

Annual Examinations for Secondary Schools 2022

YEAR 9	CHEMISTRY	TIME: 2 hours
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Name: _____

Class: _____

Useful Data

Atomic numbers and relative atomic masses are shown in the Periodic Table printed at the back of this booklet.

Avogadro's constant: 6.02×10^{23}

Marks Grid [For Examiner's use only]

Question Nº.	Section A								Section B			Theory Total
	1	2	3	4	5	6	7	8	9	10	11	
Max Mark	12	6	6	6	6	6	12	6	20	20	20	
Actual Mark												

Theory Paper: 85%	Practical: 15%	Final Score: 100%

SECTION A: Answer ALL questions in the spaces provided.
This section carries 60 marks.

1)

a) If a glass of water is left standing for a few days, its volume decreases. This happens due to a process called _____. (1)

b) Mark as True (T) or False (F).

When a substance is heated:

i) there is an increase in volume of the substance (expansion) _____, (1)

ii) the particles making up the substance also expand _____, (1)

iii) the energy of the particles in the substance increases _____, (1)

iv) a change of state always occurs _____. (1)

c) Mark the following statements as True (T) or False (F).

i) Particles in a solid at room temperature have no motion. _____ (1)

ii) At exactly 0 °C, water can exist as both a solid and a liquid. _____ (1)

iii) Gases have no mass. _____ (1)

iv) Particles in a substance move faster when the substance is cooled. _____ (1)

d) Classify the following changes into **physical** or **chemical** changes.

i) When acid is added to limestone, a gas is evolved. _____ (1)

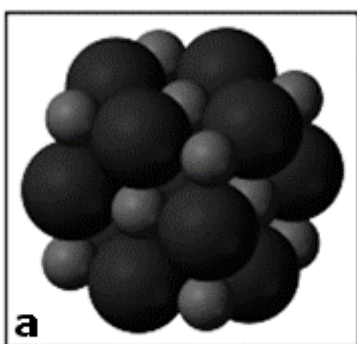
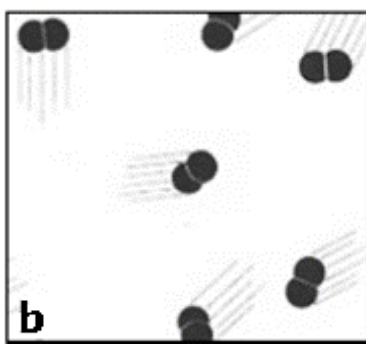
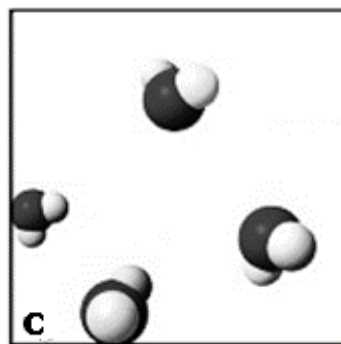
ii) A wooden bar is cut into small pieces. _____ (1)

iii) When a saturated solution of potassium nitrate is cooled, some of it precipitates.
_____ (1)

Total: 12 marks

2) This question is about elements and compounds, metals and non-metals.

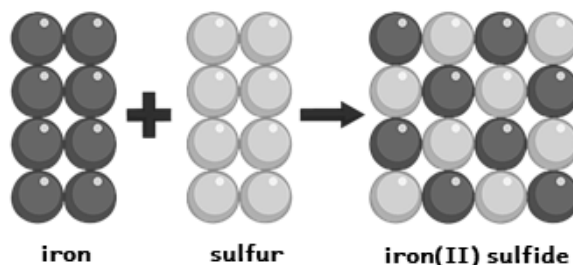
a) Iodine (I_2) exists as diatomic molecules. Which of the pictures below shows gaseous iodine? _____ (1)



b) Iodine is an element. Explain why?

(1)

c) Some iron filings and sulfur powder are mixed. This mixture can be easily separated. However, if the mixture is heated, a new compound iron(II) sulfide is formed.



i) Iron is a metal. Give **one** physical property of metals.

(1)

ii) Why is iron(II) sulfide classified as a compound.

(1)

iii) Write a balanced chemical equation for the reaction between iron and sulfur to form iron(II) sulfide.

(2)

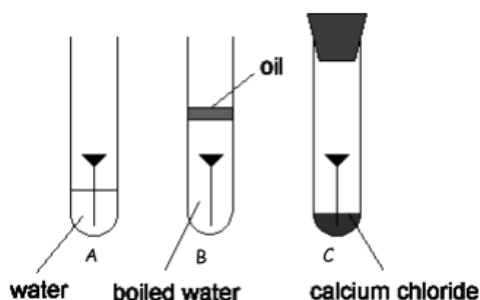
Total: 6 marks

3) Oxygen is a reactive gas found in air.

a) When hydrocarbon fuels burn completely in a plentiful supply of oxygen, the same two products are always produced. Complete the following word equation:

hydrocarbon fuel + oxygen → _____ + _____ (2)

b) Three test-tubes, each with a clean shiny iron nail inside, were set up as shown in the diagram and left to stand for two weeks.



i) What are the conditions needed for rusting?

(2)

ii) Identify the test-tube/s in which the nail will rust.

_____ (1)

iii) Explain your reasoning for your answer in part (b) (ii).

_____ (1)

Total: 6 marks

4) Magnesium reacts with steam to give magnesium oxide and hydrogen gas.

a) Draw a dot-cross diagram to show the covalent bonding in steam.

Show outer shell electrons only.

(3)

b) Draw a dot-cross diagram to show the ionic bonding in magnesium oxide.

Show all electrons.

(3)

Total: 6 marks

5) This question is about water.

a) Some substances contain water of crystallization. In an experiment, known masses of some compounds are left in air for a period of time. The following changes in mass were observed.

Substance	Mass before	Mass after
A	10.00 g	13.20 g
B	10.00 g	10.00 g
C	10.00 g	8.02 g

Which of the substances in the above table is most likely to be:

i) Efflorescent: _____ (1)

ii) Hygroscopic: _____ (1)

- b) Solubility in water of different substances may vary with temperature and pressure.

Fill in by stating whether the solubility **increases** or **decreases**:

- i) The solubility of sugar crystals _____ with temperature. (1)
- ii) The solubility of carbon dioxide gas _____ with temperature. (1)
- c) At 100 °C, 5 kg of sugar can be dissolved in 1 kg of water. Calculate the solubility of sugar in **g/100 g H₂O** at 100 °C.

_____ (2)

Total: 6 marks

- 6) Two students were given two samples of hard water labelled A and B. They were told that one of the samples contained dissolved calcium hydrogen carbonate only, while the other contained the same amount of dissolved calcium hydrogen carbonate and some magnesium sulfate. Their task was to distinguish between the two samples. So, they carried out the following procedure and recorded their observations at each step.

Steps	Observations	
	Sample A	Sample B
1. Boiled each sample for several minutes in a beaker.	A white residue was observed at bottom of beaker.	A white residue was observed at bottom of beaker.
2. Filtered off the boiled water.	Clear filtrate obtained.	Clear filtrate obtained.
3. Added washing soda to the filtrate.	A white precipitate was obtained.	Solution remained clear (no changes).

- a) Look at the observations and state which of the samples contained calcium hydrogen carbonate only and which contained both calcium hydrogen carbonate and magnesium sulfate.

Calcium hydrogen carbonate only: _____ (1)

Calcium hydrogen carbonate and magnesium sulfate: _____ (1)

- b) Which type of hardness is present in each of the original water samples?

Sample A: _____ (1)

Sample B: _____ (1)

- c) Which type of hardness cannot be removed by boiling?

_____ (1)

- d) Another method used to distinguish between hard and soft water is adding soap solution. Give the expected result.

_____ (1)

Total: 6 marks

7) This question is about acids, bases and salts.

a) Look at the table below and then answer the questions that follow.

Substance	pH
cabbage juice	5
tonic water	8.2
sodium hydroxide solution	13
orange juice	3

i) Which substance has the highest concentration of H^+ ions?

_____ (1)

ii) Both orange juice and cabbage juice are weak acids. What is a weak acid?

_____ (1)

iii) Acid indigestion (heartburn) is caused by excessive acid in the stomach which creates a burning sensation. Which of the liquids in the table above would you advise a person suffering from acid indigestion to drink?

_____ (1)

b) Complete and balance the following equations involving acids.

i) $\text{H}_2\text{SO}_4(\text{aq}) + \text{_____}(\text{aq}) \rightarrow \text{Na}_2\text{SO}_4(\text{aq}) + \text{_____}(\text{l})$ (2)

ii) $\text{_____}(\text{aq}) + \text{_____}(\text{aq}) \rightarrow \text{KNO}_3(\text{aq}) + \text{_____}(\text{l}) + \text{CO}_2(\text{g})$ (2)

c) Acid salts can be produced from the incomplete neutralisation of dibasic acids. Give the name or formula of the acid salt that can be produced from the reaction of sodium hydroxide and sulfuric acid.

_____ (1)

d) Insoluble salts are made by mixing solutions of two soluble salts.

i) Suggest **two** salts that can be used to prepare lead(II) chloride (PbCl_2).

_____ (2)

ii) Give a balanced chemical equation for the reaction in part (d)(i).

_____ (2)

Total: 12 marks

8) This question is about percentage composition by mass.

a) Good fertilizers usually have a high proportion of nitrogen. One commonly used fertilizer is ammonium nitrate (NH_4NO_3). Calculate the:

i) relative formula mass of ammonium nitrate,

(RAM: N = 14, H = 1, O = 16)

_____ (1)

ii) percentage nitrogen by mass present in ammonium nitrate.

_____ (1)

b) A hydrocarbon has 83.7% carbon by mass. Calculate:

i) the empirical formula of this hydrocarbon,

(RAM: C = 12, H = 1),

_____ (3)

ii) its molecular formula given that its RMM is 86.

_____ (1)

Total: 6 marks

SECTION B: Answer TWO questions ONLY on the foolscaps provided.
This section carries 40 marks.

- 9) This question is about mixed states and separation techniques.
- a) A student accidentally dropped two glass bottles containing different white powders. The broken glass was safely removed, and the two powders were collected and put in a container. Both chemicals are expensive, so it was worth separating them. The following table shows some information on the two chemicals involved.

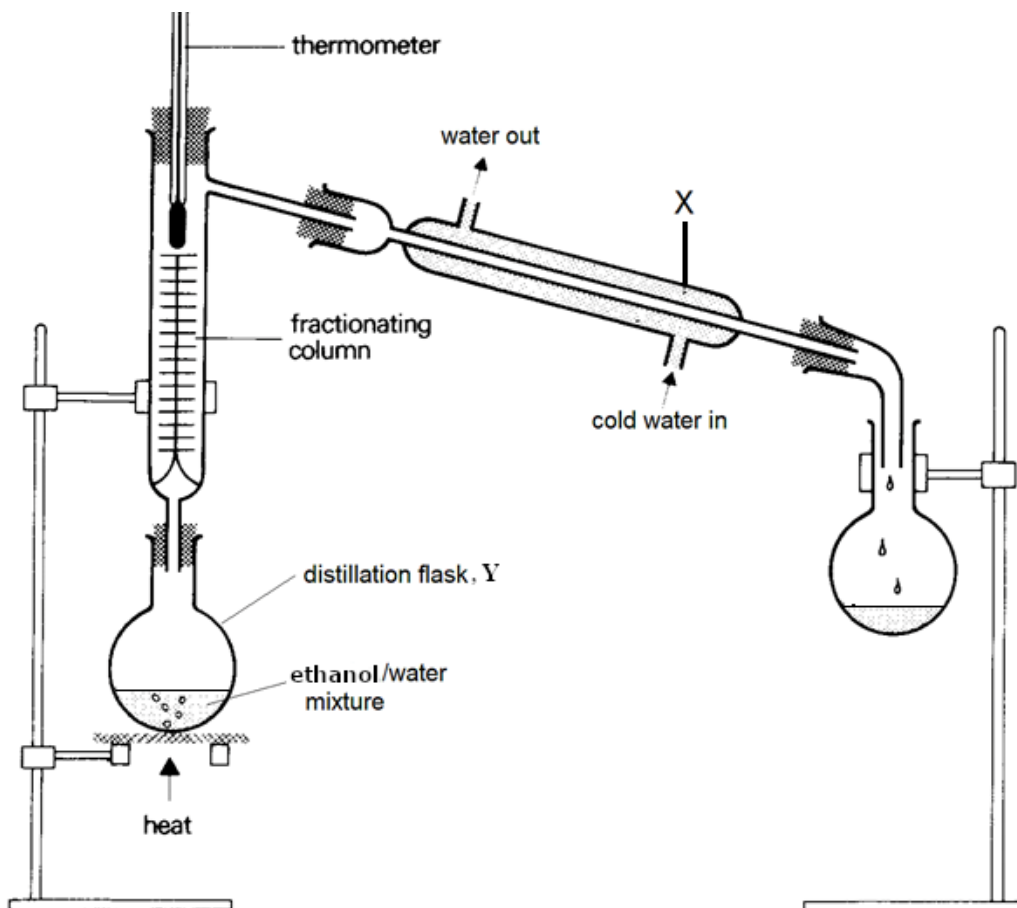
	silver nitrate	silver chloride
Solubility in water	soluble	insoluble
Solid decomposes on heating	yes	no

Using the information in the above table, describe how you would obtain each chemical in a **pure** and **dry** form from their mixture. Your answer should include:

- a brief description of the method used, (5)
- clear well-labelled diagrams of the **two** separating techniques used. (8)

- b) The figure below shows the laboratory apparatus which can be used to produce almost pure ethanol from a mixture of ethanol and water.

(Boiling points: water 100 °C, ethanol 78 °C.)



- i) Name the process being used. (1)
- ii) What does part 'X' do? (1)
- iii) Why is a fractionating column important in such a process? (1)
- iv) What will be left in the distillation flask, Y, at the end of the process? (1)
- v) Explain why the two liquids can be separated using this method and why they are distilled one after the other. (2)
- vi) State **one** industrial application of the process. (1)

Total: 20 marks

10) This question is about oxygen and its compounds.

a) Oxygen is prepared and collected in the lab by the catalytic decomposition of hydrogen peroxide which produces water and oxygen.

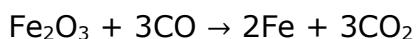
- i) Write a balanced chemical equation for the reaction. Include state symbols. (3)
- ii) Name or give the formula of the catalyst used. (1)
- iii) Draw a labelled diagram of the apparatus setup that can be used for this experiment. (5)

b) In a similar experiment, 5.1 g of pure hydrogen peroxide decomposed completely to produce 2.4 g of oxygen gas.

- i) What is the mass of water produced? (1)
- ii) Calculate the number of moles of hydrogen peroxide used. (2)

c) Oxygen can form different types of oxides when it reacts with other elements. Four examples are: iron(III) oxide (Fe_2O_3), aluminium oxide (Al_2O_3), carbon monoxide (CO) and sulfur dioxide (SO_2).

- i) For each oxide mentioned above, state whether it is acidic, basic, amphoteric or neutral. (4)
- ii) Iron(III) oxide and carbon monoxide can react together according to the following equation:



Calculate the amount (both in grams and in moles) of carbon dioxide produced if 160 kg of iron(III) oxide is used.

(RAM: Fe = 56, O = 16, C = 12) (4)

Total: 20 marks

11) This question is about hydrogen and its compounds.

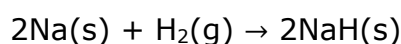
a) Hydrogen can be prepared and collected in the lab by the action of a dilute acid on a metal.

i) Write a balanced chemical equation for a suitable reaction that can be used to produce hydrogen in the laboratory. Include state symbols. (3)

ii) Draw a labelled diagram of the apparatus setup that can be used for this experiment. (5)

iii) Describe a simple test that can be carried out to confirm that the gas collected is in fact hydrogen and state the observations made. (2)

b) Hydrogen can react with metals to form metal hydrides as in the following example:



Given that 9.2 g of sodium react completely with 0.4 g of hydrogen, what would be the mass of sodium hydride produced? (1)

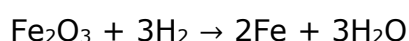
c) Hydrogen can also react with metal oxides.

i) Write an equation for the reaction of copper(II) oxide with hydrogen to produce copper and water. (2)

ii) Copper(II) oxide is an ionic compound. Calculate the number of ions in 159 g of copper(II) oxide.

(RAM: Cu = 63.5, O = 16) (3)

d) Hydrogen reacts with iron(III) oxide according to the following equation:



Calculate the amount (both in moles and in grams) of iron produced if 1.6 kg of iron(III) oxide are used.

(RAM: Fe = 56, O = 16) (4)

Total: 20 marks

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PERIODIC TABLE OF THE ELEMENTS

1	2
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3	4	5	6	7	0
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1 H Hydrogen 1

4 He Helium 2

7 Li Lithium 3	9 Be Beryllium 4
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23 Na Sodium 11	24 Mg Magnesium 12
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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