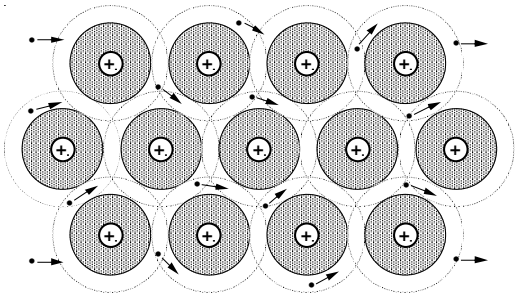
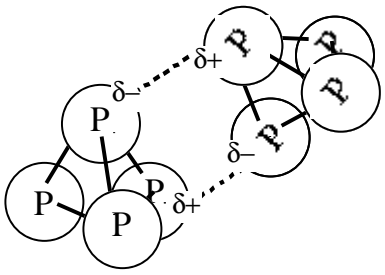
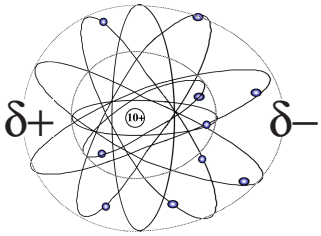


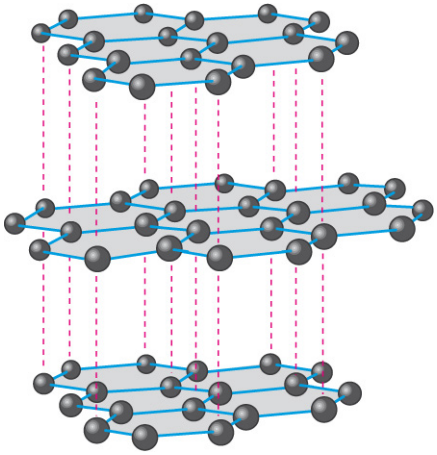


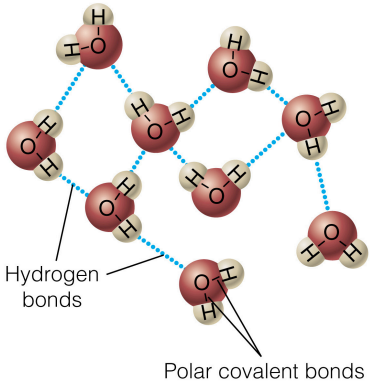


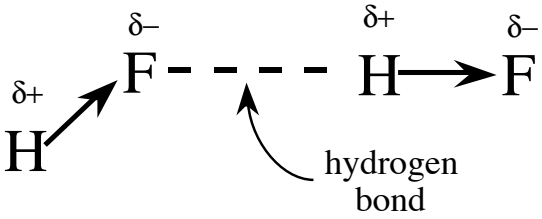
Topic 1:

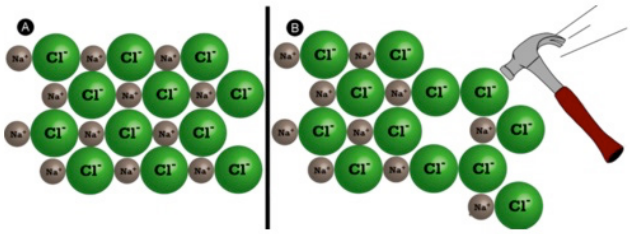
Periodicity, Structure & Bonding

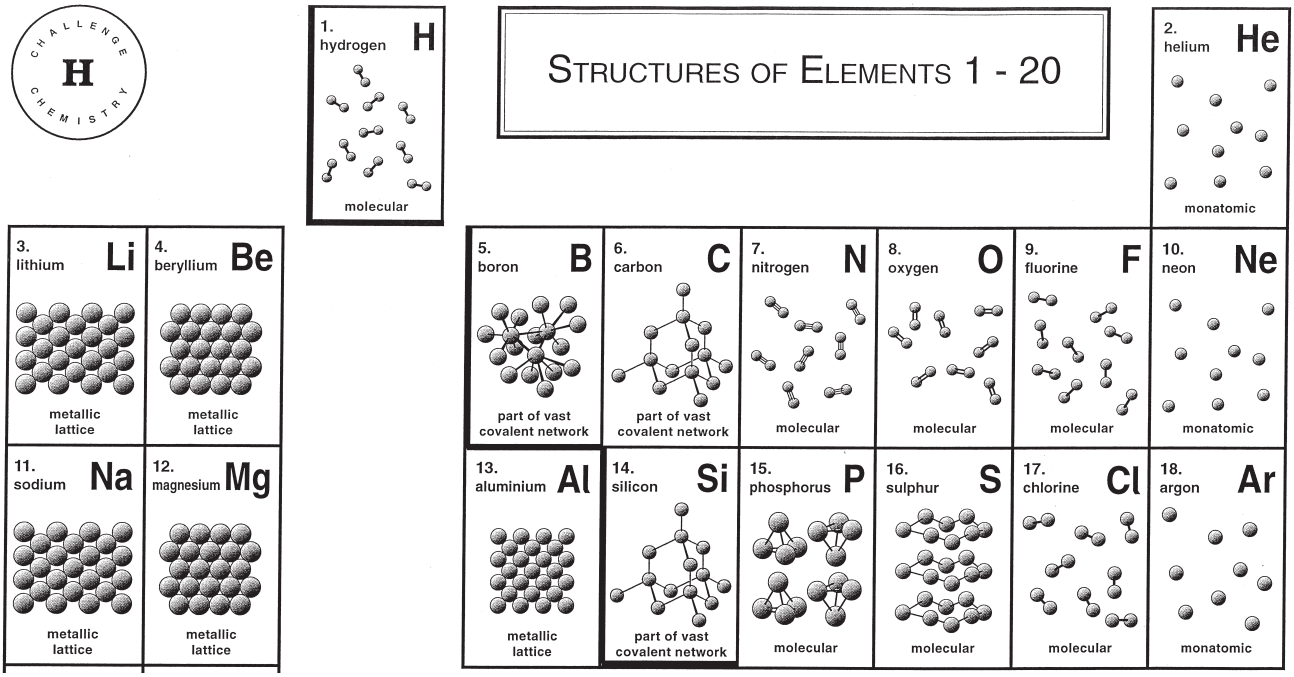
Answer Book











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;*

1.1 A	A	B	C	D
1			■	
2				■
3		■		
4	■			
5	■			
6		■		
7			■	
8				■

1.1 B	A	B	C	D
1		■		
2			■	
3				■
4		■		
5	■			
6				■
7		■		
8			■	

1.2 A	A	B	C	D
1			■	
2	■			
3			■	
4		■		
5	■			
6		■		
7				■
8				■

1.2 B	A	B	C	D
1		■		
2				■
3				■
4		■		
5	■			
6	■			
7	■			
8			■	

1.2 C	A	B	C	D
1			■	
2	■			
3				■
4		■		
5				■
6		■		
7		■		
8		■		

1.3 A	A	B	C	D
1		■		
2			■	
3			■	
4		■		
5			■	
6		■		
7	■			
8	■			

1.3 B	A	B	C	D
1		■		
2		■		
3		■		
4			■	
5			■	
6			■	
7				■
8		■		

1.4 A	A	B	C	D
1		■		
2	■			
3			■	
4				■
5			■	
6		■		
7				■
8				■

1.4 B	A	B	C	D
1				■
2		■		
3	■			
4				■
5			■	
6	■		■	
7				■
8			■	

1.5	A	B	C	D
1		■		
2		■		
3	■			
4		■		
5				■
6				■
7			■	
8				■

1.6 A	A	B	C	D
1	■			
2		■		
3			■	
4	■			
5				■
6			■	
7		■		
8			■	

1.6 B	A	B	C	D
1			■	
2	■			
3				■
4		■		
5		■		
6				■
7				■
8			■	

	1	2	3	4	5	6	7	8
D			■		■			■
C							■	
B		■		■				
A	■					■		

1.7 A

	1	2	3	4	5	6	7	8
D	■				■			■
C			■				■	
B						■		
A		■		■				

1.7 B

Home Practice Answers 1.1A

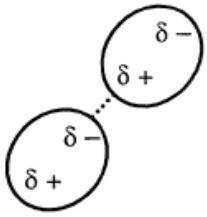
Q1. ***a)*** electrostatic (1) ***b)*** negatively (1) ***c)*** mobile (1) ***d)*** positively (1)
e) neighbouring (1)

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

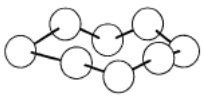
Q1. ***a)*** Slightly positive and slightly negative (1) ***b)*** Two electric poles (or sides) (1)
c) The electron cloud wobbling (or vibrating) (1)
d) Because the wobble keeps changing (so the dipole keeps changing too). (1)

Q2. ***a)*** It attracts the electron cloud. (1)
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)
b) 

(1)

Q3. The larger the atom the greater the wobble of the electron cloud (½)
giving a greater dipole effect (½)
resulting in stronger attraction between the atoms (½)
so more heat energy is needed to overcome these forces when melting the solid (½) (2)

Home Practice Answers 1.2A

Q1. ***a)*** S_8 (1) ***b)***  (1) ***c)*** covalent (1) ***d)*** London dispersion forces (1)

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

Q3. ***a)*** Fullerenes (1) ***b)*** C_{60} (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)

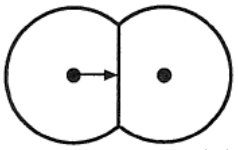
g) Any 3 from: hydrogen, nitrogen, oxygen, fluorine, and chlorine
phosphorus, sulphur, and fullerene
helium, neon and argon (1)

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)

c)  (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)

b) $N_{(g)} \longrightarrow N^{+}_{(g)} + e^{-}$ (1) ***c)*** $N^{+}_{(g)} \longrightarrow N^{2+}_{(g)} + e^{-}$ (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)

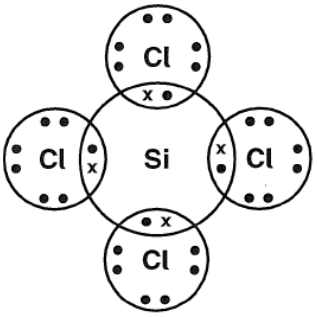
Q3. ***a)*** Higher (1) ***b)*** Because of the greater attraction of the more positive nucleus (1)

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

e) Neon (1)

HOME PRACTICE ANSWERS 1.4A

Q1. ***a)*** $SiCl_4$ (1)



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

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

e) London dispersion forces (1)

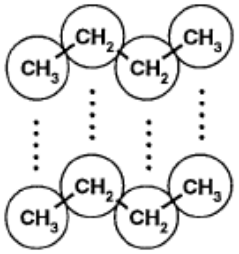
Q2. ***a)*** Fluorine atoms have one less energy level (½) , so they are smaller than chlorine atoms (½).

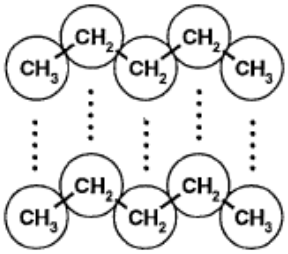
Smaller atoms result in weaker London dispersion forces between the molecules (½). These are not strong enough to hold SiF_4 molecules together as a liquid at room temperature. (½)

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. ***a)*** $\overset{\delta+}{H}\rightarrow\overset{\delta-}{Br}$ (1) ***b)*** $\overset{\delta+}{H}\rightarrow\overset{\delta-}{C}$ (1) ***c)*** C — C non-polar (1)

Q2. ***a)*** Not deflected (1) ***b)*** Deflected (1) ***c)*** Not deflected (1)

Q3. ***a)*** **C — Br** 2.8 — 2.5 = 0.3 (½)
H — F 4.0 — 2.2 = 1.8 (½)
Therefore H — F is more polar (1)

a) **C — I** 2.6 — 2.5 = 0.1 (½)
N — S 3.0 — 2.5 = 0.5 (½)
Therefore N — S is more polar (1)

Home Practice Answers 1.5

Q1. ***a)*** $\overset{\delta-}{O}\rightleftharpoons\overset{\delta+}{C}\rightleftharpoons\overset{\delta-}{O}$ (1)

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. ***a)*** CH_3 attached to $\overset{\delta+}{CH}\rightleftharpoons\overset{\delta-}{O}$ (1)

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).

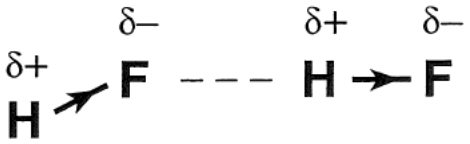
Q3. ***a)*** It is symmetrical, so the dipoles of the CF bonds cancel. (1)

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)***



[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 — Br_2 non-polar/ICl polar – 1 mark
Br_2 and ICl have same number of electrons – 1 mark
BPt ICl higher than BPt Br_2 – 1 mark

b) H—H , H_2 – 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

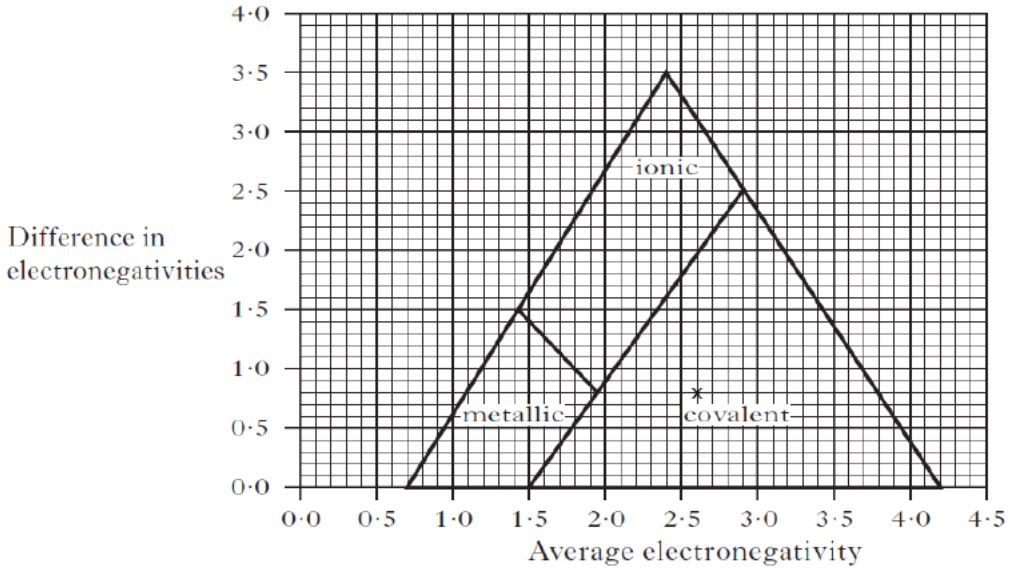
b) *As you go down group* Electrons are further from the nucleus
or atomic size increases ***or*** extra energy level - 1 mark

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

CONSOLIDATION C

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 D

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