

SECTION A – Answer ALL questions. This section carries 60 marks.

1 Consider the following metals:

magnesium

sodium

aluminium

iron

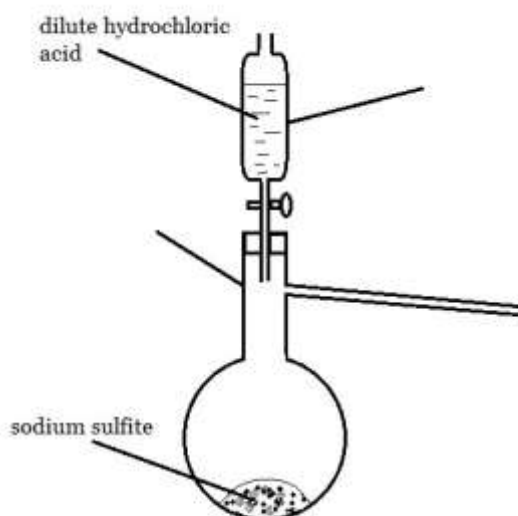
copper

Choose one metal from the above list that fits each description. Each metal may be used once, more than once or not at all.

Has a reddish-brown appearance	
Floats on water but sinks in alcohol	
Reacts with oxygen to form a brown flaky substance	
Produces an intense white light when used in fireworks	
Silvery metal that is highly resistant to corrosion	
Is the major component of steel	
Used in household electrical wires	
Is a very soft metal	
Used to make overhead electrical cables	
Burns to produce a white solid that is slightly alkaline	

[10]

- 2 The diagram below shows the apparatus that can be used to generate sulfur dioxide gas in the laboratory.



a. On the diagram above:

(i) Fill in the two missing labels. [2]

(ii) Complete the diagram by drawing and labelling the apparatus needed to make a **solution** of sulfur dioxide. [3]

b. What condition is necessary for the reaction shown in the diagram to take place?

_____ [1]

c. Write a balanced chemical equation to show how sulfur dioxide is produced from the reactants shown in the diagram.

_____ [2]

d. Describe a chemical test to show that the resulting solution contains sulfur dioxide.

 _____ [2]

- 3 A Chemistry student wanted to find out the molar concentration (molarity) of a sulfuric acid solution. She titrated it with 25 cm³ samples of sodium hydroxide solution of molar concentration 0.40 mol dm⁻³.

a. (i) What apparatus did she use to transfer exactly 25 cm³ of sodium hydroxide solution into a conical flask?

_____ [1]

(ii) Into what apparatus did she put the acid so that it could be added dropwise to the alkali?

_____ [1]

b. The student repeated the titration for 5 times and obtained the following results:

Experiment run	1	2	3	4	5
Volume of acid in cm ³	38.60	35.30	34.90	35.10	35.00

(i) Which 2 readings should she leave out of the calculation? Give a reason for your answer.

_____ [2]

(ii) Calculate the average value for the volume of acid used (average titre value).

_____ [1]

c. Work out the molar concentration of the sulfuric acid solution.

_____ [5]

- 4 The picture below shows the heating element of an electric kettle which has been used for several months. It has been covered by a thick, flaky yellowish deposit.



a. What is the flaky deposit called?

_____ [1]

b. Name the substance found dissolved in water that causes this deposit to form.

_____ [1]

c. Write a balanced chemical equation to show how the substance mentioned in question b above decomposes on heating to produce the deposit.

_____ [2]

d. Would you classify this compound as responsible for temporary or permanent hardness? Give a reason for your answer.

_____ [2]

e. Why is it a disadvantage if a kettle heating element gets covered by such a deposit?

_____ [1]

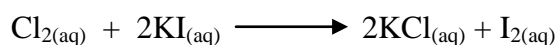
f. In the case of old water pipes, getting covered on the inside with this deposit is actually an advantage. Why do you think this is so?

_____ [1]

g. Name 2 methods by which water can be treated to remove hardness.

_____ [2]

- 5 When chlorine water is added to a solution of potassium iodide, a brown colour is formed. The following reaction occurs:



- a. Which product is responsible for the brown colour in the solution?

_____ [1]

- b. Write an ionic equation for this reaction, leaving out spectator ions.

_____ [2]

- c. State which substance is acting as the oxidizing agent in this reaction and give a reason why.

_____ [2]

- d. This reaction can be described both as a **displacement** and as a **redox** reaction. Explain why in both cases.

- (i) Displacement:

_____ [2]

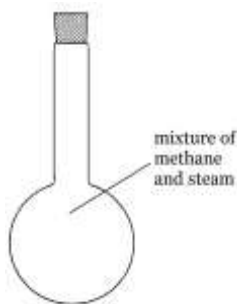
- (ii) Redox:

_____ [2]

- e. Astatine is another halogen element like chlorine and iodine. Would you expect a solution of astatine to displace iodine from a potassium iodide solution? Give a reason for your answer.

_____ [1]

6 The reaction of methane gas with steam is an equilibrium reaction as shown:



A small amount of methane and a small amount of steam have been added together in the sealed container shown on the left.

- a. Write a balanced chemical equation to show the only reaction that is occurring just as the two gases are mixed together.

_____ [1]

- b. What will happen to the **rate** of this first reaction as time goes by?

_____ [1]

- c. After some time, a second reaction will start and it will get faster and faster. Write a balanced chemical equation to show this second reaction.

_____ [1]

- d. Eventually the two reactions that are occurring in the flask will reach a stage called **dynamic equilibrium**. Underline the best description for this stage:

1. The amounts of reactants and products are equal.
2. The rates of the 2 reactions are equal.
3. The products are formed at a faster rate than the reactants.
4. The reactants are formed at a faster rate than the products.

[1]

- e. State, giving reasons, whether the equilibrium will shift to the **left** or to the **right** if the following changes are made:

- (i) The concentration of steam in the mixture is **decreased**.

_____ [2]

- (ii) The pressure of the gases in the mixture is **increased**.

_____ [2]

- (iii) The temperature of the gases in the mixture is **increased**.

_____ [2]

SECTION B – Answer TWO questions only on the foolscap provided.
This section carries 40 marks.

- 7 Two chemistry students are discussing the preparation of the salt copper (II) chloride in the laboratory.



They come up with 3 alternative methods for its preparation using:

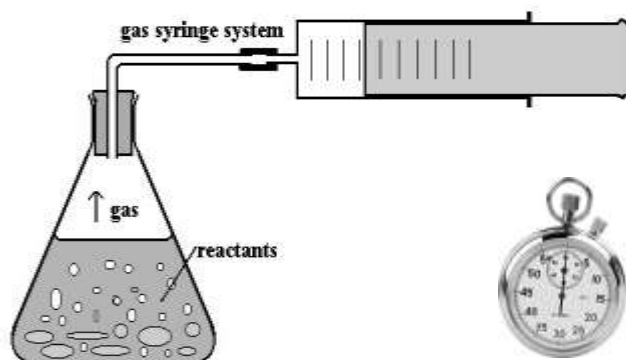
1. Copper metal and chlorine gas
2. Copper metal and dilute hydrochloric acid
3. Copper (II) oxide powder and dilute hydrochloric acid

- a. The students try out method 1 by plunging a piece of copper foil in a gas jar full of chlorine. The reaction is extremely slow.
- (i) Suggest what the students could do to make the reaction go faster in a safe way. [1]
 - (ii) What type of reaction is this? [1]
 - (iii) Write a balanced chemical equation for this reaction. [2]
- b. The students then try out method 2 but observe no reaction between copper and dilute hydrochloric acid. Explain why this happens. [2]
- c. Method 3 is a commonly used method for preparing water soluble salts in the laboratory. Describe how you can obtain a sample of solid, hydrated copper (II) chloride starting from copper (II) oxide and dilute hydrochloric acid.

Your answer should include:

- A description of the method used [5]
- An important observation [1]
- Labelled diagrams [7]
- One essential precaution [1]

- 8 A laboratory scientist wants to find out which is the best catalyst for the decomposition of hydrogen peroxide. Her laboratory equipment is shown in the diagram below.



She has 3 possible catalysts in the form of powders. These include:

manganese (IV) oxide – MnO_2

lead (IV) oxide
– PbO_2

iron (III) oxide
– Fe_2O_3

- a. What do you understand by the word **catalyst**? [1]
- b. Write a balanced chemical equation to show the decomposition of hydrogen peroxide. [2]
- c. Describe an experiment you would do to show how, using the equipment in the diagram above, you can test which of the three catalysts speeds up the rate of hydrogen peroxide decomposition most.

Your answer should include:

- A description of the method [4]
 - The measurements needed to be taken [3]
 - Important precautions necessary to make the comparison between catalysts fair [2]
- d. Copy the axes on the foolscap and draw on them the sketches of the 3 graphs that you expect to be obtained. There is no need to identify which graph belongs to which catalyst. Remember to **label** the Y and X axes with the quantities that should be measured.



- e. Draw a labelled diagram for another alternative apparatus that can also be used to measure the rate of hydrogen peroxide decomposition. [4]

- 9 Liquefied Petroleum Gas (LPG) is a product of the fractional distillation of crude oil. Its main components are propane and butane, both of which are colourless, odourless gases. A foul-smelling chemical called mercaptan is added to LPG before it is bottled in gas cylinders. LPG is commonly used in Malta as a household fuel.



- a. (i) Draw the structures of propane and butane. [2]
- (ii) To which homologous series do these two compounds belong? [1]
- (iii) Write 2 balanced chemical equations to represent the complete combustion of propane and butane. [4]
- (iv) Briefly describe a chemical test that can be used to show that LPG contains no unsaturated compounds. [2]
- (v) Would you expect petrol to be made of longer or shorter-chained hydrocarbons compared to LPG? Give a reason for your answer. [4]
- (vi) What basic condition makes it possible for LPG to turn from a gas into a liquid during the bottling of the gas into cylinders? [1]
- b. (i) Why do you think that foul-smelling mercaptan is added to LPG? [1]
- (ii) What should you **do** and what should you **not do** if you enter a room where you suspect that there is a gas leak? [2]
- (iii) In the event of a gas leak, would you expect to find the highest concentration of gas near the floor or near the ceiling of the room? Give a reason for your answer. [2]
- (iv) Natural gas is similar to LPG as a fuel. Name the gas which is the main component of natural gas. [1]