Number		
1	C	**1**

Question Number	Correct Answer	Mark
2 (a)	B	**1**

Question Number	Correct Answer	Mark
2 (b)	C	**1**

Question Number	Correct Answer	Mark
2 (c)	D	**1**

Question Number	Correct Answer	Mark
3	C	**1**

Question Number	Correct Answer	Mark
4	B	**1**

Question Number	Correct Answer	Mark
5	B	**1**

Question Number	Correct Answer	Mark
6	A	**1**

Question Number	Correct Answer	Mark
7	D	**1**

Question Number	Correct Answer	Mark
8	A	**1**

9)

	C		1

10)

	D		1

11)

	D		1

12)

	Correct Answer	Reject	Mark
9	D		**1**

13)

	Correct Answer	Reject	Mark
	A		**1**

14)

	Correct Answer	Reject	Mark
	C		**1**

15)

	B		**1**

16)

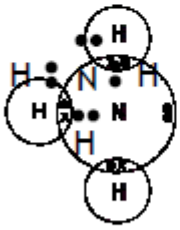
(a)(i)	reflects IR (radiation) / heat **(1)** (re-radiating) **from the earth** **(1)** ALLOW **Back** to the earth	(heat) from the sun From the earth's atmosphere	

Question Number	Acceptable Answers	Reject	Mark
(a)(ii)	(water is a greenhouse gas) because it absorbs infrared (IR) radiation **(1)** The polarity of the water molecule changes when its bonds vibrate ALLOW Water is a polar molecule/has polar bonds **(1)**	Reflects (for absorbs) Heat (for IR) Traps IR/heat from the earth	**2**

Question Number	Acceptable Answers	Reject	Mark
(a)(iii)	$CH_4 + 2H_2O \rightarrow CO_2 + 4H_2$ ALLOW $CH_4 + H_2O \rightarrow CO + 3H_2$ Species **(1)** balance **(1)** No TE on incorrect species	$CH_4 + 2H_2O \rightarrow CO_2 + 8H$ $CH_4 + H_2O \rightarrow CO + 6H$	**2**

Question Number	Acceptable Answers	Reject	Mark
(a)(iv)	Hydrogen is obtained from the water (as well as from the methane) OR Easier to capture the CO_2 in a chemical plant than in a moving vehicle ALLOW Higher yield of/more hydrogen		**1**

Number			
. **(a)(v)**	(High cost of) energy needed (to generate the pressure) OR (High cost of) **construction/ maintenance** of the equipment OR (High cost of) the equipment required to **withstand / contain** the high pressure	High pressure is expensive	**1**

Question Number	Acceptable Answers	Reject	Mark
(b)(i)	ALLOW  Accept dots and/or crosses for electrons, provided there are 3 bond pairs plus 2 electrons with or without lines for the bonds With or without circles		**1**

Number			
(b)(ii)	**Comment** Any incorrect statement cancels a correct one. The order of the marking points is not important. **Marking Point 1** Ammonia has hydrogen bonds (as well as London forces) **(1)** IGNORE permanent dipole-dipole forces here **Marking Point 2** Methane (only) has London / dispersion forces **(1)** ALLOW van der Waals forces **Marking Point 3** (So) Intermolecular forces (stated or implied) in ammonia are (much) stronger than those in methane **(1)** **Marking Point 4** (Ammonia has hydrogen bonds) because nitrogen is very electronegative **(1)** (and has a lone pair) OR London forces are similar in both methane and ammonia (because they have the same number of electrons) **(1)** OR So more energy is needed to separate ammonia molecules (than methane molecules)		**4**

17)

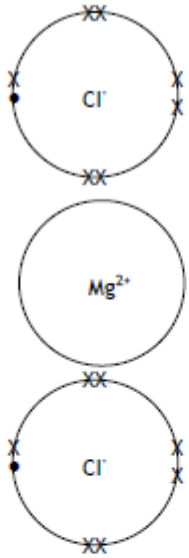
mber			
(a)	**(i) Structure** Lattice /close-packed **(1)** (or a diagram with at least 3 rows) positive ions or cations (allow metal ions) **(1)** delocalized electrons / sea of electrons **(1)** **(ii) Bonding** (Electrostatic) **attraction** between positive ions / cations (allow metal ions) and delocalized electrons / sea of electrons **(1)**	layers protons 'free' electrons	**4**

(b)	Any three from 1. Magnesium ion / Mg^{2+} (allow magnesium) has a larger charge (density) than the sodium ion (allow sodium) / Na^+ some comparison of the ions is required **(1)** 2. magnesium ions / Mg^{2+} smaller than sodium ions **(1)** 3. Magnesium / Mg^{2+} contributes two / more electrons (per atom) to the "sea" of electrons **(1)** 4. magnesium ions / Mg^{2+} have greater attraction for the delocalized "sea" of electrons **(1)** Ignore reference to number of outer electrons in Mg / Na Any references to the bonding being ionic, covalent or intermolecular (max 2) Reverse argument can gain full marks	Just Mg^{2+} and Na^+ More bonds	**3**

(c)	The delocalized electrons / sea of electrons **(1)** Flow (allow move / free to move) **(1)** (When a potential difference/voltage is applied) 'Carry the current' is not sufficient for the mark	'free' electrons	**2**

18)

(a)	$(1s^2\ 2s^2)\ 2p^6\ 3s^2\ 3p^5$ (ignore repetition of $1s^2\ 2s^2$) *ALLOW* subscripts, correct use of p_x, p_y and p_z orbitals or normal font for electrons	2 8 7	1

(b) (i)	 Correct number of outer electrons (ignore whether dots and / or crosses) drawn **and also** ratio of magnesium : chloride ions is 1:2 **(1)** Correct formulae and charges of the ions shown somewhere **(1)** **NOTE:** Diagram for Mg^{2+} showing the outermost shell with $8e^-$ (dots and/or crosses) and/or Cl^- shown with a 2 in front or 2 as a subscript would also score both marks **Mark the two points independently**	Covalent bonding (0) Incorrect numbers of electrons in inner shells if drawn for first mark "MG^{2+}" and/or "CL^{-}" for second mark	**2**
(b) (ii)	4 shared pairs of electrons around the carbon labelled C **(1)** ALL outer electrons, including lone pairs, are correctly shown on each of the four chlorine atoms labelled Cl **(1)** *ALLOW* versions without circles *IGNORE* lines between the shared electrons **Mark two points independently**	Ionic bonding (0)	**2**

(b) (iii)	(Comparison of) charges: O^{2-} ions whereas Cl^- ions OR Statement to the effect that oxide ion has a greater (negative) charge / greater charge density than the chloride ion **(1)** (so the force of) attraction between **ions** is stronger in MgO (than $MgCl_2$) / stronger **ionic** bonding in MgO (than $MgCl_2$) **(1)** More **energy** is required to separate the ions in MgO (than $MgCl_2$) / more **energy** is required to break (ionic) bonds in MgO (than $MgCl_2$) / **(1)** **Mark the above three points independently** *NOTE ALTERNATIVE ANSWER WITH A MAXIMUM OF TWO MARKS:-* O^{2-} (ions) **smaller** (than Cl^- ions) **(1)** so (force of) attraction between **ions** is stronger in MgO (than $MgCl_2$) /stronger **ionic** bonding in MgO (than $MgCl_2$) **(1)** Ignore *ANY* references to polarization of ions / covalent character / degree of covalency.	Use of term chlorine and/or oxygen "atoms" or "molecules" **(0) for answer overall** "More bonds need to be broken" **(0) for answer overall** if mentions "intermolecular forces"	3

mber			
(c)	**First Mark:** *EITHER* Magnesium reacts with chlorine to form only magnesium chloride/ magnesium reacts with chlorine to form only one product / magnesium reacts with hydrochloric acid to form hydrogen (as well as magnesium chloride) / magnesium reacts with hydrochloric acid to form more than one product / magnesium reacts with hydrochloric acid to form a waste product *OR* **Both** equations $Mg + Cl_2 \rightarrow MgCl_2$ **and** $Mg + 2HCl \rightarrow MgCl_2 + H_2$ *IGNORE* state symbols, even if incorrect **(1)** **Second Mark:** *EITHER* The reaction with chlorine has an atom economy which is higher /100% ALLOW "high" *OR* Any mention of numbers comparing 100 % v. 97.9% **(1)** *IGNORE* any comments about **yield** **Mark the two points independently**		**2**