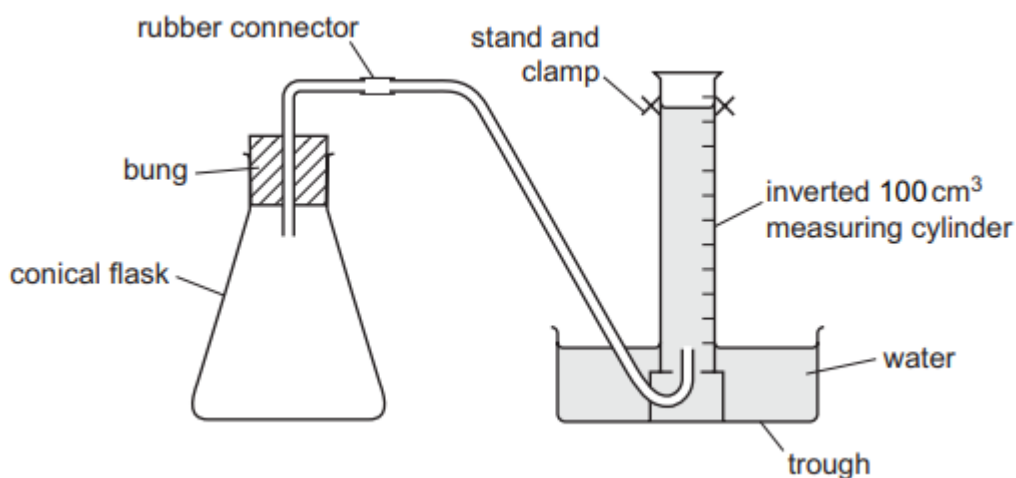
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[2]

- d) Iron reacts with hydrochloric acid to produce iron chloride and hydrogen gas.  
An experiment was carried out to study this reaction.  
The apparatus is shown below.



The hydrogen gas is collected in the measuring cylinder and its volume can be measured.

At the start of the experiment, the bung is removed and 4 iron nails are placed into the conical flask.

50cm<sup>3</sup> of hydrochloric acid is measured out and poured into the flask with the nails and the bung is quickly replaced.

The volume of gas in the measuring cylinder is recorded every 30 seconds.

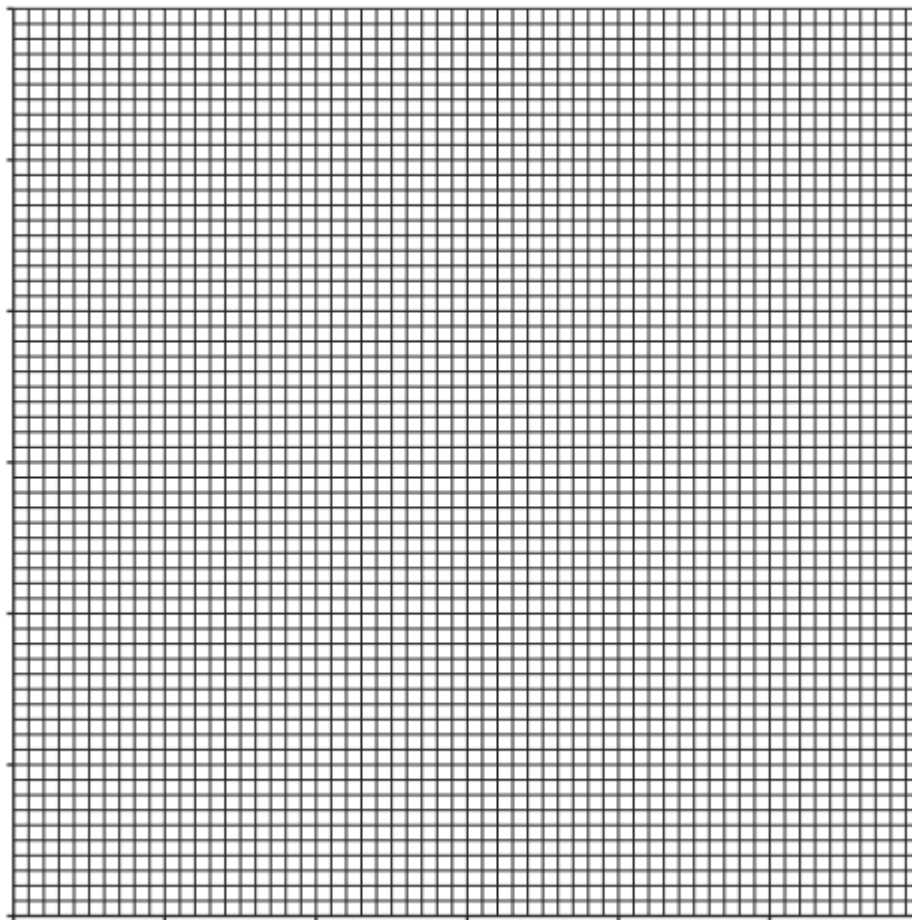
Here are the results of the experiment:

Time / sec	0	30	60	90	120	180
Volume/ cm <sup>3</sup>	0	21	38	50	56	60

**TURN OVER**

- i) Plot the results on the grid below and draw a smooth curve through the points.

[3]



- ii) From your graph, find the time required to collect 25cm<sup>3</sup> of hydrogen gas.

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[1]

- iii) The rate of this reaction can be calculated using this formula:

$$\text{rate} = \frac{\text{volume of gas / cm}^3}{\text{time taken / s}}$$

Calculate the rate of this reaction for the first 30 seconds.

Give your answer appropriate units

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[2]

- iv) The same reaction was carried out using exactly the same reactants, but at a higher temperature.

Draw a line on your graph to show how you would expect the results of this experiment to look.

[2]

- v) A student suggested that the nails should be rubbed thoroughly with sandpaper before being used in this experiment. Using your knowledge of chemistry, explain why this could lead to more accurate results.

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[2]

- e) Iron can be found with other metals in the reactivity series. The position of a metal in the reactivity series can be determined through different chemical reactions.

The observations made when iron, silver, magnesium and calcium were reacted with water and with dilute acid are recorded in the table:

Metal	Reaction with water	Reaction with dilute acid
Iron	No observed reaction	Bubbles of gas produced slowly
Calcium	Lots of bubbles	Very exothermic reaction with lots of bubbles
Magnesium	Very slow reaction with cold water, slow production of bubbles in hot water	Lots of bubbles.
Silver	No observed reaction	No observed reaction

- i) Place the metals in order of their reactivity putting the most reactive first.

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[1]

- ii) Iron does not react with water, but under certain conditions it does react with steam to form iron oxide and hydrogen gas.

Give a word equation for this reaction.

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[1]

**TURN OVER**

- f) The reaction of iron with steam is a type of displacement reaction.  
Other displacement reactions involve colour changes in solutions and metal coatings on the surface of the reacting metal.

Study the information in the table below.

The metals are listed in order of their reactivity, with the most reactive being at the top of the table, and the least reactive being at the bottom.

The colours of their nitrate solutions are also given.

Metal	Colour of metal nitrate solution
Cerium	Yellow
Vanadium	Blue
Iron	Green
Cadmium	Colourless

- i) An iron nail was placed in some cadmium nitrate solution. Describe what you would see.

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[1]

- ii) Give a word equation for the reaction that occurred

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[1]

- iii) A **small** amount of cerium was mixed with some vanadium nitrate solution. Describe what you would expect to see.

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[1]

- iv) In fact, when the experiment with cerium and vanadium nitrate was done, a green solution was observed.

The pupil had not made a mistake and all the chemicals were pure.

Explain why a green solution was observed.

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[2]

- v) You are given a sample of cobalt metal, and some cobalt nitrate solution, which is red. Describe the experiment that you would carry out, including your expected observations, to decide if cobalt is more or less reactive than iron. Your planned experiment **MUST** involve a colour change.

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[3]

**[Total for paper: 25 marks]**

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