1 (a)	B	1

Question Number	Correct Answer	Mark
1 (b)	D	1

Question Number	Correct Answer	Mark
2	D	1

Question Number	Correct Answer	Mark
3	A	1

Question Number	Correct Answer	Mark
4 (a)	B	1

Question Number	Correct Answer	Mark
4(b)	D	1

Question Number	Correct Answer	Mark
4 (c)	C	1

Question Number	Correct Answer	Mark
4 (d)	A	1

Question Number	Correct Answer	Mark
5	B	1

6)

	Correct Answer	Mark
	B	1

7)

	Correct Answer	Mark
	C	1

8)

uestion umber	Correct Answer	Mark
(a)	B	1

uestion umber	Correct Answer	Mark
(b)	A	1

9)

	Correct Answer	Mark
	C	1

10)

	Correct Answer	Mark
	B	1

11)

(a) (i)	$H_2O + CO_2 \rightarrow H_2CO_3$ (Allow atoms in H_2CO_3 in any order) Or $H_2O + CO_2 \rightarrow H^+ + HCO_3^-$ Or $H_2O + CO_2 \rightarrow 2H^+ + CO_3^{2-}$ Or H_3O^+ in place of H^+ *IGNORE STATE SYMBOLS EVEN IF INCORRECT*		1

Question Number	Acceptable Answers	Reject	Mark
(a) (ii)	$2H^+ + CO_3^{2-} \rightarrow H_2O + CO_2$ LHS **(1)** RHS **(1)** **OR** $2H_3O^+ + CO_3^{2-} \rightarrow 3H_2O + CO_2$ LHS **(1)** RHS **(1)** *IGNORE STATE SYMBOLS, EVEN IF INCORRECT* *IGNORE* ⇌ arrows	H_2CO_3 as a product $H^+ + CO_3^{2-} \rightarrow HCO_3^-$ Any other ions including spectator ions (e.g. Ca^{2+}, Cl^-) in the equation scores zero	**2**

12)

	Correct Answer	Mark
	C	1

13)

(a)	D	1

Question Number	Correct Answer	Mark
(b)	A	1

Question Number	Correct Answer	Mark
(c)	C	1

14)

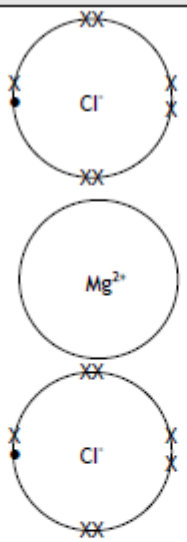
(a)	Average/mean mass of an atom/isotopes (1) (1/12 mass of an atom of) carbon-12 (1) **First mark:** mention of mean or average mass of either an atom/isotopes *IGNORE* "weighted" before average or mean *IGNORE* any mention of "moles" in definition **Second mark: any mention** of carbon-12 *IGNORE* any reference to "moles" or "1 mole" at any stage *IGNORE* 12 g with reference to carbon-12 **Mark the two points independently**	"weight" instead of mass mean or average mass **of an element...** without prior mention of either an atom or isotopes	2

estion mber	Acceptable Answers	Reject	Mark
(b) (i)	(Rubidium/it has) two **isotopes** *ALLOW* (Rubidium/it has) "different **isotopes**" *ALLOW* abbreviations such as formulae of rubidium atoms or cations with isotopic masses		1

estion mber	Acceptable Answers	Reject	Mark
(b) (ii)	$\frac{85 \times 72 + 87 \times 28}{100}$ **(1)** = 85.56 or 85.6 **(1)** Correct answer with no working **(2)** **NOTE:** Rounding error giving answer 85.5 scores **(1)** *IGNORE* **any** units (for example, g/g mol^{-1}/%) **NOTE:** If 71% abundance used for ^{85}Rb and 29% for ^{87}Rb, answer = 85.58 or 85.6 scores **(1)** Second mark awarded if answer CQ correct on wrong abundances and /or wrong isotopic masses.	Calculation of simple arithmetic mean of 85 + 87 = 86 scores zero	2

15)

(a)	$(1s^2\ 2s^2)\ 2p^6\ 3s^2\ 3p^3$ (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	Covalent bonding (0) Incorrect numbers of electrons in inner shells if drawn for first mark "MG^{2+}" and/or "CL^-" for second mark	**2**

16)

(a)	**First mark** The energy (allow enthalpy / heat) required (allow change) per mole **(1)** **Second mark** to form (gaseous) singly charged positive ions Or to remove (1 mole of) electrons **(1)** **Third mark** from **gaseous** atoms (of the element) **(1)** $X(g) \longrightarrow X^{+}(g) + e^{(-)}$ scores last 2 marks Ignore standard conditions Per mole scores at any point	Energy / enthalpy produced Just gaseous element	**3**

estion mber	Acceptable Answers	Reject	Mark
(b)	Nuclear charge / effective nuclear charge / number of protons / atomic number increases **(1)** **Two of** (Outer) electrons in the **same** (quantum) shell / **same** number of electron shells **(1)** Shielding (of nucleus)(about) the same **(1)** Distance from nucleus/atomic radius less **(1)**	charge density orbitals, sub-shell	**3**
(c)	**Route 1** Electrons (in the p sub-shell) are **paired** (for the first time) (in S) / two electrons occupy the same (p) orbital / full orbital / electrons-in-boxes diagram **(1)** **repulsion** between the (paired) electrons (reduces IE) **(1)** **Route 2** P has a half-filled p sub-shell / half-filled p orbitals which is stable **(1)** (on ionization) S gains a half-filled p sub-shell / half-filled p orbitals **(1)**		**2**

estion mber	Acceptable Answers	Reject	Mark
(d)	200 – 490 ($kJ\ mol^{-1}$)	Negative values	**1**

17)

(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**

estion mber	Acceptable Answers	Reject	Mark
(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)

3(a)	**ALLOW reverse arguments in each case** **Any three from:-** • **sodium atoms/sodium ions** are larger (than magnesium atoms/ions) **NOTE:** Allow symbols (eg Na or Na^+) **(1)** • sodium ions are Na^+ whereas magnesium ions are Mg^{2+} OR Na^+/sodium **ions** have smaller charge (density) than Mg^{2+}/ magnesium **ions** **(1)** **[NOTE:** It follows that the statement that "Na^+ ions are larger than Mg^{2+} ions" would score the first two scoring points above)**]** • sodium has fewer **delocalized** electrons (than magnesium) **(1)** • attraction between the positive ions and (delocalized) electrons is weaker in sodium (than magnesium) **(1)** • sodium is not close-packed (but magnesium is close-packed) **(1)** • less energy needed (to break bonds) **(1)**	Attraction between **nucleus** and (delocalized) electrons Mention of **intermolecular forces/molecules** negates the energy mark **NOTE:** Arguments based on ionization energies **OR** suggestion of removal of outer shell electrons as part of the melting process scores **(0) overall**	**3**

3(b)	**First mark:** Idea of (breaking) **covalent bonds** in silicon **(1)** **Second and third marks:** **ANY TWO FROM** • Silicon is **giant** covalent / giant atomic/giant molecular/ macromolecular/giant structure/giant lattice IGNORE just "giant" **(1)** • Phosphorus made up of simple molecules /small molecules/ P_4 molecules /phosphorus is molecular covalent /molecular/simple covalent IGNORE just "simple"/"simple structure" **(1)** • Between phosphorus molecules: weak forces/weak intermolecular forces/weak London forces/weak van der Waals' forces/weak dispersion forces/weak induced-dipole forces **(1)** **[ALLOW** "weak bonds" if implies between phosphorus **molecules]** • More energy needed (to break bonds in silicon) **(1)**	Intermolecular forces broken in silicon/ covalent bonds broken in phosphorus "silicon giant ionic"/"silicon giant metallic" Weak bonds between phosphorus **atoms**	**3**
(c)	**IGNORE any references to "energy" in this part of the question** Argon monatomic/argon (composed of) single atoms **NOTE:** This must be stated in words, not just by use of its symbol Ar IGNORE any comments about argon atoms having a full outer shell or argon being a noble gas IGNORE any comment about forces/bonds between argon particles	Any suggestion that argon is molecular Argon having a giant structure (of atoms)	**1**

(d)	**First mark:** Mg has mobile electrons/delocalized electrons/free electrons/sea of electrons (to carry the charge) ALLOW Mg^{2+} instead of Mg or magnesium **(1)** **Second mark:** Sulfur's electrons are fixed (in covalent bonds)/sulfur's electrons are involved in bonding/sulfur's electrons are not free (to move)/no delocalized electrons in sulfur/no mobile electrons in sulfur **(1)**	Mg has free ions/Mg has mobile ions Sulfur has 'no free **ions**'/sulfur **has** delocalized electrons/just "sulfur has covalent bonds"/ just "sulfur is not a metal"	**2**