MARKING SCHEME

SEC CHEMISTRY

MAIN SESSION 2018

L-Università ta' Malta

MATSEC
Examinations Board

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In the case of marking schemes which include expected solutions or answers, it should be noted that these are not intended to be exhaustive. Variations and alternatives may also be acceptable. Examiners must consider all answers on their merits, and will have consulted with the MATSEC Examinations Board when in doubt.

PAPER 1

Question			Suggested answers	Additional notes	Marks
Section A					
1	a		Solvent / to dissolve components	Do not accept: to separate components	1
	b	i	Blue		1
		ii	Purple		1
	c		Only blue is soluble in water / blue and purple not soluble in water		1
	d		Range of temperatures		1
			Not pure / mixture of compounds / colours / pigments / inks		1
				Total:	**6**
2	a		1mol Zn : 1 mol H_2	Accept any other valid way of getting to the answer	1
			Mol Zn = 26/65		1
			0.4 mol Zn		1
			0.4 mol Zn : 0.4 mol H_2		1
			1mol H_2= 22.4 dm^3 Vol H_2 = 22.4 x 0.4		1
			= 8.96 dm^3		1
	b		The volume will be greater.	Do not accept: will not change.	1
			With more energy particles 'push' each other more and occupy more space / due to Charles' law / volume is directly proportional to temperature / as temperature increases, volume increases.	Do not accept: because the temperature is higher.	1
				Total:	**8**
3	a	i	Potassium		1
		ii	Silver		1
		iii	Aluminium		1
	b		$Zn(s) + 2\ AgNO_3(aq) \rightarrow Zn(NO_3)_2(aq) + 2\ Ag(s)$	1 mark for balancing 1 mark for formulae/symbols Ignore state symbols	2
				Total:	**5**
4	a		$Fe^{2+}(aq) + 2OH^-(aq) \rightarrow Fe(OH)_2(s)$	1 mark for balancing 1 mark for formulae/symbols 1 mark for state symbols If a correct, non-ionic equation is presented, mark only the state symbols.	3
	b		Pale green /green / green with brown at the top		1
	c		Aerial oxidation / Fe(III) formed / Reacts with oxygen/air	Any valid answer	1
	d		Forms coloured compounds /multiple oxidation states/valence	Any valid answer	1
				Total:	**6**
5	a	i	Correct $[Mg]^{2+}$ with 8 valence electrons.	No marks if the charge is incorrect.	1
			Correct $2[Cl]^-$ with 8 valence electrons, one of which is marked as coming from other chemical species.		1
		ii	Correct electronic configuration of C, Cl, and H.		1
			Correct drawing of covalent molecule		1
				Total:	**4**

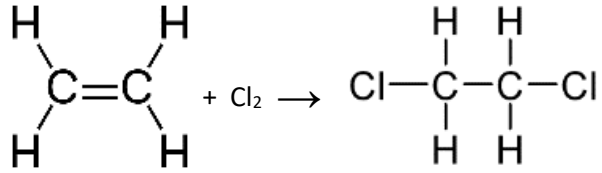
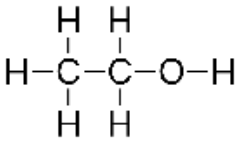
6	a		C_2H_{2n+2}		1
	b		propane		1
	c		Structures of two valid isomers from either **A** or **D**	• 1 mark for each correct structure • If compound A or D are chosen and one correct structure is shown, award 1 mark • No marks if hydrogen atoms are not shown	2
	d		**C** < **B** < **D** < **A**	Award 0 marks if one is misplaced	1
	e	i	Clean fuels/leave no residue/high calorific value	Do not accept: they are inflammable, burn properly/easily, less pollution	1
		ii	CO is toxic/ for complete combustion/ dangerous gas/es is/are formed	Do not accept: oxygen is needed for combustion	1
				Total:	**7**
7	a		white		1
	b		filtration	Accept: filter paper Do not accept: (filter) funnel	1
	c	i	1 $BaSO_4$ = 137 + 32 + 64 = 233		1
			2.91/233 = 0.0125 moles		1
		ii	0.0125 moles		1
		iii	0.0125 * 1000/250 = 0.05 mol/dm^{-3}		1
	d		Carbonates/sulfites also formed		1
				Total:	**7**
8	a		In steam particles in constant random motion/ far from each other / have weak intermolecular forces/ collide with each other while in ice they vibrate about a fixed point/ are closer together/ have strong intermolecular forces/ have a specific arrangement.	1 mark for each comparison For a correct comparison, the candidate should state the property in **both** states. Do not accept 'particles expand/have a fixed volume'	2
	b	i	Sugar particles get into the spaces between liquid water molecules		1
		ii	Sugar - solute Water - solvent		1 1
	c		More of the solid dissolves/ solid dissolves/ solution is no longer saturated	Do not accept: crystals form, water evaporates	1
				Total:	**6**
9	a		Water Air or oxygen		1 1
	b		Painting / galvanisation / greasing / chrome plating / plastic coating / sacrificial protection	1 mark for each **different** method. 'Anti-rust spray' and 'painting' are the same. 'Cover in a protective layer' is the same as any stated method except sacrificial protection. Do not accept: cover in stainless steel or other impractical methods.	3
				Total:	**6**

10	a		Same maximum reached by all graphs		1
			Order – Rate C > Rate A > Rate B		1
			Shape of graphs		1
	b		Larger surface area in **A** than in **B**		1
	c	i	**Rate** of forward reaction equals **rate** of reverse reaction		1
		ii	CO_2 escapes / equilibrium shifts to produce more CO_2 / system is not closed / particles escape		1
				Total:	**6**
			Section B		
11	a	i	Oxygen and nitrogen have different boiling points.	Accept: have different liquefaction/condensation point. Do not accept: is a mixture.	1
		ii	rekindles a glowing splint		1
	b	i	Manganese(IV) oxide / manganese dioxide	0 marks if oxidation state is absent. Accept any other catalyst including enzymes, potassium iodide, and iron(III) oxide. Do not accept: potassium permanganate.	1
			MnO_2	Accept formula of correct catalyst stated in b(i)	1
		ii	$2\ H_2O_2 \longrightarrow 2\ H_2O\ (l) + O_2\ (g)$	1 mark for formulae/symbols 1 mark for balancing Ignore state symbols	2
		iii	Photocatalysed / decomposes in the presence of light / light increases the rate of reaction/decomposition		1
	c		$22{,}4\ dm^3 = 1$ mol $20.16\ dm^3 =$	Accept any other valid way of getting to the answer	1
			20.16/22.4 = 0.9 mol		1
			3 mol O_2 = 2 mol $KClO_3$		1
			0.9 mol O_2 = 0.6 mol $KClO_3$		1
			Formula mass $KClO_3$ = 122.5		1
			Mass $KClO_3$ = 0.6 x 122.5		1
			= 73.5g		1
	d	i	$2CO(g) + O_2(g) \longrightarrow 2CO_2(g)$	1 mark for formulae/symbols 1 mark for balancing Ignore state symbols	2
		ii	1 mol O_2 : 2 mol CO	Accept any other valid way of getting to the answer.	1
			$20.16\ dm^3 : 40.32\ dm^3$ CO		1
			Unreacted CO = 45.0 – 40.32		1
			$= 4.68\ dm^3$		1
				Total:	**20**
12	a	i	the energy given out when bonds are formed than the energy taken in to break bonds		1 1 1
		ii	Energy of liquid state		1

			Energy of gas state higher than that for liquid	1 mark for an unlabelled correct energy level diagram.	1
			Clearly labelled Δ*H*		1
	b	i	Nitric acid		1
			Potassium hydroxide		1
		ii	Fast		1
			Reduce heat losses		1
		iii	$H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$ If a correct, non-ionic equation is presented, mark only the state symbols.	1 mark for formulae/symbols 1 mark for balancing 1 mark for state symbols	3
	c	i	Q = mcΔθ = 330 x 4.2 x 15		1
			= 20,790 J		1
			Molar mass hexane = 86 $gmol^{-1}$		1
			0.43 g = 20.79 kJ 86 g =		1
			4,158 kJ mol^{-1}		1
		ii	Loss of heat to surroundings/ some water evaporates/ not all the hexane is used up/ no lid on the water etc.	Do not accept: human errors (e.g. reading errors); use of uncalibrated equipment; 'impurities' in either water or hexane.	2
				Total:	**20**

PAPER 2A

Question			Award marks for	Additional notes	Marks
Section A					
1	a	i	MgO	Do not award marks if not balanced.	1
		ii	ZnO	Do not award marks if not balanced.	1
		iii	$Na_2CO_3 + CO_2$	In any order. Do not award marks if not balanced.	1, 1
		iv	$FeSO_4 + 7\ H_2O$	In any order. Do not award marks if not balanced.	1, 1
	b		Turns yellow on heating (physical change reversible on cooling)		1
				Total:	**7**
2			Hydrogen		1
			positive		1
			carbonate		1
			hydroxide		1
			water		1
				Total:	**5**
3	a		Diagram showing at least two hexagonal layers of carbon atoms, one of which contains at least two hexagons.		1
			Labelled weak forces/Van der Waals between layers.	Do not accept: intermolecular forces	1
	b		Each carbon atom has 3 bonded electrons and one free electron. There are delocalised/free electrons. Electrons act as charge carriers.	Any two points.	2
	c	i	$Fe_2O_3 + 3\ CO \rightarrow 3\ CO_2 + 2\ Fe$	All symbols correct All balancing correct	1 1
		ii	CO removes oxygen / Reduction of oxidation state of Fe / CO gets oxidised / Iron gains electrons		1
				Total:	**7**
4	a		Chlorine - Hydrogen Oxygen - Copper	In this order	1 – 1 1 – 1
	b		Carbon reacts with oxygen	Do not accept: reacts with acid	1
	c	i	Copper is 'used up' / reduction of copper ions at the cathode		1
		ii	Copper is reduced at the anode / copper 'used up' is replenished		1
	d		2 x 60 x 60 = 7200		1
			7200/96500 = 0.075 mols		1
				Total:	**9**

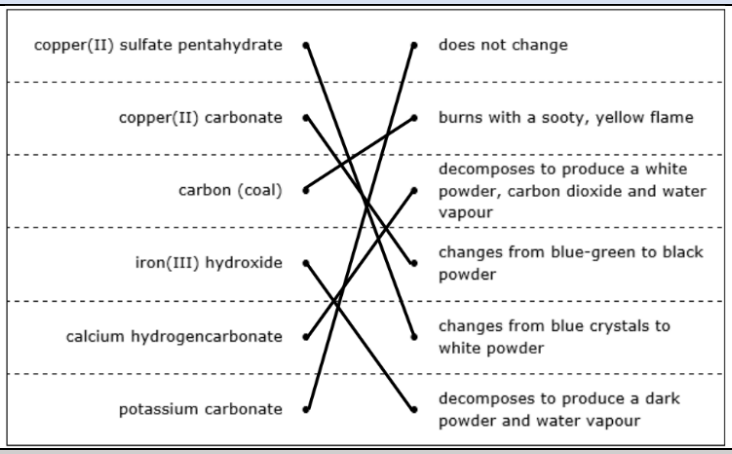
5	a			Correct structure of ethene. Correct structure of 1,2-dichloroethane. Structures must show all bonds.	1 1
	b	i	Correct structure of ethyne.	Structure must show all bonds.	1
		ii	Correct structure of 1,2-dichloroethene.	Structure must show all bonds.	1
		iii	Correct structure of 1,1,2,2-tetrachloroethane.	Structure must show all bonds.	1
	c		Both burn with a sooty flame **OR** both decolourize bromine water		1
	d	i	Ethanol		1
		ii		Structure must show all bonds.	1
				Total:	**8**
6	a	i	Bottled gas fuel Heating	Any valid answer. Do not accept: power source, gas, manufacture of medicines/chemicals, lubricants, jet fuel, etc	1
		ii	Automotive fuel		1
	b		Fraction A		1
			Shortest carbon chain	Accept: smallest number of carbon atoms	1
	c		Causes pollution / forms greenhouse gases / non-renewable	Any one	1
	d		Cracking (of long chain alkanes)		1
				Total:	**6**
7	a		$2Pb(NO_3)_2 \rightarrow 2PbO + 4NO_2 + O_2$	All balancing correct All symbols correct	1 1
	b		Low boiling point / lower than 0 °C / higher than that of oxygen		1
	c		Nitric acid – Nitrous Acid / Nitric(V) acid – Nitric(III) acid	Any order No marks for formulae	1 - 1
	d	i	$2\ NO_2 + 4\ CO \rightarrow N_2 + 4\ CO_2$	All formulae correct Correct balancing	1 1
		ii	Give out carbon dioxide / less efficient with time / can get poisoned over time	Any one	1
				Total:	**8**
8	a		22.70 cm^3		1
	b		$\frac{25 \times 0.5}{1000} = 0.0125$ mol		1
	c		2 mol of HCl with 1 mol Na_2CO_3 0.0125 x 2 = 0.025 mol		1
	d		$\frac{1000 \times 0.025}{22.7} = 1.1$ mol dm^{-3}		1
				Total:	**4**

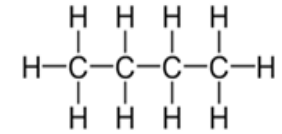
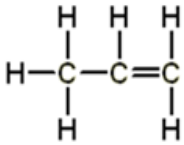
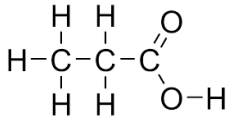
9	a	i	Butanoic acid		1
		ii	ethanol		1
	b	i	Carboxylic acid	Accept: organic acid	1
		ii	Esters		1
	c		Catalyst		1
			Drying agent / removal of water / shift equilibrium to produce ester	Do not accept: to smell better / to remove alkali/s	1
				Total:	**6**
			Section B		
10	a		Water and CO_2 removed Air is liquified under pressure Air is fractionally distilled to obtain N_2		1 1 1
	b		High energy required to break triple bond.		1
	c	i	$N_2 + 3H_2 \rightarrow 2NH_3$	All symbols correct All balancing correct	2
		ii	Iron/molybdenum		1
		iii	400^0C		1
			200-300 atmospheres		1
		iv	Low temperature as reaction is exothermic		1
			too low a temperature and the reaction would be too slow / temperature increases the rate of reaction		1
			Therefore a compromise of 400^0C is used		1
			4 vols to 2 vols / a high pressure will favour the forward reaction		1
	d		Production of fertilizers		1
	e	i	$3CuO + 2NH_3 \rightarrow N_2 + 3H_2O + 3Cu$	All symbols correct All balancing correct	1 1
		ii	Apparatus to generate ammonia Apparatus to reduce copper(II) oxide	Accept passage of ammonia over copper(II) oxide using gas syringes as per the calculation of percentage oxygen in air	1 1
	f		Add alkali + heat gently		1
			Gas which turns red litmus blue / Gas which forms white fumes with HCl		1
				Total:	**20**
11	a		MnO_2 + conc. HCl Generator including dropping / thistle funnel A bottle with sulfuric acid or any suitable drying agent to remove water Downward delivery / gas syringe		1 1 1 1
	b		Downward delivery / gas syringe		1
	c	i	Blue litmus paper		1
			Turns red then bleached		1
		ii	Addition of acidified silver nitrate		1
			White precipitate		1
	d	i	**Chlorine** water is added to solutions of (Cl^-), **Br^- and I^-** **Bromine** water is added to solutions of (Br^-), **Cl^- and I^-** **Iodine** is added to solutions of (I^-), **Cl^- and Br^-**		1 1 1

	ii	<table><tr><th></th><th>KCl</th><th>KBr</th><th>KI</th></tr><tr><td>Cl_2</td><td>No reaction</td><td>Br_2 forms</td><td>I_2 forms</td></tr><tr><td>Br_2</td><td>No reaction</td><td>No reaction</td><td>I_2 forms</td></tr><tr><td>I_2</td><td>No reaction</td><td>No reaction</td><td>No reaction</td></tr></table>	1 mark for table format 1 mark for identifying each of the reactions between: Cl_2 and KBr; Cl_2 and KI; Br_2 and KI	4
	iii	$Cl_2(aq) + 2Br^-(aq) \rightarrow 2Cl^-(aq) + Br_2(l)$ **OR** $Cl_2(g) + 2I^-(aq) \rightarrow 2Cl^-(aq) + I_2(s)$ **OR** $Br_2(l) + 2I^-(aq) \rightarrow 2Br^-(aq) + I_2(s)$	All symbols correct All balancing correct State symbols correct	3
	iv	Chlorine is the most reactive and iodine the least reaction / the order of the halogens in increasing reactivity is Cl_2, Br_2, I_2.		1
			Total:	**20**
12	a		$2HCl + FeS \rightarrow FeCl_2 + H_2S$	All symbols correct All balancing correct	1 1
	b		Smell of rotten eggs/pungent smell		1
	c		Fume cupboard	Do not accept 'lab coat' Accept any valid answer	1
	d		$2HCl + Na_2SO_3 \rightarrow NaCl + H_2O + SO_2$	All symbols correct All balancing correct	1 1
	e	i	Blue to red – changes to red (bleached)		1
		ii	Other gases are acidic		1
		iii	Bubble sulfur dioxide through acidified dichromate		1
			Turns from orange to green		1
	f	i	Sulfur deposit		1
		ii	S in SO_2		1
			Loss of oxygen / decrease in oxidation number (+4 to 0)		1
		iii	Hydrogen sulfide		1
			It reduces SO_2		1
	g		Sulfur dioxide		1
			Hydrogen sulfide is toxic in low concentrations		1
	h		Vanadium(V) oxide		1
	i		Both form white precipitates		1
			Barium sulfite dissolves on adding acid		1
				Total:	**20**
13	a	i	Alkali metals are soft and shiny when freshly cut while alkaline earth metals are relatively hard, shiny metals.	1 mark to compare appearance. 1 mark to compare hardness. 1 mark if appearance **and** hardness of one group is explained but those of the other are incorrect/absent.	2
		ii	Alkali metals tarnish quickly as they react the oxygen in the air. Alkaline earth metals tarnish slowly.	1 mark for tarnish in air. 1 mark to compare reaction rate. 1 mark if reaction of oxygen is explained for one group only.	2

		iii	Alkali metals react vigorously to form the soluble hydroxide and hydrogen. Alkaline earth metals react moderately to form a sparingly soluble hydroxide and hydrogen.	Any two: 1 mark to compare speed of reaction or with cold/warm water. 1 mark for products of reaction. 1 mark for comparing solubility of hydroxides. 1 mark for comparing alkalinity of hydroxides.	2
	b		Basic		1
			Neutralisation of an acid		1
	c	i	Wash nichrome wire with conc. HCl (place in flame and repeat until no colouration is imparted to the flame)		1
			Dip nichrome wire in the aqueous sample / in conc. HCl and the solid		1
			Place wire in blue Bunsen flame		1
		ii	A - Calcium carbonate	Accept formula Do not accept other compounds, including group II carbonates, oxides, and hydroxides	1
			B – Calcium oxide		1
			C – Calcium hydroxide		1
		iii	Reaction 1: $CaCO_3 \rightarrow CaO + CO_2$ Reaction 2: $CaO + H_2O \rightarrow Ca(OH)_2$ Reaction 3: $Ca(OH)_2 + CO_2 \rightarrow CaCO_3$	All symbols correct All balancing correct Apply follow through if another group II carbonate, oxide, and hydroxide is stated in part ii and equations are correct.	2 2 2
				Total:	**20**

Paper 2B

Question			Award marks for	Additional notes	Marks
Section A					
1				1 mark for each correct pairing.	6
				Total:	**6**
2			allotropes structure four hard conductor reducing	1 mark for each correct word.	6
				Total:	**6**
3	a	i	zinc chloride		1
		ii	copper(II) sulfate	No marks if oxidation state is not shown.	1
	b		$CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$	1 mark for chemical formulae. 1 mark for balancing.	2
	c	i	A solution of HCl in water.		1
		ii	HCl dissociates in water to form $H^+(aq)$ ions / HCl does not dissociate in methylbenzene		1
				Total:	**6**
4	a	i	copper ion / copper(II) / Cu^{2+} / copper	Do not accept: Cu^+, Copper(I).	1
		ii	chloride ion / Cl^-	Do not accept: chlorine, Cl, Cl_2.	1
	b		The colour fades/gets lighter.	Do not accept: from blue to white / changes colour.	1
	c		$Cu^{2+} + 2e \rightarrow Cu$	1 mark for formulae. 1 mark for balancing.	2
	d		The copper anode will dissolve into the solution / mass of copper anode decreases.		1
				Total:	**6**

5	a		 Butane  Propene	1 mark each	2
	b	i	ethane		1
		ii	chloroethane	Accept: monochloroethane, ethylchloride.	1
	c		Alkenes react by addition reactions because they have a **double bond** where addition can take place/ are **unsaturated** Alkanes are **saturated molecules** and so hydrogen atoms have to be replaced hence substituted.	To be awarded both marks, attempts are to refer to both alkanes and alkenes.	2
				Total:	**6**
6	a		Average length of molecules **decreases**. Smaller molecules tend to have lower boiling points.	1 mark for each valid point.	2
	b		Natural gas. Used as fuel.	Accept other products and related uses.	1 1
	c		C_2H_4 and $C_{10}H_{22}$	1 mark for each molecule. Award marks if one molecule is an alkene and the other is an alkane **and** they amount to $C_{12}H_{26}$ Award 1 mark if ethene is shown, even if they do not amount to $C_{12}H_{26}$.	2
				Total:	**6**
7	a			1 mark for correct structure of propanoic acid. 1 mark for showing all bonds and atoms, including the O-H bond.	2
	b		sodium ethanoate and hydrogen		2
	c	i	ethanol		1
		ii	esters		1
				Total:	**6**
8	a		Brown		1
	b		Lead(II) nitrate	Accept any nitrate that produces NO_2 on heating.	1
	c		Less than 7		1
	d		• Causes respiratory problems in animals • Causes deterioration of limestone and marble buildings. • Decreases pH of rivers, lakes, etc.	Do not accept: not suitable for drinking. Harms living things (animals, plants, and/or humans) is **one** disadvantage and should be awarded 1 mark if repeated.	2
	e		Sulfur dioxide		1
				Total:	**6**

9	a		Al → 3e 27 g → 3 mol of e 9,000 g → ? 9,000 x 3 / 27 = 1000 mol of e	1 mark for method. 1 mark for answer.	2
	b		1 mol of e → 1 Faraday 1111.11 mol of e → 1000 F	Apply follow through.	1
	c		1 F → 96500 C 1000 F → 96,500,000 C	Apply follow through.	1
	d		Q = I t $t = \frac{Q}{I} = \frac{96{,}500{,}000\ C}{100{,}000\ A} = 965\ s$	1 mark for working. 1 mark for answer. Apply follow through.	2
				Total:	**6**
10	a		RFM(Na_2CO_3): (23 x 2) + 12 + (16 x 3) = 106		1
	b		1 mol Na_2CO_3 = 106 g 0.5 mol Na_2CO_3 = 106 x 0.5 = 53 g	Allow follow through.	1
	c		1000 cm^3 → 53 g 250 cm^3 → (53 x 250) / 1000 = 13.25 g	Allow follow through.	1
	d	i	1000 cm^3 Na_2CO_3 → 0.5 mol 25 cm^3 Na_2CO_3 → (0.5 x 25) / 1000 = 0.0125 mol Na_2CO_3		1
		ii	Na_2CO_3 : HCl 1 : 2 0.0125 mol : 0.025 mol HCl	Allow follow through.	1
		iii	20 cm^3 → 0.025 mol HCl 1000 cm^3 → (0.025 x 1000) / 20 = 1.25 mol HCl ∴ Standard concentration of HCl = 1.25 mol dm^{-3}	Allow follow through.	1
				Total:	**6**
			Section B		
11	a	i	It smells of rotten eggs / cabbages.		1
		ii	It has a pungent, characteristic smell of burning sulfur / choking.		1
		iii	Allow SO_2 to bubble through a solution of potassium dichromate. The colour of the potassium dichromate solution changes from **orange** to **green**.	1 1	2
	b	i	Any sulfite salt.		1
		ii	Any sulfide salt.		1
	c	i	A pale-yellow powder forms.		1
		ii	Those in sulfur dioxide are reduced. They lost oxygen / had a decrease in oxidation number.	1 1	2
		iii	Hydrogen sulfide is the strongest reducing agent. It can reduce SO_2.	1 1	2
	d		Sulfur dioxide Hydrogen sulfide is toxic to humans at how concentrations.	1 1	2
	e	i	$S + O_2 \rightarrow SO_2$	1 mark for formulae. 1 mark for balancing.	2
		ii	$2\ SO_2 + O_2 \leftrightarrow 2\ SO_3$		2
		iii	$SO_3 + H_2SO_4 \rightarrow H_2S_2O_7$		2
	f		Vanadium(V) oxide		1
				Total:	**20**

12	a	i	78 %		1
		ii	Fractional distillation of liquid air.		1
		iii	1. Air is **filtered** of particulates, water vapour and carbon dioxide. 2. The remaining air is **compressed and cooled** to produce liquid air. 3. Liquid air is **fractionally distilled** to obtain nitrogen and the other gases present in air.	1 mark for each step.	3
		iv	Nitrogen is diatomic with a **triple covalent** bond. This bond **requires more energy to break** so it reacts only in high energy situations.	1 mark each for phrases in bold.	2
	b	i	$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$	1 mark for formulae and reversible sign. 1 mark for balancing.	2
		ii	Finely divided iron.		1
		iii	Pressure of 200 atm. Temperature of 450 °C.		2
		iv	Industrial air conditioning systems / produce nitric acid/nitrates.	Accept other uses.	1
	c	i	Sulfuric acid		1
		ii	NH_4^+ Add **sodium hydroxide solution** to a solution of the salt and heat.		1
			A smell of ammonia which forms **dense white fumes** of ammonium chloride in the presence of **HCl gas.**		1
			OH^- Add **acidified barium chloride** or nitrate to a solution of the salt.		1
			A **white precipitate** confirms the presence of sulfate ions.		1
		iii	RMM: $(NH_4)_2SO_4 = 28 + 8 + 32 + 64 = 132$ % N = (28 / 132) x 100 = **21.2 %**	1 1	2
				Total:	**20**
13	a		halogens		1
	b		fluorine OR astatine		1
	c		• They are all diatomic. • They all react with metals to form salts. • Poor conductors of electricity.	Accept other correct similarities. Do not accept: They are all reactive	2
	d	i	Down the group boiling point increases.		1
		ii	Down the group reactivity decreases.		1
	e	i	**Chlorine** water is added to solutions of (Cl^-), **Br^- and I^-** **Bromine** water is added to solutions of (Br^-), **Cl^- and I^-** **Iodine** is added to solutions of (I^-), **Cl^- and Br^-**	If the method is 'correct' but there is no distinction between elements (halogens) and ions (halides), award 1 mark.	1 1 1

<table>
<tr><td></td><td></td><td>ii</td><td><table><tr><th></th><th>Cl_2</th><th>Br_2</th><th>I_2</th></tr><tr><td>Cl^-</td><td>No reaction</td><td>No reaction</td><td>No reaction</td></tr><tr><td>Br^-</td><td>Br_2 forms</td><td>No reaction</td><td>No reaction</td></tr><tr><td>I^-</td><td>I_2 forms</td><td>I_2 forms</td><td>No reaction</td></tr></table></td><td>1 mark for each correct row/column

Accept correct colours/observations instead of halogen formed.</td><td>3</td></tr>
<tr><td></td><td></td><td>iii</td><td>$Cl_2(g/aq) + 2Br^-(aq) \rightarrow 2Cl^-(aq) + Br_2(l/aq)$
OR
$Cl_2(g/aq) + 2I^-(aq) \rightarrow 2Cl^-(aq) + I_2(s)$
OR
$Br_2(l/aq) + 2I^-(aq) \rightarrow 2Br^-(aq) + I_2(s)$</td><td>1 mark for formulae.
1 mark for balancing.
1 mark for state symbols.

If a correct, non-ionic equation is presented, mark only the state symbols.</td><td>3</td></tr>
<tr><td></td><td>f</td><td></td><td>$Cl_2 + H_2O \rightarrow HOCl + HCl$</td><td>1 mark for formulae.
1 mark for balancing.</td><td>2</td></tr>
<tr><td></td><td>g</td><td></td><td>HOCl</td><td></td><td>1</td></tr>
<tr><td></td><td>h</td><td></td><td>To a solution of the suspected chloride, add acidified silver nitrate solution.
A white precipitate forms (that turns purple in sunlight).</td><td>1 mark for test
1 mark for result</td><td>2</td></tr>
<tr><td colspan="5">Total:</td><td>20</td></tr>
<tr><td>14</td><td>a</td><td></td><td>Sodium and potassium are alkali metals.
Calcium and magnesium are alkaline earth metals.</td><td>1
1</td><td>2</td></tr>
<tr><td></td><td>b</td><td>i</td><td>Alkali metals are soft and shiny when freshly cut while alkaline earth metals are relatively hard, shiny metals.</td><td>1 mark for appearance.
1 mark for hardness.</td><td>2</td></tr>
<tr><td></td><td>b</td><td>ii</td><td>Alkali metals tarnish/darken quickly as they react the oxygen in the air.
Alkaline earth metals tarnish slowly.</td><td>1 mark for tarnish in air.
1 mark for comparison.
Do not accept: react vigorously.</td><td>2</td></tr>
<tr><td></td><td>b</td><td>iii</td><td>Alkali metals react vigorously to form the (soluble) hydroxide and hydrogen.
Alkaline earth metals react moderately to form a (sparingly soluble) hydroxide and hydrogen.</td><td>1 mark for products (hydroxide and hydrogen).
1 mark for comparison (vigorous vs less vigorous, with cold water vs with warm water or steam).</td><td>2</td></tr>
<tr><td></td><td>c</td><td></td><td>Taking Na:2,8,1 and K:2,8,8,1 as examples:
• Larger distance between valence electron and nucleus;
• less energy to ionise.</td><td>Accept shielding effect.
(Candidates are not expected to show knowledge of the shielding effect but some do.)</td><td>2</td></tr>
<tr><td></td><td>d</td><td>i</td><td>A is CaO
B is $Ca(OH)_2$</td><td>1
1</td><td>2</td></tr>
<tr><td></td><td></td><td>ii</td><td>Reaction 1: $CaCO_3 \rightarrow CaO + CO_2$
Reaction 2: $CaO + H_2O \rightarrow Ca(OH)_2$
Reaction 3: $Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$</td><td>2
2
2</td><td>6</td></tr>
</table>

	e		Addition of OH^- (NaOH, KOH, or NH_3) • To the solution containing suspected calcium ions, add sodium hydroxide solution dropwise until in excess. • A white precipitate insoluble in excess forms. **OR** Flame test • Clean nichrome wire is dipped in concentrated HCl, salt, and blue Bunsen flame. • Brick red flame	1 mark for each correct point.	2
				Total:	**20**