SECONDARY SCHOOL IMPROVEMENT PROGRAMME (SSIP) 2019

GAUTENG PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

GRADE 12

SUBJECT: PHYSICAL SCIENCE

TEACHER GUIDE

TOPIC: **ORGANIC MOLECULES AND THEIR REACTIONS**

SECTION A: HOMEWORK SOLUTIONS

QUESTION 1: 20 minutes ***(Taken from NSC Nov 2015 Paper 2)***

A bond/an atom or a group of atoms ✓ that determine(s) the (physical and chemical) properties of a group of organic compounds. ✓ (2)

D / ethanoic acid ✓
Lowest vapour pressure. ✓ (2)

A / Butane ✓ (1)

- Between molecules of **A** / butane / alkanes are London / induced dipole / dispersion forces. ✓
- Between molecules of **B** / propan-2-one / ketones is dipole-dipole forces in addition to London / induced dipole / dispersion forces. ✓
- Intermolecular forces in **A** are weaker than those in **B**. / Less energy is needed in **A** to break/overcome intermolecular forces. ✓

OR

Intermolecular forces in **B** are stronger than those in **A**. / More energy is needed in **B** to break/overcome intermolecular forces.

OR

- Between molecules of **A** / butane / alkanes are weak London / induced dipole / dispersion forces.
- Between molecules of **B** /propan-2-one / ketone are strong(er) dipole-dipole forces in addition to London/induced dipole / dispersion forces. (3)

London forces/dispersion forces/induced dipole forces/dipole-dipole forces. ✓
OR
A and **B** do not have hydrogen bonding./**C** and D have hydrogen bonding. (1)

OPTION 1

- **D** has more sites for hydrogen bonding than **C** / forms dimers / is more polar than **C**. ✓
- **D** has stronger / more intermolecular forces / dipole-dipole forces. ✓
  OR
  D needs more energy to overcome/break the intermolecular forces. (2)

OPTION 2

- **C** has less sites for hydrogen bonding than **D**. / **C** does not form dimers / **C** is less polar.
- **C** has weaker / less intermolecular forces / dipole-dipole forces./ **C** needs less energy to overcome/break intermolecular forces / dipole-dipole forces.

Marking criteria/*Nasienriglyne*

- Mole ratio for $V(CO_2)$ correctly used. / *Molverhouding vir* $V(CO_2)$ *korrek gebruik.*
- Mole ratio for $V(H_2O)$ correctly used. / *Molverhouding vir* $V(H_2O)$ *korrek gebruik.*
- Mole ratio for $V(O_2$ reacted) correctly used. / *Molverhouding vir* $V(O_2$ *reageer*) *korrek gebruik.*
- $V(O_2$ excess/*oormaat*) = $V(O_2$ initial/*aanvanklik*) – $V(O_2$ change/*verandering*).
- $V_{tot} = 80\ cm^3$

OPTION 1/*OPSIE 1*

$V(CO_2) = 4V(C_4H_{10})$
$= (4)(8)$ ✓
$= 32\ cm^3$

$V(H_2O) = 5V(C_4H_{10})$
$= (5)(8)$ ✓
$= 40\ cm^3$

$V(O_2$ reacted/*reageer*):
$V(O_2) = \frac{13}{2}V(C_4H_{10})$
$= (\frac{13}{2})(8)$ ✓ $= 52\ cm^3$

$V(O_2$ excess/*oormaat*):
$V(O_2) = 60 - 52$ ✓ $= 8\ cm^3$

$V_{tot} = 32 + 40 + 8 = 80\ cm^3$ ✓ (5)

OPTION 2/*OPSIE 2*

	C_4H_{10}	O_2	CO_2	H_2O
Initial V (cm^3) *Begin*V (cm^3)	8	60	0	0
Change in V (cm^3) *Verandering* V (cm^3)	8	52 ✓	32 ✓	40 ✓
Final V (cm^3) *Finale* V (cm^3)	0	8 ✓	32	40

Total/*totale* volume = 8 + 32 + 40 = 80 cm^3 ✓

OPTION 3/*OPSIE 3*

	C_4H_{10}	O_2	CO_2	H_2O
Initial V (dm^3) *Begin* V (dm^3)	0,008	0,06	0	0
Change in V (dm^3) *Verandering* V (dm^3)	0,008	0,052 ✓	0,032 ✓	0,04 ✓
Final V (dm^3) *Finale* V (dm^3)	0	0,008 ✓	0,032	0,04

Total/*totale* volume = 0,008 + 0,032 + 0,04 = 0,08 dm^3 ✓

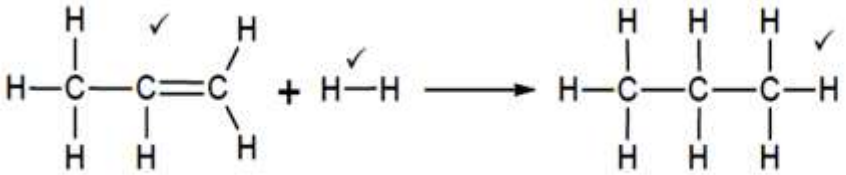
[16]

QUESTION 2: 20 minutes ***(Taken from NSC Nov 2014 Paper 2)***

2.1.1 Substitution / chlorination / halogenation ✓ (1)

2.1.2 Substitution / hydrolysis ✓ (1)

2.2.1 Hydrogenation ✓ (1)



Notes / *Aantekeninge*:

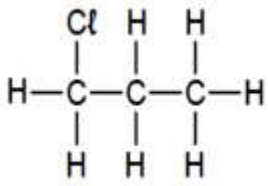
- Ignore/*Ignoreer* ⇌
- Accept H_2 if condensed. / *Aanvaar H_2 as gekondenseerd.*
- Any additional reactants and/or products

  Enige addisionele reaktanse en / of produkte: Max./*Maks.* 2/3
- Accept coefficients that are multiples.

  Aanvaar koëffisiënte wat veelvoude is.
- Molecular / condensed formulae

  Molekulêre-/ gekondenseerde formule: Max./*Maks.* 2/3

(3)



Marking criteria / *Nasienriglyne:*

- Whole structure correct:/ *Hele struktuur korrek:* 2/2
- Only ONE Cℓ atom as functional group. / *Slegs EEN Cℓ-atoom as funksionele groep.* 1/2

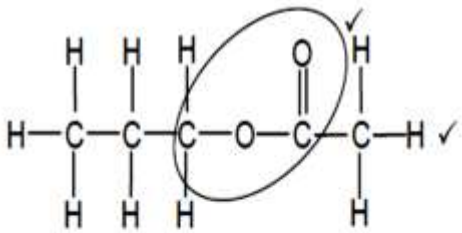
Notes / *Aantekeninge:*

- Condensed or semi-structural formula
  Gekondenseerde of semistruktuurformule: Max./*Maks.* 1/2
- Molecular formula. / *Molekulêre formule:* 0/2
- If functional group is incorrect. / *Indien funksionele groep verkeerd is:* 0/2

(2)

Esterification / Condensation ✓ (1)

(Concentrated) H_2SO_4 / (Concentrated) sulfuric acid ✓ (1)



Marking criteria / *Nasienriglyne:*

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

Notes / *Aantekeninge:*

- If two or more functional groups/Indien *twee of meer funksionele groepe:* 0/2
- Condensed or semi-structural formula:
  Gekondenseerde of semistruktuurformule: Max./*Maks.* 1/2
- Molecular formula / *Molekulêre formule:* 0/2
- If functional group is incorrect/*Indien funksionele groep verkeerd is:* 0/2

(2)

Propyl ✓ ethanoate ✓ (2)

Sulfuric acid / H_2SO_4 / Phosphoric acid / H_3PO_4 ✓ (1)

[15]

SECTION B: TYPICAL EXAM QUESTIONS

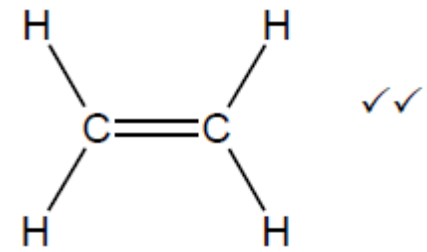
QUESTION 1: 25 minutes ***(Taken from NSC Exemplar 2014 Paper 2)***

Alkynes / *Alkyne* ✓ (1)

Hydroxyl group ✓ (1)

C✓ (1)

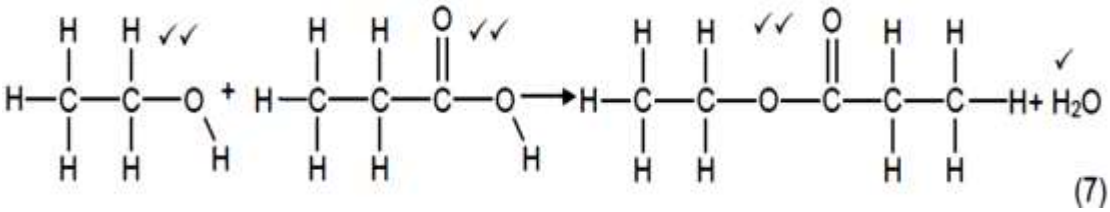
2-methylpentan-3-one ✓✓ (2)



✓✓ (2)

$2C_4H_{10} + 13O_2$ ✓→ $8CO_2 + 10H_2O$ ✓ Bal. ✓ (3)

Same molecular formula, ✓
but different positions of the functional group. ✓ (2)



(7) (7)

[19]

QUESTION 2: 15 minutes ***(Taken from NSC Feb/Mar 2015 Paper 2)***

C✓ (1)

Chain length/molecular size/molecular mass/number of carbon atoms in the chain. ✓ (1)

Boiling point ✓ (1)

London (forces)/induced dipole (forces)/dispersion (forces) ✓ (1)

Higher than ✓ (1)

Lower than ✓
• Both compounds D and E have hydrogen bonding between molecules. ✓

• Compound D has one site for hydrogen bonding whilst compound E has two sites for hydrogen bonding/forms dimers

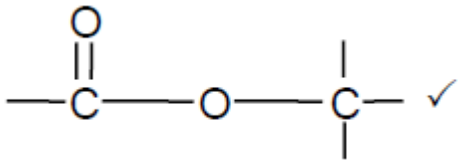
OR

Compound D has less sites for hydrogen bonding/weaker hydrogen bonding than compound E. ✓

• More energy needed to overcome intermolecular forces in compound E/less energy needed to overcome intermolecular forces in compound D. ✓ (4) **[9]**

QUESTION 3: 15 minutes ***(Taken from NSC Nov 2015 Paper 2)***

Esterification / Condensation ✓ (1)

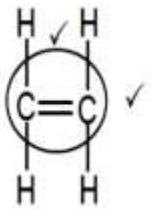


✓ (1)

Propanoic acid ✓ (1)

Dehydration / elimination ✓ (1)

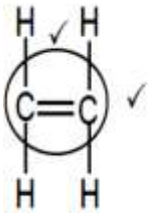
(Concentrated) H_2SO_4 / sulfuric acid / H_3PO_4 / phosphoric acid ✓ (1)



✓ ✓

Notes/*Aantekeninge*
- Functional group: ✓
  Funksionele groep:
- Whole structure correct: ✓
  Hele struktuur korrek:

(2)



✓ ✓

Notes/*Aantekeninge*
- Functional group: ✓
  Funksionele groep:
- Whole structure correct: ✓
  Hele struktuur korrek:

(2)

Addition ✓ (1)
[10]

SESSION 03

Question 1

Multiple choice questions

1.1. D ✓✓
1.2. C ✓✓
1.3. B ✓✓
1.4. D ✓✓ **[4 × 2 = 8]**

Question 2

2.1. The total linear momentum in a closed system ✓ remains constant / is conserved✓.

(2)

2.2. $\Sigma p_i = \Sigma p_f$ ✓
$(m_1 + m_2)v_i = m_1 v_{1f} + m_2 v_{2f}$
$(2m + 4m)(0)$ ✓$= (2m)(2) + (4m)(v_{2f})$ ✓
$-4m = 4mv_{2f}$
$\therefore v_f = -1\ m \cdot s^{-1}$
$\therefore v_f = 1\ m \cdot s^{-1}$ ✓; in the opposite direction to that of the boys ✓

(5)

2.3. GREATER THAN ✓.

(1)

Question 3

3.1. $p = mv$ ✓
$p = (50)(5)$ ✓
$p = 250\ kg \cdot m \cdot s^{-1}$ ✓, (downwards) (3)

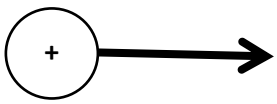
3.2. The product of the net force and thee time interval (during which the force acts) ✓✓. (2)

3.3. $\Delta p = F_{net}\Delta t$ ✓
$0 - 250$ ✓$= F_{net}(0{,}2)$
$F_{net} = -1\,250\ N$
$F_{net} = 1\,250\ N$ ✓
(3)

3.4. GREATER THAN ✓ (1)

3.5. For the same momentum change ✓, the stopping time (contact time) will be smaller (less) ✓. ∴ the (upward) force exerted (on her) is greater ✓.

Question 4



4.1. $\Sigma p_i = \Sigma p_f$ ✓
$(m_1 + m_2)v_i = m_1 v_{1f} + m_2 v_{2f}$
$(3 + 0{,}02)(0)$✓$= (3)(-1{,}4) + (0{,}02)v_{2f}$ ✓
$v_{2f} = 210\ m \cdot s^{-1}$ ✓
(4)

4.2. $v_f^2 = v_i^2 + 2a\Delta x$ ✓
$(0) = 210^2 + (2)(a)(0{,}4)$ ✓
$a = -55\,125\ m \cdot s^{-2}$

$F_{net} = ma$ ✓
$F_{net} = (0{,}02)(-55\,125)$ ✓
$F_{net} = -1\,102{,}5\ N$
$\therefore F_{net} = 1\,102{,}5\ N$ ✓
(5)

4.3. THE SAME ✓.

Question 5

5.1. The total linear momentum in a closed system remains constant/is conserved.✓✓

(2)

5.2.

5.2.1. $p_i = p_f$ ✓

$m_1v_{i1} + m_2v_{i2} = m_1v_{f1} + m_2v_{f2}$

$(m_1 + m_2)v_i = m_1v_{f1} + m_2v_{f2}$

0 ✓ $= (0{,}4)v_{f1} + (0{,}6)(4)$ ✓

$v_{f1} = -6\ m \cdot s^{-1}$

$= 6\ m \cdot s^{-1}\ to\ the\ left$ ✓

(4)

5.2.2. $\Delta p = F_{net}\Delta t$ ✓

$(0{,}6)(4-0)$ ✓ $= F_{net}(0{,}3)$ ✓

$F_{net} = 8\ N$ ✓

(4)

5.3. NO ✓

(1)