ORGANIC CHEMISTRY

APPROX 50 MARKS

ORGANIC CHEMISTRY BASICS

TABLE SHOWING THE DIFFERENT HOMOLOGOUS SERIES

HOMOLOGOUS SERIES	*FUNCTIONAL GROUP*	*ENDING TO NAME*
ALKANES		- ane
ALKENES		- ene
ALKYNES		- yne
HALOALKANES/ALKYL HALIDES		- bromo, chloro, iodo, fluoro
ALCOHOLS	Hydroxyl group	- ol
CARBOXYLIC ACIDS	Carboxyl group	- oic acid
ESTERS		- oate
ALDEHYDES	Formyl group	- al
KETONES	Carbonyl group	- one

IUPAC RULES FOR NAMING ORGANIC COMPOUNDS

1. Always find the longest CARBON CHAIN, number it on the question

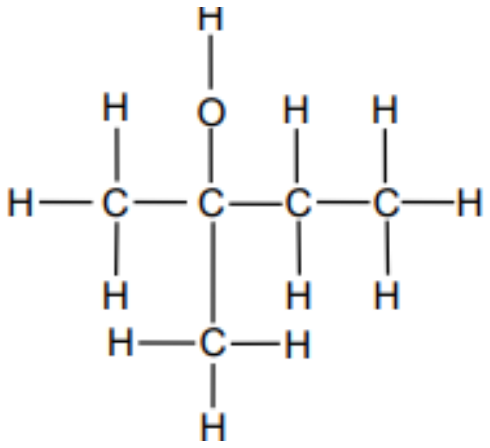
2. Identify the position (number) of the FUNCTIONAL GROUP

3. Circle all the side groups and note their position (number)

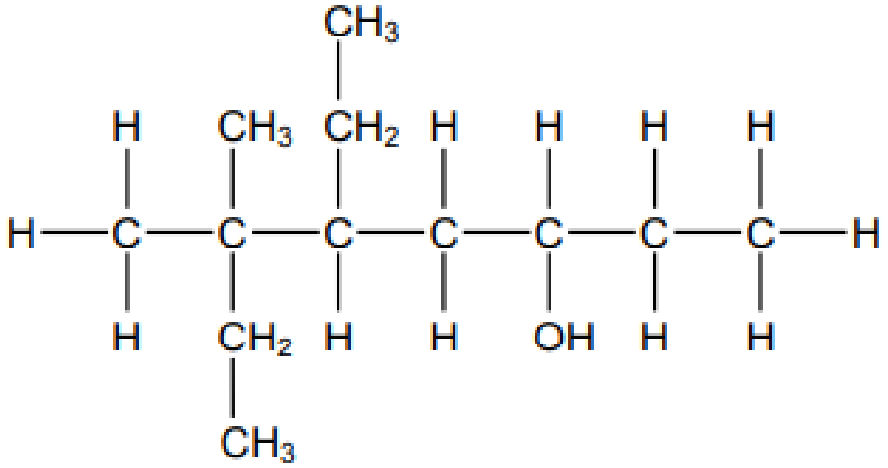
4. When writing down the IUPAC name:

4.1 Start with side groups. Comma between numbers and dash between numbers and letters

4.2 End the name with the longest chain and put the position of functional group



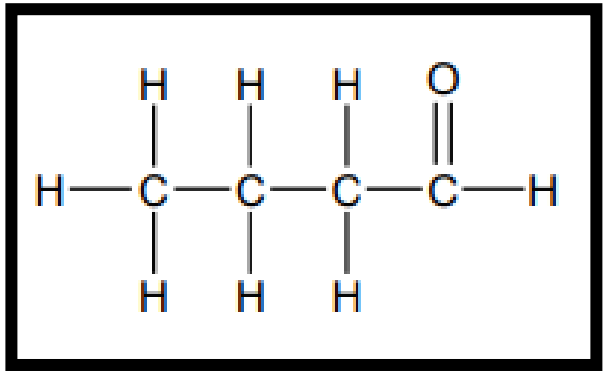
2 – methylbutan – 2 – ol



5 –ethyl – 6,6 – dimethyloctan – 3 – ol

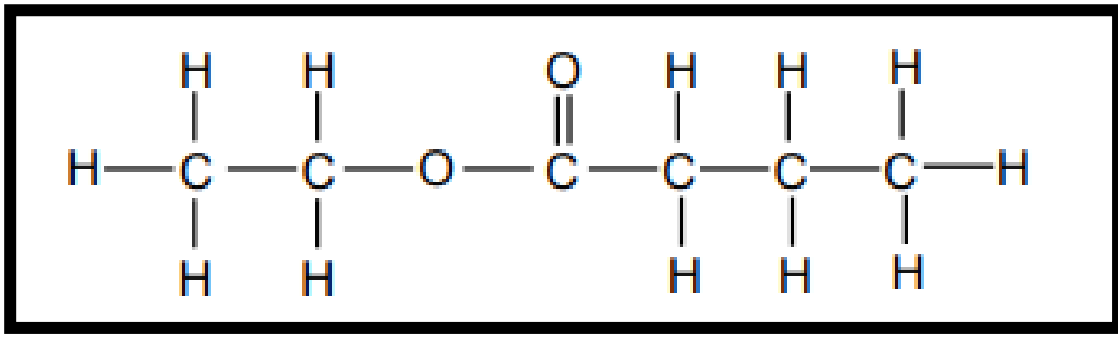
NOW YOU TRY!!!

1



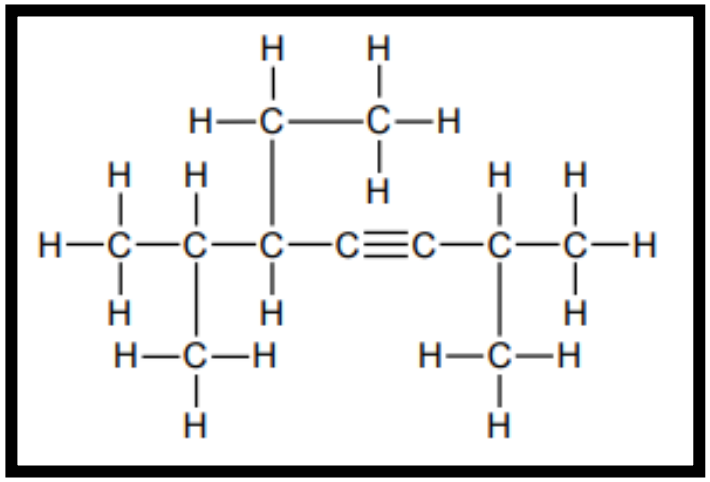
butanal

2



Ethyl butanoate

3



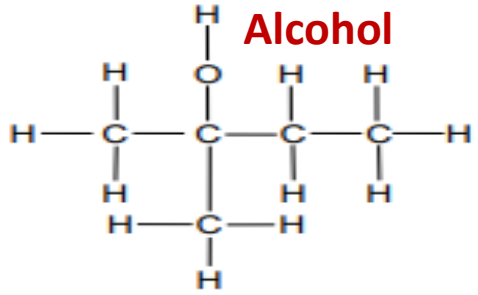
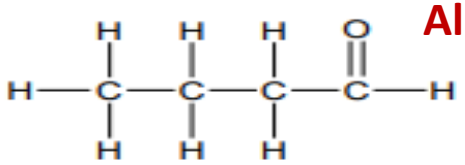
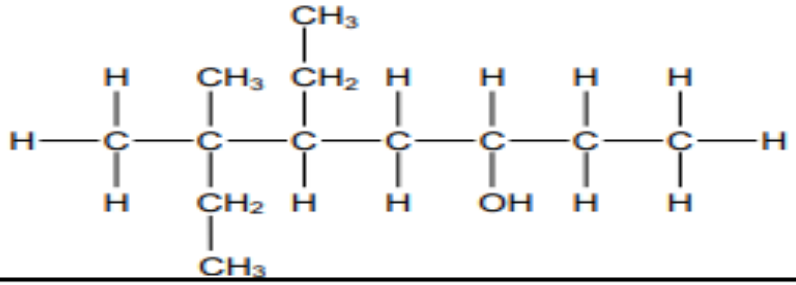
5 – ethyl – 2,6 – dimethylhept – 3 – yne

UNSATURATED HYDROCARBON

STRUCTURAL ISOMERS

Organic molecules with the same molecular formula but different structural formula

POSITIONAL	CHAIN	FUNCTIONAL
*Molecules from the **same homologous series**, but with the functional group or side group on a different carbon.*	*Molecules from the **same homologous series**, but one has a branch and the other does not.*	*Molecules from **different homologous series**.*
But – 1 – ene and But – 2- ene C_4H_8 C_4H_8	Butane and 2 – methylpropane C_4H_{10} C_4H_{10}	Methyl methanoate and ethanoic acid $C_2H_4O_2$ $C_2H_4O_2$ **Alcohol & acid** **OR** **Aldehyde & ketone**

A	 Alcohol	**B**	 Aldehyde
C	Butan-1-ol Alcohol	**D**	Butan-2-one Ketone
E	 Alcohol		

2.1 Write down the LETTER that represents EACH of the following:

2.1.1 A tertiary alcohol (1)

2.1.2 An aldehyde (1)

2.1.3 A ketone (1)

2.1.4 A functional isomer of compound **B** (1)

2.2 Write down the IUPAC name of:

2.2.1 Compound **B** (1)

2.2.2 Compound **E** (4)

2.3 Define *positional isomers*. (2)

2.4 Write down the STRUCTURAL FORMULA of:

2.4.1 A positional isomer of compound **C** (2)

2.4.2 Compound **D** (2)

2.4.3 The organic acid that will react with compound **C** to form butyl propanoate (2)

HINTS

TERTIARY ALCOHOL
The carbon bonded to the hydroxyl group is bonded to THREE other carbon atoms

Functional isomers –
ACID & ESTER
OR
ALDEHYDE & KETONE

ester–
Alcohol (yl) +
Acid (oate)

ANSWERS

2.1

2.1.1 A ✓ (1)

2.1.2 B ✓ (1)

2.1.3 D ✓ (1)

2.1.4 D ✓ (1)

2.2

2.2.1 Butanal/*Butanaal* ✓ (1)

2.2.2 5-ethyl-6,6-dimethyloctan-3-ol/*5-etiel-6,6-dimetieloktan-3-ol*

OR/*OF*

5-ethyl-6,6-dimethyl-3-octanol/*5-etiel-6,6-dimetiel-3-oktanol*

Marking criteria/*Nasienriglyne:*

- Stem, i.e. octan./*Stam d.i. oktan.* ✓
- Correct functional group, i.e. –ol./*Korrekte funksionele groep d.i. –ol.* ✓
- Two methyl groups and one ethyl group.
  Twee metielgroepe en een etielgroep. ✓
- Correct numbering of substituents and functional group ✓
  Korrekte nommering van substituente en funksionele groep.

IF/*INDIEN:*

Any error e.g. hyphens omitted and/or incorrect sequence:

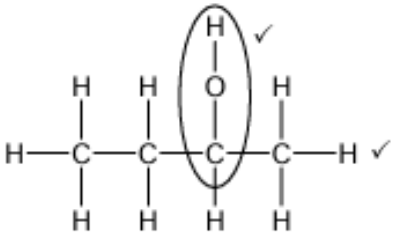
Enige fout bv. koppeltekens weggelaat en/of verkeerde volgorde: Max./*Maks.* $^{3}/_{4}$ (4)

ANSWERS

2.3 Compounds with the same molecular formula, ✓ but different positions of the side chain/substituents/functional groups on parent chain. ✓
Verbindings met dieselfde molekulêre formule, maar verskillende posisies van die syketting/substituente/funksionele groepe op die stamketting. (2)

2.4

2.4.1

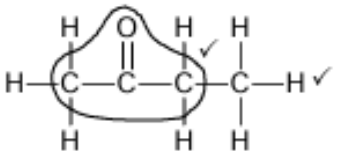


Marking criteria/*Nasienriglyne:*
- Whole structure correct:
  Hele struktuur korrek: 2/2
- Only functional group correct:/*Slegs funksionele groep korrek:* Max/*Maks.*: 1/2

IF/*INDIEN*:
More than one functional group:
Meer as een funksionele groep: 0/2

(2)

2.4.2

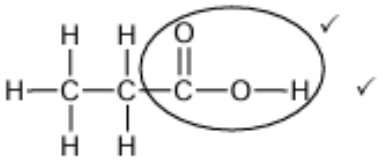


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- Only functional group correct:/*Slegs funksionele groep korrek:* Max/*Maks.*: 1/2

IF/*INDIEN*:
More than one functional group:
Meer as een funksionele groep: 0/2

(2)

2.4.3



Marking criteria/*Nasienriglyne:*
- Whole structure correct:
  Hele struktuur korrek: 2/2
- Only functional group correct:/*Slegs funksionele groep korrek:* Max/*Maks.*: 1/2

IF/*INDIEN*:
More than one functional group:
Meer as een funksionele groep: 0/2

(2)

ORGANIC CHEMISTRY
PHYSICAL PROPERITIES

Alkanes
Alkenes
Alkynes

→ NON – POLAR MOLECULES

WEAK LONDON FORCES ONLY

Esters
Haloalkanes
Aldehydes
Ketones

→ **LONDON FORCES & DIPOLE-DIPOLE FORCES**

POLAR MOLECULES

Alcohols (1 site for hydrogen bonding only)
Carboxylic acids (2 sites for hydrogen bonding)

→ **LONDON FORCES & DIPOLE-DIPOLE FORCES & HYDROGEN BONDING**

POLAR MOLECULES

ORGANIC CHEMISTRY
PHYSICAL PROPERITIES EXPLANATIONS

Explain why butanol has a higher boiling point than methanol

1 Talk about the **STRUCTURE** of the molecules in terms of polarity

Both butanol and methanol are polar molecules

2 State the **NAMES** of **INTERMOLECULAR FORCES**

Both butanol and methanol have weak London, dipole-dipole and hydrogen bonds between their molecules.

3 Compare the **STRENGTH of INTERMOLECULAR FORCES**. If they are different carbon chain lengths it can be mentioned here.

Butanol has a LONGER CARBON CHAIN LENGTH and therefore a LARGER SURFACE AREA and therefore STRONGER LONDON FORCES

4 Talk about the amount of **ENERGY needed to overcome the FORCES between the molecules.**

More energy is therefore required to overcome the stronger London forces between the molecules of butanol and therefore the higher boiling point.

NGI NewBridge GRADUATE INSTITUTE

NOW YOU TRY!!!

Explain why butanal has a higher boiling point than butane

1. Talk about the **STRUCTURE** of the molecules in terms of polarity

   Butanal is a polar molecule and butane is a non-polar molecule.

2. State the **NAMES** of **INTERMOLECULAR FORCES**

   Butanal has weak London forces and dipole-dipole forces between its molecules. Butane has only weak London forces between its molecules.

3. Compare the **STRENGTH of INTERMOLECULAR FORCES**. If they are different carbon chain lengths it can be mentioned here.

   Dipole – dipole forces are STRONGER than London forces therefore butanal has stronger intermolecular forces.

4. Talk about the amount of **ENERGY needed to overcome the FORCES between the molecules.**

   More energy is therefore required to overcome the stronger dipole-dipole forces between the molecules of butanal and therefore the higher boiling point.

NOW YOU TRY!!!

The boiling points of three isomers are given in the table below.

	ISOMERS	BOILING POINT (°C)
A	2,2-dimethylpropane	9
B	2-methylbutane	28
C	pentane	36

3.1 Define the term *structural isomer*. (2)

3.2 What type of isomers (POSITIONAL, CHAIN or FUNCTIONAL) are these three compounds? (1)

3.3 Explain the trend in the boiling points from compound **A** to compound **C**. (3)

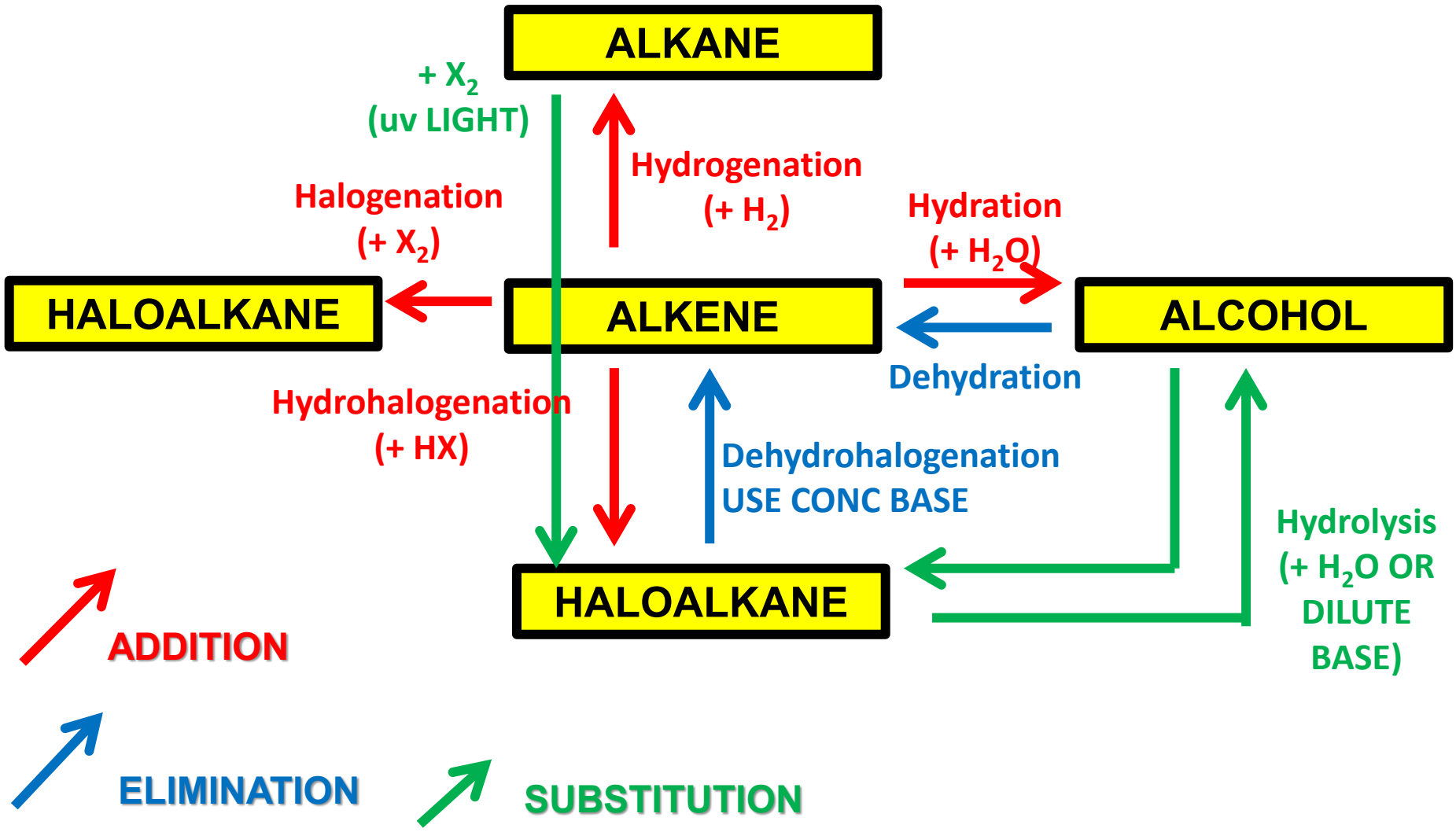
3.4 Which ONE of the three compounds (**A**, **B** or **C**) has the highest vapour pressure? Refer to the data in the table to give a reason for the answer. (2)

3.3

1. Talk about the **STRUCTURE** of the molecules in terms of polarity
2. State the **NAMES** of **INTERMOLECULAR FORCES**
3. Compare the **STRENGTH of INTERMOLECULAR FORCES**. If they are different carbon chain lengths it can be mentioned here.
4. Talk about the amount of **ENERGY needed to overcome the FORCES between the molecules.**

All the molecules are non-polar molecules with WEAK LONDON forces between their molecules.
The carbon chain length increases from A to C and therefore the surface area of the molecules increase therefore the strength of the LONDON FORCES increases.
Therefore more energy is needed to overcome the intermolecular forces in C and the higher boiling point.

ORGANIC CHEMISTRY
CHEMICAL PROPERITIES



ORGANIC CHEMISTRY
CHEMICAL PROPERITIES

COMBUSTION OF ALKANES

EXOTHERMIC
RELEASE ENERGY



Balance in this order: C then H then O

EG **Use molecular formulae to write the balanced chemical reaction when hexane burns in excess oxygen.**

EG **Use molecular formulae to write the balanced chemical reaction when propane burns in excess oxygen.**

CAN WE TALK ABOUT ESTERS QUICKLY?

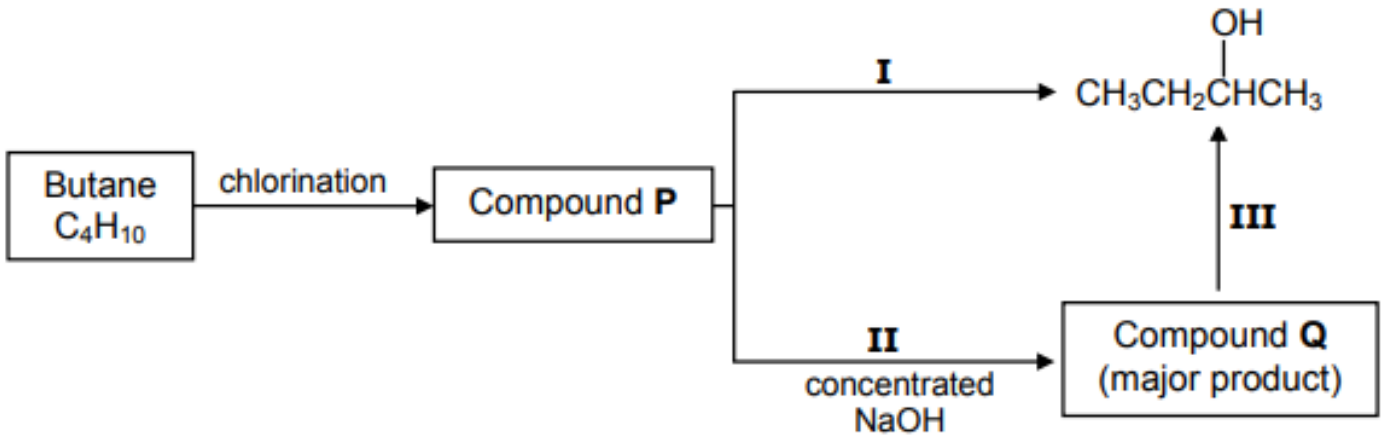
ESTERIFICATION



EG **Use structural formulae to write the balanced chemical reaction when ethanol reacts with propanoic acid in the presence of conc H_2SO_4. Name the organic product formed**

NOW YOU TRY!!!

4.3 Study the flow diagram below, which represents various organic reactions, and answer the questions that follow.



Write down the:

4.3.1 IUPAC name of compound **P** (2)

4.3.2 Type of reaction labelled **I** (1)

4.3.3 Structural formula of compound **Q** (2)

4.3.4 The type of addition reaction represented by reaction **III** (1)

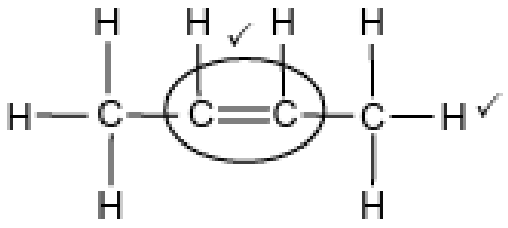
ANSWERS

4.3

4.3.1 2-chloro✓butane ✓
2-chlorobutaan (2)

4.3.2 Substitution / Hydrolysis ✓
Substitusie / Hidrolise (1)

4.3.3



Marking criteria/*Nasienriglyne:*

- Whole structure correct/*Hele struktuur korrek:* 2/2
- Only functional group correct/*Slegs funksionele groep korrek:* 1/2

IF/*INDIEN*:

More than one functional group/*Meer as een funksionele groep* 0/2

4.3.4 Hydration / *Hidrasie / Hidratering* ✓ (1)

ELECTROCHEMISTRY

Galvanic cells
&
Electrolytic cells

TABLE 4 B TRICKS!!

- All **forward** equations (LEFT to RIGHT) are written as **REDUCTION** equations.
- All **reverse** equations (RIGHT to LEFT) are written as **OXIDATION** equations
- Reducing agent strength increases from bottom to top (**Li = strongest RA on 4B**)
- Oxidising agent strength increases from top to bottom (**F_2 = strongest OA on 4B**)

OXIDISING AGENTS ARE ON THE LEFT HAND SIDE

Explain why the reaction between Zinc and $Fe(NO_3)_3$ is a spontaneous reaction

Zn is a stronger reducing agent than Fe therefore Zn will reduce Fe^{+3} to form Fe

OR

Fe^{+3} is a stronger oxidising agent than Zn^{+2} therefore Fe^{+3} will oxidise Zn to form Zn^{2+}

Increasing strength of oxidising agents/Toenemende sterkte van oksideermiddels

$Ca^{2+} + 2e^-$	⇌	Ca	− 2,87
$Na^+ + e^-$	⇌	Na	− 2,71
$Mg^{2+} + 2e^-$	⇌	Mg	− 2,36
$Al^{3+} + 3e^-$	⇌	Al	− 1,66
$Mn^{2+} + 2e^-$	⇌	Mn	− 1,18
$Cr^{2+} + 2e^-$	⇌	Cr	− 0,91
$2H_2O + 2e^-$	⇌	$H_2(g) + 2OH^-$	− 0,83
$Zn^{2+} + 2e^-$	⇌	Zn	− 0,76
$Cr^{3+} + 3e^-$	⇌	Cr	− 0,74
$Fe^{2+} + 2e^-$	⇌	Fe	− 0,44
$Cr^{3+} + e^-$	⇌	Cr^{2+}	− 0,41
$Cd^{2+} + 2e^-$	⇌	Cd	− 0,40
$Co^{2+} + 2e^-$	⇌	Co	− 0,28
$Ni^{2+} + 2e^-$	⇌	Ni	− 0,27
$Sn^{2+} + 2e^-$	⇌	Sn	− 0,14
$Pb^{2+} + 2e^-$	⇌	Pb	− 0,13
$Fe^{3+} + 3e^-$	⇌	Fe	− 0,06
$2H^+ + 2e^-$	⇌	$H_2(g)$	0,00
$S + 2H^+ + 2e^-$	⇌	$H_2S(g)$	+ 0,14
$Sn^{4+} + 2e^-$	⇌	Sn^{2+}	+ 0,15
$Cu^{2+} + e^-$	⇌	Cu^+	+ 0,16
$SO_4^{2-} + 4H^+ + 2e^-$	⇌	$SO_2(g) + 2H_2O$	+ 0,17
$Cu^{2+} + 2e^-$	⇌	Cu	+ 0,34
$2H_2O + O_2 + 4e^-$	⇌	$4OH^-$	+ 0,40
$SO_2 + 4H^+ + 4e^-$	⇌	$S + 2H_2O$	+ 0,45
$Cu^+ + e^-$	⇌	Cu	+ 0,52
$I_2 + 2e^-$	⇌	$2I^-$	+ 0,54
$O_2(g) + 2H^+ + 2e^-$	⇌	H_2O_2	+ 0,68
$Fe^{3+} + e^-$	⇌	Fe^{2+}	+ 0,77
$NO_3^- + 2H^+ + e^-$	⇌	$NO_2(g) + H_2O$	+ 0,80
$Ag^+ + e^-$	⇌	Ag	+ 0,80
$Hg^{2+} + 2e^-$	⇌	$Hg(\ell)$	+ 0,85
$NO_3^- + 4H^+ + 3e^-$	⇌	$NO(g) + 2H_2O$	+ 0,96
$Br_2(\ell) + 2e^-$	⇌	$2Br^-$	+ 1,07
$Pt^{2+} + 2e^-$	⇌	Pt	+ 1,20
$MnO_2 + 4H^+ + 2e^-$	⇌	$Mn^{2+} + 2H_2O$	+ 1,23

Increasing strength of reducing agents/Toenemende sterkte van reduseermiddels

REDUCING AGENTS ARE ON THE RIGHT HAND SIDE

Will the reaction between Nickel and silver nitrate be spontaneous?

Ni is a stronger reducing agent than Ag therefore Ni will reduce Ag^+ to form Ag

OR

Ag^+ is a stronger oxidising agent than Ni^{2+} therefore Ag^+ will oxidise Ni to form Ni^{2+}

ELECTROCHEMISTRY – GALVANIC CELLS

SPONTANEOUS REACTIONS
Strong RA and Strong OA

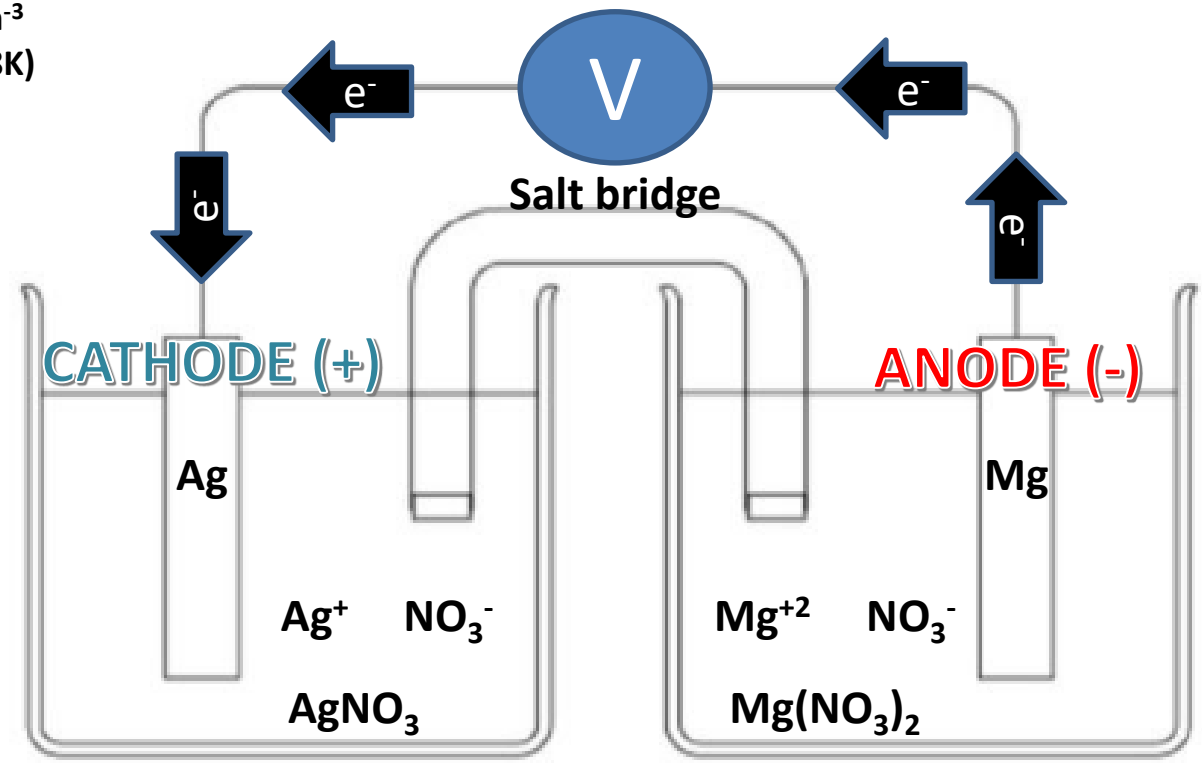
Electrolytes – a substance of which the aqueous solution contains ions
CONC OF: 1 mol.dm^{-3}
TEMP OF: 25^{0}C (298K)

Galvanic cells convert CHEMICAL ENERGY into ELECTRICAL ENERGY

Ag^{+} is a stronger oxidising agent and therefore will undergo REDUCTION

Ag = CATHODE

Mass increases



Mg is a stronger reducing agent and therefore will undergo OXIDATION

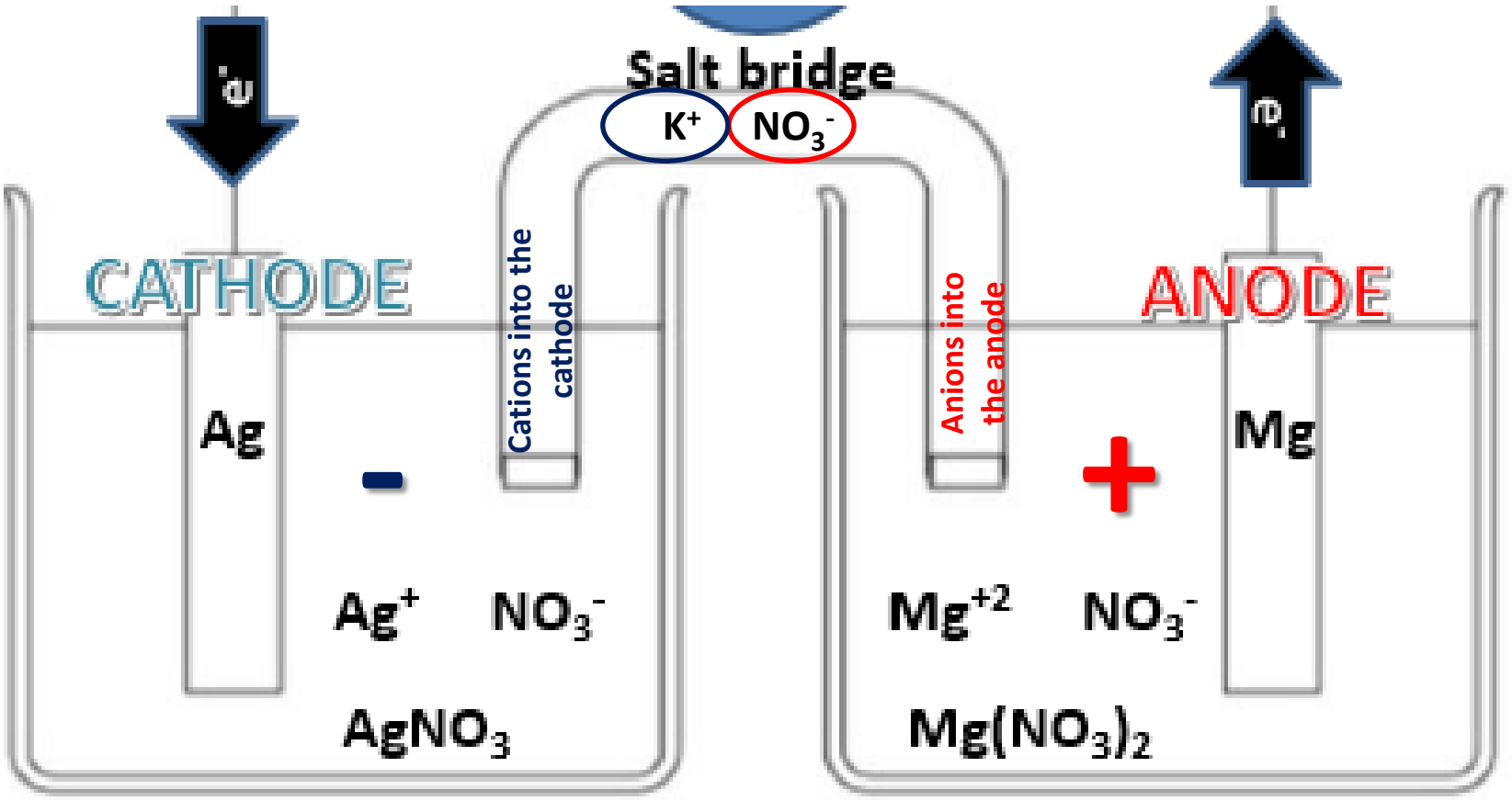
Mg = ANODE

Mass decreases

$Ag^{+} + e^{-} \rightarrow Ag$

$Mg \rightarrow Mg^{+2} + 2e^{-}$

SALT BRIDGE
Maintains electrical neutrality in the half cells and completes the circuit

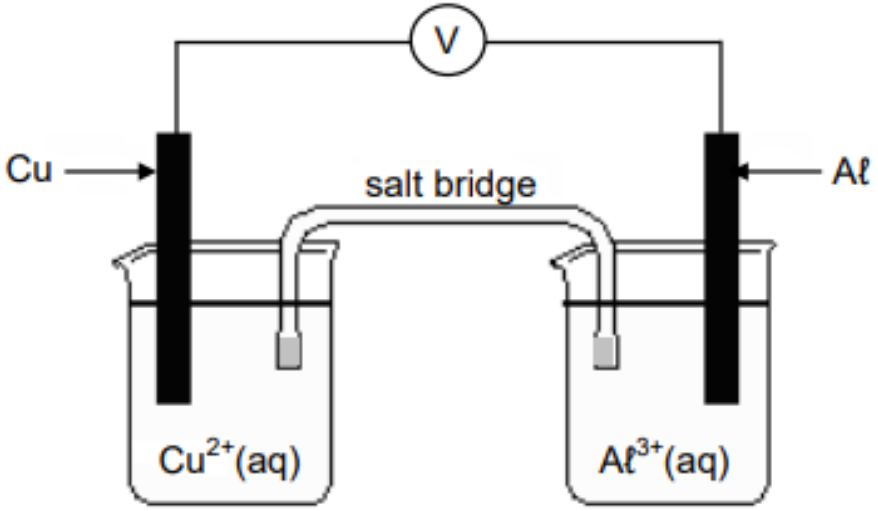


Ag^+ ions DECREASE

Mg^{2+} ions INCREASE

NOW YOU TRY!!!

8.2 The electrochemical cell shown below functions at standard conditions.



8.2.1 Which electrode (Cu or Aℓ) is the anode? (1)

8.2.2 Write down the cell notation for this cell. (3)

8.2.3 Calculate the emf of this cell. (4)

The salt bridge is now removed.

8.2.4 What will the reading on the voltmeter be? Give a reason for your answer. (2)

ANSWERS

8.2

8.2.1 Aℓ/Aluminium ✓ (1)

8.2.2 $A\ell(s) \mid A\ell^{3+}(1\ mol\cdot dm^{-3}) \parallel Cu^{2+}(1\ mol\cdot dm^{-3}) \mid Cu(s)$ ✓ ✓ ✓ (3)

8.2.3 $E^{o}_{cell} = E^{o}_{cathode} - E^{o}_{anode}$ ✓
$= 0,34$ ✓ $- (-1, 66)$ ✓
$E^{o}_{cell} = 2,(00)V$ ✓ (4)

8.2.4 0 (V)/zero/*nul* ✓
The circuit is open. ✓
Die stroombaan is oop (2)

WORK HARD, STUDY

WELL