Exercise

When choosing key words to explain – let the mark allocation guide you as to how many correct phrases to choose.
Eg 4 marks- 4 correct options

1.1 Which molecule has a higher melting point between O_2 and HCl. (1)

1.2 Choose from the list of key phrases to support your answer. (4)

Oxygen is a polar molecule and thus the IMF between molecules is Van der Waals, dipole-dipole

Oxygen is a non-polar molecule and thus the IMF between molecules is Van der Waals, London

HCl is a polar molecule and thus the IMF between molecules is Van der Waals, dipole-dipole

HCl is a non-polar molecule and thus the IMF between molecules is Van der Waals, London

London forces are stronger than dipole-dipole forces

London forces are weaker than dipole-dipole forces

Thus less energy is required to weaken the IMF and change the phase of the oxygen

Thus more energy is required to weaken the IMF and change the phase of the oxygen

2. Given the following molecules and solutions:
HCl, CO_2, I_2, H_2O, $KI(aq)$,

NH_3, $NaCl(aq)$, HF,

$MgCl_2$ in CCl_4, NO, Ar, SiO_2

Remember that (aq) means the substance is dissolved in water (which is polar)

2.1 Write the above molecules next to the IMF under which they fall

{if there are none for that specific IMF- then just type: none}

Hydrogen bonding: (3)

Van der Waals, dipole-dipole: (2)

Van der Waals, London: (4)

Ion-dipole: (2)

Ion induced-dipole: (1)

Dipole induced-dipole: (1)

In which of the substances listed above are the intermolecular forces:
(you may choose more than one substance, if applicable)

2.2.1 the strongest (2)

2.2.2 the weakest (4)

3. Use your knowledge of different types of intermolecular forces to explain the following statements: (Choose the correct key phrases)

3.1 The boiling point of F_2 is much lower than the boiling point of NH_3 (6)

NH_3 is a polar molecule

NH_3 is a non-polar molecule

The IMF between NH_3 molecules is hydrogen bonding

The IMF between NH_3 molecules is Van der Waals, dipole-dipole

The IMF between NH_3 molecules Van der Waals, London

F_2 is a polar molecule

F_2 is a non-polar molecule

The IMF between F_2 molecules is Van der Waals, dipole-dipole

The IMF between F_2 molecules is Van der Waals, London

London forces are weaker than Hydrogen bonding

London forces are stronger than Hydrogen bonding

Dipole-dipole forces are stronger than London forces

Dipole-dipole forces are weaker than London forces

Dipole-dipole forces are weaker than Hydrogen bonding

Dipole-dipole forces are stronger than Hydrogen bonding

Thus less energy is required to change the phase of the F_2

Thus more energy is required to change the phase of the F_2

3.2 Water evaporates slower than carbon tetrachloride (CCl_4). (6)

Water is a polar molecule

Water is a non-polar molecule

Water contains Van der Waals, dipole-dipole bonds

Water contains hydrogen bonds

CCl_4 is a polar molecule

CCl_4 is a non-polar molecule

CCl_4 contains Van der Waals, London forces

CCl_4 contains Van der Waals, dipole-dipole

Hydrogen bonds are stronger than London forces

Hydrogen bonds are weaker than London forces

Thus H_2O requires more energy to weaken the IMF and to evaporate (change phase)

Thus H_2O requires more energy to weaken the IMF and to evaporate (change phase)

3.3 Read over this one as an example ☺

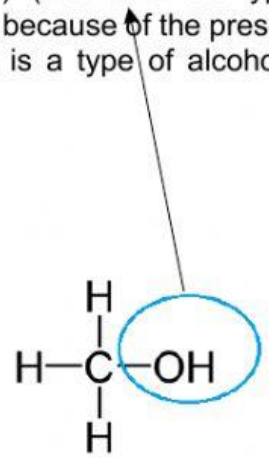
Sodium chloride is likely to dissolve in methanol (CH_3OH). (methan**ol** is a type of alcoh**ol**, and alcohols always have hydrogen bonds between them, because of the presence of OH in the molecules). {Any substance ending in the suffix –ol is a type of alcohol eg ethanol, propanol)

Sodium chloride is an ionic compound

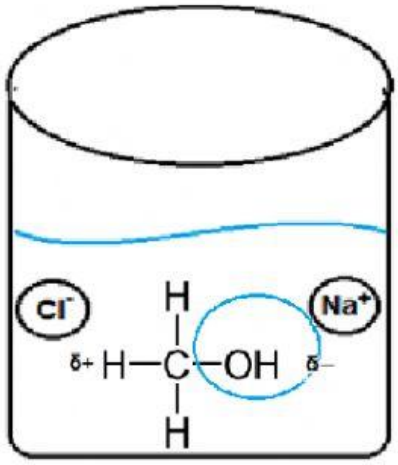
NaCl contains ionic bonds

CH_3OH is polar

CH_3OH contains Hydrogen bonds



Ionic substances break apart when in polar solvents because the water has a slightly positive and slightly negative side. Thus the Na+ is attracted to the negative side of the water molecule and the Cl- is attracted to the positive side of the water molecule.



4. Give one word or term for each of the following descriptions:

4.1 The attractive force that exists between molecules: (1)

4.2 A molecule that has an unequal distribution of charge: (1)

4.3 The amount of heat energy that is needed to increase the temperature of a unit mass of a substance by one degree. (1)

5. Refer to the list of substances below:
HCl, Cl_2, H_2O, NH_3, N_2, HF
Select the true statement from the list below: (1)

A NH_3 is a non-polar molecule

B The melting point of NH_3 will be higher than for Cl_2

C Ion-dipole forces exist between molecules of HF

D At room temperature N_2 is usually a liquid

6. Given the following melting points: (1)

HI	-34
NH_3	-33
H_2S	-60
CH_3	-164

In which of these hydrides does hydrogen bonding occur?

A. HI only
B. NH_3 only
C. HI and NH_3 only
D. HI, NH_3 and H_2S

7.) The respective boiling points for four chemical substances are given below: (1)

Hydrogen sulphide	$-60\ ^0C$
Ammonia	$-33\ ^0C$
Hydrogen fluoride	$20\ ^0C$
Water	$100\ ^0C$

7.1 Which one of the substances exhibits the strongest forces of attraction between its molecules in the liquid state? (1)

7.2 Give the name of the force responsible for the relatively high boiling points of hydrogen fluoride and water. (1)

7.3 The shapes of the molecules of hydrogen sulphide and water are similar, yet their boiling points differ. Explain by choosing the correct key words. (6)

H_2O molecule is polar

H_2O molecule is non-polar

The IMF between H_2O molecules is hydrogen bonding

The IMF between H_2O molecules is Van der Waals, dipole-dipole

H_2S molecule is polar

H_2S molecule is non-polar

The IMf between H_2S molecules Van der Waals, London

The IMf between H_2S molecules Van der Waals, dipole-dipole

Hydrogen bonding is stronger than dipole-dipole forces

Hydrogen bonding is weaker than dipole-dipole forces

Thus water requires more energy to weaken the IMF and change phase

Thus water requires less energy to weaken the IMF and change phase

8. Consider the table below and answer the questions that follow

Molecule	Melting point (°C)	Boiling point(°C)	Phase
Methane (CH_4)	-183	-162	gas
Octane (C_8H_8)	-57	126	liquid
Paraffin wax ($C_{25}H_{52}$)	53	259	solid

8.1 Give the name of the substances above that has the strongest IMF? (1)

8.2 What are the key words you would use to explain the above. (5)

The chosen substance:

Polar molecule
Non-polar molecule
The largest molar mass
The smallest molar mass
Strongest IMF
Weakest IMF
Van der Waals, London
Van der Waals, Dipole-dipole
Contains H-bonding
More energy required to weaken IMF and change its phase
Less energy required to weaken IMF and change its phase

9.

In an investigation into the relationship between the bond energy and bond length a student looked up the bond energy between various pairs of atoms: He recorded his findings in the table shown below:

BOND	LENGTH (pm)	ENERGY kJ/mol
C≡C	120	839
C=O	123	804
O=O	121	498
C–C	154	348
O–O	148	145
H–O	96	463
C–O	143	358
H–C	109	413

9.1.1 What is the INDEPENDENT VARIABLE in this investigation? (1)

9.1.2 What is the DEPENDENT VARIABLE in this investigation? (1)

9.1.3 Would this be considered a fair test? Write only YES or NO. (1)

9.1.4 Briefly explain your answer to QUESTION 9.1.3 (2)

{answer is given below}

- *there is more than one independent variable*√√
- The variables are not controlled √
- Bonds should be between atoms of the same elements √

(2)

Any chemical reaction has 2 steps

Step 1: break any existing bonds between atoms.
This step requires energy and is thus endothermic

Step 2: form new bonds
This step releases energy and is thus exothermic

Whether a reaction is overall endothermic or exothermic depends on which step requires/releases the most energy

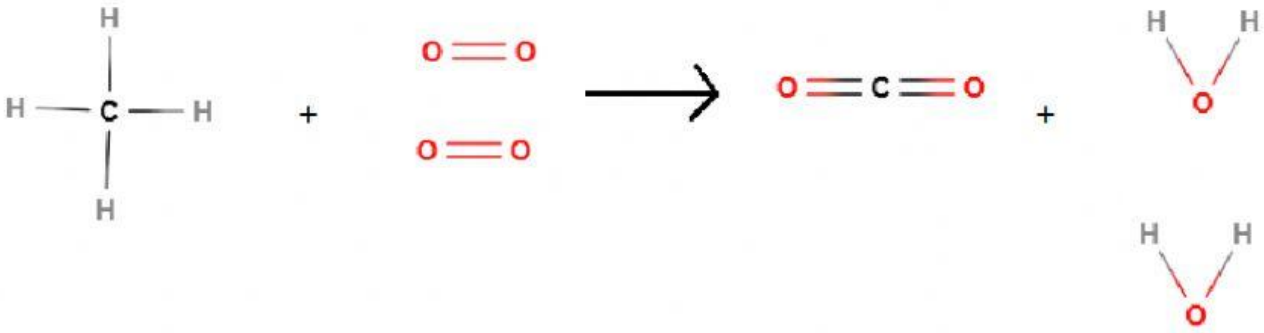
If energy required > energy released. Then the reaction overall is endothermic
If energy required < energy released. Then the reaction overall is exothermic.

Consider the combustion of 1 mol methane:

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

Use the values provided in the table given above to answer the following questions:

Let's draw this out to get a better idea



9.2.1 How many C-H bonds need to be broken in the above reaction?

9.2.2 How many O=O bonds need to be broken?

9.2.3 How many C=O bonds need to form?

9.2.4 How many H-O bonds need to form?

9.3.1 What is the total amount of energy required to break all the bonds in CH_4 and O_2?

CH_4 = kJ O_2 = kJ

9.3.2 How much energy is released when bonds form to produce H_2O and CO_2?

CO_2 = kJ H_2O = kJ

9.3.3 What is the total amount of energy absorbed in the reaction

= kJ

9.3.4 What is the total amount of energy released in the reaction.

= kJ

9.3.5 Hence calculate the energy transferred for the reaction. Include the sign.

ΔH = Energy of absorbed - Energy of released

= kJ

9.3.6 State whether this reaction is endothermic or exothermic