CHEMISTRY EXAMINATION 5TH FORM **Summer 2019**

NAME Timothy Langer **Form** 5F

Time 1 Hour 15 minutes

Instructions:

Attempt **ALL** the questions.

Write your answers in the spaces provided on the question paper.

Mark allocations are given in brackets after each question.

This exam paper consists of **15 pages** plus a **separate Periodic Table.**

Question	Mark	Marks Available
1	13	15
2	10	10
3	8	8
4	13	14
5	10	12
6	10	10
7	8	8
Total	72	77
Percentage	93.5 %	

Q1

A sample of the element potassium contained two isotopes.

a) Define what isotopes are in terms of sub-atomic particles.

isotopes are atoms with same number of protons but different number of neutrons (and electrons) [2]

b) Complete the table for the isotopes of potassium:

Atomic Number	Mass Number	Number of Protons	Number of Neutrons	% Abundance	
19	39	19	20	93.3	[1]
19	41	19	22	6.7	[1]

[2]

c) Use the data in your completed table to calculate the relative atomic mass of the sample of potassium. Give your answer to **one decimal place**.

$\left(39 \times \frac{93.3}{100}\right) + \left(41 \times \frac{6.7}{100}\right) = 39.1 \quad (1dp)$

[2]

d) Potassium reacts in a similar manner to the other Group 1 elements. Give the **formulae** of the product(s) formed when potassium reacts with:

i. water

$KOH + H_2O$ ~~H_2O~~ $KOH + H_2$ [1]

ii. bromine

KBr [1]

[2] 1

e) A small piece of potassium was burned in excess oxygen.

i. Write a balanced chemical equation for the reaction of potassium with oxygen.

$4K + O_2 \rightarrow 2K_2O$

[1 for formulae, 1 for balancing] [2]

ii. The resulting solid was dissolved in water and a few drops of phenolphthalein indicator were added. Describe the colour change that would have been observed (before and after colour), and give the **formula** of the ion responsible.

~~K^+~~ O^{2-}
~~H^+~~ OH^-

Colour change

colourless → pink

Formula of ion

O^{2-} OH^-

[2] 1

iii. A similar, but less vigorous, reaction occurs when sodium is burned in oxygen.
Explain why reactivity increases upon descending Group I.

Group I elements react by losing their outer shell electron. [As one descends Group I, this electron ~~becomes~~ moves further and further away from the nucleus] at the centre. [Less nuclear attraction is exerted on the outer shell electron & it is lost more easily,] so reactions happen more readily.

[3]

[Total: 15] 13

Q2

The Group 7 elements react with hydrogen to form hydrogen halides.

a) Write a balanced chemical equation for the reaction of bromine with hydrogen.

$Br_2 + H_2 \rightarrow 2HBr$ ✓

[2]

b) Hydrogen halides are soluble in water. When bubbled through water the hydrogen bromide molecules **ionise** to form an acidic solution called hydrobromic acid. Write an equation that represents the ionisation of hydrogen bromide and circle the ion that is responsible for making the solution acidic.

$HBr_{(g)} \xrightarrow{\text{dissolve, dissociate}} H^+_{(aq)} + Br^-_{(aq)}$ ✓

[2]

c) Copper (II) oxide can be used in the preparation of the salt copper (II) nitrate.

i. **Name** the acid that would be used in this salt preparation.

Nitric acid ✓

[1]

ii. Write a chemical equation, **with state symbols**, for the preparation of copper (II) nitrate with the acid you named above.

$CuO_{(s)} + 2HNO_{3\,(aq)} \rightarrow Cu(NO_3)_{2(aq)} + H_2O_{(l)}$ ✓

[1 formulae; 1 balancing; 1 state symbols]

[3]

iii. Write an ionic equation, **with state symbols** for the reaction in c)ii.

$CuO_{(s)} + 2H^+_{(aq)} \rightarrow Cu^{2+}_{(aq)} + H_2O_{(l)}$ ✓

[1 formulae; 1 balancing]

[2]

[Total: 10]

~~$CuO_{(s)} + 2H^+_{(aq)} + 2NO_3^-{}_{(aq)} \rightarrow Cu^{2+}_{(aq)} + 2NO_3^-{}_{(aq)} + H_2O_{(l)}$~~

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Q3

Simon decided that he wanted to make some crystals of potassium chloride. To do this he accurately measured out 25.0cm^3 of hydrochloric acid using a volumetric pipette and placed this into a small conical flask. He then added a couple of drops of phenolphthalein indicator to the acid.

Potassium hydroxide was carefully and accurately added to the acid until the indicator changed colour at the end point of the reaction. The total volume of potassium hydroxide that had been added was noted down.

a) Name the piece of apparatus that should be used to add the potassium hydroxide.

burette R biuret (or any spelling w/ letter I)

[1]

b) What is the name given to the experimental method being described – used frequently to determine the accurate reacting volumes of two solutions?

titration

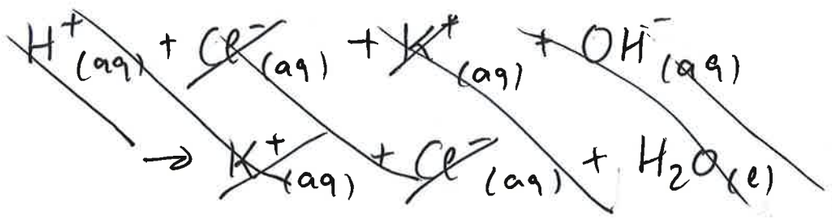
[1]

The reaction between hydrochloric acid and potassium hydroxide is classed as a **neutralisation reaction.**

c) Give the *ionic equation, with state symbols*, for the neutralisation reaction.

$H^+_{(aq)} + OH^-_{(aq)} \rightarrow H_2O_{(l)}$

[2]



d) Describe how Simon would now go on to produce pure crystals of potassium chloride, *following on from the procedure already described at the start of the question.*

The experiment was repeated using the same [known ✓ volumes] of HCl and KOH, ✓ but [indicator ✓ was not added!]
The solution was heated on a Bunsen [until 1/2 – 2/3 ✓ of it had evaporated]
The solution was [left to crystallise ✓]
~~It was then filtered~~
And placed in a warm oven. } chemically wrong but marking point in Edexcel GCSE

[4]

[Total: 8]

Q4

Crude oil is a very complex mixture of hydrocarbon molecules.

a) Define the term hydrocarbon.

a molecule containing only hydrogen and carbon atoms. [2]

One of the hydrocarbons within the Naphtha fraction is nonane (C_9H_{20}). Within the 'catalytic cracker' the molecules of nonane are 'cracked' into a variety of different alkanes and alkenes.

Hex-1-ene (C_6H_{12}) was one alkene product that was made at this cracking stage.

b) Construct a balanced chemical equation for the cracking of nonane to form hex-1-ene and one other product. Give the name of the other product formed.

~~C_9H_{20} C_6H_{12} C_3H_8~~ Propane [1]

$C_9H_{20} \rightarrow C_6H_{12} + C_3H_8$

The ethene molecules belong to the alkene homologous series.

c) Give ***two*** features of a homologous series.

1 similar chemical properties

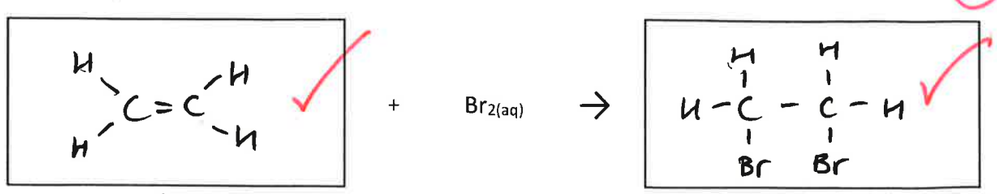
2 trends in physical properties

(+ share general formula) [2]

Bromine water ($Br_{2(aq)}$) is used as a simple chemical test for the presence of an alkene molecule.

d) Describe the major observation in the bromine water test with ethene and in the boxes you should give the displayed formula of ethene, *showing all covalent bonds*, and the displayed formula of the organic product upon reaction with bromine – called 'dibromoethane'.

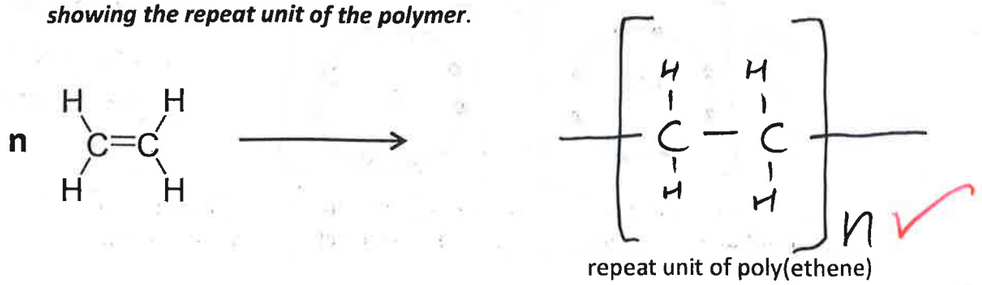
Observation ..... orange bromine water instantly decolourises [1]



ethene 'dibromoethane' [2]

Within the 'polymerisation pressure vessel' the ethene molecules are subjected to a high pressure and high temperature to allow the formation of poly(ethene).

e) Construct an equation to represent this polymerisation of ethene in the space below – ***showing the repeat unit of the polymer***.



repeat unit of poly(ethene) [2]

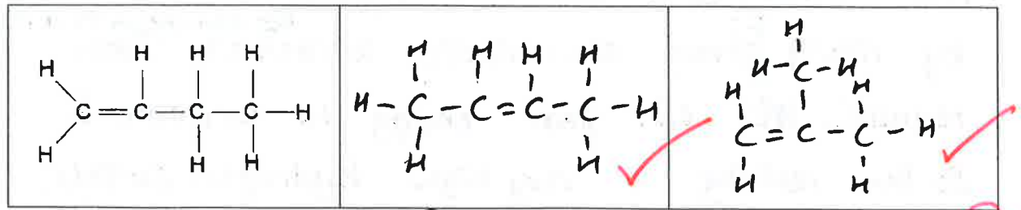
A more complex polymer is shown to contain four carbon atoms in its repeat unit. A polymer scientist deduced that this could have been made from one of three possible alkene monomers – all of which are isomers of each other.

f) Define the term isomers.

Molecules with the same molecular formula but different structural formulae (atoms arranged differently) [2]

R substances

g) Complete the two empty boxes below to show the displayed structure of the other two isomers.



But-1-ene But-2-ene 1-methylpropene [2]

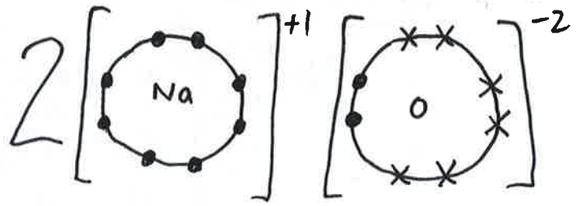
R. cyclobutane.

[Total: 14]

13

Q5

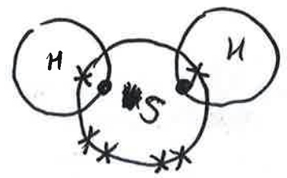
a) Draw a dot and cross diagram to show the bonding in the ionic compound sodium oxide. Show only the outer-shell electrons in your diagram.



[1 for correct • & x]
[1 brackets + charge]
[1 for (2) Na^+ ions]

[3]

b) Draw a dot and cross diagram to show the covalent bonding in a molecule of hydrogen sulfide (H_2S). Show only the outer-shell electrons in your diagram.



[1 correct • & x]
[1 for 3 circles with H & S]

[2]

c) The melting point of sodium oxide is 1132°C. The melting point of hydrogen sulfide is – 82°C.

i. With reference to their structure and bonding, explain the large difference in the melting points of sodium oxide and hydrogen sulfide.

Sodium oxide is ionic and forms [a giant ionic ~~seed~~ lattice] Ions are held together in the lattice by many [strong electrostatic attractions between opp. charged ions]. These require lots of heat energy to overcome & so the melting is very high. Hydrogen sulfide, however, is a [simple {covalent molecular} structure.] The covalent bonds do not change. The molecules are held together by [weak intermolecular forces] that require much [less heat energy to overcome] so it has a much lower melting point.

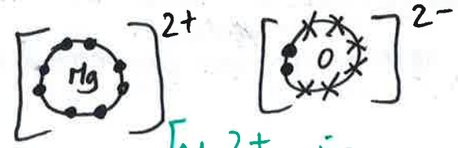
[5] 4

ii. How would the melting point of magnesium oxide compare with that of sodium oxide? Explain your answer.

(Magnesium oxide would have higher melting point) because 2 electrons go from [Mg to Mg^{2+}] (Group II)
Whereas in sodium oxide 1 electron goes [Na to Na^+]
[Stronger electrostatic attractions] mean MgO has higher melting point than Na_2O.

[2] [Total: 12]

1
1
10



[Mg^{2+} is a higher charge than Na^+]

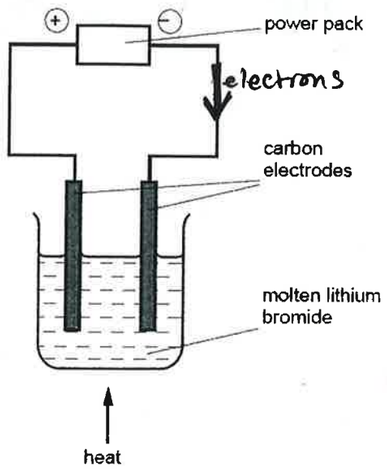
Q6

Lithium bromide is an ionic compound.
It can be electrolysed when it is molten or in aqueous solution.
It cannot be electrolysed as a solid.

a) Why must lithium bromide be molten or in aqueous solution if it is to be electrolysed? [so the ions are able to move]

To carry a current there must be mobile charged particles. In $LiBr_{(s)}$ lattice there are no ~~delocalised electrons~~ delocalised or mobile ions so it does not conduct. When molten or aqueous the ions can move & carry a charge. [1]

b) The diagram below shows the electrolysis of molten lithium bromide.



i) Mark on the diagram an arrow to show the direction of electron flow.

[1]

ii) Write an ionic equation to show the reaction that is occurring at the cathode.

$Li^+ + e^- \rightarrow Li$

[1]

iii) Write an ionic equation to show the reaction that is occurring at the anode.

$2Br^- - 2e^- \rightarrow Br_2$

[formulae] [balancing]

[2]

iv) Which ion is being oxidised?
Explain your answer.

[oxidation is loss of electrons.]
Br^- has been oxidised

[Br^-/bromide] R. bromine R. Br_2

[2]

c) When aqueous lithium bromide is electrolysed, a colourless gas is formed at the cathode and the solution becomes alkaline.

Explain these observations and give an ionic equation to show the reaction that is now occurring at the cathode.

[Hydrogen gas forms] at the cathode
H^+ ions removed → [$2H^+ + 2e^- \rightarrow H_2$]
From water (H^+ & OH^-) only [OH^- ions remain] (not balanced by H^+ ions)
[OH^- ions make the solution alkaline.]

[3]
[Total: 10]

$2H^+ + 2e^- \rightarrow H_2$
$4OH^- \rightarrow O_2 + 4e^- + 2H_2O$
4

Q7

The table below describes the appearance of some substances at room temperature.

Substance	Appearance
copper metal	a reddish-orange coloured solid
magnesium powder	a silvery-grey coloured solid
copper (II) sulfate (aq)	a blue solution
magnesium sulfate (aq)	a colourless solution

When magnesium powder is dropped into a solution of copper (II) sulfate a displacement reaction takes place and this is shown by the word equation below.

R. effervescence

magnesium (s) + copper (II) sulfate (aq) → copper (s) + magnesium sulfate (aq)

R.>2 (negative marking)

a) State the ***two major observations*** that you would make through the course of this reaction.

magnesium piece of silvery-grey turns reddish-brown copper colour

blue ($CuSO_{4(aq)}$) solution turns colourless ($MgSO_{4(aq)}$)

[2]

b) Explain clearly why this displacement reaction occurs in terms of metal reactivity.

Mg is {more reactive} than Cu
{higher in reactivity series}

[1]

The displacement reaction can also be classified as a ***redox reaction***.

c) What is meant by the term redox reaction?

When reduction & oxidation are happening
{simultaneously / same time} in a reaction.

[1]

The ionic equation for the reaction is shown below.

$Cu^{2+}(aq) + Mg(s) \rightarrow Cu(s) + Mg^{2+}(aq)$

d) Use this ionic equation to state and explain which of these species has been oxidised and which has been reduced.

Mg has lost electrons to form Mg^{2+} Oxidised

Cu^{2+} has gained electrons to form Cu Reduced

[2]

Whilst studying the reactivity of metals Barnaby suggested that this displacement reaction to produce some copper metal would be faster if potassium metal were used instead of magnesium though his teacher suggested this was inadvisable.

e) Suggest why the use of potassium would result in a faster reaction ***and*** suggest why his teacher thought this was inadvisable.

Potassium is much more reactive than magnesium so would react faster
It would react but not safely in a lab so we don't do it.
Potassium ~~might~~ could react with water instead? [K reacts with H_2O]

[2]

[Total: 8]

END OF EXAMINATION