

Structure and Bonding of Solids



Part A Ionic and covalent solids

Which of the following statements about the properties associated with different types of bonding is correct?

- ☐ Ionic compounds differ from metals in that ionic compounds do not conduct electricity in the solid state.
- ☐ Any covalent compound that contains both oxygen and hydrogen in its molecule forms hydrogen bonds.
- ☐ The only covalent compounds with high melting-points are those in which hydrogen bonds occur.
- ☐ A covalent compound cannot be an electrolyte.
- ☐ Ionic bonds and covalent bonds cannot both occur in the same compound.

Part B Structure of a solid

A solid melts sharply just above 100°C . It does not conduct electricity even when molten. It dissolves in hydrocarbon solvents.

What is the structure of the solid most likely to be?

- ☐ metallic
- ☐ simple molecular
- ☐ a giant molecular structure
- ☐ a giant ionic structure
- ☐ simple atomic

Dry Ice and Carbon Tetrachloride

A Level



Part A Interactions in dry ice

Solid carbon dioxide, $\text{CO}_2(\text{s})$, (dry ice) is used as a refrigerating agent because it readily changes directly from the solid into vapour state at a low temperature.

What does this indicate the main intermolecular interactions in $\text{CO}_2(\text{s})$ to be?

- ☐ covalent bonding
- ☐ hydrogen bonding
- ☐ ionic bonding
- ☐ van der Waals' forces

Part B Liquid tetrachloromethane

Which type of interaction is responsible for intermolecular forces in liquid tetrachloromethane, CCl_4 ?

- ☐ covalent bonding
- ☐ hydrogen bonding
- ☐ induced dipole - dipole attractions
- ☐ permanent dipole - dipole attractions

Breaking Hydrogen Bonds

A Level

Part A Hydrogen bonding between same molecules

Which of the following molecules will **not** form a hydrogen bond with another of its own molecules?

- ☐ CH₄
- ☐ H₂O
- ☐ CH₃OH
- ☐ NH₃

Part B Breaking hydrogen bonds

In which of the following processes will hydrogen bonds be broken?

- ☐ H₂ (l) \longrightarrow H₂ (g)
- ☐ H₂ (g) \longrightarrow 2 H (g)
- ☐ NH₃ (l) \longrightarrow NH₃ (g)
- ☐ C₂H₅OC₂H₅ (l) \longrightarrow C₂H₅OC₂H₅ (g)
- ☐ 2 HI (g) \longrightarrow H₂ (g) + I₂ (g)

Sulfates and Detergents

A Level



Part A Solubility of sulfates

Which of the following factors helps to explain the differing solubility in water of magnesium sulfate compared with that of barium sulfate?

- 1 Barium sulfate has a numerically (in terms of magnitude) larger lattice energy than magnesium sulfate.
- 2 The enthalpy change of hydration of magnesium ions is more exothermic than that of barium ions.
- 3 The charge density of magnesium ions is greater than that of barium ions.

- ☐ 1, 2 and 3 are correct
- ☐ 1 and 2 only are correct
- ☐ 2 and 3 only are correct
- ☐ 1 only is correct
- ☐ 3 only is correct
-

Part B Detergents

Long-chain alkanes are converted on an industrial scale into alkyl sulfates for use as detergents, e.g. sodium lauryl sulfate.

Which of the following are properties of this substance?

- 1 It possesses both a water-attracting and a water-repelling part.
- 2 The sulfate group is anionic in aqueous solutions.
- 3 The alkyl chain is soluble in oil droplets.

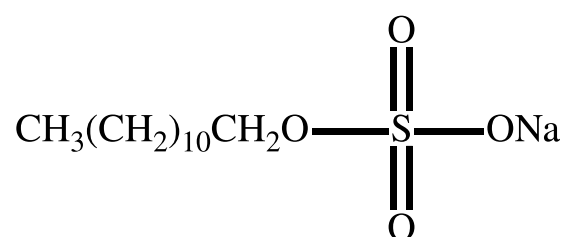


Figure 1: Sodium lauryl sulfate

- ☐ 1, 2 and 3 are correct
- ☐ 1 and 2 only are correct
- ☐ 2 and 3 only are correct
- ☐ 1 only is correct
- ☐ 3 only is correct

Part A adapted with permission from UCLES, A-Level Chemistry, November 1995, Paper 4, Question 35;

Part B adapted with permission from UCLES, A-Level Chemistry, November 1990, Paper 1, Question 32

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Shapes of Molecules and Ions

A Level



Part A F_2O

By considering the number of lone and bonding pairs of electrons, predict the shape of F_2O .

Part B H_3O^+

By considering the number of lone and bonding pairs of electrons, predict the shape of H_3O^+ .

Part C ClF_4^-

By considering the number of lone and bonding pairs of electrons, predict the shape of ClF_4^- .

Part D SbF_5^{n-}

Antimony, Sb, is in group 15 of the Periodic Table. It forms a series of salts which contain the SbF_5^{n-} anion, the structure of which is a square-based pyramid:

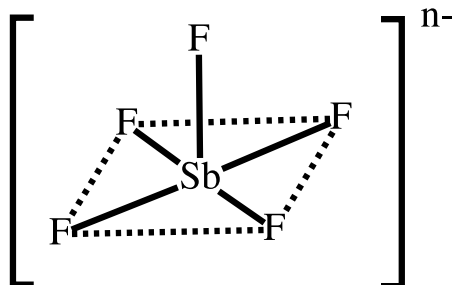


Figure 1: Structure of the SbF_5^{n-} anion

Deduce the total number of electrons around the antimony atom.

Deduce the value of n .

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Shapes of Molecules and Ions Extension

A Level



Antimony, Sb, is in group 15 of the Periodic Table. It forms a series of salts which contain the SbF_5^{n-} anion, the structure of which is a square-based pyramid:

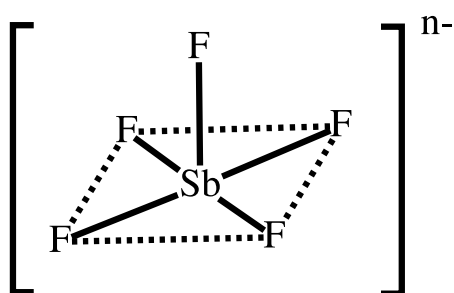


Figure 1: Structure of the SbF_5^{n-} anion

Deduce the oxidation number of Sb in the SbF_5^{n-} anion above.

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Shapes of Xenon Compounds

A Level



For each of the following, deduce the shape of the molecules and enter a one to two word answer, using appropriate shape of molecule terminology, e.g. "linear".

Part A XeF_2

Describe the shape of XeF_2 .

Part B XeOF_2

Describe the shape of XeOF_2 .

Part C XeO_4

Describe the shape of XeO_4 .

Part D XeF_4

Describe the shape of XeF_4 .

Part E XeOF_4

Describe the shape of XeOF_4 .

Part A adapted with permission from OCR, STEP Chemistry, June 1999, Question 5

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Half-equations 1

Essential Pre-Uni Chemistry K2.1

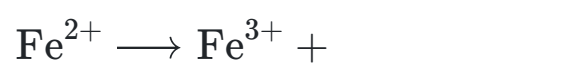
A Level



Complete and balance the following half-equations (assume all are in aqueous solution):

Part A Fe^{2+}

Complete and balance the half equation



Part B Cu^{2+}

Complete and balance the half equation



Please **click on and drag** the pre-loaded species in the equation editor to create your chemical equation.

Part C MnO_4^-

Complete and balance the half equation



Please **click on and drag** the pre-loaded species in the equation editor to create your chemical equation.

Part D H_2O_2

Complete and balance the half equation



Please **click on and drag** the pre-loaded species in the equation editor to create your chemical equation.

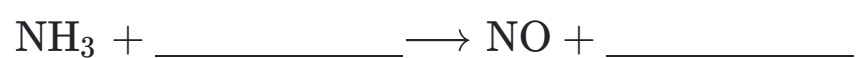
Part E H_2O_2 ii

Complete and balance the half equation



Part F NH_3

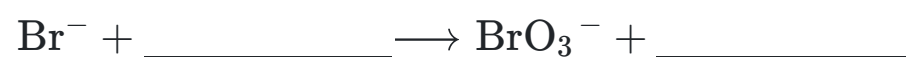
Complete and balance the half equation



Please **click on and drag** the pre-loaded species in the equation editor to create your chemical equation.

Part G Br^-

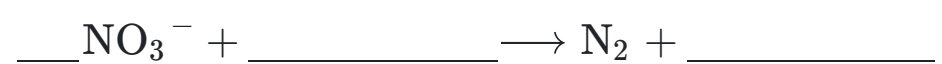
Complete and balance the half equation



Please **click on and drag** the pre-loaded species in the equation editor to create your chemical equation.

Part H NO_3^-

Complete and balance the half equation



Please **click on and drag** the pre-loaded species in the equation editor to create your chemical equation.

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Atomic and Ionic Radii and Ionisation Energy 1



Essential Pre-Uni Chemistry D3.1

There are trends evident in atomic and ionic radii. Ionisation energies also show trends. Complete the sentences below with the words 'increase' or 'decrease', to indicate what happens to the radii and ionisation energy of the atoms or ions [(a)–(f)], or to the ionisation energies [(g)–(i)].

Part A Along a period, L-R

Going along a period from left to right, the atomic radii...

- ☐ increase
- ☐ decrease
-

Part B Down a group

Going down a group, the atomic radii...

- ☐ increase
- ☐ decrease
-

Part C Electrons removed

As successive electrons are removed from the same atom/ion, the radii...

- ☐ increase
- ☐ decrease
-

Part D Same charge, down a group

The radii of ions of the same charge, on descending a group...

- ☐ increase
- ☐ decrease
-

Part E Adding electrons

As successive electrons are added to one atom to make increasingly negative ions, the radii...

- ☐ increase
- ☐ decrease
-

Part F Along period, L-R

Along a period from left to right, the radii of isoelectronic species generally...

- ☐ increase
- ☐ decrease
-

Part G Along period, L-R

Along a period from left to right, the first ionisation energies generally...

- ☐ increase
- ☐ decrease
-

Part H Down a group

Going down a group, the first ionisation energies...

- ☐ decrease
- ☐ increase
-

Part I Ionisation energies

Successive ionisation energies for the same element...

- ☐ increase
- ☐ decrease
-

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Ionisation of Elements

The table below shows the first five ionisation energies of five elements in the same group of the Periodic Table.

		Element	Ionisation Energy / kJ mol ⁻¹				
			1st	2nd	3rd	4th	5th
Increasing proton (atomic) number	↓	<i>A</i>	1090	2350	4610	6220	37830
		<i>B</i>	786	1580	3230	4360	16090
		<i>C</i>	762	1540	3300	4390	6970
		<i>D</i>	707	1410	2940	3930	6970
		<i>E</i>	716	1450	3080	4080	6640

Part A Group

In which group of the Periodic Table are the elements found?

Part B Ionisation of Na

Write an equation, with state symbols, to define the first ionisation energy of Na.

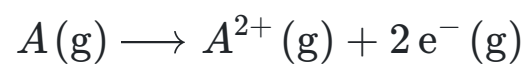
Part C Decrease in ionisation energy

Why does the first ionisation energy of the element tend to show a decrease down the table?

- ☐ Hydration energy decreases.
 - ☐ The effective nuclear charge experienced by the electron decreases down the group.
 - ☐ Lattice energy decreases.
 - ☐ Electron affinity decreases.
 - ☐ Electronegativity decreases.
 - ☐ Electrons are being removed from higher energy shells.
-

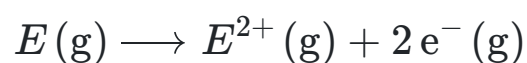
Part D A^{2+}

Calculate the energy change of:



Part E E^{2+}

Calculate the energy change of:



Part F A bonding

What sorts of bond would you expect A to form?
