11.1 Water

01. 0620_s20_qp_43 Q: 4

(a) Filtration and chlorination are two stages in water treatment.

State the purpose of each stage.

filtration .....

.....

chlorination .....

.....

[2]

(b) A student uses anhydrous copper(II) sulfate to test for the presence of water.

(i) What colour change is seen if water is present?

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

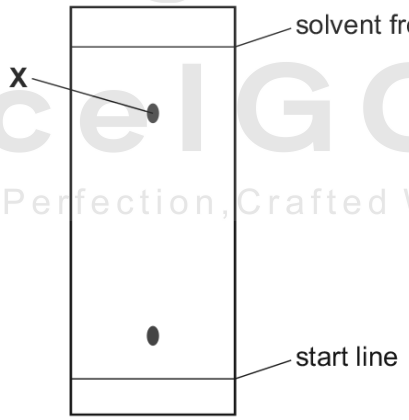
(ii) The purity of a sample of water can be assessed by measuring its boiling point.

How is the boiling point of water affected by impurities?

..... [1]

(c) Chromatography can be used to test the purity of substances.

The diagram shows the chromatogram of a coloured substance.



(i) How does this chromatogram show that this substance is **not** pure?

..... [1]

(ii) Draw a circle round the correct R_f value for the spot labelled **X**.

0.2 0.4 0.8 1.2 [1]

(iii) State how a colourless substance can be made visible on a chromatogram.

..... [1]

[Total: 8]

02. 0620_s19_qp_41 Q: 3

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]

(d) A compound of copper can be used to test for water.

(i) State the full name of this compound of copper.

..... [1]

(ii) State the colour change that occurs when water is added to this compound of copper.

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

(e) Aqueous potassium iodide reacts with aqueous copper(II) sulfate to produce iodine.

(i) Balance the chemical equation for this reaction.

$$KI + CuSO_4 \rightarrow CuI + I_2 + K_2SO_4$$

[2]

(ii) Deduce the charge on the copper ion in CuI.

..... [1]

(iii) In terms of electron transfer, explain why copper is reduced in this reaction.

..... [1]

(iv) Identify the reducing agent.

..... [1]

[Total: 16]

03. 0620_s18_qp_42 Q: 6

(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]

04. 0620_s16_qp_41 Q: 2

Period 3 contains the elements sodium to argon. This question asks about the chemistry of each of the Period 3 elements or their compounds.

(a) Sodium nitrate is a white crystalline solid. When heated it melts and the following reaction occurs.

$$2NaNO_3(l) \rightarrow 2NaNO_2(l) + O_2(g)$$

A 3.40 g sample of sodium nitrate is heated.

Calculate the

- number of moles of $NaNO_3$ used,

..... mol

- number of moles of O_2 formed,

..... mol

- volume of O_2 formed, in dm^3 (measured at r.t.p.).

..... dm^3
[3]

(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]

(e) Calcium phosphate is used in fertilisers. The bonding in calcium phosphate is ionic. Calcium phosphate contains the phosphate ion, PO_4^{3-}.

(i) What is ionic bonding?

.....

..... [2]

(ii) Deduce the formula of calcium phosphate.

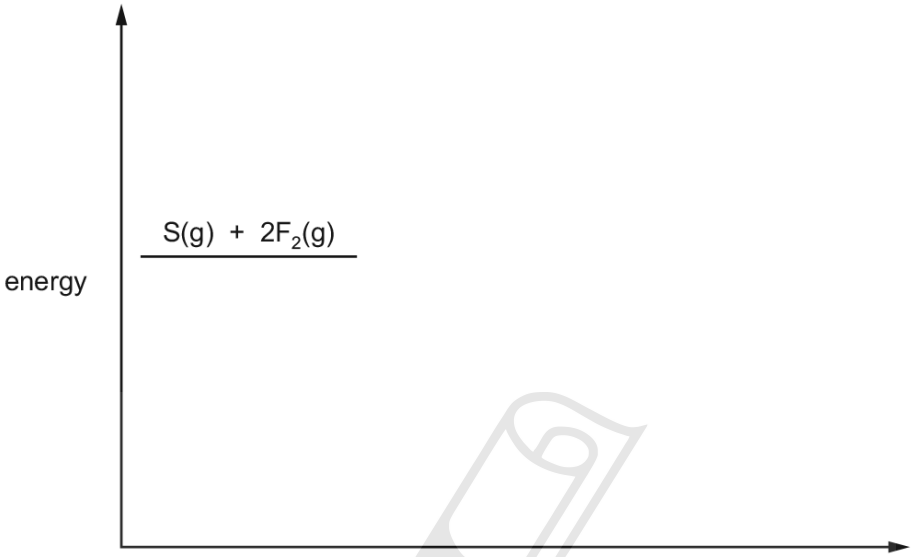
..... [1]

(f) Sulfur tetrafluoride, SF_4, can be made by combining gaseous sulfur with fluorine.

$$S(g) + 2F_2(g) \rightarrow SF_4(g)$$

The reaction is exothermic.

(i) Complete the energy level diagram for this reaction. Include an arrow which clearly shows the energy change during the reaction.

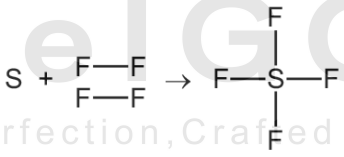


[3]

(ii) During the reaction the amount of energy given out is 780 kJ / mol.

The F–F bond energy is 160 kJ / mol.

Use this information to determine the bond energy, in kJ / mol, of one S–F bond in SF_4.



..... kJ / mol [3]

(g) Chlorine and compounds of chlorine are important in water treatment and in laboratory testing for water.

(i) Chlorine is added to water to make the water safe to drink.

Explain why adding chlorine makes water safe to drink.

..... [1]

(ii) A compound of chlorine is used in the laboratory to test for the presence of water.

Name the compound of chlorine used in this test and describe the colour change seen in a positive result of this test.

name of compound .....

colour change from ..... to .....
[3]

(h) Argon is an unreactive noble gas.

(i) Explain why argon is unreactive.

..... [1]

(ii) Give **one** use of argon.

..... [1]

[Total: 27]

05. 0620_m15_qp_32 Q: 1

For each of the following, give the name of an element from Period 3 (sodium to argon), which matches the description.

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

..... [1]

(b) an element that is added to water to kill bacteria

..... [1]

(c) an element that forms a basic oxide of the type XO

..... [1]

(d) an element used as an inert atmosphere in lamps

..... [1]

(e) an element that forms an amphoteric oxide

..... [1]

(f) an element that reacts vigorously with cold water to produce hydrogen

..... [1]

[Total: 6]

06. 0620_w15_qp_33 Q: 1

(a) Describe a chemical test which shows the presence of water.

test .....

colour change if water is present .....

.....

[3]

(b) How could you show that a sample of water is pure?

..... [1]

(c) Describe how water is treated before it is supplied to homes and industry.

.....

..... [2]

(d) State **two** industrial uses of water.

.....

..... [2]

[Total: 8]

07. 0620_s14_qp_31 Q: 2

(a) Water is needed for industry and in the home.

(i) Rain water is collected in reservoirs. How is it treated before entering the water supply?

.....

..... [2]

(ii) State **two** industrial uses of water.

.....

..... [2]

(iii) State **two** uses of water in the home.

.....

..... [1]

(b) In many regions, drinking water is obtained by the distillation of sea-water. Explain how distillation separates the water from sea-water.

.....

.....

..... [2]

[Total: 7]

08. 0620_s12_qp_32 Q: 4

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]

01. 0620_s20_ms_43 Q: 4

(a)	(filtration:) remove solids from water / remove insoluble substances (chlorination:) sterilises / kill microbes / prevent illness	2
(b)(i)	white to blue	2
(b)(ii)	higher boiling point / greater than 100°C	1
(c)(i)	more than one spot	1
(c)(ii)	0.8 (circled)	1
(c)(iii)	use a locating agent	1

02. 0620_s19_ms_41 Q: 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
(b)	brass	1
(c)	form coloured compounds / ions (1) act as catalysts (1)	2
(d)(i)	**anhydrous** copper(II) sulfate	1
(d)(ii)	white (1) blue (1)	2

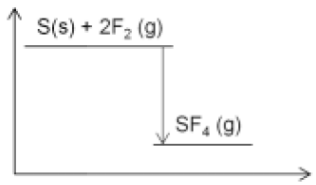
(e)(i)	$4KI + 2CuSO_4 \rightarrow 2CuI + I_2 + 2K_2SO_4$ (2)	2
(e)(ii)	1+	1
(e)(iii)	gains electron(s)	1
(e)(iv)	KI / potassium iodide / iodide (ions) / I^-	1

03. 0620_s18_ms_42 Q: 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
(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
(b)(ii)	$2Cu(NO_3)_2.3H_2O(s) \rightarrow$ **2**$CuO(s) +$ **4**$NO_2(s) + O_2(g) +$ **6**$H_2O(g)$ all 3 numbers = 2 marks any 2 numbers = 1 mark	2
(b)(iii)	blue	1
	pink	1
(b)(iv)	boiling point sharp / melting point sharp / freezing point sharp / boiling point 100 (□)C / freezing point or melting point 0 (□)C	1

04. 0620_s16_ms_41 Q: 2

(a)	number of moles of $NaNO_3$ used: 3.40/85 = 0.04(00) (mol) **OR** 4.(00) × 10^{-2} (mol); number of moles of O_2 formed: 0.04/2 = 0.02(00) (mol) **OR** 2.(00) × 10^{-2} (mol); volume of O_2 formed: 0.02 × 24 = 0.48 (dm^3);	**3**
(b)(i)	(a substance which is) a proton/H^+/hydrogen ion acceptor;	**1**
(b)(ii)	$Mg(s) + 2H_2O(l) \rightarrow Mg(OH)_2(aq) + H_2(g)$ $Mg(OH)_2$; rest of equation;	**2**
(c)	**M1** add a *named* acid, e.g. HC*l* **and** a named alkali, e.g. NaOH; 1 **M2** Al_2O_3 will react with/neutralises both reagents; 1 **M3** and so it will dissolve into the reagent/form a solution; 1	**3**
(d)(i)	covalent;	**1**
(d)(ii)	any 2 from: high melting point/high boiling point; poor conductor (of electricity); hard; insoluble;	**2**
(e)(i)	**M1** (electrostatic) attraction; 1 **M2** between oppositely charged ions; 1	**2**
(e)(ii)	$Ca_3(PO_4)_2$;	**1**

(f)(i)	 **M1** *exothermic mark*: horizontal product energy line at lower energy than that of reactant energy line; 1 **M2** *label of product mark*: SF_4; 1 **M3** *correct direction of vertical heat of reaction arrow*: arrow must start level with reactant energy and finish level with product energy **and** must have only **one** (correct) arrow-head; 1	**3**
(f)(ii)	**M1** *bond energy of* $2F_2$: 2 × F–F = 2 × 160 = 320 (kJ/mol); 1 **M2** *bond energy of all bonds in* SF_4: 780 + 320 = 1100 (kJ/mol); 1 **M3** *calculated bond energy of* SF_4 *divided by 4*: 1100/4 = 275 (kJ/mol); 1	**3**
(g)(i)	kills bacteria;	**1**
(g)(ii)	name of compound: cobalt(II) chloride; 1 from: blue; 1 to: pink; 1	**3**
(h)(i)	it has a complete outer shell/a full outer shell/8 electrons in the outer shell;	**1**
(h)(ii)	(in) lamps;	**1**

05. 0620_m15_ms_32 Q: 1

(a) chlorine / argon [1]

(b) chlorine [1]

(c) magnesium [1]

(d) argon [1]

(e) aluminium [1]

(f) sodium [1]

[Total:6]

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06. 0620_w15_ms_33 Q: 1

(a)	cobalt chloride (paper) / anhydrous cobalt chloride / $CoCl_2$; from blue; to pink; **or** copper sulfate / anhydrous copper sulfate / $CuSO_4$; from white; to blue;	**3**
(b)	boils at 100 °C / boiling point 100 °C / freezes at 0 °C / freezing point 0 °C / melts at 0 °C / melting point 0 °C;	**1**
(c)	any two from: • filtration / sedimentation / sieving / screening / (pass through) gravel (beds) / flocculation / decantation / clarification / coagulation / flotation / settling tank / add aluminium sulfate; • (add) carbon; • chlorination / (add) chlorine / add Cl_2; • fluoridation / add fluoride; • ozone dosing; • desalination; • aeration; • distillation;	**2**
(d)	any two from: making steel; making paper; textiles; generating electricity / energy / power / turbines; HEP; water mills; steam power (e.g. steam engines); geothermal power; agriculture; livestock; irrigation; hydration of alkenes / manufacture of ethanol / alcohols; manufacture of sulfuric acid / Contact process; manufacture of hydrogen; solvent / dissolving; coolant / cooling; cleaning / washing; (supply of) drinking (water); central heating; production of slaked lime; cooking;	**2**

07. 0620_s14_ms_31 Q: 2

(a) (i) filtration (1)

chlorination (1) [2]

(ii) Any **two** from: [2]
- manufacture of ethanol
- used in the manufacture of sulfuric acid **or** in the Contact process
- manufacture of hydrogen **or** ammonia **or** for the Haber process

(iii) Any **two** from: [2]
- cooking
- washing or laundry
- drinking
- toilets
- watering plants
- (domestic) heating

(b) boiling or turning to steam (1)

then condensing / condensation (1) [2]

[Total: 7]

08. 0620_s12_ms_32 Q: 4

(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]