Chemistry - 0620

■ 30 Questions

Topics Covered :

✓ 12.4 - Separation and purification
✓ 7.3 - Preparation of salts
✓ 5.1 - Exothermic and endothermic reactions
✓ 6.2 - Rate of reaction
✓ 6.4 - Redox
✓ 9.6 - Extraction of metals
✓ 1.1 - Solids, liquids and gases
✓ 3.1 - Formulae
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Question No 1 - (0620_w19_41_4)

Topics: 12.4 - Separation and purification, 5.1 - Exothermic and endothermic reactions, 6.2 - Rate of reaction, 7.3 - Preparation of salts

Subsection Topics: a: 12.4 - Separation and purification | b: 7.3 - Preparation of salts

Insoluble salts can be made by precipitation reactions.

A student mixed solutions of some soluble salts.

The results the student obtained are shown in the table.

		second salt solution		
		$Co(NO_3)_2(aq)$	$AgNO_3(aq)$	$Pb(NO_3)_2(aq)$
first salt solution	NaI(aq)	no change	yellow precipitate	yellow precipitate
	$Na_2CO_3(aq)$	purple precipitate	yellow precipitate	white precipitate
	$Na_2SO_4(aq)$	no change	white precipitate	white precipitate

All sodium salts are soluble in water.
Use only results from the table to answer the following questions.

(a) Name:

(i) an insoluble cobalt salt ..... [1]

(ii) an insoluble yellow lead salt. ..... [1]

(b) Write the chemical equation for the reaction in which silver carbonate is formed.

..... [2]

(c) Write the ionic equation for the reaction in which lead(II) iodide is formed.

..... [2]

(d) Aqueous silver nitrate produces a yellow precipitate with both iodide ions and carbonate ions. When testing an unknown solution for iodide ions, the aqueous silver nitrate is acidified.

Explain why the aqueous silver nitrate is acidified.

.....

..... [1]

[Total: 7]

Question No 2 - (0620_s22_41_6)

Topics: 10.2 - Fertilisers, 1.1 - Solids, liquids and gases, 12.2 - Acid–base titrations, 12.4 - Separation and purification, 3.1 - Formulae, 3.3 - The mole and the Avogadro constant, 6.2 - Rate of reaction, 6.3 - Reversible reactions and equilibrium, 6.4 - Redox, 7.1 - The characteristic properties of acids and bases, 7.3 - Preparation of salts, 9.6 - Extraction of metals

Subsection Topics: c: 6.4 - Redox | a: 9.6 - Extraction of metals, 1.1 - Solids, liquids and gases | b: 7.3 - Preparation of salts, 6.2 - Rate of reaction, 12.4 - Separation and purification, 3.1 - Formulae | d: 12.2 - Acid–base titrations, 3.3 - The mole and the Avogadro constant

This question is about zinc and its compounds.

(a) Zinc is extracted from its ore which is mainly zinc sulfide, ZnS.

The steps for this extraction are shown.

step 1 Zinc sulfide is converted into zinc oxide.

step 2 The zinc oxide is then reduced to zinc in a furnace. The zinc formed becomes a gas.

step 3 The zinc gas is cooled to form molten zinc.

(i) Name the ore of zinc, which is mainly zinc sulfide.

..... [1]

(ii) Describe how zinc sulfide is converted into zinc oxide in **step 1**.

.....

..... [1]

(iii) Name the reducing agent used in **step 2**.

..... [1]

(iv) Explain why the zinc forms a gas in **step 2** inside the furnace.

..... [1]

(v) State the name of the physical change occurring when zinc gas is converted into molten zinc.

..... [1]

(b) Zinc sulfate crystals, $ZnSO_4 \cdot 7H_2O$, are hydrated.

Zinc sulfate crystals are made by reacting zinc carbonate with dilute sulfuric acid.

The equation for the overall process is shown.

$$ZnCO_3 + H_2SO_4 + 6H_2O \rightarrow ZnSO_4 \cdot 7H_2O + CO_2$$

step 1 Large pieces of solid zinc carbonate are added to dilute sulfuric acid until the zinc carbonate is in excess. This forms aqueous zinc sulfate.

step 2 The excess zinc carbonate is separated from the aqueous zinc sulfate.

step 3 The aqueous zinc sulfate is heated until a saturated solution is formed.

step 4 The saturated solution is allowed to cool and crystallise.

step 5 The crystals are removed and dried.

(i) In **step 1**, zinc carbonate is in excess when no more zinc carbonate dissolves.

State one **other** observation that indicates the zinc carbonate is in excess in **step 1**.

..... [1]

(ii) Name a different substance, other than zinc carbonate, that can be added to dilute sulfuric acid to produce aqueous zinc sulfate in **step 1**.

..... [1]

(iii) **Step 1** is repeated using powdered zinc carbonate instead of large pieces.

All other conditions are kept the same.

The rate of reaction increases.

Give a reason why the rate of reaction increases. Explain your answer in terms of particles.

.....

.....

..... [2]

(iv) Suggest what is observed when the solution is saturated in **step 3**.

.....

.....

..... [1]

(v) The formula of zinc sulfate crystals is $ZnSO_4 \bullet 7H_2O$.

Give the formula of the solid formed if the crystals are heated to dryness in **step 3**.

..... [1]

[Total: 11]

Question No 3 - (0620_s20_43_6)

Topics: 10.3 - Air quality and climate, 11.1 - Formulae, functional groups and terminology, 11.3 - Fuels, 11.7 - Carboxylic acids, 11.8 - Polymers, 12.5 - Identification of ions and gases, 3.1 - Formulae, 5.1 - Exothermic and endothermic reactions, 7.1 - Characteristics of Acids & Bases, 7.3 - Preparation of salts

Subsection Topics: a: 7.3 - Preparation of salts | b: 7.1 - Characteristics of Acids & Bases | c: 7.1 - Characteristics of Acids & Bases | d: 7.1 - Characteristics of Acids & Bases

(a) An endothermic reaction occurs when calcium nitrate is heated.

(i) Balance the equation for this reaction.

$$.....Ca(NO_3)_2 \rightarrow .....CaO + ...NO_2 + ...O_2$$ [1]

(ii) State the type of reaction shown by the equation.

..... [1]

(b) Describe the test for a nitrate ion.

test .....

.....

result .....

.....

[3]

[Total: 5]

Question No 4 - (0620_s19_42_4)

Topics: 11.1 - Formulae, functional groups and terminology, 11.6 - Alcohols, 11.7 - Carboxylic acids, 12.4 - Separation and purification, 12.5 - Identification of ions and gases, 3.1 - Formulae, 5.1 - Exothermic and endothermic reactions, 6.2 - Rate of reaction, 6.3 - Reversible reactions and equilibrium, 7.1 - Characteristics of Acids & Bases, 7.3 - Preparation of salts

Subsection Topics: c: 12.5 - Identification of ions and gases | a: 7.1 - Characteristics of Acids & Bases, 12.5 - Identification of ions and gases, 3.1 - Formulae | b: 7.3 - Preparation of salts, 12.4 - Separation and purification

Methanol is made industrially by reacting carbon monoxide with hydrogen. The gases react at a temperature of 250 °C and a pressure of 75 atmospheres.

$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$$

The forward reaction is exothermic.

(a) Suggest a source of hydrogen for this industrial process.

..... [1]

(b) Complete the table using only the words *increases*, *decreases* or *no change*.

	effect on the rate of the reverse reaction	effect on the equilibrium yield of $CH_3OH(g)$
adding a catalyst		no change
increasing the temperature	increases	
decreasing the pressure		

[4]

(c) Methanol is a member of the homologous series of alcohols.

(i) State **two** general characteristics of a homologous series.

1 .....

2 .....

[2]

(ii) Draw the structures of **two** different alcohols, each containing **three** carbon atoms. Show all of the atoms and all of the bonds.

Name these **two** alcohols.

name	name .....

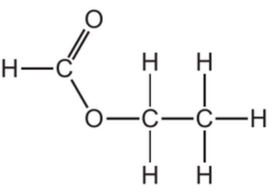
[4]

(iii) What term is used to describe compounds with the same molecular formula but different structural formulae?

..... [1]

(d) Alcohols react with carboxylic acids to produce esters.

(i) The structure of ester **X** is shown.



Name ester **X**.

..... [1]

(ii) Give the name of the carboxylic acid and the alcohol that react together to produce ester **X**.

carboxylic acid .....

alcohol .....

[2]

(iii) Ester **Y** is different from ester **X** but also has the formula $C_3H_6O_2$.

Draw the structure of ester **Y**. Show all of the atoms and all of the bonds.

.....

[2]

[Total: 17]

Question No 5 - (0620_m24_42_1)

Topics: 2.2 - Atomic structure and the Periodic Table, 2.4 - Ions and ionic bonds, 3.2 - Relative masses of atoms and molecules, 3.3 - The mole and the Avogadro constant, 4.1 - Electrolysis, 6.1 - Physical and chemical changes, 6.4 - Redox, 7.1 - The characteristic properties of acids and bases, 7.2 - Oxides, 9.4 - Reactivity series, 9.6 - Extraction of metals

Subsection Topics: a: 9.6 - Extraction of metals | b: 3.2 - Relative masses of atoms and molecules, 9.6 - Extraction of metals, 6.4 - Redox | c: 6.1 - Physical and chemical changes | d: 7.2 - Oxides | e: 9.6 - Extraction of metals, 4.1 - Electrolysis | f: 2.2 - Atomic structure and the Periodic Table

Iron ore contains iron(III) oxide, Fe_2O_3. A blast furnace is used to extract iron from Fe_2O_3.

Equations for some of the reactions in the blast furnace are shown.

equation 1 $C + O_2 \rightarrow CO_2$

equation 2 $CaCO_3 \rightarrow CaO + CO_2$

equation 3 $CaO + SiO_2 \rightarrow CaSiO_3$

(a) **Equation 1** shows the combustion of carbon in the blast furnace.

(i) Name the substance which provides the carbon for this reaction.

..... [1]

(ii) State the purpose of the combustion of carbon in the blast furnace.

..... [1]

(b) Iron(III) oxide, Fe_2O_3, in iron ore is converted to iron when it reacts with carbon monoxide, CO, in the blast furnace.

(i) Calculate the percentage by mass of iron in iron(III) oxide, Fe_2O_3.

percentage = ...% [2]

(ii) State the name of the iron ore which consists mainly of iron(III) oxide.

..... [1]

(iii) Describe how carbon monoxide is formed in the blast furnace.

..... [1]

(iv) Write the symbol equation to show the reaction that occurs when iron(III) oxide is converted to iron in the blast furnace.

..... [2]

(v) Name the chemical process which happens to iron when iron(III) oxide is converted to iron in the blast furnace.

..... [1]

(c) State the type of reaction shown by **equation 2**.

..... [1]

(d) **(i)** Explain why the reaction in **equation 3** can be described as an acid–base reaction.

.....

.....

..... [2]

(ii) State:

- the chemical name of SiO_2

.....

- the common name given to $CaSiO_3$ when it is formed in the blast furnace.

..... [2]

(e) Aluminium **cannot** be extracted from its ore using a blast furnace.

(i) State why aluminium is **not** extracted from its ore using a blast furnace.

..... [1]

(ii) Name the process used to extract aluminium from its ore.

..... [1]

(f) Both iron(III) oxide and aluminium oxide contain metal ions with a 3+ charge.

(i) Write the electronic configuration of an Al^{3+} ion.

..... [1]

(ii) Deduce the number of protons and electrons in an Fe^{3+} ion.

protons	electrons

[2]

[Total: 19]

Question No 6 - (0620_w23_41_6)

Topics: 11.3 - Fuels, 11.5 - Alkenes, 11.6 - Alcohols, 11.7 - Carboxylic acids, 3.1 - Formulae, 6.4 - Redox, 7.1 - Characteristics of Acids & Bases, 7.1 - The characteristic properties of acids and bases

Subsection Topics: f: 11.7 - Carboxylic acids, 3.1 - Formulae | a: 11.3 - Fuels | b: 11.6 - Alcohols | c: 7.1 - Characteristics of Acids & Bases, 6.4 - Redox | d: 11.3 - Fuels | e: 6.4 - Redox

Ethanol is manufactured by **two** methods:

method 1 fermentation of aqueous glucose

method 2 catalytic addition of steam to an alkene.

(a) Method 1 takes place at room temperature and pressure.

State **two** other conditions needed in method 1.

1 .....

2 ..... [2]

(b) **(i)** State the typical temperature and pressure used in method 2.

temperature ..... °C

pressure ..... kPa [2]

(ii) Name the alkene used in method 2.

..... [1]

(iii) State why the reaction in method 2 is referred to as an addition reaction.

..... [1]

(c) The catalyst in method 2 is phosphoric acid, H_3PO_4. Dilute phosphoric acid is a weak acid which contains phosphate ions, PO_4^{3-}.

(i) State what is meant by the term acid.

..... [1]

(ii) State the meaning of weak in the term weak acid.

..... [1]

(iii) Determine the oxidation number of phosphorus in the PO_4^{3-} ion.

Show your working.

oxidation number = ... [2]

(d) Give **one** advantage of each method of production of ethanol.

method 1 .....

method 2

method 2 ..... [2]

(e) Ethanol can be converted to ethanoic acid by reacting it with an acidified oxidising agent.

(i) Name the acidified oxidising agent.

..... [1]

(ii) State, in terms of redox, what type of reagent ethanol is in this reaction.

..... [1]

(f) Ethanoic acid reacts with calcium to form a salt and one other product.

(i) Name the salt.

..... [1]

(ii) Write the formula of the salt.

..... [1]

(iii) Identify the other product.

..... [1]

[Total: 17]

Question No 7 - (0620_s23_43_6)

Topics: 10.2 - Fertilisers, 12.5 - Identification of ions and gases, 3.1 - Formulae, 6.2 - Rate of reaction, 6.3 - Reversible reactions and equilibrium, 6.4 - Redox, 7.3 - Preparation of salts

Subsection Topics: a: 10.2 - Fertilisers, 6.2 - Rate of reaction | b: 10.2 - Fertilisers, 3.1 - Formulae | c: 3.1 - Formulae, 12.5 - Identification of ions and gases, 7.3 - Preparation of salts

This question is about nitrogen and compounds of nitrogen.

(a) Ammonia is manufactured by the reaction between nitrogen and hydrogen in the Haber process.
The equation is shown.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

(i) State the source of nitrogen for the Haber process.

..... [1]

(ii) State the source of hydrogen for the Haber process.

..... [1]

(iii) State the typical conditions used in the Haber process.

temperature ..... °C

pressure ..... atm

[2]

(iv) Name the catalyst used in the Haber process.

..... [1]

(v) State what is meant by the term catalyst.

.....

..... [2]

(b) Ammonia is converted into nitric acid.

(i) The first stage is the conversion of ammonia into nitrogen monoxide, NO.
The equation is shown.

$$4NH_3(g) + 5O_2(g) \rightleftharpoons 4NO(g) + 6H_2O(g)$$

The reaction is carried out at a temperature of 900 °C and a pressure of 7 atm.
The forward reaction is exothermic.

Using explanations that do **not** involve cost:

- explain why a temperature less than 900 °C is **not** used

.....

- explain why a pressure greater than 7 atm is **not** used.

.....

[2]

(ii) In the second stage, nitrogen monoxide reacts with water and oxygen to produce nitric acid.

Balance the symbol equation for the reaction.

$$.....NO + ...O_2 + ...H_2O \rightarrow .....HNO_3$$ [1]

(c) A student makes aqueous copper(II) nitrate by adding an excess of solid copper(II) carbonate to dilute nitric acid.

(i) Write the symbol equation for this reaction.

..... [2]

(ii) State **two** observations that indicate the copper(II) carbonate is in excess.

1 .....

2 .....
[2]

(iii) Name **one** compound, other than copper(II) carbonate, that can be added to dilute nitric acid to produce aqueous copper(II) nitrate.

..... [1]

[Total: 15]

Question No 8 - (0620_m24_42_3)

Topics: 11.7 - Carboxylic acids, 3.3 - The mole and the Avogadro constant, 7.1 - Characteristics of Acids & Bases, 7.1 - The characteristic properties of acids and bases

Subsection Topics: a: 7.1 - Characteristics of Acids & Bases | b: 7.1 - Characteristics of Acids & Bases | c: 7.1 - Characteristics of Acids & Bases | d: 7.1 - Characteristics of Acids & Bases | e: 7.1 - Characteristics of Acids & Bases | f: 7.1 - Characteristics of Acids & Bases | g: 3.3 - The mole and the Avogadro constant

This question is about acids, bases and alkalis.

Table 3.1 shows the pH values of some substances.

Table 3.1

substance	pH
NaOH(aq)	14
$Ca(OH)_2$(aq)	10
H_2O(l)	7
CH_3COOH(aq)	4
HNO_3(aq)	1

(a) Define the term base.

..... [1]

(b) State what is meant by the term alkali.

..... [1]

(c) Thymolphthalein is an indicator.

State the colour of thymolphthalein in:

- NaOH(aq) .....
- CH_3COOH(aq). .....

[2]

(d) **(i)** Use the information in Table 3.1 to identify the substance with the highest concentration of H^+(aq) ions.

Explain your answer.

substance .....

explanation .....

[2]

(ii) Name an indicator which can be used to identify the substance with the highest concentration of H^+(aq) ions.

..... [1]

(e) Complete the equation to show the dissociation of ethanoic acid, CH_3COOH, in aqueous solution.

CH_3COOH(aq) ..... [3]

(f) Write the **ionic** equation which represents a neutralisation reaction between any acid and any alkali.

..... [1]

(g) Dilute nitric acid, HNO_3(aq), reacts with aqueous calcium hydroxide, $Ca(OH)_2$(aq), as shown.

$$2HNO_3(aq) + Ca(OH)_2(aq) \rightarrow Ca(NO_3)_2(aq) + 2H_2O(l)$$

20.0 cm^3 of 0.0150 mol/dm^3 $Ca(OH)_2$(aq) reacts with 25.0 cm^3 of HNO_3(aq).

Calculate the concentration of HNO_3(aq) in g/dm^3.

Use the following steps.

- Calculate the number of moles of $Ca(OH)_2$(aq) used.

..... mol

- Determine the number of moles of $HNO_3(aq)$ which react with the $Ca(OH)_2(aq)$.

..... mol

- Calculate the concentration of $HNO_3(aq)$ in mol/dm^3.

..... mol/dm^3

- Calculate the concentration of $HNO_3(aq)$ in g/dm^3.

..... g/dm^3
[5]

[Total: 16]

Question No 9 - (0620_w21_43_3)

Topics: 10.3 - Air quality and climate, 12.5 - Identification of ions and gases, 2.4 - Ions and ionic bonds, 2.5 - Simple molecules and covalent bonds, 2.6 - Giant covalent structures, 3.1 - Formulae, 3.2 - Relative masses of atoms and molecules, 3.3 - The mole and the Avogadro constant, 6.1 - Physical and chemical changes, 7.3 - Preparation of salts, 9.4 - Reactivity series, 9.6 - Extraction of metals

Subsection Topics: a: 3.2 - Relative masses of atoms and molecules | b: 3.2 - Relative masses of atoms and molecules | c: 9.6 - Extraction of metals | d: 6.1 - Physical and chemical changes | e: 7.3 - Preparation of salts | f: 2.5 - Simple molecules and covalent bonds, 2.6 - Giant covalent structures | g: 9.4 - Reactivity series | h: 12.5 - Identification of ions and gases, 10.3 - Air quality and climate

Lead is a metallic element in Group IV. One of the ores of lead is galena, which is an impure form of lead(II) sulfide, PbS.

Lead also occurs in the ore cerussite, which contains lead(II) carbonate, $PbCO_3$.

(a) Calculate the relative formula mass, M_r, of $PbCO_3$.

M_r of $PbCO_3$ = ... [1]

(b) The M_r of PbS is 239.

Calculate the percentage of lead by mass in PbS.

percentage of lead by mass in PbS = ... [1]

(c) The percentage of lead by mass in $PbCO_3$ is 77.5%.

Use this information and your answer to **(b)** to suggest whether it would be better to extract lead from $PbCO_3$ or PbS.

Give a reason for your answer.

.....

..... [1]

(d) When lead(II) carbonate is heated it decomposes into lead(II) oxide, PbO, and carbon dioxide.

Write a chemical equation for this reaction.

..... [1]

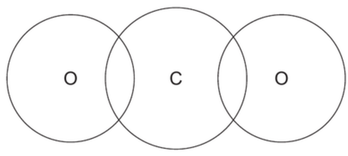
(e) Lead(II) carbonate reacts with dilute nitric acid. One of the products is aqueous lead(II) nitrate, $Pb(NO_3)_2$.

Write a chemical equation for this reaction.

..... [2]

(f) Lead(II) oxide and carbon dioxide are oxides of Group IV elements.

(i) Complete the diagram to show the electron arrangement in one molecule of CO_2. Show only the outer electrons.



[2]

(ii) The melting points of lead(II) oxide and carbon dioxide are shown.

	melting point / °C
lead(II) oxide	886
carbon dioxide	–56

Use your knowledge of structure and bonding to explain why lead(II) oxide has a much higher melting point than carbon dioxide.

Your answer should refer to:

- the types of particles involved
- the relative strength of the forces of attraction between the particles.

.....

.....

.....

..... [3]

(g) Part of the reactivity series is shown.

magnesium	most reactive
lead	↑
copper	least reactive

Aqueous lead(II) nitrate contains Pb^{2+} ions.

Two experiments are carried out.

In Experiment 1, magnesium is added to aqueous lead(II) nitrate.

In Experiment 2, copper is added to aqueous lead(II) nitrate.

Write an ionic equation for any reaction that occurs in each experiment. If no reaction occurs write 'no reaction'.

Experiment 1 .....

Experiment 2 .....
[2]

(h) When lead(II) nitrate is heated it decomposes to produce the same gaseous products as when copper(II) nitrate is heated.

(i) One of the gaseous products is oxygen.

Describe a test for oxygen.

test .....

observations .....
[2]

(ii) Name the other gaseous product.

..... [1]

[Total: 16]

Question No 10 - (0620_s19_42_3)

Topics: 2.4 - Ions and ionic bonds, 2.5 - Simple molecules and covalent bonds, 3.1 - Formulae, 6.4 - Redox, 7.1 - Characteristics of Acids & Bases, 7.1 - The characteristic properties of acids and bases, 7.2 - Oxides
Subsection Topics: a: 2.5 - Simple molecules and covalent bonds | b: 3.1 - Formulae, 6.4 - Redox | c: 7.1 - Characteristics of Acids & Bases | d: 2.5 - Simple molecules and covalent bonds | e: 7.1 - Characteristics of Acids & Bases, 3.1 - Formulae

This question is about phosphorus and compounds of phosphorus.

(a) Phosphorus has the formula P_4. Some properties of P_4 are shown.

melting point / °C	45
boiling point / °C	280
electrical conductivity	non-conductor
solubility in water	insoluble

(i) Name the type of bonding that exists between the atoms in a P_4 molecule.

..... [1]

(ii) Explain, in terms of attractive forces between particles, why P_4 has a low melting point.

.....

..... [1]

(iii) Explain why phosphorus is a non-conductor of electricity.

.....

..... [1]

(b) Phosphorus, P_4, reacts with air to produce phosphorus(V) oxide, P_4O_{10}.

(i) Write a chemical equation for this reaction.

..... [2]

(ii) What type of chemical reaction is this?

..... [1]

(c) Phosphorus(V) oxide, P_4O_{10}, is an acidic oxide.

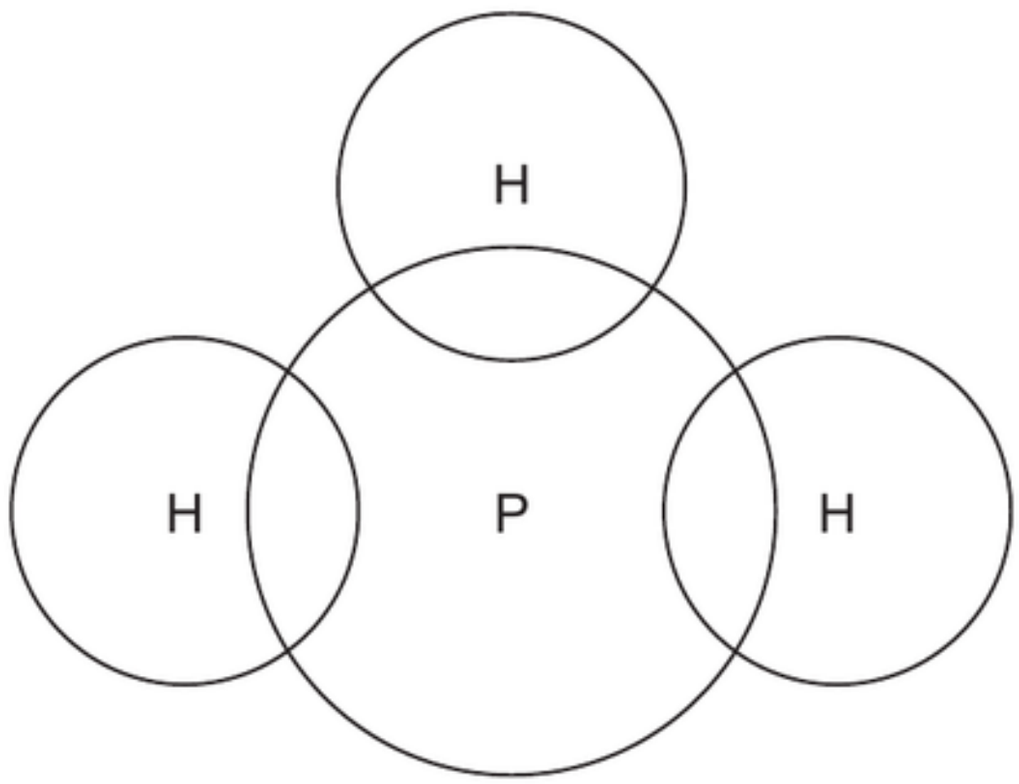
Phosphorus(V) oxide, P_4O_{10}, reacts with aqueous sodium hydroxide to form a salt containing the phosphate ion, PO_4^{3-}. Water is the only other product.

Write a chemical equation for the reaction between phosphorus(V) oxide and aqueous sodium hydroxide.

..... [2]

(d) Phosphine has the formula PH_3.

Complete the dot-and-cross diagram to show the electron arrangement in a molecule of phosphine. Show outer shell electrons only.



[2]

(e) Phosphine, PH_3, has a similar chemical structure to ammonia, NH_3.

Ammonia acts as a base when it reacts with sulfuric acid.

(i) What is meant by the term *base*?

..... [1]

(ii) Write a chemical equation for the reaction between ammonia and sulfuric acid.

..... [2]

[Total: 13]

Question No 11 - (0620_w24_42_4)

Topics: 12.1 - Experimental design, 12.4 - Separation and purification, 12.5 - Identification of ions and gases, 3.1 - Formulae, 3.2 - Relative masses of atoms and molecules, 3.3 - The mole and the Avogadro constant, 4.1 - Electrolysis, 7.3 - Preparation of salts

Subsection Topics: a: 4.1 - Electrolysis | b: 7.3 - Preparation of salts | c: 3.3 - The mole and the Avogadro constant | d: 12.5 - Identification of ions and gases | e: 3.3 - The mole and the Avogadro constant | f: 7.3 - Preparation of salts | g: 12.1 - Experimental design | h: 7.3 - Preparation of salts, 3.1 - Formulae

Silver bromide, AgBr, is made when aqueous silver ethanoate, CH_3COOAg, is added to aqueous sodium bromide, NaBr.

The equation for the reaction is shown in **equation 1**.

equation 1 $CH_3COOAg + NaBr \rightarrow CH_3COONa + AgBr$

The method includes the following steps.

step 1 Add 200.0 cm^3 of 0.0500 mol/dm^3 CH_3COOAg to a beaker.
This volume contains 0.0100 mol of Ag^+ ions.

step 2 Add 50.0 cm^3 of aqueous NaBr. This volume contains 0.0100 mol of Br^- ions.
A precipitate forms.

step 3 Filter the mixture.

step 4 Dry the solid residue until all the water is removed.

step 5 Record the mass of the dry residue.

(a) Complete the ionic equation for the reaction by adding the missing state symbols.

$$Ag^+(.....) + Br^-(.....) \rightarrow AgBr(.....)$$

[1]

(b) Name a different aqueous silver salt which could be used in **step 1**.

..... [1]

(c) Use the information in **step 2** to calculate the concentration of aqueous NaBr.

concentration = ... mol/dm^3 [1]

(d) State the colour of the precipitate which forms in **step 2**.

..... [1]

(e) Use the information in **step 1**, **step 2** and **equation 1** to determine the number of moles of AgBr formed. Use this value to calculate the mass of AgBr formed.

number of moles of AgBr = ...

DO NOT WRITE IN THIS MARGIN

mass of AgBr = ... g
[3]

(f) Name the salt dissolved in the filtrate in **step 3**.

..... [1]

(g) The recorded mass of the dry residue in **step 5** is greater than the mass calculated in **(e)** because a step is missing from the procedure.

(i) Suggest the missing step.

..... [1]

(ii) Name the substance responsible for the greater mass of the dry residue.

..... [1]

(h) Barium sulfate can be made by the same method but with different aqueous solutions.

(i) Suggest **two** aqueous solutions which can be added together to make barium sulfate.

..... and ..... [2]

(ii) Write the balanced symbol equation for this reaction.

..... [2]

[Total: 14]

Question No 12 - (0620_w23_43_3)

Topics: 2.4 - Ions and ionic bonds, 2.5 - Simple molecules and covalent bonds, 3.1 - Formulae, 6.3 - Reversible reactions and equilibrium, 6.4 - Redox, 7.3 - Preparation of salts, 9.2 - Uses of metals, 9.3 - Alloys and their properties, 9.5 - Corrosion of metals, 9.6 - Extraction of metals
Subsection Topics: a: 9.6 - Extraction of metals | b: 9.6 - Extraction of metals, 6.4 - Redox | c: 7.3 - Preparation of salts | d: 9.3 - Alloys and their properties, 9.2 - Uses of metals | e: 9.5 - Corrosion of metals | f: 9.5 - Corrosion of metals

This question is about nitrogen and some of its compounds.

(a) Nitrogen is converted into ammonia, NH_3, in the Haber process.

(i) Nitrogen is obtained from air.

State the percentage of nitrogen in clean, dry air.

..... [1]

(ii) State the source of hydrogen for the Haber process.

..... [1]

(iii) Complete the dot-and-cross diagram in Fig. 3.1 for a molecule of ammonia.

Show the outer shell electrons only.

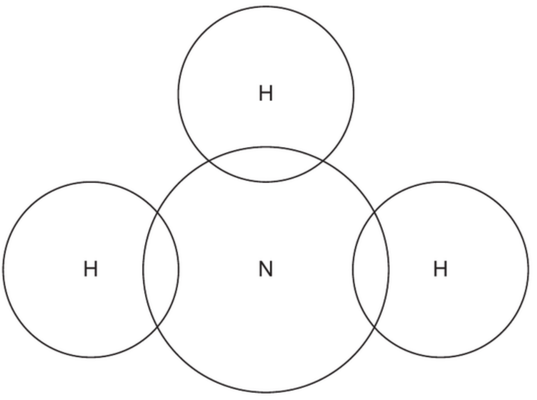


Fig. 3.1

[2]

(iv) Write a chemical equation for the reaction occurring in the Haber process and give the typical reaction conditions. Include units where appropriate.

chemical equation .....

reaction conditions:

temperature .....

pressure .....

catalyst .....

[5]

(b) Ammonia is converted into nitric acid.

The first stage of this conversion uses a catalyst and occurs at a temperature of 900 °C and a pressure of 5 atmospheres.

$$4NH_3(g) + 5O_2(g) \rightleftharpoons 4NO(g) + 6H_2O(g)$$

The forward reaction is exothermic.

(i) Suggest which of the following elements is most likely to be used as a catalyst.
Draw a circle around your answer.

calcium **lead** **platinum** **sodium** **sulfur** [1]

(ii) State the oxidation number of nitrogen in:

NH_3 .....

NO .....

[2]

(iii) Use your answer to **(ii)** to explain whether the nitrogen in ammonia undergoes oxidation or reduction.

.....

..... [1]

(iv) Complete Table 3.1 using the words **increases**, **decreases** or **no change**.

Table 3.1

Table 3.1

	effect on the equilibrium yield of NO(g)	effect on the rate of the forward reaction
decreasing the pressure		
decreasing the temperature		decreases
removing the catalyst		decreases

[4]

(v) Decreasing the temperature causes the rate of the forward reaction to decrease.

Explain, using collision theory, why the rate of the reaction is slower at the decreased temperature.

.....

.....

.....

..... [3]

(c) In the second stage, nitric acid is produced.

Balance the symbol equation for this reaction.

$$.....NO + ...O_2 + ...H_2O \rightarrow .....HNO_3$$ [1]

[Total: 21]

Question No 13 - (0620_m19_42_5)

Topics: 10.1 - Water, 12.4 - Separation and purification, 12.5 - Identification of ions and gases, 3.1 - Formulae, 3.3 - The mole and the Avogadro constant, 4.1 - Electrolysis, 7.1 - Characteristics of Acids & Bases, 7.3 - Preparation of salts, 9.6 - Extraction of metals

Subsection Topics: a: 3.1 - Formulae, 7.1 - Characteristics of Acids & Bases | b: 7.3 - Preparation of salts, 12.4 - Separation and purification | c: 12.5 - Identification of ions and gases, 10.1 - Water

Titanium is extracted from an ore called rutile. Rutile is an impure form of titanium(IV) oxide, TiO_2.

(a) Rutile is mixed with coke and heated in a furnace through which chlorine gas is passed. The product is gaseous titanium(IV) chloride, $TiCl_4$.

$$TiO_2(s) + 2C(s) + 2Cl_2(g) \rightarrow TiCl_4(g) + 2CO(g)$$

The gaseous titanium(IV) chloride produced is condensed into the liquid state. The titanium(IV) chloride is then separated from liquid impurities.

(i) Suggest the name of the process by which liquid titanium(IV) chloride could be separated from the liquid impurities.

..... [1]

(ii) Carbon monoxide, CO(g), is also produced in the reaction.

Why should carbon monoxide **not** be released into the atmosphere?

..... [1]

(b) Calculate the volume of chlorine gas, $Cl_2(g)$, at room temperature and pressure, that reacts completely with 400 g of $TiO_2(s)$ using the following steps.

$$TiO_2(s) + 2Cl_2(g) + 2C(s) \rightarrow TiCl_4(g) + 2CO(g)$$

- Calculate the relative formula mass, M_r, of TiO_2.

M_r of TiO_2 = ...

- Calculate the number of moles in 400 g of TiO_2.

..... mol

- Determine the number of moles of Cl_2 that react with 400 g of TiO_2.

moles of Cl_2 = ... mol

- Calculate the volume of Cl_2 that reacts with 400 g of TiO_2.

volume of Cl_2 = ... dm^3

[4]

(c) Titanium(IV) chloride, $TiCl_4$, is heated with an excess of magnesium, in an atmosphere of argon.

(i) Balance the chemical equation for the reaction.

$$TiCl_4 + ... Mg \rightarrow Ti + ... MgCl_2$$

[1]

(ii) Titanium(IV) chloride can be reacted with sodium instead of magnesium.

The reaction between titanium(IV) chloride and sodium is similar to the reaction between titanium(IV) chloride and magnesium.

Write a chemical equation for the reaction between titanium(IV) chloride and sodium.

..... [1]

(iii) Suggest why the reaction between titanium(IV) chloride and magnesium is done in an atmosphere of argon and **not** in air.

.....

..... [1]

(d) After titanium(IV) chloride is heated with magnesium, the unreacted magnesium is removed by adding an excess of dilute hydrochloric acid to the mixture.

by adding an excess of dilute hydrochloric acid to the mixture.

The dilute hydrochloric acid also dissolves the magnesium chloride.
The dilute hydrochloric acid does **not** react with the titanium or dissolve it.

(i) Give **two** observations and write a chemical equation for the reaction that occurs when dilute hydrochloric acid reacts with magnesium.

1 .....

2 .....

chemical equation .....
[3]

(ii) Name the process that is used to separate the titanium from the mixture after all the magnesium has been removed.

..... [1]

(iii) Titanium does not react with the dilute hydrochloric acid or dissolve in it.

Suggest why titanium does **not** react with dilute hydrochloric acid.

..... [1]

(e) Magnesium cannot be produced by electrolysis of aqueous magnesium chloride using inert electrodes.

(i) Name the product formed at the negative electrode (cathode) during the electrolysis of aqueous magnesium chloride.

..... [1]

(ii) Suggest how magnesium can be produced from magnesium chloride by electrolysis.

..... [1]

[Total: 16]

Question No 14 - (0620_w22_42_2)

Topics: 12.4 - Separation and purification, 12.5 - Identification of ions and gases, 2.2 - Atomic structure and the Periodic Table, 2.3 - Isotopes, 2.4 - Ions and ionic bonds, 2.7 - Metallic bonding, 3.1 - Formulae, 3.3 - The mole and the Avogadro constant, 5.1 - Exothermic and endothermic reactions, 7.1 - Characteristics of Acids & Bases, 7.1 - The characteristic properties of acids and bases, 7.3 - Preparation of salts, 8.2 - Group I properties, 9.4 - Reactivity series

Subsection Topics: a: 9.4 - Reactivity series | b: 5.1 - Exothermic and endothermic reactions, 12.5 - Identification of ions and gases, 3.1 - Formulae, 2.4 - Ions and ionic bonds | c: 7.1 - Characteristics of Acids & Bases, 12.5 - Identification of ions and gases, 3.3 - The mole and the Avogadro constant | d: 12.4 - Separation and purification, 12.5 - Identification of ions and gases, 3.1 - Formulae

Sodium is a reactive metal.

(a) Suggest why sodium is stored under oil.

..... [1]

(b) Sodium burns in air to form sodium oxide, Na_2O.

(i) State the term given to a reaction in which a substance burns.

..... [1]

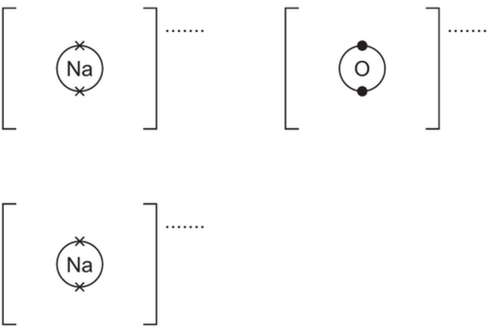
(ii) State the colour of the flame seen when sodium burns.

..... [1]

(iii) Write a chemical equation for the reaction which takes place when sodium burns in air to form sodium oxide.

..... [2]

(iv) Complete the dot-and-cross diagram to show the electron arrangement and charges of the ions in sodium oxide.



[3]

(c) Sodium reacts vigorously with water to form aqueous sodium hydroxide, NaOH, which is a strong base.

(i) Explain in terms of proton transfer what is meant by a base.

..... [1]

(ii) State a pH number that indicates the presence of a strong alkali.

..... [1]

(iii) State the colour of methyl orange in aqueous sodium hydroxide.

..... [1]

(iv) The equation for the reaction is shown.

$$2Na(s) + 2H_2O(l) \rightarrow 2NaOH(aq) + H_2(g)$$

Calculate the concentration of NaOH(aq) formed, in g/dm^3, when 0.345 g of sodium is added to 50.0 cm^3 of distilled water. Assume there is no change in volume.

Use the following steps.

- Calculate the number of moles of Na added.

= ..... mol

- Determine the number of moles of NaOH formed.

= ..... mol

- Calculate the concentration of NaOH in mol / dm^3.

concentration of NaOH = ... mol / dm^3

- Determine the M_r of NaOH and calculate the concentration of NaOH in g / dm^3.

concentration of NaOH = ... g / dm^3
[5]

(d) When NaOH(aq) is added to aqueous iron(III) chloride, $FeCl_3$(aq), a solid product is formed.

(i) Name the type of reaction where a solid is formed from two solutions.

..... [1]

(ii) State the colour of this solid product.

..... [1]

(iii) Name this solid product.

..... [1]

(iv) Write the ionic equation for the reaction. Include state symbols.

..... [3]

[Total: 22]

Question No 15 - (0620_s24_41_6)

Topics: 1.1 - Solids, liquids and gases, 3.1 - Formulae, 6.1 - Physical and chemical changes, 7.2 - Oxides, 7.3 - Preparation of salts, 9.5 - Corrosion of metals, 9.6 - Extraction of metals

Subsection Topics: a: 9.6 - Extraction of metals | b: 1.1 - Solids, liquids and gases | c: 9.5 - Corrosion of metals | d: 7.2 - Oxides, 3.1 - Formulae, 7.3 - Preparation of salts

This question is about metals.

(a) Fig. 6.1 shows a blast furnace used to extract iron from its ore.

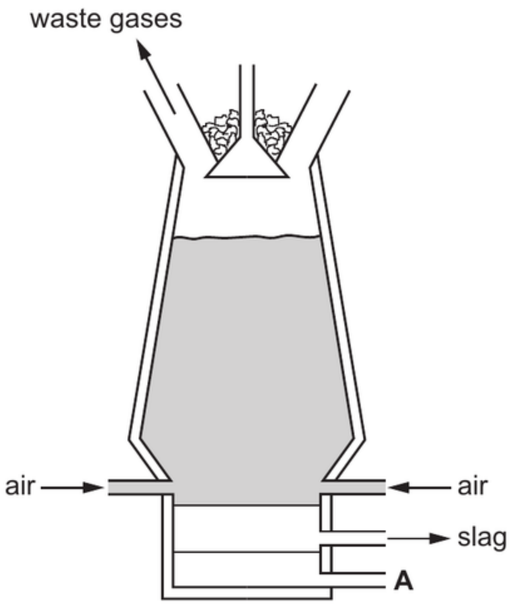


Fig. 6.1

(i) Coke and iron ore are added at the top of the blast furnace.

Name one **other** substance that is added at the top of the blast furnace.

..... [1]

(ii) Name the substance that leaves the blast furnace at **A**.

..... [1]

(iii) Slag is produced from an impurity in iron ore.

Name the impurity in iron ore that is converted into slag.

..... [1]

(iv) Name **two** substances that react together to produce the high temperature in the blast furnace.

..... and ..... [1]

(v) Name **two** waste gases that leave the blast furnace.

1 .....

2 .....
[2]

(b) Zinc is produced from zinc oxide in a furnace.

The zinc is produced as a gas. It then forms molten zinc.

(i) Suggest why the zinc produced inside the furnace is a gas.

..... [1]

(ii) State the name of the physical change that occurs when gaseous zinc is converted into molten zinc.

molten zinc.

..... [1]

(c) Zinc is used to coat iron to prevent rusting.

(i) Name the process used to coat iron with zinc as a method of rust prevention.

..... [1]

(ii) When the zinc coating is scratched, the iron underneath does not rust.

Explain why the iron underneath the zinc does **not** rust.

.....

..... [2]

(d) Zinc oxide neutralises both acids and bases.

(i) State the general name given to oxides that neutralise both acids and bases.

..... [1]

(ii) When zinc oxide neutralises aqueous sodium hydroxide, sodium zincate is formed.

The formula of the zincate ion is ZnO_2^{2-}.

Deduce the formula of sodium zincate.

..... [1]

(iii) Name the zinc compound that forms when zinc oxide neutralises dilute sulfuric acid.

..... [1]

[Total: 14]

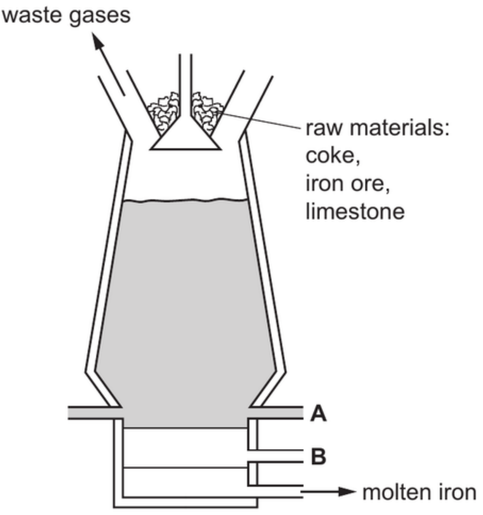
Question No 16 - (0620_s21_41_6)

Topics: 10.2 - Fertilisers, 12.2 - Acid–base titrations, 3.1 - Formulae, 3.3 - The mole and the Avogadro constant, 6.1 - Physical and chemical changes, 6.3 - Reversible reactions and equilibrium, 7.1 - The characteristic properties of acids and bases, 7.2 - Oxides, 8.2 - Group I properties, 8.4 - Transition elements, 9.5 - Corrosion of metals, 9.6 - Extraction of metals

Subsection Topics: a: 7.2 - Oxides | b: 3.1 - Formulae, 6.1 - Physical and chemical changes | c: 7.2 - Oxides

This question is about iron.

(a) Iron is extracted from its main ore in a blast furnace.



(i) Name the main ore of iron used in the blast furnace.

..... [1]

(ii) Name the substance that enters the blast furnace at **A**.

..... [1]

(iii) Name the substance that leaves the blast furnace at **B**.

..... [1]

(iv) Give **two** reasons for using coke in the blast furnace.

1 .....

2 .....

[2]

(b) Another ore of iron is iron pyrites, FeS_2. Iron pyrites contains the positive ion, Fe^{2+}.

Deduce the formula of the negative ion in FeS_2.

..... [1]

(c) Iron is a transition element.

A list of properties of iron is shown.

- Iron is a good conductor of electricity.
- Iron forms soluble salts.
- Iron forms coloured compounds.
- Iron has variable oxidation states.
- Iron acts as a catalyst.
- Iron forms a basic oxide.

(i) Give **two** properties from the list in which iron differs from Group I elements.

1 .....

2 .....

[2]

(ii) Give **two** properties from the list in which iron is similar to Group I elements.

1 .....

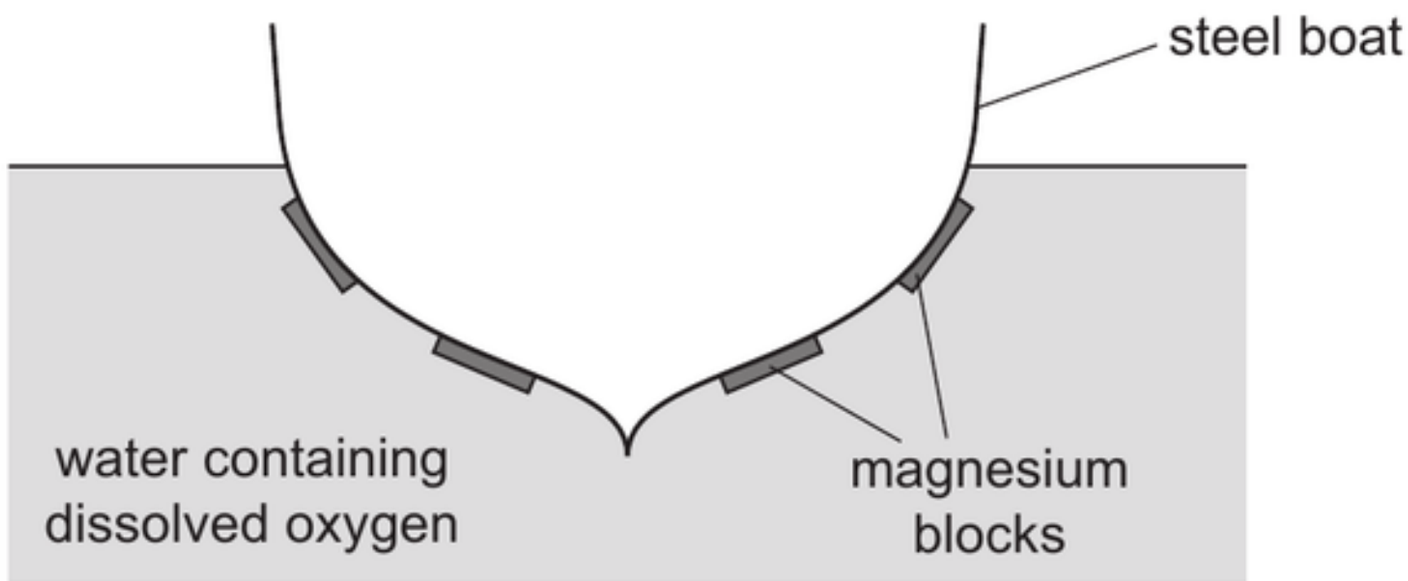
2 .....

– .....
[2]

(d) Steel consists mainly of iron.

Iron forms rust when it reacts with water and oxygen.

Magnesium blocks can be attached to the bottom of steel boats. The magnesium does not completely cover the steel.



(i) Explain how the magnesium blocks prevent iron from rusting.

.....

.....

.....

..... [2]

(ii) Explain why replacing the magnesium blocks with copper blocks will **not** prevent the bottom of the boat from rusting.

.....

..... [1]

[Total: 13]

Question No 17 - (0620_w22_43_5)

Topics: 10.3 - Air quality and climate, 12.5 - Identification of ions and gases, 2.6 - Giant covalent structures, 3.1 - Formulae, 3.3 - The mole and the Avogadro constant, 4.1 - Electrolysis, 4.2 - Hydrogen–oxygen fuel cells, 6.3 - Reversible reactions and equilibrium, 7.1 - Characteristics of Acids & Bases, 7.3 - Preparation of salts

Subsection Topics: a: 6.3 - Reversible reactions and equilibrium, 3.1 - Formulae, 7.1 - Characteristics of Acids & Bases | b: 10.3 - Air quality and climate | c: 3.3 - The mole and the Avogadro constant | d: 12.5 - Identification of ions and gases | e: 3.1 - Formulae

This question is about sulfuric acid, H_2SO_4, and salts that can be made from sulfuric acid.

(a) Sulfuric acid is manufactured by the Contact process.

stage 1 Molten sulfur burns in air to produce sulfur dioxide.

stage 2 Sulfur dioxide reacts with oxygen to form sulfur trioxide, SO_3.

stage 3 Sulfur trioxide reacts with concentrated sulfuric acid to form oleum, $H_2S_2O_7$.

stage 4 Oleum is converted into sulfuric acid.

(i) The equation for the reaction in **stage 2** is shown.

$$2SO_2 + O_2 \rightleftharpoons 2SO_3$$

State the temperature and pressure used in **stage 2**.

Name the catalyst used in **stage 2**.

temperature ..... °C

pressure ..... atm

catalyst .....

[3]

(ii) Write the chemical equation for the reaction in **stage 3**.

..... [1]

(iii) Name the substance that reacts with oleum in **stage 4**.

..... [1]

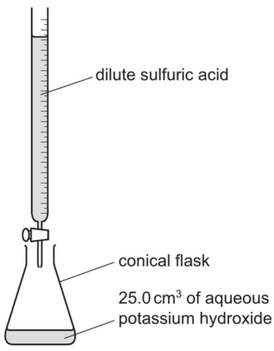
(b) Name the black solid that is produced when concentrated sulfuric acid is added to sugar, $C_{12}H_{22}O_{11}$.

..... [1]

(c) Dilute sulfuric acid and aqueous potassium hydroxide are used to make aqueous potassium sulfate.

$$H_2SO_4 + 2KOH \rightarrow K_2SO_4 + 2H_2O$$

The method includes use of the following apparatus.



(i) Calculate the volume of 0.0625 mol / dm³ dilute sulfuric acid, H_2SO_4, that completely reacts with 25.0 cm³ of 0.100 mol / dm³ potassium hydroxide, KOH, to produce aqueous potassium sulfate.

Use the following steps.

- Calculate the number of moles of KOH in 25.0 cm³ of 0.100 mol / dm³ KOH.

= ..... mol

- Deduce the number of moles of H_2SO_4 that react with KOH.

= ..... mol

- Calculate the volume of H_2SO_4 required.

volume = ... cm^3
[3]

(ii) The experiment is repeated using the same volume and concentration of potassium hydroxide and the same concentration of dilute sulfuric acid. In this second experiment, the product is aqueous potassium hydrogensulfate, $KHSO_4$.

$$H_2SO_4 + KOH \rightarrow KHSO_4 + H_2O$$

Use your answer to **(c)(i)** and the equation to deduce the volume of H_2SO_4 required.

volume = ... cm^3 [1]

(d) Aqueous potassium hydrogensulfate, $KHSO_4(aq)$, contains the ions $K^+(aq)$, $H^+(aq)$ and $SO_4^{2-}(aq)$.

Describe the observations in the following tests.

(i) A flame test is carried out on aqueous potassium hydrogensulfate.

..... [1]

(ii) Solid copper(II) carbonate is added to aqueous potassium hydrogensulfate.

.....

..... [2]

(iii) An acidic solution containing aqueous barium ions, $Ba^{2+}(aq)$, is added to aqueous potassium hydrogensulfate.

..... [1]

(e) Write the ionic equation for the reaction in **(d)(iii)**.

Include state symbols.

..... [3]

[Total: 17]

Question No 18 - (0620_m24_42_2)

Topics: 10.1 - Water, 12.5 - Identification of ions and gases, 2.2 - Atomic structure and the Periodic Table, 2.4 - Ions and ionic bonds, 2.5 - Simple molecules and covalent bonds, 4.1 - Electrolysis, 7.3 - Preparation of salts, 8.3 - Group VII properties

Subsection Topics: g: 7.3 - Preparation of salts, 4.1 - Electrolysis | a: 8.3 - Group VII properties | b: 8.3 - Group VII properties | c: 8.3 - Group VII properties | d: 2.5 - Simple molecules and covalent bonds, 8.3 - Group VII properties | e: 12.5 - Identification of ions and gases | f: 2.4 - Ions and ionic bonds

The elements in Group VII of the Periodic Table are known as the halogens. Halogens can form halide ions.

(a) Identify the halogen with the lowest density at r.t.p. (room temperature and pressure).

..... [1]

(b) State the appearance of bromine at r.t.p.

..... [1]

(c) Use the Periodic Table to:

- give the symbol of the halogen with the highest atomic number

.....

- deduce the number of occupied electron shells in an atom of this element.

..... [2]

(d) Bromine molecules have covalent bonding.

(i) State what is meant by the term covalent bond.

.....

..... [2]

(ii) Name **one** halide ion which bromine molecules can displace.

..... [1]

(iii) Explain why bromine can displace the halide ion in **(d)(ii)**.

..... [1]

(e) Name a halide compound which can be used to detect the presence of water.

..... [2]

(f) Calcium chloride is an ionic compound.

Complete the dot-and-cross diagram in Fig. 2.1 for the ions in calcium chloride.

Give the charges on each of the ions.

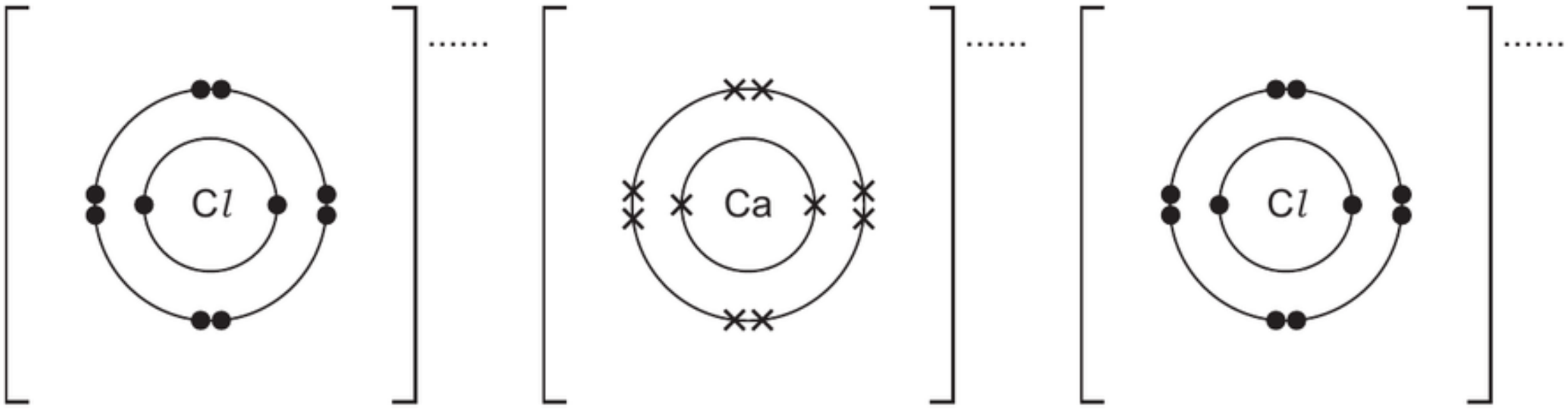


Fig. 2.1

[3]

(g) Aqueous lead(II) ions are added to aqueous chloride ions. A white precipitate of insoluble lead(II) chloride, $PbCl_2$, is formed.

(i) Name a lead(II) compound which can be used in this reaction.

..... [1]

(ii) Write the ionic equation for this reaction. Include state symbols.

.....

..... [3]

(iii) Name one **other** insoluble chloride.

..... [1]

[Total: 18]

Question No 19 - (0620_w23_42_3)

Topics: 3.1 - Formulae, 6.4 - Redox, 7.2 - Oxides, 9.2 - Uses of metals, 9.3 - Alloys and their properties, 9.5 - Corrosion of metals, 9.6 - Extraction of metals

Subsection Topics: a: 9.6 - Extraction of metals | b: 9.6 - Extraction of metals, 3.1 - Formulae, 6.4 - Redox | c: 7.2 - Oxides | d: 9.3 - Alloys and their properties, 9.2 - Uses of metals | e: 9.5 - Corrosion of metals | f: 9.5 - Corrosion of metals

Iron is manufactured in a blast furnace.

(a) Three of the starting materials added to the blast furnace are coke, iron ore and limestone.

Name the **other** starting material added to the blast furnace.

..... [1]

(b) The source of iron in the blast furnace is Fe_2O_3. Fe_2O_3 is found in iron ore.

(i) Name the main ore of iron which contains Fe_2O_3.

..... [1]

(ii) The iron in Fe_2O_3 is reduced by reaction with carbon monoxide. The unbalanced symbol equation is shown.

Complete the equation.

$$Fe_2O_3 + ...CO \rightarrow .....CO_2 + ...Fe$$ [1]

(iii) State the change in oxidation number of iron in the reaction in **(ii)**.

from ..... to ..... [2]

(iv) Explain how the change of oxidation number shows that iron has been reduced.

..... [1]

(c) The major impurity in iron ore is silicon(IV) oxide. Limestone is added to the blast furnace to remove this impurity.

Write two symbol equations to show how silicon(IV) oxide is removed. For each equation, state the type of chemical reaction that takes place.

equation 1 .....

type of chemical reaction .....

equation 2 .....

type of chemical reaction .....

[4]

(d) Iron is converted to steel by mixing it with carbon and other elements.

(i) State the term given to a substance which is a mixture of a metal and other elements.

..... [1]

(ii) Name **one** element, other than carbon, mixed with iron in the making of stainless steel.

..... [1]

(e) Preventing the rusting of steel is important.

State the chemical name of rust.

..... [1]

(f) Steel can be coated with zinc to prevent rusting. This provides both a barrier method and sacrificial protection.

(i) State the term used for coating steel with zinc.

..... [1]

(ii) Describe another barrier method for preventing rusting.

..... [1]

(iii) Explain how zinc provides sacrificial protection.

.....

..... [2]

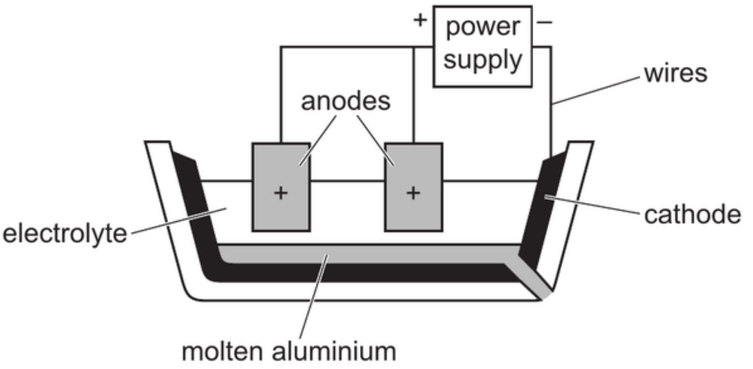
[Total: 17]

Question No 20 - (0620_m20_42_2)

Topics: 2.2 - Atomic structure and the Periodic Table, 2.3 - Isotopes, 3.1 - Formulae, 4.1 - Electrolysis, 7.1 - Characteristics of Acids & Bases, 7.2 - Oxides, 9.6 - Extraction of metals

Subsection Topics: a: 9.6 - Extraction of metals, 4.1 - Electrolysis | b: 9.6 - Extraction of metals, 4.1 - Electrolysis | c: 7.1 - Characteristics of Acids & Bases, 3.1 - Formulae, 9.6 - Extraction of metals

Aluminium is extracted from its ore. The ore is converted into pure aluminium oxide, which then undergoes electrolysis as shown.



(a) **(i)** Name an ore of aluminium.

..... [1]

(ii) What is meant by the term *electrolysis*?

.....

..... [2]

(b) Aluminium oxide has a melting point of about 2000 °C, but the electrolysis process operates at about 900 °C.

(i) Name the compound added to aluminium oxide to reduce the operating temperature.

..... [1]

(ii) Suggest **one** benefit to the environment of reducing the operating temperature.

.....

..... [1]

(iii) Write the ionic half-equation for the reaction taking place at:

the negative electrode (cathode) .....

the positive electrode (anode) .....

[4]

(iv) Explain why the anodes need frequent replacement.

.....

..... [2]

(c) Aluminium oxide reacts with acids and with alkalis.

(i) What term is used to describe an oxide that reacts with acids and with alkalis?

..... [1]

(ii) Aluminium oxide reacts with dilute sulfuric acid to form a salt.

State the name and write the formula of the salt formed.

name .....

formula .....
[2]

(iii) Aluminium oxide reacts with dilute sodium hydroxide to form a salt and one other product.

Name the other product.

..... [1]

(iv) Aluminium hydroxide, $Al(OH)_3$, decomposes when heated to form aluminium oxide and water.

Write the chemical equation for this reaction.

..... [2]

(v) Suggest the names of **two** other aluminium compounds that decompose when heated to form aluminium oxide.

.....

..... [2]

[Total: 19]

Question No 21 - (0620_w21_42_5)

Topics: 2.7 - Metallic bonding, 4.1 - Electrolysis, 6.3 - Reversible reactions and equilibrium, 7.1 - Characteristics of Acids & Bases, 8.2 - Group I properties, 8.4 - Transition elements, 9.1 - Properties of metals, 9.2 - Uses of metals

Subsection Topics: a: 2.7 - Metallic bonding | b: 9.1 - Properties of metals, 9.2 - Uses of metals | c: 8.4 - Transition elements | d: 8.2 - Group I properties, 7.1 - Characteristics of Acids & Bases | e: 6.3 - Reversible reactions and equilibrium

Iron is a transition element. Potassium is a Group I element.

(a) Iron and potassium have the same type of bonding.

Name and describe the type of bonding in these two elements.

name .....

description .....

.....

.....

.....
[4]

(b) Transition elements and Group I elements have some similar physical properties.

They can both:

- be hammered into a shape
- conduct electricity
- be stretched into wires.

(i) Name the term used to describe the ability of elements to be hammered into a shape.

..... [1]

(ii) Describe what happens to the particles in iron when it is hammered into a shape.

.....

..... [1]

(iii) Suggest why copper, rather than other transition elements, is used for wires which conduct electricity.

..... [1]

(c) Transition elements are harder and stronger than Group I elements.

Describe how **two** other **physical** properties of transition elements are different from those of Group I elements.

1 .....

2 .....
[2]

(d) Chemical properties of some Group I elements are shown in the table.

element	reaction with cold water	reaction with oxygen	flame test colour
lithium	• steadily effervesces • forms a colourless solution	very slowly forms an oxide layer	red
sodium	• strongly effervesces • forms a colourless solution	slowly forms an oxide layer	
potassium	• very strongly effervesces • forms a colourless solution	quickly forms an oxide layer	
rubidium			ruby red

(i) Add to the table:

- the flame test colours for sodium and potassium
- the predicted reactions of rubidium with water and with oxygen.

[4]

(ii) Name the gas produced when Group I elements react with water.

..... [1]

(iii) Name the solution formed when potassium reacts with water.

..... [1]

(iv) Predict the pH of the colourless solution formed when potassium reacts with water.

..... [1]

(v) Write the chemical equation for the reaction of sodium with oxygen.

..... [2]

(e) Iron is a typical transition element. It is the catalyst used in the Haber process.

(i) Write the equation for the reaction that occurs in the Haber process.

..... [2]

(ii) State the temperature and pressure used in the Haber process. Include units.

temperature .....

pressure .....
[2]

[Total: 22]

Question No 22 - (0620_m18_42_1)

Topics: 10.3 - Air quality and climate, 11.3 - Fuels, 12.1 - Experimental design, 12.4 - Separation and purification, 2.1 - Elements, compounds and mixtures, 2.5 - Simple molecules and covalent bonds, 6.1 - Physical and chemical changes, 7.1 - Characteristics of Acids & Bases, 8.5 - Noble gases
Subsection Topics: a: 10.3 - Air quality and climate, 2.1 - Elements, compounds and mixtures, 7.1 - Characteristics of Acids & Bases, 8.5 - Noble gases, 11.3 - Fuels | b: 2.5 - Simple molecules and covalent bonds | c: 2.1 - Elements, compounds and mixtures, 10.3 - Air quality and climate, 12.4 - Separation and purification

This question is about gases.

(a) The following substances are gases at room temperature.

letter	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**
substance	SO_2	Ar	CO	Cl_2	NH_3	CO_2	CH_4	C_3H_8

Identify, by letter:

(i) a gas which combines with water to form acid rain ..... [1]

(ii) **two** gases which exist as diatomic molecules ..... [2]

(iii) a gas which bleaches damp litmus paper ..... [1]

(iv) a gas which is used as an inert atmosphere in lamps ..... [1]

(v) **two** gases which are found in clean dry air ..... [2]

(vi) **two** gases which are found in refinery gas. ..... [2]

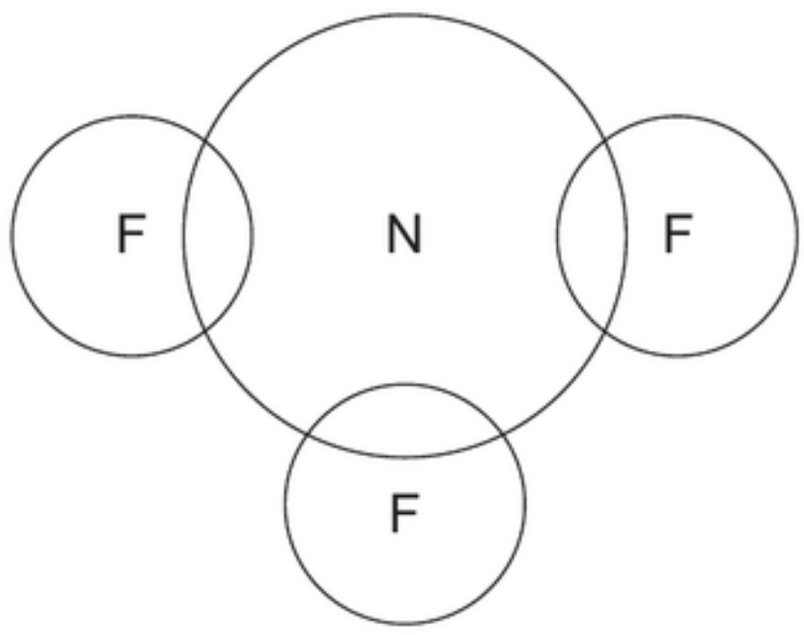
(b) NF_3 has covalent bonds.

(i) What is a covalent bond?

.....

..... [2]

(ii) Complete the dot-and-cross diagram to show the electron arrangement in a molecule of NF_3.
Show outer shell electrons only.



[3]

(c) Air is a mixture. Nitrogen and oxygen are the two most common gases in air.

(i) What is meant by the term *mixture*?

.....

..... [1]

(ii) State the percentage of oxygen, to the nearest whole number, in clean dry air.

..... [1]

(iii) Describe the steps in the industrial process which enables nitrogen and oxygen to be separated from clean dry air.

Use scientific terms in your answer.

.....

.....

.....

.....

.....

.....

..... [3]

(iv) Which physical property of nitrogen and oxygen allows them to be separated?

..... [1]

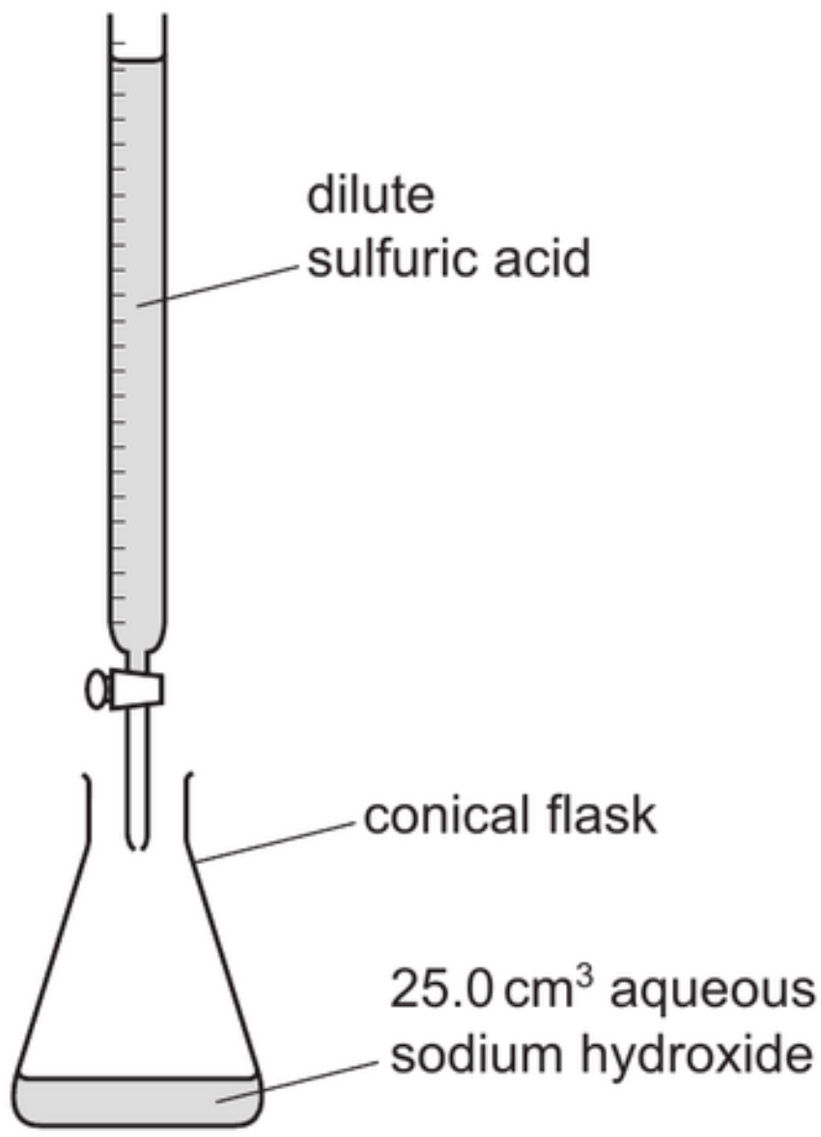
[Total: 20]

Question No 23 - (0620_w21_43_5)

Topics: 12.2 - Acid–base titrations, 12.5 - Identification of ions and gases, 4.1 - Electrolysis, 7.1 - Characteristics of Acids & Bases, 7.3 - Preparation of salts

Subsection Topics: a: 12.2 - Acid–base titrations | b: 7.3 - Preparation of salts | c: 12.5 - Identification of ions and gases, 7.1 - Characteristics of Acids & Bases

(a) Dilute sulfuric acid and aqueous sodium hydroxide can be used to prepare sodium sulfate crystals using a method that involves titration.



(i) Suggest why universal indicator is **not** suitable for this titration.

..... [1]

(ii) Name an indicator that can be used in this titration.

..... [1]

$20.0\,cm^3$ of dilute sulfuric acid neutralises $25.0\,cm^3$ of $1.00\,mol/dm^3$ aqueous sodium hydroxide. At the end of the titration the conical flask contains aqueous sodium sulfate with the dissolved indicator as an impurity.

(b) Describe how to prepare a **pure** sample of sodium sulfate crystals from the original solutions of dilute sulfuric acid and aqueous sodium hydroxide of the same concentrations.

You are not required to give details of how to carry out the titration.

.....

.....

.....

.....

.....

.....

.....

.....

..... [5]

(c) Sodium hydrogensulfate, $NaHSO_4$, dissolves in water to produce an aqueous solution, **X**, containing Na^+, H^+ and SO_4^{2-} ions.

State the observations when the following tests are done.

(i) A flame test is carried out on **X**.

..... [1]

(ii) Copper(II) oxide is warmed with an excess of **X**.

.....

..... [2]

(iii) Acidified aqueous barium nitrate is added to **X**.

..... [1]

[Total: 11]

Question No 24 - (0620_s18_42_6)

Topics: 10.1 - Water, 12.5 - Identification of ions and gases, 3.1 - Formulae, 6.3 - Reversible reactions and equilibrium, 6.4 - Redox, 7.3 - Preparation of salts

Subsection Topics: c: 7.3 - Preparation of salts | a: 7.3 - Preparation of salts | b: 6.4 - Redox, 3.1 - Formulae, 12.5 - Identification of ions and gases

(a) All sodium salts are soluble in water. All nitrates are soluble in water. Barium carbonate is insoluble in water.

Describe how you would make a pure, dry sample of barium carbonate by precipitation. Include:

- the names of the starting materials
- full practical details
- a chemical equation.

.....

.....

.....

.....

.....

..... [5]

(b) Nitrates decompose when heated.

(i) Write a chemical equation for the decomposition of sodium nitrate when it is heated.

..... [2]

(ii) The unbalanced chemical equation for the decomposition of hydrated copper(II) nitrate crystals is shown.

Balance the chemical equation for this reaction.

$2Cu(NO_3)_2.3H_2O(s) \rightarrow$ .....$CuO(s)$ + ...$NO_2(g)$ + $O_2(g)$ + ...$H_2O(g)$

[2]

(iii) When the hydrated copper(II) nitrate crystals are heated, steam is produced. When the steam condenses on a cool surface, it turns into a colourless liquid.

Anhydrous cobalt(II) chloride is used to show that the colourless liquid contains water.

How does the colour of the anhydrous cobalt(II) chloride change?

from ..... to .....

[2]

(iv) How would the student test to determine if the water produced in **(b)(iii)** is pure?

..... [1]

[Total: 12]

Question No 25 - (0620_s24_42_5)

Topics: 2.3 - Isotopes, 2.4 - Ions and ionic bonds, 3.1 - Formulae, 3.2 - Relative masses of atoms and molecules, 3.3 - The mole and the Avogadro constant, 4.1 - Electrolysis, 6.4 - Redox, 7.3 - Preparation of salts

Subsection Topics: a: 2.3 - Isotopes, 3.2 - Relative masses of atoms and molecules, 3.3 - The mole and the Avogadro constant | b: 2.4 - Ions and ionic bonds, 4.1 - Electrolysis | c: 7.3 - Preparation of salts, 3.1 - Formulae | d: 6.4 - Redox

Sulfur is a Group VI element.

(a) A sample of sulfur contains two isotopes, ^{32}S and ^{34}S.

(i) Complete Table 5.1 to show the number of protons and neutrons in one atom of each isotope of sulfur.

Table 5.1

	^{32}S	^{34}S
protons		
neutrons		

[2]

(ii) State why these isotopes have identical chemical properties.

..... [1]

(iii) State the mass of 6.02×10^{23} atoms of ^{34}S. Include units in your answer.

..... [1]

(iv) State the name of the amount of substance which contains 6.02×10^{23} atoms.

..... [1]

(v) Table 5.2 shows the relative abundance of these isotopes of sulfur in the sample.

Table 5.2

atom	^{32}S	^{34}S
relative abundance	95%	5%

Calculate the relative atomic mass of sulfur in this sample to **one** decimal place.

relative atomic mass = ... [2]

(b) Sulfur reacts with magnesium to form magnesium sulfide, MgS, an ionic compound.

(i) Complete the dot-and-cross diagram in Fig. 5.1 of the ions in magnesium sulfide.

Give the charges on the ions.

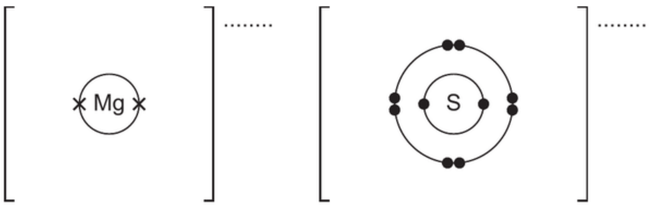


Fig. 5.1

[3]

(ii) State why MgS has a high melting point.

..... [1]

(iii) State why molten MgS conducts electricity.

..... [1]

DO NOT WRITE IN THIS MARGIN

(c) An acid containing sulfur reacts with sodium hydroxide, NaOH, to form a salt and water. The salt has the formula Na_2SO_3.

(i) Deduce the formula of this acid.

..... [1]

(ii) Deduce the formula of the anion in Na_2SO_3.

..... [1]

(d) Na_2SO_3 is oxidised by acidified aqueous potassium manganate(VII).

(i) State what VII refers to in the name potassium manganate(VII).

..... [1]

(ii) State the colour change when this reaction happens.

from ..... to ..... [2]

[Total: 17]

Question No 26 - (0620_s21_42_5)

Topics: 10.2 - Fertilisers, 2.4 - Ions and ionic bonds, 2.5 - Simple molecules and covalent bonds, 3.1 - Formulae, 3.2 - Relative masses of atoms and molecules, 3.3 - The mole and the Avogadro constant, 4.1 - Electrolysis, 5.1 - Exothermic and endothermic reactions, 7.1 - Characteristics of Acids & Bases, 7.1 - The characteristic properties of acids and bases

Subsection Topics: a: 3.1 - Formulae, 2.4 - Ions and ionic bonds | b: 5.1 - Exothermic and endothermic reactions, 2.5 - Simple molecules and covalent bonds | c: 2.4 - Ions and ionic bonds | d: 3.2 - Relative masses of atoms and molecules, 10.2 - Fertilisers, 7.1 - Characteristics of Acids & Bases | e: 7.1 - Characteristics of Acids & Bases

This question is about compounds of nitrogen.

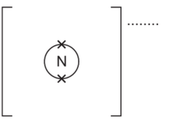
(a) Nitrogen reacts with lithium to form lithium nitride, Li_3N.

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

..... [2]

(ii) Lithium nitride is ionically bonded.

Complete the diagram to show the electronic structure of the nitride ion.
Show the charge on the nitride ion.



[2]

(b) Nitrogen reacts with fluorine to form nitrogen trifluoride, NF_3.

(i) The chemical equation can be represented as shown.

$$N{\equiv}N + 3\,F{-}F \rightarrow 2\,F{-}\underset{\underset{F}{|}}{N}{-}F$$

Some bond energies are shown in the table.

bond	bond energy in kJ / mol
N≡N	945
F–F	160
N–F	300

Calculate the energy change for the reaction between nitrogen and fluorine, using the following steps:

- energy taken in to break bonds

..... kJ

- energy released when bonds are formed

..... kJ

- energy change during the reaction.

..... kJ / mol
[3]

(ii) Use your answer to **(i)** to deduce whether this reaction is endothermic or exothermic. Explain your answer.

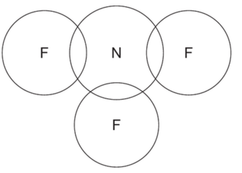
.....

..... [1]

(iii) Complete the dot-and-cross diagram to show the electron arrangement in a molecule of NF_3.

Use dots for nitrogen electrons and crosses for fluorine electrons.

Show outer electrons only.



[3]

(c) Lithium nitride melts at 813 °C. Nitrogen trifluoride melts at –206 °C.

Explain in terms of attractive forces why lithium nitride has a much higher melting point than nitrogen trifluoride.

In your answer refer to the types of attractive forces between particles and their relative strengths.

.....

.....

.....

..... [3]

(d) Ammonium nitrate, NH_4NO_3, is a compound of nitrogen.

(i) Calculate the percentage by mass of nitrogen in ammonium nitrate.

percentage by mass of nitrogen = ... [2]

(ii) State a use of ammonium nitrate in agriculture.

..... [1]

(iii) State the name of a compound that will displace ammonia from ammonium nitrate.

..... [1]

(e) Ammonia is a base which forms a weakly alkaline solution when dissolved in water.

(i) Define the term *base*.

..... [1]

(ii) Suggest the pH of aqueous ammonia.

..... [1]

[Total: 20]

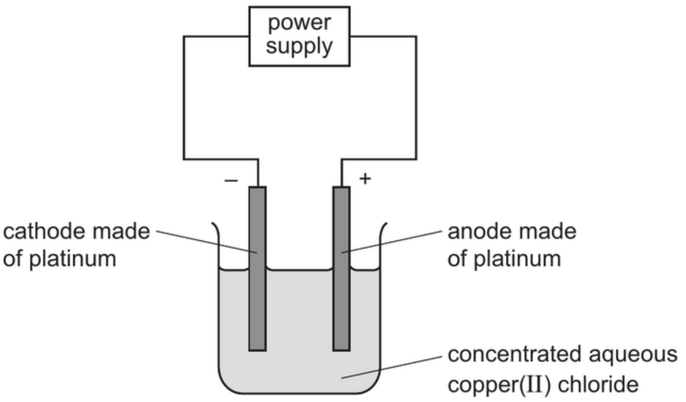
Question No 27 - (0620_s19_43_4)

Topics: 12.1 - Experimental design, 3.1 - Formulae, 4.1 - Electrolysis, 5.1 - Exothermic and endothermic reactions, 6.2 - Rate of reaction, 7.1 - Characteristics of Acids & Bases

Subsection Topics: a: 3.1 - Formulae, 12.1 - Experimental design | b: 7.1 - Characteristics of Acids & Bases

Solutions of ionic compounds can be broken down by electrolysis.

(a) Concentrated aqueous copper(II) chloride was electrolysed using the apparatus shown.



The ionic half-equations for the reactions at the electrodes are shown.

negative electrode: $Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$

positive electrode: $2Cl^-(aq) \rightarrow Cl_2(g) + 2e^-$

(i) Platinum is a solid which is a good conductor of electricity.

State **one** other property of platinum which makes it suitable for use as electrodes.

.....

..... [1]

(ii) State what would be **seen** at the positive electrode during this electrolysis.

.....

..... [1]

(iii) State and explain what would happen to the mass of the negative electrode during this electrolysis.

.....

.....

..... [2]

(iv) The concentrated aqueous copper(II) chloride electrolyte is green.

Suggest what would happen to the colour of the electrolyte during this electrolysis.
Explain your answer.

.....

.....

..... [2]

(v) Identify the species that is oxidised during this electrolysis.
Explain your answer.

species that is oxidised .....

explanation .....

.....

[2]

(b) Metal objects can be electroplated with silver.

(i) Describe how a metal spoon can be electroplated with silver.

(i) Describe how a metal spoon can be electroplated with silver.

Include:

- what to use as the positive electrode and as the negative electrode
- what to use as the electrolyte
- an ionic half-equation to show the formation of silver.

You may include a diagram in your answer.

.....

.....

.....

ionic half-equation .....

[4]

(ii) Give **one** reason why metal spoons are electroplated with silver.

.....

..... [1]

[Total: 13]

Question No 28 - (0620_w22_43_3)

Topics: 2.4 - Ions and ionic bonds, 2.5 - Simple molecules and covalent bonds, 3.1 - Formulae, 4.1 - Electrolysis, 6.2 - Rate of reaction, 7.1 - Characteristics of Acids & Bases, 7.2 - Oxides, 9.4 - Reactivity series, 9.6 - Extraction of metals

Subsection Topics: a: 9.6 - Extraction of metals | b: 4.1 - Electrolysis | c: 4.1 - Electrolysis | d: 6.2 - Rate of reaction | e: 7.1 - Characteristics of Acids & Bases | f: 3.1 - Formulae

Aluminium is extracted from its ore by electrolysis.

(a) Name the ore of aluminium which consists mainly of aluminium oxide.

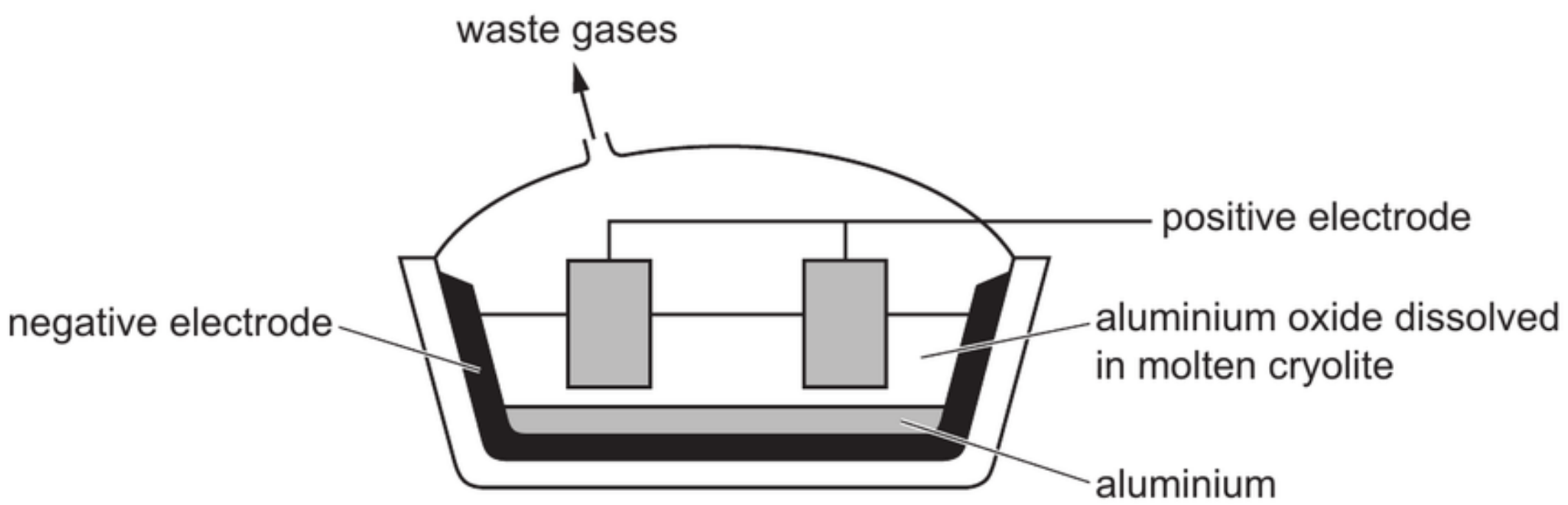
..... [1]

(b) State what is meant by the term *electrolysis*.

.....

..... [2]

(c) Electrolysis is carried out on aluminium oxide dissolved in molten cryolite.



(i) Give **two** reasons why the electrolysis is carried out on aluminium oxide dissolved in molten cryolite instead of electrolysing molten aluminium oxide only.

1 .....

2 .....
[2]

(ii) Write the ionic half-equation for the reaction occurring at the negative electrode.

..... [2]

(iii) The positive electrodes are made of carbon.

Explain why the positive carbon electrodes are replaced regularly.

.....

..... [2]

(d) Aluminium is more reactive than copper.

When aluminium is added to aqueous copper(II) sulfate, no immediate reaction is seen.

Explain why.

..... [1]

(e) Aluminium reacts with oxygen to form an amphoteric oxide.

(i) State what is meant by the term *amphoteric*.

.....

..... [1]

(ii) The reaction between aluminium oxide and aqueous sodium hydroxide forms a salt containing the negative ion AlO_2^-. The only other product is water.

Write a chemical equation for the reaction between aluminium oxide and aqueous sodium hydroxide.

..... [2]

(f) Gallium is in the same group as aluminium and forms similar compounds.

Predict the formulae of:

gallium(III) chloride .....

gallium(III) sulfate. .....
[2]

[Total: 15]

Question No 29 - (0620_s23_42_4)

Topics: 11.1 - Formulae, functional groups and terminology, 11.7 - Carboxylic acids, 12.2 - Acid–base titrations, 3.1 - Formulae, 3.3 - The mole and the Avogadro constant, 6.2 - Rate of reaction, 7.1 - Characteristics of Acids & Bases, 7.1 - The characteristic properties of acids and bases, 7.2 - Oxides, 7.3 - Preparation of salts

Subsection Topics: e: 7.2 - Oxides | f: 11.1 - Formulae, functional groups and terminology, 7.1 - Characteristics of Acids & Bases | g: 3.3 - The mole and the Avogadro constant | a: 7.1 - Characteristics of Acids & Bases | b: 7.1 - Characteristics of Acids & Bases | c: 7.1 - Characteristics of Acids & Bases | d: 7.3 - Preparation of salts

Solid sodium hydroxide is a base which dissolves to form an aqueous solution, NaOH(aq).

(a) State what is meant by the term base.

..... [1]

(b) State the term given to a base which dissolves to form an aqueous solution.

..... [1]

(c) State the colour of thymolphthalein in NaOH(aq).

..... [1]

(d) Complete the word equation for the reaction of NaOH(aq) with ammonium chloride.

sodium ydroxide + ammonium chloride → ..... + ... + ...
.....

[3]

(e) Some metal oxides react with NaOH(aq).

(i) State the term given to metal oxides which react with bases such as NaOH(aq).

..... [1]

(ii) Name a metal oxide which reacts with NaOH(aq).

..... [1]

(f) Ethanoic acid, CH_3COOH, is a weak acid.

(i) Complete the dot-and-cross diagram in Fig. 4.1 of a molecule of ethanoic acid.

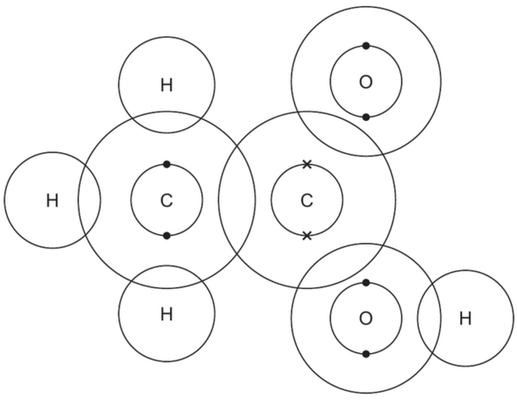


Fig. 4.1

[3]

(ii) Suggest the pH of dilute ethanoic acid.

..... [1]

(iii) Complete the symbol equation to show the dissociation of ethanoic acid.

CH_3COOH ..... [3]

(iv) Write the ionic equation for the reaction when an acid neutralises a soluble base.

..... [1]

(g) In a titration, 25.0 cm^3 of 0.0800 mol / dm^3 aqueous potassium hydroxide, KOH(aq), is neutralised by 20.0 cm^3 of dilute sulfuric acid, H_2SO_4(aq).

$$2KOH(aq) + H_2SO_4(aq) \rightarrow K_2SO_4(aq) + 2H_2O(l)$$

Calculate the concentration of H_2SO_4, in g / dm^3 using the following steps.

- Calculate the number of moles of KOH used.

..... mol

- Determine the number of moles of H_2SO_4 which react with the KOH.

..... mol

- Calculate the concentration of H_2SO_4 in mol / dm^3.

..... mol / dm^3

- Calculate the concentration of H_2SO_4 in g / dm^3.

..... g / dm^3
[5]

[Total: 21]

Question No 30 - (0620_w18_42_3)

Topics: 10.3 - Air quality and climate, 12.1 - Experimental design, 12.2 - Acid–base titrations, 12.4 - Separation and purification, 3.1 - Formulae, 3.3 - The mole and the Avogadro constant, 4.1 - Electrolysis, 6.3 - Reversible reactions and equilibrium, 7.3 - Preparation of salts

Subsection Topics: d: 3.3 - The mole and the Avogadro constant | a: 10.3 - Air quality and climate | b: 6.3 - Reversible reactions and equilibrium, 10.3 - Air quality and climate | c: 12.1 - Experimental design, 7.3 - Preparation of salts, 12.4 - Separation and purification, 3.1 - Formulae

Sulfur is an important element.

(a) Explain how burning fossil fuels containing sulfur leads to the formation of acid rain.

.....

.....

..... [2]

(b) Sulfuric acid is manufactured by the Contact process. One step in the Contact process involves a reversible reaction in which sulfur trioxide, SO_3, is formed.

(i) Write a chemical equation for this reversible reaction. Include the correct symbol to show that the reaction is reversible.

..... [2]

(ii) State the conditions and name the catalyst used in this reversible reaction.

temperature .....

pressure .....

catalyst .....

[3]

(iii) Describe how the sulfur trioxide formed is converted into sulfuric acid in the next steps of the Contact process.

.....

.....

..... [2]

(c) Dilute sulfuric acid is used to make salts known as sulfates.

A method consisting of three steps is used to make zinc sulfate from zinc carbonate.

step 1 Add an excess of zinc carbonate to $20\,cm^3$ of $0.4\,mol/dm^3$ dilute sulfuric acid until the reaction is complete.

step 2 Filter the mixture.

step 3 Heat the filtrate until a saturated solution forms and then allow it to crystallise.

(i) Name a suitable piece of apparatus for measuring $20\,cm^3$ of dilute sulfuric acid in **step 1**.

..... [1]

(ii) State **two** observations which would show that the reaction is complete in **step 1**.

1 .....

2 .....

[2]

(iii) Why is it important to add an excess of zinc carbonate in **step 1**?

..... [1]

(iv) What is meant by the term *saturated solution* in **step 3**?

.....

..... [2]

(v) The equation for the reaction is shown.

$$ZnCO_3(s) + H_2SO_4(aq) \rightarrow ZnSO_4(.....) + H_2O(l) + CO_2(g)$$

Complete the equation by inserting the state symbol for zinc sulfate. [1]

(vi) Name another zinc compound which could be used to make zinc sulfate from dilute sulfuric acid using this method.

..... [1]

(vii) Suggest why this method would **not** work to make barium sulfate from barium carbonate and dilute sulfuric acid.

..... [1]

(d) In a titration, a student added $25.0\,cm^3$ of $0.200\,mol/dm^3$ aqueous sodium hydroxide to a conical flask. The student then added a few drops of methyl orange to the solution in the conical flask.

Dilute sulfuric acid was then added from a burette to the conical flask. The volume of dilute sulfuric acid needed to neutralise the aqueous sodium hydroxide was $20.0\,cm^3$.

$$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$$

(i) What was the colour of the methyl orange in the aqueous sodium hydroxide?

..... [1]

(ii) Determine the concentration of the dilute sulfuric acid in g/dm^3.

- Calculate the number of moles of aqueous sodium hydroxide added to the conical

- Calculate the number of moles of aqueous sodium hydroxide added to the conical flask.

..... mol

- Calculate the number of moles of dilute sulfuric acid added from the burette.

..... mol

- Calculate the concentration of the dilute sulfuric acid in mol / dm^3.

..... mol / dm^3

- Calculate the concentration of the dilute sulfuric acid in g / dm^3.

..... g / dm^3
[4]

(e) Iron(II) sulfate decomposes when heated strongly.

$$2FeSO_4(s) \rightarrow Fe_2O_3(s) + SO_2(g) + SO_3(g)$$

15.20 g of $FeSO_4(s)$ was heated and formed 4.80 g of $Fe_2O_3(s)$.

[M_r, $FeSO_4$ = 152; M_r, Fe_2O_3 = 160]

Calculate the percentage yield for this reaction.

..... % [3]

[Total: 26]

Answer for Question 1 (0620_w19_41_4)

Question	Answer	Marks
4(a)(i)	cobalt carbonate	1
4(a)(ii)	lead iodide	1
4(b)	$2\ AgNO_3 + Na_2CO_3 \rightarrow Ag_2CO_3 + 2\ NaNO_3$ formula of silver carbonate correct (1) fully correct equation (1)	2
4(c)	$Pb^{2+} + 2\ I^- \rightarrow PbI_2$ Pb^{2+} **and** I^- on left of equation (1) fully correct equation (1)	2
4(d)	(nitric) acid reacts with / removes carbonate ions	1

Answer for Question 2 (0620_s22_41_6)

Question	Answer	Marks
6(a)(i)	zinc blende	**1**
6(a)(ii)	heat(zinc sulfide) strongly in air / roast in air	**1**
6(a)(iii)	carbon **or** carbon monoxide	**1**
6(a)(iv)	the temperature in the furnace is above **or** higher than the boiling point of zinc **OR** the boiling point of zinc is below **or** less than the temperature of the furnace	**1**
6(a)(v)	condensation / condensing / condense	**1**
6(b)(i)	no bubbles **or** no fizzing **or** no effervescence	**1**

Question	Answer	Marks
6(b)(ii)	zinc / zinc oxide / zinc hydroxide	**1**
6(b)(iii)	(powder has) larg**er** surface area **OR** lumps have small**er** surface area (1) (powder has) more collisions per unit time / more collision frequency **OR** **lumps** have fewer collisions per unit time / less collision frequency (1)	**2**
6(b)(iv)	crystals (form on glass rod or microscope slide)	**1**
6(b)(v)	$ZnSO_4$	**1**

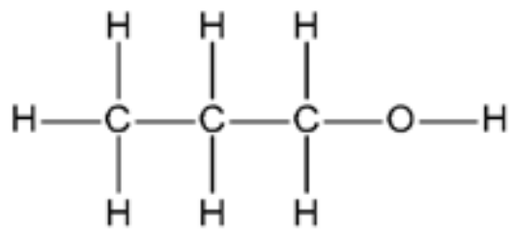
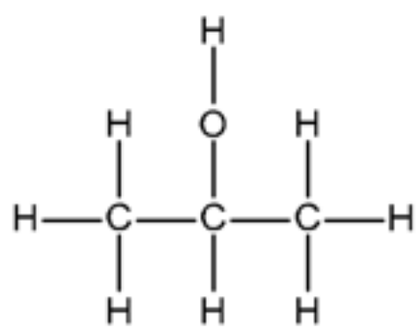
Answer for Question 3 (0620_s20_43_6)

Question	Answer	Marks
6(a)(i)	2, 2, 4, 1	1
6(a)(ii)	thermal decomposition	1
6(b)	• add aqueous sodium hydroxide • then (reduction with) aluminium (foil) (and warm) • (ammonia gas produced which) turns damp red litmus blue	3

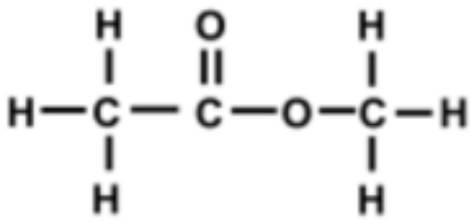
Answer for Question 4 (0620_s19_42_4)

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>4(a)</td><td>water / natural gas / hydrocarbons</td><td>1</td></tr>
<tr><td>4(b)</td><td><table>
<tr><td>effect on the rate of the reverse reaction</td><td>effect on the percentage of methanol in the equilibrium mixture</td></tr>
<tr><td>M1 increases(1)</td><td>no change</td></tr>
<tr><td>increases</td><td>M3 decreases(1)</td></tr>
<tr><td>M2 decreases(1)</td><td>M4 decreases(1)</td></tr>
</table></td><td>4</td></tr>
<tr><td>4(c)(i)</td><td>any 2 from:
• same or similar chemical properties or reactions (1)
• (same) general formula (1)
• (consecutive members) differ by CH_2 (1)
• same functional group (1)
• common (allow similar) methods of preparation (1)
• physical properties vary in predictable manner / show trends / gradually change
OR
example of a physical property variation i.e. melting point / boiling point / volatility (1)</td><td>2</td></tr>
</table>

Answer for Question 4 (0620_s19_42_4)

Question	Answer	Marks
4(c)(ii)	**M1**  (1) **M2** propan-1-ol (1) **M3**  (1) **M4** propan-2-ol (1)	**4**
4(c)(iii)	structural isomers / structural isomerism	**1**
4(d)(i)	ethyl methanoate	**1**
4(d)(ii)	**M1** methanoic acid (1) **M2** ethanol (1)	**2**

Answer for Question 4 (0620_s19_42_4)

Question	Answer	Marks
4(d)(iii)	 **M1** correct displayed ester linkage (1) **M2** whole molecule fully correct (1)	2

Answer for Question 5 (0620_m24_42_1)

Question	Answer	Marks
1(a)	coke	1
1(a)(ii)	provide heat	1
1(b)(i)	**M1** 160 **M2** 112 **AND** 70.(0)(%)	2
1(b)(ii)	hematite	1
1(b)(iii)	by reduction of carbon dioxide	1
1(b)(iv)	$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$ **M1** species **M2** correct equation	2
1(b)(v)	reduction	1
1(c)	thermal decomposition	1
1(d)(i)	**M1** CaO is basic **M2** SiO_2 is acidic	2
1(d)(ii)	**M1** silicon(IV) oxide **M2** slag	2
1(e)(i)	aluminium is above carbon in the reactivity series **OR** aluminium is more reactive than carbon	1

Answer for Question 5 (0620_m24_42_1)

Question	Answer	Marks
1(e)(ii)	electrolysis	1
1(f)(i)	2,8	1
1(f)(ii)	**M1** 26 (protons) **M2** 23 (electrons)	2

Answer for Question 6 (0620_w23_41_6)

Question	Answer	Marks
6(a)	**M1** yeast (1) **M2** absence of air (1)	**2**
6(b)(i)	**M1** 300 (1) **M2** 6000 (1)	**2**
6(b)(ii)	ethene	**1**
6(b)(iii)	only one product	**1**
6(c)(i)	proton donor	**1**
6(c)(ii)	partial dissociation	**1**
6(c)(iii)	**M1** 4×-2 or -8 (1) **M2** $P + (4 \times -2) = -3 \therefore P = \mathbf{+5}$ (1)	**2**
6(d)	**M1** uses renewable resources (1) **M2** high rate of reaction (1)	**2**
6(e)(i)	potassium manganate(VII)	**1**

Question	Answer	Marks
6(e)(ii)	reducing agent	**1**
6(f)(i)	calcium ethanoate	**1**
6(f)(ii)	$(CH_3COO)_2Ca$	**1**
6(f)(iii)	hydrogen	**1**

Answer for Question 7 (0620_s23_43_6)

Question	Answer	Marks
6(a)(i)	air	1
6(a)(ii)	methane	1
6(a)(iii)	**M1** 450 (°C) **M2** 200 (atm)	2
6(a)(iv)	iron	1
6(a)(v)	**M1** (a substance which) increases the rate of a reaction **M2** remains unchanged at the end of the reaction	2

Question	Answer	Marks
6(b)(i)	**temperature change:** **M1** low(er) rate (of reaction) **pressure change:** **M2** (position of) equilibrium shifts to the left hand side/ towards reactants	2
6(b)(ii)	**4**NO + **3**O_2 + **2**H_2O →.**4**HNO_3	1
6(c)(i)	$CuCO_3 + 2HNO_3 \rightarrow Cu(NO_3)_2 + CO_2 + H_2O$ **M1** $Cu(NO_3)_2$ **M2** correct equation	2
6(c)(ii)	**M1** undissolved solid **M2** effervescence stops on addition of more copper(II) carbonate	2
6(d)(iii)	copper(II) oxide **or** copper(II) hydroxide	1

Answer for Question 8 (0620_m24_42_3)

Question	Answer	Marks
3(a)	proton acceptor	1
3(b)	a soluble base	1
3(c)	**M1** blue **M2** colourless	2
3(d)(i)	**M1** HNO_3 **M2** lowest pH	2
3(d)(ii)	universal indicator	1
3(e)	$(CH_3COOH) \rightleftharpoons CH_3COO^- + H^+$ **M1** H^+ **M2** CH_3COO^- **M3** $\rightleftharpoons$	3

Question	Answer	Marks
3(f)	$H^+ + OH^- \rightarrow H_2O$	1
3(g)	**M1** (0.0150 × 20.0/1000 =) 0.0003(00) / 3.00×10^{-4} (mol) **M2** (M1 × 2 = $3.00 \times 10^{-4} \times 2$ =) 0.0006(00) / 6.00×10^{-4} (mol) **M3** (M2 × 1000/25.0 = $6.00 \times 10^{-4} \times 1000 / 25.0$ =) 0.0240 (mol / dm^3) **M4** 63 (g / mol) **M5** (M3 × M4 = 0.0240 × 63 =) 1.51(2) (g / dm^3)	5

Answer for Question 9 (0620_w21_43_3)

Question	Answer	Marks
3(a)	267	1
3(b)	(207 / 239 × 100 =) 86.6%	1
3(c)	PbS because the percentage of lead is larger in PbS **or** answer to **(b) >** 77.5%	1
3(d)	$PbCO_3 \rightarrow PbO + CO_2$	1
3(e)	$PbCO_3 + 2HNO_3 \rightarrow Pb(NO_3)_2 + H_2O + CO_2$	2
3(f)(i)	**M1** two double bonds (1) **M2** two pairs of non-bonding electrons on each oxygen and no non-bonding electrons on carbon (1)	2
3(f)(ii)	**M1** bonds between ions **or** ionic bonds in lead(II) oxide (1) **M2** attraction **between molecules** in carbon dioxide (1) **M3** weak**er** attraction (between particles) in carbon dioxide **ORA** (1)	3
3(g)	**M1** $Mg + Pb^{2+} \rightarrow Mg^{2+} + Pb$ (1) **M2** no reaction (1)	2

Question	Answer	Marks
3(h)(i)	**M1** glowing splint (1) **M2** relights (1)	2
3(h)(ii)	nitrogen dioxide / nitrogen(IV) oxide	1

Answer for Question 10 (0620_s19_42_3)

Question	Answer	Marks
3(a)(i)	covalent	1
3(a)(ii)	forces of attraction between molecules **AND** are weak / need a small amount of energy to break	1
3(a)(iii)	no **moving** or **flowing** or **mobile charged particles** or **ions** or **electrons**	1
3(b)(i)	$P_4 + 5O_2 \rightarrow P_4O_{10}$ **M1** all formulae correct (1) **M2** equation correctly balanced (1)	2
3(b)(ii)	redox / combustion	1
3(c)	$P_4O_{10} + 12NaOH \rightarrow 4Na_3PO_4 + 6H_2O$ **M1** Na_3PO_4 (1) **M2** equation completely correct (1)	2
3(d)	**M1** 3 pairs of bonding electrons (1) **M2 only** 1 lone pair on P (1)	2
3(e)(i)	proton / H^+ / hydrogen ion acceptor	1
3(e)(ii)	$2NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$ **M1** $(NH_4)_2SO_4$ (1) **M2** equation completely correct (1)	2

Answer for Question 11 (0620_w24_42_4)

Question	Answer	Marks
4(a)	$Ag^+(aq) + Br^-(aq) \rightarrow AgBr(s)$	1
4(b)	(silver) nitrate	1
4(c)	$0.01 \times 1000 / 50 = 0.2(00)$ (mol / dm^3)	1
4(d)	cream	1
4(e)	**M1** mol of AgBr = 0.01(00) **M2** M_r of AgBr = 188 **M3** 188 x 0.01 = 1.88 (g)	3
4(f)	sodium ethanoate	1
4(g)(i)	rinsing of residue	1
4(g)(ii)	(crystals of) sodium ethanoate	1

Question	Answer	Marks
4(h)(i)	**M1** named soluble barium salt e.g. barium chloride / barium nitrate **M2** named soluble sulfate salt e.g. sodium sulfate / potassium sulfate / ammonium sulfate / sulfuric acid	2
4(h)(ii)	**M1** any equation with $BaSO_4$ as a product **M2** correct equation using soluble reactants	2

Answer for Question 12 (0620_w23_43_3)

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>3(a)(i)</td><td>78</td><td>1</td></tr>
<tr><td>3(a)(ii)</td><td>natural gas</td><td>1</td></tr>
<tr><td>3(a)(iii)</td><td>M1 three single bonding pairs containing one dot and one cross (1)

M2 two dots or two crosses on N (and no additional electrons on Hs) to complete the outer shell on N and all 3 Hs (1)</td><td>2</td></tr>
<tr><td>3(a)(iv)</td><td>M1 $N_2 + 3H_2 \rightarrow 2NH_3$ (1)

M2 $\rightleftharpoons$ (1)

M3 450 °C (1)

M4 200 atmospheres / 20 000 kPa (1)

M5 iron (1)</td><td>5</td></tr>
<tr><td>3(b)(i)</td><td>platinum</td><td>1</td></tr>
<tr><td>3(b)(ii)</td><td>M1 –3 (1)

M2 +2 (1)</td><td>2</td></tr>
<tr><td>3(b)(iii)</td><td>oxidation AND oxidation number increases</td><td>1</td></tr>
<tr><td>3(b)(iv)</td><td><table><tr><td>M1 increase (1)</td><td>M4 decrease (1)</td></tr><tr><td>M2 increase (1)</td><td></td></tr><tr><td>M3 no change (1)</td><td></td></tr></table></td><td>4</td></tr>
</table>

Answer for Question 12 (0620_w23_43_3)

Question	Answer	Marks
3(b)(v)	**M1** kinetic energy of particles is lower (1) **M2** frequency of collisions between particles is lower (1) **M3** fewer / lower percentage **/** lower proportion **/** lower fraction of particles have energy greater than / equal to activation energy **OR** fewer / lower percentage / lower fraction of collisions have energy greater than / equal to activation energy (1)	**3**
3(c)	**4**NO + **3**O_2 + **2**H_2O → **4**HNO_3	**1**

Answer for Question 13 (0620_m19_42_5)

Question	Answer	Marks
5(a)(i)	fractional distillation	1
5(a)(ii)	carbon monoxide is toxic/poisonous	1
5(b)	• 80 • 5 • 10 • 240	4
5(c)(i)	$TiCl_4 + 2Mg \rightarrow Ti + 2MgCl_2$	1

Question	Answer	Marks
5(c)(ii)	$TiCl_4 + 4Na \rightarrow Ti + 4NaCl$	1
5(c)(iii)	magnesium burns in air or oxygen **OR** reacts with air or oxygen / argon is unreactive or inert	1
5(d)(i)	**M1 / 2** bubbles / fizzing / effervescence(1) **M1 / 2** (magnesium or solid) dissolves / disappears / **forms** solution(1) **M3** $Mg + 2HCl \rightarrow MgCl_2 + H_2$(1)	3
5(d)(ii)	filtration	1
5(d)(iii)	titanium is below hydrogen in the reactivity series **ORA** **OR** titanium less reactive than hydrogen **ORA** **OR** titanium coated with an oxide layer	1
5(e)(i)	hydrogen	1
5(e)(ii)	Heat until magnesium chloride is molten and electrolyse	1

Answer for Question 14 (0620_w22_42_2)

Question	Answer	Marks
2(a)(i)	to prevent contact with air / oxygen and / or water	**1**
2(b)(i)	combustion	**1**
2(b)(ii)	yellow	**1**
2(b)(iii)	$4Na + O_2 \rightarrow 2Na_2O$ **M1** species (1) **M2** balancing (1)	**2**
2(b)(iv)	**M1** eight crosses in second shell of both Na (1) **M2** six dots and two crosses in second shell of O (1) **M3** '+' charge on each Na ion on correct answer line **and** '2–' charge on O ion on correct answer line (1)	**3**
2(c)(i)	proton acceptor	**1**

Answer for Question 14 (0620_w22_42_2)

Question	Answer	Marks
2(c)(ii)	pH 14	**1**
2(c)(iii)	yellow	**1**
2(c)(iv)	**M1** mol Na = 0.345 / 23 = 0.015(00) (1) **M2** mol NaOH = M1 = 0.015(00) (1) **M3** M2 × 1000 / 50 = 0.015(00) × 20 = 0.3(00) (1) **M4** M_r NaOH = 40(1) **M5** M4 × M3 = 40 x 0.3= 12.(0) (g / dm^3) (1)	**5**
2(d)(i)	precipitation	**1**
2(d)(ii)	red-brown	**1**
2(d)(iii)	iron(III) hydroxide	**1**
2(d)(iv)	$Fe^{3+}(aq) + 3OH^-(aq) \rightarrow Fe(OH)_3(s)$ **M1** $Fe(OH)_3$ (as only product) (1) **M2** Fe^{3+} and $3OH^-$ (as only reactants) (1) **M3** state symbols (1)	**3**

Answer for Question 15 (0620_s24_41_6)

Question	Answer	Marks
6(a)(i)	limestone **OR** calcium carbonate	1
6(a)(ii)	(molten) iron	1
6(a)(iii)	silicon(IV) oxide **OR** silicon dioxide	1
6(a)(iv)	coke or carbon **and** oxygen	1
6(a)(v)	**Any two from:** • nitrogen • carbon dioxide • argon	2

Answer for Question 15 (0620_s24_41_6)

Question	Answer	Marks
6(b)(i)	the temperature in the furnace is above **or** higher than the boiling point of zinc **ORA** **OR** the boiling point of zinc is below **or** less than the temperature of the furnace **ORA**	**1**
6(b)(ii)	condensation / condensing	**1**
6(c)(i)	galvanising	**1**
6(c)(ii)	**M1** zinc is more reactive than iron (1) **M2** zinc is oxidised / zinc loses electrons / zinc forms positive ions / zinc forms zinc ions (1)	**2**
6(d)(i)	amphoteric	**1**
6(d)(ii)	Na_2ZnO_2	**1**
6(d)(iii)	zinc sulfate	**1**

Answer for Question 16 (0620_s21_41_6)

Question	Answer	Marks
6(a)(i)	hematite	1
6(a)(ii)	air	1
6(a)(iii)	slag / calcium silicate	1
6(a)(iv)	any two from: • (coke) releases heat (when it reacts with oxygen or reacts in air) **OR** (acts as a) fuel **OR** increases temperature (in the furnace) / heats (the furnace) **OR** source of energy • (coke or carbon monoxide) reduces iron oxide **OR** is a reducing agent **OR** converts iron oxide to iron / removes oxygen from iron oxide • (coke) reacts with oxygen to **form** carbon monoxide **OR** reacts with carbon dioxide to **form** carbon monoxide	2
6(b)	S_2^{2-} **or** S^-	1
6(c)(i)	any two from: • (iron forms) coloured compounds • (iron has) variable oxidation states • (iron acts as a) catalyst	2
6(c)(ii)	any two from: • (iron is) good conductor of electricity • (iron) forms a basic oxide • (iron salts are) soluble (in water)	2

Answer for Question 16 (0620_s21_41_6)

Question	Answer	Marks
6(d)(i)	magnesium is **more** reactive than iron / steel **ORA** (1) iron is not oxidised **OR** iron does not lose electrons **OR** magnesium loses electrons **more easily** than or **in preference** (to iron) **ORA** **OR** magnesium is oxidised **more easily or** reacts with oxygen **more easily or** corrodes **more easily** or **in preference** (to iron) **ORA** (1)	**2**
6(d)(ii)	copper is less reactive than iron / copper is lower in the reactivity series than iron **ORA**	**1**

Answer for Question 17 (0620_w22_43_5)

Question	Answer	Marks
5(a)(i)	**M1** 450 (1) **M2** 1-2 (1) **M3** vanadium (V) oxide (1)	**3**
5(a)(ii)	$SO_3 + H_2SO_4 \rightarrow H_2S_2O_7$	**1**
5(a)(iii)	water	**1**
5(b)	carbon	**1**
5(c)(i)	**M1** 2.5×10^{-3} / 0.0025 (1) **M2** 1.25×10^{-3} / 0.00125 (1) **M3** 20 (1)	**3**
5(c)(ii)	40	**1**
5(d)(i)	lilac flame	**1**

Answer for Question 17 (0620_w22_43_5)

Question	Answer	Marks
5(d)(ii)	**Any Two from** • solid disappears • blue solution • bubbles / effervescence / fizzing	**2**
5(d)(iii)	white precipitate	**1**
5(e)	$Ba^{2+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s)$ **M1** $BaSO_4$ on the right (1) **M2 ONLY** Ba^{2+} and SO_4^{2-} on the left (1) **M3** state symbols (1)	**3**

Answer for Question 18 (0620_m24_42_2)

Question	Answer	Marks
2(a)	fluor**ine**	**1**
2(b)	red-brown **AND** liquid	**1**
2(c)	**M1** Ts **M2** 7	**2**
2(d)(i)	**M1 pair** of electrons **M2** electron(s) shared between **two** atoms	**2**
2(d)(ii)	iod**ide /** astat**ide** / teness**ide**	**1**
2(d)(iii)	brom**ine** is more reactive than iod**ine** / astat**ine** / teness**ine**	**1**
2(e)	**M1** cobalt(II) chloride **M2** anhydrous	**2**
2(f)	**M1** 8 crosses in third shell of Ca **M2** 7 dots and 1 cross in third shell of both C*l* **M3** '2+' charge on Ca on correct answer line **AND** '–' charge on both C*l* ions on correct answer line	**3**

Answer for Question 18 (0620_m24_42_2)

Question	Answer	Marks
2(g)(i)	lead(II) nitrate	1
2(g)(ii)	$Pb^{2+}(aq) + 2Cl^{-}(aq) \rightarrow PbCl_2(s)$ **M1** $PbCl_2$ as **only** product **M2** $Pb^{2+} + 2Cl^{-}$ as **only** reactants **M3** correct state symbols	3
2(g)(iii)	silver chloride	1

Answer for Question 19 (0620_w23_42_3)

Question	Answer	Marks
3(a)	(hot) air	1
3(b)(i)	hematite	1
3(b)(ii)	$Fe_2O_3 + 3CO \rightarrow 3CO_2 + 2Fe$	1
3(b)(iii)	**M1** from +3 (1) **M2** to 0 (1)	2
3(b)(iv)	decrease (in oxidation number)	1

Question	Answer	Marks
3(c)	**M1** $CaCO_3 \rightarrow CaO + CO_2$ (1) **M2** thermal decomposition (1) **M3** $SiO_2 + CaO \rightarrow CaSiO_3$ (1) **M4** acid-base reaction (1)	4
3(d)(i)	alloy	1
3(d)(ii)	nickel / chromium	1
3(e)	hydrated iron(III) oxide	1
3(f)(i)	galvanising	1
3(f)(ii)	painting / greasing / coating with plastic	1
3(f)(iii)	**M1** zinc more reactive (than iron) (1) **M2** zinc corrodes / oxidises / reacts in preference to / instead of iron (1)	2

Answer for Question 20 (0620_m20_42_2)

Question	Answer	Marks
2(a)(i)	bauxite	1
2(a)(ii)	**breakdown** by (the passage of) **electricity** (1) of an **ionic compound** in **molten / aqueous** (state) (1)	2
2(b)(i)	cryolite	1
2(b)(ii)	less CO_2 emission	1

Question	Answer	Marks
2(b)(iii)	$Al^{3+} + 3e^- \rightarrow Al$ any positive Al species gaining electron(s) (1) correct species and balance (1) $2O^{2-} \rightarrow O_2 + 4e^-$ any negative O species losing electron(s) (1) correct species and balance (1)	4
2(b)(iv)	anodes **or** carbon / graphite react with oxygen / O_2 (1) (form) carbon dioxide (1)	2
2(c)(i)	amphoteric	1
2(c)(ii)	aluminium sulfate (1) $Al_2(SO_4)_3$ (1)	2
2(c)(iii)	water	1
2(c)(iv)	$2Al(OH)_3 \rightarrow Al_2O_3 + 3H_2O$ species (1) balance (1)	2
2(c)(v)	aluminium carbonate (1) aluminium nitrate (1)	2

Answer for Question 21 (0620_w21_42_5)

Question	Answer	Marks
5(a)	metallic (1) (lattice of) positive ions (1) sea of / delocalised / mobile electrons (1) attraction between positive ions and electrons (1)	**4**
5(b)(i)	malleability / malleable	**1**
5(b)(ii)	(particles) slide (over each other)	**1**
5(b)(iii)	unreactive	**1**
5(c)	high(er) density high(er) melting points	**2**
5(d)(i)	Na – yellow (1) K – lilac (1) colourless solution (1) clear idea of increased reactivity in **both** reactions (1)	**4**

Question	Answer	Marks
5(d)(ii)	hydrogen	**1**
5(d)(iii)	potassium hydroxide	**1**
5(d)(iv)	any number in the range $7 < pH \leqslant 14$	**1**
5(d)(v)	$4Na + O_2 \rightarrow 2Na_2O$ Na_2O (1) correct equation (1)	**2**
5(e)(i)	$N_2 + 3H_2 \rightarrow 2NH_3$ species (1) correct equation (1)	**2**
5(e)(ii)	450 °C (1) 200 atm (1)	**2**

Answer for Question 22 (0620_m18_42_1)

Question	Answer	Marks
1(a)(i)	**A**	**1**
1(a)(ii)	M1 **C** M2 **D**	**2**
1(a)(iii)	**D**	**1**
1(a)(iv)	**B**	**1**
1(a)(v)	M1 **F** M2 **B**	**2**
1(a)(vi)	M1 **G** M2 **H**	**2**
1(b)(i)	a shared **pair** of electrons (between two atoms) M1 shared electrons M2 pair of / two electrons	**2**
1(b)(ii)	M1 three correct bonding pairs from one N atom to each of three F atoms M2 (3 pairs of) non-bonding electrons on each of three F atoms to complete an octet M3 (1 pair of) non-bonding electrons on N atom to complete an octet	**3**
1(c)(i)	two (or more) substances not chemically combined	**1**
1(c)(ii)	21(%)	**1**
1(c)(iii)	fractional distillation of liquid air M1 air is made into a liquid M2 (allow air to) boil or evaporate M3 condense the vapours / collect the vapours in order (of evaporation) fractional distillation gets M2 and M3	**3**

Answer for Question 23 (0620_w21_43_5)

Question	Answer	Marks
5(a)(i)	too many colour changes	1
5(a)(ii)	Any acid-base indicator, e.g. methyl orange or phenolphthalein	1
5(b)	**M1** repeat without indicator using same volumes **OR** remove indicator by adding charcoal or carbon and filtering (1) **M2** evaporate / heat / warm/ boil/leave in hot place (1) **M3** until most of the water is gone / some water left / saturation(point) / crystallisation (point) / evaporate **some** of the water (1) **M4** cool / leave to crystallise(1) **M5** description of drying (1)	5
5(c)(i)	yellow flame	1
5(c)(ii)	**M1 solid** dissolves / disappears(1) **M2** blue solution(1)	2
5(c)(iii)	white precipitate	1

Answer for Question 24 (0620_s18_42_6)

Question	Answer	Marks
6(a)	(mix) sodium carbonate **AND** barium nitrate / barium chloride	1
	in solution / aqueous / dissolved (in water)	1
	filter / centrifuge (barium carbonate)	1
	wash (residue) **AND** dry / description of washing and drying	1
	$Ba(NO_3)_2 + Na_2CO_3 \rightarrow BaCO_3 + 2NaNO_3$ / $Ba^{2+} + CO_3^{2-} \rightarrow BaCO_3$ **OR** $BaCl_2 + Na_2CO_3 \rightarrow BaCO_3 + 2NaCl$	1
6(b)(i)	$2NaNO_3 \rightarrow 2NaNO_2 + O_2$ 1 mark for either $NaNO_2$ or O_2 on the right-hand side 1 mark for fully correct equation	2
6(b)(ii)	$2Cu(NO_3)_2.3H_2O(s) \rightarrow \mathbf{2}CuO(s) + \mathbf{4}NO_2(s) + O_2(g) + \mathbf{6}H_2O(g)$ all 3 numbers = 2 marks any 2 numbers = 1 mark	2
6(b)(iii)	blue	1
	pink	1
6(b)(iv)	boiling point sharp / melting point sharp / freezing point sharp / boiling point 100 (°)C / freezing point or melting point 0 (°)C	1

Answer for Question 25 (0620_s24_42_5)

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>5(a)(i)</td><td><table><tr><th></th><th>^{32}S</th><th>^{34}S</th></tr><tr><td>protons</td><td>16</td><td>16</td></tr><tr><td>neutrons</td><td>16</td><td>18</td></tr></table></td><td>2</td></tr>
<tr><td>5(a)(ii)</td><td>same electronic configuration / structure</td><td>1</td></tr>
<tr><td>5(a)(iii)</td><td>34 and g</td><td>1</td></tr>
<tr><td>5(a)(iv)</td><td>1 mole</td><td>1</td></tr>
<tr><td>5(a)(v)</td><td>M1 (32 × 95) + (34 × 5) = 3210

M2 3210 / 100 = 32.1</td><td>2</td></tr>
<tr><td>5(b)(i)</td><td>M1 eight crosses in second shell of Mg
M2 6 dots and 2 cross in third shell of S
M3 ‘2+’ charge on Mg on correct answer line
and ‘2–’ charge on S on correct answer line</td><td>3</td></tr>
<tr><td>5(b)(ii)</td><td>ionic bonds are strong</td><td>1</td></tr>
<tr><td>5(b)(iii)</td><td>mobile ions</td><td>1</td></tr>
<tr><td>5(c)(i)</td><td>H_2SO_3</td><td>1</td></tr>
<tr><td>5(c)(ii)</td><td>SO_3^{2-}</td><td>1</td></tr>
<tr><td>5(d)(i)</td><td>the oxidation number of manganese / Mn is +7</td><td>1</td></tr>
<tr><td>5(d)(ii)</td><td>M1 purple
to
M2 colourless</td><td>2</td></tr>
</table>

Answer for Question 26 (0620_s21_42_5)

Question	Answer	Marks
5(a)(i)	$6Li + N_2 \rightarrow 2Li_3N$ N_2 as reactant (1) rest of equation (1)	2
5(a)(ii)	new octet of 8 electrons consisting of 5 crosses and 3 dots in second shell (1) charge of 3– (1)	2

Question	Answer	Marks
5(b)(i)	bonds broken [945 + (3 × 160)] = 1425 (1) bonds formed (2 × 3 × 300) = 1800 (1) energy change = M1 – M2 = 1425 – 1800 = –375 (1)	3
5(b)(ii)	*Answer must reflect answer in* ***5(b)(i)*** exothermic **and** more energy released (in bond formation) than used/taken in (in bond breaking)	1
5(b)(iii)	N with 1 bonding pair with each F (1) 2 non-bonding dots for N (1) 6 non-bonding crosses for F (1)	3
5(c)	ionic bonds in Li_3N (1) attraction between molecules in NF_3 (1) weaker attraction (between particles) in NF_3 ORA (1)	3
5(d)(i)	rfm of NH_4NO_3 = 80 (1) mass of N = 2 × 14 = 28 and percentage N = 100 × 28 / 80 = 35% (1)	2
5(d)(ii)	fertiliser	1
5(d)(iii)	calcium hydroxide	1
5(e)(i)	proton acceptor	1
5(e)(ii)	$7 < \times \leqslant 11$	1

Answer for Question 27 (0620_s19_43_4)

Question	Answer	Marks
4(a)(i)	inert / unreactive / does not react with chlorine	1
4(a)(ii)	bubbles / fizzing / effervescence	1
4(a)(iii)	**M1** increases **M2** (solid) copper deposited	2
4a(iv)	**M1** colour fades / becomes pale(r) / becomes colourless / becomes lighter **M2** copper (ions) removed (from solution)	2
4(a)(v)	**M1** species oxidised: chloride (ions) / Cl^- **M2** explanation: loss of electrons / increase in oxidation state	2
4(b)(i)	**M1** spoon as cathode **M2** (pure)silver as anode **M3** aqueous silver nitrate as electrolyte **M4** $Ag^+ + e^- \rightarrow Ag$	4
4(b)(ii)	any one from: • Improves appearance • prevent / resist corrosion / oxidation • antibacterial	max 1

Answer for Question 28 (0620_w22_43_3)

Question	Answer	Marks
3(a)	bauxite	**1**
3(b)	**M1 breakdown** by (the passage of) **electricity** (1) **M2** of an **ionic compound** in **molten or aqueous** (state) (1)	**2**
3(c)(i)	**M1** improves conductivity of the electrolyte / makes the electrolyte a better conductor (1) **M2** low**er** operating temperature (1)	**2**
3(c)(ii)	$Al^{3+} + 3e^- \rightarrow Al$ **M1** only Al^{3+} + (3) e^- on the left (1) **M2** equation fully correct (1)	**2**
3(c)(iii)	**M1** anodes **or** carbon react(s) with oxygen (1) **M2** form carbon dioxide (1)	**2**
3(d)	unreactive coating of aluminium oxide (1)	**1**
3(e)(i)	neutralises both acids **AND** alkalis	**1**

Question	Answer	Marks
3(e)(ii)	$2NaOH + Al_2O_3 \rightarrow 2NaAlO_2 + H_2O$ **M1** $NaAlO_2$ on the right hand side (1) **M2** equation fully correct (1)	**2**
3(f)	**M1** $GaCl_3$ (1) **M2** $Ga_2(SO_4)_3$ (1)	**2**

Answer for Question 29 (0620_s23_42_4)

Question	Answer	Marks
4(a)	proton acceptor	1
4(b)	alkali	1
4(c)	blue	1
4(d)	M1 sodium chloride M2 water M3 ammonia	3
4(e)(i)	amphoteric (oxides)	1
4(e)(ii)	aluminium oxide **or** zinc oxide	1
4(f)(i)	M1 all single bonding dot and cross pairs correct M2 double C = O bond dot and cross pairs are correct M3 complete diagram is correct	3
4(f)(ii)	$3 \leq pH < 7$	1
4(f)(iii)i	$CH_3COOH \rightleftharpoons CH_3COO^- + H^+$ M1 H^+ M2 CH_3COO^- M3 use of $\rightleftharpoons$	3
4(f)(iv)	$H^+ + OH^- \rightarrow H_2O$	1

Answer for Question 29 (0620_s23_42_4)

Question	Answer	Marks
4(g)	M1 mol KOH = 0.0800 × 25 / 1000 = 0.002(00) / 2(00) × 10^{-3} M2 mol H_2SO_4 = M1 / 2 = 0.002 / 2 = 0.001(00) / 1(00 × 10^{-3} M3 = M2 × 1000 / 20 = 0.001 × 1000 / 20 = 0.05(00) / 5.(00) × 10^{-2} M4 = 98 M5 = 98 × M3 = 98 × 0.05(00) = 4.9(0) (g / dm^3)	5

Answer for Question 30 (0620_w18_42_3)

Question	Answer	Marks
3(a)	M1 Sulfur dioxide / SO_2 is formed M2 SO_2 reacts with (atmospheric) water (vapour) / rain	**2**
3(b)(i)	$2SO_2 + O_2 \rightleftharpoons 2SO_3$ M1 Balanced equation M2 reversible arrow	**2**
3(b)(ii)	M1 450 °C (units required) M2 1–5 atmospheres (units required) M3 Vanadium (V) oxide **or** vanadium pentoxide **or** V_2O_5	**3**
3(b)(iii)	M1 SO_3 added to (concentrated) H_2SO_4 M2 (Oleum) diluted with / added to water	**2**
3(c)(i)	Measuring cylinder	**1**
3(c)(ii)	M1 No more fizzing; M2 ($ZnCO_3$) stops dissolving or a (white) solid remains / is visible	**2**
3(c)(iii)	To use up all the acid / H^+ ions	**1**
3(c)(iv)	M1 A solution that can hold no more solute M2 at the specified temperature	**2**
3(c)(v)	(aq)	**1**
3(c)(vi)	Zinc oxide **or** zinc hydroxide	**1**
3(c)(vii)	Barium sulfate is insoluble	**1**

Answer for Question 30 (0620_w18_42_3)

Question	Answer	Marks
3(d)(i)	yellow	1
3(d)(ii)	M1 $0.2 \times 25 / 1000 = 5(.00) \times 10^{-3}$ or 0.005(00) (mol) M2 $5(.00) \times 10^{-3} / 2 = 2.5(.0) \times 10^{-3}$ or 0.0025(0) (mol) M3 $2.5(.0) \times 10^{-3} \times 1000 / 20 = 0.125$ (mol / dm^3) M4 $0.125 \times 98 = 12.25$ (g / dm^3)	4
3(e)	M1 Mol $FeSO_4$ = 15.2 / 152 = 0.1(00) M2 Expected mol of Fe_2O_3 = 0.1 / 2 = 0.05(00)) **or** Actual mol of Fe_2O_3 = 4.80 / 160= 0.03(00) M3 Percentage yield = $100 \times 0.03(00) / 0.05(00) = 60\%$	3