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SECONDARY SCHOOL IMPROVEMENT PROGRAMME (SSIP) 2016



GAUTENG PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

GRADE 12

SUBJECT: PHYSICAL SCIENCES

LEARNER SOLUTIONS

(Page 1 of 41)

SESSION 9: ACIDS AND BASES

SECTION A: HOMEWORK SOLUTIONS

QUESTION 1: 25 minutes

(Taken from NCS Feb/Mar 2016 Paper 2)

1.1 An acid is a proton (H^+ ion) donor. ✓✓ (2)

1.2.1 CO_3^{2-} (aq) ✓ (1)

1.2.2 $H_2CO_3 + H_2O \rightleftharpoons HCO_3^-(aq) + H_3O^+(aq)$ ✓ ✓ bal

Notes

• Reactants ✓ Products ✓ Balancing ✓

Ignore → and phases

1.2.3

<u>OPTION/OPSIE 1</u>	<u>OPTION/OPSIE 2</u>
$pH = -\log[H^+] \checkmark$ $3,4 = -\log[H^+] \checkmark$ $[H^+] = 10^{-3,4} / 3,98 \times 10^{-4} \text{ mol} \cdot \text{dm}^{-3}$ $[H^+][OH^-] = 10^{-14} \checkmark$ $\therefore [OH^-] = \frac{1 \times 10^{-14}}{3,98 \times 10^{-4}} \checkmark$ $= 2,51 \times 10^{-11} \text{ mol} \cdot \text{dm}^{-3} \checkmark$	$pH + pOH = 14 \checkmark$ $3,4 + pOH = 14 \checkmark$ $pOH = 11,6$ $pOH = -\log[OH^-] \checkmark$ $11,6 = -\log[OH^-] \checkmark$ $[OH^-] = 10^{-11,6} / 2,51 \times 10^{-11} \text{ mol} \cdot \text{dm}^{-3} \checkmark$

(5)

1.3.1 An acid that donates ONE proton/ H^+ / H_3O^+ -ion. ✓

OR

An acid of which ONE mol ionises to form ONE mol of protons/ H^+ ions/ H_3O^+ ions.

(1)

1.3.2

OPTION/OPSIE 1 $\frac{c_a \times V_a}{c_b \times V_b} = \frac{n_a}{n_b} \checkmark$ $\frac{c_a \times 25}{0,1 \times 27,5} = \frac{1}{1} \checkmark$ $c_a = 0,11 \text{ mol} \cdot \text{dm}^{-3} \checkmark$	Marking guidelines/Nasienriglyne: - Formula./ Formule. - Substitution of/Substitusie van $c_a \times 25$. - Substitution of/Substitusie van $0,1 \times 27,5$ - Use mol ratio/Gebruik molverhouding 1:1. - Final answer/Finale antwoord: $0,11 \text{ mol} \cdot \text{dm}^{-3}$
OPTION/OPSIE 2 $n(\text{NaOH}) = cV \checkmark$ $= 0,1 \times 0,0275 \checkmark$ $= 0,00275 \text{ mol}$ $n(\text{acid X}) = n(\text{NaOH}) \checkmark$ $= 0,00275 \text{ mol} \checkmark$ $c(\text{acid X}) = \frac{n}{V}$ $= \frac{2,75 \times 10^{-3}}{0,025} \checkmark$ $= 0,11 \text{ mol} \cdot \text{dm}^{-3} \checkmark$	Marking guidelines/Nasienriglyne: $n = cV$ - Substitution into $n = cV$ to calculate $n(\text{NaOH})$. Substitusie in $n = cV$ om $n(\text{NaOH})$ te bereken. - Use mol ratio 1:1. Gebruik molverhouding 1:1. - Substitution into $c = \frac{n}{V}$ to calculate $c(\text{acid})$. Substitusie in $c = \frac{n}{V}$ om $c(\text{suur})$ te berei. - Final answer: $0,11 \text{ mol} \cdot \text{dm}^{-3}$ Finale antwoord: $0,11 \text{ mol} \cdot \text{dm}^{-3}$

(5)

1.3.3 Weak ✓

The $[\text{H}^+]$ OR $[\text{H}_3\text{O}^+]$ is lower than the concentration of acid X. ✓

Therefore the acid is incompletely ionised. ✓

(3)
[20]**QUESTION 2:**

(Taken from Exemplar 2014)

- 2.1 An acid forms hydronium ions / H_3O^+ ions when it dissolves in water. ✓✓ (2)
- 2.2 Incompletely / partially ionised ✓ (1)
- 2.3 Solution of known concentration ✓ (1)
- 2.4 Burette ✓
Pipette ✓ (2)

2.5 2.5.1

<u>OPTION 1/OPSIE 1</u>	<u>OPTION 2/OPSIE 2</u>	
$K_w = [\text{H}_3\text{O}^+][\text{OH}^-]$ $\therefore 1 \times 10^{-14} = [\text{H}_3\text{O}^+](0,5) \checkmark$ $\therefore [\text{H}_3\text{O}^+] = 2 \times 10^{-14} \text{ mol} \cdot \text{dm}^{-3}$ $\downarrow$ $\text{pH} = -\log[\text{H}_3\text{O}^+] \checkmark$ $= -\log(2 \times 10^{-14}) \checkmark$ $= 13,7 \checkmark$	$\text{pOH} = -\log[\text{OH}^-] \checkmark$ $= -\log(0,5) \checkmark$ $= 0,3$ $\text{pH} = 14 - \text{pOH} \checkmark$ $= 14 - 0,3$ $= 13,7 \checkmark$	(4)

2.5.2

$$n(\text{NaOH}) = cV \checkmark$$

$$= (0,5)(0,04) \checkmark$$

$$= 0,02 \text{ mol}$$

$$n(\text{CH}_3\text{COOH}) = n(\text{NaOH}) = 0,02 \text{ mol} \checkmark$$

$$m(\text{CH}_3\text{COOH}) = nM \checkmark$$

$$= (0,02)(60) \checkmark$$

$$= 1,2 \text{ g}$$

$$\% \text{ mass of / massa van } \text{CH}_3\text{COOH} = \frac{1,2}{20} \times 100 \checkmark = 6\% \checkmark \quad (6)$$

2.6

(3)
[20]

SECTION B: TYPICAL EXAM SOLUTIONS

QUESTION 1: 20 minutes

(Taken from NCS Feb/Mar 2015 Paper 2)

- 1.1 1.1.1 An acid is a proton (H^+ ion) donor. $\checkmark \checkmark$ (2)
- 1.1.2 It ionises to form 2 protons/2 moles of H^+ ions.
OR
 It donates 2 H^+ ions per H_2SO_4 molecule. $\checkmark$ (1)
- 1.2 1.2.1 Amphiprotic (substance)/Ampholyte $\checkmark$ (1)
- 1.2.2 $\text{H}_2\text{CO}_3(\text{aq}) \checkmark$ (1)

1.3 1.3.1

$$\begin{aligned}
 n(\text{NaHCO}_3) &= \frac{m}{M} \checkmark \\
 &= \frac{27}{84} \checkmark \\
 &= 0,32 \text{ mol} \quad (0,0321485 \text{ mol}) \\
 n(\text{H}_2\text{SO}_4) &= \frac{1}{2}n(\text{NaHCO}_3) = \frac{1}{2}(0,32) \checkmark = 0,16 \text{ mol} \quad (0,01607142 \text{ mol}) \\
 c &= \frac{n}{V} \checkmark \\
 6 &= \frac{0,16}{V} \checkmark \\
 \therefore V &= 0,03 \text{ dm}^3 \checkmark \quad (30 \text{ cm}^3 / 0,027 \text{ dm}^3 / 27 \text{ cm}^3)
 \end{aligned}
 \tag{6}$$

1.3.2

$$\begin{aligned}
 n_a(\text{initial}) &= n_a(\text{final}) \\
 c_a v_a(\text{initial}) &= c_a v_a(\text{final}) \\
 \therefore (6)v_a &= (0,1)(1) \checkmark \\
 \therefore v_a &= 0,02 \text{ dm}^3 \checkmark \quad (20 \text{ cm}^3 / 0,0167 \text{ dm}^3 / 16,7 \text{ cm}^3)
 \end{aligned}
 \tag{2}$$

1.3.3 Shows end point (of titration) / Shows when neutralisation occurs. $\checkmark$ (1)

1.3.4

Marking criteria/Nasienriglyne:

- Substitute initial [acid] and volume/Vervang aanvanklike [suur] en volume
- Substitute initial [base] and volume/Vervang aanvanklike [basis] en volume
- Use ratio/Gebruik verhouding 1 : 2
- Initial mole acid – mole acid reacted/Aanvanklike mol suur – mol suur gereageer
- Substitute volume acid + volume base/Vervang volume suur + volume basis
- pH formula/pH-formule
- Substitute $2 \times c_a$ in pH formula/Vervang $2 \times c_a$ in pH-formule
- Final answer/Finale antwoord: 1,44

$$n_a(\text{initial/aanvanklik}) = c_a V_a$$

$$= (0,1)(25 \times 10^{-3}) \checkmark$$

$$= 2,5 \times 10^{-3} \text{ mol}$$

$$n_b(\text{reacted/gereageer}) = c_b V_b$$

$$= (0,1)(30 \times 10^{-3}) \checkmark$$

$$= 3 \times 10^{-3} \text{ mol}$$

$$\frac{n_a}{n_b} = \frac{1}{2}$$

$$\therefore n_a(\text{neutralised/geneutraliseer}) = \frac{1}{2}n_b = \frac{1}{2}(3 \times 10^{-3}) \checkmark = 1,5 \times 10^{-3} \text{ mol}$$

$$n_a(\text{left/oorgebly}) = n_a(\text{initial/aanvanklik}) - n_a(\text{neutralised/geneutraliseer})$$

$$= 2,5 \times 10^{-3} - 1,5 \times 10^{-3} \checkmark$$

$$= 1 \times 10^{-3} \text{ mol}$$

$$c_a = \frac{n}{V}$$

$$= \frac{1 \times 10^{-3}}{(25 \times 10^{-3} + 30 \times 10^{-3})}$$

$$= 0,018 \text{ mol} \cdot \text{dm}^{-3}$$

$$\text{pH} = -\log[\text{H}_3\text{O}^+] \checkmark$$

$$= -\log(2 \times 0,018) \checkmark$$

$$= 1,44 \checkmark$$

(8)
[22]**QUESTION 2: 20 minutes**

(Taken from NCS Nov 2015 Paper 2)

2.1 2.1.1 Hydrolysis $\checkmark$ (1)2.1.2 Acidic / Suur $\checkmark$
Forms H_3O^+ ions during hydrolysis. $\checkmark$ **OR**

Salt of strong acid and weak base

OR (NH_4^+) acts as proton donor (2)2.2 2.2.1 $n = cV \checkmark$
 $= (0,1)(0,1) \checkmark$
 $= 0,01 \text{ mol} \checkmark$ (3)

2.2.2 POSITIVE MARKING FROM QUESTION 2.2.1.

Marking criteria/Nasienriglyne

- Substitute volume and concentration to calculate $n(\text{HCl})$ ✓
Vervang volume en konsentrasie om $n(\text{HCl})$ te bereken.
- Use mole ratio/*Gebruik molverhouding*: $n(\text{NaOH}) = n(\text{HCl}) = 1:1$ ✓
- $n(\text{NaOH}) \times 4$ **OR/OF** $V(\text{HCl}) \times 4$ **OR/OF** $n(\text{HCl}) \times 4$ ✓
- Subtraction/*Aftrekking*: $n(\text{NaOH}_{\text{initial/aanvanklik}}) - n(\text{NaOH}_{\text{excess/oormaat}})$ ✓
- Use mole ratio/*Gebruik molverhouding*: $n(\text{NaOH}) = n(\text{NH}_4\text{Cl}) = 1:1$ ✓
- Substitute/*Vervang* $53,5 \text{ g} \cdot \text{mol}^{-1}$ in $n = \frac{m}{M}$. ✓
- Percentage calculation/*Persentasieberekening* ✓
- Final answer/*Finale antwoord*: $0,11 \text{ g} - 0,21 \text{ g}$ ✓

(8)

OPTION 1/OPSIE 1

$$n(\text{HCl}) = c_a V_a = (0,11)(14,55 \times 10^{-3}) \checkmark = 1,6 \times 10^{-3} \text{ mol}$$

$$n(\text{NaOH}) = n(\text{HCl}) = 1,6 \times 10^{-3} \text{ mol} \checkmark$$

$$n(\text{NaOH excess/oormaat}) \text{ in } 100 \text{ cm}^3 = 1,6 \times 10^{-3} \times 4 \checkmark = 6,4 \times 10^{-3} \text{ mol}$$

$$n(\text{NaOH reacted/gereageer}) = 0,01 - 6,4 \times 10^{-3} \checkmark = 3,6 \times 10^{-3} \text{ mol}$$

$$n(\text{NH}_4\text{Cl}) = n(\text{NaOH}) = 3,6 \times 10^{-3} \text{ mol} \checkmark \quad (0,003598 \text{ mol})$$

$$m(\text{NH}_4\text{Cl}) = nM = (3,6 \times 10^{-3})(53,5) \checkmark = 0,193 \text{ g}$$

$$\begin{array}{l} 92\% : 0,193 \text{ g} \\ 100\% : x \end{array}$$

$$\therefore x = \frac{0,193 \times 100}{92} \checkmark = 0,21 \text{ g} \checkmark$$

$$n(\text{NH}_4\text{Cl}) = 0,92 \frac{x}{53,5} \checkmark$$

$$\therefore 3,6 \times 10^{-3} = 0,92 \frac{x}{53,5}$$

$$\therefore x = 0,21 \text{ g} \checkmark$$

$$n(\text{NH}_4\text{Cl}) = \frac{m}{53,5} \checkmark$$

$$\therefore 3,6 \times 10^{-3} = \frac{m}{53,5}$$

$$n(\text{NH}_4\text{Cl}) = 0,192 \text{ g}$$

$$m(\text{fertiliser/kunsmis}):$$

$$m = \frac{0,192 \times 100}{92} \checkmark = 0,21 \text{ g} \checkmark$$

OPTION 2/OPSIE 2 $V(\text{HCl})$ to neutralise $100 \text{ cm}^3 \text{ NaOH}$: $V(\text{HCl})$ neutraliseer $100 \text{ cm}^3 \text{ NaOH}$: $V(\text{HCl}) = 14,55 \times 4 \checkmark$ $= 58,2 \text{ cm}^3$ $n(\text{HCl}) = cV$ $= (0,11)(0,0582) \checkmark$ $= 0,006402 \text{ mol}$ $n(\text{NaOH}) = n(\text{HCl})$ $= 0,006402 \text{ mol} \checkmark$ $n(\text{NaOH reacted/gereageer})$: $n(\text{NaOH}) = 0,01 - 0,006402 \checkmark$ $= 0,003598 \text{ mol}$ $n(\text{NH}_4\text{Cl}) = n(\text{NaOH})$ $= 0,003598 \text{ mol} \checkmark$ $m(\text{NH}_4\text{Cl}) = nM$ $= (0,003598)(53,5) \checkmark$ $= 0,192 \text{ g}$ 92% : 0,192 g 100% : $0,192 \times \frac{100}{92} \checkmark = 0,21 \text{ g} \checkmark$	OPTION 3/OPSIE 3 $n(\text{HCl})$ to neutralise $100 \text{ cm}^3 \text{ NaOH}$: $n(\text{HCl})$ neutraliseer $100 \text{ cm}^3 \text{ NaOH}$: $n(\text{HCl}) = cV$ $= (0,11)(0,01455 \times 4 \checkmark) \checkmark$ $= 0,006402 \text{ mol} (6,4 \times 10^{-3} \text{ mol})$ $n(\text{NaOH excess/oormaat})$: $n(\text{NaOH}) = n(\text{HCl}) = 6,4 \times 10^{-3} \text{ mol} \checkmark$ $n(\text{NaOH reacted/gereageer})$: $n(\text{NaOH}) = 0,01 - 0,006402 \checkmark$ $= 0,003598 \text{ mol}$ $n(\text{NH}_4\text{Cl}) = n(\text{NaOH})$ $= 0,003598 \text{ mol} \checkmark$ $m(\text{NH}_4\text{Cl}) = nM$ $= (0,003598)(53,5) \checkmark$ $= 0,192 \text{ g}$ 92% : 0,192 g 100% : $0,192 \times \frac{100}{92} \checkmark = 0,21 \text{ g} \checkmark$
OPTION 4/OPSIE 4 $\frac{c_a V_a}{c_b V_b} = \frac{n_a}{n_b} \therefore \frac{0,11 \times 14,55}{c_b \times 25} = \frac{1}{1} \checkmark$ $c_b = 0,064 \text{ mol} \cdot \text{dm}^{-3}$ $n(\text{NaOH in excess in } 100 \text{ cm}^3)$: $n(\text{NaOH in oormaat in } 100 \text{ cm}^3)$: $n(\text{NaOH}) = cV$ $= (0,064)(0,1) \checkmark$ $= 6,4 \times 10^{-3} \text{ mol}$ $n(\text{NaOH reacted/gereageer})$: $n(\text{NaOH}) = 0,01 - 0,006402 \checkmark$ $= 0,003598 \text{ mol}$ $n(\text{NH}_4\text{Cl}) = n(\text{NaOH})$ $= 0,003598 \text{ mol} \checkmark$ $m(\text{NH}_4\text{Cl}) = nM$ $= (0,003598)(53,5) \checkmark$ $= 0,192 \text{ g}$ 92% : 0,192 g 100% : $0,192 \times \frac{100}{92} \checkmark = 0,21 \text{ g} \checkmark$	OPTION 5/OPSIE 5 $\frac{c_a V_a}{c_b V_b} = \frac{n_a}{n_b} \therefore \frac{0,11 \times 14,55}{c_b \times 25} = \frac{1}{1} \checkmark$ $\therefore c_b = 0,064 \text{ mol} \cdot \text{dm}^{-3}$ $\Delta c(\text{NaOH}) = 0,1 - 0,064 \checkmark \checkmark$ $= 0,036 \text{ mol} \cdot \text{dm}^{-3}$ $n(\text{NaOH reacted/gereageer})$: $n(\text{NaOH}) = cV$ $= 0,036 \times 0,1$ $= 0,0036 \text{ mol}$ $n(\text{NH}_4\text{Cl}) = n(\text{NaOH}) = 0,0036 \text{ mol} \checkmark$ $n = \frac{m}{M}$ $\therefore 0,0036 = \frac{92}{53,5} x \checkmark$ $0,0036(53,5) = 0,92x$ $x = 0,21 \text{ g} \checkmark$

2.3

OPTION 1/OPSIE 1 $[\text{OH}^-] = [\text{NaOH}] = 0,5 \text{ mol} \cdot \text{dm}^{-3}$ $K_w = [\text{H}_3\text{O}^+][\text{OH}^-]$ $1 \times 10^{-14} = [\text{H}_3\text{O}^+]0,5 \checkmark$ $\therefore [\text{H}_3\text{O}^+] = 2 \times 10^{-14} \text{ mol} \cdot \text{dm}^{-3}$ $\downarrow$ $\text{pH} = -\log[\text{H}^+] \checkmark$ $= -\log(2 \times 10^{-14}) \checkmark$ $= 13,7 \checkmark$	OPTION 2/OPSIE 2 $\text{pOH} = -\log[\text{OH}^-] \checkmark$ $= -\log(0,5) \checkmark$ $= 0,301$ $\downarrow$ $\text{pH} + \text{pOH} = 14$ $\text{pH} = 14 - 0,301 \checkmark$ $= 13,7 \checkmark \quad (13,699)$
Notes/Aantekeninge IF/INDIEN: Wrong formula/Verkeerde formule: $\text{pH} = -\log[\text{OH}^-]$; $\text{pOH} = -\log[\text{NaOH}]$ No marks for substitution and answer./Geen punte vir vervanging en antwoord.	

(4)
[18]

SESSION NO: 10

TOPIC: CONSOLIDATION OF MOMENTUM, IMPULSE AND VERTICAL PROJECTILE MOTION

SECTION A: HOMEWORK SOLUTIONS

QUESTION 1: 25 minutes

(Taken from NSC Exemplar 2014)

1.1 0,5 m $\checkmark$

(1)

1.2

OPTION 1/OPSIE 1**Upwards positive/Opwaarts positief:**

$$v_f^2 = v_i^2 + 2a\Delta y$$

$$v_f^2 = (-2)^2 + 2(-9,8)(-1,8) \checkmark$$

$$v_f = -6,27 \text{ m}\cdot\text{s}^{-1} \checkmark$$

✓ Both equations/Beide vergelykings

$$v_f = v_i + a\Delta t$$

$$-6,27 = -2 + (-9,8)\Delta t \checkmark$$

$$\Delta t = 0,44 \text{ s} \checkmark$$

Downwards positive/Afwaarts positief:

$$v_f^2 = v_i^2 + 2a\Delta y \checkmark$$

$$v_f^2 = (2)^2 + 2(9,8)(1,89) \checkmark$$

$$v_f = 6,27 \text{ m}\cdot\text{s}^{-1} \checkmark$$

✓ Both equations/Beide vergelykings

$$v_f = v_i + a\Delta t$$

$$6,27 = 2 + (9,8)\Delta t \checkmark$$

$$\Delta t = 0,44 \text{ s} \checkmark$$

OPTION 2/OPSIE 2**Upwards positive/Opwaarts positief:**

$$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2 \checkmark$$

$$-1,8 \checkmark = (-2)\Delta t \checkmark + \frac{1}{2}(-9,8)\Delta t^2 \checkmark$$

$$\Delta t = \frac{-2 \pm \sqrt{(2)^2 - 4(4,9)(-1,8)}}{2(4,9)}$$

$$= 0,44 \text{ s} \checkmark$$

Downwards positive/Afwaarts positief:

$$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2 \checkmark$$

$$1,8 \checkmark = (2)\Delta t \checkmark + \frac{1}{2}(9,8)\Delta t^2 \checkmark$$

$$\Delta t = \frac{-2 \pm \sqrt{(-2)^2 - 4(4,9)(-1,8)}}{2(4,9)} = 0,44 \text{ s} \checkmark$$

(5)

OPTION 1/OPSIE 1**Upwards positive/Opwaarts positief:**

$$v_f^2 = v_i^2 + 2a\Delta y$$

$$v_f^2 = (-2)^2 + 2(-9,8)(-1,8) \checkmark$$

$$v_f = -6,27 \text{ m}\cdot\text{s}^{-1} \checkmark$$

✓ Both equations/Beide vergelykings

$$v_f = v_i + a\Delta t$$

$$-6,27 = -2 + (-9,8)\Delta t \checkmark$$

$$\Delta t = 0,44 \text{ s} \checkmark$$

Downwards positive/Afwaarts positief:

$$v_f^2 = v_i^2 + 2a\Delta y \checkmark$$

$$v_f^2 = (2)^2 + 2(9,8)(1,89) \checkmark$$

$$v_f = 6,27 \text{ m}\cdot\text{s}^{-1} \checkmark$$

✓ Both equations/Beide vergelykings

$$v_f = v_i + a\Delta t$$

$$6,27 = 2 + (9,8)\Delta t \checkmark$$

$$\Delta t = 0,44 \text{ s} \checkmark$$

OPTION 2/OPSIE 2**Upwards positive/Opwaarts positief:**

$$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2 \checkmark$$

$$-1,8 \checkmark = (-2)\Delta t \checkmark + \frac{1}{2}(-9,8)\Delta t^2 \checkmark$$

$$\Delta t = \frac{-2 \pm \sqrt{(2)^2 - 4(4,9)(-1,8)}}{2(4,9)}$$

$$= 0,44 \text{ s} \checkmark$$

Downwards positive/Afwaarts positief:

$$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2 \checkmark$$

$$1,8 \checkmark = (2)\Delta t \checkmark + \frac{1}{2}(9,8)\Delta t^2 \checkmark$$

$$\Delta t = \frac{-2 \pm \sqrt{(-2)^2 - 4(4,9)(-1,8)}}{2(4,9)} = 0,44 \text{ s} \checkmark$$

1.3 Upwards positive:

$$v_f^2 = v_i^2 + 2a\Delta y \checkmark$$

$$0 = v_i^2 + 2(-9,8)(0,9) \checkmark$$

$$v_i = 4,2 \text{ m}\cdot\text{s}^{-1} \checkmark \text{ upwards} \checkmark$$

Downwards positive:

$$v_f^2 = v_i^2 + 2a\Delta y \checkmark$$

$$0 = v_i^2 + 2(9,8)(0,9) \checkmark$$

$$v_i = 4,2 \text{ m}\cdot\text{s}^{-1} \checkmark \text{ upwards} \checkmark$$

(4)

1.4 Upwards positive:

$$F_{\text{net}} \Delta t = m \Delta v \checkmark$$

$$F_{\text{net}} (0,2) \checkmark = (0,5)[(4,2 - (-6,27))] \checkmark$$

$$F_{\text{net}} = 26,175 \text{ N} \checkmark$$

Downwards positive:

$$F_{\text{net}} \Delta t = m \Delta v \checkmark$$

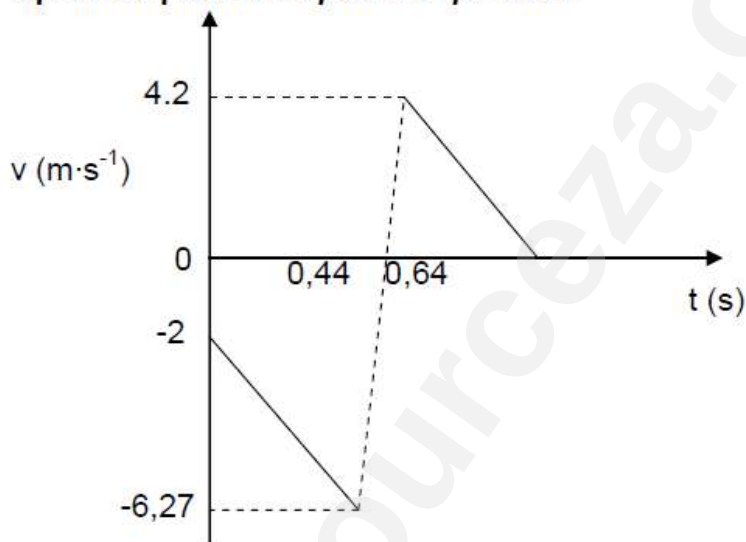
$$F_{\text{net}} (0,2) \checkmark = (0,5)[(-4,2 - (6,27))] \checkmark$$

$$F_{\text{net}} = -26,175 \text{ N}$$

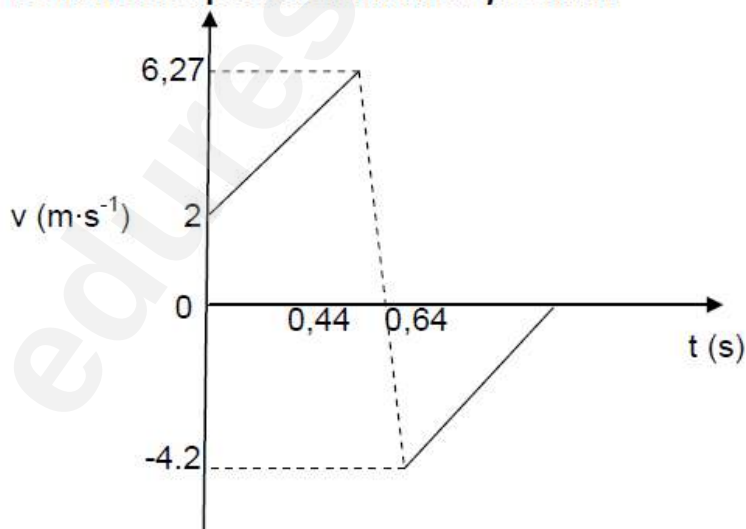
$$F_{\text{net}} = 26,175 \text{ N} \checkmark$$

(4)

1.5 Upwards positive/Opwaarts positief:



Downwards positive/Afwaarts positief:



Criteria for graph/Kriteria vir grafiek:	Marks/ Punte
First part of the graph starts at $v = 2 \text{ m}\cdot\text{s}^{-1}$ at $t = 0 \text{ s}$ and extends until $v = 6,27 \text{ m}\cdot\text{s}^{-1}$ at $t = 0,44 \text{ s}$. <i>Eerste deel van die grafiek begin by $v = 2 \text{ m}\cdot\text{s}^{-1}$ by $t = 0 \text{ s}$ en verleng tot $v = 6,27 \text{ m}\cdot\text{s}^{-1}$ by $t = 0,44 \text{ s}$.</i>	✓
Graph is discontinuous and object changes direction at $0,64 \text{ s}$. <i>Grafiek is nie kontinu nie en voorwerp verander van rigting by $0,64 \text{ s}$.</i>	✓
Second part of graph starts at $v = 4,2 \text{ m}\cdot\text{s}^{-1}$ at $t = 0,64 \text{ s}$ until $v = 0 \text{ m}\cdot\text{s}^{-1}$. <i>Tweede deel van grafiek begin by $v = 4,2 \text{ m}\cdot\text{s}^{-1}$ by $t = 0,64 \text{ s}$ tot $v = 0 \text{ m}\cdot\text{s}^{-1}$.</i>	✓

(3)
[17]**QUESTION 2: 10 minutes**

(Taken from NSC Exemplar 2014)

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

OR

In a closed system ✓ the total linear momentum before collision is equal to the total linear momentum after collision. ✓

(2)

2.2 $\Sigma p_i = \Sigma p_f$
 $(m_1 + m_2)v_i = m_1 v_{1f} + m_2 v_{2f}$ } ✓ Any one

$(2\text{m} + 4\text{m})(0) \checkmark = 2\text{m}(2) + 4\text{m}(v_{2f})$ ✓

$-4\text{m} = 4\text{m}v_f$

$\therefore v_f = -1 \text{ m}\cdot\text{s}^{-1}$

$\therefore v_f = 1 \text{ m}\cdot\text{s}^{-1}$ ✓ in the opposite direction to that of the boys ✓

(4)

- 2.3 Greater than ✓

(1)

[8]

SECTION B: TYPICAL EXAM SOLUTIONS

QUESTION 1: 20 minutes

(Taken from NCS Feb/Mar 2016)

1.1 1.1.1

OPTION 1/OPSIE 1**Upwards positive/Opwaarts positief:**

$$v_f^2 = v_i^2 + 2a\Delta y \checkmark$$

$$v_f^2 = (-2)^2 + 2(-9,8)(-45) \checkmark$$

$$v_f = 29,76 \text{ m}\cdot\text{s}^{-1} \checkmark$$

Downwards positive/Afwaarts positief:

$$v_f^2 = v_i^2 + 2a\Delta y \checkmark$$

$$v_f^2 = (2)^2 + 2(9,8)(45) \checkmark$$

$$v_f = 29,76 \text{ m}\cdot\text{s}^{-1} \checkmark (29,77 \text{ m}\cdot\text{s}^{-1})$$

(3)

OPTION 2/OPSIE 2**Upwards positive/Opwaarts positief:**

$$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2 \checkmark$$

for either equation/vir beide vergelykings

$$-45 = -2\Delta t + \frac{1}{2}(-9,8)\Delta t^2$$

$$-4,9\Delta t^2 - 2\Delta t + 45 = 0$$

$$4,9\Delta t^2 + 2\Delta t - 45 = 0 \checkmark$$

$$\Delta t = 2,83$$

$$v_f = v_i + a\Delta t$$

$$v_f = 0 + (-9,8)(2,83)$$

$$v_f = -29,73 \text{ m}\cdot\text{s}^{-1} \checkmark$$

Downwards positive/Afwaarts positief:

$$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2 \checkmark$$

for either equation/vir beide vergelykings

$$45 = 2\Delta t + \frac{1}{2}(9,8)\Delta t^2$$

$$4,9\Delta t^2 + 2\Delta t - 45 = 0 \checkmark$$

$$\Delta t = 2,83$$

$$v_f = v_i + a\Delta t$$

$$v_f = 0 + (9,8)(2,83)$$

$$v_f = 29,73 \text{ m}\cdot\text{s}^{-1} \checkmark$$

OPTION 3/OPSIE 3**Downwards positive/Afwaarts positief:**

$$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2 \checkmark$$

for either equation/vir beide vergelykings

$$45 = 2\Delta t + \frac{1}{2}(9,8)\Delta t^2$$

$$4,9\Delta t^2 + 2\Delta t - 45 = 0 \checkmark$$

$$\Delta t = 2,83$$

$$\Delta y = \left(\frac{v_i + v_f}{2} \right) \Delta t$$

$$45 = \frac{2 + v_f}{2} \cdot 2,83$$

$$v_f = 29,80 \text{ m}\cdot\text{s}^{-1} \checkmark$$

Upwards positive/Opwaarts positief:

$$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2 \checkmark$$

for either equation/vir beide vergelykings

$$-45 = -2\Delta t + \frac{1}{2}(-9,8)\Delta t^2$$

$$-4,9\Delta t^2 - 2\Delta t + 45 = 0$$

$$4,9\Delta t^2 + 2\Delta t - 45 = 0 \checkmark$$

$$\Delta t = 2,83$$

$$\Delta y = \left(\frac{v_i + v_f}{2} \right) \Delta t$$

$$-45 = \frac{-2 + v_f}{2} \cdot 2,83 \checkmark$$

$$v_f = -29,80 \text{ m}\cdot\text{s}^{-1} \checkmark$$

OPTION 3/OPSIE 3**Downwards positive/Afwaarts positief:**

$$\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2 \checkmark$$

for either equation/vir beide vergelykings

$$45 = 2\Delta t + \frac{1}{2}(9,8)\Delta t^2$$

$$4,9 \Delta t^2 + 2\Delta t - 45 = 0 \checkmark$$

$$\Delta t = 2,83$$

$$\Delta y = \left(\frac{v_i + v_f}{2} \right) \Delta t$$

$$45 = \frac{2 + v_f}{2} \cdot 2,83$$

$$v_f = 29,80 \text{ m s}^{-1} \checkmark$$

Upwards positive/Opwaarts positief:

$$\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2 \checkmark$$

for either equation/vir beide vergelykings

$$-45 = -2\Delta t + \frac{1}{2}(-9,8)\Delta t^2$$

$$-4,9 \Delta t^2 - 2\Delta t + 45 = 0$$

$$4,9 \Delta t^2 + 2\Delta t - 45 = 0 \checkmark$$

$$\Delta t = 2,83$$

$$\Delta y = \left(\frac{v_i + v_f}{2} \right) \Delta t$$

$$-45 = \frac{-2 + v_f}{2} \cdot 2,83 \checkmark$$

$$v_f = -29,80 \text{ m s}^{-1} \checkmark$$

OPTION 4/OPSIE 4 $E_{\text{mech at top}} = E_{\text{mech at surface of water}}$

$$\frac{1}{2} m v_i^2 + mgh_i = \frac{1}{2} m v_f^2 + mgh_f \checkmark$$

$$\frac{1}{2} (2)^2 + 9,8(45) = \frac{1}{2} v_f^2 + 0 \checkmark$$

$$v_f = 29,76 \text{ m} \cdot \text{s}^{-1} \checkmark$$

OPTION 5/OPSIE 5

$$W_{\text{net}} = \Delta K \checkmark$$

$$F_g \Delta h \cos \theta = \frac{1}{2} m (v_f^2 - v_i^2)$$

$$mg \Delta h \cos \theta = \frac{1}{2} m (v_f^2 - v_i^2)$$

$$9,8(45) \cos 0 = \frac{1}{2} (v_f^2 - 2^2) \checkmark$$

$$v_f = 29,76 \text{ m} \cdot \text{s}^{-1} \checkmark$$

(3)

1.1.2

POSITIVE MARKING FROM 3.1 POSITIEWE NASIEN VANAF 3.1 OPTION 1/OPSIE 1 Upwards positive/Opwaarts positief: The balls hit the water at the same instant./Die balle tref die water gelyktydig $v_f = v_i + a\Delta t$ ✓ Ball/Bal A $-29,76 = -2 + (-9,8) \Delta t$ $\Delta t = 2,83 \text{ s}$ ✓ $\therefore$ for ball/vir bal B $\Delta t_B = 2,83 - 1 = 1,83 \text{ s}$ $\therefore$ for ball/vir bal B $\Delta t_B = 2,83 - 1 = 1,83 \text{ s}$ ✓	POSITIVE MARKING FROM 3.1 POSITIEWE NASIEN VANAF 3.1 OPTION 1/OPSIE 1 Downwards positive/Afwaarts positief The balls hit the water at the same instant./Die balle tref die water gelyktydig $v_f = v_i + a\Delta t$ ✓ Ball/Bal A $29,76 = 2 + (9,8) \Delta t$ $\Delta t = 2,83 \text{ s}$ ✓ $\therefore$ for ball/vir bal B $\Delta t_B = 2,83 - 1 = 1,83 \text{ s}$ $\therefore$ for ball/vir bal B $\Delta t_B = 2,83 - 1 = 1,83 \text{ s}$ ✓
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(3)

OPTION 2 Upwards positive/Opwaarts positief: Ball/Bal A $\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$ ✓ $-45 = -2\Delta t + \frac{1}{2}(-9,8)\Delta t^2$ $-4,9 \Delta t^2 - 2\Delta t + 45 = 0$ $4,9 \Delta t^2 + 2\Delta t - 45 = 0$ $\Delta t = 2,83$ ✓ $\therefore$ for ball/vir bal B $\Delta t_B = 2,83 - 1 = 1,83 \text{ s}$ ✓	Downwards positive/Afwaarts positief: $\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$ ✓ $45 = 2\Delta t + \frac{1}{2}(9,8)\Delta t^2$ $4,9 \Delta t^2 + 2\Delta t - 45 = 0$ $\Delta t = 2,83$ ✓ $\therefore$ for ball/vir bal B $\Delta t_B = 2,83 - 1 = 1,83 \text{ s}$ ✓
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OPTION 2 Upwards positive/Opwaarts positief: Ball/Bal A $\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$ ✓ $-45 = -2\Delta t + \frac{1}{2}(-9,8)\Delta t^2$ $-4,9 \Delta t^2 - 2\Delta t + 45 = 0$ $4,9 \Delta t^2 + 2\Delta t - 45 = 0$ $\Delta t = 2,83$ ✓ $\therefore$ for ball/vir bal B $\Delta t_B = 2,83 - 1 = 1,83 \text{ s}$ ✓	Downwards positive/Afwaarts positief: $\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$ ✓ $45 = 2\Delta t + \frac{1}{2}(9,8)\Delta t^2$ $4,9 \Delta t^2 + 2\Delta t - 45 = 0$ $\Delta t = 2,83$ ✓ $\therefore$ for ball/vir bal B $\Delta t_B = 2,83 - 1 = 1,83 \text{ s}$ ✓
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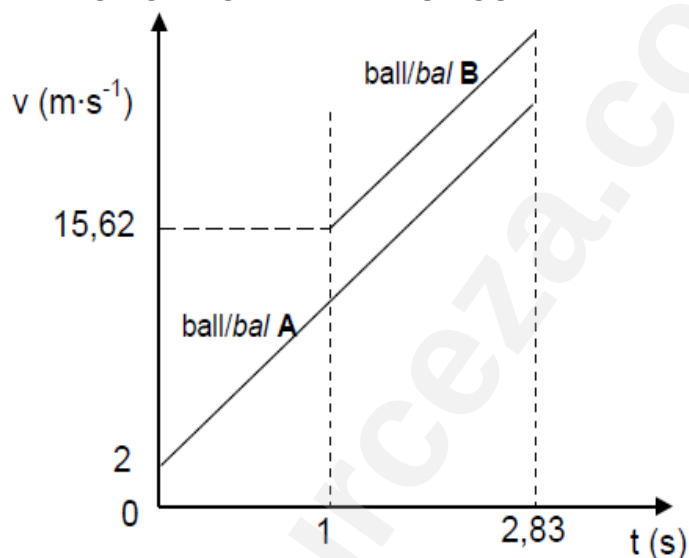
OPTION 3 Downwards positive/Afwaarts positief: Ball/Bal A $\Delta y = \left(\frac{v_i + v_f}{2} \right) \Delta t$ ✓ $45 = \frac{2 + 29,76}{2} \Delta t$ $\Delta t = 2,83$ ✓ $\therefore$ for ball/vir bal B $\Delta t_B = 2,83 - 1 = 1,83 \text{ s}$ ✓	Upwards positive/Opwaarts positief: Ball/Bal A $\Delta y = \left(\frac{v_i + v_f}{2} \right) \Delta t$ ✓ $-45 = \frac{-2 - 29,76}{2} \Delta t$ $\Delta t = 2,83$ ✓ $\therefore$ for ball/vir bal B $\Delta t_B = 2,83 - 1 = 1,83 \text{ s}$ ✓
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1.1.3

POSITIVE MARKING FROM 3.2/POSITIEWE NASIEN VANAF 3.2 Upwards positive/Opwaarts positief: $\Delta t_B = 1.83\text{s} \checkmark$ $\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2 \checkmark$ $-45 \checkmark = v_i (1.83) + \frac{1}{2} (-9.8)(1.83)^2 \checkmark$ $v_i = -15.62 \text{ m}\cdot\text{s}^{-1} \checkmark$	Downwards positive/Afwaarts positief: $\Delta t_B = 1.83\text{s} \checkmark$ $\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2 \checkmark$ $45 \checkmark = v_i (1.83) + \frac{1}{2} (9.8)(1.83)^2 \checkmark$ $v_i = 15.62 \text{ m}\cdot\text{s}^{-1} \checkmark$
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(5)

1.2 **POSITIVE MARKING FROM 1.1.2; 1.1.3**
CONSIDER MOTION DOWNWARD AS POSITIVE

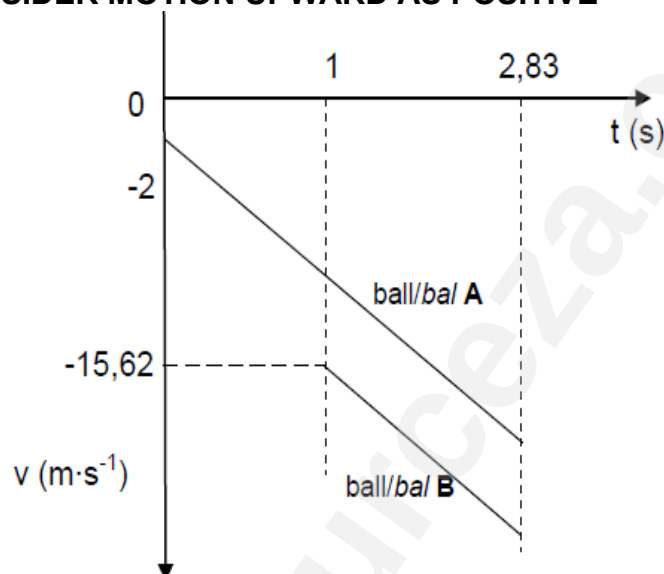


CRITERIA FOR MARKING/KRITERIA VIR NASIEN	
1 mark for each initial velocity shown/1 punt vir elke beginsnelheid aangedui (For/Vir A $2 \text{ m}\cdot\text{s}^{-1}$ for/vir B $15.62 \text{ m}\cdot\text{s}^{-1}$)	✓✓
Time of release of ball/Tyd van vrystelling van bal B $t = 1\text{s}$	✓
Time of flight for both balls must be indicated as same on time axis/Vlugtyd van beide balle moet op dieselfde tydas aangetoon word (2.83s)	✓
Shape: Lines must be parallel or nearly so/Vorm: Lyne moet parallel of amper parallel wees	✓

(5)

CRITERIA FOR MARKING/KRITERIA VIR NASIEN	
1 mark for each initial velocity shown/1 punt vir elke beginsnelheid aangedui (For/Vir A $2 \text{ m}\cdot\text{s}^{-1}$ for/vir B $15,62 \text{ m}\cdot\text{s}^{-1}$)	✓✓
Time of release of ball/Tyd van vrystelling van bal B $t = 1 \text{ s}$	✓
Time of flight for both balls must be indicated as same on time axis/Vlugtyd van beide balle moet op dieselfde tyd as aangetoon word (2,83 s)	✓
Shape: Lines must be parallel or nearly so/Vorm: Lyne moet parallel of amper parallel wees	✓

CONSIDER MOTION UPWARD AS POSITIVE



CRITERIA FOR MARKING/KRITERIA VIR NASIEN	
1 mark for each initial velocity shown/1 punt vir elke beginsnelheid aangedui (For/Vir A $-2 \text{ m}\cdot\text{s}^{-1}$ for/vir B $-15,62 \text{ m}\cdot\text{s}^{-1}$)	✓✓
Time of release of ball/Tyd van vrystelling van bal B $t = 1 \text{ s}$	✓
Time of flight for both balls must be indicated as same on time axis/Vlugtyd van beide balle moet op dieselfde tyd as aangetoon word (2,83 s)	✓
Shape: Lines must be parallel or nearly so/Vorm: Lyne moet parallel of amper parallel wees	✓

[16]

QUESTION 2: 15 minutes

(Taken from Gaut Prep Exam 2014 P1)

2.1 Impulse = area between graph and x – axis ✓

$$\text{Impulse} = \frac{1}{2}bh + \frac{1}{2}bh + lb \quad \checkmark$$

$$\text{Impulse} = \frac{1}{2}(2)(10) + \frac{1}{2}(2)(-10) + (6)(-10) \quad \checkmark$$

$$\text{Impulse} = -60 \text{ N} \cdot \text{s} \quad \checkmark$$

$$\therefore \text{Impulse} = 60 \text{ N} \cdot \text{s} \quad \text{in oppositedirection/west}$$

$$\therefore \text{Impuls} = 60 \text{ N} \cdot \text{s} \quad \text{in teenoorges telde rigting/wes}$$

(3)

2.2 Greater than $\checkmark$

(1)

2.3 **OPTION 1 / OPSIE 1****East positive:****Oos positief:**

$$\text{Impulse} = mv_f - mv_i \quad \checkmark$$

$$\checkmark -60 = (12)v_f - (12)(5,5) \quad \checkmark$$

$$v_f = 0,5 \text{ m} \cdot \text{s}^{-1} \text{ east/ oos} \quad \checkmark$$

OPTION 2 / OPSIE 2**West positive:****Wes positief:**

$$\text{Impulse} = mv_f - mv_i \quad \checkmark$$

$$\checkmark -60 = (12)v_f - (12)(5,5) \quad \checkmark$$

$$v_f = 0,5 \text{ m} \cdot \text{s}^{-1} \text{ east/ oos} \quad \checkmark$$

(4)

[8]

QUESTION 3: 20 minutes*(Taken from Feb/Mar 2014 P1)*3.1 Momentum is the product of the mass and velocity of an object. $\checkmark \checkmark$

(2)

3.2 $\Delta p = 0 \quad \checkmark$

$$F_{\text{net}} = \frac{\Delta p}{\Delta t} = 0 \quad \checkmark$$

OR

$$\Delta p = 0 \quad \checkmark$$

$$\therefore \Delta v = 0 \therefore a = 0 \therefore F_{\text{net}} = ma \quad \checkmark$$

OR

$$\text{Gradient of graph} = F_{\text{net}} = \frac{\Delta p}{\Delta t} \quad \checkmark$$

Gradient of graph between $t = 10 \text{ s}$ and $20 \text{ s} = 0 \quad \checkmark$

(2)

3.3

OPTION 1

$$F_{\text{net}} \Delta t = \Delta p \quad \checkmark$$

$$= -120 - 50 \quad \checkmark$$

$$= -170$$

$$\therefore F_{\text{net}} \Delta t = 170 \text{ N} \cdot \text{s} / \text{kg} \cdot \text{m} \cdot \text{s}^{-1} \quad \checkmark$$

OPTION 2

$$F_{\text{net}} = \frac{\Delta p}{\Delta t} \quad \checkmark$$

$$= \frac{-120 - 50}{50 - 20}$$

$$\therefore F_{\text{net}} = -5,67$$

$$F_{\text{net}} \Delta t = (-5,67)(30) \quad \checkmark$$

$$= -170$$

$$\therefore F_{\text{net}} \Delta t = 170 \text{ N} \cdot \text{s} / \text{kg} \cdot \text{m} \cdot \text{s}^{-1} \quad \checkmark$$

(3)

3.4

OPTION 1/ OPSIE 1 $\Sigma p_i = \Sigma p_f$ ✓ $-120 + 70$ ✓ = $50 + p_{Bf}$ ✓ $\therefore p_{Bf} = -100$ $\therefore p_{Bf} = 100 \text{ kg}\cdot\text{m}\cdot\text{s}^{-1}$ ✓ west / wes ✓	OPTION 2/OPSIE 2 $\Delta p_A = -\Delta p_B$ ✓ $50 - (-120)$ ✓ = $-(p_{Bf} - 70)$ ✓ $\therefore p_{Bf} = -100$ $\therefore p_{Bf} = 100 \text{ kg}\cdot\text{m}\cdot\text{s}^{-1}$ ✓ west / wes ✓
Other formulae/Ander formules: $m_1 v_{i1} + m_2 v_{i2} = m_1 v_{f1} + m_2 v_{f2}$ or $m_1 u_1 + m_2 u_2 = m_1 v_1 + m_2 v_2$ or $m_A v_{iA} + m_B v_{iB} = m_A v_{fA} + m_B v_{fB}$ $p_{\text{total before}} = p_{\text{total after}}$ Accept /Aanvaar: $p_{\text{before}} = p_{\text{after}}$ $p_i = p_f$	Notes/Aantekeninge: • If no formula/principle – Max. $\frac{4}{5}$ <i>Indien geen formule/beginsel –</i> <i>Maks. $\frac{4}{5}$</i> • Mark direction independently. <i>Sien rigting onafhanklik na.</i>

(5)
[12]

SESSION NO: 11
 TOPIC: CONSOLIDATION OF ORGANIC MOLECULES AND THEIR REACTIONS

SECTION A: HOMEWORK SOLUTIONS

QUESTION 1: 20 minutes

(Taken from NSC Nov 2015 Paper 2)

- 1.1 A bond/an atom or a group of atoms ✓ that determine(s) the (physical and chemical) properties of a group of organic compounds. ✓ (2)
- 1.2 1.2.1 D / ethanoic acid ✓
 Lowest vapour pressure. ✓ (2)
- 1.2.2 A / Butane ✓ (1)
- 1.3
- Between molecules of **A** / butane / alkanes are London / induced dipole / dispersion forces. ✓
 - Between molecules of **B** / propan-2-one / ketones are 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. (3)
- 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.

1.4 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)

1.5 **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.

1.6

Marking criteria/Nasienriglyne

- Mole ratio for $V(\text{CO}_2)$ correctly used. / *Molverhouding vir $V(\text{CO}_2)$ korrek gebruik.*
- Mole ratio for $V(\text{H}_2\text{O})$ correctly used. / *Molverhouding vir $V(\text{H}_2\text{O})$ korrek gebruik.*
- Mole ratio for $V(\text{O}_2 \text{ reacted})$ correctly used. / *Molverhouding vir $V(\text{O}_2 \text{ reageer})$ korrek gebruik.*
- $V(\text{O}_2 \text{ excess/oormaat}) = V(\text{O}_2 \text{ initial/aanvanklik}) - V(\text{O}_2 \text{ change/verandering})$.
- $V_{\text{tot}} = 80 \text{ cm}^3$

OPTION 1/OPSIE 1

$$\begin{aligned} V(\text{CO}_2) &= 4V(\text{C}_4\text{H}_{10}) \\ &= (4)(8) \checkmark \\ &= 32 \text{ cm}^3 \end{aligned}$$

$$\begin{aligned} V(\text{H}_2\text{O}) &= 5V(\text{C}_4\text{H}_{10}) \\ &= (5)(8) \checkmark \\ &= 40 \text{ cm}^3 \end{aligned}$$

$V(\text{O}_2 \text{ reacted/reageer})$:

$$\begin{aligned} V(\text{O}_2) &= \frac{13}{2} V(\text{C}_4\text{H}_{10}) \\ &= \left(\frac{13}{2}\right)(8) \checkmark = 52 \text{ cm}^3 \end{aligned}$$

$V(\text{O}_2 \text{ excess/oormaat})$:

$$V(\text{O}_2) = 60 - 52 \checkmark = 8 \text{ cm}^3$$

$$V_{\text{tot}} = 32 + 40 + 8 = 80 \text{ cm}^3 \checkmark$$

(5)

OPTION 2/OPSIE 2

	C ₄ H ₁₀	O ₂	CO ₂	H ₂ O
Initial V (cm ³) <i>Begin V (cm³)</i>	8	60	0	0
Change in V (cm ³) <i>Verandering V (cm³)</i>	8	52 ✓	32 ✓	40 ✓
Final V (cm ³) <i>Finale V (cm³)</i>	0	8 ✓	32	40

Total/totale volume = 8 + 32 + 40 = 80 cm³ ✓

OPTION 3/OPSIE 3

	C ₄ H ₁₀	O ₂	CO ₂	H ₂ O
Initial V (dm ³) <i>Begin V (dm³)</i>	0,008	0,06	0	0
Change in V (dm ³) <i>Verandering V (dm³)</i>	0,008	0,052 ✓	0,032 ✓	0,04 ✓
Final V (dm ³) <i>Finale V (dm³)</i>	0	0,008 ✓	0,032	0,04

Total/totale volume = 0,008 + 0,032 + 0,04 = 0,08 dm³ ✓

[16]

QUESTION 2: 20 minutes

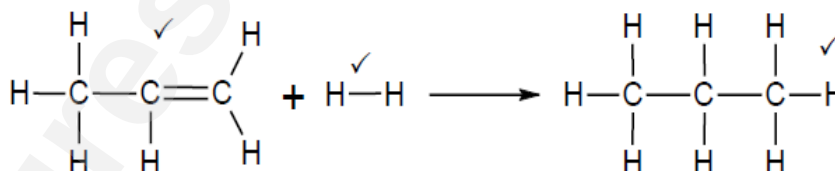
(Taken from NSC Nov 2014 Paper 2)

2.1 2.1.1 Substitution / chlorination / halogenation ✓ (1)

2.1.2 Substitution / hydrolysis ✓ (1)

2.2 2.2.1 Hydrogenation ✓ (1)

2.2.2

**Notes / Aantekeninge:**

- Ignore/Ignoreer ⇌
- Accept H₂ if condensed. / Aanvaar H₂ as gekondenseerd.
- Any additional reactants and/or products

Enige addisionele reaktanse en / of produkte:

Max./Maks. $\frac{2}{3}$

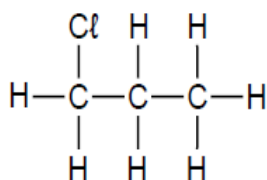
- Accept coefficients that are multiples.
Aanvaar koëffisiënte wat veelvoude is.
- Molecular / condensed formulae

Molekulêre-/ gekondenseerde formule:

Max./Maks. $\frac{2}{3}$

(3)

2.3

**Marking criteria / Nasienriglyne:**

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

Notes / Aantekeninge:

- Condensed or semi-structural formula

Gekondenseerde of semistruktuurformule: Max./Maks. $\frac{1}{2}$

- Molecular formula. / Molekulêre formule: $\frac{0}{2}$

- If functional group is incorrect. / Indien funksionele groep verkeerd is: $\frac{0}{2}$

(2)

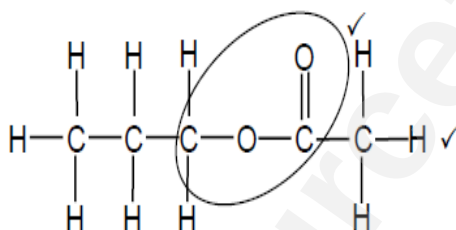
2.4 2.4.1 Esterification / Condensation ✓

(1)

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

(1)

2.4.3

**Marking criteria / Nasienriglyne:**

- Whole structure correct / Hele struktuur korrek: $\frac{2}{2}$
- Only functional group correct / Slegs funksionele groep korrek: $\frac{1}{2}$

Notes / Aantekeninge:

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

(2)

2.4.4 Propyl ✓ ethanoate ✓

(2)

2.4.5 Sulfuric acid / H_2SO_4 / Phosphoric acid / H_3PO_4 ✓

(1)

[15]

SECTION B: TYPICAL EXAM QUESTIONS

QUESTION 1: 25 minutes

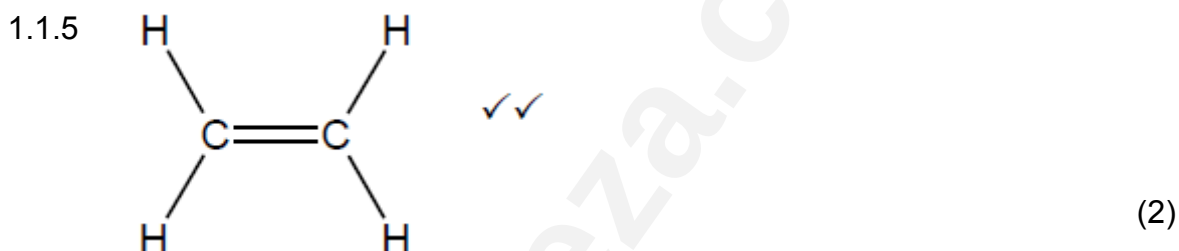
(Taken from NSC Exemplar 2014 Paper 2)

1.1 1.1.1 Alkynes / Alkyne ✓ (1)

1.1.2 Hydroxyl group ✓ (1)

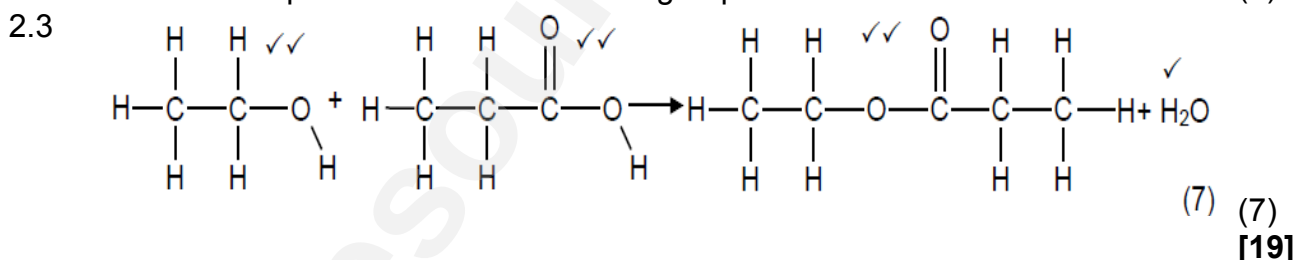
1.1.3 C ✓ (1)

1.1.4 2-methylpentan-3-one ✓✓ (2)



1.1.6 $2\text{C}_4\text{H}_{10} + 13\text{O}_2 \rightarrow 8\text{CO}_2 + 10\text{H}_2\text{O}$ ✓ Bal. ✓ (3)

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



QUESTION 2: 15 minutes

(Taken from NSC Feb/Mar 2015 Paper 2)

2.1 C ✓ (1)

2.2 2.2.1 Chain length/molecular size/molecular mass/number of carbon atoms in the chain. ✓ (1)

2.2.2 Boiling point ✓ (1)

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

2.4 Higher than ✓ (1)

2.5 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

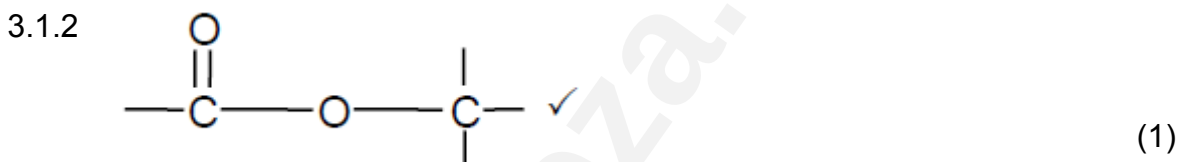
Compound D has less sites for hydrogen bonding/weaker hydrogen bonding than compound E. ✓

- 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)

3.1 3.1.1 Esterification / Condensation ✓ (1)

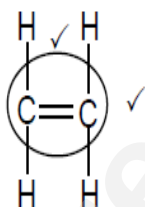


3.1.3 Propanoic acid ✓ (1)

3.1.4 Dehydration / elimination ✓ (1)

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

3.1.6

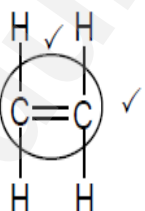


Notes/Aantekeninge

- Functional group: ✓
Funksionele groep:
- Whole structure correct: ✓
Hele struktuur korrek:

(2)

3.2 3.2.1



Notes/Aantekeninge

- Functional group: ✓
Funksionele groep:
- Whole structure correct: ✓
Hele struktuur korrek:

(2)

3.2.2 Addition ✓ (1)

[10]

SESSION NO: 12
 TOPIC: CONSOLIDATION OF WORK, ENERGY AND POWER

SECTION A: HOMEWORK QUESTIONS

QUESTION 1: 20 minutes

(Taken from NSC Feb/Mar 2015 Paper 1)

1.1 $\Delta U + \Delta K = 0$ ✓
 $(5)(9,8)(5) + 0 + (0 + \frac{1}{2}(5v_f^2)) = 0$ ✓
 $v_f = \sqrt{2 \times 9,8 \times 5}$ ✓
 $= 9,90 \text{ m} \cdot \text{s}^{-1}$ ✓ (9,899 m·s⁻¹)

Notes / Aantekeninge

Accept/Aanvaar

$$Mgh_i + \frac{1}{2} Mv_i^2 = Mgh_f + \frac{1}{2} Mv_f^2$$

(4)

1.2 No friction/zero resultant force ✓ so there is no loss in energy. ✓ / Only conservative forces present. / Mechanical energy is conserved (2)

1.3 A force for which the work done is path dependent. ✓ ✓ (2)
Note:

Accept

A force which does not conserve mechanical energy.

1.4

OPTION 1/OPSIE 1

$$W_{nc} = \Delta U + \Delta K \quad \checkmark$$

$$F \Delta x \cos \theta = \Delta U + \Delta K$$

$$(18 \Delta x \cos 180^\circ) = (5)(9,8)(3 - 0) + \frac{1}{2}(5)(0 - 9,90^2) \quad \checkmark$$

$$\Delta x = 5,4458 \text{ m} \quad \checkmark$$

$$\theta = \sin^{-1} \frac{3}{5,4458} \quad \checkmark$$

$$\theta = 33,43^\circ \quad \checkmark$$

OPTION 2/OPSIE 2

$$W_{net} = W_f + W_G \quad \checkmark$$

$$W_{net} = f \Delta x \cos \theta + m g \sin \theta \Delta x \cos \theta$$

$$= [(18) \Delta x \cos 180^\circ] + 5(9,8) \frac{3}{\Delta x} (\Delta x) \cos 180^\circ \quad \checkmark$$

$$= -18\Delta x - 147$$

$$W_{net} = \Delta K \quad \checkmark$$

$$\Delta K = \frac{1}{2}(5)(0 - 9,90^2) \quad \checkmark$$

$$= -245,025$$

$$-18\Delta x - 147 = -245,025$$

$$\Delta x = 5,4458 \text{ m} \quad \checkmark$$

$$\theta = \sin^{-1} \frac{3}{5,4458} \quad \checkmark$$

$$\theta = 39,43^\circ \quad \checkmark$$

(7)

OPTION 1/OPSIE 1

$$W_{nc} = \Delta U + \Delta K \checkmark$$

$$F \Delta x \cos \theta = \Delta U + \Delta K$$

$$(18 \Delta x \cos 180^\circ) = (5)(9,8)(3-0) \checkmark + \frac{1}{2}(5)(0 - 9,90^2) \checkmark$$

$$\Delta x = 5,4458 \text{ m} \checkmark$$

$$\theta = \sin^{-1} \frac{3}{5,4458} \checkmark$$

$$\theta = 33,43^\circ \checkmark$$

OPTION 2/OPSIE 2

$$W_{net} = W_f + W_G \checkmark$$

$$W_{net} = f \Delta x \cos \theta + mg \sin \theta \Delta x \cos \theta$$

$$= [(18) \Delta x \cos 180^\circ] + 5(9,8) \frac{3}{\Delta x} (\Delta x) \cos 180^\circ \checkmark$$

$$= -18\Delta x - 147$$

$$W_{net} = \Delta K \checkmark$$

$$\Delta K = \frac{1}{2}(5)(0 - 9,90^2) \checkmark$$

$$= -245,025$$

$$-18\Delta x - 147 = -245,025$$

$$\Delta x = 5,4458 \text{ m} \checkmark$$

$$\theta = \sin^{-1} \frac{3}{5,4458} \checkmark$$

$$\theta = 39,43^\circ \checkmark$$

[15]**QUESTION 2: 15 minutes***(Taken from GDE SEPT 2014 Paper 1)*

- 2.1 It is a weak acid $\checkmark$ (1)
- 2.2 An acid that forms a large no of moles per volume of water $\checkmark \checkmark$ (2)
- 2.3 $\text{H}_2\text{PO}_4^- + \text{H}_2\text{O} \rightleftharpoons \text{H}_3\text{PO}_4 + \text{OH}^- \checkmark$ (2)
- 2.4 $\text{H}_2\text{O}/\text{OH}^- \checkmark$ (1)
or
 $\text{H}_2\text{PO}_4^-/\text{H}_3\text{PO}_4 \checkmark$
- 2.5 2.5.1 $m = cMV \checkmark = 58 \checkmark \times 0,2 \checkmark \times 0,5 \checkmark = 5,8 \text{ g} \checkmark$ (5)
- 2.5.2 $0,1 \times 2 = 0,2 \text{ mol} \cdot \text{dm}^{-3} \checkmark$ (1)
- 2.5.3 Not safe $\checkmark$ $\downarrow$ positive marking
 $[\text{OH}^-] = 0,2 \text{ mol} \cdot \text{dm}^{-3} \checkmark$
 $\text{pOH} = -\log[\text{OH}^-] = -\log(0,2) \checkmark = 0,7 \checkmark$
 $\text{pH} + \text{pOH} = 14$
 $\text{pH} = 14 - 0,7 = 13,3 \checkmark$
 OR
 $[\text{H}^+][\text{OH}^-] = 10^{-14} \checkmark$

$$[H^+](0,2) = 10^{-14} \checkmark$$

$$[H^+] = 5 \times 10^{-14} \text{ mol} \cdot \text{dm}^{-3} \checkmark$$

$$\text{pH} = -\log[H^+] = -\log(5 \times 10^{-14}) = 13,3 \checkmark \quad (4)$$

$$2.6 \quad n_a = \frac{c_a V_a}{c_b V_b} \checkmark$$

$$\frac{2}{1} \checkmark = \frac{(0,1)V}{(0,2)25} \checkmark$$

$$V = 100 \text{ cm}^3 \checkmark$$

$$V = 100 \text{ cm}^3 \checkmark$$

(4)

[22]

SECTION B: TYPICAL EXAM SOLUTIONS

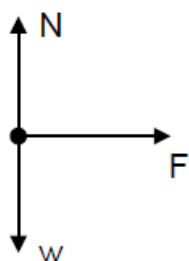
QUESTION 1:

20 minutes

(Taken from NSC Exemplar 2014 Paper 1)

1.1 Frictional force $\checkmark$

(1)

1.2 F_N / Normal force $\checkmark$ F_g / Gravitational force / Weight $\checkmark$ F_{app} / 10 N / Horizontal applied force $\checkmark$ 

Accepted labels/Aanvaarde benoemings

w	F_g / F_w / weight / mg / gravitational force F_g / F_w / gewig / mg / gravitasiekrag
N	F_N / F_{normal} / normal force F_N / F_{normaal} / normaalkrag
F	F_{app} / applied force / 10 N F_{toeg} / toegepaste krag / 10 N

(3)

1.3 The net work done $\checkmark$ on an object is equal to the change in kinetic energy $\checkmark$ of the object. (2)

1.4

OPTION 1/OPSIE 1

$$W_{nc} = \Delta E_p + \Delta E_k \checkmark$$

$$f\Delta x \cos\theta = (mgh_f - mgh_i) + \left(\frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2\right)$$

$$(2)(10)\cos 180^\circ \checkmark = (3)(9,8)h_f - 0 \checkmark + 0 - \frac{1}{2}(3)(4,08)^2 \checkmark$$

$$\therefore h = 0,17 \text{ m} \checkmark$$

(5)

OPTION 2/OPSIE 2

$$W_{net} = \Delta E_k \checkmark$$

$$W_f + W_w = \frac{1}{2}m(v_f^2 - v_i^2)$$

$$(2)(10)\cos 180^\circ \checkmark + (3)(9,8)h \cos 180^\circ \checkmark = \frac{1}{2}(3)(0^2 - 4,08^2) \checkmark$$

$$\therefore h = 0,17 \text{ m} \checkmark$$

OPTION 3/OPSIE 3

$$W_{net} = \Delta E_k \checkmark$$

$$mgsin\alpha \Delta x \cos\theta + f\Delta x \cos\theta = \frac{1}{2}m(v_f^2 - v_i^2)$$

$$(3)(9,8)\left(\frac{h}{10}\right)(10)\cos 180^\circ \checkmark + (2)(10)\cos 180^\circ \checkmark = \frac{1}{2}(3)(0^2 - 4,08^2) \checkmark$$

$$\therefore h = 0,17 \text{ m} \checkmark$$

[15]

QUESTION 2: 20 minutes

(Taken from MP SEPT 2015 Paper 1)

2.1

$$\Sigma p_i = \Sigma p_f$$

$$(mv_i)_1 + (mv_i)_2 = (mv_f)_1 + (mv_f)_2$$

$$0 \checkmark = \underline{1,6(0,26) + 0,8v_f} \checkmark$$

$$v_f = -0,52$$

$$v_f = 0,52 \text{ m}\cdot\text{s}^{-1} \checkmark$$

(4)

2.2

✓ - F ✓ / Experiences the same force in magnitude ✓, but in opposite direction ✓

Newtons Third Law. ✓

(3)

2.3

External forces present P/ friction present ✓

(1)

2.4

$$f = \mu k \cdot N \checkmark$$

$$= (0,12)(1,6 \times 9,8 \times \cos 30^\circ) \checkmark$$

$$= 1,63 \text{ N} \checkmark$$

(3)

2.5 POSITIVE MARKING FROM 2.4

OPTION 1/OPSIE 1 $W_{\text{net}} = \Delta E_k \checkmark$ $W_{\text{w}} + W_f = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ $(1,6 \times 9,8 \times \sin 30^\circ)(0,5) \cos 0^\circ \checkmark + (1,63)(0,5) \cos 180^\circ \checkmark = \frac{1}{2}(1,6)v_f^2 - \frac{1}{2}(1,6)(0,2)^2 \checkmark$ $v_f = 1,98 \text{ m} \cdot \text{s}^{-1} \checkmark$	(5)
OPTION 2/OPSIE 2 $W_{\text{net}} = \Delta E_k \checkmark$ $W_w + W_f = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ $(1,6 \times 9,8)(0,5) \cos 60^\circ \checkmark + (1,63)(0,5) \cos 180^\circ \checkmark = \frac{1}{2}(1,6)v_f^2 - \frac{1}{2}(1,6)(0,2)^2 \checkmark$ $v_f = 1,98 \text{ m} \cdot \text{s}^{-1} \checkmark$	(5)
OPTION 3/OPSIE 3 $W_{\text{net}} = \Delta E_k \checkmark$ $W_w + W_f = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ $(1,6 \times 9,8)(0,25) \cos 0^\circ \checkmark + (1,63)(0,5) \cos 180^\circ \checkmark = \frac{1}{2}(1,6)v_f^2 - \frac{1}{2}(1,6)(0,2)^2 \checkmark$ $v_f = 1,98 \text{ m} \cdot \text{s}^{-1} \checkmark$	(5)
OPTION 4/OPSIE 4 $W_{\text{net}} = \Delta E_k \checkmark$ $F_{\text{net}} \cdot \Delta x \cdot \cos \theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ $(1,6 \times 9,8 \times \sin 30^\circ - 1,63)(0,5) \cos 0^\circ \checkmark = \frac{1}{2}(1,6)v_f^2 - \frac{1}{2}(1,6)(0,2)^2 \checkmark$ $v_f = 1,98 \text{ m} \cdot \text{s}^{-1} \checkmark$	(5)
OPTION 5/OPSIE 5 $W_{\text{nc}} = \Delta E_k + \Delta E_p \checkmark$ $f \cdot \Delta x \cdot \cos \theta = (\frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2) + (mgh_f - mgh_i)$ $(1,63)(0,5) \cos 180^\circ \checkmark = [\frac{1}{2}(1,6)(v_f^2) - \frac{1}{2}(1,6)(0,2)^2] \checkmark + [0 - (1,6)(9,8)(0,25)] \checkmark$ $v_f = 1,98 \text{ m} \cdot \text{s}^{-1} \checkmark$	(5)

(5)
[16]

SESSION NO: 13
 TOPIC: CONSOLIDATION OF DOPPLER EFFECT AND RATES OF REACTION

SECTION A: HOMEWORK SOLUTIONS

QUESTION 1: 20 minutes

(Taken from MP SEPT 2015 Paper 1)

1.1 $1 \times 10^{-3} \text{ s} \checkmark$ / $0,001 \text{ s} \checkmark$

(1)

1.2 POSITIVE MARKING FROM 1.1

$$T = \frac{1}{f} \checkmark$$

OR

$$f = \frac{\text{number of waves}}{\text{time}}$$

$$f = \frac{1}{0,001} \checkmark$$

$$= \frac{0,25}{2,5 \times 10^{-4}}$$

(3)

$$= 1000 \text{ Hz} \checkmark$$

$$= 1000 \text{ Hz}$$

- 1.3 The change in frequency (or pitch) of the sound detected by a listener $\checkmark$ because the sound source and the listener have different velocities $\checkmark$ relative to the medium of sound propagation. (2)

1.4 POSITIVE MARKING FROM 1.2

$$f_L = \frac{v \pm v_L}{v \pm v_S} f_S \checkmark$$

$$1000 \checkmark = \frac{340}{340 - v_S} \checkmark (800) \checkmark$$

$$v_S = 68 \text{ m} \cdot \text{s}^{-1} \checkmark$$

(5)

- 1.5 Decreases $\checkmark$. $f \propto \frac{1}{\lambda} \checkmark$, if velocity stays constant $\checkmark$ ($v = f\lambda$) (3)
[14]

QUESTION 2: 25 minutes

(Taken from NSC Feb/Mar 2016 Paper2)

2.1 ONLY ANY TWO OF:

- Increase temperature. $\checkmark$
- Increase concentration of acid $\checkmark$
- Add a catalyst

(2)

2.2 ONLY ANY ONE OF:

- Change in concentration of products/reactants $\checkmark$ per (unit) time. $\checkmark$
- Rate of change in concentration. $\checkmark \checkmark$
- Change in amount/number of moles/volume/mass of products or reactants per (unit) time.
- Amount/number of moles/volume/mass of products formed or reactants used per (unit) time.

(2)

2.3 2.3.1

$$\begin{aligned}
 \text{average rate / gemiddelde tempo} &= -\frac{\Delta c}{\Delta t} \\
 &= -\frac{(1,45 - 1,90) \checkmark}{(15 - 0) \checkmark} \\
 &= 0,03 \text{ (mol} \cdot \text{dm}^{-3}) \cdot \text{min}^{-1} \checkmark
 \end{aligned}$$

Notes/Aantekeninge**Accept /Aanvaar:**

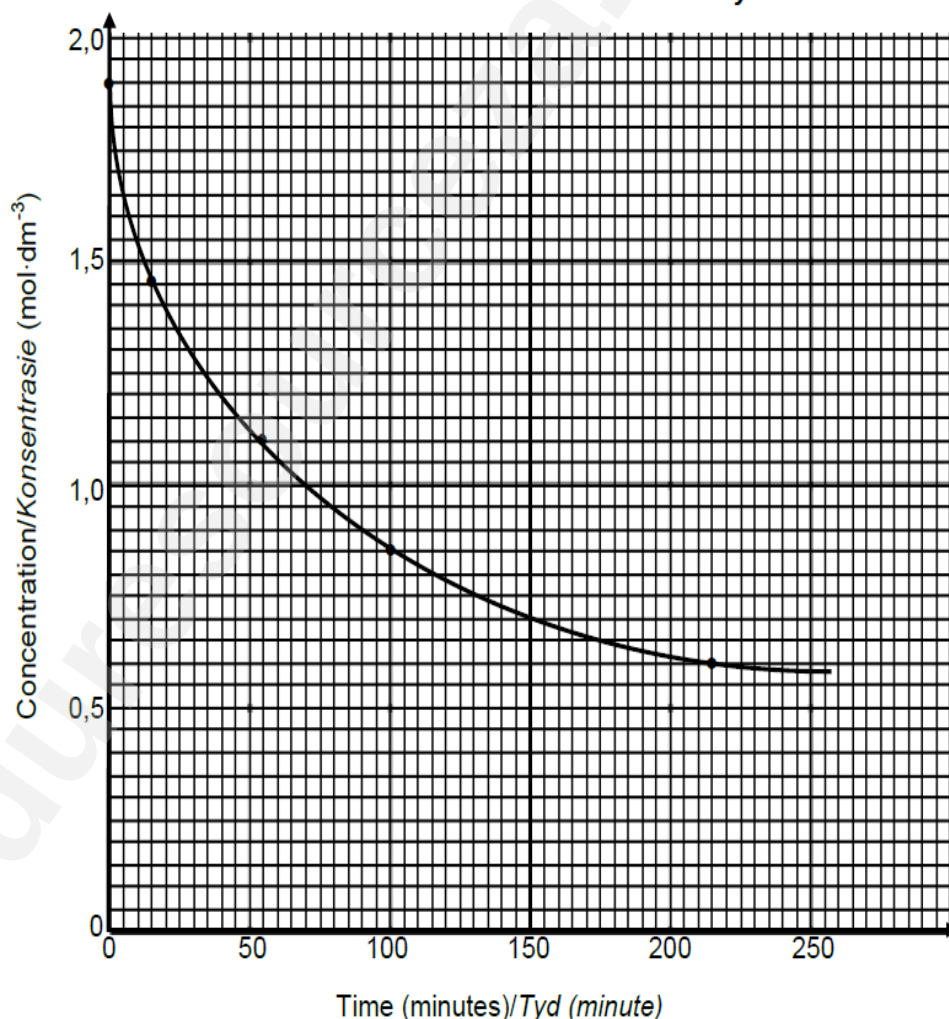
- If unit omitted/Indien eenheid weggelaat is.

$$\begin{aligned}
 \text{Rate/Tempo} &= \frac{\Delta c}{\Delta t} \\
 &= \frac{1,45 - 1,90}{15 - 0} \\
 &= -0,03 \text{ (mol} \cdot \text{dm}^{-3}) \cdot \text{min}^{-1}
 \end{aligned}$$

(3)

2.3.2

Graph of concentration versus time
Grafiek van konsentrasie teenoor tyd

**Marking criteria/Nasiennriglyne**

Four points correctly plotted./Vier punte korrek gestip.

✓✓

Curve drawn as shown./Kurve getrek soos getoon.

✓

(3)

2.3.3 POSITIVE MARKING FROM QUESTION 2.3.2

$$1,2 \text{ mol} \cdot \text{dm}^{-3} \checkmark$$

Accept range: 1,15 to 1,25 $\text{mol} \cdot \text{dm}^{-3}$

(1)

2.3.4 • Concentration of reactants decreases. ✓

• Less particles per unit volume. ✓

• Less effective collisions per unit time. ✓

(3)

2.3.5

Marking criteria/Nasienriglyne

• Use $n = cV$ to calculate $\Delta n/n(\text{initial})$ & $n(\text{final})$.
 Gebruik $n = cV$ om $\Delta n/n(\text{aanvanklik})$ & $n(\text{finaal})$ te bereken.

• $\Delta n(\text{HCl}) = n(\text{final/finaal}) - n(\text{initial/aanvanklik})$.
 OR/OF
 $\Delta c(\text{HCl}) = c(\text{final/finaal}) - c(\text{initial/aanvanklik})$

• Use ratio/Gebruik verhouding $n(\text{CH}_3\text{Cl}) : n(\text{HCl}) = 1 : 1$

• Substitute/Vervang $50,5 \text{ g} \cdot \text{mol}^{-1}$ in $n = \frac{m}{M}$.

• Final answer/Finale antwoord: 3,54–4,0 g.

OPTION 1/OPSIE 1

Mol initially/begin:

$$\begin{aligned} n(\text{HCl}) &= cV \checkmark \\ &= (1,9)(60 \times 10^{-3}) \checkmark \\ &= 0,11 \text{ mol } (0,114) \end{aligned}$$

Mol final/finaal:

$$\begin{aligned} n(\text{HCl}) &= cV \\ &= (0,6)(60 \times 10^{-3}) \\ &= 0,04 \text{ mol } (0,036) \end{aligned}$$

$$\begin{aligned} \Delta n(\text{HCl}) &= 0,04 - 0,11 \checkmark \\ &= -0,07 \text{ mol } (0,078 \text{ mol}) \end{aligned}$$

$$\Delta n(\text{HCl}) = 0,07 \text{ mol } (0,078)$$

$$\begin{aligned} n(\text{formed/gevorm}) &= n(\text{reacted/reageer}) \\ n(\text{CH}_3\text{Cl}) &= n(\text{HCl}) \checkmark \\ &= 0,07 \text{ mol} \end{aligned}$$

$$\begin{aligned} m(\text{CH}_3\text{Cl}) &= nM \\ &= (0,07)(50,5) \checkmark \\ &= 3,54 \text{ g } \checkmark \end{aligned}$$

Accept range/Aanvaar gebied:
 3,54 – 4,0 g

OPTION 2/OPSIE 2

$$\begin{aligned} \Delta c(\text{HCl}) &= 0,6 - 1,9 \checkmark \\ &= -1,3 \\ &= 1,3 \text{ mol} \cdot \text{dm}^{-3} \end{aligned}$$

$$\begin{aligned} \Delta n(\text{HCl}) &= \Delta cV \\ &= (1,3)(60 \times 10^{-3}) \checkmark \\ &= 0,08 \text{ mol } (0,078) \end{aligned}$$

$$\begin{aligned} n(\text{formed/gevorm}) &= n(\text{reacted/reageer}) \\ n(\text{CH}_3\text{Cl}) &= n(\text{HCl}) \checkmark \\ &= 0,08 \text{ mol} \end{aligned}$$

$$\begin{aligned} m(\text{CH}_3\text{Cl}) &= nM \\ &= (0,08)(50,5) \checkmark \\ &= 4 \text{ g } \checkmark \end{aligned}$$

Accept range/Aanvaar gebied:
 3,54 – 4,0 g

(5)

[19]

SECTION B: TYPICAL EXAM SOLUTIONS

QUESTION 1: 10 minutes

(Taken from WC SEPT 2014 Paper 1)

- 1.1 1.1.1 Doppler flow meter ✓ (1)
- 1.1.2 Transmitter sends sound which is reflected off a red blood cell ✓
Reflected sound has different frequency so velocity of blood cells can be measured ✓ (2)
- 1.2 1.2.1 Doppler effect ✓ (1)
- 1.2.2 $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓
✓
 $0,9 f_L = \frac{(340 - 0)}{(340 + v)} f_s$ ✓
 $v = 37,78 \text{ m} \cdot \text{s}^{-1}$ ✓ (4)
- [8]**

QUESTION 2: 10 minutes

(Taken from WCP SEPT 2014 Paper 2)

- 2.1 The change in concentration of reactants or products per unit time. ✓ (1)
- 2.2 2.2.1 Concentration ✓ (1)
2.2.2 reaction rate ✓ (1)
- 2.3 2.3.1 5. Repeat the experiment but add 2 ml of HCl and 3ml of distilled water
6. Repeat the experiment but add 1 ml of HCl and 4ml of distilled water
✓ HCl volume is changed
✓ the conc of HCl is changed (water added to keep volume the same)
✓ the steps indicate a decrease in conc of HCl. (3)
- 2.3.2 Volume of sodium thiosulphate needs to be kept constant / temp constant /
Judgement of when cross disappears needs to be constant (same learner) /
Swirling needs to be the same / stopwatch needs to be started at same time
In process (*any one of the above is correct*) ✓ (1)

2.4 Sulfur / S ✓ (1)

2.5 Experiment 1 ✓ (1)

[9]

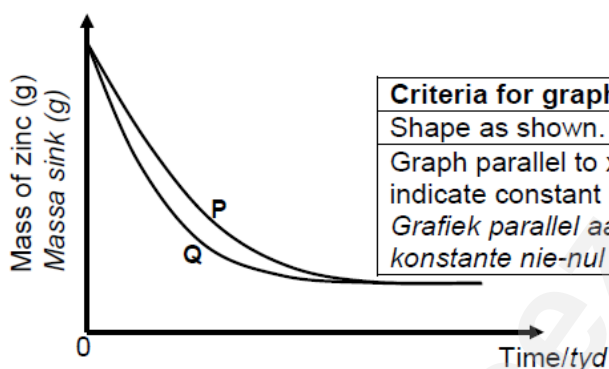
QUESTION 3: 20 minutes

(Taken from NSC Exemplar 2014 Paper 2)

3.1 Hydrochloric acid / HCl ✓ (1)

3.2 Hydrogen gas escapes from the flask. ✓ (1)

3.3



Criteria for graph P: / Riglyne vir grafiek P:	
Shape as shown. / Vorm soos aangetoon.	✓
Graph parallel to x-axis after a certain time to indicate constant non-zero mass of zinc. Grafiek parallel aan x-as na 'n sekere tyd om konstante nie-nul massa van sink aan te dui.	✓

(2)

3.4

Criteria for graph Q / Riglyne vir grafiek Q:	
Steeper gradient than Graph P. / Steiler gradiënt as Grafiek P.	✓
Joins parallel section of Graph P after a shorter time. Verbind met die parallelle deel van Grafiek P na 'n korter tyd.	

(1)

3.5 At a higher temperature:

- More molecules have sufficient kinetic energy / kinetic energy equal to or greater than the activation energy. ✓
- More effective collisions per unit time / second. ✓

(2)

3.6

$$c(\text{HCl}) = \frac{n}{V} \checkmark$$

$$\therefore 0,2 = \frac{n}{0,1} \checkmark$$

$$\therefore n(\text{HCl}) = 0,02 \text{ mol}$$

$$n(\text{Zn}) = \frac{1}{2}n(\text{HCl}) = 0,01 \text{ mol} \checkmark$$

$$\begin{aligned} m(\text{Zn reacted / gereageer}) &= nM \checkmark \\ &= (0,01)(65) \checkmark \\ &= 0,65 \text{ g} \end{aligned}$$

Mass of Zn initially in flask / Massa Zn aanvanklik in fles:

$$0,65 + 0,12 = 0,77 \text{ g} \checkmark$$

(6)
[13]

SESSION NO: 14

TOPIC: CONSOLIDATION OF CHEMICAL EQUILIBRIUM AND ACIDS AND BASES

SECTION A: HOMEWORK SOLUTIONS

QUESTION 1: 20 minutes

(Taken from NSC Feb/Mar 2014 Paper 2)

- 1.1 CO₂ gas is a greenhouse gas ✓
and will contribute to global warming. ✓ (2)
- 1.2 (The stage in a chemical reaction when the) rate of forward reaction equals the rate of reverse reaction. ✓✓ (2 marks or zero)
OR
(The stage in a chemical reaction when) the concentration of reactants and products remain constant. ✓✓ (2)

1.3

CALCULATIONS USING NUMBER OF MOLES
BEREKENINGE WAT GETAL MOL GEBRUIK

Mark allocation/Punttoekenning:

- **USING** ratio/**GEBRUIK** verhouding: $\text{CH}_4 : \text{H}_2\text{O} : \text{CO}_2 : \text{H}_2 = 1 : 2 : 1 : 4$ ✓
- Equilibrium/Ewewig: $n(\text{CH}_4) = \text{initial/aanvanklik} - \text{change/verandering}$ ✓
- Equilibrium/Ewewig: $n(\text{H}_2\text{O}) = \text{initial/aanvanklik} - \text{change/verandering}$ ✓
- Equilibrium/Ewewig: $n(\text{H}_2) = \text{initial/aanvanklik} + \text{change/verandering}$ ✓
- Divide ALL equilibrium moles 5 dm^3 ✓
Deel ALLE ewewigsmolle deur 5 dm^3
- Correct K_c expression (formulae in square brackets) ✓
Korrekte K_c uitdrukking (formules in vierkanthakies)
- Substitution of concentrations into K_c expression ✓
Vervanging van konsentrasies in K_c -uitdrukking
- Final answer/Finale antwoord: 0,25 ✓

OPTION 1/OPSIE 1

	CH_4	H_2O	CO_2	H_2	
Initial quantity (mol) <i>Aanvangshoeveelheid (mol)</i>	1	2	0	0	
Change (mol) <i>Verandering (mol)</i>	0,3	0,6	0,3	1,2	
Quantity at equilibrium (mol)/ <i>Hoeveelheid by ewewig (mol)</i>	0,7	1,4 ✓	0,3	1,2 ✓	ratio · verho
Equilibrium concentration ($\text{mol} \cdot \text{dm}^{-3}$) <i>Ewewigskonsentrasie ($\text{mol} \cdot \text{dm}^{-3}$)</i>	0,14	0,28	0,06	0,24	

$$K_c = \frac{[\text{CO}_2][\text{H}_2]^4}{[\text{CH}_4][\text{H}_2\text{O}]^2} \checkmark$$

$$= \frac{(0,06)(0,24)^4}{(0,14)(0,28)^2} \checkmark$$

$$= 0,02 \text{ (0,018)} \checkmark$$

Divide by /gedeel deur 5 ✓

No K_c expression, correct substitution / *Geen K_c uitdrukking, korrekte substitusie: Max. / Maks. $\frac{6}{7}$*

Wrong K_c expression / *Verkeerde K_c -uitdrukking: Max. / Maks. $\frac{4}{7}$*

OPTION 2/OPSIE 2**CALCULATIONS USING CONCENTRATIONS**
BEREKENINGE WAT KONSENTRASIES GEBRUIK**Mark allocation/Puntetoekenning**

- Initial concentrations: $[\text{CH}_4] = 0,2 \text{ mol}\cdot\text{dm}^{-3}$ & $[\text{H}_2\text{O}] = 0,4 \text{ mol}\cdot\text{dm}^{-3}$ } ✓
- Equilibrium concentration $[\text{CO}_2] = 0,06 \text{ mol}\cdot\text{dm}^{-3}$ } ✓
- USING ratio/GEBRUIK verhouding:** $\text{CH}_4 : \text{H}_2\text{O} : \text{CO}_2 : \text{H}_2 = 1 : 2 : 1 : 4$ ✓
- Equilibrium/Ewewig: $c(\text{CH}_4) = \text{initial/aanvanklik} - \text{change/verandering}$ } ✓
- Equilibrium/Ewewig: $c(\text{H}_2\text{O}) = \text{initial/aanvanklik} - \text{change/verandering}$ } ✓
- Equilibrium/Ewewig: $c(\text{H}_2) = \text{initial/aanvanklik} - \text{change/verandering}$ ✓
- Correct K_c expression (formulae in square brackets) ✓
Korrekte K_c uitdrukking (formules in vierkanthakies)
- Substitution of concentrations into K_c expression ✓
Vervanging van konsentrasies in K_c -uitdrukking
- Final answer/Finale antwoord: 0,25 ✓

	CH_4	H_2O	CO_2	H_2	
Initial concentration ($\text{mol}\cdot\text{dm}^{-3}$) <i>Aanvangskonsentrasie ($\text{mol}\cdot\text{dm}^{-3}$)</i>	0,2	0,4	0	0	
Change ($\text{mol}\cdot\text{dm}^{-3}$) <i>Verandering ($\text{mol}\cdot\text{dm}^{-3}$)</i>	0,06	0,12	0,06	0,24	ratio ✓ verhouding
Equilibrium concentration ($\text{mol}\cdot\text{dm}^{-3}$) <i>Ewewigskonsentrasie ($\text{mol}\cdot\text{dm}^{-3}$)</i>	0,14	0,28 ✓	0,06	0,24 ✓	

$$K_c = \frac{[\text{CO}_2][\text{H}_2]^4}{[\text{CH}_4][\text{H}_2\text{O}]^2}$$

Divide by 5 / Gedeel deur 5 ✓

$$= \frac{(0,06)(0,24)^4}{(0,14)(0,28)^2} \checkmark$$

$$= 0,02 \text{ (0,018)} \checkmark$$

No K_c expression, correct substitution / Geen K_c uitdrukking, korrekte substitusie: Max. / Maks. $\frac{6}{7}$ Wrong K_c expression / Verkeerde K_c -uitdrukking: Max. / Maks. $\frac{4}{7}$

(7)

1.4 Exothermic ✓

 K_c decreased, thus less products and more reactants. ✓

Therefore reverse reaction is favoured. ✓

An increase in temperature favours the endothermic reaction and thus the forward reaction is endothermic. ✓

(4)

[15]

SECTION B: TYPICAL EXAM SOLUTIONS

QUESTION 1: 20 minutes

(Taken from NSC Feb/Mar 2015 Paper 2)

1.1 A reaction is reversible when products can be converted back to reactants. ✓ (1)

1.2 No change ✓ (1)

1.3 1.3.1 Temperature decreases ✓ (1)

1.3.2 Decrease in temperature decreases the rate of both forward and reverse reactions. ✓

Decrease in temperature favours the exothermic reaction. ✓

The rate of the reverse (exothermic) reaction is faster or the reverse reaction is favoured. / The rate of the forward (endothermic) reaction is slower. ✓ (3)

1.4

Mark criteria/Nasienriglyne:

- Correct K_c expression (formulae in square brackets). ✓
Korrekte K_c uitdrukking (formules in vierkanthakies).
- Divide equilibrium moles by 2 dm^3 . ✓
Deel aantal mol by ewewig deur 2 dm^3 .
- At equilibrium: $[\text{H}_2] = [\text{I}_2] = x$ / By ewewig: $[\text{H}_2] = [\text{I}_2]$ ✓
- Substitution of concentrations into K_c expression. ✓
Vervanging van konsentrasies in K_c -uitdrukking.
- Substitution of K_c value. ✓
Vervanging van K_c -waarde.
- Final answer/Finale antwoord: $2,83 \times 10^{-3} \text{ mol} \cdot \text{dm}^{-3}$ ✓

OPTION 1/OPSIE 1At equilibrium/by ewewig: $[H_2] = [I_2]$ ✓

$$K_c = \frac{[H_2][I_2]}{[HI]^2} \checkmark$$

$$\therefore 0,02 \checkmark = \frac{(x)(x)}{\left(\frac{0,04}{2}\right)^2} \checkmark \quad \begin{array}{l} \text{Divide by } 2 \text{ dm}^3 \checkmark \\ \text{Deel deur } 2 \text{ dm}^3 \end{array}$$

$$\therefore x = [H_2] = 2,83 \times 10^{-3} \text{ mol} \cdot \text{dm}^{-3} \checkmark \quad (0,0028 \text{ mol} \cdot \text{dm}^{-3})$$

No K_c expression, correct substitution: Geen K_c -uitdrukking, korrekte substitusie:	Max./Maks. $\frac{5}{6}$
Wrong K_c expression/Verkeerde K_c -uitdrukking:	Max./Maks. $\frac{2}{6}$

(6)

OPTION 2/OPSIE 2

	HI	H ₂	I ₂	
Initial quantity (mol) Aanvangshoeveelheid (mol)	x	0	0	
Change (mol) Verandering (mol)	x - 0,04	$\frac{x - 0,04}{2}$	$\frac{x - 0,04}{2}$	ratio ✓ verhouding
Quantity at equilibrium (mol)/ Hoeveelheid by ewewig (mol)	0,04	$\frac{x - 0,04}{2}$	$\frac{x - 0,04}{2}$	
Equilibrium concentration (mol·dm ⁻³) Ewewigskonsentrasie (mol·dm ⁻³)	0,02	$\frac{x - 0,04}{4}$	$\frac{x - 0,04}{4}$	Divide by 2 dm ³ ✓ Deel deur 2 dm ³

$$K_c = \frac{[H_2][I_2]}{[HI]^2} \checkmark$$

$$\therefore 0,02 \checkmark = \frac{\left(\frac{x - 0,04}{4}\right)\left(\frac{x - 0,04}{4}\right)}{(0,02)^2} \checkmark$$

$$\therefore x = 0,05$$

$$[H_2] = \frac{x - 0,04}{2}$$

$$= \frac{0,05 - 0,04}{2}$$

$$= 2,83 \times 10^{-3} \text{ mol} \cdot \text{dm}^{-3} \checkmark$$

No K_c expression, correct substitution/Geen K_c -uitdrukking, korrekte substitusie: Max./Maks. $\frac{5}{6}$

Wrong K_c expression/Verkeerde K_c -uitdrukking: Max./Maks. $\frac{2}{6}$

(6)

1.5 $K_c = \frac{1}{0,02}$
 $= 50 \checkmark$ (1)

1.6 Increases $\checkmark$ (1)
[14]

QUESTION 2: 30 minutes (Taken from Gauteng Sept 2014 Paper 2)

2.1 It is a weak acid $\checkmark$ (1)

2.2 An acid that forms a large number of moles per volume of water $\checkmark\checkmark$ (2)

2.3 $H_2PO_4^- + H_2O \checkmark \rightleftharpoons H_3PO_4 + OH^- \checkmark$ (2)

2.4 $H_2O/OH^- \checkmark$ or $H_2PO_4^- / H_3PO_4 \checkmark$ (2)

2.5 2.5.1 $m = cMV \checkmark = 58 \checkmark \times 0,2 \checkmark \times 0,5 \checkmark = 5,8g \checkmark$ (5)

2.5.2 $0,1 \times 2 = 0,2 \text{ mol} \cdot \text{dm}^{-3} \checkmark$ (1)

2.5.3 Not safe $\checkmark$
 $[OH^-] = 0,2 \text{ mol} \cdot \text{dm}^{-3} \checkmark$
 $pOH = -\log[OH^-] = -\log(0,2) \checkmark = 0,7 \checkmark$
 $pH + pOH = 14$
 $pH = 14 - 0,7 = 13,3 \checkmark$ (5)

OR

$[H^+][OH^-] = 10^{-14} \checkmark$
 $[H^+](0,2) = 10^{-14} \checkmark$
 $[H^+] = 5 \times 10^{-14} \text{ mol} \cdot \text{dm}^{-3} \checkmark$
 $pH = -\log[H^+] = -\log(5 \times 10^{-14}) = 13,3 \checkmark$

2.6 $\frac{n_a}{n_b} = \frac{c_a V_a}{c_b V_b} \checkmark$
 $2/1 \checkmark = \frac{(0,1)V}{(0,2)25} \checkmark$

$V = 100 \text{ cm}^3 \checkmark$

(4)
[22]