Topic 1:

Periodicity, Structure & Bonding

Answer Book

Structures of Elements 1 - 20

KHS June 2014 - Cheviot Learning Community - based on CHALLENGE CHEMISTRY © R.I.S.E
SQA Key Words:

‘First level’: should be reasonably straightforward requiring good recall of information learnt:

identify, name, give, or state, - need only name or present in brief form;
complete, - must finish a chemical equation or fill in a table with information;
write, - must complete a chemical or word equation;
draw, - must draw a diagram or structural formula;

Second level’: deeper understanding required and more detailed answer:

describe, - must provide a statement or structure of characteristics and/or features;
compare, - must demonstrate knowledge and understanding of the similarities and/or differences between things;
determine or calculate, - must determine a number from given facts, figures or information;
estimate, - must determine an approximate value for something;
predict, - must suggest what may happen based on available information;

‘Top level’: complete understanding needed as well as the ability to think clearly:

explain, - must relate cause and effect and/or make relationships between things clear;
evaluate, - must make a judgement based on criteria;
suggest, - must apply their knowledge and understanding of [subject] to a new situation;
use your knowledge of, - must apply their skills, knowledge and understanding to respond appropriately to the problem/situation presented;
### Home Practice Answers 1.1A

**Q1.**
- **a)** electrostatic (1)
- **b)** negatively (1)
- **c)** mobile (1)
- **d)** positively (1)
- **e)** neighbouring (1)

**Q2.**
- **a)** decreases (1)
- **b)** increases (1)
- **c)** decreases (1)

**Q3.**
- **a)** Able to be shaped by beating (or hitting) (1)
- **b)** The metallic bond can move round in any direction. (1)

### Home Practice Answers 1.1B

**Q1.**
- **a)** Slightly positive and slightly negative (1)
- **b)** Two electric poles (or sides) (1)
- **c)** The electron cloud wobbling (or vibrating) (1)
- **d)** Because the wobble keeps changing (so the dipole keeps changing too). (1)

**Q2.**
- **a)** It attracts the electron cloud. (1)
- **b)** (1)
- **c)** The opposite charges of the o+ on one atom is attracted to the o- of the other. (1)
- **d)** It is called a London dispersion force (1)

**Q3.**
- The larger the atom the greater the wobble of the electron cloud giving a greater dipole effect resulting in stronger attraction between the atoms so more heat energy is needed to overcome these forces when melting the solid (2)

### Home Practice Answers 1.2A

**Q1.**
- **a)** S₈ (1)
- **b)** covalent (1)
- **c)** London dispersion forces (1)

**Q2.**
- **a)** diatomic (1)
- **b)** the atoms are smaller so the London dispersion forces are weaker (½)
- **c)** it has fewer atoms so there are fewer London dispersion forces (½)

**Q3.**
- **a)** Fullerenes (1)
- **b)** C₆₀ (1)
- **c)** The large space inside each molecule (1)

**Q4.**
- **a)** covalent (1)
- **b)** The covalent bonding extends throughout the entire structure (1)
- **c)** The covalent bonds are fixed in position (1)
- **d)** It does not have any delocalised electrons. (1)
- **e)** It is very hard (1)
**Home Practice Answers 1.2B**

**Q1.**
- **a)** Carbon (1)  
  **b)** London dispersion forces (1)  
  **c)** delocalised electrons (1)  
  **d)** The bonding *between* layers is weak (1)  
  **e)** Conduction and slipperiness (1)

**Q2.**
- **a)** Any 3 from: lithium, beryllium, sodium, magnesium, aluminium, potassium, and calcium (1)  
  **b)** Helium, neon, and argon (1)  
  **c)** Phosphorus, sulphur, and fullerene (1)  
  **d)** Any 3 from: hydrogen, nitrogen, oxygen, fluorine, and chlorine (1)  
  **e)** Boron, silicon, and carbon (diamond or graphite) (1)  
  **f)** Boron, silicon, and carbon (diamond or graphite) (1)  
  **g)** Any 3 from: hydrogen, nitrogen, oxygen, fluorine, and chlorine, phosphorus, sulphur, and fullerene, helium, neon and argon (1)

**Home Practice Answers 1.3A**

**Q1.**
- **a)** There is no clear-cut edge to an atom. (1)  
  **b)** The bonding *between* layers is weak (1)  
  **d)** Half the distance between the nuclei of covalently bonded atoms (1)

**Q2.**
- **a)** 208 pm (1)  
  **b)** 380 pm (1)

**Q3.**
- **a)** Decreasing from left to right (1)  
  **b)** The increasing nuclear charge pulls the outermost electrons in more strongly (1)

**Q4.**
- **a)** 135 (± 5) pm (1)  
  **b)** Each atom has one more energy level (or shell of electrons) making the outermost electron further from the nucleus. (1)
**Home Practice Answers 1.3B**

**Q1.**

a) The energy to remove one electron from every atom in a mole of free nitrogen atoms. (1)

\[ N(g) \rightarrow N^+(g) + e^- \quad (1) \]

b) \[ N(g) \rightarrow N^+(g) + e^- \quad (1) \]

c) \[ N^+(g) \rightarrow N^{2+}(g) + e^- \quad (1) \]

**Q2.**

a) one of the two outermost electrons (1)

b) The inner electrons screen (or shield) the outermost electrons from the full attractive force of the nucleus (1)

**Q3.**

a) Higher (1)  
b) Because of the greater attraction of the more positive nucleus (1)

c) Lower (1)  
d) Because the outermost electron is further from the nucleus and screened from it by more layers (or shells) of electrons (½)

e) Neon (1)

---

**Home Practice Answers 1.4A**

**Q1.**

a) SiCl₄ (1)

b) The atoms are held together by covalent bonds with discrete (or individual) molecules. (½)

d) A stable octet, or stable electron arrangement (1)

e) London dispersion forces (1)

**Q2.**

a) Fluorine atoms have one less energy level, so they are smaller than chlorine atoms. Smaller atoms result in weaker London dispersion forces between the molecules. These are not strong enough to hold SiF₄ molecules together as a liquid at room temperature. (½)

**Q3.**

a) London Dispersion forces (1)

b) Pentane (½) Because it has more London dispersion forces between molecules. or Because it has larger (or longer) molecules. (½)

c) [Pentane can have more London dispersion forces] (1)
**Home Practice Answers 1.4B**

**Q1.**

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>$\text{H} \rightarrow \text{Br}$</td>
<td>(1)</td>
<td>b)</td>
</tr>
</tbody>
</table>

**Q2.**

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>Not deflected</td>
<td>(1)</td>
<td>b)</td>
</tr>
</tbody>
</table>

**Q3.**

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>$\text{C} \rightarrow \text{Br}$</td>
<td>2.8</td>
<td>$-$</td>
</tr>
<tr>
<td></td>
<td>$\text{H} \rightarrow \text{F}$</td>
<td>4.0</td>
<td>$-$</td>
</tr>
</tbody>
</table>

Therefore $\text{H} \rightarrow \text{F}$ is more polar | (1)

Therefore $\text{N} \rightarrow \text{S}$ is more polar | (1)

---

**Home Practice Answers 1.5**

**Q1.**

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>$\text{O} \Leftrightarrow \text{C} \Rightarrow \text{O}$</td>
<td>(1)</td>
</tr>
</tbody>
</table>

b) Because the two dipoles cancel each other or 
The molecule does not have a δ+ side and a δ- side | (1)

c) London dispersion forces | (1) 
d) London dispersion forces are weak | (1)

**Q2.**

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>$\text{CH}_3$</td>
<td>$\delta^+$</td>
</tr>
</tbody>
</table>

b) Because it has a dipole which is not cancelled by another or 
The molecule does have a δ+ side and a δ- side | (1)

c) Polar—polar attractions | (½) and London dispersion forces | (½)

d) Polar—polar attractions are slightly stronger than London dispersion forces (½) and the combination is sufficient to keep the molecules together as a liquid (½).

**Q3.**

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>It is symmetrical, so the dipoles of the CF bonds cancel.</td>
<td>(1)</td>
</tr>
</tbody>
</table>

b) It is not symmetrical, so the three dipoles do not cancel. or It has a δ+ side and a δ- side. | (1)
**Home Practice Answers 1.6A**

**Q1. a)** Nitrogen, oxygen, fluorine (1)  
**b)** They are particularly small (1) and very strongly electron-attracting (1)

**Q2. a)** ![Chemical Structure](image)  
[These three atoms should be in a straight line.] (1)

**b)** Much weaker (1)  
**c)** Much stronger (1)

**d)** HCl has stronger London dispersion forces than HF (1) but the hydrogen bonding in HF is far stronger than this. (1)

**Q3. a)** Liquid A (½) because it has hydrogen bonding (½)

**b)** Because both molecules have the same shape and size (½), so the van der Waals attractions will be equal (½)

---

**Home Practice Answers 1.6B**

**Q1. a)** Water (1)  
**b)** Covalent Bond or polar covalent bond (1) and hydrogen bond (1)

**c)** Hexagonal (or six-sided) (1)

**d)** (the network of) Hydrogen bonding (1)

**e)** The spaces in the open network structure (1)

**Q2. a)** Soluble (½) water can hydrogen bond to the oxygen (½)

**b)** Insoluble (½) water cannot hydrogen bond to it (½)

**c)** Insoluble (½) it is non-polar or water cannot hydrogen bond to it (½)

**d)** Soluble (½) it has hydrogen bonding or water can hydrogen bond to it (½)

---

**Home Practice Answers 1.7A**

**Q1. a)** Na\(^+\) (½) 2,8 (½)  
**b)** P\(^3-\) (½) 2,8,8 (½)  
**c)** Se\(^2-\) (½) 2,8,18,8 (½)

**Q2. a)** Ionic (1)  
**b)** 6 (1)  
**c)** The ratio of calcium ions to oxide ions is 1:1 (1)

**d)** The calcium ion has one more energy level (½) so it is larger than the magnesium ion (½). As the size of ion increases the strength of attraction decreases (½) so less heat energy is needed to overcome the ionic bonding in calcium oxide. (½)

**Q3. a)** As the ionic size increases, the enthalpy of lattice breaking decreases (1)

**b)** 760 ± 10 kJ mol\(^{-1}\) (1)
**HOME PRACTICE ANSWERS 1.7B**

Q1.  

a) SiC  (1)  

b) Covalent  (1)  

c) Because the covalent bonds extend throughout the entire structure.  (1)  

d) Because the silicon and carbon atoms form a **regular repeating pattern**.  (1)  

e) The covalent network structure.  (1)  

f) It takes a lot of energy to break the many strong covalent bonds  (1)  

---

Q2.  

a) 4  (1)  

b) Because the ratio of silicon to oxygen atoms in the structure is 1:2  (1)  

c) 1610 °C  (1)  

c) A hard material that can be used to rub down or wear away      (1)  

---

**CONSOLIDATION A**

Q1.  

a) monatomic gas - one from helium, neon or argon  

covalent network solid - one from boron, silicon or carbon (graphite or diamond)  

covalent molecular gas - one from nitrogen, oxygen, fluorine or chlorine  

covalent molecular solid - one from sulphur, phosphorus or iodine  

4 correct — 2 marks  
2 or 3 correct — 1 mark  

b) Increasing nuclear charge/number of protons or Decreasing atomic size — 1 mark  

c) open ended question

---

**CONSOLIDATION B**

Q1.  

a) Looking for three ideas — Br₂ non-polar/ICl polar — 1 mark  

Br₂ and ICl have same number of electrons — 1 mark  

B²⁺ ICl higher than B²⁺ Br₂ — 1 mark  

b) H—H , H₂ — 1 mark  

ICl has permanent dipole/permanent dipole — 1 mark

---

Q2.  

a) i) Boron or Carbon  ii) Number of protons or atomic number increases  

or greater nuclear/positive charge (pull)  

or greater pull on (outer) electrons — 1 mark  

b) As you go down group  

Electrons are further from the nucleus  

or atomic size increases or extra energy level — 1 mark  

increased screening or shielding reduces tha ability to attract electrons — 1 mark
**CONSOLIDATION**

**Q1.**  
**a)** 2.9 — 1 mark  
**b)** covalent — 1 mark  
**c)** Cross at (2.6, 0.8) on graph

For calculation of both average electronegativity (2.6) and difference (0.8) — 1 mark  
For correctly plotting the point (even if wrong values) — 1 mark

**CONSOLIDATION**

**Q1.** Looking for three things — naming of intermolecular forces — 1 mark  
description of how they arise — 1 mark  
comparison of strength and effect on boiling point — 1 mark

Hydrogen cyanide molecules are polar with permanent dipole — permanent dipole attractions between molecules.

Nitrogen molecules are non-polar. The intermolecular forces between nitrogen molecules are London dispersion forces.

Hydrogen cyanide molecules are polar due to electronegativity difference between nitrogen and hydrogen.

London dispersion forces are temporary dipole-temporary dipole attractions due to temporary wobbles of the electrons.

More energy is required to break permanent dipole — permanent dipole attractions.

**Q2.**

**a)** Covalent radii decrease across the period. — 1 mark

**b)** As you go from Na to Al the number of (delocalised) electrons in the outer shell increases — 1 mark

This increases the strength of the metallic bonding — 1 mark

**c)** fourth electron being removed is from an inner electron shell or shell closer to the nucleus (and therefore requires more energy to remove) — 1 mark