GRADE 12

TECHNICAL SCIENCES

PHYSICAL PROPERTIES OF ORGANIC MOLECULES

TERM 2 2020

NAME:

SCHOOL:

TEACHER:

PHYSICAL PROPERTIES AND INTERMOLECULAR FORCES: WORKSHEET 2

Background information

Concepts

Boiling point: temperature at which the **Vapour pressure** is **equal** to the **atmospheric** pressure.

Melting point: The **temperature** at which the **solid and liquid phases** of a substance are **at equilibrium**.

Vapour pressure: The **pressure exerted** by a **Vapour at equilibrium** with its **liquid phases** of a substances are **at equilibrium.**

Viscosity is the **property** of the fluid to **oppose relative motion** between the two **adjacent layers**.

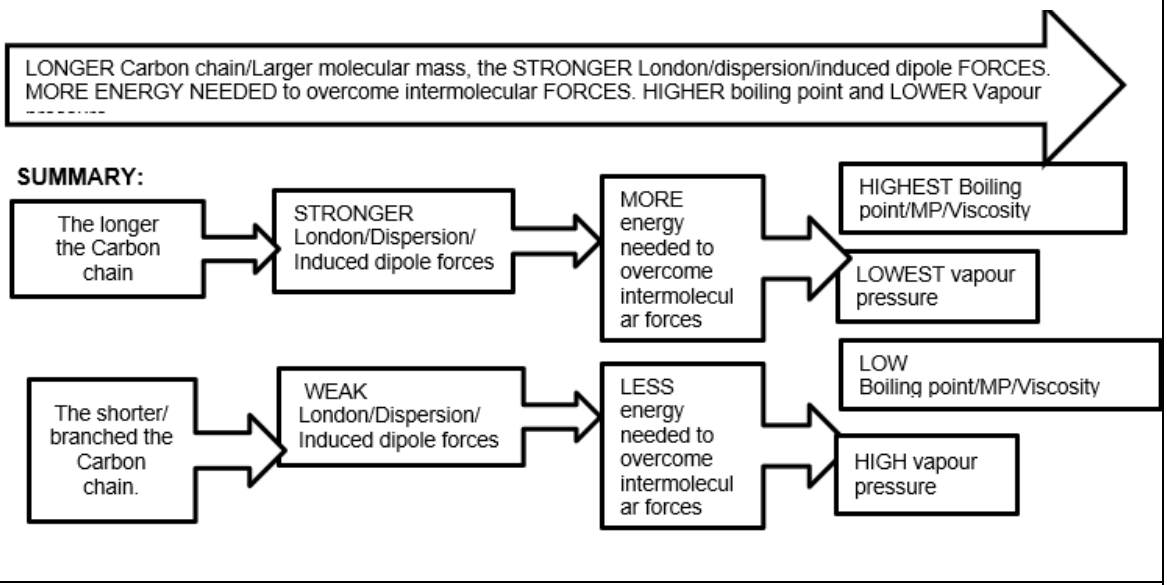
Factors affecting Physical Properties: intermolecular forces

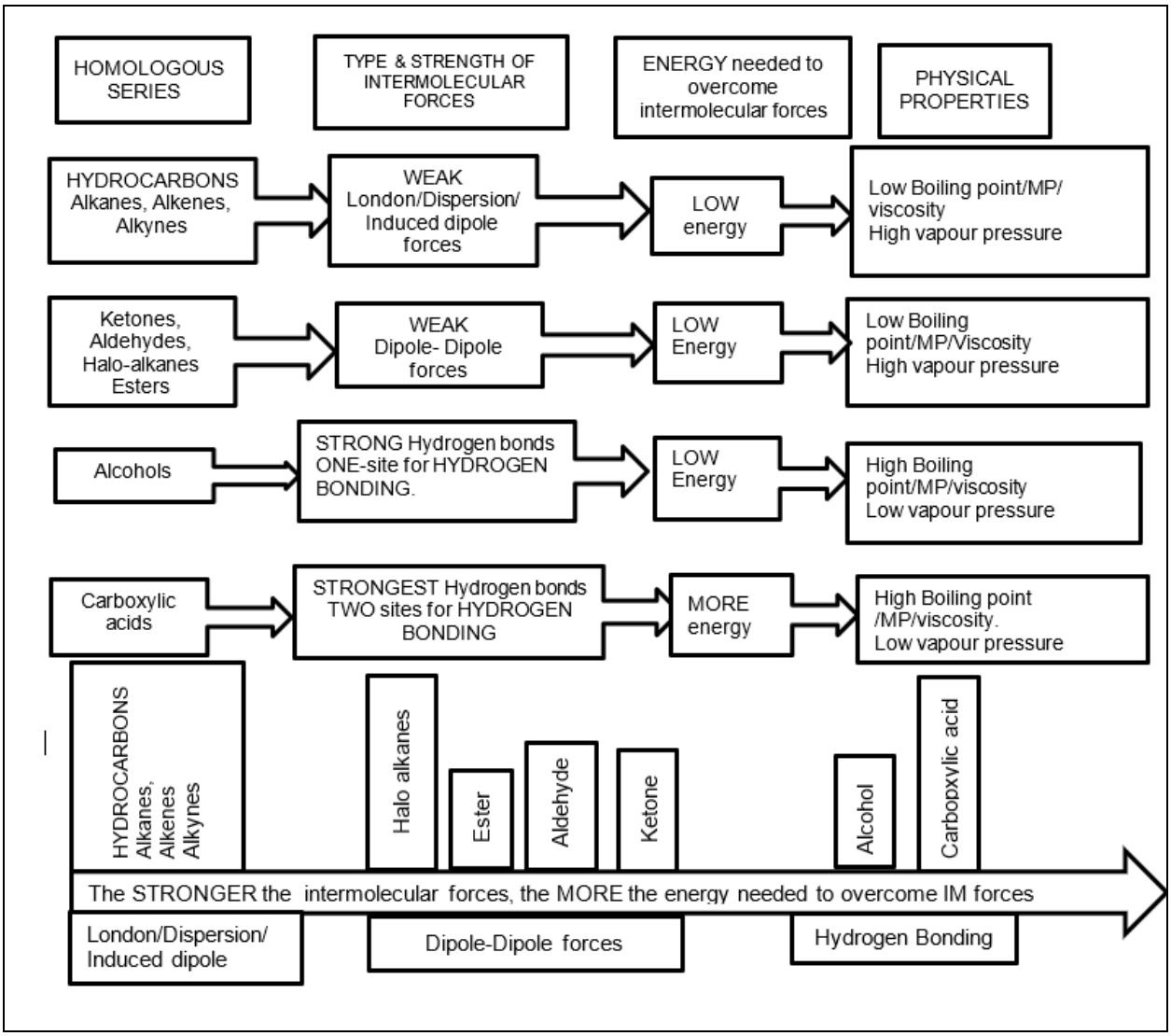
Induced dipole / dispersion/ London	**Dipole-Dipole**	**Hydrogen bond**
Alkanes	Halo-alkanes	Alcohols (1hydrogen site)
Alkenes	Aldehydes	Carboxylic acids (2 hydrogen sites)

Alkynes	Ketones	
	Esters	

RELATIONSHIP BETWEEN PHYSICAL PROPERTIES AND INTERMOLECULAR FORCES

Physical Properties	**Relationship to intermolecular forces**
BOILING POINT: The temperature at which vapour pressure of a substances equals the atmospheric pressure.	Increase with increase in Boiling Point.
MELTING POINT: The temperature at which a solid and liquid phase of a substance are at equilibrium.	Increase with increase in Melting Point.
VAPOUR PRESSURE: The pressure exerted by a Vapour at equilibrium with its liquid phases of a substances are at equilibrium.	Decrease with increase in Vapour Pressure.
Viscosity is the property of the fluid to oppose relative motion between the two adjacent layers.	Increase with increase with viscosity.


LONGER Carbon chain/Larger molecular mass, the STRONGER London/dispersion/induced dipole FORCES. MORE ENERGY NEEDED to overcome intermolecular FORCES. HIGHER boiling point and LOWER Vapour
SUMMARY:
The longer the Carbon chain
STRONGER London/Dispersion/ Induced dipole forces
MORE energy needed to overcome intermolecul ar forces
HIGHEST Boiling point/MP/Viscosity
LOWEST vapour pressure
The shorter/ branched the Carbon chain.
WEAK London/Dispersion/ Induced dipole forces
LESS energy needed to overcome intermolecul ar forces
LOW Boiling point/MP/Viscosity
HIGH vapour pressure


HOMOLOGOUS SERIES
TYPE & STRENGTH OF INTERMOLECULAR FORCES
ENERGY needed to overcome intermolecular forces
PHYSICAL PROPERTIES
HYDROCARBONS Alkanes, Alkenes, Alkynes
WEAK London/Dispersion/ Induced dipole forces
LOW energy
Low Boiling point/MP/ viscosity High vapour pressure
Ketones, Aldehydes, Halo-alkanes Esters
WEAK Dipole- Dipole forces
LOW Energy
Low Boiling point/MP/Viscosity High vapour pressure
Alcohols
STRONG Hydrogen bonds ONE-site for HYDROGEN BONDING.
LOW Energy
High Boiling point/MP/viscosity Low vapour pressure
Carboxylic acids
STRONGEST Hydrogen bonds TWO sites for HYDROGEN BONDING
MORE energy
High Boiling point /MP/viscosity. Low vapour pressure
HYDROCARBONS Alkanes, Alkenes Alkynes
Halo alkanes
Ester
Aldehyde
Ketone
Alcohol
Carbopxylic acid
The STRONGER the intermolecular forces, the MORE the energy needed to overcome IM forces
London/Dispersion/ Induced dipole
Dipole-Dipole forces
Hydrogen Bonding

Worked example 1

The boiling points of straight chain alkanes are invetigated and results are recorded in the table below

	Compounds	**Boiling points (ºC)**
A	Methane	-162
B	Ethane	-89
C	Propane	-42

1.1		Which of the compounds in the table has the longest chain length?	(1)
1.2		Explain the increase in boiling points of alkanes, as indicated in the table, by referring to INTERMOLECULAR FORCES	(3)
1.3		Which ONE of COMPOUNDS **A to C** has the HIGHEST VAPOUR PRESSURE? Give a reason for the answer, using the data in the table	(2)
1.4		Which ONE of COMPOUNDS **A to C** has the HIGHEST Viscosity?	(2)

		Solution for worked example 1	
1.1		Alkanes ✓	(1)
1.2		FROM compound **A to C** • Chain length/molecular mass INCREASES✓ • STRENGTH of intermolecular forces/London //Dispersion /Induced dipole forces increases. ✓ • More energy is needed to break the Intermolecular forces. ✓	(3)
1.3		**A.**✓ LOWEST boiling point. ✓	(2)
1.4		**C**✓ longest chain length✓	(2)
			[8]

Worked example 2

Three compounds are used to investigate **ONE** of the factors that influences boiling point. The results obtained are shown in the table below

	COMPOUND	Molecular mass($g.mol^{-1}$)	Boiling point(^oC)
A	**Butane**	**58**	**-0,5**
B	**Propan-1-ol**	**60**	**98**
C	**Ethanoic acid**	**60**	**118**

2.1		Write down the type of intermolecular force found in each of the compounds A-C	(3)
2.2		Which ONE of compounds **A, B** or **C** has the HIGHEST vapour pressure? Give a reason for the answer by refering to the given data in the table.	(2)
2.3		Which ONE of compounds **A, B** and **C** has the HIGHEST boiling point? Explain the answer by refering to intermolecular forces present in EACH compound.	(4)
2.4		Which compound, BUTANE and BUTANAL has the higher Melting point? Explain the answer by refering to the intermolecular forces.	(4)

SOLUTIONS FOR WORKED EXAMPLE 2			
2.1		**A-** Dispersion/London/induced dipole intermolecular forces ✓	(1)
		B- Hydrogen Bond ✓	(1)
		C- Hydrogen Bond ✓	(1)
2.2		A ✓/ Butane. Lowest boiling point✓/Weakest intermolecular forces	(2)
2.3		**From A to C**	
		Compound **A / Butane** consist of LONDON forces/ DISPERSION forces/ INDUCED-DIPOLE FORCES. ✓ Compound **B/propan-1-ol** consist of ONE site for hydrogen bonding. ✓ Compound **C/ ethanoic acid** consist of TWO sites for hydrogen bonding. ✓ Strength of intermolecular forces INCREASE from **A to C.** ✓ **OR** Intermolecular forces in compound **A/butane** are the WEAKEST and intermolecular forces in compound **C/ethanoic acid** are the STRONGEST. ✓	(4)

		MORE energy is needed to overcome intermolecular forces in compound **C/ethanoic acid**. ✓	
2.4		**Butane** consist of LONDON forces/ DISPERSION forces/ INDUCED-DIPOLE FORCES. ✓ **Butanal** consist of DIPOLE-DIPOLE forces. ✓ **DIPOLE - DIPOLE forces** are STRONGER than London forces/ Dispersion forces/Induced-Dipole forces. ✓ **MORE** energy needed to overcome intermolecular forces in **Butanal.** ✓	(4)
			[13]

Activities

Activity 1

Learners investigate which factor influence the boiling points of **straight-chain alkanes**.

The results are shown in the table below are are given in the table below:

	Number of carbon atoms	**Boiling points (^{o}C)**
A	**1**	**-162**
B	**2**	**-89**
C	**3**	**-42**
D	**4**	**-0,5**

1.1		Which compound **(A-D)** has the highest vapour pressure? Use the **data in the table** to explain the answer.	(2)
1.2		Explain the **trend** in boiling point of compounds **A to D** by refering to the intermolecular forces.	(4)
1.3		Write down the **STRUCTURAL FORMULA** of the CHAIN isomer of compound **D.**	(2)

1.4		How will the boiling point of 2-methyl propane **compare** to that of 2-methyl butane? Explain the answer by refering to intermolecular forces.	(4)
			[12]

Activity 2

Three compounds are used to investigate ONE of the factors that influence boiling point. The results are obtained are shown in the table below:

	Compounds	**Boiling point(^{o}C)**
A	Butane	-0,5
B	Butan-1-ol	117,7
C	Butanoic acid	164

2.1		Is compound **B** a PRIMARY, SECONDARY or TERTIARY alcohol? Give a reason for the answer.	(2)
2.2		Write down the NAME and FORMULA for the functional group of :	
	2.2.1		(2)

	2.2.2		(2)
2.3		Write down the STRUCTURAL FORMULA of a POSITIONAL ISOMER of compound **B.**	(2)
2.4		The boiling points increases from compound **A to C**.	
		Fully explain this trend by refeing to the intermolecular forces present in **EACH** compound.	(5)

2.5		Which compound, BUTANE or BUTANONE, has the higher boiling point? Explain the answer by refering to intermolecular forces.	(4)
			[17]
			[29]

TOTAL [29]

YOUR TOTAL