
CHEMISTRY
Workbook
Year 10

This workbook will be available in digital format (PDF) only. It is intended to be used by secondary school students and teachers in Malta and Gozo. This workbook is a companion to the Chemistry Year 10 textbook.

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Acknowledgements

The following persons contributed towards the content of this workbook: Doreen Mizzi (HOD), Maria-Liza Scicluna Mantas (TR), Sarah Farrugia (TR), Katielena Mizzi (TR), Simon Cassar (TR), and Nicole Farrugia (TR).

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Contents

1 Physical and chemical changes (LO 9)

1.1 Distinguishing between physical and chemical changes

1.

a. Read the following passage and answer the questions beneath.

> The Covid-19 pandemic has increased investing in gold. This element is mined and found in its native state. Gold is in hot demand as an investment, a status symbol, and a key component in many electronic products. But it's also a finite resource, and there will eventually come a stage when there is none left to be mined. Price rises have been driven by the pandemic as investors view gold as a safer asset in times of economic uncertainty. While gold in the ground may be hard to quantify, it's not the only source. There is also gold on the moon. However, the costs associated with mining it and transporting it back to earth are significantly higher than the value of the gold. A large amount of gold is used in electronic products that are widely viewed as disposable, such as mobile phones. The amount of gold in the average phone is worth a few pounds. Efforts to recycle gold extracted from electronic waste are already well under way.
>
> *https://www.bbc.com/news/business-54230737*

i. List THREE main uses of gold in its native state.

_____

_____

_____ (3)

ii. List TWO benefits of recycling gold other than mining it.

_____

_____ (2)

iii. Explain why gold is found in its native state and not reacted with other non-metals to form compounds.

_____

_____

_____ (2)

b. On the other hand, the element calcium is rarely found in its native state. Complete the table below by filling in the spaces related to the different compounds of calcium and their uses.

Compound Name	Chemical formula	Common name	Use
Calcium carbonate		Limestone	
	$CaSO_4$	Chalk	
		Marble	Buildings, stairs, statues.
		Quicklime	Water softeners, air purifiers, treat acidic soils.
Calcium hydroxide			
	$CaSO_4$	Gypsum	

(13)

Total: 20 marks

2. State if these statements are true or false giving a reason for your answer (chemical equations should be used where necessary).

- The conversion of hydrated copper(II) sulfate into anhydrous copper(II) sulfate is a physical reaction as it is a reversible reaction.

True/false: _____ (1)

Reason:

_____

_____ (1)

- When a pink wall is painted green a chemical change takes place as this is accompanied by a change in colour.

True/false: _____ (1)

Reason:

_____

_____ (1)

- When potatoes are cut into chips a chemical reaction takes place as the process is irreversible.

True/false: _____ (1)

Reason:

_____

_____ (1)

Total: 6 marks

3. State if the following processes are physical or chemical changes.

Process	Physical/chemical
Two chemicals are mixed, and a gas is produced.	
Mixing salt and pepper in water.	
Toasting a marshmallow on a campfire.	
Autumn leaves changing colour.	
Dissolving copper(II) sulfate in water.	
Chocolate blocks changing into molten chocolate when heating on a flame.	
Magnesium pellets crushed into magnesium powder.	
A bicycle changes colour as it rusts when exposed to air and humidity.	
Paper towel absorbing water.	
Wood rotting.	

Total: 10 marks

4. Joel wrote this explanation in his discussion for a lab report titled 'The differences between mixtures and compounds':

> When the black iron and the yellow powdered sulfur are mixed a physical change takes place as a mixture forms. However, when this mixture is heated using a Bunsen burner a new colour change is seen as a red glow is observed before the new compound forms a black colour. Using a magnet and reactions with hydrochloric acid one can prove that producing a mixture is a physical change and the new compound, iron(II) sulfide is the result of a chemical change.

a. Write a chemical equation, using state symbols, for the reaction between iron and sulfur.

_____ (2)

b. Fill in the table below listing the observations that would be noted by Joel in the lab.

Sample	Colour	Magnet (Is it magnetic?)	With hydrochloric acid (observations)
Iron (Fe)			
Sulfur (S)			
Iron and sulfur mixture	Greyish/yellow		
Iron (II) sulfide compound produced			Produces a toxic gas the smell of rotten eggs. This gas is hydrogen sulfide.

(10)

Total: 12 marks

1.2 The three states of matter and 1.3 Changes of state

1. Fill in the following paragraphs related to the three states of matter using suitable words or phrases.

a. Particles in a solid are arranged _____ together and cannot move around. They can only _____in fixed positions. This is why solids have a _____shape and a _____ volume. The _____ are strongly attracted to each other with very _____ space in between. Thus it is very difficult to _____ them. (7)

b. Particles in the liquid state have enough space between them so they can move around by rolling _____ each other. They can be poured from one _____ to another. The particles are _____ attracted to each other than in solids. A liquid can _____ shape and take the shape of any _____ they are in. However, they still have a _____ volume. The liquid particles are still arranged close together, and so it is _____ to compress them. (7)

c. The particles in a gas are arranged very _____ apart from each other. This means that they can move about at a _____ speed. The particles in a gas spread out in all directions to _____ the space in a container. The space between the particles is very big and thus it is _____to compress a gas. Many gases are invisible but they still have _____. (5)

Total: 19 marks

2.

a. Molly took an aluminium can filled with lemonade out of the refrigerator in a hot summer day. Soon drops of liquid were seen trickling down the sides of the can. Molly started complaining that the can was damaged, and lemonade was trickling down the sides ruining her dress. However, Jacob explained this was not so. In the space provided, write what Jacob would have said to Molly.

_____

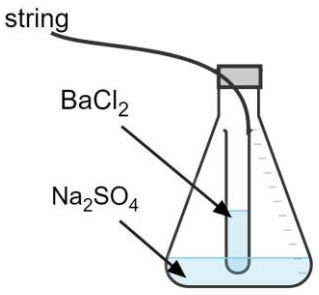
_____

_____

_____

_____ (3)

b. Jane poured 5 ml of sodium sulfate solution in a conical flask and 5 ml of barium chloride in a test tube, securing the test tube with a string as can be shown by the figure on the right. She weighed all the contents together on a weighing balance. The mass obtained was 160.2 g.



She turned the setup upside down (holding the corked conical flask) so that the two solutions mixed well together. She then swirled the conical flask several times making sure that both solutions mix well. Jane then left the setup to stand for 10 minutes making sure that the reaction was complete. A white precipitate forms at the bottom of the conical flask. After 10 minutes, allowing complete reaction, she weighed the contents again and found the mass to be 160.2 g.

i. Write a balanced chemical equation including state symbols, of the reaction taking place.

_____ (3)

ii. Explain why the same value was obtained before and after the experiment.

_____

_____

_____ (3)

3. Explain the following statements by referring to the kinetic theory.

a. The melting point of the metal gallium is 29.7 °C. When gallium is held in one's hand it forms a liquid.

_____

_____ (2)

b. A layer of water is placed carefully over a red dye. After two days the red dye spread throughout the water.

_____

_____ (2)

c. A bottle of perfume is opened at the front of the classroom but after a while you can smell the perfume from the back of the classroom.

_____

_____ (2)

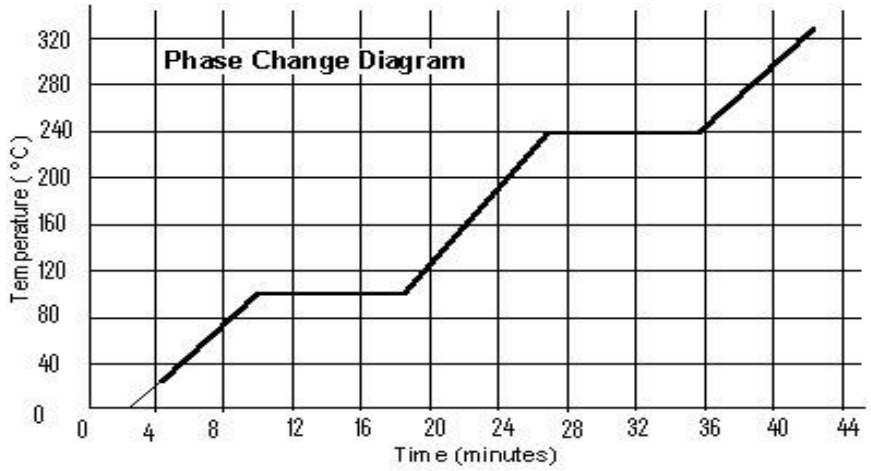
d. The relative molecular mass of four gases is: carbon dioxide 44, methane 16, nitrogen 28 and oxygen 32. Put these gases in order of their diffusion rate with the fastest first.

_____

_____ (2)

Total: 17 marks

4. The diagram below shows the heating curve of a metal.



a. State the melting point of the metal. _____ (1)

b. State the boiling point of the metal. _____ (1)

c. What happens to the temperature as the substance changes state?

_____ (1)

d. How can you say that the substance is not water?

_____

_____ (2)

e. What is a cooling curve and how is this different from a heating curve?

_____

_____ (2)

Total: 7 marks

5. The state at which a substance exists at room temperature depends upon its melting and boiling in relation to room temperature. If room temperature is 25 °C, in which state of matter will each of the following substance exist:

Substance	Melting point /°C	Boiling point /°C	State
A	-183	-88	
B	80	216	
C	-89	118	

Total: 3 marks

6. Complete the following sentences using one word or a phrase from the list below. The words can be used ONCE or not at all:

compound, mixture, element, condensation, sublimation, squeeze, evaporation, diffusion, vibrate

a. A pure substance that cannot be split up into anything simpler is called an _____. (1)

b. When a solid changes directly to a gas, this is called _____. (1)

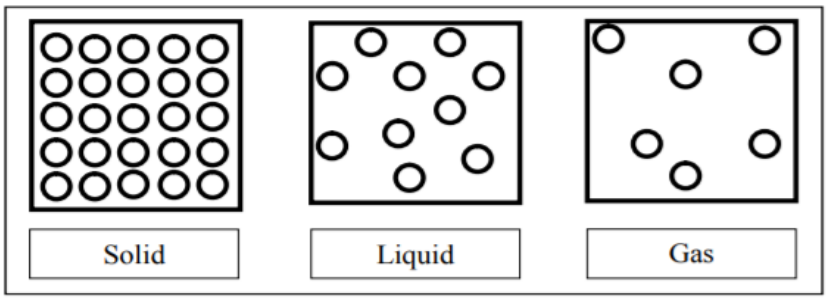
c. When baking a cake, it smells in every corner of the house because of _____.(1)

d. In a solid the particles are very close together and can only _____ about fixed positions. (1)

e. Iron and sulfur are put on a filter paper and mixed to form a _____. They are then placed in a crucible and heated over a Bunsen burner and tripod to form a black _____ of iron(II) sulfide. (2)

Total: 6 marks

7. The kinetic theory states that all matter is made up from small indivisible particles as shown below.



a. Fill in the spaces with appropriate words/phrases:
These small indivisible particles are known as _____. Elements have only _____ type of particles while compounds and mixtures have _____ than one type of particle. Steel is an alloy. It is an example of a _____ (4)

b. Use the kinetic theory to explain why:

i. Solids have a fixed shape.

_____

_____ (1)

ii. Liquids can take the shape of a container.

_____

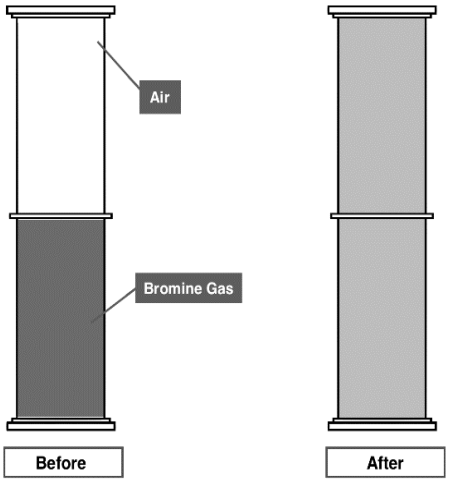
_____ (1)

iii. Gases can be compressed easily.

_____

_____ (1)

c. The diagram below shows what happens when bromine gas present in a gas cylinder and air in a separate gas jar are mixed.



i. What is the name of the process taking place?

_____ (1)

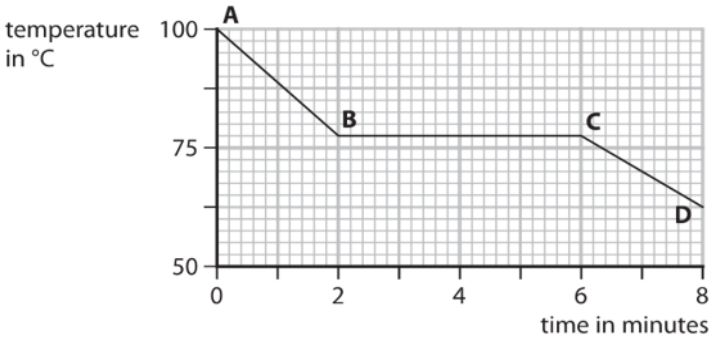
ii. Explain what is observed after a couple of hours in terms of particles.

_____

_____ (2)

Total: 10 marks

8. The graph below shows how the temperature of a substance varies with time as it is cooling down.



a. Fill in the spaces with suitable words.

The figure shows the _____ curve of a substance. From point A to point B the substance is in a _____ state and from point ____ to point _____ the substance is a liquid. The conversion to a liquid happens between the _____ and _____ minute. (5)

b. The table below shows the melting and boiling points of substances W, X, Y and Z.

Substance	Melting point (°C)	Boiling point (°C)
W	-220	-188
X	-101	-34
Y	-7	59
Z	114	184

Using the information in the table above:

i. Give the letter of the substance that is a solid at 20 °C _____ (1)

ii. Give the letter of the substance that is a liquid at 50 °C _____ (1)

Total: 7 marks

9. A student is given some solid wax. He needs to turn this into a liquid and determine the melting point of the wax.

a. Using TWO diagrams draw the particle arrangement in solid wax and in the melted wax.

Solid

Melted wax

(2)

b. Dry ice (solid carbon dioxide) forms a gas without having a liquid stage at a temperature of -78 °C at atmospheric pressure.

i. What is this process called? _____ (1)

ii. Sketch the heating curve of dry ice labelling both the x-axis and the y-axis as well as any changes of state taking place.

(2)

c. Explain what happens to the particles as solid dry ice reaches room temperature.

_____

_____

_____ (2)

Total: 7 marks

2 Rates of chemical reactions (LO 11)

1. 0.2 g of magnesium pieces were reacted with an excess of 20 cm^3 of 1 mol dm^{-3} hydrochloric acid. The rate of this reaction was measured by noting the volume of hydrogen gas produced per 2 s time interval.

a. Give the definition of the term 'rate of reaction'.

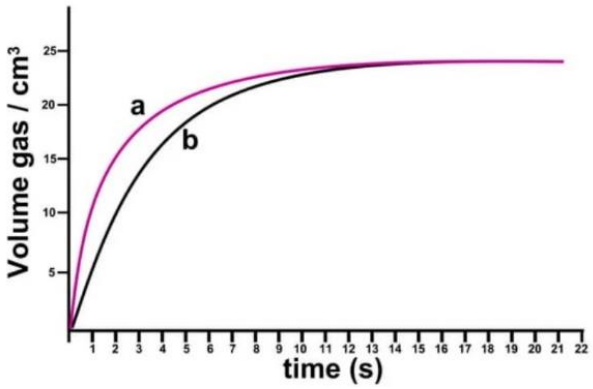
_____

_____ (2)

b. The experiment was repeated with 0.2 g powdered magnesium. Identify which of the two graphs below (a or b), best represents:

i. the reaction carried out with **magnesium pieces**.

ii. the reaction carried out with **magnesium powder**.



Adapted from: Reaction Rate Graph Tutorial 2 (slideshare.net)

Graph A: _____

Graph B: _____ (2)

c. The surface area of reactants affects the rate of a reaction. Name TWO other factors that would increase the rate of this reaction.

i. _____

ii. _____ (2)

d. Suggest how the experiment can be altered to increase the final volume of gas collected.

_____

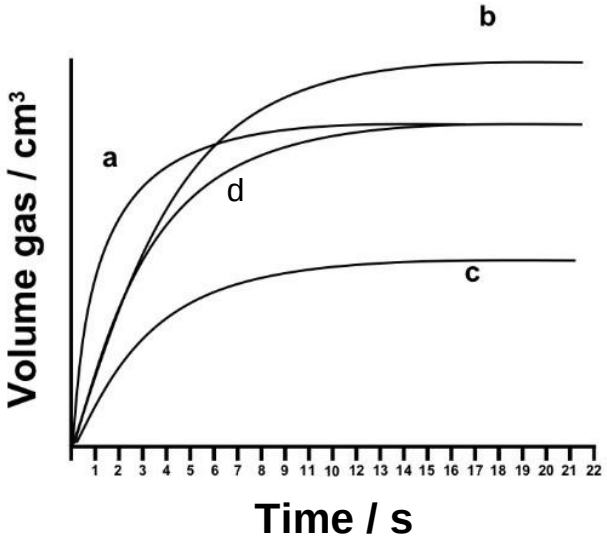
_____ (2)

Total: 8 marks

2. 0.5 g of powdered calcium carbonate were reacted with 60 cm^3 0.8 mol dm^{-3} hydrochloric acid (in excess), at 25 °C. The equation for the reaction is as follows:

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$$

The volume of carbon dioxide collected was measured with time and **graph a** was plotted.



Adapted from: Reaction Rate Graph Tutorial (slideshare.net)

a. The experiment was repeated 3 times, each time, using different experimental conditions. Using the information given above, identify which graph (b, c, or d) best represents the following: (3)

Original Experiment:	**Graph**
0.5 g powdered calcium carbonate + 60 cm^3 0.8 mol dm^{-3} hydrochloric acid at 25 °C	a
The experiment was repeated with:	
0.5 g calcium carbonate chunks + 60 cm^3 0.8 mol dm^{-3} hydrochloric acid at 25 °C	
0.7 g calcium carbonate chunks + 60 cm^3 0.8 mol dm^{-3} hydrochloric acid at 25 °C	
0.25 g calcium carbonate chunks + 60 cm^3 0.5 mol dm^{-3} hydrochloric acid at 25 °C	

b. In this experiment, the rate of reaction was determined by measuring the volume of gas collected per time intervals, at 25 °C.

i. Draw the apparatus used.

(4)

ii. Identify a different method with which the rate of this reaction could have been measured.

_____ (1)

Total: 8 marks

3. 10 g of sodium sulfite were placed in a crucible on an electronic balance. 10 cm^3 of 1 mol dm^{-3} sulfuric acid were added. The mass of the contents of the container on the electronic balance, was recorded at different time intervals. This experiment was repeated at different temperatures. The observations made were as follows:

Time (mins)		**0**	**2**	**4**	**6**	**8**	**10**	**12**
Mass (g)	(A) At **20 °C**	20.0	18.2	17.3	16.5	15.7	14.2	13.8
	(B) At **25 °C**	20.0	17.9	16.4	15.6	14.9	13.8	13.8
	(C) At **30 °C**	20.0	17.1	15.8	14.5	13.8	13.8	13.8

a. Write a balanced chemical equation for the reaction including state symbols.

_____ (3)

b. Explain why a decrease in mass was observed.

_____

_____ (2)

c. Plot graphs of experiments A, B, and C. Label the graphs accordingly. (5)

d. How does the rate of reaction vary with temperature? Explain your answer using the collision theory.

_____

_____ (3)

e. Using the same reaction, describe another method which could be used to investigate the effect of temperature on this reaction.

_____

_____

_____

_____

_____

_____

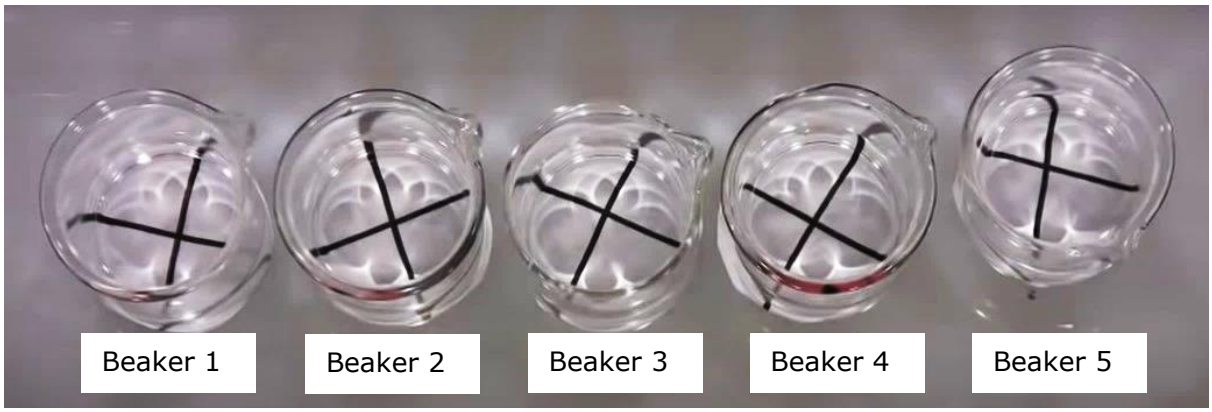
_____ (6)

Total: 19 marks

4. Karl wanted to investigate the effect of reactant concentration on the rate of a reaction. He used varying volumes of a 0.1 mol dm^{-3} solution of sodium thiosulfate ($Na_2S_2O_3$) and reacted it with 10 cm^3 of 0.5 mol dm^{-3} hydrochloric acid, in each case. The reaction that took place is represented by means of the following equation:

$$Na_2S_2O_3(aq) + 2HCl(aq) \rightarrow NaCl(aq) + S(s) + SO_2(g) + H_2O(l)$$

Karl set up his apparatus as shown below:

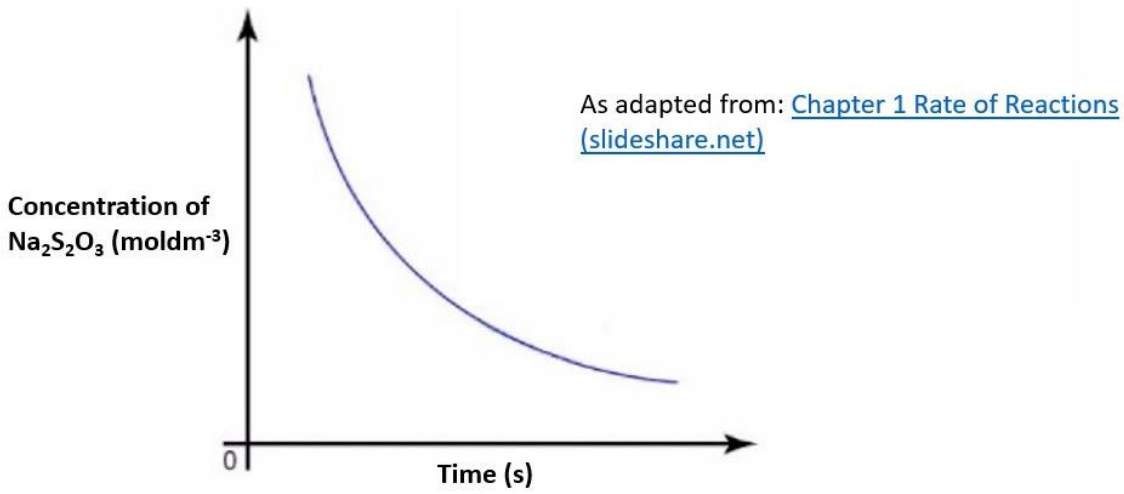


Adapted from: Rate of Reaction of Sodium Thiosulfate and Hydrochloric Acid - Bing video

Karl used a stopwatch to record the time it took for the black crosses to disappear due the formation of opaque sulfur. He devised a table with the results obtained, as follows:

Beaker	**Volume of 0.1 mol dm^{-3} $Na_2S_2O_3$ (cm^3)**	**H_2O (cm^3)**	**Concentration of $Na_2S_2O_3$ (mol dm^{-3})**	**Time (s)**	**1/time (s^{-1})**
1	50	0	0.10	22.8	
2	40	10	0.08	27.6	
3	30	20	0.06	35.4	
4	20	30	0.04	60.2	
5	10	40	0.02	160.1	

a. Karl sketched a graph of sodium thiosulfate concentration with time, as shown below:



As adapted from: Chapter 1 Rate of Reactions (slideshare.net)

i. Describe the relationship of sodium thiosulfate concentration with time, from Karl's graph.

_____

_____ (2)

ii. Using the collision theory explain the shape of the graph.

_____

_____

_____ (2)

b.

i. Calculate the rate of reaction (1/time) for the reactions taking place in beakers 1 to 5 and fill in the table accordingly.

_____

_____

_____ (5)

ii. Plot the graph of sodium thiosulfate concentration against 1/time, from the results obtained. (4)

iii. Using the shape of the graph obtained in part (b) (ii), identify the relationship between the concentration of sodium thiosulfate and 1/time.

_____

_____ (1)

Total: 14 marks

5. Hydrogen peroxide is photosensitive and decomposes in the presence of light.

a. Write a balanced chemical equation for the reaction.

_____ (2)

b. An experiment was set up to determine the effect of light intensity on the rate of decomposition of hydrogen peroxide. Two bottles labelled A and B, containing hydrogen peroxide solution were exposed to different light intensities, for a total of 24 hours. The following table portrays the volume of oxygen collected with time (in hours).

	Time (hours)	**0**	**4**	**8**	**12**	**16**	**20**	**24**
Volume of O_2 collected (cm^3)	**Bottle A**	0	3.2	4.0	4.9	6.1	6.9	6.9
	Bottle B	0	2.4	3.5	4.3	5.0	5.7	6.5

c. Using a graph paper, plot the graphs of the volume of oxygen collected (in cm^3) per bottle against the time taken (in hours). Label the graphs A and B, accordingly. (5)

d. Identify in which bottle (A or B), the rate of decomposition of H_2O_2 was highest. Explain your answer with reference to the graphs plotted.

_____

_____ (2)

e. Draw a labelled diagram for the apparatus used during this reaction in the space provided below.

(4)

f. Give TWO precautions that must be followed to ensure fair testing during the execution of this experiment.

_____

_____

_____

_____ (2)

g. Predict what would happen to the concentration of H_2O_2 with time, upon exposure to light.

_____ (1)

h. Mention ONE other factor (apart from light) that increases the rate of decomposition of hydrogen peroxide.

_____ (1)

Total: 17 marks

3 Quantitative calculations (LO 10)

3.1 Calculations related to relative mass and percentage composition by mass

1. Work out the relative molecular mass (RMM) of the following substances.

a. Chlorine gas _____ (2)

b. Bromine liquid_____ (2)

c. Iodine crystals _____ (2)

d. Ozone gas_____ (2)

Total: 8 marks

2. Calculate the RMM of the following molecules.

a. Ammonia gas _____ (2)

b. Carbon monoxide _____ (2)

c. Methane gas _____ (2)

d. Sulfur dioxide _____ (2)

Total: 8 marks

3. Find the relative formula mass (RFM) of the following compounds.

a. Copper(II) oxide _____ (2)

b. Magnesium sulfate _____ (2)

c. Zinc nitrate _____ (2)

d. Ammonium carbonate _____ (2)

e. Calcium phosphate _____ (2)

Total: 10 marks

4. Find the number of moles in:

a. 56 g carbon monoxide

_____

_____ (2)

b. 120 g sulfur trioxide

_____

_____ (2)

c. 23 g ethanol (C_2H_5OH)

_____

_____ (2)

Total: 6 marks

5. Find the mass of:

a. 2 moles ethanoic acid (CH_3COOH)

_____

_____ (2)

b. 0.5 moles fluorine gas

_____

_____ (2)

c. 0.25 moles bromine liquid

_____

_____ (2)

Total: 6 marks

6. Find the number of moles contained in:

a. 40 g copper(II) sulfate

_____

_____ (2)

b. 87 g potassium sulfate

_____

_____ (2)

c. 32 g ammonium carbonate

_____

_____ (2)

Total: 6 marks

7. Find the mass of:

a. 0.5 moles calcium carbonate

_____

_____ (2)

b. 3 moles aluminium carbonate

_____

_____ (2)

c. 0.25 moles sodium hydroxide

_____

_____ (2)

Total: 6 marks

8. Given that Avogadro's constant is 6.02×10^{23} find:

a. the number of molecules in 34 g of ammonia gas.

_____

_____ (2)

b. the number of atoms in 48 g of methane gas.

_____

_____ (2)

c. the number of ions in 684 g of aluminium sulfate.

_____

_____

_____ (2)

d. the number of hydrogen ions in 49 g of sulfuric acid.

_____

_____

_____ (2)

Total: 8 marks

9. Scientists often want to find the percentage by mass of an element in a compound. Usually this is to find out which compounds are better value for money, especially when extracting elements from their ores or compounds. For example, iron is extracted from two main iron ores - haematite Fe_2O_3 or magnetite Fe_3O_4. Which iron ore has the highest percentage by mass of iron?

_____

_____

_____

_____

_____

_____

_____

Total: 4 marks

10. Fertilisers contain nitrogen which is needed by plants to build their amino acids, needed for growth. So, a bag of fertiliser usually shows the percentage of nitrogen it contains on the outside. This advert on a Maltese newspaper is showing that ammonium sulfate has 21% N by mass.

a. Prove that the advert is correct by showing your working.

_____

_____

_____

_____ (4)

b. Another supplier is selling another fertiliser, sodium nitrate, commonly known as saltpetre. If this supplier is selling this fertiliser at the same price as the ammonium sulfate, which fertiliser would you suggest a farmer to buy? Show your working and explain your answer.

_____

_____

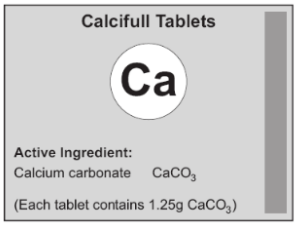
_____

_____

_____ (6)

Total: 10 marks

11. Calcium carbonate tablets are used to treat people with calcium deficiency. Calcium ions are important in order to maintain healthy bones and teeth.



a. Calculate the relative formula mass of calcium carbonate.

_____ (1)

b. Calculate the percentage by mass of calcium in calcium carbonate.

_____

_____ (2)

c. Calculate the mass of calcium in each tablet. (Each tablet contains 1.25 g $CaCO_3$)

_____

_____

_____ (2)

Total: 5 marks

12. During a school visit to the National History Museum in Mdina, the students visited the hall dedicated to minerals and ores. In this area there are exhibited more than 850 pieces of rocks and minerals, with both raw material and worked pieces of art and jewellery. John found the following four ores:

a. Chalcopyrite; $CuFeS_2$

b. Atacamite; $Cu_2Cl(OH)_3$

c. Brochantite; $Cu_4SO_4(OH)_6$ and

d. Linarite; $PbCuSO_4(OH)_2$

Help John to work out the percentage by mass of copper in each ore.

Total: 8 marks

13. Magnesium chloride has healing effects on a wide range of diseases. The hydrated form of magnesium chloride contains water of crystallisation and has the formula $MgCl_2.6H_2O$.

a. What is meant by the term water of crystallisation?

(1)

b. Calculate the relative formula mass of hydrated magnesium chloride, $MgCl_2.6H_2O$.

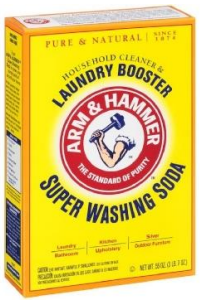
(2)

c. Use the value calculated in part (b) to find the percentage of water of crystallisation in hydrated magnesium chloride.

(3)

Total: 6 marks

14. Mary bought a 500 g bag of washing soda (hydrated sodium carbonate, $Na_2CO_3.10H_2O$) to treat water hardness. She left the bag open and noticed that the mass of contents was decreasing! Then she realized that the substance was losing its water of crystallisation to the surroundings. Find the percentage by mass of water of crystallisation in the washing soda.



Total: 4 marks

15. Which of the following hydrated salts has the highest percentage by mass of water?

a. $CoCl_2.6H_2O$

b. $CuSO_4.5H_2O$

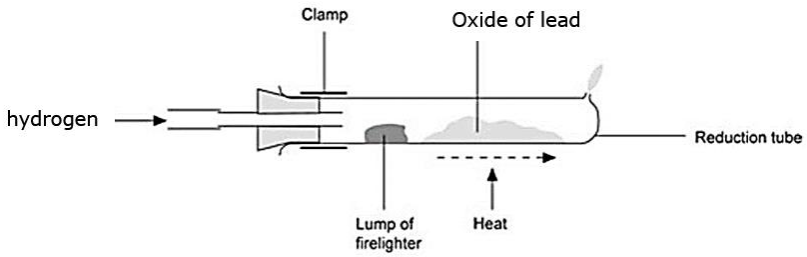
c. $Ba(OH)_2.8H_2O$

Total: 6 marks

3.2 Calculations to determine the amount of reacting substances

1. In an experiment to find the empirical formula of an oxide of lead, a small porcelain dish was weighed, filled with an oxide of lead, and weighed again. The dish was placed in a tube and was heated in a stream of hydrogen. The hydrogen reduced the oxide of lead to a bead of metallic lead. When the apparatus was cool, the dish with the bead of lead was weighed.

   Mass of porcelain dish = 17.95 g
   Mass of porcelain dish + oxide of lead = 24.80 g
   Mass of porcelain dish + lead = 24.16 g



a. Calculate the mass of lead in the oxide of lead.

_____ (1)

b. Calculate the mass of oxygen in the oxide of lead.

_____ (1)

c. There are three different oxides of lead: PbO, PbO_2 and Pb_3O_4. Use your results from parts (a) and (b) to find the empirical formula of the oxide used in this experiment.

_____

_____

_____

_____ (4)

d. Which of the three above mentioned oxides has the highest percentage of lead? (Show your working for all the oxides).

_____

_____

_____

_____

_____

_____ (3)

Total: 9 marks

2. A student was given some hydrated copper(II) sulfate crystals, $CuSO_4.\mathbf{x}H_2O$. They were placed in a previously weighed test-tube which was then reweighed.

Mass of test-tube + hydrated copper(II) sulfate crystals = 9.25 g

Mass of test-tube = 5.40 g

Mass of test-tube + copper(II) sulfate after heating = 7.90 g

a. What colour do hydrated copper(II) sulfate crystals have?

_____ (1)

b. Calculate the mass of hydrated copper(II) sulfate used in the experiment.

_____ (1)

c. The crystals were gently heated until they became anhydrous, i.e. no more water vapour was given off. The crystals changed colour and became powdery. What colour was the copper(II) sulfate after heating?

_____ (1)

d. Calculate the mass of:

i. copper(II) sulfate which remained after heating.

_____ (1)

ii. water lost from the crystals.

_____ (1)

e. Calculate:

i. the relative formula mass of anhydrous copper(II) sulfate.

_____ (1)

ii. the relative molecular mass of water.

_____ (1)

f. Using your answers to parts (d) and (e), calculate:

i. how many moles of anhydrous copper(II) sulfate remained after heating.

_____

_____ (2)

ii. how many moles of water were lost on heating.

_____

_____ (2)

g. Calculate the value of **x** and hence write the formula of hydrated copper (II) sulfate crystals.

_____

_____

_____

_____ (2)

Total: 13 marks

3. When a hippopotamus is seen out of water it looks as though it is bleeding. This is due to a red coloured secretion which protects the hippopotamus against sunburn caused by UVB radiation. Scientists have found that one of the active ingredients in this natural sunscreen is a chemical called hipposudoric acid, (an organic acid made up of carbon, hydrogen, and oxygen).

a. Find the empirical formula of hipposudoric acid, given that a sample of this acid has 2.4 g of carbon, 0.1 g of hydrogen and 1.6 g of oxygen.

_____

_____

_____

_____

_____ (4)

b. Given that the RMM of hipposudoric acid is 328, find its molecular formula.

_____

_____ (2)

Total: 6 marks

4. This question is about different medicines.

a. Paracetamol is a widely used over-the-counter analgesic (pain reliever) and antipyretic (fever reducer). It is commonly used for the relief of fever, headaches, and other minor aches and pains, and is a major ingredient in numerous cold and flu remedies.

i. Given that the elements found in the paracetamol molecule have the following percentage by mass; 63.58% carbon, 5.96% hydrogen, 9.27% nitrogen and 21.19% oxygen, find the empirical formula of paracetamol.

_____

_____

_____

_____

_____

_____ (4)

ii. If the relative molecular mass of paracetamol is 151, find its molecular formula.

_____

_____ (2)

iii. Each tablet contains 500 mg (0.5 g) of paracetamol. Calculate the number of moles present in one tablet of paracetamol. Give your answer to three decimal places.

_____

_____

_____

_____ (2)

b. Aspirin is another drug used to treat pain relief. The chemical name for aspirin is acetylsalicylic acid which contains 60.00% by mass of carbon, 4.48% hydrogen and 35.52% oxygen. Use this information to calculate the empirical formula of acetylsalicylic acid.

_____

_____

_____

_____

_____ (3)

c. The relative molecular mass of acetylsalicylic acid is 180. Find the molecular formula of aspirin.

_____

_____ (2)

Total: 13 marks

5. Saccharin is an artificial sweetener that is used in many soft drinks.

a. If the percentage by mass of each element in saccharin is 45.90% carbon, 2.73% hydrogen, 7.65% nitrogen, 26.23% oxygen and the rest is sulfur, calculate the empirical formula of saccharin.

_____

_____

_____

_____

_____ (4)

b. Given that the RMM of saccharin is 183, find its molecular formula.

_____

_____ (2)

Total: 6 marks

6. In an experiment to find the number of molecules of water of crystallisation in sodium sulfate crystals, $Na_2SO_4.nH_2O$, 3.22 g of hydrated sodium sulfate crystals were heated gently. When all the water of crystallisation had been driven off, 1.42 g of anhydrous sodium sulfate was left. Find the value for "n" in the formula.

_____

_____

_____

_____

_____

_____

Total: 4 marks

7. Find the molecular formula for each of the following compounds from the empirical formula and the relative molecular mass.

	Empirical Formula	**RMM**	**Molecular Formula**
A	CF_2	100	
B	C_2H_4O	88	
C	CH_3	30	
D	CH	78	
E	CH_2	42	
F	CH_3O	62	
G	CH_2Cl	99	
H	C_2NO_2	210	

Total: 8 marks

8. Given that the RMM of a hydrocarbon is 56, calculate its molecular formula if it contains 0.12 g of carbon and 0.02 g of hydrogen.

_____

_____

_____

_____

_____

Total: 2 marks

9. Calculate the empirical formula of an organic liquid containing 52.17% of carbon, 13% of hydrogen with the rest being oxygen. If the RMM of this liquid is 92, work out its molecular formula.

_____

_____

_____

_____

_____

_____

Total: 4 marks

10. Calculate the number of moles at STP present in:

a. 50 dm^3 nitrogen gas,

_____

_____ (2)

b. 1500 cm^3 neon gas,

_____

_____ (2)

c. 10 dm^3 methane gas.

_____

_____ (2)

Total: 6 marks

11. Find the volume, in cm^3, at STP of:

a. 7 g of nitrogen gas, _____

_____ (2)

b. 2 g of helium gas, _____

_____ (2)

c. 6.4 g sulfur dioxide gas. _____

_____ (2)

Total: 6 marks

12. Find the mass, in grams, for the following volumes of gases at STP:

a. 100 cm^3 of oxygen gas, _____

_____ (2)

b. 2 dm^3 of argon gas, _____

_____ (2)

c. 500 cm^3 of methane gas. _____

_____ (2)

Total: 6 marks

13. 4.46 g of lead(II) oxide are heated in a stream of hydrogen until it has all changed to lead and water vapour. The water vapour that forms is condensed. What will the mass of water be?

_____

_____

_____

_____

Total: 4 marks

14. 2 g of magnesium were reacted with dilute hydrochloric acid. Find the:

a. mass of salt produced.

_____

_____

_____ (3)

b. volume of hydrogen at STP formed during this reaction.

_____

_____

_____ (3)

Total: 6 marks

14. Dilute hydrochloric acid was reacted with 1.2 g sodium carbonate. Find the mass of sodium chloride and the volume of carbon dioxide produced at STP.

_____

_____

_____

_____

_____

Total: 6 marks

15. Calcium cyanamide, $CaCN_2$ is used as a fertiliser, and it reacts with water to give ammonia as follows:

$$CaCN_2(s) + 3H_2O(l) \rightarrow CaCO_3(s) + 2NH_3(g)$$

What mass of $CaCN_2$ when reacted with water will produce 15 dm^3 of NH_3 at STP?

_____

_____

_____

_____

_____

_____

_____

Total: 4 marks

16. Potassium chlorate decomposes upon heating, according to the reaction below.

$$2KClO_3(s) \rightarrow 2KCl(s) + 3O_2(g)$$

In an experiment, 40.0 g $KClO_3$ are heated until it completely decomposes.

a. What is the theoretical yield, in grams, of oxygen gas?

_____

_____

_____

_____

_____ (3)

b. When the experiment is performed, the oxygen gas is collected, and its mass is found to be 14.9 g. What is the percentage yield of the reaction?

_____

_____

_____

_____ (2)

Total: 5 marks

17. When 1.274 g of anhydrous copper(II) sulfate were reacted completely with zinc metal, 0.392 g copper metal were obtained according to the equation:

$$CuSO_4(aq) + Zn(s) \rightarrow Cu(s) + ZnSO_4(aq)$$

What is the percentage yield of copper?

(**Hint:** First you need to calculate the theoretical yield.)

Total: 5 marks

18. A student reacts 30.5 g of zinc with nitric acid and evaporates the remaining water to obtain 65.2 g of zinc nitrate.

a. Write down a balanced chemical equation for the reaction.

(2)

b. What is the theoretical yield of zinc nitrate?

(3)

c. Find the percentage yield of zinc nitrate.

(2)

Total: 7 marks

4 Groups in the Periodic Table (LO 6)

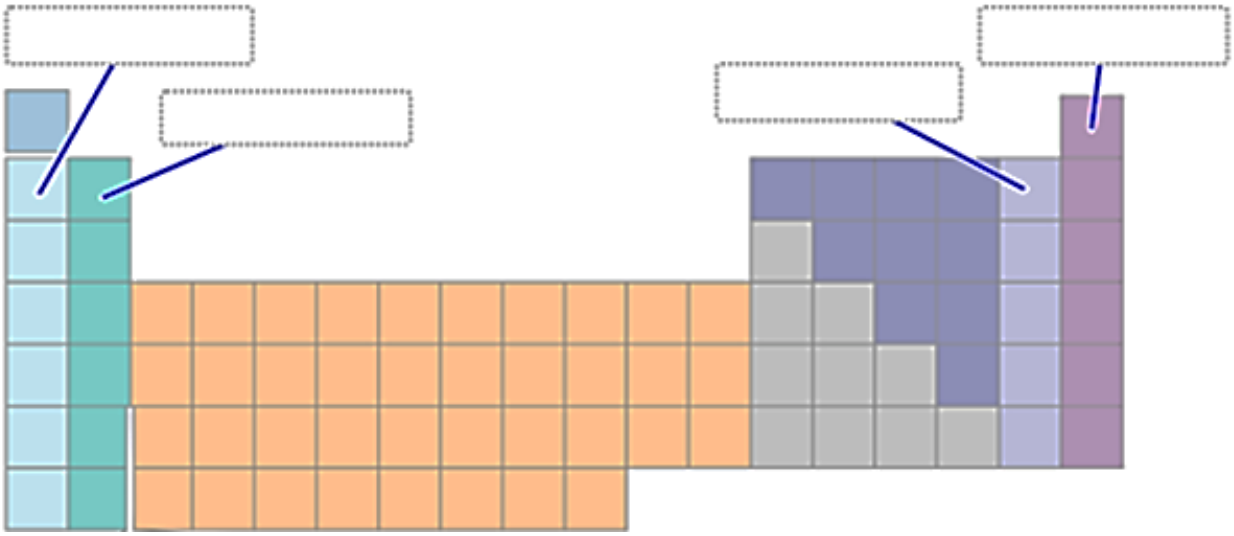
4.1 Some groups in the Periodic Table. Distinguishing between metals and non-metals

1. State whether the properties below refer to metals or non-metals:

Property	**Metal / Non-metal**
Can be solid, liquid or gas at room temperature	
Sonorous	
Malleable	
Brittle	
Good conductor of heat and electricity	

Total: 5 marks

2. Label the groups below.



Total: 4 marks

3. State THREE uses of halogens.

_____

_____

_____

_____

_____

Total:3 marks

4.2 Group 1 and group 7 elements

1. Match the following properties to the respective element:

Property	Chemical
Yellow gas	Iodine
Violet black solid which sublimes	Bromine
Reddish brown, volatile liquid	Chlorine

Total: 3 marks

2. This question is about the reactions of halogens with hydrogen.

a. Describe how chlorine would react with hydrogen in sunlight.

_____ (1)

b. Give a balanced chemical equation including state symbols for the reaction.

_____ (3)

c. Would you expect iodine to react more or less vigorously with hydrogen?

_____ (1)

d. Explain your answer in part (c) in terms of atomic structure.

_____

_____

_____ (3)

Total: 8 marks

3. Joanna wanted to investigate the reactivity series of the halogens using displacement reactions.

a. Give a description of the method.

_____

_____

_____

_____

_____

_____ (4)

b. State ONE precaution Joanna should take and explain the reason.

_____

_____

_____

_____ (2)

c. In the space provided, draw a table to show the expected observations.

(6)

d. For any one of the reactions give a balanced chemical equation.

_____ (2)

Total: 14 marks

4. Potassium is stored under oil as it is a very reactive metal.

a. Give a word equation to show the reaction between potassium and oxygen.

_____ (2)

b. Give a balanced chemical equation, including state symbols, for the reaction of potassium with oxygen.

_____ (3)

c. Give a balanced chemical equation to show the reaction between lithium and oxygen.

_____ (2)

d. Would you expect lithium to react faster or slower than potassium? Give a reason for your answer.

_____ (2)

Total: 9 marks

5. Sodium is a soft, reactive metal. Its melting point is 97 °C.

a. Give a balanced chemical equation, including state symbols for the reaction of sodium with water.

_____ (3)

b. Give TWO observations would you expect to observe during the reaction.

_____

_____ (2)

c. If a few drops of phenolphthalein indicator are added to the water, what would you expect to see?

_____ (1)

d. Rubidium is a metal in group 1. If placed in water, would the reaction be more or less vigorous than the reaction of sodium with water?

_____ (1)

e. Explain your answer in part (d) in terms of atomic structure.

_____

_____

_____ (3)

Total: 10 marks

6. A group of students discuss the reactivity of the halogens. They discuss what would happen if bromine was added to a solution of sodium chloride, sodium bromide, and sodium iodide. Below is what they said. State whether the students were correct or mistaken. Explain your reasoning.

a. Janice: Bromine and sodium chloride will not react.

_____

_____ (2)

b. Karl: Bromine and sodium iodide will react.

_____

_____ (2)

c. Josef: Bromine is oxidised when it reacts with any halide solution.

_____

_____ (2)

d. Antoinette: If iodine is added to sodium bromide, it will react.

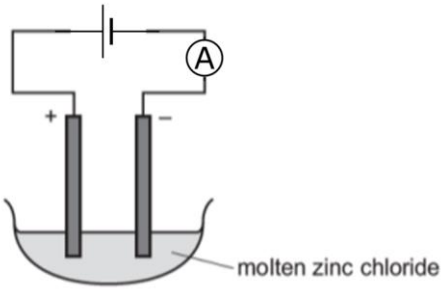
_____

_____ (2)

Total: 8 marks

5 The conduction of electricity through solutions and molten salts (LO 5)

1. Solid zinc chloride is heated in a crucible until it becomes molten. The diagram below shows the apparatus which may be used to pass electricity through the molten zinc chloride using inert electrodes.



a. Name the process by which a substance is broken down using electricity.

_____ (1)

b. The circuit is switched on. The bulb does not light when solid zinc chloride is in the crucible, but it lights after zinc chloride melts. Explain in terms of particles why this happens.

_____

_____ (2)

c. Inert electrodes are used in this experiment

i. Explain why inert electrodes are used.

_____ (1)

ii. Suggest a material for these inert electrodes.

_____ (1)

d. Give the expected observations taking place at the:

positive electrode: _____ (1)

negative electrode: _____ (1)

e. Write the half equations for the reactions taking place at the:

positive electrode: _____ (1)

negative electrode: _____ (1)

f. In another experiment, zinc turnings are melted in the crucible and the bulb lights when the circuit is switched on. Describe one difference in the conduction of electricity between molten zinc chloride and molten zinc. Explain your answer.

_____

_____

_____

_____ (4)

Total: 13 marks

2. Electricity is passed through the following substances.

a. Complete the following table by writing the half equation taking place at each electrode.

Substance	Half equation at cathode	Half equation at anode
Molten lead(II) bromide		
Molten sodium chloride		
Molten aluminium oxide		
Molten calcium iodide		

(8)

b. Using the above half equations explain why a reduction reaction takes place at the cathode.

_____ (1)

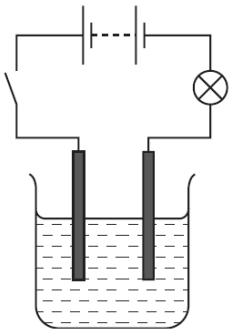
c. Using the above half equations explain why an oxidation reaction takes place at the anode.

_____ (1)

Total: 10 marks

3. The following diagram shows the apparatus used to investigate the effect of electric current on different solutions using inert electrodes.

a. Label the electrodes and their polarity on the diagram. (2)



b. Complete the table below by naming the products given off at each electrode when electricity passes through the following solutions. (8)

Solution	Product at positive electrode	Product at negative electrode
Sodium hydroxide solution		
Copper(II) nitrate solution		
Concentrated potassium iodide solution		
Silver nitrate solution		

c. Predict whether or not the bulb would light if ethanol was placed in the beaker. Explain your answer.

_____

_____ (2)

d. When acidified water is placed in the beaker, two gases are given off which bubble out of solution.

i. Draw a labelled diagram of the set-up that can be used to conduct the electrolysis of acidified water and collect the gases produced.

(4)

ii. Explain why acidified water conducts electricity but deionised / distilled water does not.

_____

_____ (2)

iii. Double the amount of gas is produced at cathode than at anode during the electrolysis of acidified water. Suggest a reason for this, supporting your answer with half equations.

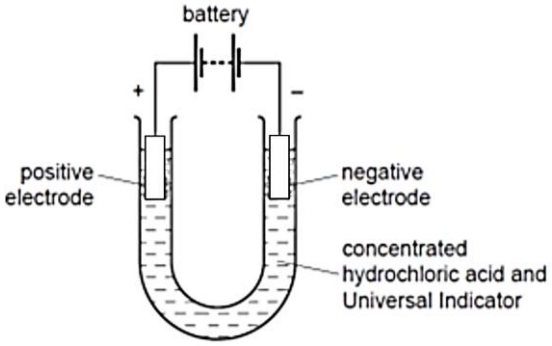
_____

_____

_____ (3)

Total: 21 marks

4. Electricity is passed through concentrated hydrochloric acid as shown in the diagram below.



a. Effervescence is noted at both electrodes.

i. Describe a test and the expected result to confirm the identity of the gas given off at the:

Cathode: _____ (1)

Anode: _____ (1)

ii. Give the half equations taking place at the:

Cathode: _____ (1)

Anode: _____ (1)

iii. What would be the colour of the universal indicator around the positive electrode at the end of the experiment? Explain your answer.

_____

_____ (2)

b. Predict the products given off at each electrode if a very dilute solution of hydrochloric acid were used. Explain your answer.

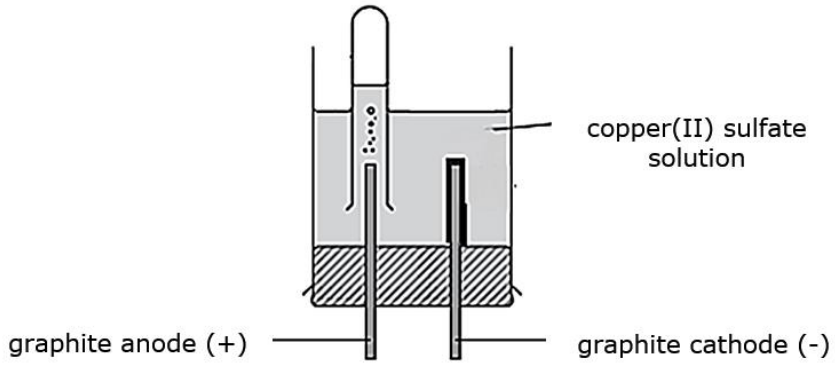
_____

_____

_____ (3)

Total: 9 marks

5. A student carries out the electrolysis of copper(II) sulfate solution using the apparatus in the diagram below.



a. Give the observations noted at each electrode and support your answer with half equations.

_____

_____

_____

_____ (4)

b. After the experiment, when blue litmus paper is dipped into the solution, it turns red. Explain.

_____

_____ (2)

c. With time the electrolyte turns from blue to colourless.

i. Explain the meaning of the term electrolyte.

_____

_____ (2)

ii. Explain in terms of ions why the solution fades with time.

_____

_____ (2)

iii. Describe what changes can be made to the apparatus so that the electrolyte remains blue during the process.

_____

_____ (2)

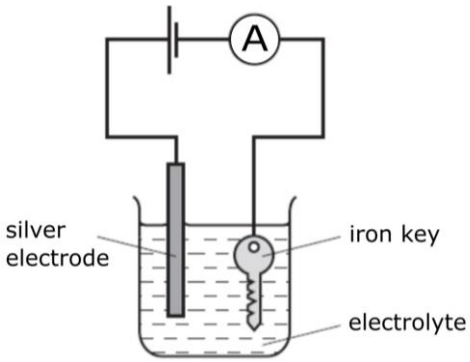
iv. Explain how the changes made in part (c) (iii) would affect the electrolytic process of copper(II) sulfate.

_____

_____ (2)

Total: 14 marks

6. A student sets up the following experiment in the diagram below to coat an iron key with silver.



a. Prior to the experiment the iron key was rubbed with sandpaper. Give a reason for this.

_____ (1)

b. Name the process used to coat the key with silver.

_____ (1)

c. Give a possible electrolyte that could be used in this experiment.

_____ (1)

d. Predict what would be observed after the experiment has been running for 30 minutes. Support your answer with half equations.

_____

_____

_____

_____ (4)

e. Explain why an iron key is used in the experiment and not a plastic key.

_____

_____ (2)

f. Name ONE industrial process where an active electrode is used and explain why this is done.

_____

_____ (2)

Total: 11 marks

6 Substances found in rocks, their extraction, chemical nature, responsible use, and environmental impact (LO 8)

6.1 Limestone and other building materials

1. Calcium carbonate can exist as calcite or aragonite in sedimentary rock. Calcium carbonate has various uses. It can be obtained naturally from sedimentary rock or by the reaction of carbon dioxide with calcium hydroxide.

a. Give a balanced chemical equation for this reaction.

_____ (2)

b. Describe an observation for the reaction in part (a).

_____ (1)

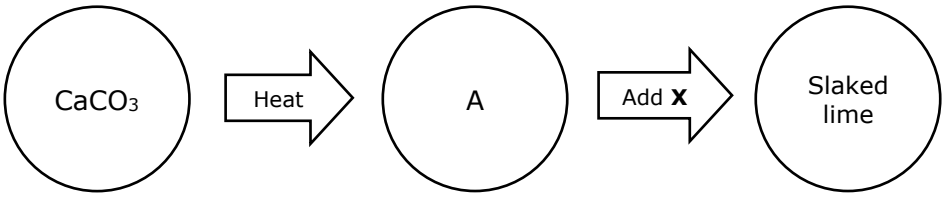
2. Limestone undergoes a series of chemical reactions known as the limestone cycle.

a. Describe TWO industrial uses of limestone.

_____

_____ (2)

b. The diagram below shows a series of reactions.



i. Give the formulae of the following substances:

A: _____ X: _____ (2)

ii. State how substance A can be converted to slaked lime.

_____ (1)

c. Explain how acid rain can affect statues made of limestone.

_____

_____ (2)

d. Give TWO reasons why limestone is a good building material.

_____

_____ (2)

Total: 12 marks

6.2 Metals and their reactivity

1. Copper is an important transition metal extracted by various methods from different ores.

a. Mention TWO properties of copper that make it useful in everyday life.

_____

_____ (2)

b. Explain why copper does not react with dilute hydrochloric or sulfuric acid.

_____

_____ (2)

c. Metals can undergo displacement reactions when reacted with aqueous metallic salts.

i. Write a balanced chemical equation to show the reaction that occurs when copper is added to a silver nitrate solution.

_____ (2)

ii. State ONE observation for the reaction in part (c) (i).

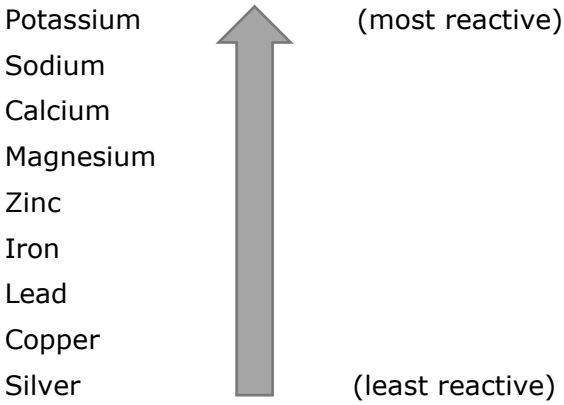
_____ (1)

iii. State why nothing is observed when copper is added to a zinc nitrate solution.

_____ (1)

Total: 8 marks

2. The list below shows metals in order of reactivity:



a. Name the metals which are stored under oil.

_____ (1)

b. Suggest a reason for your answer in part a).

_____

_____ (1)

c. Name the metals which will react with cold water.

_____ (2)

d. Choose ONE metal that will react with steam but not with cold water.

_____ (1)

e. Give the formula of the gas given off in parts (c) and (d).

_____ (1)

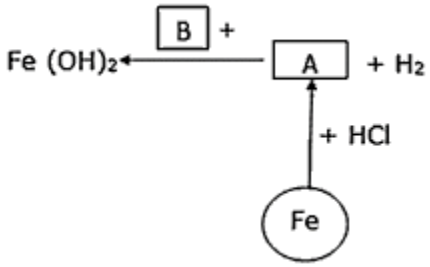
Total: 6 marks

3. Iron is one of the most important metals in the transition metal block of the Periodic Table.

a. Give TWO properties that are particular to transition metals.

_____ (2)

b. Iron undergoes a variety of reactions. The diagram below shows some of these reactions.



i. Give the names of substances A and B. These letters are not chemical symbols.

_____ (3)

ii. Give a balanced chemical equation for the reaction of iron (Fe) with hydrochloric acid (HCl) including state symbols.

_____ (3)

iii. Give a balanced chemical equation for the reaction of A with B including state symbols.

_____ (3)

iv. Name the type of reaction happening in part (b) (iii).

_____ (1)

v. Explain why silver does not react with HCl(aq).

_____ (1)

Total: 13 marks

4. A series of chemical tests were carried out to identify transition metal '**X**'. The statements below explain the tests and any observations:
   - Transition metal '**X'** does not react with cold water but reacts with steam to form a black solid **A** and gas **B**.
   - Transition metal '**X**' reacts with HCl(aq) to form a green solution of salt **C** and gas **B**.
   - Salt **C** reacts with NaOH to form a dirty green precipitate **D**.

a. Give the **name** of transition metal '**X**'. _____ (1)

b. Give the **formulae** of substances: **A**, **B**, **C**, and **D**.

_____

_____

_____ (4)

Total: 5 marks

5. Table 1 below shows the reactions of metals labelled L, Q and R with zinc sulfate and silver nitrate solutions respectively.

Metal	**Reaction with zinc sulfate solution**	**Reaction with silver nitrate solution**
L	No reaction	A silvery deposit is observed
Q	A greyish black solid is observed	A silvery deposit is observed
R	No reaction	No reaction

Table 1: Reactions of metals labelled L, Q, and R

a. Identify the following metals by writing the letter that matches their observations in Table 1 above.

i. Magnesium: _____ (1)

ii. Copper: _____ (1)

iii. Silver: _____ (1)

b. Give the name of another metal that will show the same reactions as metal labelled R.

_____ (1)

c. Write a balanced chemical equation for the reaction of metal Q with silver nitrate solution.

_____ (2)

Total: 6 marks

6.3 Metals and their extraction

1. In industry, metals are extracted from their metal ores using different techniques.

a. Iron is extracted from its ore by reduction with carbon monoxide whilst the aluminium ore undergoes electrolysis.

i. Give the names of the iron and aluminium ores.

_____ (2)

ii. Explain why the iron ore can be reduced by carbon monoxide but the aluminium ore cannot.

_____

_____ (2)

iii. For the extraction of aluminium by electrolysis.

- State any other chemical/s added to the ore and their purpose.

_____

_____ (2)

- Give the ionic half equations happening at the cathode and anode.

_____

_____ (2)

b. Give THREE uses of aluminium and the reason for each use.

_____

_____

_____ (6)

c. Discuss why it is better to use recycled aluminium rather than extracted aluminium.

_____

_____

_____ (2)

Total: 16 marks

2. Iron is a metal which is found towards the middle of the reactivity series. It can be extracted from its ore in the blast furnace. Use your knowledge of the reactivity series and the blast furnace to answer the following questions.

a. Write a balanced chemical equation for each of the following processes which occur in the blast furnace.

i. The thermal decomposition of limestone.

_____ (2)

ii. The oxidation of coke.

_____ (2)

iii. The formation of carbon monoxide.

_____ (2)

iv. The extraction of iron from its ore.

_____ (2)

v. The formation of slag.

_____ (2)

b. Explain the purpose of the limestone in the blast furnace.

_____

_____ (2)

c. The iron produced by the blast furnace is called 'pig iron'.

i. Explain the above statement.

_____

_____ (1)

ii. Give ONE use of pig iron.

_____ (1)

d. Give THREE uses of iron and the reason for each use.

_____

_____

_____ (6)

e. Discuss why it is better to use recycled iron rather than extracted iron.

_____

_____

_____ (3)

f. Discuss the environmental issues related to the extraction of iron.

_____

_____

_____ (3)

Total: 26 marks

6.4 Redox reactions

1. Hydrogen reacts with copper(II) oxide as shown in Figure 1.

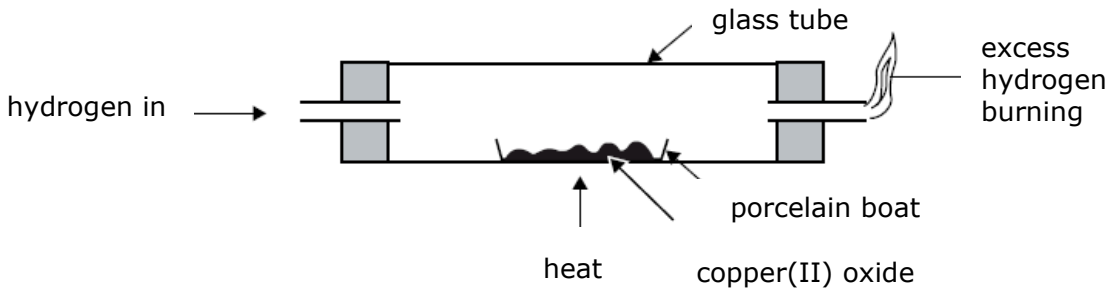


Figure 1

a. Give TWO chemicals which can be used to generate a sample of hydrogen in the laboratory in a safe way.

_____ (2)

b. The following chemical equation represents the reaction between hydrogen and copper(II) oxide.

$$H_{2(}g) + CuO(s) \rightarrow Cu(s) + H_2O(g)$$

State which substance is oxidised, and which is reduced. Explain your answer.

_____

_____

_____

_____ (4)

c. Give TWO observations noted in this reaction.

_____

_____ (2)

d. Describe the role of hydrogen in this reaction and explain your answer.

_____

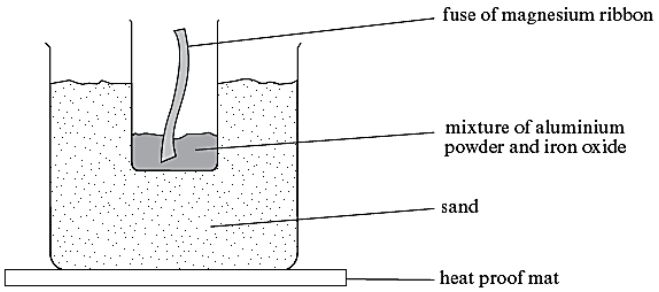
_____ (2)

e. After the reaction takes place, the Bunsen burner is removed but a stream of hydrogen is still allowed in the apparatus until the contents have cooled down. Explain why the contents are cooled in stream of hydrogen.

_____ (1)

Total: 11 marks

2. When a mixture of iron(III) oxide and aluminium powder (Thermit mixture) is heated, there is a violent reaction. The reaction is carried out in a can surrounded by sand because the temperature reaches 2500 °C. A bead of iron is recovered from the sand.



a. Explain why the iron formed in the reaction is molten.

_____ (1)

b. Write a balanced chemical equation for this reaction.

_____ (1)

c. State which substance is oxidised, and which is reduced. Explain your answer.

_____

_____ (2)

d. This reaction indicates that metals have different reactivities. Which is the most reactive metal from this reaction?

_____ (1)

3. Iron reacts with chlorine to form a brown solid as in the following chemical equation.

$$Fe(s) + Cl_2(g) \rightarrow FeCl_3(s)$$

a. Work out the oxidation numbers of the following.

Fe _____ Cl_2 _____ Fein $FeCl_3$ _____ Cl in $FeCl_3$ _____ (4)

b. Using oxidation numbers state which substance has been oxidised and reduced. Explain your answer.

_____

_____ (2)

c. Name the oxidising agent.

_____ (1)

Total: 12 marks

4.

a. Determine the oxidation number of each species in the table below.

Species	Oxidation Number	Species	Oxidation number
C in CO_2		Pb in $PbCl_2$	
N in N_2O		C in CO	
S in H_2S		N in NH_3	

(6)

b. Look at the chemical equations below and determine whether copper has been oxidised or reduced. Give a reason for your answer.

i. $CuO(s) + Fe(s) \rightarrow FeO(s) + Cu(s)$

Oxidised /Reduced: _____ Reason: _____

ii. $Cu(s) + 2Ag^{+}(aq) \rightarrow Cu^{2+}(aq) + 2Ag(s)$

Oxidised /Reduced: _____ Reason: _____

iii. $Cu(s) + 4HNO_3(l) \rightarrow Cu(NO_3)_2(aq) + 2NO_2(g) + 2H_2O(l)$

Oxidised /Reduced: _____ Reason: _____

(6)

Total: 12 marks

5. The following reactions represent redox reactions. For each reaction, circle the substance which has been **oxidised**. Give a reason for your answer.

a. $2NH_3(g) + 3Cl_2(g) \rightarrow N_2(g) + 6HCl(g)$

Reason _____

(2)

b. $2FeCl_2(s) + Cl_2(g) \rightarrow 2FeCl_3(s)$

Reason _____

(2)

c. $H_2S(g) + Cl_2(g) \rightarrow 2HCl(g) + S(s)$

Reason _____

(2)

d. $3Fe(s) + 4H_2O(g) \rightarrow Fe_3O_4(s) + 4H_2(g)$

Reason _____

(2)

Total: 8 marks

6.5 Net ionic equations

1. Write the net ionic equations, omitting spectator ion of the following chemical equations:

a. $KOH(aq) + HCl(aq) \rightarrow KCl(aq) + H_2O(l)$

_____

_____ (2)

b. $Na_2CO_3(aq) + 2HNO_3(aq) \rightarrow 2NaNO_3(aq) + H_2O(l) + CO_2(g)$

_____

_____ (2)

c. $ZnO(s) + 2HNO_3(aq) \rightarrow Zn(NO_3)_2(aq) + H_2O(l)$

_____

_____ (2)

d. $NH_4Cl(aq) + KOH(aq) \rightarrow KCl(aq) + H_2O(l) + NH_3(g)$

_____

_____ (2)

e. $2HCl(aq) + Na_2SO_3(aq) \rightarrow 2NaCl(aq) + H_2O(l) + SO_2(g)$

_____

_____ (2)

f. $HCl(aq) + KHCO_3(aq) \rightarrow KCl(aq) + H_2O(l) + CO_2(g)$

_____

_____ (2)

g. $Zn(s) + H_2SO_4(aq) \rightarrow ZnSO_4(aq) + H_2(g)$

_____

_____ (2)

h. $Cl_2(g) + MgI_2(aq) \rightarrow MgCl_2(aq) + I_2(s)$

_____

_____ (2)

i. $BaCl_2\,(aq) + MgSO_4\,(aq) \rightarrow BaSO_4\,(s) + MgCl_2\,(aq)$

_____

_____ (2)

j. $AgNO_3$ (aq) + KI (aq) → AgI (s) + KNO_3 (aq)

_____

_____ (2)

Total: 20 marks

6.6 Displacement reactions as redox reactions

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

$$Cl_2(aq) + 2KI(aq) \rightarrow 2KCl(aq) + I_2(s)$$

a. Which product is responsible for the brown colour?

_____ (1)

b. Write a net ionic equation for this reaction including state symbols.

_____

_____ (2)

c. Give the half equations for each reactant and state which substance is oxidised and which is reduced.

_____

_____

_____

_____ (4)

d. State the oxidising agent of this reaction. Give a reason for your answer.

_____

_____ (2)

Total: 9 marks

2. Copper, magnesium, silver, and zinc were added separately to solutions containing copper(II) nitrate, magnesium nitrate, silver nitrate and zinc nitrate.

a. Complete the table by marking with an (✓) when the reaction takes place and a (×) when the reaction does not take place.

	copper(II) nitrate (aq)	magnesium nitrate (aq)	silver nitrate (aq)	zinc nitrate (aq)
copper				
magnesium				
silver				
zinc				

(4)

b. Name the type of reactions taking place. Explain what these reactions show.

_____

_____ (2)

c. Write a balanced chemical equation for the reaction of magnesium and copper(II) nitrate solution.

_____ (2)

d. Write TWO observations for the reaction in (c).

_____

_____ (2)

e. State the oxidation numbers of:

Mg _____ Cu in $Cu(NO_3)_2$ _____ (2)

f. Explain why Mg is oxidised when reacting with copper(II) nitrate solution in terms of oxidation numbers.

_____ (1)

g. State the oxidising agent in the reaction between magnesium and copper(II) nitrate.

_____ (1)

h. Write a net ionic equation including state symbols for the reaction of zinc and silver nitrate solution.

_____

_____ (2)

i. For the reaction in part (h) between zinc and silver nitrate solutions, state which substance is oxidised and which is reduced in terms of electrons. Support your answer with the necessary half equations.

_____

_____

_____

_____ (4)

Total: 20 marks

3.

a. Define oxidation and reduction in terms of electron transfer.

Oxidation: _____

Reduction: _____

(2)

b. Magnesium reacts with sulfuric acid to liberate hydrogen gas.

i. Write a balanced chemical equation for this reaction.

_____ (2)

ii. Derive a net ionic equation for this reaction including state symbols.

_____

_____ (2)

iii. In terms of half equations explain which substance has been oxidised and reduced.

_____

_____

_____

_____ (4)

Total: 10 marks

6.7 Allotropes of carbon

1. Carbon is a non-metal that can exist in various forms. Two of these forms include graphite and diamond.

a. State the name given to these different forms of carbon.

_____ (1)

b. Both diamond and graphite show **covalent bonding**. Explain the term in bold.

_____

_____ (2)

c. Although they are both covalent, one of these different forms conducts electricity while the other does not.

i. Give the name of the 'form' that conducts electricity.

_____ (1)

ii. Explain why the 'form' mentioned in part (c) (i) conducts electricity while the other does not.

_____

_____ (2)

iii. Explain why simple covalent compounds have lower melting points and boiling points than giant molecular structures.

_____

_____ (2)

Total: 8 marks

2. Graphene and fullerenes (nanotubes and spheres) are two allotropes of carbon.

a. Which of the allotropes mentioned above are similar to graphite? Give a reason for your answer.

_____

_____ (2)

b. Graphene can be manipulated to form tubes and spheres (fullerenes). Give one industrial use for each of the following:

i. 'Carbon nanotubes': _____ (1)

ii. 'Carbon spheres': _____ (1)

c. Carry out some research on allotropes of your choice from the ones mentioned in this question and explain how the structure of the chosen allotrope is related to its industrial use.

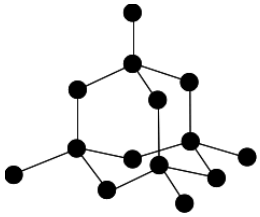
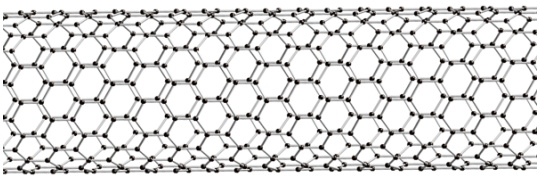
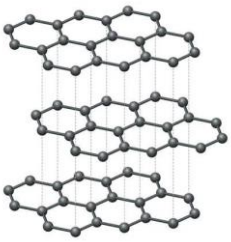
_____

_____

_____ (3)

Total: 7 marks

3. Fill in the table below by giving the correct name and use for each of the following allotropes of carbon.

Diagram of allotrope	Name of allotrope	Use of allotrope
		
		
		

Total: 6 marks

PERIODIC TABLE OF THE ELEMENTS

1	2										3	4	5	6	7	0
							1 **H** Hydrogen 1									4 **He** Helium 2
7 **Li** Lithium 3	9 **Be** Beryllium 4										11 **B** Boron 5	12 **C** Carbon 6	14 **N** Nitrogen 7	16 **O** Oxygen 8	19 **F** Fluorine 9	20 **Ne** Neon 10
23 **Na** Sodium 11	24 **Mg** Magnesium 12										27 **Al** Aluminium 13	28 **Si** Silicon 14	31 **P** Phosphorus 15	32 **S** Sulfur 16	35.5 **Cl** Chlorine 17	40 **Ar** Argon 18
39 **K** Potassium 19	40 **Ca** Calcium 20	45 **Sc** Scandium 21	48 **Ti** Titanium 22	51 **V** Vanadium 23	52 **Cr** Chromium 24	55 **Mn** Manganese 25	56 **Fe** Iron 26	59 **Co** Cobalt 27	59 **Ni** Nickel 28	63.5 **Cu** Copper 29	65 **Zn** Zinc 30	70 **Ga** Gallium 31	73 **Ge** Germanium 32	75 **As** Arsenic 33	79 **Se** Selenium 34	80 **Br** Bromine 35	84 **Kr** Krypton 36
85 **Rb** Rubidium 37	88 **Sr** Strontium 38	89 **Y** Yttrium 39	91 **Zr** Zirconium 40	93 **Nb** Niobium 41	96 **Mo** Molybdenum 42	99 **Tc** Technetium 43	101 **Ru** Ruthenium 44	103 **Rh** Rhodium 45	106 **Pd** Palladium 46	108 **Ag** Silver 47	112 **Cd** Cadmium 48	115 **In** Indium 49	119 **Sn** Tin 50	122 **Sb** Antimony 51	128 **Te** Tellurium 52	127 **I** Iodine 53	131 **Xe** Xenon 54
133 **Cs** Caesium 55	137 **Ba** Barium 56	139 **La** Lanthanum 57	178 **Hf** Hafnium 72	181 **Ta** Tantalum 73	184 **W** Tungsten 74	186 **Re** Rhenium 75	190 **Os** Osmium 76	192 **Ir** Iridium 77	195 **Pt** Platinum 78	197 **Au** Gold 79	201 **Hg** Mercury 80	204 **Tl** Thallium 81	207 **Pb** Lead 82	209 **Bi** Bismuth 83	210 **Po** Polonium 84	210 **At** Astatine 85	222 **Rn** Radon 86

Key: a **X** y b — *relative atomic mass* ***SYMBOL*** ***Name*** *atomic number*