IGCSE CHEMISTRY TOPICAL PAPER 4

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[0620/31/M/J/11/Q5]

Q1. Hydriodic acid, HI(aq), is a strong acid. Its salts are iodides.

(a) It has the reactions of a typical strong acid. Complete the following equations.

(i) .....Li + ...HI → ..... + ... [1]

(ii) zinc carbonate + hydriodic acid → ..... + ... + ... [1]

(iii) MgO + ...HI → ..... + ... [1]

(b) Two of the reactions in **(a)** are acid / base and one is redox. Which one is redox? Explain your choice.

.....

.....

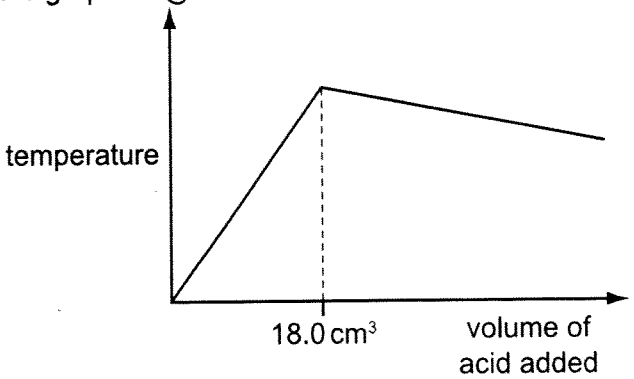
..... [2]

(c) Describe how you could distinguish between hydriodic, HI(aq), and hydrobromic, HBr(aq) acids, by bubbling chlorine through these two acids.

result with hydriodic acid .....

result with hydrobromic acid ..... [2]

(d) 20.0 cm^3 of aqueous sodium hydroxide, 2.00 mol / dm^3, was placed in a beaker. The temperature of the alkali was measured and 1.0 cm^3 portions of hydriodic acid were added. After each addition, the temperature of the mixture was measured. Typical results are shown on the graph.



$NaOH(aq) + HI(aq) \rightarrow NaI(aq) + H_2O(l)$

(i) Explain why the temperature increases rapidly at first then stops increasing.

.....

..... [2]

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(ii) Suggest why the temperature drops after the addition of 18.0 cm^3 of acid.

..... [1]

(iii) In another experiment, it was shown that 15.0 cm^3 of the acid neutralised 20.0 cm^3 of aqueous sodium hydroxide, 1.00 mol/dm^3. Calculate the concentration of the acid.

.....

..... [2]

[Total: 12]

[0620/32/M/J/11/Q1]

Q2. Choose an element from the list below which best fits the description.

Rb **Fe** **Si** **I** **P** **Sr**

(a) An element which reacts with cold water. ..... [1]

(b) It is a solid at room temperature and exists as diatomic molecules, X_2. ..... [1]

(c) It can form two oxides, XO and X_2O_3. ..... [1]

(d) This element has a hydride of the type XH_3. ..... [1]

(e) It has a macromolecular structure similar to that of carbon. ..... [1]

[Total: 5]

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[0620/32/M/J/11/Q7-B]

Q3. **(b)** Phosphorus trichloride reacts with water to form two acids.

(i) Balance the equation for this reaction.

$$PCl_3 + ...H_2O \rightarrow .....HCl + H_3PO_3$$

[1]

(ii) Describe how you could show that phosphorus acid, H_3PO_3, is a weaker acid than hydrochloric acid.

.....

.....

..... [3]

(iii) Two salts of phosphorus acid are its sodium salt, which is soluble in water, and its calcium salt which is insoluble in water. Suggest a method of preparation for each of these salts from aqueous phosphorus acid. Specify any other reagent needed and briefly outline the method.

sodium salt .....

.....

.....

..... [2]

calcium salt .....

.....

.....

..... [2]

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[0620/31/O/N/11/Q1-A]

Q4. This question is concerned with the following oxides.

sulfur dioxide
carbon monoxide
lithium oxide
aluminium oxide
nitrogen dioxide
strontium oxide

(a) (i) Which of the above oxides will react with hydrochloric acid but not with aqueous sodium hydroxide?

..... [1]

(ii) Which of the above oxides will react with aqueous sodium hydroxide but not with hydrochloric acid?

..... [1]

(iii) Which of the above oxides will react with both hydrochloric acid and aqueous sodium hydroxide?

..... [1]

(iv) Which of the above oxides will not react with hydrochloric acid or with aqueous sodium hydroxide?

..... [1]

[0620/31/O/N/11/Q7-A-B]

Q5.

Some hydroxides, nitrates and carbonates decompose when heated.

(a) (i) Name a metal hydroxide which does not decompose when heated.

..... [1]

(ii) Write the equation for the thermal decomposition of copper(II) hydroxide.

..... [2]

(iii) Suggest why these two hydroxides behave differently.

..... [1]

(b) (i) Metal nitrates, except those of the Group 1 metals, form three products when heated. Name the products formed when zinc nitrate is heated.

.....

..... [2]

(ii) Write the equation for the thermal decomposition of potassium nitrate.

..... [2]

[0620/32/O/N/11/Q3-A-B]

Q6. Antimony, Sb, is an element in Group V.

(a) The main ore of antimony is its sulfide. The extraction of antimony is similar to that of zinc.
Describe how each of these changes in the extraction of antimony is carried out.

(i) antimony sulfide to antimony oxide

..... [1]

(ii) antimony oxide to antimony

..... [1]

(b) Antimony oxide is a white powder which is insoluble in water.
Describe how you would find out if it is a basic, an acidic or an amphoteric oxide.

.....

.....

.....

..... [4]

[0620/32/O/N/11/Q6-B]

Q7. (b) Potassium chloride can be made from hydrochloric acid and potassium carbonate.

(i) Why must a different experimental method be used for this preparation?

.....

..... [1]

(ii) Give a description of the different method used for this salt preparation.

.....

.....

.....

..... [4]

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Q8. [0620/33/O/N/11/Q3-A]

Fertilisers are used to promote plant growth.
Two fertilisers are ammonium phosphate, $(NH_4)_3PO_4$, and calcium dihydrogenphosphate, $Ca(H_2PO_4)_2$.

(a) Describe a test to distinguish between these two fertilisers.

test .....

..... [2]

result .....

..... [1]

Q9. [0620/31/M/J/12/Q2]

Three ways of making salts are

- titration using a soluble base or carbonate
- neutralisation using an insoluble base or carbonate
- precipitation.

(a) Complete the following table of salt preparations.

method	reagent 1	reagent 2	salt
titration	....	....	sodium nitrate
neutralisation	nitric acid	....	copper(II) nitrate
precipitation	....	....	silver(I) chloride
neutralisation	sulfuric acid	zinc(II) carbonate	....

[6]

(b) (i) Write an ionic equation with state symbols for the preparation of silver(I) chloride.

..... [2]

(ii) Complete the following equation.

$ZnCO_3 + H_2SO_4 \rightarrow$ ..... + ... + ...

[2]

[Total: 10]

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[0620/32/M/J/12/Q8]

Q10. Ethylamine, $CH_3–CH_2–NH_2$, is a base which has similar properties to ammonia.

(a) In aqueous ethylamine, there is the following equilibrium.

$$CH_3–CH_2–NH_2 + H_2O \rightleftharpoons CH_3–CH_2–NH_3^+ + OH^-$$

Explain why water is behaving as an acid in this reaction.

..... [1]

(b) Given aqueous solutions of ethylamine and sodium hydroxide, describe how you could show that ethylamine is a weak base like ammonia and not a strong base like sodium hydroxide.

.....

.....

..... [3]

(c) Ethylamine, like ammonia, reacts with acids to form salts.

$$CH_3–CH_2–NH_2 + HCl \rightarrow CH_3–CH_2–NH_3Cl$$

ethylammonium chloride

Suggest how you could displace ethylamine from the salt, ethylammonium chloride.

.....

..... [2]

(d) Explain the chemistry of the following reaction:

When aqueous ethylamine is added to aqueous iron(III) chloride, a brown precipitate is formed.

.....

..... [2]

[Total: 8]

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[0620/31/M/J/13/Q3-B]

Q15. **(b)** The equation for the reaction in experiment 1 is:

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

Complete the following ionic equation.

$$CaCO_3(s) + 2H^+(aq) \rightarrow \ldots\ldots + \ldots\ldots + \ldots\ldots$$

[1]

[0620/31/M/J/13/Q6-A-E]

Q16.

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

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

..... [1]

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

.....

.....

..... [2]

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

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

..... [1]

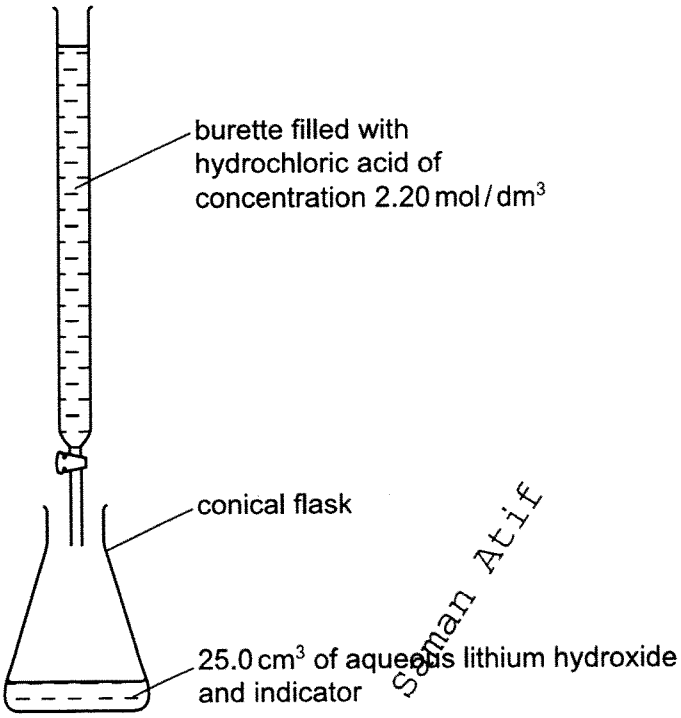
(ii) Give a reason, other than pH, why hydrazine reduces the rate of rusting.

..... [1]

[0620/31/M/J/13/Q7-A]

Q17. The hydroxides of the Group I metals are soluble in water. Most other metal hydroxides are insoluble in water.

(a) (i) Crystals of lithium chloride can be prepared from lithium hydroxide by titration.



$25.0\,cm^3$ of aqueous lithium hydroxide is pipetted into the conical flask.
A few drops of an indicator are added. Dilute hydrochloric acid is added slowly to the alkali until the indicator just changes colour. The volume of acid needed to neutralise the lithium hydroxide is noted.

A neutral solution of lithium chloride, which still contains the indicator, is left. Describe how you could obtain a neutral solution of lithium chloride which does **not** contain an indicator.

.....

..... [2]

(ii) You cannot prepare a neutral solution of magnesium chloride by the same method. Describe how you could prepare a neutral solution of magnesium chloride.

.....

.....

..... [3]

437

Q18. [0620/33/M/J/13/Q4-A-B]

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

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

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

[1]

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

..... [1]

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

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

[2]

438

[0620/33/M/J/13/Q6-B-C]

Q19.(b) **(i)** Suggest why a solution of malonic acid, concentration 0.2 mol / dm^3, has a higher pH than one of sulfuric acid of the same concentration.

..... [1]

(ii) Describe a test, other than measuring pH, which can be carried out on both acid solutions to confirm the explanation given in **(b)(i)** for the different pH values of the two acids.

.....

..... [2]

(c) Complete the following equations for reactions of these two acids.

(i) sodium hydroxide + malonic acid → ..... + ... [1]

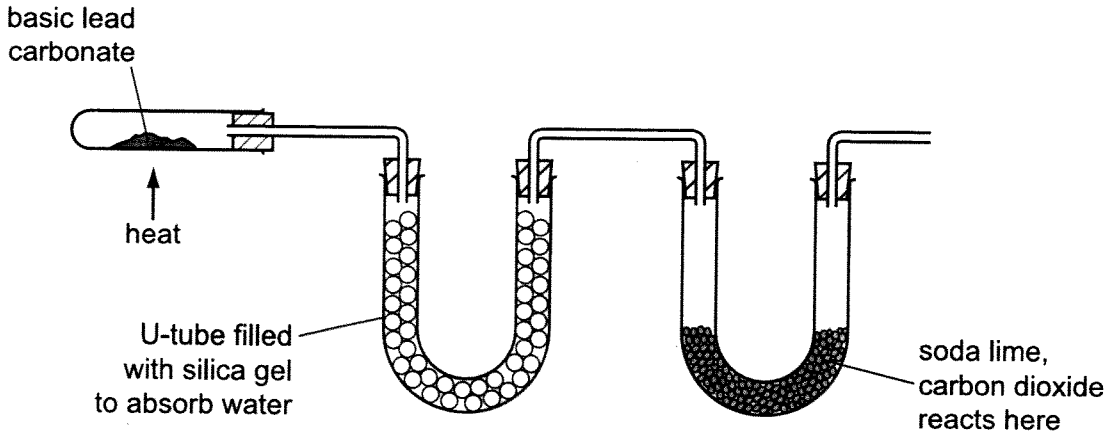
(ii) $CuO + H_2SO_4 \rightarrow$ ..... + ... [2]

(iii) $Mg + CH_2(COOH)_2 \rightarrow$ ..... + ... [2]

(iv) $K_2CO_3 + H_2SO_4 \rightarrow$ ..... + ... + ... [2]

Q20. [0620/31/O/N/13/Q6-B]

(b) Basic lead(II) carbonate is heated in the apparatus shown below. Water and carbon dioxide are produced.



(i) Silica gel absorbs water. Silica gel often contains anhydrous cobalt(II) chloride. When this absorbs water it changes from blue to pink.
Suggest a reason.

..... [1]

(ii) Soda lime is a mixture of sodium hydroxide and calcium oxide. Why do these two substances react with carbon dioxide?

.....

..... [2]

(iii) Name **two** substances formed when soda lime reacts with carbon dioxide.

..... [2]

[0620/32/O/N/13/Q5-A-B-C]

Q21. Silver(I) chromate(VI) is an insoluble salt. It is prepared by precipitation.
$20\,cm^3$ of aqueous silver(I) nitrate, concentration $0.2\,mol/dm^3$, was mixed with $20\,cm^3$ of aqueous potassium chromate(VI), concentration $0.1\,mol/dm^3$. After stirring, the mixture was filtered. The precipitate was washed several times with distilled water. The precipitate was then left in a warm oven for several hours.

$$2AgNO_3(aq) + K_2CrO_4(aq) \rightarrow Ag_2CrO_4(s) + 2KNO_3(aq)$$

(a) What difficulty arises if the name of a compound of a transition element does not include its oxidation state, for example iron oxide?

.....

..... [2]

(b) These questions refer to the preparation of the salt.

(i) Why is it necessary to filter the mixture after mixing and stirring?

..... [1]

(ii) What is the purpose of washing the precipitate?

..... [1]

(iii) Why leave the precipitate in a warm oven?

..... [1]

(c) **(i)** Explain why the concentrations of silver(I) nitrate and potassium chromate(VI) are different.

..... [1]

[0620/33/O/N/13/Q1-C]

Q22. **(c)** It is possible to determine whether zirconium(IV) oxide is acidic, neutral, basic or amphoteric using an acid and an alkali. Complete the table of possible results. If the oxide is predicted to react write 'R', if it is predicted not to react write 'NR'.

if the oxide is	predicted result with hydrochloric acid	predicted result with aqueous sodium hydroxide
acidic		
neutral		
basic		
amphoteric		

[4]

441

[0620/31/O/N/14/Q1]

Q27.

(a) Match the following pH values to the solutions given below.

1 3 7 10 13

The solutions all have the same concentration.

solution	**pH**
aqueous ammonia, a weak base	.....
dilute hydrochloric acid, a strong acid	.....
aqueous sodium hydroxide, a strong base	.....
aqueous sodium chloride, a salt	.....
dilute ethanoic acid, a weak acid	.....

[5]

(b) Explain why solutions of hydrochloric acid and ethanoic acid with the same concentration, in mol / dm^3, have a different pH.

.....

.....

..... [2]

(c) Measuring pH is one way of distinguishing between a strong acid and a weak acid. Describe another method.

method .....

.....

results .....

.....

[2]

[Total: 9]

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[0620/33/O/N/14/Q5-B]

Q28.

(b) The ions present in aqueous sodium chloride are $Na^+(aq)$, $Cl^-(aq)$, $H^+(aq)$ and $OH^-(aq)$.

The electrolysis of concentrated aqueous sodium chloride forms three products. They are hydrogen, chlorine and sodium hydroxide.

(i) Explain how these **three** products are formed. Give ionic equations for the reactions at the electrodes.

.....

.....

.....

.....

..... [4]

(ii) If the solution of the electrolyte is stirred, chlorine reacts with sodium hydroxide to form sodium chlorate(I), sodium chloride and water.
Write an equation for this reaction.

Cl_2 + ...NaOH → ..... + ... + ...

[2]

[0620/33/O/N/14/Q8-A-B]

Q29.

(a) Describe how cobalt chloride paper can be used to test for the presence of water.

.....

..... [2]

(b) Complete the description of the preparation of crystals of the soluble salt, cobalt(II) chloride-6-water, $CoCl_2.6H_2O$, from the insoluble base, cobalt(II) carbonate.

$$CoCO_3(s) + 2HCl(aq) \rightarrow CoCl_2(aq) + CO_2(g) + H_2O(l)$$

50 cm^3 of dilute hydrochloric acid, concentration 2.2 mol/dm^3, was heated and cobalt(II) carbonate was added in small amounts until .....

.....

.....

.....

..... [4]

445

[0620/31/M/J/15/Q6-A-B]

Q30.

Acid-base reactions are examples of proton transfer.

(a) Ethylamine is a weak base and sodium hydroxide is a strong base.

(i) In terms of proton transfer, explain what is meant by the term *weak base*.

.....

..... [2]

(ii) Given aqueous solutions of both bases, describe how you could show that sodium hydroxide is the stronger base. How could you ensure a 'fair' comparison between the two solutions?

.....

.....

.....

..... [3]

(b) Ethylamine reacts with acids to form salts.

$$CH_3CH_2NH_2 + HCl \rightarrow \underset{\text{ethylammonium chloride}}{CH_3CH_2NH_3Cl}$$

(i) Complete the equation for the reaction between sulfuric acid and ethylamine. Name the salt formed.

.....$CH_3CH_2NH_2$ + ... → .....

name of salt ..... [3]

(ii) Amines and their salts have similar chemical properties to ammonia and ammonium salts.

Suggest a reagent that could be used to displace the weak base, ethylamine, from its salt ethylammonium chloride.

..... [1]

[0620/32/M/J/15/Q5]

Q31.

Three common methods of preparing salts are shown below.

method **A** adding an excess of an insoluble base or carbonate or metal to a dilute acid and removing excess by filtration

method **B** using a burette and indicator

method **C** mixing two solutions to obtain the salt by precipitation

For each of the following salt preparations, choose a method, **A**, **B** or **C**. Name any additional reagent which is needed and complete the equation.

(a) the soluble salt, nickel chloride, from the insoluble compound nickel carbonate

method .....

reagent .....

word equation .....

[3]

(b) the insoluble salt, lead(II) bromide, from aqueous lead(II) nitrate

method .....

reagent .....

ionic equation ..... + ... → $PbBr_2$

[3]

(c) the soluble salt, lithium sulfate, from the soluble base lithium hydroxide

method .....

reagent .....

equation .....

[4]

[Total: 10]

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[0620/41/M/J/16/Q2-B-C-D]

Q32.

(b) Magnesium reacts slowly with warm water to form a base, magnesium hydroxide.

(i) Explain what is meant by the term *base*.

..... [1]

(ii) Write a chemical equation for the reaction between magnesium and warm water.

..... [2]

(c) Aluminium oxide is amphoteric. It is insoluble in water.

Describe experiments to show that aluminium oxide is amphoteric.

.....

.....

.....

..... [3]

(d) Silicon(IV) oxide has a giant structure.

(i) Name the type of bonding in silicon(IV) oxide.

..... [1]

(ii) Give two **physical** properties of silicon(IV) oxide.

.....

..... [2]

[0620/41/M/J/16/Q5]

Q33.

Sulfuric acid is produced by the Contact process. The steps of the Contact process are shown.

starting material **step 1** → sulfur dioxide **step 2** → sulfur trioxide **step 3** → oleum **step 4** → sulfuric acid

(a) Sulfur is a common starting material for the Contact process.

Name a source of sulfur.

..... [1]

(b) Describe **step 2**, giving reaction conditions and a chemical equation. Reference to reaction rate and yield is not required.

.....

.....

.....

.....

.....

.....

..... [5]

(c) **Step 3** involves adding sulfur trioxide to concentrated sulfuric acid to form oleum.

Complete the chemical equation for this reaction.

$H_2SO_4 + SO_3 \rightarrow$ .....

[1]

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(d) Dilute sulfuric acid is a typical acid.

A student adds excess dilute sulfuric acid to a sample of solid copper(II) carbonate in a test-tube.

(i) Give **three** observations the student would make.

.....

.....

..... [2]

(ii) Give the **names** of all products formed.

.....

..... [1]

(e) Concentrated sulfuric acid has different properties to dilute sulfuric acid.

When concentrated sulfuric acid is added to glucose, $C_6H_{12}O_6$, steam is given off and a black solid is formed.

(i) Name the black solid.

..... [1]

(ii) What type of reaction has occurred?

..... [1]

[Total: 12]

[0620/42/M/J/16/Q6-A-D]

Q34.

Zinc is extracted from an ore called zinc blende, which consists mainly of zinc sulfide, ZnS.

(a) (i) The zinc sulfide in the ore is first converted into zinc oxide.

Describe how zinc oxide is made from zinc sulfide.

.....

..... [1]

(ii) Write a chemical equation for the reaction in **(a)(i)**.

..... [2]

(d) When a sample of steel is added to dilute hydrochloric acid, an aqueous solution of iron(II) chloride, $FeCl_2$, is formed.

When a sample of rust is added to dilute hydrochloric acid, an aqueous solution of iron(III) chloride, $FeCl_3$, is formed.

(i) Aqueous sodium hydroxide is added to the solutions of iron(II) chloride and iron(III) chloride.

Complete the table below, showing the observations you would expect to make.

	iron(II) chloride solution	iron(III) chloride solution
aqueous sodium hydroxide		

[2]

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[0620/43/M/J/16/Q4-B]

Q35.

(b) Potassium iodide and lead nitrate are both soluble. Lead iodide is insoluble.

(i) Describe how a pure dry sample of lead iodide could be made from solid potassium iodide and solid lead nitrate.

.....

.....

.....

.....

.....

..... [4]

(ii) Write an ionic equation for the formation of lead iodide, PbI_2, when potassium iodide and lead nitrate react with each other.
State symbols are **not** required.

..... [2]

[0620/43/M/J/16/Q6-B]

Q36.

(b) Some of the white solid is removed from the tube and dissolved in water.

Describe how the white solid could be tested to show it contains,

(i) ammonium ions,

test .....

.....

result .....

.....
[3]

(ii) chloride ions.

test .....

.....

result .....

.....
[3]

Q37. [0620/42/O/N/16/Q4]

Dilute nitric acid behaves as a typical acid in some reactions but **not** in other reactions.

(a) Dilute nitric acid behaves as a typical acid when reacted with copper(II) oxide and with copper(II) carbonate.

Describe what you would **see** if excess dilute nitric acid is added separately to solid samples of copper(II) carbonate and copper(II) oxide followed by warming the mixtures.

copper(II) carbonate

.....

.....

copper(II) oxide

.....

.....

[4]

(b) When dilute nitric acid is added to pieces of copper and heated, a reaction takes place and copper(II) nitrate is formed.

(i) Part of the chemical equation for the reaction between copper and dilute nitric acid is shown.

Complete the chemical equation by inserting the formula of copper(II) nitrate and balancing the equation.

.....Cu(s) + $8HNO_3$(aq) → .....(aq) + $4H_2O$(l) + 2NO(g)

[2]

(ii) How is the reaction of dilute nitric acid with copper different from that of a typical metal with a typical acid?

.....

..... [1]

[Total: 7]

Q38. [0620/42/O/N/16/Q5-Eii]

(ii) The oxide of iodine in **(e)(i)** dissolves in water.

Predict and explain the effect of adding Universal Indicator to an aqueous solution of this oxide of iodine.

effect on Universal Indicator .....

explanation .....

[2]

[0620/43/O/N/16/Q2-D]

Q39.

(d) Beryllium hydroxide is amphoteric.
Beryllium hydroxide reacts with acids. The salts formed contain positive beryllium ions.

(i) Give the formula of the positive beryllium ion.

..... [1]

(ii) Write a chemical equation for the reaction between beryllium hydroxide and hydrochloric acid.

..... [2]

(iii) Beryllium hydroxide also reacts with alkalis. The salts formed contain beryllate ions, BeO_2^{2-}.

Suggest a chemical equation for the reaction between beryllium hydroxide and sodium hydroxide solution.

..... [2]

[0620/43/O/N/16/Q5-F]

Q40.

(f) Sulfuric acid reacts with a hydrocarbon called benzene to produce benzenesulfonic acid, $C_6H_5SO_3H$. Benzenesulfonic acid is a strong acid which ionises to produce hydrogen ions, H^+, and benzenesulfonate ions, $C_6H_5SO_3^-$.

(i) What is meant by the term *strong acid*?

..... [1]

(ii) Describe how to show that a 1 mol/dm^3 solution of benzenesulfonic acid is a strong acid.

.....

..... [2]

(iii) Write a chemical equation for the reaction between benzenesulfonic acid and sodium carbonate, Na_2CO_3.

..... [2]

Q41. [0620/41/M/J/17/Q2]

Some oxides of some elements are listed.

CO CO_2 Na_2O MgO Al_2O_3

SiO_2 P_4O_{10} SO_2 Cl_2O_7 Cr_2O_3

(a) Answer the following questions using only oxides from the list. Each oxide may be used once, more than once or not at all.

Give the formula of an oxide

(i) which is the main cause of acid rain, ...

(ii) which would give a solution of pH 14 when added to water, ...

(iii) which is coloured, ...

(iv) which is the major impurity in iron ore, ...

(v) which is amphoteric, ...

(vi) which is neutral. .....

[6]

(b) Amphoteric oxides and neutral oxides are different from each other.

(i) What is meant by the term *amphoteric oxide*?

.....

..... [1]

(ii) What is meant by the term *neutral oxide*?

.....

..... [1]

[Total: 8]

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Q42. [0620/41/M/J/17/Q3-A-C-D]

Magnesium sulfate and lead(II) sulfate are examples of salts.

(a) A student prepared magnesium sulfate crystals starting from magnesium carbonate. The student carried out the experiment in four steps.

step 1 The student added excess magnesium carbonate to a small volume of dilute sulfuric acid until no more magnesium carbonate would react.

step 2 The student filtered the mixture.

step 3 The student heated the filtrate obtained from **step 2** until it was saturated.

step 4 The student allowed the hot filtrate to cool to room temperature and then removed the crystals which formed.

(i) How did the student know when the reaction had finished in **step 1**?

..... [1]

(ii) Name the residue in **step 2**.

..... [1]

(iii) A saturated solution forms in **step 3**.

What is a saturated solution?

.....

..... [2]

(iv) Explain why magnesium sulfate crystals form during **step 4**.

.....

..... [1]

(c) Lead(II) sulfate, $PbSO_4$, is insoluble.

Describe how you would prepare a pure dry sample of lead(II) sulfate crystals starting from solutions of lead(II) nitrate and sodium sulfate.
Include a series of key steps in your answer.

.....

.....

.....

.....

.....

.....

.....

..... [4]

(d) Write the ionic equation for the reaction which takes place between solutions of lead(II) nitrate and sodium sulfate.
Include state symbols.

..... [2]

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[0620/42/M/J/17/Q2-E-F]

Q43.

(e) Carbon dioxide, CO_2, is a gas at room temperature and pressure, whereas silicon(IV) oxide, SiO_2, is a solid.

(i) Name the type of structure which the following compounds have.

carbon dioxide ..... [1]

silicon(IV) oxide ..... [1]

(ii) Use your knowledge of structure and bonding to explain why carbon dioxide is a gas at room temperature and pressure, whereas silicon(IV) oxide is a solid.

.....

.....

.....

..... [3]

(f) Silicon(IV) oxide is an acidic oxide. When silicon(IV) oxide reacts with alkalis, the salts formed contain the ion SiO_3^{2-}.

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

..... [2]

458

[0620/42/M/J/17/Q3-D]

Q44.

(d) Describe how you would prepare a pure dry sample of copper(II) nitrate crystals in the laboratory using dilute nitric acid and solid copper(II) carbonate.
Include a series of key steps in your answer.
You should include a chemical equation for the reaction.

.....

.....

.....

.....

.....

.....

.....

..... [6]

[0620/41/O/N/17/Q4-D]

Q45.

(d) Ethanoic acid is a weak acid.

(i) When referring to an acid, what is meant by the term *weak*?

.....

..... [1]

(ii) Describe how you could show that ethanoic acid is a weaker acid than hydrochloric acid.

.....

.....

.....

..... [3]

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[0620/41/O/N/17/Q5-B]

Q46.

(b) Copper(II) carbonate reacts with dilute nitric acid. One of the products of the reaction is a solution of copper(II) nitrate.

(i) Describe tests for copper(II) ions and nitrate ions. Include the results of the tests.

copper(II) ions .....

.....

.....

nitrate ions .....

.....

.....

[4]

(ii) Copper(II) nitrate undergoes thermal decomposition.

Balance the chemical equation for the thermal decomposition of copper(II) nitrate.

.....$Cu(NO_3)_2$ → .....CuO + ...NO_2 + ...O_2

[1]

[0620/43/O/N/17/Q3-E]

Q47.

(e) Aqueous sodium hydroxide, aqueous potassium iodide and aqueous acidified potassium manganate(VII) are added to aqueous solutions of iron(II) sulfate and iron(III) sulfate.

- Iron(II) ions, Fe^{2+}, are reducing agents in aqueous solution.
- Iron(III) ions, Fe^{3+}, are oxidising agents in aqueous solution.

Complete the table.

reagent	observations with aqueous iron(II) sulfate	observations with aqueous iron(III) sulfate
aqueous sodium hydroxide	green precipitate	
aqueous potassium iodide		
aqueous acidified potassium manganate(VII)		no change

[4]

[0620/42/M/J/18/Q6]

Q48.

(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]

[0620/43/M/J/18/Q4-F]

Q49.

(f) Ethanoic acid, CH_3COOH, is a weak acid. It reacts with copper(II) carbonate to form the salt copper(II) ethanoate, $Cu(CH_3COO)_2$.

(i) What is meant by the term *weak* when applied to acids?

..... [1]

(ii) Describe how a crystalline sample of copper(II) ethanoate can be prepared starting with ethanoic acid and copper(II) carbonate.

.....

.....

.....

.....

.....

..... [3]

(iii) Write the word equation for the reaction between ethanoic acid and copper(II) carbonate.

..... [1]

[0620/43/M/J/18/Q6-C]

Q50.

(c) Chloric(V) acid, $HClO_3$, is a strong acid. It can be made from calcium chlorate(V).

(i) What colour is methyl orange indicator in chloric(V) acid?

..... [1]

(ii) Define the term *acid* in terms of proton transfer.

..... [1]

(iii) Complete the chemical equation to show $HClO_3$ behaving as an acid in water.

$HClO_3 + H_2O \rightarrow$ ..... + ...

[1]

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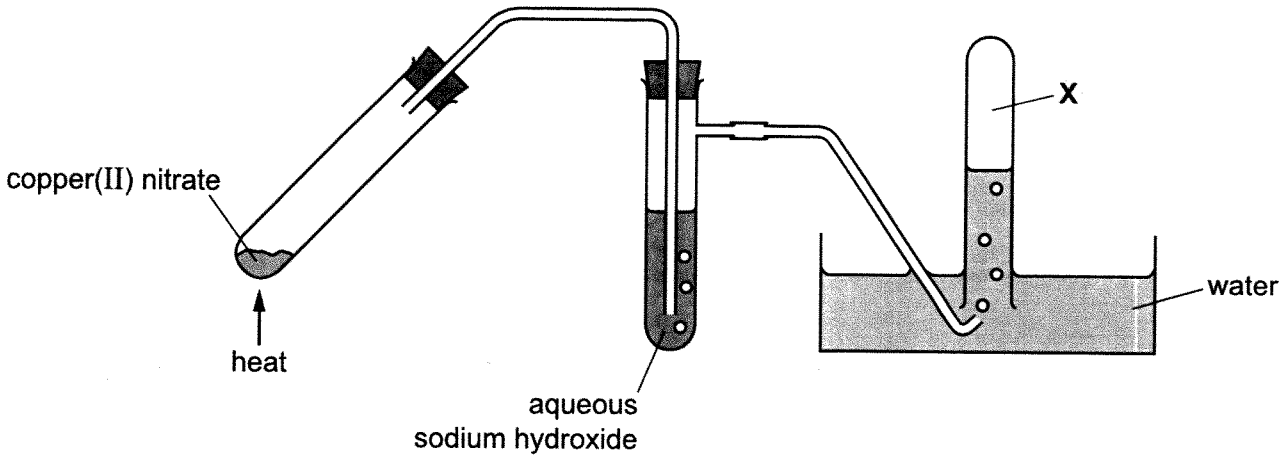
[0620/41/O/N/18/Q3-D]

Q51.

(a) Copper(II) nitrate decomposes when heated. Two gases, oxygen and nitrogen dioxide, and a solid are made in the reaction.

A sample of copper(II) nitrate was decomposed using the apparatus shown.



(d) A sample of copper(II) nitrate was dissolved in water to form an aqueous solution.

The aqueous solution was split into three portions. A separate test was done on each portion as shown.

test	reagent added	result
1	aqueous sodium hydroxide	light blue precipitate forms
2	zinc powder	solution changes from blue to colourless and a brown solid forms
3		ammonia gas is produced

(i) Give the formula of the light blue precipitate formed in **test 1**.

..... [1]

(ii) Explain the changes seen in **test 2**.

.....

.....

..... [3]

(iii) Identify the **two** reagents that must be added to the aqueous copper(II) nitrate in **test 3**.

1 .....

2 .....

[2]

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[0620/41/O/N/18/Q4-A]

Q52.

(a) Sulfuric acid is made industrially by a four-step process.

step 1 Sulfur is burned in air to produce sulfur dioxide.

step 2 Sulfur dioxide is converted into sulfur trioxide.

step 3 Sulfur trioxide is reacted with concentrated sulfuric acid to produce oleum.

step 4 Oleum is reacted with water to produce concentrated sulfuric acid.

(i) Some sulfur is obtained by mining.

Name **one** other major source of sulfur.

..... [1]

(ii) What is the name of the process by which sulfuric acid is made industrially?

..... [1]

(iii) Describe the conversion of sulfur dioxide into sulfur trioxide in **step 2**.

In your answer, include:
- a chemical equation for the reaction
- the essential reaction conditions.

.....

.....

.....

.....

.....

.....

..... [5]

[0620/42/O/N/18/Q2-E]

Q53.

(e) Aqueous magnesium chloride is added to aqueous silver nitrate. A white precipitate forms.

Write an **ionic** equation for this reaction. Include state symbols.

..... [2]

[0620/42/O/N/18/Q3-B-C]

Q54.

(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]

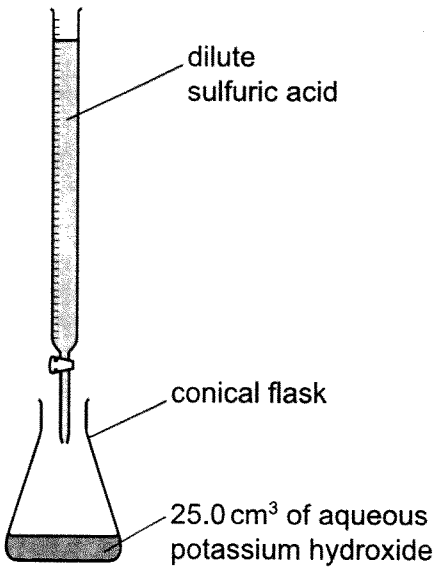
(vii) Suggest why this method would **not** work to make barium sulfate from barium carbonate and dilute sulfuric acid.

..... [1]

[0620/43/SM/18/Q4-B-C-D]

Q55.

(a) Dilute sulfuric acid and aqueous potassium hydroxide can be used to make potassium sulfate crystals using a method that includes titration.



(b) After the titration has been completed, the conical flask contains an aqueous solution of potassium sulfate and some of the dissolved indicator.

Describe how to prepare a **pure**, dry sample of potassium sulfate crystals from new solutions of dilute sulfuric acid and aqueous potassium hydroxide of the same concentrations as used in the titration. Include a series of key steps in your answer.

.....

.....

.....

.....

.....

.....

..... [5]

(c) Potassium hydrogensulfate, $KHSO_4$, is an acid salt. It dissolves in water to produce an aqueous solution, **X**, containing K^+, H^+ and SO_4^{2-} ions.

Describe what you would see when the following experiments are done.

(i) Magnesium ribbon is added to an excess of solution **X**.

.....

..... [2]

(ii) A flame test is done on solution **X**.

..... [1]

(iii) An aqueous solution containing barium ions is added to solution **X**.

..... [1]

(d) Dilute sulfuric acid reacts with bases, metals and carbonates.

Write chemical equations for the reaction of dilute sulfuric acid with each of the following:

(i) magnesium hydroxide

..... [2]

(ii) zinc

..... [2]

(iii) sodium carbonate

..... [2]

[0620/41/M/J/19/Q4-D-E]

$$MgCO_3 + 2HCl \rightarrow MgCl_2 + H_2O + CO_2$$

Q56.

(d) A student prepares crystals of magnesium chloride by adding an excess of magnesium carbonate to 50.00 cm^3 of 2.00 mol/dm^3 hydrochloric acid.

The student filters the mixture and rinses the residue.

(i) Why does the student add an **excess** of magnesium carbonate?

..... [1]

(ii) Why does the student rinse the residue?

..... [1]

(iii) Describe how the student would obtain pure crystals of magnesium chloride from the filtrate.

.....

.....

..... [3]

(e) Silver chloride, $AgCl$, is insoluble. It can be made by a precipitation reaction between aqueous barium chloride and a suitable aqueous silver salt.

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

.....

..... [2]

(ii) Name a suitable silver salt to use to prepare silver chloride.
Complete the chemical equation to show the formation of insoluble silver chloride from aqueous barium chloride and the silver salt you have named.

name of a suitable silver salt .....

$$BaCl_2 + \text{.....} \rightarrow \text{.....} + \text{.....}$$

[3]

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[0620/42/M/J/19/Q3-B-C-D-E]

Q57.

(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.

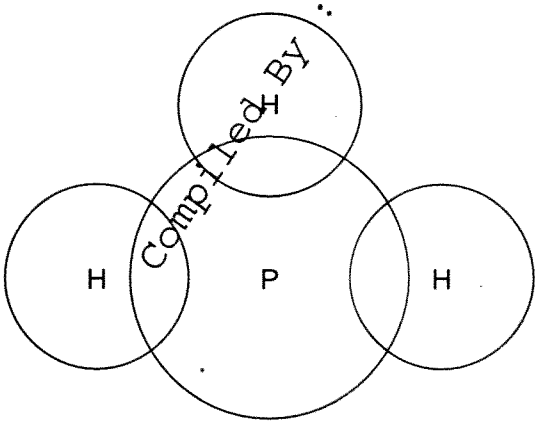
Phosphorus(V) oxide, P_4O_{10}, reacts with aqueous sodium hydroxide to form a salt containing the phosphate ion, PO_4^{3-}. Water is the only other product.

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]

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[0620/42/M/J/19/Q5-B-C-D-E-F-G]

Q58.

Copper(II) sulfate crystals, $CuSO_4.5H_2O$, are hydrated.

Copper(II) sulfate crystals are made by reacting copper(II) carbonate with dilute sulfuric acid.

The equation for the overall process is shown.

$$CuCO_3 + H_2SO_4 + 4H_2O \rightarrow CuSO_4.5H_2O + CO_2$$

step 1 Powdered solid copper(II) carbonate is added to 50.0 cm^3 of 0.05 mol/dm^3 sulfuric acid until the copper(II) carbonate is in excess.

step 2 The excess of copper(II) carbonate is separated from the aqueous copper(II) sulfate.

step 3 The aqueous copper(II) sulfate is heated until the solution is saturated.

step 4 The solution is allowed to cool and crystallise.

step 5 The crystals are removed and dried.

(b) **Steps 1–5** were done correctly but the mass of crystals obtained was less than the maximum mass.

Explain why.

..... [1]

(c) State **two** observations that would indicate that the copper(II) carbonate is in excess in **step 1**.

1 .....

2 .....

[2]

(d) When the reaction in **step 1** is done using lumps of copper(II) carbonate instead of powder, the rate of reaction decreases. All other conditions are kept the same.

Give a reason for this. Explain your answer in terms of particles.

.....

.....

..... [2]

(e) Name a different substance, other than copper(II) carbonate, that could be added to dilute sulfuric acid to produce copper(II) sulfate in **step 1**.

..... [1]

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(f) Name the process used to separate the aqueous copper(II) sulfate from the excess of copper(II) carbonate in **step 2**.

..... [1]

(g) The solution of aqueous copper(II) sulfate was heated until it was saturated in **step 3**.

(i) Suggest what is meant by the term *saturated solution*.

.....

.....

..... [2]

(ii) What evidence would show that the solution was saturated in **step 3**?

..... [1]

(iii) Why should the aqueous copper(II) sulfate **not** be heated to dryness in **step 3**?

..... [1]

[0620/41/O/N/19/Q1-A]

Q59.

This question is about ions and ionic compounds.

(a) Choose from the following list of ions to answer the questions.

Br^-	Ca^{2+}	Cl^-	Cr^{3+}	Cu^{2+}
K^+	Li^+	Na^+	SO_3^{2-}	SO_4^{2-}

Each ion may be used once, more than once or not at all.

State which ion:

(i) gives a lilac colour in a flame test ..... [1]

(ii) forms a grey-green precipitate with aqueous ammonia ..... [1]

(iii) forms a white precipitate with aqueous sodium hydroxide ..... [1]

(iv) forms a cream precipitate with acidified aqueous silver nitrate ..... [1]

(v) forms a white precipitate with acidified aqueous barium nitrate. ..... [1]

Q60. [0620/43/M/J/19/Q3-C-D]

(c) Some airbags contain silicon(IV) oxide.
When the airbag is used sodium oxide is formed.

Oxides can be classified as acidic, amphoteric, basic or neutral.

Classify each of these oxides:

sodium oxide .....

silicon(IV) oxide. .....
[2]

(d) Lead(II) azide is insoluble in water. Solid lead(II) azide can be made in a precipitation reaction between aqueous lead(II) nitrate and aqueous sodium azide.
Lead(II) azide has the formula $Pb(N_3)_2$.

(i) Deduce the formula of the azide ion.

..... [1]

(ii) Complete the chemical equation for the reaction between aqueous lead(II) nitrate and aqueous sodium azide to form solid lead(II) azide and aqueous sodium nitrate. Include state symbols.

$Pb(NO_3)_2$(aq) + ... NaN_3(aq) → $Pb(N_3)_2$(.....) + ...(.....)
[2]

(iii) Describe how you could obtain a sample of lead(II) azide that is **not** contaminated with any soluble salts from the reaction mixture.

.....

.....

.....

..... [2]

[0620/41/O/N/19/Q2-C-D]

Q61.

(c) The manufacture of sulfuric acid by the Contact process occurs in four stages.

stage 1 Molten sulfur is burned in air to produce sulfur dioxide gas.

stage 2 Sulfur dioxide is reacted with oxygen to form sulfur trioxide.

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

stage 4 Oleum is added to water to form sulfuric acid.

(i) Complete the chemical equation for **stage 1** by adding the appropriate state symbols.

$$S(.....) + O_2(.....) \rightarrow SO_2(.....)$$ [1]

(ii) Name the catalyst used in **stage 2** and state the temperature used.

catalyst .....

temperature ..... °C

[2]

(iii) Write chemical equations for the reactions in **stage 3** and **stage 4**.

stage 3 .....

stage 4 .....

[2]

(d) Sulfur dioxide is a toxic gas.

(i) State one **environmental** reason why sulfur dioxide should **not** be released into the atmosphere.

..... [1]

(ii) Describe the test for sulfur dioxide.

test .....

.....

observations .....

.....

[2]

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[0620/41/O/N/19/Q3-D]

Q62.

(d) Zinc oxide is amphoteric.

Describe **two** simple experiments to show that zinc oxide is amphoteric.
Name the reagents you would use and describe the observations you would make.

reagent 1 .....

observation .....

reagent 2 .....

observation .....

[3]

[0620/42/O/N/19/Q3-C]

Q63.

(c) When aqueous ammonia is added to aqueous iron(II) sulfate a green precipitate is seen. This green precipitate turns red-brown at the surface.

(i) Name the green precipitate.

..... [1]

(ii) Suggest why the green precipitate turns red-brown at the surface.

.....

..... [2]

(iii) State what happens when an excess of aqueous ammonia is added to the green precipitate.

..... [1]

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[0620/41/O/N/19/Q4]

Q64.

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]

[0620/43/O/N/19/Q4-E-F-G]

Q65.

(e) Phosphine, PH_3, is produced by the reaction between water and calcium phosphide, Ca_3P_2.

Balance the chemical equation for this reaction.

$$Ca_3P_2 + ...H_2O \rightarrow .....Ca(OH)_2 + ...PH_3$$ [2]

(f) The phosphonium ion, PH_4^+, is similar to the ammonium ion.

(i) State the formula of the ammonium ion. ..... [1]

(ii) Suggest the formula of phosphonium iodide. ..... [1]

(g) Calcium phosphate contains the phosphate ion, PO_4^{3-}.

What is the formula of calcium phosphate?

..... [1]

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[0620/43/O/N/19/Q6]

Q66.

This question is about sulfuric acid and substances that can be made from sulfuric acid.

(a) Sulfuric acid is a strong acid.

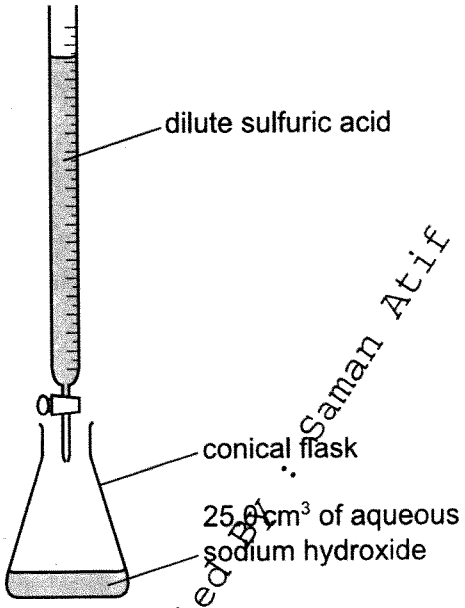
What is meant by the term *strong acid*?

strong .....

acid .....

[2]

(b) Dilute sulfuric acid and aqueous sodium hydroxide are used to make aqueous sodium sulfate, $Na_2SO_4(aq)$, or aqueous sodium hydrogen sulfate, $NaHSO_4(aq)$. The method includes use of the following apparatus.



$25.0\,cm^3$ of aqueous sodium hydroxide of concentration $0.100\,mol/dm^3$ was neutralised by $25.0\,cm^3$ of dilute sulfuric acid of concentration $0.0500\,mol/dm^3$. The equation for the reaction is shown. This is **reaction 1**.

$$2NaOH(aq) + H_2SO_4(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(l) \qquad \textbf{reaction 1}$$

The same technique and the same solutions can be used to make aqueous sodium hydrogen sulfate. The equation for the reaction is shown. This is **reaction 2**.

$$NaOH(aq) + H_2SO_4(aq) \rightarrow NaHSO_4(aq) + H_2O(l) \qquad \textbf{reaction 2}$$

Complete the table to calculate the volume of dilute sulfuric acid that reacts with $25.0\,cm^3$ of aqueous sodium hydroxide in **reaction 2**.

	volume of $0.0500\,mol/dm^3$ dilute sulfuric acid in cm^3	volume of $0.100\,mol/dm^3$ aqueous sodium hydroxide in cm^3
reaction 1	25.0	25.0
reaction 2		25.0

[1]

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(c) Aqueous sodium hydrogen sulfate, $NaHSO_4(aq)$, contains the ions $Na^+(aq)$, $H^+(aq)$ and $SO_4^{2-}(aq)$.

Describe what you would **see** if the following experiments were done.

(i) A flame test was done on aqueous sodium hydrogen sulfate.

..... [1]

(ii) Solid copper(II) oxide was added to aqueous sodium hydrogen sulfate and the mixture was warmed.

.....

..... [2]

(d) A test can be done to show the presence of $SO_4^{2-}(aq)$ by adding acidified aqueous barium chloride **or** acidified aqueous barium nitrate.

(i) State the observation that would show that SO_4^{2-} is present.

..... [1]

(ii) Write an ionic equation for the reaction that occurs if SO_4^{2-} is present. Include state symbols.

..... [2]

[Total: 9]

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[0620/42/M/J/20/Q3-D-E-F-G]

Q67.

(d) When copper is reacted with hot concentrated sulfuric acid, sulfur dioxide gas is formed.

Balance the chemical equation for this reaction.

$$Cu + ...H_2SO_4 \rightarrow CuSO_4 + SO_2 + ...H_2O$$ [1]

(e) Sulfur dioxide is a reducing agent.

Give the colour change that occurs when excess sulfur dioxide is bubbled into acidified aqueous potassium manganate(VII).

starting colour of the solution .....

final colour of the solution .....
[1]

(f) When sulfuric acid reacts with ammonia the salt produced is ammonium sulfate.

Write the chemical equation for this reaction.

..... [2]

(g) Barium sulfate is an insoluble salt.

Barium sulfate can be made from aqueous ammonium sulfate using a precipitation reaction.

(i) Name a solution that can be added to aqueous ammonium sulfate to produce a precipitate of barium sulfate.

..... [1]

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

..... [2]

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Q68. [0620/43/M/J/20/Q6]

(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]

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Page 4	Mark Scheme: Teachers' version	Syllabus	Paper
	IGCSE – May/June 2011	0620	31

Q1.

(a) (i) $2Li + 2HI \rightarrow 2LiI + H_2$ [1]

(ii) zinc carbonate + hydriodic acid → zinc iodide + carbon dioxide + water [1]

(iii) $MgO + 2HI \rightarrow MgI_2 + H_2O$ [1]

(b) reaction 1 is redox / Li/2HI reaction [1]
cond reason either oxidation number/state / electron transfer [1]

(c) with hydriodic acid – iodine formed / goes dark brown / grey/black solid [1]

not purple vapour **not** purple/black solution

with hydrobromic acid – bromine formed / goes orange / yellow / brown / reddish brown / red / brown vapour [1]

note can accept brown for iodine provided bromine is different orange/brown etc.

(d) (i) the reaction is exothermic / reaction produces heat/energy [1]
all the sodium hydroxide used up/neutralised / reaction has stopped [1]

(ii) adding colder acid / no more heat produced [1]
if not given in **(d)(i)** any comments such as "reaction has stopped" can gain mark

(iii) 1.33 / 1.3 / 1.3333 (mol/dm^3) scores both marks [2]
not 1.34
for a correct method – $M_1 V_1$ / moles of NaOH = 0.02
with an incorrect answer **only** [1]

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Q2. (i) Rb / Sr [1]

(ii) I [1]

(iii) Fe [1]

(iv) P [1]

(v) Si [1]

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Q3.

(b) (i) $PCl_3 + 3H_2O \rightarrow 3HCl + H_3PO_3$ [1]

(ii) acid solutions same concentration [1]
measure pH/pH paper/Universal indicator [1]
hydrochloric acid lower pH [1]

colours of Universal indicator can be given as red<orange<yellow
ignore precise pH values as long as HCl is lower than H_3PO_3

OR Acid solutions same concentration [1]
add magnesium or any named metal above Hydrogen in reactivity series but not above magnesium
calcium carbonate or any insoluble carbonate [1]
hydrochloric acid react faster/shorter time [1]

OR acid solutions same concentration [1]
measure electrical conductivity [1]
hydrochloric acid better conductor/bulb brighter [1]

OR acid solutions same concentration [1]
add sodium thiosulphate [1]
hydrochloric acid forms precipitate faster/less time [1]

(iii) sodium hydroxide/sodium carbonate [1]
titration **cond** on correct reagent [1]
second mark scores for mention of titration /burette/pipette/indicator.
experimental detail not required

any named soluble calcium salt e.g. calcium chloride/nitrate/hydroxide [1]

precipitation/filter/decant/centrifuge [1]

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Q4.

(a) (i) lithium oxide / strontium oxide [1]

(ii) sulfur dioxide / nitrogen dioxide [1]

(iii) aluminium oxide [1]

(iv) carbon monoxide [1]
accept: correct formulae

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Q5.

(a) (i) any Group 1 metal [1]
accept: LiOH

(ii) $Cu(OH)_2 \rightarrow CuO + H_2O$ [2]
note: products only = 1

(iii) reactivity of metals / metals have different reactivities [1]

(b) (i) zinc oxide, nitrogen dioxide, oxygen [2]
note: two correct = 1

(ii) $2KNO_3 \rightarrow 2KNO_2 + O_2$ [2]
note: unbalanced = 1, correct word equation = 1

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Q6.

(a) (i) heat / roast in air / oxygen [1]
accept: burn in air / oxygen

(ii) (reduce) with carbon / carbon monoxide [1]

(b) test it with both hydrochloric acid and sodium hydroxide(aq) [1]
accept: any named strong acid and any strong alkali
if only acid and alkali given then max = 3
basic oxide reacts with acid [1]
acidic oxide reacts with alkali/base [1]
amphoteric reacts with both [1]
accept: for react – form salt and water

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Q7.

(b) (i) potassium carbonate is soluble / both salts soluble [1]

(ii) use potassium carbonate solution [1]
accept: implication of solution – in pipette / burette / 25 cm^3
titrate / titration term required [1]
use an indicator **accept:** any named acid/base indicator [1]
repeat without indicator / use carbon to remove indicator [1]

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Q8.

(a) sodium hydroxide solution [1]
warm [1]
(only) ammonium phosphate gives off ammonia / gas (which will turn red litmus paper blue) [1]
or:
sodium hydroxide solution [1]
dissolve fertiliser in water [1]
Ca^{2+} gives (white) ppt [1]
or:
flame test [1]
Ca^{2+} brick red / orange / orange-red [1]
NH_4^+ no colour [1]

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Q9.

(a) nitric acid; [1]
sodium hydroxide / carbonate / hydrogen carbonate; [1]

copper(II) oxide / hydroxide / carbonate; [1]

any named soluble chloride; [1]
accept: *hydrochloric acid / hydrogen chloride*
silver(I) nitrate / ethanoate / sulfate; [1]
must be soluble silver salt **not** *silver oxide / carbonate*

zinc(II) sulfate [1]

(b) **(i)** $Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$ [2]
equation correct state symbols missing [1]

(ii) $ZnCO_3 + H_2SO_4 \rightarrow ZnSO_4 + CO_2 + H_2O$ [2]
correct formula for zinc sulfate = 1

[Total: 10]

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Q10.

(a) proton donor; [1]

(b) equal concentrations of both (solutions); [1]
add Universal indicator / determine pH / pH paper; [1]
ethylamine has lower pH / ORA; [1]
or
equal concentration of both (solutions); [1]
measure conductivity of aqueous ethylamine and sodium hydroxide; [1]
ethylamine will have lower conductivity / sodium hydroxide will have higher conductivity; [1]

(c) add strong(er) base / NaOH / KOH; [1]
warm / heat; [1]

(d) (ethylamine forms) hydroxide ions / OH^- (in water); [1]
hydroxide ions / OH^- reacts with iron(III) ions / Fe^{3+};
or
iron(III) hydroxide / $Fe(OH)_3$ (forms as a brown precipitate); [1]
note: balanced or unbalanced ionic equation, ie. $Fe^{3+} + (3)OH^- \rightarrow Fe(OH)_3$ scores both marks

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Q11.

(a) giant covalent; [1]
or: polymer made from monomers;

(b) **(i)** any three from:
high mp / bp;
hard;
brittle;
insoluble (in water);
poor conductor of electricity / heat; [3]

(ii) carbon / diamond / silicon / boron; [1]
not: graphite

(c) **(i)** sodium hydroxide / any named alkali / reactive metal; [1]

(ii) named acid; [1]
zirconium oxide; [1]

[Total: 8]

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Q12.

(a) Ca / calcium; [1]

(b) Kr / krypton; [1]

(c) Ge / germanium; [1]

(d) Ni / nickel **or** Cr / chromium; [1]

(e) Br / bromine / Br_2; [1]

(f) Se / selenium; [1]

(g) Cu / copper; [1]

(h) Br / bromine / Br_2; [1]

[Total: 8]

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Q13.

(ii) add metal / carbonate / insoluble base / strong alkali **allow:** ammonia with an indicator / use pH meter;
COND: on reagent [1]

metal - hydrogen given off / metal dissolves / effervescence / gas given off / burning splint pops;

carbonate - carbon dioxide given off / effervescence / gas given off / limewater milky;

insoluble base - solution formed / dissolves;

alkali - use of indicator to show neutralisation / temperature increase;

pH meter - gives pH less than 7 [1]

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Q14.

(e) it would react with/dissolves in a named strong acid [1]
it would react with/dissolves in a named alkali [1]
it shows both basic and acid properties =1 [1]
it reacts with both acids and bases/alkalis =1 [1]
[max 2]

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Q15.

(b) experiment 1 $Ca^{2+} + CO_2 + H_2O$ [1]

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Q16.

(a) (i) proton or H^+ acceptor [1]

(ii) (measure) pH or (use) UI indicator [1]
note: can be implied need not be explicit
sodium hydroxide has higher pH / ammonia(aq) has lower pH [1]
(this sentence would score 2 marks)
or
appropriate colours with UI / appropriate numerical values [1]
ammonia is closer to green, blue-green, turquoise or lighter blue
sodium hydroxide is darker blue / purple / violet [1]
or
measure electrical conductivity [1]
can be implied need not be explicit
ammonia (aq) is the poorer conductor/ sodium hydroxide is the better conductor [1]

(e) (i) pH increases [1]

(ii) oxygen needed for rusting / removes oxygen / reacts with oxygen [1]

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Q17.

(a) (i) add carbon / animal charcoal [1]
filter [1]

OR

repeat experiment without indicator [1]
using same quantity / volume of acid [1]

(ii) add magnesium metal / carbonate / oxide / hydroxide
to (hot) (hydrochloric) acid [1]

cond: until in excess **or** no more dissolves **or** reacts [1]

cond: filter (to remove unreacted solid) [1]

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Q18.

(a) (i) any ambiguous formula, e.g. GeH_3-GeH_2-GeH_3 [1]

(ii) Ge_nH_{2n+2} [1]
NOT C instead of Ge

(b) correct formula [1]
COND 4bps around germanium atom
COND 3nbps and 1bp around each chlorine atom [1]

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Q19.

(b) (i) malonic is a weaker acid/less dissociated
OR sulfuric acid is a stronger acid/more dissociated
NOT sulfuric acid is a strong acid [1]

(ii) add piece of suitable metal, e.g. Mg **ALLOW** Al, Ca **NOT** K, Na, Cu [1]

sulfuric acid reacts faster **OR** malonic reacts slower [1]

OR
as above add a piece of $CaCO_3$, if soluble carbonate then [1] only

OR measure electrical conductivity [1]
sulfuric acid is the better conductor
OR malonic acid poorer conductor [1]
NOT sulfuric acid is a good conductor

(c) (i) sodium malonate **and** water [1]

(ii) $CuSO_4$
H_2O [2]

(iii) $CH_2(COO)_2Mg$
H_2 [2]

(iv) K_2SO_4
CO_2 **and** H_2O **NOT** H_2CO_3 [2]

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Q20.

(b) (i) anhydrous cobalt chloride becomes hydrated [1]
ACCEPT: hydrous

(ii) carbon dioxide is acidic [1]
sodium hydroxide and calcium oxide are bases / alkalis [1]

(iii) Any two of:
water, calcium carbonate and sodium carbonate [2]
ACCEPT: sodium bicarbonate

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Q21.

(a) because they have more than one oxidation state or valency / form ions with different charges [1]

there are two iron oxides (iron(III) oxide and iron(II) oxide) / iron forms Fe^{2+} and Fe^{3+} compounds / iron forms iron(II) and iron(III) compounds [1]

(b) (i) to remove the precipitate / remove the silver(I) chromate(VI) / remove the residue [1]

(ii) to remove soluble impurities / remove named soluble salt e.g. potassium nitrate / remove reactants [1]

(iii) to dry solid / to remove water [1]

(c) (i) need one mole of potassium chromate(VI) for two moles of silver(I) nitrate / correct references to mole ratio [1]

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Q22.

(c)

if the oxide is	predicted result with hydrochloric acid	predicted result with aqueous aqueous sodium hydroxide
acidic	NR	R
neutral	NR	NR
basic	R	NR
amphoteric	R	R

(1) per line [4]

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Q23.

(c) (i) → magnesium hexanesulfonate + hydrogen [1]

(ii) → calcium hexanesulfonate + water [1]

(iii) $2C_6H_{13}SO_3H + Na_2CO_3 \rightarrow 2C_6H_{13}SO_3Na + CO_2 + H_2O$

$C_6H_{13}SO_3Na$ = (1) [1]
remaining species correct and equation balanced = (1) [1]

(d) (i) measure pH / add universal indicator [1]
both acids have a low value / pH 0–2 / same colour / red [1]
or
measure rate with named reactive metal, Mg, Zn (1)
both fast reactions (1)
or
measure rate using piece of insoluble carbonate, $CaCO_3$ (1)
both fast reactions (1)
NOTE: must be insoluble for first mark
or
measure electrical conductivity (1)
both good conductors (1)

(ii) to have same concentration of H^+ / one acid is H_2SO_4, the other is $C_6H_{13}SO_3H$ / sulfuric acid is dibasic, hexanesulfonic is monobasic [1]

(iii) a strong acid is completely ionised [1]
a weak acid is partially ionised [1]

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Q24.

(c) (i) zinc + propanoic acid → zinc propanoate (+ hydrogen) (1) [1]

(ii) calcium oxide + propanoic acid → calcium propanoate + water (1) [1]

(iii) $LiOH + CH_3CH_2COOH \rightarrow CH_3CH_2COOLi + H_2O$ (1) [1]

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Q25.

(c) name or formula of strong acid and alkali (1)

reacts with or neutralises both acid and base or alkali (then amphoteric) (1)

it dissolves / soluble in both(acid and alkali) or form solutions in both (1) [3]

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Q26.

(a) repeat without indicator/repeat using same volumes of acid and alkali **or** use carbon/charcoal to remove indicator (1)

evaporate/heat/warm/boil/leave in sun (1)

until most of the water has gone/some water is left/saturation (point)/ crystallisation point (1)

leave/allow to cool/allow to crystallise (1)

filter (off crystals)/wash(with distilled water)/dry crystals with filter paper/dry crystals in warm place/oven/windowsill (1)

[5]

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Q27.

(a) Match the following pH values to the solutions given below.

1 3 7 10 13

The solutions all have the same concentration.

solution	pH
aqueous ammonia, weak base	10
dilute hydrochloric acid, a strong acid	1
aqueous sodium hydroxide, a strong base	13
aqueous sodium chloride, a salt	7
dilute ethanoic acid, a weak acid	3

[5]

(b) Hydrochloric acid strong acid **or** ethanoic acid weak acid [1]
OR: hydrochloric acid completely ionised **or** ethanoic acid partially ionised
hydrochloric acid greater concentration of/more H^+ ions (than ethanoic acid) [1]

(c) Rate of reaction with Ca, Mg, Zn, Fe [1]

Strong (hydrochloric) acid bubbles faster **or** more bubbles **or** dissolves faster [1]

OR: rate of reaction with (metal) carbonate [1]
strong (hydrochloric) acid faster **or** more bubbles **or** dissolves faster (only if carbonate insoluble) [1]

OR: electrical conductivity [1]
strong (hydrochloric) acid better conductor [1]

[Total: 9]

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Q28.

(b) (i) $2Cl^- \rightarrow Cl_2 + 2e^-$ / $2Cl^- - 2e^- \rightarrow Cl_2$ [1]

$2H^+ + 2e^- \rightarrow H_2$ / $2H^+ \rightarrow H_2 - 2e^-$ [1]

hydrogen formed at cathode/– and chlorine at anode/+ [1]

Na^+ and OH^- **or** sodium ions and hydroxide ions left in solution/form/become sodium hydroxide [1]

(ii) $Cl_2 + 2NaOH \rightarrow NaClO/NaOCl + NaCl + H_2O$ [2]
Species (1) Balancing (1)

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Q29.

(a) (changes from) blue (1) to pink (1) [2]

(b) no more (solid) dissolves **or** no more cobalt(II) carbonate dissolves **or** no more effervescence **or** bubbling **or** fizzing [1]

filter(residue)/centrifuge/decant [1]

evaporate/heat/warm/boil/leave in sun **AND** until most of the water has gone/some water is left/until it is concentrated/saturation (point)/crystallisation point/crystals form on glass rod or microscope slide/crystals start to form [1]

Leave/allow to cool/allow to crystallise/filter (off crystals)/wash(with distilled water)/dry crystals with filter paper/dry crystals in warm place **or** dry in oven **or** dry on windowsill [1]

Q30.

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Question	Answer	Marks	Guidance
6(a)(i)	M1 proton acceptor; M2 does not accept (protons) readily **OR** less able to accept protons (than strong bases);	2	**A** alternative words to 'acceptor' e.g. 'receiver' **I** references to pH **A** 'hydrogen ion' or 'H^+' for proton **I** accepts fewer/less protons
6(a)(ii)	M1 same concentration of both bases; M2 measure their pH; M3 the higher pH is the stronger base;	3	**A** suitable method e.g. universal indicator or pH paper or pH meter **I** litmus or methyl orange or phenolphthalein **I** titration methods for M2 and M3 **A** suitable colours of both weak strong bases e.g. ethylamine is (greeny)blue, NaOH is darker blue/purple **A** alternative methods for M2 and M3 e.g. measure conductivity (M2) and higher conductivity is the stronger base (M3) e.g.add aluminium/Al (M2) and stronger base gives faster rate of effervescence/more fizzing/more bubbling (M3)
6(b)(i)	$2CH_3CH_2NH_2 + H_2SO_4 \rightarrow (CH_3CH_2NH_3)_2SO_4$ species; balancing; the salt is ethylammonium sulfate;	3	**A** multiples **I** state symbols **A** one mark for correct product **A** close spellings **A** diethylammonium sulfate
6(b)(ii)	sodium hydroxide / calcium hydroxide / NaOH / $Ca(OH)_2$;	1	**A** any Group 1 or Group 2 hydroxide or oxide

Q31.

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Question	Answer	Marks	Guidance
5(a)	method A; hydrochloric acid/HCl/hydrogen chloride solution; nickel carbonate + hydrochloric acid → nickel chloride + water + carbon dioxide;	3	hydrochloric acid/HCl can only score if written in the reagent space i.e. **R** hydrochloric acid/HCl in equation if reagent space is blank **I** hydrogen chloride (therefore 'hydrogen chloride + HCl' would get mark 2 BOD) **I** nickel carbonate **A** fully correct balanced chemical equation i.e. $NiCO_3 + 2HCl \rightarrow NiCl_2 + CO_2 + H_2O$ for the third mark **R** combination of words and formulae in the same equation for the third mark **I** concentration of acid for marks 2 and 3
5(b)	method C; any (aqueous/dilute/solution of soluble) bromide including potassium bromide/KBr, hydrogen bromide/HBr i.e. all bromides except silver, lead and mercury; $Pb^{2+} + 2Br^- \rightarrow PbBr_2$;	3	**A correct** formula of soluble bromide **I** lead nitrate **I** state symbols **A** multiples
5(c)	method B; sulfuric acid/hydrogen sulfate/H_2SO_4 ; $2LiOH + H_2SO_4 \rightarrow Li_2SO_4 + 2H_2O$ species; balancing;	4	**I** concentration of acid for mark 2 **I** indicators/lithium hydroxide **I** state symbols **A** multiples

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Q32.

Question	Answer	Marks
2(b)(i)	(a substance which is) a proton/H^+/hydrogen ion acceptor;	1
2(b)(ii)	$Mg(s) + 2H_2O(l) \rightarrow Mg(OH)_2(aq) + H_2(g)$ $Mg(OH)_2$; rest of equation;	2
2(c)	**M1** add a *named* acid, e.g. HC*l* **and** a named alkali, e.g. NaOH; **M2** Al_2O_3 will react with/neutralises both reagents; **M3** and so it will dissolve into the reagent/form a solution;	3 1 1 1
2(d)(i)	covalent;	1
2(d)(ii)	any 2 from: high melting point/high boiling point; poor conductor (of electricity); hard; insoluble;	2

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Q33.

Question	Answer	Marks
5(a)	(sulfur-containing) fossil fuels;	1
5(b)	**M1** vanadium pentoxide/vanadium(V) oxide/V_2O_5 (catalyst); **M2** 1–5 atmospheres (units required); **M3** 450 °C (units required); **M4** $2SO_2 + O_2 \rightarrow 2SO_3$; **M5** equilibrium/reversible reaction;	5 1 1 1 1 1
5(c)	$H_2S_2O_7$;	1
5(d)(i)	3 correct (2 marks) 2 correct (1 mark) bubbles/effervescence/fizzing; dissolves/disappears/*forms* a solution; blue (solution);	2
5(d)(ii)	carbon dioxide and water and copper(II) sulfate;	1
5(e)(i)	carbon;	1
5(e)(ii)	dehydration;	1

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Q34.

Question	Answer	Marks
6(a)(i)	roast/heat **and** in air/oxygen;	1
6(a)(ii)	$2ZnS + 3O_2 \rightarrow 2ZnO + 2SO_2$; SO_2 on right of equation; all formulae and balancing correct;	2
6(d)(i)	green precipitate; red-brown/brown/orange precipitate;	2 1 1

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Q35.

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Question	Answer	Marks
4(b)(i)	**M1** dissolve solids (in water) and mix/combine/add; **M2** filter; **M3** wash the residue (with water); **M4** leave to dry/place in oven/dry between filter papers;	4 1 1 1 1
4(b)(ii)	$Pb^{2+} + 2I^- \rightarrow PbI_2$ formulae of ions correct; rest correct;	2

Q36.

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Question	Answer	Marks
6(b)(i)	test: add sodium hydroxide (solution and warm); result: test gas/ammonia with (red) litmus/Universal Indicator/pH paper; indicator turns blue/ammonia produced;	3 1 2
6(b)(ii)	test: add silver nitrate (solution); result: add (dilute) nitric acid; white precipitate;	3 1 2

Q37.

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Question	Answer	Mark
4(a)	*copper(II) carbonate* fizzes/bubbles/effervescence dissolves/disappears *copper(II) oxide* dissolves/disappears blue (solution formed)	2 2
4(b)(i)	$Cu(NO_3)_2$ $\underline{3}Cu$ **AND** $\underline{3}Cu(NO_3)_2$	2
4(b)(ii)	hydrogen (gas) is not produced (when copper reacts with nitric acid)	1

Q38.

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Question	Answer	Mark
5(e)(ii)	(turns) red/pink/orange/yellow iodine is a non-metal	2

Q39.

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Question	Answer	Marks
2(d)(i)	Be^{2+}	1
2(d)(ii)	$Be(OH)_2 + 2HCl \rightarrow BeCl_2 + 2H_2O$ formula of $BeCl_2$ all formulae correct and balancing correct	2
2(d)(iii)	$2NaOH + Be(OH)_2 \rightarrow Na_2BeO_2 + 2H_2O$ formula of Na_2BeO_2 all formulae correct and balancing correct	2

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Q40.

Question	Answer	Marks
5(f)(i)	exists completely as ions (in solution) / completely dissociates (in solution) / completely ionises (in solution)	1
5(f)(ii)	Universal Indicator / pH paper / pH indicator / pH meter Universal Indicator or pH paper or pH indicator turns red / pH 0–1	1 1
5(f)(iii)	$Na_2CO_3 + 2C_6H_5SO_3H \rightarrow 2C_6H_5SO_3Na + CO_2 + H_2O$ formula of $C_6H_5SO_3Na$ all formulae correct and balancing correct	2

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Q41.

Question	Answer	Marks
2(a)(i)	SO_2	1
2(a)(ii)	Na_2O	1
2(a)(iii)	Cr_2O_3	1
2(a)(iv)	SiO_2	1
2(a)(v)	Al_2O_3 / Cr_2O_3	1
2(a)(vi)	CO	1
2(b)(i)	an amphoteric oxide will react with acids **AND** with bases	1
2(b)(ii)	a neutral oxide will **not** react with acids **or** with bases	1

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Q42.

Question	Answer	Marks
3(a)(i)	no (more) effervescence	1
3(a)(ii)	magnesium carbonate	1
3(a)(iii)	(a solution in which) no more solute will dissolve	1
	at that temperature	1
3(a)(iv)	the solubility deceases as the temperature decreases	1
3(c)	mix and stir the two solutions	1
	filter (to obtain residue)	1
	wash (the residue) using water	1
	dry the residue between filter papers / in a warm place	1
3(d)	$Pb^{2+}(aq) + SO_4^{2-}(aq) \rightarrow PbSO_4(s)$ **M1** correct species **M2** correct state symbols	2

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Q43.

Question	Answer	Marks
2(e)(i)	carbon dioxide: (simple) molecular / simple covalent	1
	silicon(IV) dioxide: macromolecular / giant molecular / giant covalent / giant atomic	1
2(e)(ii)	carbon dioxide: **weak (force of) attraction** between molecules / **weak** intermolecular forces / **weak** van der Waals' forces / **weak** dispersion forces / **weak** London forces	1
	silicon(IV) dioxide: covalent bonds are **strong** / force of attraction between atoms is **strong** / no weak bonds (are present) / **all** bonds are **strong**	1
	(weak) **forces of attraction** in carbon dioxide need small amounts of **energy** or heat to break / **less energy** or heat needed to break **forces of attraction** in carbon dioxide **OR** (strong) **bonds** in silicon(IV) dioxide need large amounts of **energy** or heat to break / **more energy** or heat needed to break **bonds** in silicon(IV) dioxide	1
2(f)	$2NaOH + SiO_2 \rightarrow Na_2SiO_3 + H_2O$ **IF** full credit is not awarded, allow 1 mark for Na_2SiO_3 **OR** $2OH^- + SiO_2 \rightarrow SiO_3^{2-} + H_2O$ **M1** species correct **M2** balancing	2

Q44.

Question	Answer	Marks
3(d)	add copper(II) carbonate (to acid) until it stops dissolving or no more effervescence / bubbling / fizzing	1
	filter (to remove copper(II) carbonate)	1
	evaporate / heat / warm / boil / leave in sun **AND** until most of the water has gone / some water is left / evaporate **some** of the water / until it is concentrated / saturation (point) / crystallisation point / crystals form on glass rod or microscope slide / crystals **start** to form	1
	(for any solution) leave / allow to cool / allow to crystallise **OR** (for any crystals) filter / wash / dry with filter paper / dry in warm place / dry in a **(low)** oven / leave to dry	1
	formula of $Cu(NO_3)_2$	1
	equation: $CuCO_3 + 2HNO_3 \rightarrow Cu(NO_3)_2 + CO_2 + H_2O$	1

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Q45.

Question	Answer	Marks
4(d)(i)	partially ionised / dissociated	1
4(d)(ii)	**M1** (acids) have same concentration	1
	M2: measure pH **OR** describe how to measure pH (such as use Universal Indicator) **M3**: lower pH corresponds to the stronger acid / hydrochloric acid **OR** **M2**: add calcium / magnesium / zinc / iron **M3**: faster rate of forming bubbles corresponds to the stronger acid / hydrochloric acid **OR** **M2**: rate of reaction with (metal) carbonate **M3**: faster rate of forming bubbles corresponds to the stronger acid / hydrochloric acid **OR** **M2**: rate of reaction with (named) metal oxide **M3**: dissolves faster means that reaction is with the stronger acid / hydrochloric acid **OR** **M2**: electrical conductivity **M3**: greater conductivity corresponds to the stronger acid / hydrochloric acid **OR** **M2**: add sodium hydroxide (or other named alkali) **M3**: greater temperature change corresponds to the stronger acid / hydrochloric acid	2

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Q46.

Question	Answer	Marks
5(b)(i)	(*copper(II) ions*) add sodium hydroxide (solution)	1
	(*copper(II) ions*) blue ppt.	1
	(*nitrate ions*) add aluminium **AND** aqueous sodium hydroxide **AND** warm	1
	ammonia given off / gas turns damp (red) litmus blue	1
5(b)(ii)	2 / 2 / 4 / 1	1

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Q47.

Question	Answer	Marks
3(e)		4

	observation with aqueous iron(II) sulfate	observation with aqueous iron(III) sulfate
aqueous sodium hydroxide		**M3** brown precipitate
aqueous potassium iodide	**M1** no change	**M4** brown solution / black solid
aqueous acidified potassium manganate(VII)	**M2** (pink / purple to) colourless / decolourised	

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Q48.

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

0620/43 Cambridge IGCSE – Mark Scheme PUBLISHED May/June 2018

Q49.

Question	Answer	Marks
4(f)(i)	partially dissociated / partially ionised	1
4(f)(ii)	add excess copper(II) carbonate to ethanoic acid	1
	filter	1
	heat to point of crystallisation **AND** leave (to cool)	1
4(f)(iii)	ethanoic acid + copper carbonate → copper ethanoate + carbon dioxide + water	1

Q50.

[0620/43/M/J/2018/Q6-C]

6(c)(i)	red	1
6(c)(ii)	proton donor	1
6(c)(iii)	→ $ClO_3^- + H_3O^+$	1

Q51.

[0620/41/O/N/2018/Q3-D]

3(d)(i)	$Cu(OH)_2$	1
3(d)(ii)	Any three from: **1** zinc more reactive than copper **2** displacement / redox reaction **OR** zinc displaces copper **OR** zinc reacts with copper **ions** **3** copper is solid / copper is brown **4** zinc nitrate is colourless (solution) **OR** blue colour disappears because Cu^{2+} ions removed (from solution)	max 3
3(d)(iii)	**M1** sodium hydroxide / NaOH **M2** aluminium / Al	2

[0620/41/O/N/2018/Q4-A]

Q52.

4(a)(i)	from petroleum or (crude) oil or fossil fuels	1
4(a)(ii)	Contact (process)	1
4(a)(iii)	**M1** vanadium pentoxide **or** vanadium(V) oxide **or** V_2O_5 (catalyst);	1
	M2 1–5 atmospheres; (Units required)	1
	M3 450°C; units required	1
	M4 $2SO_2 + O_2 \rightarrow 2SO_3$;	1
	M5 equilibrium / reversible reaction in equation or text	1

[0620/42/O/N/2018/Q2-E]

Q53.

2(e)	$Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$ M1 Species M2 States	2

[0620/42/O/N/2018/Q3-B-C]

Q54.

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

Q55.

[0620/43/O/N/2018/Q4-B-C-D]

4(b)	**SUMMARY** **M1** repeat **M2** heat (liquid or solution should be implied) **M3** when to stop heating **M4** what to do after heating **M5** method of drying crystals (crystals or solid should be implied) **M1** repeat without indicator using same volumes **M2** evaporate / heat / warm / boil / leave in sun **M3** until most of the water is gone / some water left / saturation(point) / crystallisation point / evaporate **some** of the water **M4** leave / (allow to) cool / allow to crystallise **M5** details of drying	5
4(c)(i)	**M1** bubbles / effervescence / fizzing **M2** solid or magnesium dissolves / solid or magnesium disappears	2
4(c)(ii)	lilac flame	1
4(c)(iii)	white precipitate	1
4(d)(i)	$Mg(OH)_2 + H_2SO_4 \rightarrow MgSO_4 + 2H_2O$ **M1** formula of **both** $Mg(OH)_2$ and $MgSO_4$ **M2** equation fully correct	2
4(d)(ii)	$Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$ **M1** formula of $ZnSO_4$ **M2** equation fully correct	2
4(d)(iii)	$Na_2CO_3 + H_2SO_4 \rightarrow Na_2SO_4 + CO_2 + H_2O$ **M1** formulae of **both** Na_2CO_3 and Na_2SO_4 **M2** equation fully correct	2

Q56.

[0620/41/M/J/2019/Q4-D-E]

4(d)(i)	to remove the acid / make sure all the acid is used up / no acid is left over	1
4(d)(ii)	to make sure all the filtrate / $MgCl_2$ / salt goes through / no $MgCl_2$ left behind	1
4(d)(iii)	evaporation mark (1) the starting of crystallisation mark (1) drying the crystals mark (1)	3
4(e)(i)	a solid (1) which forms when two solutions are mixed / reacted / added (1)	2
4(e)(ii)	(silver) nitrate (1) $BaCl_2 + 2AgNO_3 \rightarrow 2AgCl + Ba(NO_3)_2$ formulae (1) balance(1)	3

[0620/42/M/J/2019/Q3-B-C-D-E]

Q57.

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

[0620/42/M/J/2019/Q5-B-C-D-E-F-G]

Q58.

5(b)	some copper(II) sulfate remains in solution / some copper(II) sulfate does not form crystals **OR** some of the crystals decomposed **OR** some crystals lost in transfer	1
5(c)	**M1 no more** bubbling / fizzing / effervescence (1) **M2 solid** or **powder** stops dissolving (1)	2
5(d)	**M1** (lumps have) smaller surface area **OR powder** has larger surface area (1) **M2** (lumps have) fewer collisions per unit time / less collision frequency **OR powder** has more collisions per unit time / more collision frequency	2
5(e)	copper(II) oxide **or** copper(II) hydroxide	1
5(f)	filtration	1
5(g)(i)	**M1** containing the maximum amount of **dissolved** solute / no more solute can **dissolve** (1) **M2** at any given temperature (1)	2
5(g)(ii)	when crystals form on a glass rod withdrawn from solution / on a sample of solution placed on microscope slide etc.	1
5(g)(iii)	(heating to dryness) would remove water **of crystallisation**	1

[0620/41/O/N/2019/Q1-A]

Q59.

1(a)(i)	K^+	1
1(a)(ii)	Cr^{3+}	1
1(a)(iii)	Ca^{2+}	1
1(a)(iv)	Br^-	1
1(a)(v)	SO_4^{2-}	1

[0620/43/M/J/2019/Q3-C-D]

Q60.

3(c)	**M1** (sodium oxide) basic **M2** (silicon dioxide) acidic	2
3(d)(i)	N_3^-	1
3(d)(ii)	**M1** state symbols on right correct (s) then (aq) **M2** $(Pb(NO_3)_2 +)\ 2\ (NaN_3) \rightarrow (Pb(N_3)_2 +)\ 2NaNO_3$	2
3(d)(iii)	**M1** filter **M2** wash with water	2

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[0620/41/O/N/2019/Q2-C-D]

Q61.

2(c)(i)	l.....g.....g.	1
2(c)(ii)	vanadium (V) oxide **or** vanadium pentoxide (1) 450 (°C) (1)	2
2(c)(iii)	$SO_3 + H_2SO_4 \rightarrow H_2S_2O_7$ (1) $H_2S_2O_7 + H_2O \rightarrow 2\,H_2SO_4$ (1)	2
2(d)(i)	(it causes) acid rain	1
2(d)(ii)	test – (aqueous) potassium manganate (VII) (1) (purple to) colourless (1)	2

[0620/41/O/N/2019/Q3-D]

Q62.

3(d)	(add a) named acid (1) (add a) named alkali (1) disappears / dissolves in both (1)	3

[0620/42/O/N/2019/Q3-C]

Q63.

3(c)(i)	iron(II) hydroxide	1
3(c)(ii)	any **two** from: - it (iron(II) hydroxide) is oxidised - to form iron(III) (hydroxide) / (oxide) - by (iron(II) hydroxide reacting with) air / oxygen	2
3(c)(iii)	(green ppt) Remains	1

[0620/41/O/N/2019/Q4]

Q64.

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

[0620/43/O/N/2019/Q4-E-F-G]

Q65.

4(e)	any two numbers correct (1) equation fully balanced (1) $Ca_3P_2 + 6H_2O \rightarrow 3Ca(OH)_2 + 2PH_3$	2
4(f)(i)	NH_4^+	1
4(f)(ii)	PH_4I	1
4(g)	$Ca_3(PO_4)_2$	1

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[0620/43/O/N/2019/Q6]

Q66.

6(a)	strong = exists entirely as ions in solution / fully dissociated 100% dissociated in solution (1) acid = proton donor (1)	2
6(b)	50.0 (cm^3)	1
6(c)(i)	yellow flame	1
6(c)(ii)	solid dissolves / disappears (1) blue solution (1)	2
6(d)(i)	white precipitate	1
6(d)(ii)	$Ba^{2+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s)$ correct ionic equation (1) state symbols (1)	2

[0620/42/M/J/2020/Q3-D-E-F-G]

Q67.

3(d)	$Cu + 2H_2SO_4 \rightarrow CuSO_4 + SO_2 + 2H_2O$	1
3(e)	purple to colourless	1
3(f)	$2NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$	2
3(g)(i)	barium nitrate / barium chloride	1
3(g)(ii)	$Ba^{2+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s)$ formulae (1) state symbols (1)	2

[0620/43/M/J/2020/Q6]

Q68.

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 damped litmus blue	3

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[0620/31/M/J/12/Q3-A-B]

Q1. The Group I metals show trends in both their physical and chemical properties.

(a) (i) How do their melting points vary down the Group?

..... [1]

(ii) Which element in the Group has the highest density?

..... [1]

(iii) All Group I metals react with cold water. Complete the following equation.

.....Rb + ...H_2O → ..... + ...

[2]

(b) Lithium reacts with nitrogen to form the ionic compound, lithium nitride.

(i) State the formula of the lithium ion. ..... [1]

(ii) Deduce the formula of the nitride ion. ..... [1]

(iii) In all solid ionic compounds, the ions are held together in a lattice.
Explain the term *lattice*.

.....

..... [1]

[0620/31/M/J/12/Q4-A]

Q2. Vanadium is a transition element. It has more than one oxidation state.
The element and its compounds are often used as catalysts.

(a) Complete the electron distribution of vanadium by inserting one number.

2 + 8 + ... + 2

[1]

(b) Predict **three** physical properties of vanadium which are typical of transition elements.

1. .....

2. .....

3. ..... [2]

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[0620/32/O/N/12/Q1-A]

Q3. This question is concerned with the elements in Period 5, Rb to Xe.

(a) The electron distributions of some of these elements are given in the following list.

element **A** 2 + 8 + 18 + 8 + 2
element **B** 2 + 8 + 18 + 18 + 8
element **C** 2 + 8 + 18 + 18 + 5
element **D** 2 + 8 + 18 + 18 + 6
element **E** 2 + 8 + 18 + 18 + 4
element **F** 2 + 8 + 18 + 18 + 7

(i) Identify element **C**. ..... [1]

(ii) Which element in the list does not form any compounds?

..... [1]

(iii) Which element in the list forms a chloride of the type XCl_2?

..... [1]

(iv) Which **two** elements would react together to form a compound of the type XY_4?

..... [1]

(v) Which element in the list would react with cold water to form an alkaline solution and hydrogen?

..... [1]

[0620/33/O/N/12/Q2]

Q4. (a) State a use for each of the following gases.

(i) chlorine ..... [1]

(ii) argon ..... [1]

(iii) ethene ..... [1]

(iv) oxygen ..... [1]

(b) Describe how oxygen is obtained from air.

.....

..... [2]

[Total: 6]

[0620/33/O/N/12/Q4-Biii]

Q5. (iii) This impure solution of zinc sulfate contains zinc ions, silver(I) ions and lead ions.
Explain why the addition of zinc powder produces pure zinc sulfate solution.
Include at least one ionic equation in your explanation.

.....

.....

.....

.....

..... [4]

[0620/31/M/J/13/Q2-A-B-C-D]

Q6. An element, **M**, has the electron distribution 2 + 8 + 18 + 3.

(a) Which group in the Periodic Table is element **M** likely to be in?

..... [1]

(b) Predict whether element **M** is a poor or a good conductor of electricity.
Give a reason for your answer.

..... [1]

(c) Binary compounds contain two atoms per molecule, for example HCl.
Identify an element which could form a binary compound with element **M**.

..... [1]

(d) Predict the formula of the sulfate of **M**. The formula of the sulfate ion is SO_4^{2-}.

..... [1]

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Q7. [0620/31/O/N/13/Q2]

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

1. .....

2. .....

3. ..... [3]

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

potassium
zinc
copper

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

potassium .....

.....

zinc .....

.....

copper .....

..... [5]

[Total: 8]

Q8. [0620/31/O/N/13/Q6-A]

Lead is an excellent roofing material. It is malleable and resistant to corrosion. Lead rapidly becomes coated with basic lead carbonate which protects it from further corrosion.

(a) Lead has a typical metallic structure which is a lattice of lead ions surrounded by a 'sea' of mobile electrons. This structure is held together by attractive forces called a metallic bond.

(i) Explain why there are attractive forces in a metallic structure.

.....

..... [2]

(ii) Explain why a metal, such as lead, is malleable.

.....

..... [2]

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[0620/32/O/N/13/Q2-A-B]

Q9. The halogens are a collection of diatomic non-metals in Group VII.

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

..... [1]

(ii) What do the electron distributions of the halogens have in common?

..... [1]

(iii) How do their electron distributions differ?

..... [1]

(iv) Complete the table.

halogen	solid, liquid or gas at room temperature	colour
chlorine	.....	.....
bromine	.....	.....
iodine	.....	.....

[2]

(b) The halogens react with other non-metals to form covalent compounds.
Draw a diagram which shows the arrangement of the valency electrons in one molecule of the covalent compound arsenic trifluoride.
The electron distribution of an arsenic atom is 2 + 8 + 18 + 5.

Use x to represent an electron from an arsenic atom.
Use o to represent an electron from a fluorine atom.

[3]

[0620/32/M/J/14/Q6-A]

Q10.

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

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

.....

.....

.....

..... [3]

[0620/41/M/J/16/Q4-C]

Q11.

(c) Copper, nickel and silver are transition elements.
Typical physical properties of transition elements are a high density and a high melting point.

Give **three** different properties of transition metals which are not typical of other metals.

.....

.....

..... [3]

[0620/42/M/J/16/Q1]

Q12.

(a) For each of the following, give the name of an element from Period 2 (lithium to neon), which matches the description.
Elements may be used once, more than once or not at all.

(i) an element which is gaseous at room temperature and pressure

..... [1]

(ii) an element which forms an oxide that is a reactant in photosynthesis

..... [1]

(iii) an element that is a product of photosynthesis

..... [1]

(iv) an element that makes up approximately 78% by volume of the air

..... [1]

(v) an element which has atoms with a full outer shell of electrons

..... [1]

(vi) an element which exists as both diamond and graphite

..... [1]

(vii) an element that reacts vigorously with cold water

..... [1]

(viii) a soft metallic element which is stored in oil

..... [1]

(b) Give the formula of a compound that contains

(i) only boron and oxygen, ... [1]

(ii) only lithium and nitrogen. ..... [1]

[Total: 10]

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[0620/42/M/J/17/Q4-A]

Q13.

Nickel, copper and zinc are three consecutive elements in the Periodic Table.

(a) Nickel and copper are transition elements.

State **three** chemical properties of transition elements.

.....

.....

..... [3]

[0620/42/M/J/17/Q5-A]

Q14.

(a) The elements in Group VII are known as the halogens. Some halogens react with aqueous solutions of halides.

(i) Complete the table by adding a ✓ to indicate when a reaction occurs and a ✗ to indicate when no reaction occurs.

	aqueous potassium chloride	aqueous potassium bromide	aqueous potassium iodide
chlorine	✗	✓	
bromine		✗	
iodine			✗

[3]

(ii) Write a chemical equation for the reaction between chlorine and aqueous potassium bromide.

..... [1]

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[0620/43/O/N/17/Q7-A]

Q15.

(a) Carbon and silicon are elements in Group IV of the Periodic Table.
Carbon dioxide from the air moves into green plants and is converted into carbohydrates.

(i) Name the process by which carbon dioxide molecules move through the air into green plants.

..... [1]

(ii) Explain why silicon(IV) oxide **cannot** move through the air in the same way that carbon dioxide can.

..... [1]

(iii) Name the process by which carbon dioxide is converted into glucose, $C_6H_{12}O_6$, in green plants. Give **two** conditions required for this process to occur. Write a chemical equation for the reaction which occurs.

name of process .....

condition 1 .....

condition 2 .....

chemical equation .....

[5]

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[0620/41/M/J/18/Q2]

Q16.

Flerovium, F*l*, atomic number 114, was first made in research laboratories in 1998.

(a) Flerovium was made by bombarding atoms of plutonium, Pu, atomic number 94, with atoms of element **Z**.

- The nucleus of **one** atom of plutonium combined with the nucleus of **one** atom of element **Z**.
- This formed the nucleus of **one** atom of flerovium.

Suggest the identity of element **Z**.

..... [1]

(b) In which period of the Periodic Table is flerovium?

..... [1]

(c) Predict the number of outer shell electrons in an atom of flerovium.

..... [1]

(d) Two isotopes of flerovium are ^{286}Fl and ^{289}Fl. The nuclei of both of these isotopes are unstable and emit energy when they split up.

(i) State the term used to describe isotopes with unstable nuclei.

..... [1]

(ii) Complete the table to show the number of protons, neutrons and electrons in the atoms of the isotopes shown.

isotope	number of protons	number of neutrons	number of electrons
^{286}Fl			
^{289}Fl			

[2]

(e) Only a relatively small number of atoms of flerovium have been made in the laboratory and the properties of flerovium have not yet been investigated.

It has been suggested that flerovium is a typical metal.

(i) Suggest **two** physical properties of flerovium.

1 .....

2 .....

[2]

(ii) Suggest **one** chemical property of flerovium oxide.

..... [1]

[Total: 9]

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Q17. [0620/42/M/J/18/Q2]

This question is about the elements in Period 3 of the Periodic Table.

Na	Mg	Al	Si	P	S	Cl	Ar

For each of the following, identify a Period 3 element which matches the description. Each element may be used once, more than once or not at all.

State which Period 3 element:

(a) forms an oxide with a macromolecular structure

..... [1]

(b) is extracted from the ore bauxite

..... [1]

(c) is soft, metallic and stored in oil

..... [1]

(d) is a green gas at room temperature and pressure

..... [1]

(e) provides an inert atmosphere in lamps

..... [1]

(f) forms **two** different oxides during the Contact process

..... [1]

(g) is non-metallic and an important component of fertilisers.

..... [1]

[Total: 7]

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Q18. [0620/43/M/J/18/Q1]

The following are the symbols and formulae of some elements and compounds.

Ar $Ca(OH)_2$ Cl_2 CO_2 Cu Fe SO_2 V_2O_5

Answer the following questions using only the elements or compounds in the list.
Each element or compound may be used once, more than once or not at all.

State which element or compound is used:

(a) to kill bacteria in drinking water ..... [1]

(b) as a food preservative ..... [1]

(c) as an electrical conductor in cables ..... [1]

(d) as an inert atmosphere in lamps ..... [1]

(e) to neutralise excess acidity in soil ..... [1]

(f) as a catalyst in the Contact process. ..... [1]

[Total: 6]

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Q19. [0620/43/M/J/18/Q3-A-B-C]

Cobalt is a transition element. Potassium is in Group I of the Periodic Table.

(a) State **one** physical property that is similar for cobalt and potassium.

..... [1]

(b) (i) State **one** physical property that is different for cobalt and potassium.

..... [1]

(ii) Describe how the physical property given in **(b)(i)** is different for cobalt compared to potassium.

..... [1]

(c) When a small piece of potassium is added to cold water, the potassium floats and disappears as it reacts.

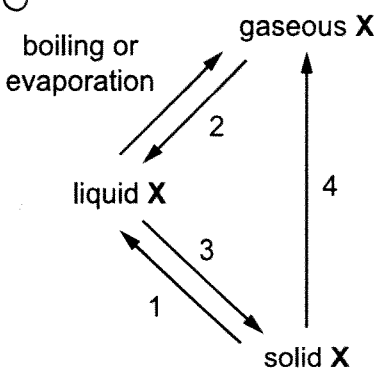
Give **two** other observations that would be made when a small piece of potassium is added to cold water.

1 .....

2 .....
[2]

[0620/42/O/N/18/Q1-C]

Q20. Element **X** can undergo the following physical changes.



(c) Element **X** is a Group I metal. It burns in air to form an oxide X_2O.

Write a chemical equation for this reaction.

..... [2]

Q21. [0620/42/O/N/18/Q2-C]

(c) Calcium reacts with cold water to form two products:

- a colourless gas, **P**, which 'pops' with a lighted splint
- a weakly alkaline solution, **Q**, which turns milky when carbon dioxide is bubbled through it.

(i) Name gas **P**.

..... [1]

(ii) Identify the ion responsible for making solution **Q** alkaline.

..... [1]

(iii) Suggest the pH of solution **Q**.

..... [1]

(iv) Write a chemical equation for the reaction of calcium with cold water.

..... [2]

Q22. [0620/42/O/N/19/Q1-B]

The Periodic Table is very useful to chemists.

Refer only to elements with atomic numbers 1 to 36 in the Periodic Table provided when answering **Question 1**.

(b) State which metal in the first 36 elements:

(i) is the Group I element which reacts most vigorously with water ..... [1]

(ii) reacts with air to form lime. ..... [1]

[0620/43/O/N/18/Q3-F-G]

Q23.

(f) Copper(II) nitrate, $Cu(NO_3)_2$, decomposes when it is heated. The only solid product is copper(II) oxide, CuO. There are two gaseous products. One of the gaseous products is oxygen.

(i) Describe a test for oxygen.

test .....

result .....

[2]

(ii) Name the other gaseous product. Describe its appearance.

name .....

appearance .....

[2]

(iii) Write a chemical equation for the thermal decomposition of copper(II) nitrate.

..... [1]

(g) Iron does not rust when it is completely coated with zinc. When the zinc is scratched, the iron still does not rust.

(i) Explain why the iron does **not** rust when it is completely coated with zinc.

..... [1]

(ii) Explain why the iron still does **not** rust when the zinc is scratched.

.....

.....

.....

.....

.....

..... [3]

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Q24. [0620/41/M/J/19/Q3-A-B-C]

Zinc and copper are elements next to each other in the Periodic Table.

(a) Zinc is obtained from zinc blende in a two-step process.

- In **step 1**, zinc blende is converted into zinc oxide.
- In **step 2**, zinc oxide is converted into zinc in a blast furnace.

Outline how each of these steps are done.

In your answer:
- give **one** chemical equation for each step
- describe how zinc is removed from the blast furnace in **step 2**.

step 1 .....

.....

chemical equation .....

step 2 .....

.....

chemical equation .....

removal of zinc in **step 2** .....

.....

[5]

(b) Name the alloy formed when zinc is mixed with copper.

..... [1]

(c) Copper is a transition element. It can have variable oxidation states.

State **two** other chemical properties of transition elements which make them different from Group I elements.

1 .....

2 .....

[2]

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Q25. [0620/42/M/J/19/Q6]

The halogens are the elements in Group VII of the Periodic Table.

(a) Predict the physical state and colour of astatine at room temperature and pressure.

physical state .....

colour .....

[2]

(b) When chlorine reacts with aqueous potassium bromide a displacement reaction occurs.

(i) Describe the colour change of the solution.

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

[2]

(ii) Write a chemical equation for this reaction.

..... [2]

(c) Reactions occur when some aqueous solutions of halogens are added to aqueous solutions of halides.

Use the key to complete the table to show the results of adding halogens to halides.

key
✓ = reaction
✗ = no reaction

		halides		
		KCl(aq)	KBr(aq)	KI(aq)
halogens	Cl_2(aq)		✓	
	Br_2(aq)			
	I_2(aq)			

[2]

[Total: 8]

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[0620/43/O/N/19/Q4-A-B-i]

Q26.

This question is about phosphorus and compounds of phosphorus.

(a) A phosphorus molecule contains four phosphorus atoms **only**.

What is the formula of a phosphorus molecule?

..... [1]

(b) Phosphorus reacts with chlorine gas to produce phosphorus(III) chloride, PCl_3.

(i) Write a chemical equation for the reaction between phosphorus and chlorine to produce phosphorus(III) chloride, PCl_3.

..... [2]

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[0620/41/M/J/20/Q1]

Q27.

This question is about elements **X**, **Y** and **Z**.

(a) An atom of element **X** is represented as $^{34}_{16}\mathbf{X}$.

(i) Name the different types of particles found in the nucleus of this atom of **X**.

.....

..... [2]

(ii) What is the term for the total number of particles in the nucleus of an atom?

..... [1]

(iii) What is the total number of particles in the nucleus of an atom of $^{34}_{16}\mathbf{X}$?

..... [1]

(iv) What is the electronic structure of the ion $\mathbf{X}^{2-}$?

..... [1]

(v) Suggest the formula of the compound formed between aluminium and **X**.

..... [1]

(b) (i) What term is used to describe atoms of the same element with different numbers of particles in the nucleus?

..... [1]

(ii) Identify the atom against which the relative masses of all other atoms are compared.

..... [1]

(iii) What is the name of the amount of any substance that contains 6.02×10^{23} particles?

..... [1]

(iv) The constant 6.02×10^{23} has a name.

What is the name of this constant?

..... [1]

(c) Part of the definition of relative atomic mass is 'the average mass of naturally occurring atoms of an element'.

Some relative atomic masses are not whole numbers.

Element **Y** has only two different types of atom, ^{69}**Y** and ^{71}**Y**.

The ratio of atoms present in element **Y** is shown.

$$^{69}\mathbf{Y} : {}^{71}\mathbf{Y} = 3 : 2$$

- Calculate the relative atomic mass of element **Y** to **one decimal place**.

relative atomic mass = ...

- Identify element **Y**.

.....

[3]

(d) Element **Z** is in Period 3 and Group V.

(i) Identify element **Z**.

..... [1]

(ii) Explain in terms of electron transfer why **Z** behaves chemically as a non-metal.

.....

..... [2]

[Total: 16]

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[0620/42/M/J/20/Q1]

Q28.

(a) Give the name of the process that:

(i) occurs when a gas turns into a liquid

..... [1]

(ii) occurs when a solid turns into a gas without first forming a liquid

..... [1]

(iii) is used to separate a mixture of liquids with different boiling points

..... [1]

(iv) is used to extract aluminium from aluminium oxide

..... [1]

(v) is used to separate a mixture of amino acids.

..... [1]

(b) The symbols of the elements in Period 2 of the Periodic Table are shown.

Li Be B C N O F Ne

For each of the following, give the symbol of an element from Period 2 which matches the description.

Each element may be used once, more than once or not at all.

Which element:

(i) combines with hydrogen to produce ammonia

..... [1]

(ii) makes up approximately 21% of clean, dry air

..... [1]

(iii) has atoms with only two electrons in the outer shell

..... [1]

(iv) has atoms with only seven protons

..... [1]

(v) is a monoatomic gas

..... [1]

(vi) is a soft metal stored in oil?

..... [1]

[Total: 11]

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Q29. [0620/41/O/N/2020/Q1]

(a) This question is about elements.

aluminium
carbon
iron
hydrogen
oxygen
silicon
sodium
sulfur

Answer the following questions about these elements.

Each element may be used once, more than once or not at all.

(i) Name the element that can be used as a fuel.

..... [1]

(ii) Name the element that forms an oxide with a similar structure to diamond.

..... [1]

(iii) Name the element that forms an amphoteric oxide.

..... [1]

(iv) Name the element that has oxidation states of +2 and +3.

..... [1]

(v) Name the element extracted from bauxite.

..... [1]

(vi) Name the element that has atoms with the electronic structure 2,6.

..... [1]

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(b) Iron rusts when it is in contact with oxygen and water.

(i) Explain how sacrificial protection prevents rusting.

.....

.....

.....

..... [2]

(ii) State one **other** method of rust prevention.

..... [1]

[Total: 9]

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Q30. [0620/43/O/N/2020/Q1]

The names of nine substances are shown.

aluminium oxide

ammonia

carbon monoxide

anhydrous cobalt(II) chloride

hydrated copper(II) sulfate

iron(III) oxide

nitrogen dioxide

silver

steel

Answer the following questions using these substances. Each substance may be used once, more than once or not at all.

Name the substance that is:

(a) the main constituent of hematite ..... [1]

(b) a gas produced in car engines which causes acid rain ..... [1]

(c) an alkaline gas ..... [1]

(d) an element ..... [1]

(e) a gas formed by the incomplete combustion of fossil fuels ..... [1]

(f) used to test for the presence of water. ..... [1]

[Total: 6]

Page 3	Mark Scheme: Teachers' version	Syllabus	Paper
	IGCSE – May/June 2012	0620	31

Q1.

(a) (i) decrease down group; [1]

(ii) caesium / francium; [1]

(iii) $2Rb + 2H_2O \rightarrow 2RbOH + H_2$ [2]
not balanced = [1]

(b) (i) Li^+ [1]

(ii) N^{3-} [1]

(iii) regular arrangement of ions / particles / positive and negative ions alternate; [1]
not: atoms

(iv) 3:1; [1]
ratio to balance charges / reason in terms of valency [1]

[Total: 9]

Page 3	Mark Scheme: Teachers' version	Syllabus	Paper
	IGCSE – May/June 2012	0620	31

Q2.

(a) 2 + 8 + 11 + 2

(b) hard;

strong / high tensile strength;
high mp / bp / high fixed points;
high density; [2]

three properties = [2]
two properties = [1]
not: properties of all metals e.g. good conductor, lustre etc. or form coloured compounds

Page 2	Mark Scheme	Syllabus	Paper
	IGCSE – October/November 2012	0620	32

Q3.

(a) (i) Sb;

(ii) Xe / B;

(iii) Sr / Te / A / D;

(iv) Sn and I / E and F;

(v) Sr / A; [5]

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Page 2	Mark Scheme	Syllabus	Paper
	IGCSE – October/November 2012	0620	33

Q4.

(a) (i) manufacture of plastics / (solvents for) dry cleaning / metal degreasing / textiles / agrochemicals / pharmaceuticals / insecticides / dyestuffs / household cleaning bleach / water treatment / swimming pools / kill bacteria or germs or microorganisms or pathogens / sterilisation / disinfectants; [1]

(ii) electric light bulbs / fluorescent tubes / (inert gas shield for) arc welding / production of titanium / inert atmosphere / car headlights / food packaging; [1]

(iii) (manufacture of) polyethene / polyvinyl chloride (PVC) / making polymers / (to prepare) epoxyethane (which is used in the manufacture of detergents / (to make) ethylene glycol (which is used to prepare Terylene) / (to make) anti-freeze / or making ethanol (accept making alcohol) / ripening fruits; [1]

(iv) (making) steel / (oxy-acetylene) welding / cutting of metals / medical or diving or (oxygen tanks in) hospitals / astronauts / (deep sea) diving / fire fighters; [1]

(b) liquid air; [1]
fractional distillation; [1]

[Total: 6]

Page 2	Mark Scheme	Syllabus	Paper
	IGCSE – October/November 2012	0620	33

Q5.

(iii) (lattice) positive ions / cations / metal ions / sea of electrons / delocalised or free or mobile or moving electrons; [1]
attraction between positive ions and electrons; [1]
the layers (of ions) or particles can slide or slip or shift past each other; [1]

Page 2	Mark Scheme	Syllabus	Paper
	IGCSE – May/June 2013	0620	31

Q6.

(a) 3 or III [1]

(b) good conductor and it is a metal/has delocalised (free) electrons [1]

(c) N **or** P **or** As **or** Sb [1]
accept Bi

(d) $M_2(SO_4)_3$ [1]
accept: $Ga_2(SO_4)_3$

Page 2	Mark Scheme	Syllabus	Paper
	IGCSE – October/November 2013	0620	31

Q7.

(a) Any three of:
iron is harder
iron has higher density
ACCEPT: heavier **or** potassium lighter
iron has higher mp **or** bp
iron has higher tensile strength **or** stronger
iron has magnetic properties [3]
NOTE: has to be comparison, e.g. iron is hard (0) but iron is harder (1)
NOT: appearance e.g. shiny
ACCEPT: comparative statements relating to potassium

(b) potassium hydrogen (1) and potassium hydroxide (1)
zinc hydrogen (1) and zinc oxide (1)
copper no reaction (1) [5]

[Total: 8]

Page 3	Mark Scheme	Syllabus	Paper
	IGCSE – October/November 2013	0620	31

Q8.

(a) **(i)** (attractive force between) positive ions [1]
and (negative) electrons [1]
opposite charges attract ONLY [1]
electrostatic attraction ONLY [1]

(ii) lattice / rows / layers of lead ions / cations / positive ions [1]
NOT: atoms / protons / nuclei
can slide past each other / the bonds are non-directional [1]

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Page 2	Mark Scheme	Syllabus	Paper
	IGCSE – October/November 2013	0620	32

Q9.

(a) (i) two atoms per molecule [1]

(ii) 7e in outer shell or level / same number of outer electrons / need to gain one electron [1]

(iii) different number of energy levels / different number of electrons [1]

(iv)

halogen	solid, liquid or gas at room temperature	colour
chlorine	gas	yellow / yellow green / green
bromine	liquid	brown / red-brown / orange-brown not: red / orange
iodine	solid	black / grey / silver-grey / purple / violet **NOT**: blue-black

NOTE: one mark for each vertical column [2]

(b) correct formula, AsF_3 [1]
3nbps and 1bp around all 3 fluorine atoms [1]
3bps and 1nbp around arsenic atom [1]

Page 6	Mark Scheme	Syllabus	Paper
	IGCSE – May/June 2014	0620	32

Q10.

(a) any **three** from:
(it would have) more than one or variable valency/oxidation state/oxidation number (1)

(metal/element/titanium/it has a) high density (1)

coloured compounds/ions/solutions (1)

form complex (ions) (1)

(element/compound act as) catalyst (1) [3]

Page 7	Mark Scheme	Syllabus	Paper
	Cambridge IGCSE – May/June 2016	0620	41

Q11.

4(c)

(good) catalysts; 1
variable oxidation numbers; 1
form coloured compounds/coloured ions; 1

3

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Page 3	Mark Scheme	Syllabus	Paper
	Cambridge IGCSE – May/June 2016	0620	42

Q12.

Question	Answer	Marks
1(a)(i)	nitrogen / oxygen / fluorine / neon;	1
1(a)(ii)	carbon;	1
1(a)(iii)	oxygen;	1
1(a)(iv)	nitrogen;	1
1(a)(v)	neon;	1
1(a)(vi)	carbon;	1
1(a)(vii)	lithium / fluorine;	1
1(a)(viii)	lithium;	1
1(b)(i)	B_2O_3;	1
1(b)(ii)	Li_3N;	1

Page 4	Mark Scheme	Syllabus	Paper
	Cambridge IGCSE – May/June 2017	0620	42

Q13.

4(a) any 3 from: 3

- catalyst
- more than one / variable oxidation state / oxidation number / valency
- form coloured **compounds** / coloured **ions**
- forms complex ions / complexes

Page 4	Mark Scheme	Syllabus	Paper
	Cambridge IGCSE – May/June 2017	0620	42

Q14.

5(a)(i) 3

	aqueous potassium chloride	aqueous potassium bromide	aqueous potassium iodide
chlorine			✓
bromine	×		✓
iodine	×	×	

5 cells completed correctly = [3]
3 or 4 cells completed correctly = [2]
2 cells completed correctly = [1]

5(a)(ii) $Cl_2 + 2KBr \rightarrow 2KCl + Br_2$ 1

OR

$Cl_2 + 2Br^- \rightarrow 2Cl^- + Br_2$

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Q15.

Question	Answer	Marks
7(a)(i)	diffusion	1
7(a)(ii)	silicon(IV) oxide is a solid, whereas carbon dioxide is a gas	1
7(a)(iii)	photosynthesis	1
	chlorophyll / chloroplasts	1
	M2 sunlight / UV (light)	1
	$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$ **M1** species correct **M2** balanced	2

0620/41 Cambridge IGCSE – Mark Scheme **PUBLISHED** May/June 2018

Q16.

Question	Answer	Marks
2(a)	calcium / Ca	1
2(b)	7	1
2(c)	4	1
2(d)(i)	radioisotopes	1
2(d)(ii)	^{286}Fl 114p 172n 114e	1
	^{289}Fl 114p 175n 114e	1
2(e)(i)	any **two** from: high melting point / boiling point hard dense conduct electricity conduct heat ductile / malleable sonorous lustrous / shiny	2
2(e)(ii)	basic (oxide)	1

0620/42 Cambridge IGCSE – Mark Scheme **PUBLISHED** May/June 2018

Q17.

Question	Answer	Marks
2(a)	silicon / Si	1
2(b)	aluminium / Al	1
2(c)	sodium / Na	1
2(d)	chlorine / Cl_2 / Cl	1
2(e)	argon / Ar	1
2(f)	sulfur / S	1
2(g)	phosphorus / P	1

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Q18.

Question	Answer	Marks
1(a)	Cl_2 / chlorine	1
1(b)	SO_2 / sulfur dioxide	1
1(c)	Cu / copper	1
1(d)	Ar / argon	1
1(e)	$Ca(OH)_2$ / calcium hydroxide	1
1(f)	V_2O_5 / vanadium(V) oxide	1

0620/43 Cambridge IGCSE – Mark Scheme May/June 2018
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Q19.

Question	Answer	Marks
3(a)	any **one** from: conduct electricity conduct heat malleable ductile shiny	1
3(b)(i)	any **one** from: melting point hardness strength density	1
3(b)(ii)	(cobalt) high(er) / (cobalt) strong(er)	1
3(c)	any **two** from: potassium melts / potassium forms a ball fizzes / bubbles potassium moves (lilac) flame	2

[0620/42/O/N/18/Q1-C]

Q20.

1(c)	$4X + O_2 \rightarrow 2X_2O$ M1 Species M2 Balance	2

[0620/42/O/N/2018/Q2-C]

Q21.

2(c)(i)	Hydrogen	1
2(c)(ii)	Hydroxide OR OH	1
2(c)(iii)	$7 < pH \leqslant 12$	1
2(c)(iv)	$Ca + 2H_2O \rightarrow Ca(OH)_2 + H_2$ M1 $Ca(OH)_2$ M2 Rest of equation	2

[0620/42/O/N/2019/Q1-B]

Q22.

1(b)(i)	potassium / K	1
1(b)(ii)	calcium / Ca	1

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[0620/43/O/N/2018/Q3-F-G]

Q23.

3(f)(i)	**M1** glowing splint **M2** relights / rekindles	2
3(f)(ii)	**M1** nitrogen dioxide / nitrogen(IV) oxide **M2** brown (gas)	2
3(f)(iii)	$2Cu(NO_3)_2 \rightarrow 2CuO + 4NO_2 + O_2$	1
3(g)(i)	zinc acts as a barrier which prevents contact between iron and water and air / oxygen	1
3(g)(ii)	**SUMMARY** **M1** zinc is **more** reactive than iron / steel **ORA** **M2** zinc loses electrons / zinc is oxidised **M3** electrons are transferred to iron / iron is not oxidised / iron does not lose electrons	3

M1	comparison of reactivity
M2	zinc loses **electrons**
M3	where **electrons** move to **OR** iron does not lose electrons

[0620/41/M/J/2019/Q3-A-B-C]

Q24.

3(a)	roast zinc blende (in air) (1) $2ZnS + 3O_2 \rightarrow 2ZnO + 2SO_2$ (1) add/react with coke (1) $ZnO + C \rightarrow Zn + CO$ **OR** $2ZnO + C \rightarrow 2Zn + CO_2$ (1) (zinc is) distilled (1)	5
3(b)	brass	1
3(c)	form coloured compounds / ions (1) act as catalysts (1)	2

[0620/42/M/J/2019/Q6]

Q25.

6(a)	**M1** solid (1) **M2** black (1)	2
6(b)(i)	**M1** colourless (1) **M2** to brown / orange / yellow (1)	2
6(b)(ii)	$Cl_2 + 2KBr \rightarrow 2KCl + Br_2$ **OR** $Cl_2 + 2Br^- \rightarrow 2Cl^- + Br_2$ **M1** all formulae (1) **M2** equation balanced correctly (1)	2
6(c)	**M1** two ticks for Cl_2 / KI, Br_2 / KI (1) **M2** three crosses for Br_2 / KCl, I_2 / KCl and I_2 / KBr (1)	2

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Q26.

[0620/43/O/N/2019/Q4-A-B-i]

4(a)	P_4	1
4(b)(i)	$P_4 + 6Cl_2 \rightarrow 4PCl_3$ formulae correct (1) equation balanced (1)	2

Q27.

[0620/41/M/J/2020/Q1]

1(a)(i)	protons	1
	neutrons	1
1(a)(ii)	nucleon numbe	1
1(a)(iii)	34	1
1(a)(iv)	2 : 8 : 8	1
1(a)(v)	AlX_3	1
1(b)(i)	isotopes	1
1(b)(ii)	^{12}C	1
1(b)(iii)	a mole	1
1(b)(iv)	vogadro constant	1
1(c)	M1 $(3 \times 69) + (2 \times 71)$ M2 $= \frac{349}{5} = 69.8$ M3 Y = Ga / gallium	3
1(d)(i)	phosphorus / P	1
1(d)(ii)	gains electrons three electrons (when forming ion)	2

Q28.

[0620/42/M/J/2020/Q1]

1(a)(i)	condensation	1
1(a)(ii)	sublimation	1
1(a)(iii)	fractional distillation	1
1(a)(iv)	electrolysis	1
1(a)(v)	chromatography	1
1(b)(i)	N	1
1(b)(ii)	O	1
1(b)(iii)	Be	1
1(b)(iv)	N	1
1(b)(v)	Ne	1
1(b)(vi)	Li	1

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Q29. [0620/41/O/N/2020/Q1]

1(a)(i)	hydrogen / carbon	1
1(a)(ii)	silicon	1
1(a)(iii)	aluminium	1
1(a)(iv)	iron	1
1(a)(v)	aluminium	1
1(a)(vi)	oxygen	1
1(b)(i)	metal higher in reactivity series / metal more reactive (than iron) / allow named metal e.g. magnesium or zinc (1) zinc corrodes/oxidises/reacts in preference to iron (1)	2
1(b)(ii)	any barrier method e.g. painting	1

Q30. [0620/43/O/N/2020/Q1]

1(a)	iron(III) oxide	1
1(b)	nitrogen dioxide	1
1(c)	ammonia	1
1(d)	silve	1
1(e)	carbon monoxide	1
1(f)	anhydrous cobalt(II) chloride	1

[0620/31/M/J/11/Q3]

Q1. Iron from the blast furnace is impure. It contains about 4 % carbon and 0.5 % silicon. Most of this impure iron is used to make mild steel, an alloy of iron containing less then 0.25 % carbon.

(a) A jet of oxygen is blown through the molten iron in the presence of a base, usually calcium oxide. Explain how the percentage of carbon is reduced and how the silicon is removed.

.....

.....

.....

..... [4]

(b) (i) Why are steel alloys used in preference to iron?

..... [1]

(ii) State a use of the following alloys.

mild steel .....

stainless steel ..... [2]

(c) Both iron and steel have typical metallic structures - a lattice of positive ions and a sea of electrons.

(i) Suggest an explanation for why they have high melting points.

.....

.....

..... [2]

(ii) Explain why, when a force is applied to a piece of steel, it does not break but just changes its shape.

.....

..... [2]

[Total: 11]

Q2. [0620/31/M/J/11/Q4]

A major ore of zinc is zinc blende, ZnS. A by-product of the extraction of zinc from this ore is sulfur dioxide which is used to make sulfuric acid.

(a) (i) Zinc blende is heated in air. Zinc oxide and sulfur dioxide are formed. Write the balanced equation for this reaction.

..... [2]

(ii) Zinc oxide is reduced to zinc by heating with carbon. Name **two** other reagents which could reduce zinc oxide.

..... [2]

(iii) The zinc obtained is impure. It is a mixture of metals. Explain **how** fractional distillation could separate this mixture.
zinc bp = 908 °C, cadmium bp = 765 °C, lead bp = 1751 °C

.....

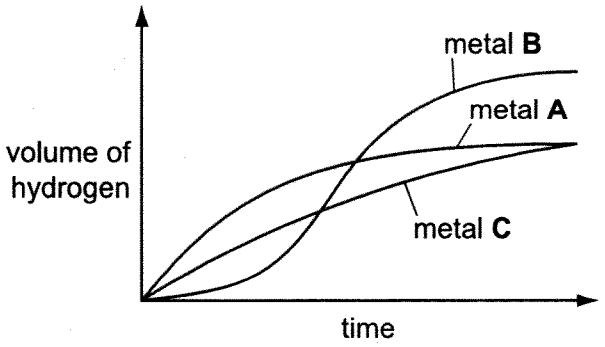
..... [2]

542

[0620/31/M/J/11/Q7]

Q3. Excess hydrochloric acid was added to powdered zinc. The hydrogen evolved was collected and its volume measured every 20 seconds.

The experiments were repeated at the same temperature using the same number of moles of powdered magnesium and aluminium.



(a) Identify metals **A**, **B** and **C** by choosing from zinc, magnesium and aluminium. Give a reason for each choice.

metal **A** .....

.....

metal **B** .....

.....

metal **C** .....

..... [5]

(b) Using 'moles', explain why two of the metals form the same volume of hydrogen but the third metal forms a larger volume.

.....

.....

..... [3]

[Total: 8]

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[0620/32/M/J/11/Q2-A-C]

Q4.

Tin is an element in Group IV.

(a) The position of tin in the reactivity series is:

zinc
iron
tin
copper

(i) For each of the following, decide if a reaction would occur. If there is a reaction, complete the equation, otherwise write 'no reaction'.

$Cu + Sn^{2+} \rightarrow$ .....

$Fe + Sn^{2+} \rightarrow$ .....

$Sn + Zn^{2+} \rightarrow$ ..... [4]

(ii) Name the **three** products formed when tin(II) nitrate is heated.

.....

..... [2]

(c) Steel articles can be plated with tin or zinc to prevent rusting.
When the zinc layer is damaged exposing the underlying steel, it does not rust, but when the tin layer is broken the steel rusts. Explain.

.....

.....

..... [4]

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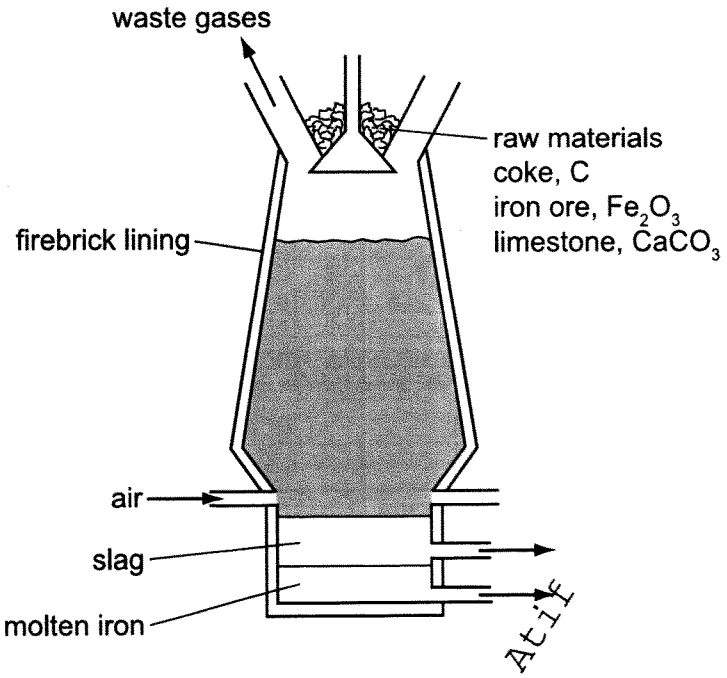
[0620/32/M/J/11/Q4]

Q5. Iron is extracted from its ore, hematite, in the blast furnace.



Describe the reactions involved in this extraction. Include in your description an equation for a redox reaction and one for an acid / base reaction.

.....

.....

.....

.....

..... [5]

[Total: 5]

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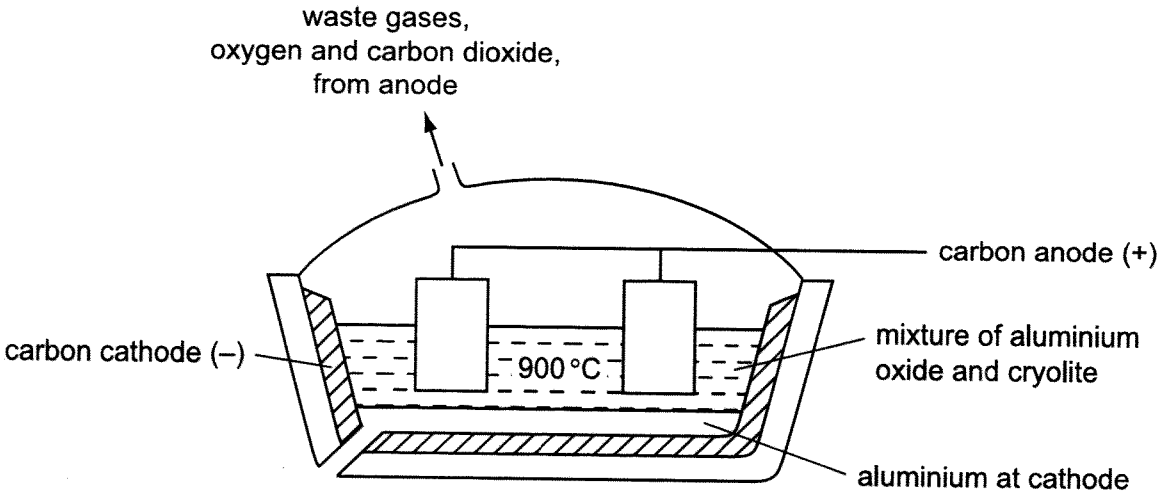
[0620/31/O/N/11/Q3]

Q6. Aluminium is extracted by the electrolysis of a molten mixture of alumina, which is aluminium oxide, and cryolite.



(a) (i) Alumina is obtained from the main ore of aluminium.
Name this ore.

..... [1]

(ii) Explain why it is necessary to use a mixture, alumina and cryolite, rather than just alumina.

.....

..... [2]

(iii) Copper can be extracted by the electrolysis of an aqueous solution.
Suggest why the electrolysis of an aqueous solution cannot be used to extract aluminium.

.....

.....

..... [2]

(b) The ions which are involved in the electrolysis are Al^{3+} and O^{2-}. The products of this electrolysis are given on the diagram.
Explain how they are formed. Use equations where appropriate.

.....

.....

.....

..... [4]

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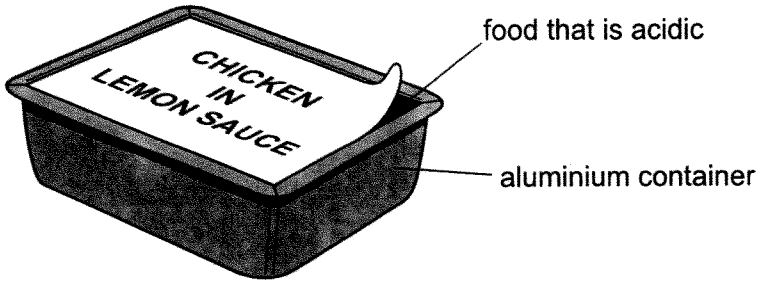
(c) The uses of a metal are determined by its properties.

(i) Foods which are acidic can be supplied in aluminium containers.

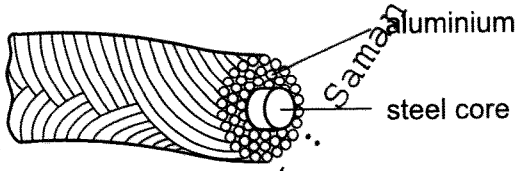


Explain why the acid in the food does not react with the aluminium.

.....

..... [1]

(ii) Explain why overhead electrical power cables are made from aluminium with a steel core.



.....

.....

..... [3]

[Total: 13]

547

[0620/33/O/N/11/Q4]

Q7.(a) Steel rusting is an example of an oxidation reaction.

(i) Define the term *steel*.

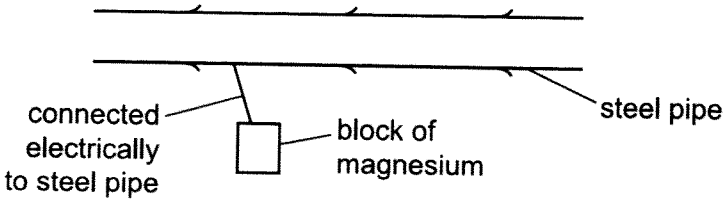
.....

..... [2]

(ii) Define oxidation in terms of electron transfer.

..... [1]

(b) A method of preventing steel rusting is sacrificial protection.

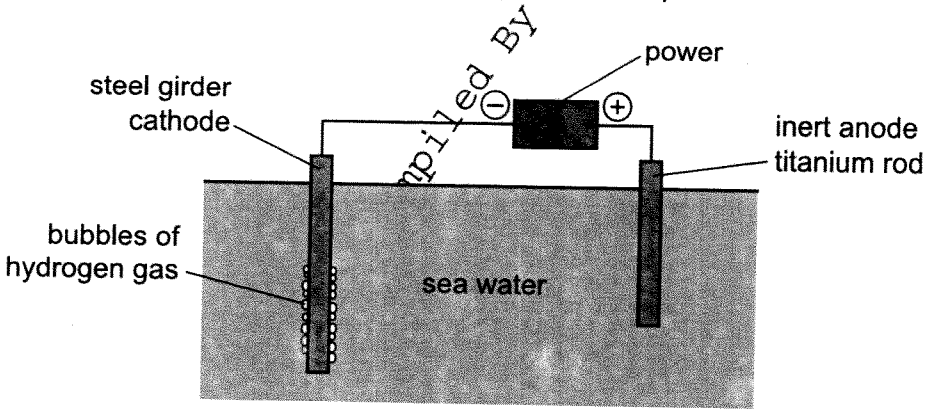


Give an explanation, in terms of electron transfer, why the steel does not rust.

.....

..... [2]

(c) Another method of preventing steel rusting is cathodic protection.



(i) Write an equation for the formation of the gas given off at the steel cathode during cathodic protection.

..... [2]

(ii) Give **one** difference between the two methods.

.....

..... [2]

[Total: 9]

[0620/33/O/N/11/Q6-A]

Q8. Nickel is a transition element.

(a) Predict **three** differences in the chemical properties of nickel and barium.

.....

.....

..... [3]

[0620/31/M/J/12/Q5]

Q9. Reactive metals tend to have unreactive compounds. The following is part of the reactivity series.

sodium	most reactive
calcium	↓
zinc	
copper	
silver	least reactive

(a) Sodium hydroxide and sodium carbonate do not decompose when heated.
The corresponding calcium compounds do decompose when heated.
Complete the following equations.

calcium carbonate → ..... + ...

$Ca(OH)_2$ → ..... + ... [2]

(b) All nitrates decompose when heated.

(i) The equation for the thermal decomposition of silver(I) nitrate is given below.

$$2AgNO_3 \rightarrow 2Ag + 2NO_2 + O_2$$

What are the products formed when copper(II) nitrate is heated?

..... [1]

(ii) Complete the equation for the action of heat on sodium nitrate.

.....$NaNO_3$ → ..... + ...

[2]

(c) Which of the metals in the list on page 5 have oxides which are not reduced by carbon?

..... [1]

(d) Choose from the list on page 5, metals whose ions would react with zinc.

..... [2]

[Total: 8]

549

Q10. [0620/32/M/J/12/Q4]

The ore of aluminium is bauxite which is impure aluminium oxide. Alumina, pure aluminium oxide, is obtained from bauxite.
Aluminium is formed at the cathode when a molten mixture of alumina and cryolite, Na_3AlF_6, is electrolysed.

(a) (i) Name **two** products formed at the anode in this electrolysis.

..... [2]

(ii) All the aluminium formed comes from the alumina not the cryolite.
Suggest **two** reasons why the electrolyte must contain cryolite.

.....

..... [2]

(iii) The major impurity in bauxite is iron(III) oxide. Iron(III) oxide is basic, aluminium oxide is amphoteric. Explain how aqueous sodium hydroxide can be used to separate them.

.....

.....

..... [2]

(b) The purification of bauxite uses large amounts of sodium hydroxide.

(i) Describe the chemistry of how sodium hydroxide is made from concentrated aqueous sodium chloride. The description must include at least one ionic equation.

.....

.....

.....

.....

..... [5]

(ii) Making sodium hydroxide from sodium chloride produces two other chemicals. Name these two chemicals and state one use of each chemical.

chemical .....

use .....

chemical .....

use ..... [2]

[Total: 13]

[0620/32/O/N/12/Q1-B]

Q11.(b) Predict **two** differences in physical properties and **two** differences in chemical properties between rubidium and the transition metal niobium.

physical .....

.....

.....

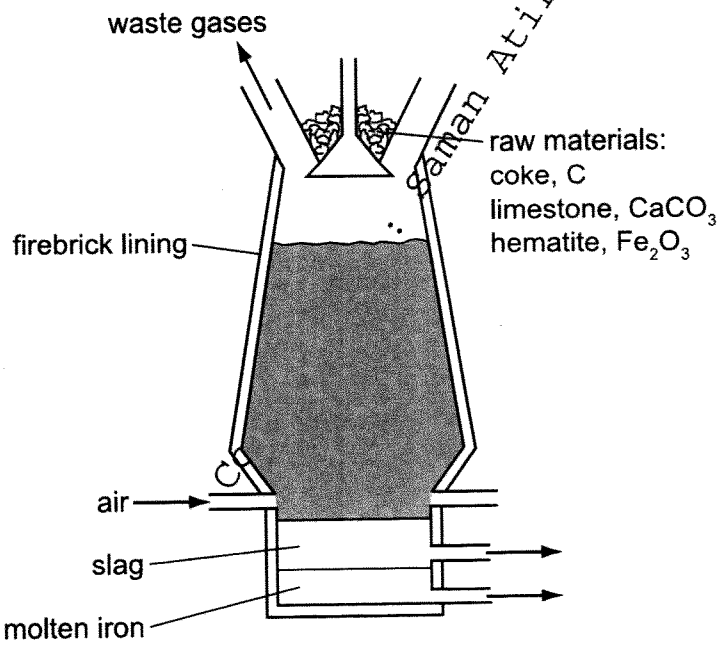
chemical .....

.....

..... [4]

[0620/32/O/N/12/Q4]

Q12. Iron is extracted from its ore, hematite, in the blast furnace.



(a) The temperature inside the blast furnace can rise to 2000 °C.
Write an equation for the exothermic reaction which causes this high temperature.

..... [1]

(b) Carbon monoxide is formed in the blast furnace. This reduces the ore hematite, Fe_2O_3, to iron.

(i) Explain how carbon monoxide is formed in the blast furnace.

.....

..... [2]

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(ii) Write an equation for the reduction of hematite by carbon monoxide.

..... [2]

(c) Explain why it is necessary to add limestone, calcium carbonate, to the blast furnace. Include an equation in your explanation.

.....

.....

..... [3]

(d) Most of the iron from the blast furnace is converted into mild steel. A method of preventing the steel from rusting is coating it with zinc.

(i) What is the name of this method of rust prevention?

..... [1]

(ii) Explain, using the idea of electron transfer, why zinc-coated steel does not rust even when the coating is scratched and the steel is in contact with oxygen and water.

.....

.....

.....

..... [3]

[Total: 12]

[0620/33/O/N/12/Q4-Bii]

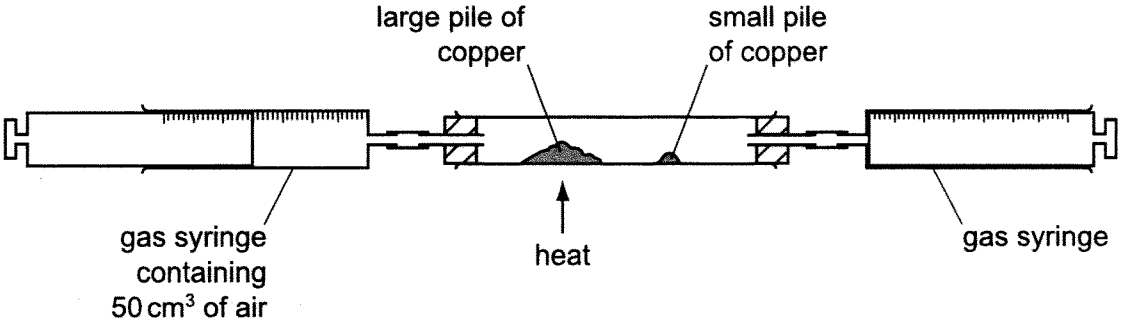
Q13. (ii) Some of the zinc oxide is dissolved in sulfuric acid to make aqueous zinc sulfate. Write a balanced symbol equation for this reaction.

..... [2]

552

[0620/32/M/J/13/Q1-C]

Q14. (c) The percentage of oxygen in air can be determined by the following experiment.



The gas syringe contains 50 cm^3 of air. The large pile of copper is heated and the air is passed from one gas syringe to the other over the hot copper. The large pile of copper turns black. The gas is allowed to cool and its volume measured.

The small pile of copper is heated and the remaining gas passed over the hot copper. The copper does not turn black. The final volume of gas left in the apparatus is less than 50 cm^3.

(i) Explain why the copper in the large pile turns black.

.....

..... [2]

(ii) Why must the gas be allowed to cool before its volume is measured?

..... [1]

(iii) Explain why the copper in the small pile did not turn black.

..... [1]

(iv) What is the approximate volume of the gas left in the apparatus?

..... [1]

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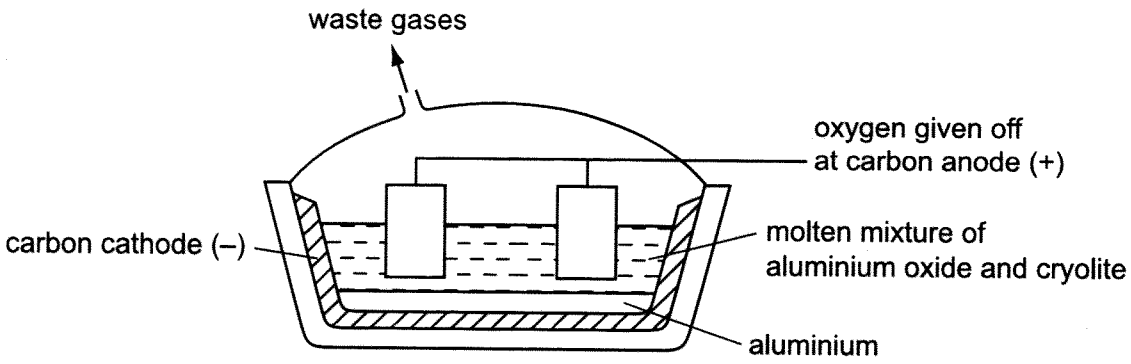
[0620/32/M/J/13/Q6]

Q15.

Aluminium is an important metal with a wide range of uses.

(a) Aluminium is obtained by the electrolysis of aluminium oxide dissolved in molten cryolite.



(i) Solid aluminium oxide is a poor conductor of electricity. It conducts either when molten or when dissolved in molten cryolite. Explain why.

.....

.....

..... [2]

(ii) Why is a solution of aluminium oxide in molten cryolite used rather than molten aluminium oxide?

..... [1]

(iii) Explain why the carbon anodes need to be replaced periodically.

..... [1]

(iv) One reason why graphite is used for the electrodes is that it is a good conductor of electricity. Give another reason.

..... [1]

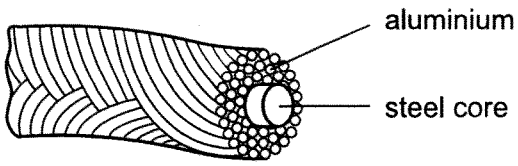
(b) Aluminium is used to make food containers because it resists corrosion.
Explain why it is not attacked by the acids in food.

.....

..... [2]

554

(c) Aluminium is used for overhead power (electricity) cables which usually have a steel core.



(i) Give **two** properties of aluminium which make it suitable for this use.

.....

..... [2]

(ii) Explain why the cables have a steel core.

.....

..... [1]

[Total: 10]

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Q16. [0620/33/M/J/13/Q3]

Iron from the blast furnace is impure. It contains 5% of impurities, mainly carbon, sulfur, silicon and phosphorus. Almost all of this impure iron is converted into the alloy, mild steel.

(a) (i) State a use of mild steel.

..... [1]

(ii) Name and give a use of another iron-containing alloy.

name .....

use ..... [2]

(b) The oxides of carbon and sulfur are gases. The oxides of silicon and phosphorus are not. Explain how these impurities are removed from the impure iron when it is converted into mild steel.

.....

.....

.....

.....

..... [5]

[Total: 8]

Q17. [0620/33/M/J/13/Q5-A]

All metal nitrates decompose when heated. A few form a nitrite and oxygen. Most form the metal oxide, oxygen and a brown gas called nitrogen dioxide.

(a) (i) Name a metal whose nitrate decomposes to form the metal nitrite and oxygen.

..... [1]

(ii) Complete the equation for the action of heat on lead(II) nitrate.

.....$Pb(NO_3)_2$ → ..... + ...NO_2 + O_2 [2]

(iii) Suggest why the nitrate of the metal, named in **(a)(i)**, decomposes less readily than lead(II) nitrate.

.....

..... [2]

[0620/32/O/N/13/Q4-A]

Q18. For centuries, iron has been extracted from its ore in the blast furnace. The world production of pig iron is measured in hundreds of million tonnes annually.

(a) The following raw materials are supplied to a modern blast furnace.

iron ore which is hematite, Fe_2O_3
limestone which is calcium carbonate
carbon in the form of coke
air

Describe the essential reactions in the blast furnace. Each of the four raw materials must be mentioned at least once. Give the equation for the reduction of hematite.

.....

.....

.....

.....

.....

.....

.....

.....

..... [6]

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Q19. [0620/33/O/N/13/Q3-A-B-D]

The main uses of zinc are preventing steel from rusting and making alloys.

(a) The main ore of zinc is zinc blende. Zinc blende consists mainly of zinc sulfide, ZnS. There are two major methods of extracting zinc from its ore. They are the direct reduction of zinc oxide to zinc and by electrolysis. In both methods, zinc oxide is made from the zinc sulfide in the ore.

(i) How is zinc oxide made from zinc sulfide?

.....

..... [1]

(ii) Write an equation for the reaction used to reduce zinc oxide to zinc.

..... [1]

(b) In the electrolytic method, zinc oxide reacts with sulfuric acid to form impure aqueous zinc sulfate. This solution contains Ni^{2+}, Co^{2+} and Cu^{2+} ions as impurities.

(i) Write the equation for the reaction between zinc oxide and sulfuric acid.

..... [1]

(ii) Nickel, cobalt and copper are all less reactive than zinc. Explain why the addition of zinc powder removes these ions from the solution.

.....

..... [2]

(d) **(i)** Brass is an alloy of copper and zinc. Suggest **two** reasons why brass is often used in preference to copper.

.....

..... [2]

(ii) Sacrificial protection is a method of rust prevention. Explain in terms of electron transfer why steel, which is in electrical contact with zinc, does not rust.

.....

.....

.....

..... [4]

[0620/31/M/J/14/Q5]

Q20.

Zinc is obtained from the ore, zinc blende, ZnS.

(a) Describe the extraction of zinc from its ore, zinc blende. Include at least one balanced equation in your description.

.....

.....

.....

.....

..... [5]

(b) State **two** major uses of zinc.

.....

..... [2]

[Total: 7]

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Q21. [0620/31/M/J/14/Q7-A]

One way of establishing a reactivity series is by displacement reactions.

(a) A series of experiments was carried out using the metals lead, magnesium, zinc and silver. Each metal was added in turn to aqueous solutions of the metal nitrates.

The order of reactivity was found to be:

magnesium	most reactive
zinc	↓
lead	
silver	least reactive

(i) Complete the table.

✓ = reacts
✗ = does not react

aqueous solution	metal: lead Pb	magnesium Mg	zinc Zn	silver Ag
lead(II) nitrate		✓	✓	✗
magnesium nitrate				
zinc nitrate				
silver nitrate				

[3]

(ii) Displacement reactions are redox reactions.
On the following equation, draw a **ring** around the reducing agent and an **arrow** to show the change which is oxidation.

$$Zn + Pb^{2+} \rightarrow Zn^{2+} + Pb$$

[2]

(iii) Complete the following ionic equation.

$$Zn + 2Ag^{+} \rightarrow \ldots\ldots + \ldots\ldots$$

[1]

[0620/33/M/J/14/Q4]

Q22.

Iron from a blast furnace contains about 5% of the impurities – carbon, silicon, phosphorus and sulfur. Most of this impure iron is used to make steels, such as mild steel, and a very small percentage is used to make pure iron.

(a) Calcium oxide and oxygen are used to remove the impurities from the iron produced in the blast furnace.

(i) State how these chemicals are manufactured.

calcium oxide .....

.....

oxygen .....

.....

[3]

(ii) Describe how these two chemicals remove the four impurities. Include at least one equation in your answer.

.....

.....

.....

.....

.....

.....

..... [5]

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(b) (i) Describe the structure of a typical metal such as iron. You may include a diagram.

.....

.....

[2]

(ii) Explain why pure iron is malleable.

.....

..... [2]

(iii) Mild steel is an alloy of iron and carbon.
Suggest why mild steel is harder than pure iron.

.....

.....

..... [2]

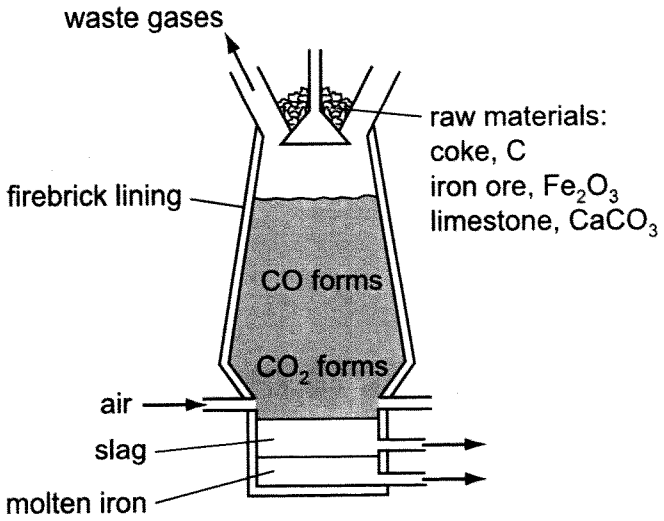
[Total: 14]

562

[0620/31/O/N/14/Q4]

Q23.

Iron is extracted from the ore hematite in the Blast Furnace.



(a) The coke reacts with the oxygen in the air to form carbon dioxide.

$$C + O_2 \rightarrow CO_2$$

(i) Explain why carbon monoxide is formed higher in the Blast Furnace.

.....

..... [2]

(ii) Write an equation for the reduction of hematite, Fe_2O_3, by carbon monoxide.

..... [2]

(b) (i) Limestone decomposes to form two products, one of which is calcium oxide. Name the other product.

..... [1]

(ii) Calcium oxide reacts with silicon(IV) oxide, an acidic impurity in the iron ore, to form slag. Write an equation for this reaction.

..... [2]

(iii) Explain why the molten iron and the molten slag form two layers and why molten iron is the lower layer.

.....

..... [2]

(iv) Suggest why the molten iron does **not** react with the air.

..... [1]

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(c) Iron and steel rust. Iron is oxidised to hydrated iron(III) oxide, $Fe_2O_3.2H_2O$, which is rust.

(i) Name the **two** substances which cause iron to rust.

..... [1]

(ii) Explain why an aluminium article coated with aluminium oxide is protected from further corrosion but a steel article coated with rust continues to corrode.

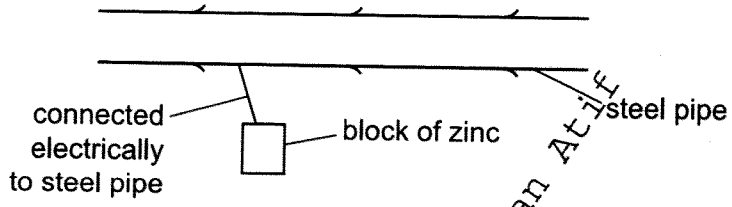
.....

..... [1]

(d) There are two electrochemical methods of rust prevention.

(i) The first method is sacrificial protection.

Explain why the steel article does not rust.



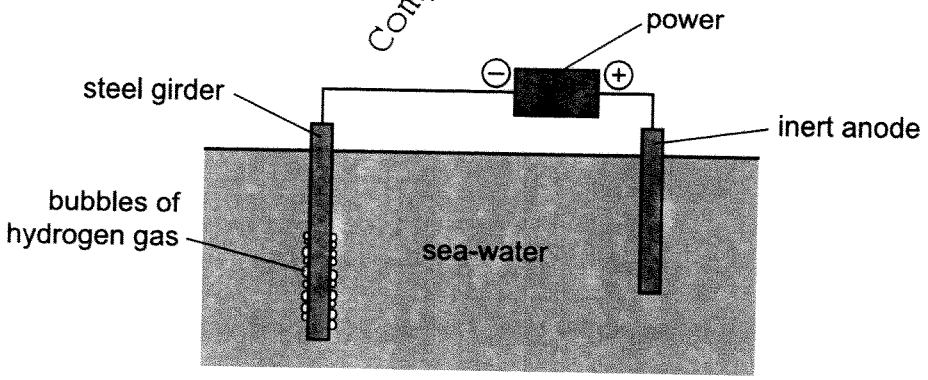
.....

.....

.....

..... [4]

The second method is to make the steel article the cathode in a circuit for electrolysis.



(ii) Mark on the diagram the direction of the electron flow. [1]

(iii) The steel girder does not rust because it is the cathode. Reduction takes place at the cathode. Give the equation for the reduction of hydrogen ions.

..... [2]

[Total: 19]

564

[0620/32/O/N/14/Q2-D]

Q24.

(d) A major use of aluminium is the manufacture of pots and pans. One reason for this is its resistance to corrosion.

(i) Explain why aluminium, a reactive metal, is resistant to corrosion.

.....

..... [1]

(ii) Suggest **two** other reasons why aluminium is suitable for making pots and pans.

.....

..... [2]

[0620/32/O/N/14/Q4-A-B]

Q25.

Zinc is an important metal. Its uses include making alloys and the construction of dry cells (batteries).

(a) Name an alloy which contains zinc. What is the other metal in this alloy?

name of alloy .....

other metal in alloy .....

[2]

(b) The main ore of zinc is zinc blende, ZnS.

(i) The ore is heated in the presence of air to form zinc oxide and sulfur dioxide. Write the equation for this reaction.

..... [2]

(ii) Give a major use of sulfur dioxide.

..... [1]

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Q26. [0620/31/M/J/15/Q2]

Iron from the Blast Furnace is impure. It contains about 5% of impurities, mainly carbon, sulfur, silicon and phosphorus, which have to be removed when this iron is converted into steel.

(a) Explain how the addition of oxygen and calcium oxide removes these impurities. Include an equation for a reaction of oxygen and a word equation for a reaction of calcium oxide in this process.

.....

.....

.....

.....

.....

.....

[5]

(b) Mild steel is the most common form of steel. Mild steel contains a maximum of 0.3% of carbon.

High carbon steel contains 2% of carbon. It is less malleable and much harder than mild steel.

(i) Give a use of mild steel.

..... [1]

(ii) Suggest a use of high carbon steel.

..... [1]

(iii) Explain why metals are malleable.

.....

.....

.....

..... [3]

(iv) Suggest an explanation why high carbon steel is less malleable and harder than mild steel.

.....

.....

..... [2]

[Total: 12]

566

[0620/42/M/J/16/Q6-B-C]

Q27.

(b) Zinc oxide is converted into zinc. Zinc oxide and coke are fed into a furnace. Hot air is blown into the bottom of the furnace.

Zinc has a melting point of 420 °C and a boiling point of 907 °C. The temperature inside the furnace is over 1000 °C.

(i) Explain how zinc oxide is converted into zinc. Your answer should include details of how the heat is produced and equations for all the reactions you describe.

.....

.....

.....

.....

..... [3]

(ii) Explain why the zinc produced inside the furnace is a gas.

..... [1]

(iii) State the name of the physical change for conversion of gaseous zinc into molten zinc.

..... [1]

(c) Rusting of steel can be prevented by coating the steel with a layer of zinc.

Explain, in terms of electron transfer, why steel does **not** rust even if the layer of zinc is scratched so that the steel is exposed to air and water.

.....

.....

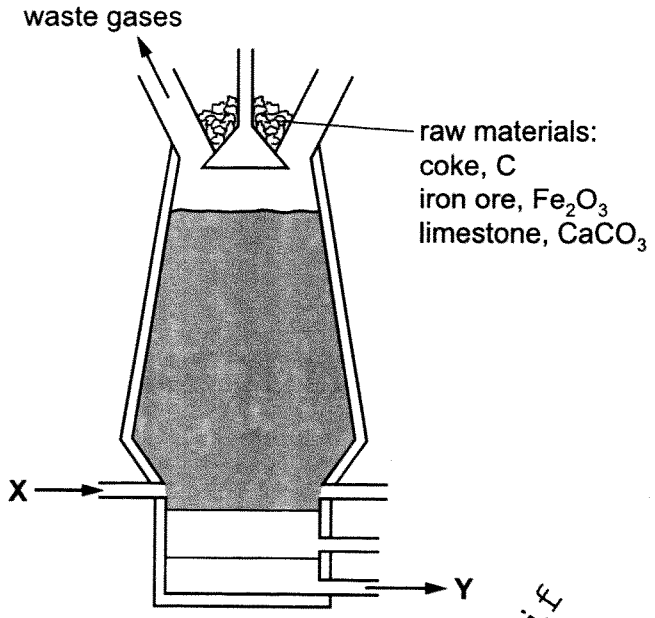
.....

.....

..... [4]

Q28. [0620/43/M/J/16/Q1]

The diagram shows a blast furnace.



(a) The following equations represent reactions which take place in the blast furnace.

A $C + O_2 \rightarrow CO_2$

B $CaCO_3 \rightarrow CaO + CO_2$

C $CaO + SiO_2 \rightarrow CaSiO_3$

D $CO_2 + C \rightarrow 2CO$

E $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$

(i) Which reaction is used to increase the temperature inside the blast furnace? ..... [1]

(ii) Which reaction is an example of thermal decomposition? ..... [1]

(iii) In which reaction is carbon both oxidised and reduced? ..... [1]

(iv) Which equation shows the removal of an impurity from the iron? ..... [1]

(v) Which equation shows the reaction of an acidic substance with a basic substance?

..... [1]

(b) Use the diagram of the blast furnace to help you answer these questions.

(i) What enters the blast furnace at **X**?

..... [1]

(ii) What leaves the blast furnace at **Y**?

..... [1]

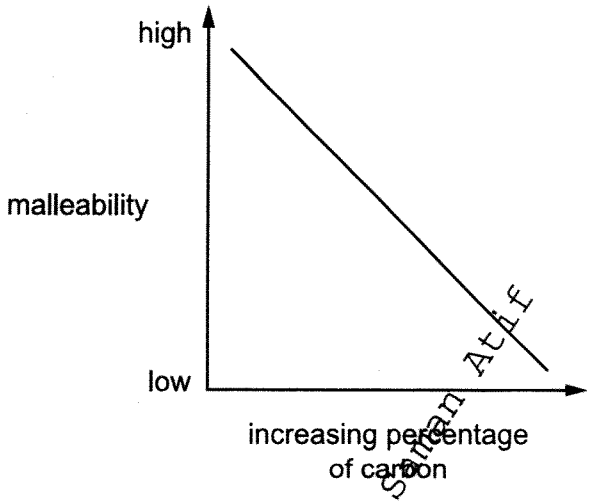
(iii) Name **two** waste gases that leave the blast furnace.

1. .....

2. .....

[2]

(c) The graph shows how the malleability of iron changes as the percentage of carbon in the iron changes.



(i) Describe how the malleability of iron changes as the percentage of carbon changes.

.....

..... [1]

(ii) Iron obtained from the blast furnace contains high levels of carbon.

Explain how the amount of carbon in the iron can be decreased.

.....

.....

..... [2]

[Total: 12]

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[0620/42/O/N/16/Q6]

Q29.

Aluminium is a very important metal.

Aluminium is extracted from its ore, bauxite, by electrolysis. Bauxite is an impure form of aluminium oxide, Al_2O_3.

(a) Describe how aluminium is extracted from **bauxite**. Include an ionic half-equation for the reaction at each electrode.

description .....

.....

.....

.....

.....

.....

.....

.....

.....

ionic half-equation for the anode reaction .....

ionic half-equation for the cathode reaction.....

[5]

(b) Explain why the anodes have to be replaced regularly.

.....

..... [2]

(c) Give **two** uses of aluminium and give a reason why aluminium is suitable for each use.

use 1 .....

reason .....

use 2 .....

reason .....

[4]

[Total: 11]

[0620/41/M/J/17/Q4-A-B]

Q30.

Zinc is a very important metal.

(a) Zinc is extracted from its ore, zinc blende. Zinc blende contains zinc sulfide, ZnS.

Zinc sulfide is converted to zinc oxide in an industrial process.

(i) Describe how zinc sulfide is converted to zinc oxide in this industrial process.

.....

..... [1]

(ii) Write the chemical equation for this reaction.

..... [2]

(b) Zinc oxide is then reduced in a furnace.

(i) Name the substance added to the furnace to reduce the zinc oxide.

..... [1]

(ii) Describe how the pure zinc is removed from the furnace and collected.

.....

.....

..... [2]

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571

Q31. [0620/41/O/N/17/Q3]

(a) When magnesium is added to aqueous copper(II) sulfate a reaction occurs.
The ionic equation for the reaction is shown.

$$Mg + Cu^{2+} \rightarrow Mg^{2+} + Cu$$

(i) Give **one** change you would observe during this reaction.

..... [1]

(ii) Explain why this is a redox reaction.

.....

..... [1]

(iii) Identify the oxidising agent in this reaction. Give a reason for your answer.

.....

..... [2]

(iv) A redox reaction occurs when magnesium is heated with iron(III) oxide.

Write a chemical equation for the reaction between magnesium and iron(III) oxide.

..... [2]

(b) The metal iron and the alloy steel are commonly used materials. A problem with them is that they rust.

(i) How does painting iron and steel prevent rusting?

.....

..... [1]

(ii) Magnesium blocks can be attached to the bottom of steel boats.

Explain how the magnesium blocks prevent the whole of the bottom of the boat from rusting.

.....

.....

.....

..... [2]

(iii) Replacing the magnesium blocks with copper blocks does not prevent rusting.

Explain why the copper blocks do **not** prevent rusting.

.....

..... [1]

[Total: 10]

[0620/41/O/N/17/Q6-A-C-D]

Q32.

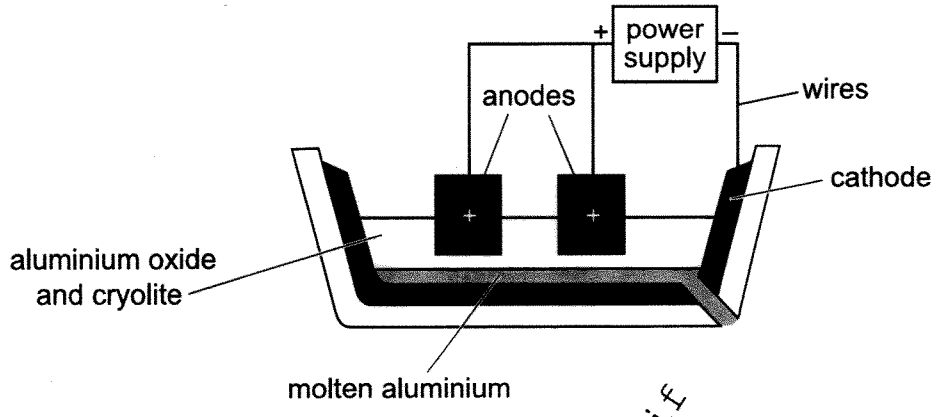
Aluminium is extracted from aluminium oxide by electrolysis.

(a) Why is aluminium **not** extracted by heating aluminium oxide with carbon?

.....

..... [1]

(c) Aluminium can be extracted by electrolysis using the apparatus shown.



(i) Name the type of particle responsible for the transfer of charge in

the wires, ...

the electrolyte. ..... [2]

(ii) Give **two** reasons why cryolite is used.

1 .....

2 ..... [2]

(iii) Write the ionic half-equation for the formation of aluminium during the electrolysis.

..... [1]

(iv) Explain how carbon dioxide gas is formed at the anodes.

.....

.....

..... [3]

(d) When a piece of aluminium is placed in dilute hydrochloric acid, there is no immediate visible reaction.
If the aluminium is left in the dilute hydrochloric acid for several hours, bubbles start to form.

Explain why aluminium does **not** react immediately with dilute hydrochloric acid.

.....

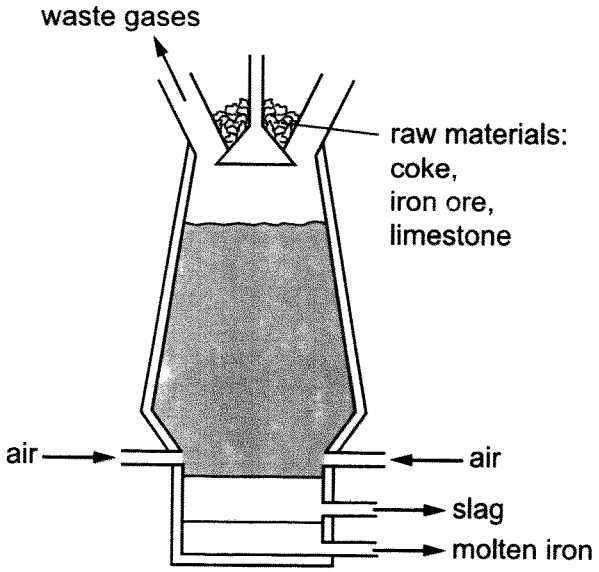
..... [1]

[Total: 14]

573

Q33. [0620/43/O/N/17/Q3]

Iron is extracted from its ore using coke in a blast furnace.



(a) Name the ore of iron which is mainly iron(III) oxide.

..... [1]

(b) Describe the reactions occurring in the blast furnace.

In your answer, include

- **two** reasons for using coke in the blast furnace,
- a chemical equation for the reduction of iron(III) oxide,
- an explanation for using limestone in the blast furnace.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [6]

574

(c) (i) Describe the bonding in iron. Include a diagram in your answer.

.....

..... [3]

(ii) Use your diagram in **(c)(i)** to explain why iron is malleable.

.....

..... [2]

(iii) Iron containing a small amount of carbon is known as steel.

Explain why steel is less malleable than iron.

.....

..... [2]

(d) (i) When iron is added to dilute sulfuric acid, an aqueous solution of iron(II) sulfate is formed as one of the products.

Write a chemical equation for the reaction.

..... [1]

(ii) When iron(III) oxide is added to dilute sulfuric acid, an aqueous solution of iron(III) sulfate is formed as one of the products.

Write a chemical equation for the reaction.

..... [3]

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575

[0620/43/O/N/17/Q5-A]

Q34.

(a) (i) Name the products formed when sodium nitrate is heated.

..... [2]

(ii) When copper(II) nitrate, $Cu(NO_3)_2$, undergoes thermal decomposition, three products are formed. One of the products is nitrogen dioxide, NO_2.

Write a chemical equation for the thermal decomposition of copper(II) nitrate.

..... [2]

576

[0620/41/M/J/18/Q3]

Q35.

This question is about iron.

(a) Three of the raw materials added to a blast furnace used to extract iron from hematite are coke, hematite and limestone.

Name **one** other raw material added to the blast furnace.

..... [1]

(b) A series of reactions occurs in a blast furnace during the extraction of iron from hematite.

Describe these reactions.
Include:

- **one** chemical equation for the reduction of hematite
- **one** chemical equation for the formation of slag.

.....

.....

.....

.....

.....

.....

.....

..... [5]

(c) The iron extracted from hematite using a blast furnace is impure.

Identify the main impurity in this iron and explain how it is removed in the steel-making process.

main impurity .....

how it is removed .....

.....

.....

[3]

[Total: 9]

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577

[0620/43/M/J/18/Q2]

Q36.

(a) ^{29}Al is a radioactive isotope of aluminium. The only non-radioactive isotope of aluminium is ^{27}Al.

(i) Describe, in terms of protons, neutrons and electrons, how the isotopes ^{29}Al and ^{27}Al are similar and how they are different.

how they are similar .....

how they are different .....

[2]

(ii) Complete the table to show the number of nucleons, neutrons and electrons in an $^{27}_{13}Al^{3+}$ ion.

	number in $^{27}_{13}Al^{3+}$
nucleons	
neutrons	
electrons	

[3]

(b) Aluminium is extracted from its ore by electrolysis.

(i) Name the main ore of aluminium.

..... [1]

(ii) Why is aluminium **not** extracted from its ore by reduction with carbon?

..... [1]

(iii) The main ore of aluminium contains aluminium oxide. Aluminium oxide is dissolved in molten cryolite before it is electrolysed.

Give **two** reasons, other than cost, why cryolite is used.

1 .....

2 .....

[2]

(iv) The reaction at the anode during the extraction of aluminium by electrolysis is shown.

$$2O^{2-} \rightarrow O_2 + 4e^-$$

Is this process oxidation or reduction?
Give a reason for your answer.

..... [1]

(v) During the extraction of aluminium by electrolysis, carbon dioxide is formed at the anode.

Explain how carbon dioxide is formed at the anode.

.....

..... [2]

(c) When a piece of zinc metal is added to copper(II) sulfate solution there is an immediate reaction.

$$Zn + CuSO_4 \rightarrow ZnSO_4 + Cu$$

When a piece of aluminium metal is added to copper(II) sulfate solution the initial reaction is very slow.

(i) Explain why zinc metal reacts with copper(II) sulfate.

..... [1]

(ii) What type of reaction is this?

..... [1]

(iii) Explain why the initial reaction between aluminium metal and copper(II) sulfate is very slow.

..... [1]

[Total: 15]

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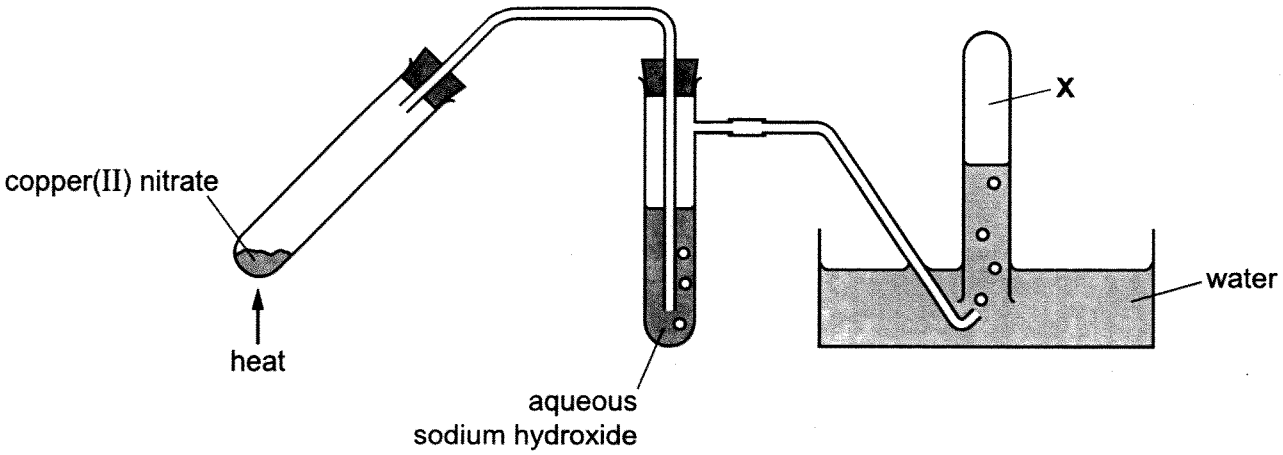
[0620/41/O/N/18/Q3-A-B]

Q37.

(a) Copper(II) nitrate decomposes when heated. Two gases, oxygen and nitrogen dioxide, and a solid are made in the reaction.

A sample of copper(II) nitrate was decomposed using the apparatus shown.



(i) Complete the chemical equation for the reaction.

$2Cu(NO_3)_2 \rightarrow O_2 + ...NO_2 + ...$ [2]

(ii) Only oxygen gas is collected at **X**.

Explain why.

.....

..... [1]

(b) Nitrogen dioxide and other oxides of nitrogen are formed in car engines.

Explain how nitrogen dioxide is formed in car engines.

.....

.....

.....

..... [2]

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Q38. [0620/42/M/J/19/Q7-A-B-C]

(a) Displacement reactions occur between metals and metal ions.

Displacement reactions can be used to determine the order of reactivity of metals such as lead (Pb), nickel (Ni), and silver (Ag).

The ionic equation for a displacement reaction is shown.

$$Ni(s) + Pb^{2+}(aq) \rightarrow Pb(s) + Ni^{2+}(aq)$$

The ionic half-equations for this reaction are shown.

$$Ni(s) \rightarrow Ni^{2+}(aq) + 2e^-$$

$$Pb^{2+}(aq) + 2e^- \rightarrow Pb(s)$$

The ionic half-equations show that electrons are donated by nickel atoms and accepted by lead ions.

(i) Identify the reducing agent in the displacement reaction. Give a reason for your answer.

reducing agent.....

reason.....

[2]

(ii) What is the general term given to the type of reaction in which electrons are transferred from one species to another?

..... [1]

(b) The ionic equation for another displacement reaction is shown.

$$Pb(s) + 2Ag^+(aq) \rightarrow 2Ag(s) + Pb^{2+}(aq)$$

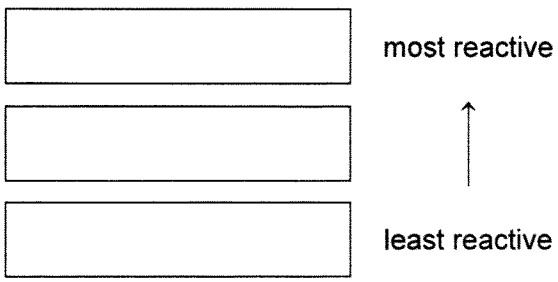
Write the **two** ionic half-equations for this reaction.

1 .....

2 .....

[2]

(c) Use the information in **(a)** and **(b)** to put the **three** metals lead, nickel and silver in order of reactivity.



[1]

581

[0620/41/O/N/19/Q3-A-B]

Q39.

This question is about metals and metal oxides.

(a) Most metals have a high melting point.

State **one** other physical property that all metals have.

..... [1]

(b) Iron often rusts.

Name the **two** substances, other than iron, that must be present for iron to rust.

1 .....

2 .....

[1]

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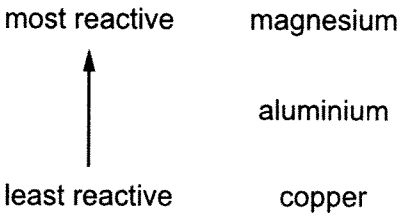
582

[0620/43/O/N/19/Q3-C-D]

Q40.

(c) The positions of some common metals in the reactivity series are shown.



(i) When magnesium is placed in aqueous copper(II) sulfate a displacement reaction occurs immediately.

Write an ionic equation for the reaction. Include state symbols.

..... [2]

(ii) State **two** observations you would make when magnesium is placed in aqueous copper(II) sulfate.

1 .....

2 .....

[2]

(iii) When aluminium foil is added to aqueous copper(II) sulfate no immediate reaction takes place.

Explain why.

..... [1]

(d) Aluminium powder reacts with iron(III) oxide to produce aluminium oxide and iron.

Write a chemical equation for this reaction.

..... [2]

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583

[0620/43/M/J/2020/Q7-E]

Q41.

(e) Iron is a transition element.

(i) Iron forms hydrated iron(III) oxide when it rusts.

Write a word equation to represent the formation of rust.

..... [2]

(ii) Give **two** ways in which the properties of transition elements differ from the properties of Group I metals.

1 .....

2 .....

[2]

584

Q42. [0620/41/O/N/2020/Q2]

Zinc is extracted from an ore containing zinc sulfide.

(a) State the name of this zinc ore.

..... [1]

(b) This ore is converted to zinc oxide, ZnO.

Zinc oxide is then reacted with carbon.

(i) Write a chemical equation for the reaction of zinc oxide with carbon.

..... [1]

(ii) State what type of chemical change happens to the zinc in zinc oxide in this reaction.

Explain your answer.

chemical change .....

explanation .....

.....

..... [2]

(iii) Explain why aluminium is **not** extracted from aluminium oxide by heating with carbon.

.....

..... [1]

(iv) Suggest an alternative method for the extraction of zinc from zinc oxide.

..... [1]

(c) Brass is an alloy of zinc.

Explain, in terms of particles, why brass is harder than pure zinc.

.....

.....

.....

.....

..... [3]

[Total: 9]

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Q43. [0620/42/O/N/2020/Q3]

Group I metals are very reactive. Transition elements are also metals but are less reactive than Group I metals.

(a) State **two** physical properties of Group I metals which are similar to those of transition metals.

1 .....

2 .....

[2]

(b) Describe **two** ways in which the physical properties of Group I metals are different from those of transition metals.

1 .....

.....

2 .....

.....

[2]

(c) When Group I metals are added to water they fizz and an alkaline solution forms.

(i) Name the gas given off.

..... [1]

(ii) Identify the ion present in the solution which makes the solution alkaline.

..... [1]

(iii) Write the chemical equation for the reaction between sodium and water.

..... [2]

(d) When the transition element iron is added to water the iron rusts.

When an iron object is coated with a layer of zinc, rusting is prevented.

(i) Name this process of coating iron objects with a layer of zinc.

..... [1]

(ii) Explain how completely coating an iron object with a layer of zinc prevents rusting.

..... [1]

(iii) Rusting of iron ships can be prevented by attaching zinc blocks to the hull of the ship.

Explain how this prevents rusting.

.....

..... [2]

[Total: 12]

Q44. [0620/43/O/N/2020/Q4]

Zinc is manufactured from zinc blende. Zinc blende is an ore which consists mainly of zinc sulfide, ZnS.

(a) Zinc blende is roasted in air. One of the products is zinc oxide.

Name the **other** product formed in this reaction.

..... [1]

(b) Zinc oxide is then converted into zinc.

Zinc oxide and coke, a source of carbon, are heated in a furnace. Hot air is blown into the furnace.

(i) Give **two** reasons why coke is needed.

1 .....

2 .....
[2]

(ii) Write a chemical equation for the formation of zinc in the furnace.

..... [1]

(iii) Zinc has a melting point of 420 °C and a boiling point of 907 °C. The temperature inside the furnace is 1200 °C.

Explain how this information shows that the zinc produced inside the furnace is a gas.

..... [1]

(iv) The gaseous zinc is converted to molten zinc.

Name this change of state.

..... [1]

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(c) Zinc reacts with dilute sulfuric acid to produce aqueous zinc sulfate.

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

Hydrated zinc sulfate crystals are made from aqueous zinc sulfate.

Step 1 Solid zinc is added to dilute sulfuric acid until zinc is in excess.

Step 2 Excess zinc is separated from aqueous zinc sulfate by filtration.

Step 3 Aqueous zinc sulfate is heated until the solution is saturated.

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

Step 5 The crystals are removed and dried.

(i) Name the residue in **step 2**.

..... [1]

(ii) In **step 3**, a saturated solution is produced.

Describe what a saturated solution is.

.....

.....

..... [2]

(iii) Name **two** compounds each of which react with dilute sulfuric acid to produce aqueous zinc sulfate.

1 .....

2 .....

[2]

588

(d) When hydrated magnesium sulfate crystals, $MgSO_4 \cdot xH_2O$, are heated they give off water.

$$MgSO_4 \cdot xH_2O(s) \rightarrow MgSO_4(s) + xH_2O(g)$$

A student carries out an experiment to determine the value of x in $MgSO_4 \cdot xH_2O$.

Step 1 Hydrated magnesium sulfate crystals were weighed.

Step 2 Hydrated magnesium sulfate crystals were heated.

Step 3 The remaining solid was weighed.

(i) Describe how the student can ensure that all the water is given off.

.....

.....

..... [2]

(ii) In an experiment, all the water was removed from 1.23 g of $MgSO_4 \cdot xH_2O$. The mass of $MgSO_4$ remaining was 0.60 g.

M_r: $MgSO_4$ = 120; M_r: H_2O = 18

Determine the value of x using the following steps.

- Calculate the number of moles of $MgSO_4$ remaining.

moles of $MgSO_4$ = ...

- Calculate the mass of H_2O given off.

mass of H_2O = ... g

- Calculate the moles of H_2O given off.

moles of H_2O = ...

- Determine the value of x.

x = ...

[4]

[Total: 17]

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Q45. [0620/43/O/N/2020/Q5]

Group I elements, Group VII elements and transition elements are found in different parts of the Periodic Table.

(a) Describe the trend in the reactivity of Group I elements.

.....

..... [1]

(b) When potassium is added to water a chemical reaction occurs.

(i) State **two** observations that can be made when potassium is added to water.

.....

..... [2]

(ii) Write a chemical equation for the reaction of potassium with water.

..... [2]

(c) Excess aqueous potassium iodide is added to chlorine.

(i) Write a chemical equation for the reaction that occurs when aqueous potassium iodide is added to chlorine.

..... [2]

(ii) State the final colour of the reaction mixture.

..... [1]

(d) Sodium is extracted from sodium chloride by electrolysis.

(i) State the meaning of the term *electrolysis*.

.....

..... [2]

(ii) State what must be done to sodium chloride before it can be electrolysed to produce sodium.

..... [1]

(iii) Write an ionic half-equation for the change that occurs at the cathode during this electrolysis.

..... [1]

(e) Chromium is a transition element.

- Chromium has a high melting point.
- Chromium is a good conductor of electricity.
- Many chromium compounds are soluble in water.
- Hydrated chromium(III) sulfate is green.
- Chromium forms the chlorides $CrCl_2$ and $CrCl_3$.
- Oxides of chromium act as catalysts in the manufacture of poly(ethene).

(i) Use this information to give **two** properties of chromium which are different from properties of Group I elements such as sodium.

1 .....

2 .....

[2]

(ii) Use this information to give **two** properties of chromium which are similar to properties of Group I elements such as sodium.

1 .....

2 .....

[2]

[Total: 16]

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Page 3	Mark Scheme: Teachers' version	Syllabus	Paper
	IGCSE – May/June 2011	0620	31

Q1.

(a) any four max 4
carbon forms carbon dioxide / carbon monoxide [1]
this is a gas it escapes / blown out / diffuses [1]
silicon forms silicon(IV) oxide / silica [1]
/ silicon(IV) oxide present in impure iron
silicon(IV) oxide reacts with calcium oxide to form slag **or** calcium silicate [1]
slag removed from surface [1]
accept skimmed, syphoned, poured off
not tapped max [4]
accept correct formula or equations
not calcium oxide reacts with silicon

(b) (i) any sensible suggestion – harder/stronger/can be tailored for a specific use/more resistant to corrosion [1]
not steel does not rust

(ii) mild steel – cars or any vehicle/bicycles/white goods/screws or nails/roof/bridges/tools/ buildings/ships/pipes/machinery etc. [1]

stainless steel – chemical plants/cooking utensils/jewellery/cutlery/surgical equipment/ kitchen sinks/pipes/etc. [1]

(c) (i) strong attractive forces / strong bonds / bonds hard to break / requires a lot of energy to break bonds [1]
not between ions, **not** between positive and negative ions,
not between electrons

between positive ions and (negative) electrons / opposite charges attract [1]

(ii) because the layers, lattice or rows of ions/cations [1]
accept sheets of ions
not atoms / molecules / protons / nuclei

can move / slip / slide past each other [1]

Page 3	Mark Scheme: Teachers' version	Syllabus	Paper
	IGCSE – May/June 2011	0620	31

Q2.

(a) (i) $2ZnS + 3O_2 \rightarrow 2ZnO + 2SO_2$ [2]
not balanced only [1]

(ii) **two** reagents from named metal(s) more reactive than zinc/carbon monoxide [2]
not hydrogen

(iii) they have different boiling points [1]
cadmium will distil first then zinc leaving lead/lead distilled last [1]

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Page 5	Mark Scheme: Teachers' version	Syllabus	Paper
	IGCSE – May/June 2011	0620	31

Q3.

(a) metal A is magnesium [1]
cond most reactive or fastest reaction [1]

metal B is aluminium [1]
cond faster reaction after removal of oxide layer / it would give more hydrogen / aluminium more reactive than zinc [1]

metal C is zinc [1]
zinc least reactive [1]
NOTE MAX [5]
If you encounter different reasoning which is correct, please award the appropriate marks.

(b) for magnesium and zinc same volume of hydrogen [1]

because both have valency of 2 / 1 mole of metal gives 1 mole of hydrogen / 1 mole of metal reacts with 2 moles of acid [1]

bigger volume for aluminium because its valency is 3 / 1 mole of metal gives 1.5 moles of hydrogen / 1 mole of metal reacts with 3 moles of acid [1]

If you encounter different reasoning which is correct, please award the appropriate marks.

accept balanced equations
accept ionic charges as alternative to valency

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Page 2	Mark Scheme: Teachers' version	Syllabus	Paper
	IGCSE – May/June 2011	0620	32

Q4.

(a) (i) no reaction [1]

$Fe + Sn^{2+} \rightarrow Fe^{2+} + Sn$ / $2Fe + 3Sn^{2+} \rightarrow 2Fe^{3+} + 3Sn$ [2]
for realising that there would be a reaction shown by an attempt to write an equation e.g. writing Fe_2Sn etc. allow [1]

no reaction [1]

(ii) tin oxide, nitrogen dioxide (accept nitogen(IV) oxide/dinitrogen tetroxide), oxygen
All three for two [2]
accept correct formulae

any two correct products [1]

(c) zinc is more reactive than iron/steel [1]
tin is less reactive than iron/steel [1]

zinc corrodes/reacts/loses electrons/is oxidised/is anodic/provides sacrificial protection/ forms positive ions (in preference to iron or steel) ORA
allow iron is cathodic for this mark. [1]

Iron/steel corrodes/reacts/rusts/loses electrons/is oxidised/is anodic/forms positive ions (in preference to tin). ORA
allow tin is cathodic for this mark [1]

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Q5.

One redox equation [1]
accept $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$
$2Fe_2O_3 + 3C \rightarrow 4Fe + 3CO_2$
$Fe_2O_3 + 3C \rightarrow 2Fe + 3CO$
$C + O_2 \rightarrow CO_2$
$CO_2 + C \rightarrow 2CO$

one acid/base equation [1]
$CaO + SiO_2 \rightarrow CaSiO_3$
or $CaCO_3 + SiO_2 \rightarrow CaSiO_3 + CO_2$

three more equations or comments [3]
carbon burns to form carbon dioxide
this reaction is exothermic or produces heat
carbon dioxide is reduced to carbon monoxide
carbon monoxide reduces hematite to iron
carbon reduces hematite to iron
limestone removes silica which is an impurity
to form slag which is a waste product
limestone decomposes or symbol/word equation

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Q6.

(a) (i) bauxite [1]

(ii) lowers melting point [1]
better conductor / reduces amount of energy needed / reduces cost / more economic / makes process viable / conserves energy [1]

(iii) aluminium more reactive than copper / aluminium higher in reactivity series [1]
hydrogen not aluminium formed at cathode [1]

(b) $Al^{3+} + 3e \rightarrow Al$ [1]
$2O^{2-} \rightarrow O_2 + 4e$ [2]
note: not balanced = 1
oxygen reacts with carbon (anode) to form carbon dioxide / $C + O_2 \rightarrow CO_2$ [1]
note: if mark(s) for an electrode reaction are not awarded then allow aluminium ions accept electrons / are reduced [1]
oxide ion loses electrons / is oxidised [1]
max 4

(c) (i) protective oxide layer [1]

(ii) aluminium low density / light [1]
aluminium is a good conductor [1]
strength / prevent sagging / allows greater separation of pylons / core made of steel because it is strong [1]

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Q7.

(a) (i) alloy / mixture [1]
iron and carbon / another metal or element etc. [1]

(ii) electron loss [1]

(b) electrons move from / lost from Mg [1]
to steel / iron [1]

(c) (i) $2H^+ + 2e \rightarrow H_2$ [2]
not balanced = 1

(ii) sacrificial protection – is a <u>cell</u> [1]
cathodic protection – is electrolysis NOT electrical cell [1]
or:
sacrificial protection – electrons from more reactive metal [1]
cathodic protection – electrons from battery etc. [1]
or:
sacrificial protection – does not need or use power / battery / electricity / electrical cell [1]
cathodic protection – does [1]
or:
sacrificial protection uses up / needs a sacrificial / more reactive metal [1]
cathodic protection doesn't [1]

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Q8.

(a) any **three** from:
barium more reactive / forms ions more readily
barium reacts with (cold) water, nickel does not
barium more vigorous with acids
nickel compounds coloured, barium compounds white
nickel has more than one oxidation state, barium has one
nickel / nickel compounds catalysts, barium / barium compounds not catalysts
nickel forms complex ions, barium does not [3]

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Q9.

(a) calcium carbonate → calcium oxide + carbon dioxide [1]
accept: correct symbol equation

$Ca(OH)_2 \rightarrow CaO + H_2O$ [1]

(b) **(i)** CuO **and** NO_2 **and** O_2; [1]
accept: names or correct formulae

(ii) $2NaNO_3 \rightarrow 2NaNO_2 + O_2$ [2]
accept: $NaNO_3 \rightarrow NaNO_2 + 1/2\ O_2$
not balanced = [1]

(c) Na / Ca; [1]

(d) Cu; Ag; [2]
accept: *ions* Cu^{2+} *and* Ag^{+}

[Total: 8]

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Q10.

(a) (i) oxygen; [1]
carbon dioxide / fluorine / carbon monoxide; [1]

(ii) decrease mpt (of alumina/Al_2O_3) / lower (operating) temperature (from 1900/2100 (°C) to 800/1000 (°C) / reduce energy (accept heat or electrical) requirement; [1]
improve conductivity / dissolves the Al_2O_3 / acts as solvent; (**allow:** makes aluminium oxide conduct / to conduct electricity / making ions free to move) [1]

(iii) Al_2O_3 (accept alumina) reacts / dissolves / forms a salt and water / is neutralised; [1]
(Fe_2O_3 removed by) filtration / centrifugation / decantation; [1]

(b) (i) electrolysis / electrolyte / electrodes / anode / cathode / electricity / cell; [1]
chlorine formed at anode (positive electrode); (**note:** can be awarded from a correct or incorrect equation with Cl_2 as the only substance on the right as long as anode is mentioned.) [1]
hydrogen formed at cathode (negative electrode); (**note:** can be awarded from a correct or incorrect equation with H_2 as the only substance on the right as long as cathode is mentioned.) [1]
one correct half equation either $2Cl^- \rightarrow Cl_2 + 2e$ or $2H^+ + 2e \rightarrow H_2$ [1]
solution remaining contains Na^+ and OH^- / sodium and hydroxide ions / NaOH / sodium hydroxide left behind/remains in solution; [1]

note: if a mercury cathode is specified
electrolysis / electrolyte / electrodes / anode / cathode / electricity / cell; [1]
chlorine formed at anode (positive electrode); (**note:** can be awarded from a correct or incorrect equation with Cl_2 as the only substance on the right as long as anode is mentioned.) [1]
sodium formed at cathode; (**note:** can be awarded from a correct or incorrect equation with Na as the only substance on the right as long as cathode is mentioned.) [1]
one correct half equation at anode i.e. $2Cl^- \rightarrow Cl_2 + 2e$ or at cathode $Na^+ + e \rightarrow Na$ (**accept:** equivalent with NaHg amalgam) [1]
NaOH/sodium hydroxide is formed by sodium/sodium mercury amalgam reacting with or when added to water; [1]
note: award the fourth and fifth mark if correct equation given for reaction between sodium or sodium mercury amalgam reacting with water i.e.
$2Na(Hg) + 2H_2O \rightarrow 2NaOH + H_2 + (2Hg)$

(ii) H_2 / H / hydrogen **and** making ammonia / making margarine / hardening fats / fuel / energy source / cryogenics / welding; [1]
Cl_2 / Cl / chlorine **and** (making) bleach / water treatment / kill bacteria (in water) / water purification / swimming pools / making solvents / making PVC / making weed killer / making disinfectants / making hydrochloric acid / HCl / making herbicides / pesticides / insecticides; [1]

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Q11.

(b) any two from:
physical
niobium is
harder; stronger; higher mp/bp; higher density [2]
note: there has to be a comparison

any two from:
chemical
niobium is less reactive; forms coloured compounds; forms complex ions; its compounds have catalytic properties; has more than one oxidation state; has more than one valency electron; [2]
note: the response has to refer to or compare properties of both elements

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Q12.

(a) $C + O_2 \rightarrow CO_2$ [1]

(b) **(i)** CO_2 already formed (from C burning or from $CaCO_3$); [1]
then carbon reacts with carbon dioxide; [1]
or
$C + CO_2 \rightarrow 2CO$ = [2] If equation not balanced = [1]

(ii) $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$ [2]
not balanced = [1]
not: reduction by carbon

(c) to remove / neutralise silica / silicon dioxide / silicon(IV) oxide / sand; [1]
reacts with limestone to form slag / calcium silicate; [1]
$CaCO_3 + SiO_2 \rightarrow CaSiO_3 + CO_2$ [1]
or $CaO + SiO_2 \rightarrow CaSiO_3$
or $CaCO_3 \rightarrow CaO + CO_2$

(d) **(i)** galvanising / galvanisation / sacrificial protection; [1]

(ii) sacrificial protection / zinc is sacrificed;
zinc corrodes rather than iron;
zinc is oxidised in preference to iron;
zinc reacts with oxygen and / water in preference to iron;
zinc more reactive / electropositive than iron;
zinc loses electrons more readily than iron;
electrons move on to iron
any **three** [3]

[Total: 12]

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Q13.

(ii) $ZnO + H_2SO_4 \rightarrow ZnSO_4 + H_2O$ [2]
[1] for correct reactants [1]for correct products

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Q14.

(c) (i) oxygen reacts with copper [1]
to form copper oxide (which is black) [1]

(ii) measure volume at room temperature / gas has different volumes at different temperatures / volume of gas depends on temperature / hot gas has higher volume / heat causes expansion (of gases) / ORA [1]

(iii) no oxygen left **or** all the oxygen has reacted (with copper) [1]

(iv) 39–40 cm^3 **note:** units required [1]

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Q15.

(a) (i) ions cannot move / no free ions in solid state [1]
ions can move / free ions in liquid state [1]
note: ions can only move in liquid state = 2

(ii) reduce melting point / reduce energy costs / better conductor when dissolved in cryolite [1]

(iii) burns in oxygen / reacts with oxygen / oxidised by oxygen / forms carbon dioxide / forms carbon monoxide [1]

(iv) high melting point / inert / unreactive [1]

(b) protective / unreactive / resists / prevents corrosion / non-porous (layer) [1]

of (aluminium) oxide [1]

(c) (i) good conductor (of electricity) [1]
low density / light / lightweight [1]

(ii) steel core (increased) strength / prevent sagging / to increase separation of pylons / support [1]

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Q16.

(a) (i) cars, ships, bridges, construction, white goods, screws, nails, roofing, fencing, etc. [1]

(ii) e.g. stainless steel [1]
cooking utensils, surgical equipment, sinks or main use [1]

(b) blow in oxygen **NOT** air [1]
carbon dioxide and sulfur dioxide (escape as gases) [1]
COND on reaction with air / oxygen
add calcium oxide / quicklime [1]
ALLOW calcium carbonate, limestone
phosphorus oxide **or** silicon oxide (are acidic)
reacts (with calcium oxide / $CaCO_3$) [1]
to form slag / calcium silicate [1]

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Q17.

(a) (i) any Group 1 metal [1]
ACCEPT: lithium

(ii) $2Pb(NO_3)_2 \rightarrow$ **2PbO** + $4NO_2$ + O_2 [2]
PbO [1]
COND balancing [1]

(iii) the metal in **a (i)** is **more reactive** than lead [1]
more reactive metals have **more stable** compounds
OR has stronger (ionic) bonding [1]

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Q18.

(a) Any one of:
$Fe_2O_3 + 3C \rightarrow 2Fe + 3CO$
$2Fe_2O_3 + 3C \rightarrow 4Fe + 3CO_2$
$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$
for correct equation (2)
not balanced = (1) only

any four of:

coke burns to form carbon dioxide / $C + O_2 \rightarrow CO_2$

this reacts with more carbon to form carbon monoxide / $C + CO_2 \rightarrow 2CO$

calcium carbonate decomposes to form calcium oxide and carbon dioxide / $CaCO_3 \rightarrow CaO + CO_2$

calcium oxide / calcium carbonate reacts with silica / silicon oxide / silicon(IV) oxide (in ore) to form calcium silicate / slag / $CaO + SiO_2 \rightarrow CaSiO_3$ **or** $CaCO_3 + SiO_2 \rightarrow CaSiO_3 + CO_2$

the reaction between carbon and oxygen is exothermic / produces heat / coke is used as a fuel / the slag floats on the (molten) iron / the slag and molten iron can be run off separately [6]

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Q19.

(a) (i) roast or heat or burn in air / roast or heat or burn in oxygen [1]
need both of the above

(ii) $ZnO + C \rightarrow Zn + CO$ / $2ZnO + C \rightarrow 2Zn + CO2$ / $ZnO + CO \rightarrow Zn + CO_2$ [1]

(b) (i) $ZnO + H_2SO_4 \rightarrow ZnSO_4 + H_2O$ [1]

(ii) zinc reduces / gives electrons / displaces (copper / cobalt / nickel ions) [1]
forming copper / cobalt / nickel (metal which is precipitated) [1]

(d) (i) Any two of:
appearance
more resistant to corrosion
harder (accept stronger)
easier to cast [2]

(ii) zinc more reactive (than iron or steel) [1]
zinc loses electrons [1]
electrons move (from zinc) to iron [1]
zinc reacts (with air and water) / zinc corrodes / is oxidised / forms positive ions / anodic
or
iron and steel don't react (with air and water) / not oxidised / do not form ions / do not lose electrons [1]

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Q20.

(a) M1: (zinc sulfide) heated / roasted / burnt in **air** (1)

M2: zinc oxide formed (1)

M3: zinc oxide **reduced** (1)

M4: (by adding) coke or carbon (1)

M5: Balanced equation (any one of) (1) [5]

$2ZnS + 3O_2 \rightarrow 2ZnO + 2SO_2$
$2ZnO + C \rightarrow 2Zn + CO_2$
$ZnO + C \rightarrow Zn + CO$
$ZnO + CO \rightarrow Zn + CO_2$

(b) Any **two** from: [2]

- (making) brass **or** alloys (1)
- galvanising (1)
- sacrificial protection (1)
- batteries (1)

[Total: 7]

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Q21.

(a) (i)

aqueous solution	lead Pb	magnesium Mg	zinc Zn	silver Ag
lead (II) nitrate		✓	✓	✓
magnesium nitrate	✗		✗	✗
zinc nitrate	✗	✓		✗
silver(I) nitrate	✓	✓	✓	

each horizontal line correct (1) [3]

(ii) Zn (1)
An arrow **from** Zn **to** Zn_{2+} (1) [2]

(iii) $Zn + 2Ag^+ \rightarrow Zn^{2+} + 2Ag$ (1) [1]

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Q22.

(a) (i) heat limestone/calcium carbonate (1)
fractional distillation (1)
liquid air (1) [3]

(ii) any **two** of the oxides, C, S, P and Si, mentioned (1)
carbon dioxide and sulfur dioxide escape/are gases (1)

phosphorus oxide **or** silicon(IV) oxide react with calcium oxide/
phosphorus oxide **or** silicon(IV) oxide are acidic and calcium oxide is basic (1)

to form a slag **or** calcium silicate **or** calcium phosphate (1)

must have correct equation for one of the above reactions (1) [5]

(b) (i) lattice/rows/regular arrangement of cations/positive ions/Fe^{2+} (1)
mobile/free/delocalised/sea of electrons (1) [2]

(ii) the rows of ions/ions can move past each other (1)
without the metal breaking/bonds are not directional/not rigid (1) [2]

(iii) carbon particles/atoms different size (1)
prevents movement of rows, etc. (1) [2]

[Total: 14]

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Q23.

(a) (i) insufficient/limited oxygen
or $2C + O_2 \rightarrow 2CO$ [1]

coke/carbon reacts with carbon dioxide
or $C + CO_2 \rightarrow 2CO$ [1]

(ii) $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$
species (1) balancing (1) [2]

(b) (i) carbon dioxide [1]

(ii) $CaO + SiO_2 \rightarrow CaSiO_3$
[1] each side correct [2]

(iii) (molten) iron higher density (than slag) [2]

(iv) No oxygen in contact with iron **or** layer of slag prevents hot iron reacting with oxygen/air **or** (all) oxygen reacts with carbon (so no oxygen left to react with iron) [1]

(c) (i) air/oxygen and water (need both) [1]

(ii) aluminium oxide layer is impervious **or** non-porous **or** passive **or** unreactive **or** will not allow water/air to pass through it (rust allows passage of water **or** air **or** it flakes off) [1]

(d) (i) zinc more reactive (than iron/steel) [1]
loses electrons [1]
electrons move (from zinc) to iron [1]
Zinc reacts (with air and water) **or** zinc corrodes **or** zinc is oxidised **or** zinc is anodic **or** zinc forms positive ions **or** zinc forms Zn^{2+} **or** iron and steel don't react with air/water **or** iron and steel are not oxidised **or** iron and steel do not form ions **or** iron and steel do not lose electrons **or** iron and steel are cathodic [1]

(ii) R to L in wire [1]

(iii) $2H^+ + 2e^- \rightarrow H_2$
species (1) balancing (1)

[Total: 19]

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Q24.

(d) (i) Has an impervious **or** non-porous **or** passive **or** unreactive **or** protective oxide layer [1]

(ii) Any **two** from:
good conductor of heat
high melting point
Unreactive towards foods [2]

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Q25.

(a) M1 brass [1]

M2 copper **COND** on M1 [1]

(b) (i) $2ZnS + 3O_2 \rightarrow 2ZnO + 2SO_2$ [2]
species (1) balancing (1)

(ii) Manufacture of sulfuric acid
or bleach or making wood pulp or making paper
or food or fruit juice or wine preservative
or fumigant or sterilising [1]

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Q26.

Question	Answer	Marks	Guidance
2(a)	M1 *Forming an oxide* (all) elements or (all) impurities become oxides;		(All) elements or (all) impurities react with oxygen **A** M1 for any one element becoming an oxide
	M2 *Gaseous oxides* carbon dioxide or sulfur (di)oxide escape / are removed as gases;		**A** formulae / carbon monoxide **A** oxides of sulfur / carbon **I** sulfur trioxide
	M3 *Acidic oxides* silicon(IV) oxide or phosphorus(III / V) oxide react / are neutralised by calcium oxide / lime;		**A** silicon (di)oxide for silicon(IV) oxide **A** phosphorus (tri/pent)oxide for phosphorus(III / V) oxide
	M4 *Equation mark* any one of the following equations $S + O_2 \rightarrow SO_2$; $C + O_2 \rightarrow CO_2$ or $2C + O_2 \rightarrow 2CO$; $Si + O_2 \rightarrow SiO_2$; $4P + 5O_2 \rightarrow 2P_2O_5$ or $P_4 + 5O_2 \rightarrow 2P_2O_5$; $4P + 3O_2 \rightarrow 2P_2O_3$ or $P_4 + 3O_2 \rightarrow 2P_2O_3$;		**A** multiples **I** state symbols **I** unbalanced equations **R** other combustion equations with incorrect species
	M5 *Word equation mark* any one of the following word equations calcium oxide + silicon(IV) oxide → calcium silicate; calcium oxide + phosphorus(III / V) oxide → calcium phosphate;	5	**A** calcium oxide + silicon(IV) oxide → slag **A** correct symbol equation for M5 but **R** other equations with incorrect species used as M5

2(b)(i)	*Any **one** from:* (making) car (bodies); machinery; chains; pylons; white goods; nails; screws; as a building material; sheds / roofs; reinforcing concrete;	1	**A** bridges **A** tools **I** cutlery
2(b)(ii)	*Any **one** from:* knives; drills; railway tracks; machine / cutting tools / hammers; razor blades; chisels;	1	**I** cutlery items **I** bridges
2(b)(iii)	M1 atoms or cations or (positive) ions or metal ions; M2 arranged in a lattice or in layers or in rows or in a regular structure; M3 rows or layers slide over one another;	3	**I** (sea of) electrons **R** protons or nuclei for M1 **A** M2 non-directional forces **A** ECF on particle named in M1 for M3 **I** 'atoms' slide over one another
2(b)(iv)	M1 carbon **atoms** or **particles** in structure different size (to cations); M2 so reduce moving or interrupt movement;	2	**R** ions and molecules for M1 **A** M2 for prevents sliding **A** M2 for 'stops' sliding

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Q27.

Question	Answer	Marks
6(b)(i)	**M1** heat produced by carbon / coke (burning in) oxygen / air; **OR** $C + O_2 \rightarrow CO_2$ produces heat / exothermic; **OR** $2C + O_2 \rightarrow 2CO$ produces heat / exothermic; (scores **M1** and **M2**); **M2** $C + CO_2 \rightarrow 2CO$; **OR** $2C + O_2 \rightarrow 2CO$; **M3** $ZnO + CO \rightarrow Zn + CO_2$; **OR** $ZnO + C \rightarrow Zn + CO$; **OR** $2ZnO + C \rightarrow 2Zn + CO_2$;	3 1 1 1
6(b)(ii)	temperature (inside the furnace) is above 907 °C / temperature (inside the furnace) is above the boiling point (of zinc) / 1000 °C is above the boiling point (of zinc);	1
6(b)(iii)	condensation / condensing / condense;	1
6(c)	**M1** zinc is more reactive than iron / zinc is higher in the reactivity series than iron ora; **M2** zinc loses electrons; **M3** iron / steel / oxygen / air / water gains electrons **OR** electrons move to iron / steel / oxygen / air / water; **M4** (therefore) iron does not lose electrons / get oxidised / form iron(II) / form iron(III);	4 1 1 1 1

Q28.

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Question	Answer	Marks
1(a)(i)	A;	1
1(a)(ii)	B;	1
1(a)(iii)	D;	1
1(a)(iv)	C;	1
1(a)(v)	C;	1
1(b)(i)	(hot) air;	1
1(b)(ii)	(molten) iron;	1
1(b)(iii)	any 2 from: carbon dioxide; carbon monoxide; nitrogen;	2
1(c)(i)	as the percentage of carbon increases, so the malleability decreases;	1
1(c)(ii)	**M1** oxygen (gas) blown in; **M2** carbon dioxide formed / $C + O_2 \rightarrow CO_2$;	2 1 1

Q29.

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Question	Answer	Mark
6(a)	bauxite/Alumina is dissolved in molten cryolite cryolite lowers the melting temperature molten aluminium forms *anode reaction*: $2O^{2-} \rightarrow O_2 + 4e^-$ *cathode reaction:* $Al^{3+} + 3e^- \rightarrow Al$	5
6(b)	carbon or graphite electrode reacts with oxygen / burns (in oxygen) / combusts	2
6(c)	*use 1*: manufacture of aircraft *reason 1*: low density *use 2*: food containers **OR** cooking foil *reason 2*: Al resistant to corrosion	4

Q30.

Question	Answer	Marks
4(a)(i)	roast in air	1
4(a)(ii)	$2ZnS + 3O_2 \rightarrow 2ZnO + 2SO_2$ **M1** correct species **M2** correct balancing	2
4(b)(i)	coke	1
4(b)(ii)	zinc is vaporised / boiled	1
	and is condensed	1

Q31.

Question	Answer	Marks
3(a)(i)	brown / orange solid (forms / is made) **OR** solution becomes paler / colourless	1
3(a)(ii)	magnesium is oxidised **AND** copper ions are reduced **OR** magnesium loses electrons **AND** copper ions gain electrons **OR** magnesium increases in oxidation number **AND** copper decreases in oxidation number	1
3(a)(iii)	Cu^{2+} **OR** copper(II) ions **OR** copper ions	1
	gains electrons	1
3(a)(iv)	$3Mg + Fe_2O_3 \rightarrow 3MgO + 2Fe$ **M1** Fe_2O_3 **AND** MgO **M2** fully correct	2
3(b)(i)	prevents air / oxygen **AND** water from reaching the steel	1
3(b)(ii)	magnesium is more reactive than iron / steel	1
	the magnesium corrodes (before the iron / steel) **OR** the magnesium corrodes preferentially	1
3(b)(iii)	copper is less reactive than iron / steel	1

Q32.

Question	Answer	Marks
6(a)	aluminium is more reactive than carbon	1
6(c)(i)	*the wires:* electrons	1
	the electrolyte: ions	1
6(c)(ii)	any 2 from: ☐ increases conductivity ☐ as a solvent ☐ lowers the operating temperature	2
6(c)(iii)	$Al^{3+} + 3e^- \rightarrow Al$	1
6(c)(iv)	oxygen is made at the anode	1
	the anodes are made of carbon	1
	oxygen (made) reacts with carbon	1
6(d)	aluminium coated with layer of (unreactive) aluminium oxide	1

Q33.

Question	Answer	Marks
3(a)	hematite	1
3(b)	(coke reacts with oxygen / air) to produce heat / increase temperature / exothermically	1
	coke is reducing agent / produces reducing agent / produces carbon monoxide **OR** **coke reduces** Fe_2O_3 / (iron) ore / hematite (producing iron)	1
	$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$ **OR** $Fe_2O_3 + 3C \rightarrow 2Fe + 3CO$ **OR** $2Fe_2O_3 + 3C \rightarrow 4Fe + 3CO_2$ **M1** species correct **M2** balanced	2
	limestone (decomposes to calcium oxide which) reacts with / removes **acidic impurities** / SiO_2 / sand / silica / silicon(IV) oxide / silicon dioxide	1
	limestone / calcium oxide / lime is involved in the production of slag / calcium silicate	1
3(c)(i)	positive ions / cations	1
	sea of electrons / mobile electrons / delocalised electrons / moving electrons / flowing electrons	1
	attraction between positive ions and electrons	1
3(c)(ii)	layers / rows / sheets of ions	1
	slide / slip / shift (over each other or past each other)	1
3(c)(iii)	particles have different sizes / radii	1
	layers cannot slide / slip / shift	1
3(d)(i)	$Fe + H_2SO_4 \rightarrow FeSO_4 + H_2$	1
3(d)(ii)	$Fe_2O_3 + 3H_2SO_4 \rightarrow Fe_2(SO_4)_3 + 3H_2O$ **M1** formula of $Fe_2(SO_4)_3$ **M2** all formulae correct (no additional species) **M3** balanced	3

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Q34.

Question	Answer	Marks
5(a)(i)	oxygen / O_2	1
	sodium nitrite / sodium nitrate(III) / $NaNO_2$	1
5(a)(ii)	$2Cu(NO_3)_2 \rightarrow 2CuO + O_2 + 4NO_2$ **M1** CuO **M2** rest of equation fully correct	2

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Q35.

Question	Answer	Marks
3(a)	(hot) air	1
3(b)	coke is burned (to form carbon dioxide) **OR** $C + O_2 \rightarrow CO_2$	1
	carbon dioxide is reduced by (more) coke to form **carbon monoxide** or **CO** **OR** $C + CO_2 \rightarrow 2CO$	1
	$3CO + Fe_2O_3 \rightarrow 2Fe + 3CO_2$	1
	limestone (decomposes to) form lime / CaO / calcium oxide (and carbon dioxide) **OR** $CaCO_3 \rightarrow CaO + CO_2$	1
	$CaO + SiO_2 \rightarrow CaSiO_3$	1
3(c)	the impurity is C	1
	blow **into** or pass oxygen **through** (molten) **iron**	1
	carbon dioxide escapes or carbon dioxide is a gas	1

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Q36.

Question	Answer	Marks
	differences: number of neutrons	1
2(a)(ii)	nucleons: 27	1
	neutrons: 14	1
	electrons: 10	1
2(b)(i)	bauxite	1
2(b)(ii)	aluminium is more reactive than carbon	1
2(b)(iii)	to lower the operating temperature / the mixture has a lower melting point than aluminium oxide	1
	to increase the conductivity	1
2(b)(iv)	oxidation (because) (the O^{2-} ion OR 'oxide ions') electrons are lost **OR** (the O^{2-} ion OR 'oxide ions') oxidation number increases	1
2(b)(v)	electrodes/anodes are made from carbon/graphite	1
	oxygen (made) reacts with carbon/anode	1
2(c)(i)	zinc is more reactive than copper	1
2(c)(ii)	displacement / redox	1
2(c)(iii)	(aluminium) has (inert) coating of aluminium oxide	1

[0620/41/O/N/18/Q3-A-B]

Q37.

3(a)(i)	$4NO_2$ 2CuO **M1** CuO as a product (1) **M2** rest fully correct (1)	2
3(a)(ii)	nitrogen dioxide is acidic **OR** nitrogen dioxide reacts with sodium hydroxide	1
3(b)	**M1** nitrogen and oxygen (from the air) **M2** (react) at high temperatures (in engine) **or** (electrical) spark (in engine)	2

[0620/42/M/J/2019/Q7-A-B-C]

Q38.

7(a)(i)	**M1** Ni / Nickel (1) **M2** (it) loses or donates electrons (1)	2
7(a)(ii)	redox	1
7(b)	**M1** $Pb \rightarrow Pb^{2+} + 2e(^-)$ / (1) **M2** $Ag^+ + e(^-) \rightarrow Ag$ (1)	2
7(c)	most reactive nickel / Ni lead / Pb least reactive silver / Ag	1

[0620/41/O/N/2019/Q3-A-B]

Q39.

3(a)	malleable / conduct electricity / conduct heat	1
3(b)	water and oxygen / air	1

[0620/43/O/N/2019/Q3-C-D]

Q40.

3(c)(i)	$Mg(s) + Cu^{2+}(aq) \rightarrow Cu(s) + Mg^{2+}(aq)$ ionic equation correct (1) state symbols (1)	2
3(c)(ii)	any two from: □ solid dissolves / disappears □ blue colour of solution fades **OR** paler solution **OR** colour of solution disappears **OR** becomes colourless solution □ pink or orange or brown **AND** solid	2
3(c)(iii)	unreactive coating of aluminium oxide	1
3(d)	$2Al + Fe_2O_3 \rightarrow 2Fe + Al_2O_3$ Fe_2O_3 and Al_2O_3 both correct (anywhere) (1) Equation completely correct (1)	2

[0620/43/M/J/2020/Q7-E]

Q41.

7(e)(i)	iron + wate + oxygen → (hydrated) iron oxide	2
7(e)(ii)	any **two** from: • act as catalysts • variable oxidation numbers • form coloured compounds / coloured ions • higher melting point • higher density • harde	2

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Q42.

[0620/41/O/N/2020/Q2]

2(a)	zinc blende	1
2(b)(i)	$ZnO + C \rightarrow Zn + CO$ **or** $2ZnO + C \rightarrow 2Zn + CO_2$	1
2(b)(ii)	chemical change: reduction (1) explanation: oxygen is lost (1)	2
2(b)(iii)	aluminium is more reactive than carbon	1
2(b)(iv)	electrolysis	1
2(c)	exists as layers (1) (alloy) contains different sized (copper) atoms (1) makes it more difficult for layers (of atoms) to slide over each slip/shift other (1)	3

Q43.

[0620/42/O/N/2020/Q3]

3(a)	any **two** from: • shiny / lustrous • conduct electricity • conduct heat	2
3(b)	low(er) density (1) low(er) melting points (1)	2
3(c)(i)	hydrogen	1
3(c)(ii)	hydroxide / OH^-	1
3(c)(iii)	$2Na + 2H_2O \rightarrow 2NaOH + H_2$ NaOH (as a product) (1) rest of equation (1)	2
3(d)(i)	galvanising	1
3(d)(ii)	prevents water o / and oxygen reaching iron	1
3(d)(iii)	zinc more reactive (than iron) (1) zinc corrodes / oxidises / reacts in preference to iron (1)	2

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[0620/43/O/N/2020/Q4]

Q44.

4(a)	sulfur dioxide	1
4(b)(i)	**Any two from** (coke) • releases heat **or** releases energy(when it reacts with oxygen or burns in air) / (acts as a) fuel / increases temperature (in the furnace) / heats (the furnace) / source of energy (coke) • reduces zinc oxide / is a reducing agent / converts zinc oxide to zinc / removes oxygen from zinc oxide (coke) • (reacts with oxygen) to produce carbon monoxide / reacts with carbon dioxide to form carbon monoxide • carbon monoxide reduces zinc oxide / converts zinc oxide to zinc / removes oxygen from zinc oxide	2
4(b)(ii)	$ZnO + CO \rightarrow Zn + CO_2$ **OR** $2ZnO + C \rightarrow 2Zn + CO_2$ **OR** $ZnO + C \rightarrow Zn + CO$	1
4(b)(iii)	temperature inside furnace is above / higher than 907 (°C) **OR** temperature is above / higher than the boiling point (of zinc) **ORA** **OR** 1200 (°C) is above / higher than the boiling point (of zinc) **ORA** **OR** 1200 (°C) is above / higher than 907 (°C) **ORA**	1
4(b)(iv)	condensation / condensing	1
4(c)(i)	zinc	1
4(c)(ii)	(a solution containing the) **maximum** amount of solute **dissolved** / **no more** solute can **dissolve** (1) at a given temperature (1)	2
4(c)(iii)	one mark for each of any two from: • zinc oxide • zinc hydroxide • zinc carbonate	2
4(d)(i)	**heat** again and **weigh** again / repeat steps 2 and 3 (1) until **mass** is **constant** (1)	2
4(d)(ii)	(moles of $MgSO_4$ =) $0.005 / 5 \times 10^{-3}$ (1) mass of water = 0.63 g (1) moles of water = $0.63 \div 18 = 0.035 / 3.5 \times 10^{-2}$ (1) $(x = 0.035 \div 0.005) = 7$ (1)	4

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[0620/43/O/N/2020/Q5]

Q45.

5(a)	become more reactive down the group **ORA** (1)	1
5(b)(i)	one mark each for **any two** of: • floats • dissolves / disappears / melts • moves • bubbles / fizzes / effervesces • lilac flame	2
5(b)(ii)	$2K + 2H_2O \rightarrow 2KOH + H_2$ all formulae (1) equation fully correct (1)	2
5(c)(i)	$Cl_2 + 2KI \rightarrow 2KCl + I_2$ **OR** $Cl_2 + 2I^- \rightarrow 2Cl^- + I_2$ all formulae (1) equation fully correct (1)	2
5(c)(ii)	brown / black	1
5(d)(i)	**breakdown** by (the passage of) **electricity** (1) of an **ionic compound** in **molten or aqueous** (state) (1)	2
5(d)(ii)	heat until it melts / heat to or above melting point	1
5(d)(iii)	$Na^+ + e \rightarrow Na$	1
5(e)(i)	one mark for each of any two from: • (chromium has) high melting point **ORA** • (chromium forms) coloured ions / coloured compounds **ORA** • (chromium has) variable valency / variable oxidation state / variable oxidation number **ORA** • catalytic behaviour **ORA** **ORA ALLOW** group 1 **or** sodium **if stated** • no colour **or** white **or** colourless ions or compounds • fixed valency / +1 charge **only or one** oxidation state / forms **one** chloride • low melting point • doesn't behave as a catalyst	2
5(e)(ii)	one mark for each of any two from: • (chromium / sodium) **conducts** electricity • (chromium / sodium) compounds are **soluble** (in water) • (chromium / sodium) form hydrated salts / form hydrated compounds	2