The Periodic Table

Question Paper 2

Level	IGCSE
Subject	Chemistry
ExamBoard	CIE
Topic	The Periodic Table
Sub-Topic	
Paper	(Extended) Theory
Booklet	Question Paper 2

TimeAllowed: **88 minutes**

Score: **/ 73**

Percentage: **/100**

1 Nitrogen can form ionic compounds with reactive metals and covalent compounds with non-metals.

(a) Nitrogen reacts with lithium to form the ionic compound lithium nitride, Li_3N.

(i) Write the equation for the reaction between lithium and nitrogen.

..... [2]

(ii) Lithium nitride is an ionic compound. Draw a diagram which shows its formula, the charges on the ions and the arrangement of the valency electrons around the negative ion.

Use x for an electron from a lithium atom.
Use o for an electron from a nitrogen atom.

[2]

(b) Nitrogen fluoride is a covalent compound.

(i) Draw a diagram showing the arrangement of the valency electrons in one molecule of the covalent compound nitrogen trifluoride, NF_3.

Use x for an electron from a nitrogen atom.
Use o for an electron from a fluorine atom.

[2]

(ii) Lithium nitride has a high melting point, 813 °C. Nitrogen trifluoride has a low melting point, –207 °C.
Explain why the melting points are different.

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..... [2]

[Total: 8]

2 In the Periodic Table, the elements are arranged in columns called Groups and in rows called Periods.

(a) Complete the table for some of the elements in Period 3.

group number	I	II	III	IV	V	VI	VII
symbol	Na	Mg	A*l*	Si	P	S	C*l*
number of valency electrons							
valency							

[2]

(ii) What is the relationship between the group number and the number of valency electrons?

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..... [1]

(iii) Explain the relationship between the number of valency electrons and the valency

for the elements Na to A*l*,

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for the elements P to C*l*.

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.....

[4]

(b) Across a period, the elements change from metallic to non-metallic.

(i) Describe how the type of oxide changes across this period.

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..... [2]

(ii) Describe how the type of bonding in the chlorides formed by these elements changes across this period.

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..... [2]

[Total: 11]

3 Scandium, proton number 21, is not a typical transition element.

(a) Scandium is a low density metal which has only one oxidation state in its compounds. Scandium compounds are white solids which form colourless solutions. Titanium, the next metal in the period, is a far more typical transition element. How would the properties of titanium differ from those of scandium?

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..... [3]

(b) Scandium fluoride is an ionic compound. The valency of scandium in scandium fluoride is three.
Draw a diagram which shows the formula of this compound, the charges on the ions and the arrangement of the valency electrons around the negative ions.

Use × to represent an electron from a fluorine atom.
Use ○ to represent an electron from a scandium atom.

[3]

(c) Scandium oxide is insoluble in water. Describe how you could show that it is an amphoteric oxide.

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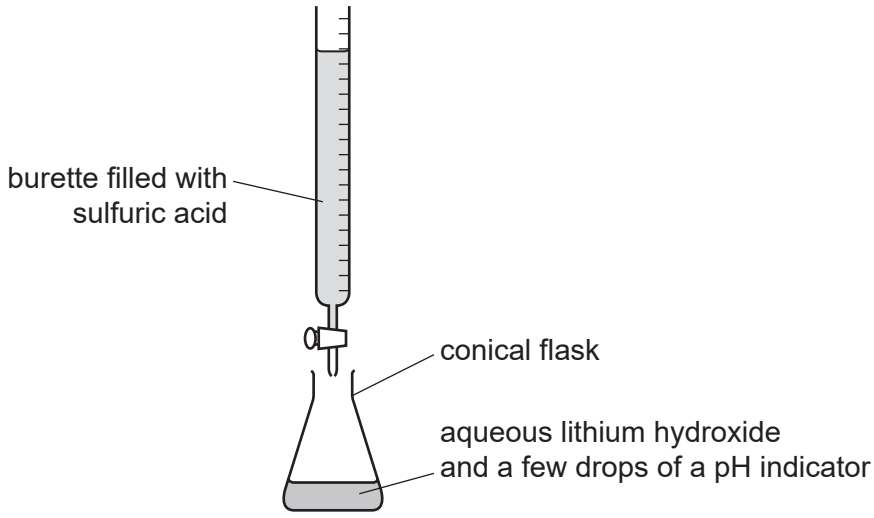
..... [3]

[Total: 9]

4 The soluble salt hydrated lithium sulfate is made by titration from the soluble base lithium hydroxide.



(a) The sulfuric acid is added slowly from the burette until the indicator just changes colour. The volume of sulfuric acid needed to just neutralise the lithium hydroxide is noted.
Describe how you would continue the experiment to obtain pure dry crystals of hydrated lithium sulfate.

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..... [5]

(b) Using 25.0 cm^3 of aqueous lithium hydroxide, concentration 2.48 mol / dm^3, 2.20 g of hydrated lithium sulfate was obtained.
Calculate the percentage yield, giving your answer to **one** decimal place.

$$2LiOH + H_2SO_4 \rightarrow Li_2SO_4 + 2H_2O$$

$$Li_2SO_4 + H_2O \rightarrow Li_2SO_4.H_2O$$

Number of moles of LiOH used = ...

Number of moles of $Li_2SO_4.H_2O$ which could be formed = ...

Mass of one mole of $Li_2SO_4.H_2O$ = 128 g

Maximum yield of $Li_2SO_4.H_2O$ = ... g

Percentage yield = ...% [4]

(c) An experiment was carried out to show that the formula of the hydrated salt is $Li_2SO_4.H_2O$. A sample of the hydrated salt was weighed and its mass recorded. It was then heated and the anhydrous salt was weighed. This procedure was repeated until two consecutive masses were the same. This procedure is called 'heating to constant mass'.

(i) What is the reason for heating to constant mass?

..... [1]

(ii) The mass of the hydrated salt is m_1 and the mass of the anhydrous salt is m_2. Explain how you could show that the hydrated salt has **one** mole of water of crystallisation per mole of the anhydrous salt.

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..... [3]

[Total: 13]

5 Ammonia is a compound which only contains the elements nitrogen and hydrogen. It is a weak base.

(a) (i) Define the term *base*.

..... [1]

(ii) Given aqueous solutions of ammonia and sodium hydroxide, both having a concentration of 0.1 mol / dm^3, how could you show that ammonia is the weaker base?

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..... [2]

(b) Ammonia is manufactured by the Haber Process. The economics of this process require that as much ammonia as possible is made as quickly as possible.
Explain how this can be done using the following information.

The conditions for the following reversible reaction are:

- 450 °C
- 200 atmospheres pressure
- iron catalyst

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ the reaction is exother

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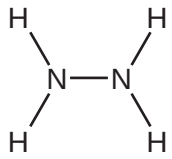
..... [5]

(c) Another compound which contains only nitrogen and hydrogen is hydrazine, N_2H_4.

Complete the equation for the preparation of hydrazine from ammonia.

$$.....NH_3 + NaCl O \rightarrow N_2H_4 + ... + H_2O$$ [2

(d) The structural formula of hydrazine is given below.



Draw a diagram showing the arrangement of the valency electrons in one molecule of the covalent compound hydrazine.
Use x to represent an electron from a nitrogen atom.
Use o to represent an electron from a hydrogen atom.

[3]

(e) Hydrazine is a weak base and it removes dissolved oxygen from water. It is added to water in steel boilers to prevent rusting.

(i) One way it reduces the rate of rusting is by changing the pH of water.
What effect would hydrazine have on the pH of water?

..... [1]

(ii) Give a reason, other than pH, why hydrazine reduces the rate of rusting.

..... [1]

[Total: 15]

6 Germanium is an element in Group IV. The electron distribution of a germanium atom is 2 + 8 + 18 + 4. It has oxidation states of +2 and +4.

(a) Germanium forms a series of saturated hydrides similar to the alkanes.

(i) Draw the structural formula of the hydride which contains three germanium atoms per molecule.

[1]

(ii) Predict the general formula of the germanium hydrides.

..... [1]

(b) Draw a diagram showing the arrangement of the valency electrons in one molecule of the covalent compound germanium(IV) chloride, $GeCl_4$.

Use o to represent an electron from a chlorine atom.
Use x to represent an electron from a germanium atom.

[2]

(c) Describe the structure of the giant covalent compound germanium(IV) oxide, GeO_2.
It has a similar structure to that of silicon(IV) oxide.

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..... [3]

(d) Is the change $GeCl_2$ to $GeCl_4$ reduction, oxidation or neither? Give a reason for your choice.

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..... [2]

[Total: 9]

7 **(a)** Give **three** differences in physical properties between the Group I metal, potassium, and the transition element, iron.

1. .....

2. .....

3. ..... [3]

(b) The following metals are in order of reactivity.

potassium
zinc
copper

For those metals which react with water or steam, name the products of the reaction, otherwise write 'no reaction'.

potassium .....

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zinc .....

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copper .....

..... [5]

[Total: 8]