basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE EXAMINATIONS/ NATIONAL SENIOR CERTIFICATE EXAMINATIONS
SENIORSERTIFIKAAT-EKSAMEN/ NASIONALE SENIORSERTIFIKAAT-EKSAMEN

PHYSICAL SCIENCES: CHEMISTRY (P2)
FISIESE WETENSKAPPE: CHEMIE (V2)

MAY/JUNE/*MEI/JUNIE* 2024

MARKING GUIDELINES/*NASIENRIGLYNE*

MARKS/*PUNTE*: 150

These marking guidelines consist of 20 pages./
Hierdie nasienriglyne bestaan uit 20 bladsye.

Approved
DBE Moderator

Approved
DBE Moderator

Approved
Ext. Mod

Approved!
Ext. moderator

QUESTION 1/*VRAAG 1*

1.1 A ✓✓ (2)

1.2 C ✓✓ (2)

1.3 A ✓✓ (2)

1.4 D ✓✓ (2)

1.5 D ✓✓ (2)

1.6 C ✓✓ (2)

1.7 B ✓✓ (2)

1.8 A ✓✓ (2)

1.9 B ✓✓ (2)

1.10 B ✓✓ (2)
[20]

QUESTION 2/*VRAAG 2*

2.1 Organic compounds that consist of hydrogen and carbon only. ✓✓ **(2 or 0)**
Organiese verbindings wat slegs uit waterstof en koolstof bestaan. **(2 *of* 0)** (2)

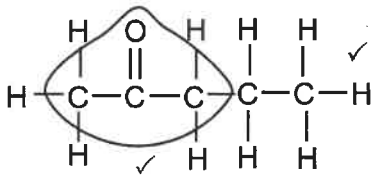
2.2.1 C and/*en* E ✓ (1)

2.2.2 D and/*en* H ✓✓ **(2 or/*of* 0)** (2)

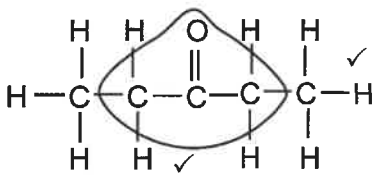
2.2.3 A ✓ (1)

2.3
2.3.1

Marking criteria/*Nasienkriteria:*	**IF/*INDIEN:***
• Functional group. ✓ *Funksionele groep.* • Whole structure correct. ✓ *Hele struktuur korrek.*	• More than one functional group/wrong functional group: *Meer as een funksionele groep/foutiewe funksionele groep:* 0/2 • If condensed structural formulae used/*Indien gekondenseerde struktuurformules gebruik:* Max/*Maks.* 1/2



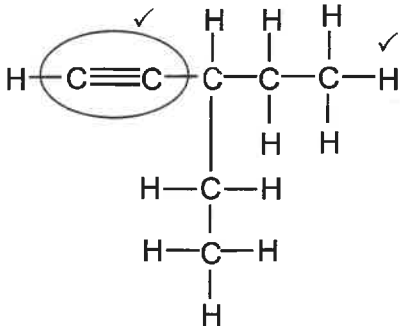
OR/OF



(2)

2.3.2 C_nH_{2n+2} ✓ (1)

2.3.3



Marking criteria/*Nasienkriteria:*
- Functional group -C≡C-. ✓
  Funksionele groep -C≡C-.
- Whole structure correct. ✓
  Hele struktuur korrek.

IF/*INDIEN*
- More than one functional group/wrong functional group:
  Meer as een funksionele groep/foutiewe funksionele groep: $^0/_2$
- If condensed structural formulae used/*Indien gekondenseerde struktuurformules gebruik:*
  Max/*Maks.* $^1/_2$

(2)

2.4.1 3-ethylhex-3-ene ✓✓✓/3-ethyl-3-hexene/*3-etielheks-3-een/3-etiel-3-hekseen*

Marking criteria:
- Correct stem i.e. hexene. ✓
- Substituent (ethyl) correctly identified. ✓
- IUPAC name completely correct including numbering, sequence, hyphens and commas. ✓

Nasienkriteria:
- *Korrekte stam d.i. hekseen.* ✓
- *Substituent (etiel) korrek geïdentifiseer.* ✓
- *IUPAC-naam heeltemal korrek insluitende nommering, volgorde, koppeltekens en kommas.* ✓

(3)

2.4.2 2,5-dichloro-2,4-dimethylhexane ✓✓✓/ *2,5-dichloro-2,4-dimetielheksaan*

Marking criteria:
- Correct stem i.e. hexane. ✓
- All substituents (dichloro and dimethyl) correctly identified. ✓
- IUPAC name completely correct including numbering, sequence, hyphens and commas. ✓

Nasienkriteria:
- *Korrekte stam d.i. heksaan.* ✓
- *Alle substituente (dichloro en dimetiel) korrek geïdentifiseer.* ✓
- *IUPAC-naam heeltemal korrek insluitende nommering, volgorde, koppeltekens en kommas.* ✓

(3)

2.4.3 2,2-dimethyl✓propanal✓/dimethylpropanal

2,2-dimetielpropanaal/dimetielpropanaal (2)

NOTE/*NOTA*:

2,2-dimethyl✓propan-1-al (Max/*Maks*: $^1/_2$)

2.5

Marking criteria/*Nasienkriteria:*
- Correct molecular formula: C_7H_{16} ✓
  Korrekte molekulêre formula: C_7H_{16}
- Correct molecular formula of inorganic reactant and products. ✓
  Korrekte molekulêre formule vir die anorganiese reaktans en produkte.
- Balancing/*Balansering* ✓

C_7H_{16} ✓+ $11O_2 \rightarrow 7CO_2 + 8H_2O$ ✓ Bal ✓

Notes/*Aantekeninge:*
- Ignore double arrows and phases./*Ignoreer dubbelpyle en fases.*
- Marking rule 6.3.10/*Nasienreël 6.3.10.*
- If condensed structural formulae used:/*Indien gekondenseerde struktuurformules gebruik:* Max/*Maks.* $\frac{2}{3}$
- **ACCEPT**: multiple coefficients for this exam.
  ***AANVAAR**: veelvoude van koëffisiënte vir hierdie eksamen.*

(3)
[22]

QUESTION 3/*VRAAG 3*

3.1

Marking criteria/*Nasienkriteria*
If any one of the underlined key phrases in the **correct context** is omitted, deduct 1 mark./*Indien enige van die onderstreepte frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.*
The underlined phrases must be in the correct context. / *Die onderstreepte frases moet in die korrekte konteks wees.*

The temperature at which the vapour pressure (of a substance) equals atmospheric pressure. ✓✓
Die temperatuur waarby die dampdruk (van die stof) gelyk is aan atmosferiese druk.

(2)

3.2 C ✓ (1)

3.3

Marking criteria:
- Compare structures. ✓
- Compare the strength of intermolecular forces. ✓
- Compare the energy required to overcome intermolecular forces. ✓

Nasienkriteria:
- *Vergelyk strukture.* ✓
- *Vergelyk die sterkte van intermolekulêre kragte.* ✓
- *Vergelyk die energie benodig om intermolekulêre kragte te oorkom.* ✓

Accept: IMF for this exam/***Aanvaar**: IMK vir hierdie eksamen*

A/$CH_3CH_2CH_2CH_2C\ell$ /1-chlorobutane
- **Structure:**
  Longer chain length/larger surface area (over which intermolecular forces act). ✓
- **Intermolecular forces:**
  Stronger/more intermolecular forces/Van der Waals forces/London forces/dipole-dipole forces. ✓
- **Energy:**
  More energy needed to overcome or break intermolecular forces/Van der Waals forces/dipole-dipole forces. ✓

OR

B/$CH_3CH(CH_3)CH_2C\ell$/1-chloro-2-methylpropane
- **Structure:**
  Shorter chain length / branched / compact / more spherical / smaller surface area (over which intermolecular forces act). ✓
- **Intermolecular forces:**
  Weaker/less intermolecular forces/Van der Waals forces/*London forces/* dipole-dipole forces. ✓
- **Energy:**
  Less energy needed to overcome or break intermolecular forces/Van der Waals forces/dipole-dipole forces. ✓

A/$CH_3CH_2CH_2CH_2C\ell$ /1-chlorobutaan
- ***Struktuur*:**
  Langer kettinglengte/groter oppervlak (waaroor intermolekulêre kragte werk). ✓
- ***Intermolekulêre kragte*:**
  Sterker/meer intermolekulêre kragte/Van der Waalskragte/Londonkragte/ dipool-dipoolkragte. ✓
- *Meer energie benodig om intermolekulêre kragte/Van der Waalskragte/ Londonkragte/dipool-dipoolkragte te oorkom/breek.* ✓

OF

B/$CH_3CH(CH_3)CH_2C\ell$/1-chloro-2-metielpropaan
- ***Struktuur*:**
  Korter kettinglengte / vertak / kompak / meer sferies / kleiner oppervlak (waaroor intermolekulêre kragte werk). ✓
- ***Intermolekulêre kragte*:**
  Swakker/minder intermolekulêre kragte/Van der Waalskragte/ Londonkragte/dipool-dipoolkragte. ✓
- ***Energie*:**
  Minder energie benodig om intermolekulêre kragte/Van der Waalskragte/ Londonkragte/dipool-dipoolkragte te oorkom/breek. ✓ (3)

3.4.1 75 (°C) ✓ (1)

3.4.2

Marking criteria:
- Compare the strength of intermolecular forces. ✓
- Compare the energy required to overcome intermolecular forces. ✓

Nasienkriteria:
- *Vergelyk die sterkte van intermolekulêre kragte.* ✓
- *Vergelyk die energie benodig om intermolekulêre kragte te oorkom.* ✓

- **Intermolecular forces:**
  C ($CH_3CH_2CH_2CH_2OH$/butanol) has stronger intermolecular forces than D ($CH_3CH_2CH_2CHO$/butanal). ✓
- **Energy:**
  More energy needed to overcome or break intermolecular forces. ✓
  Accept: Boiling point of C will be more (in relation to C and D/118°C vs 75°C).

OR

- **Intermolecular forces:**
  D ($CH_3CH_2CH_2CHO$/butanal) has weaker intermolecular forces than C ($CH_3CH_2CH_2CH_2OH$/butanol)
- **Energy:**
  Less energy is needed to overcome or break intermolecular forces.
  Accept: Boiling point of D will be less (in relation to C and D/118°C vs 75°C).

OR

- **Intermolecular forces:**
  A ($CH_3CH_2CH_2CH_2C\ell$) is a more polar molecule than D ($CH_3CH_2CH_2CHO$) increasing the intermolecular forces
- **Energy:**
  More energy is needed to overcome or break intermolecular forces.
  Accept: Boiling point of D will be less (in relation to A and D).

OR

- **Intermolecular forces:**
  Electron density of A ($CH_3CH_2CH_2CH_2C\ell$) is greater than D ($CH_3CH_2CH_2CHO$) increasing the intermolecular forces
- **Energy:**
  More energy is needed to overcome or break intermolecular forces.
  Accept: Boiling point of D will be less (in relation to A and D).

- ***Intermolekulêre kragte:***
  C ($CH_3CH_2CH_2CH_2OH$/butanol) het sterker intermolekulêre kragte as D ($CH_3CH_2CH_2CHO$/butanaal). ✓
- *Meer energie benodig om intermolekulêre kragte te oorkom/breek.* ✓
  Aanvaar: Kookpunt van D sal minder wees (met betrekking tot C en D)

OF

- ***Intermolekulêre kragte:***
  D ($CH_3CH_2CH_2CHO$/butanaal) het swakker intermolekulêre kragte as C ($CH_3CH_2CH_2CH_2OH$/butanol).
- *Minder energie benodig om intermolekulêre kragte/te oorkom/breek.*
  Aanvaar: Kookpunt van C sal meer wees (met betrekking tot C en D)

OF

- ***Intermolekulêre kragte:***
  A ($CH_3CH_2CH_2CH_2Cl$) is 'n meer polêre molekule as D wat sterker intermolekulêre kragte tot gevolg het.
- *Meer energie benodig om intermolekulêre kragte te oorkom/breek.*
  Aanvaar: Kookpunt van D sal minder wees (met betrekking tot A en D)

OF

- ***Intermolekulêre kragte:***
  Elektrondigtheid van A ($CH_3CH_2CH_2CH_2Cl$) is groter wat sterker intermolekulêre kragte tot gevolg het.
- *Meer energie benodig om intermolekulêre kragte te oorkom/breek.*
- *Aanvaar: Kookpunt van D sal minder wees (met betrekking tot A en D)* (2)

3.5 Decreases/*Neem af* ✓ (1)
[10]

QUESTION 4/*VRAAG 4*

4.1

4.1.1 (Concentrated) sulphuric acid/$H_2SO_4(aq)$ ✓
(Gekonsentreerde) swawelsuur (1)

4.1.2 Esterification / Condensation ✓/ *Verestering / Esterifikasie / Kondensasie* (1)

4.1.3 **ANY TWO/*ENIGE TWEE*:**

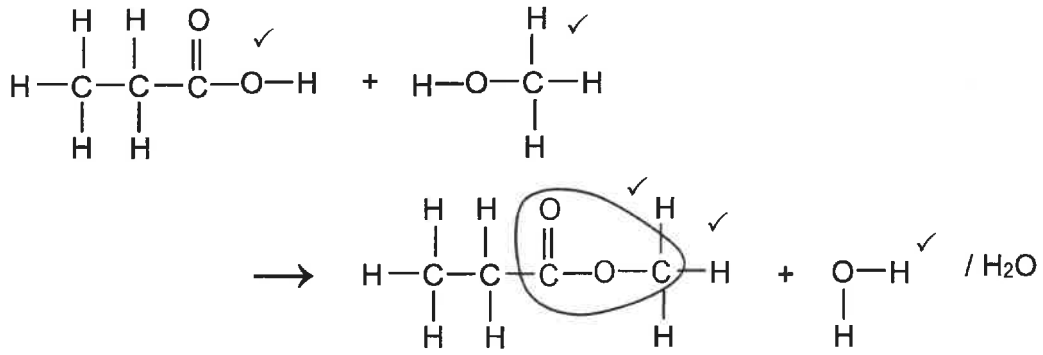
- Alcohol/methanol/reactant is flammable/catches fire easily. ✓
  Alkohol/metanol/reaktans is vlambaar/slaan maklik aan die brand.
- To heat evenly/A steady/controlled/gradual increase in temperature. ✓
  Om eweredig/gekontroleerd/gelydelik te verhit/'n Eweredige toename in temperatuur.
- Alcohol/methanol will evaporate too quickly/is volatile.
  Alkohol/metanol sal te vinnig verdamp/is vlugtig. (2)

4.1.4

Marking criteria:
- Whole structural formula correct for propanoic acid. ✓
- Whole structural formula correct for methanol. ✓
- Functional group of ester correct. ✓
- Whole structural formula of ester correct. ✓
- H_2O ✓

Nasienkriteria:
- *Hele struktuurformule vir propanoësuur korrek.* ✓
- *Hele struktuurformule vir metanol korrek.* ✓
- *Funksionele groep van ester korrek.* ✓
- *Hele struktuurformule van ester korrek.* ✓
- *H_2O* ✓

IF/*INDIEN*
- Any error e.g. omission of all H atoms, condensed or semi structural formula/*Enige fout bv. weglating van alle H-atome, gekondenseerde of semi-struktuurformule:* Max/*Maks.* $^2/_5$ (Functional group,H_2O/*Funksionele groep,H_2O*)
- Any additional reactants or products /*Enige addisionele reaktanse of produkte:* Subtract 1 mark./*Trek 1 punt af.*
- Molecular formulae used:/*Molekulêre formule gebruik:* Max/*Maks.* $^1/_5$ (water)
- No arrows: The first two structures given are considered as reactants and can be marked/*Geen pyltjie: die eerste twee strukture geskryf, word beskou as reaktanse en kan gemerk word.*



(5)

4.1.5 Methyl ✓propanoate ✓/*Metielpropanoaat* (2)

4.2.1 Hydrogen/H_2 ✓/*Waterstof(gas)* (1)

4.2.2 3,3-dimethyl✓but-1-ene✓/3,3-dimethyl-1-butene
3,3-dimetiel but-1-een/3,3-dimetiel-1-buteen (2)

4.2.3 elimination **OR** dehydrohalogenation ✓ *eliminasie **OF** dehidrohalogenering* (1)

4.2.4 H_2SO_4/H_3PO_4 **OR/*OF*** Sulphuric acid/Phosphoric acid ✓
Swawelsuur/Fosforsuur (1)

4.2.5 3,3-dimethyl✓butan-2-ol✓/3,3-dimethyl-2-butanol
3,3-dimetiel butan-2-ol/3,3-dimetiel-2-butanol (2)

4.2.6 Addition/hydration ✓ *Addisie/hidrasie* (1)

4.2.7 Secondary ✓/*Sekondêr* (1)

[20]

QUESTION 5/*VRAAG 5*

5.1.1 Exothermic/*Eksotermies* ✓

Lower (potential) energy of the products than reactants. /$\Delta H < 0$/ΔH negative / $\Delta H = -121,7$ kJ/More energy is released than absorbed. ✓
Laer (potensiële) energie van produkte as die reaktanse./$\Delta H < 0$/ΔH negatief / $\Delta H = -121,7$ kJ/Meer energie word afgegee as wat opgeneem is. (2)

5.1.2 (The number of) particles with sufficient/enough (kinetic) energy (with a catalyst) OR $E_K \geq E_A$ (which can undergo effective collisions.) ✓
(Die hoeveelheid) deeltjies met genoeg/voldoende (kinetiese) energie (met 'n katalisator) OF $E_K \geq E_A$ (om effektiewe botsings te ondergaan). (1)

5.1.3 240,8 – 208,2 ✓= 32,6 (kJ) ✓ (2)
IF: only answer award 2 marks/***INDIEN:*** *slegs antwoord gee 2 punte*

5.2

5.2.1 Decreases/*Afneem* ✓ (1)

5.2.2 Remains the same/*Bly dieselfde* ✓ (1)

5.2.3 Remains the same/*Bly dieselfde* ✓ (1)

5.3.1 Concentration (of sulphuric acid/$H_2SO_4(aq)$)/*Konsentrasie (van swawelsuur)*✓ (1)

5.3.2
- More (H_2SO_4) particles per unit volume. ✓
- More effective collisions per unit time./Higher frequency of effective collisions. ✓
- Higher reaction rate. ✓

OR

- Less (H_2SO_4) particles per unit volume. ✓
- Less effective collisions per unit time./Lower frequency of effective collisions. ✓
- Lower reaction rate ✓

- *Meer (H_2SO_4) deeltjies per eenheid volume.* ✓
- *Meer effektiewe botsings per eenheidtyd./Hoër frekwensie van effektiewe botsings.* ✓
- *Hoër reaksietempo.* ✓

OF

- *Minder (H_2SO_4)-deeltjies per eenheid volume.* ✓
- *Minder effektiewe botsings per eenheidtyd./Laer frekwensie van effektiewe botsings.* ✓
- *Laer reaksietempo.* ✓

(3)

5.3.3

Marking criteria:

(a) Substitute (2,6)(60)(40) cm^3 OR (156)(40) in rate formula ✓

(b) Substitute 27 000 cm^3 / 27 dm^3 and volume in $n(H_2) = \frac{V}{V_m}$ ✓

(c) USE mole ratio $n(A\ell) = \frac{2}{3}n(H_2)$ ✓

(d) Substitution 27 and reacting mole in $n(A\ell) = \frac{m}{M}$ ✓

(e) Substitution of $\frac{4,05}{5}(100)$ ✓

(f) Final answer: 83,2 % ✓
Range: 81 – 83,3 %

Nasienkriteria:

(a) *Vervang 2,6(60)(40) cm^3 OF (156)(40) in tempo formule* ✓

(b) *Vervang 27 000 cm^3 / 27 dm^3 en volume in* $n(H_2) = \frac{V}{V_m}$ ✓

(c) *GEBRUIK molverhouding* $n(A\ell) = \frac{2}{3}n(H_2)$ ✓

(d) *Vervang 27 en mol gereageer in* $n(A\ell) = \frac{m}{M}$ ✓

(e) *Vervang van* $\frac{4,05}{5}(100)$ ✓

(f) *Finale antwood: 81 %* ✓
Gebied: 81 – 83,3 %

OPTION 1/*OPSIE 1:*

$\text{Rate/Tempo} = \frac{\Delta V_{H_2}}{\Delta t}$

$40 = \frac{\Delta V_{H_2}}{2,6(60)}$ ✓ (a)

$V(H_2) = 6\,240\ cm^3$

$n(H_2) = \frac{V}{V_m}$

$= \frac{6\,240}{27\,000}$ ✓ (b)

$= 0,23\ mol$

$n(A\ell) = \frac{2}{3}n(H_2)$

$n(A\ell) = \frac{2}{3}(0,23)$ ✓ (c)

$= 0,15\ mol$

$n(A\ell) = \frac{m}{M}$

$0,15 = \frac{m}{27}$ ✓ (d)

$m = 4,05\ g$

✓ (e)

$\%\ \text{purity/}suiwerheid = \frac{4,05}{5}(100)$

$= 81\ \%$ ✓ (f)

OPTION 2/*OPSIE 2:*

$\text{rate } H_2 = 40\ cm^3 \cdot s^{-1}$

Rate in $n(H_2) = \frac{V}{V_m}$

$= \frac{40}{27\,000}$ ✓ (b)

$= 0,00148\ mol \cdot s^{-1}$

Rate$(A\ell) = \frac{2}{3}n(H_2)$

$= \frac{2}{3}(0,00148)$ ✓ (c)

$= 9,88 \times 10^{-4}\ mol \cdot s^{-1}$

$n(A\ell) = \frac{m}{M}$

$9,88 \times 10^{-4} = \frac{m}{27}$ ✓ (d)

$m = 0,0267\ g \cdot s^{-1}$

Rate/Tempo $= \frac{\Delta m_{Al}}{\Delta t}$

$0,0267 = \frac{\Delta m_{Al}}{2,6(60)}$

$m(A\ell) = 4,16\ g$

$\%\ \text{purity/}suiwerheid = \frac{4,16}{5}(100)$ ✓ (e)

$= 83,2\ \%$ ✓ (f)

(a) ✓ both/ beide

N. Vuil

(6)
[18]

QUESTION 6/*VRAAG 6*

6.1

Marking criteria/*Nasienkriteria:*
If any one of the underlined key phrases in the **correct context** is omitted, deduct 1 mark./*Indien enige van die onderstreepte frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.*
The underlined phrases must be in the correct context. / *Die onderstreepte frases moet in die korrekte konteks wees.*

When the equilibrium in a closed system is disturbed, the system will re-instate a new equilibrium by favouring the reaction that will cancel/oppose the disturbance. ✓✓
Wanneer die ewewig in 'n geslote sisteem versteur word, sal die sisteem 'n nuwe ewewig instel deur die reaksie te bevoordeel wat die versteuring kanselleer/teenwerk.
IF "isolated" system -1/***INDIEN:*** *"geïsoleerde" sisteem -1)* (2)

6.2 (Chemical) equilibrium/Concentrations of reactants and products remain constant./Rate of the forward and reverse reactions are equal. ✓
(Chemiese) ewewig/K*onsentrasies van reaktanse en produkte bly konstant./ Tempo van voorwaartse en terugwaartse reaksie is gelyk.* (1)

	OPTION 1/*OPSIE 1:*	**OPTION 2/*OPSIE 2:***
6.3	Exothermic/*Eksotermies* ✓	Endothermic/*Endotermies* ✓ (1)
6.4	• With an increase in temperature the endothermic reaction is favoured. ✓ • The reverse reaction is favoured./ Equilibrium shifts to the left. / Reactants / [P_2Q] increases OR Products / [PQ_2] decreases ✓ • *'n Toename in temperatuur bevoordeel die endotermiese reaksie.* • *Die terugwaartse reaksie word bevoordeel./ Ewewig skuif na links. / Reaktante / [P_2Q] neem toe OF Produkte / [PQ_2] neem af*	• With an increase in temperature the endothermic reaction is favoured. ✓ • The forward reaction is favoured./ Equilibrium shifts to the right. Reactants / [PQ_2] increases OR Products / [P_2Q] decreases ✓ • *'n Toename in temperatuur bevoordeel die endotermiese reaksie.* • *Die voorwaartse reaksie word bevoordeel./ Ewewig skuif na regs./ Reaktante / [PQ_2] neem toe OF Produkte / [P_2Q] neem af* (2)
6.5	Less than/*Kleiner as* ✓	Greater than/*Groter as* ✓ (1)

6.6

METHOD 1/*METODE 1*: Using lines/*Gebruik lyne*

CALCULATIONS USING CONCENTRATION

Marking criteria:

(a) Correct K_c expression (formulae in square brackets). ✓✓
(If solid is included deduct 1 mark)
(b) Substitute 0,49 into Kc expression. ✓
(c) Substitute equilibrium concentration (0,35) into correct K_c expression. ✓
(d) Change in concentration/mole ✓
(e) **USE** ratio: $P_2Q : 2PQ_2 = 1 : 2$ ✓
(f) Substitute 2 dm^3 in n = cV. ✓
(g) Final answer = 0,85 (mol) OR 1,11 (mol) OR 3,09 (mol) ✓

Nasienkriteria:

(a) *Korrekte K_c uitdrukking (formules in vierkantige hakies).* ✓✓
(Indien vastestof invervang is, trek 1 punt af)
(b) *Vervang 0,49 in K_c-uitdrukking.* ✓
(c) *Vervang ewewigkonsentrasie (0,35) in korrekte K_c-uitdrukking.* ✓
(d) *Verandering in konsentrasie/mol* ✓
(e) ***GEBRUIK*** *verhouding: $P_2Q : PQ_2 = 1 : 2$* ✓
(f) *Vervang 2 dm^3 in n = cV.* ✓
(g) *Finale antwoord = 0,85 (mol) OF 1,11 (mol) OF 3,09 (mol)* ✓

OPTION 1/*OPSIE 1:*

	P_2Q	PQ_2
Initial concentration ($mol \cdot dm^{-3}$) *Aanvangskonsentrasie ($mol \cdot dm^{-3}$)*	x	0
Change in concentration ($mol \cdot dm^{-3}$) *Verandering in konsentrasie ($mol \cdot dm^{-3}$)*	0,175 ✓(e)	0,35
Equilibrium concentration ($mol \cdot dm^{-3}$) *Ewewigskonsentrasie ($mol \cdot dm^{-3}$)* ✓(d)	x - 0,175	0,35

$$K_c = \frac{[PQ_2]^2}{[P_2Q]} \quad ✓✓ \text{(a)}$$

$$0,49 \ ✓\text{(b)} = \frac{(0,35)^2}{(x - 0,175)} \ ✓\text{(c)}$$

$$x = 0,425 \text{ mol} \cdot dm^{-3}$$

$$n(P_2Q) = cV$$
$$= 0,425 \times 2 \ ✓\text{(f)}$$
$$= 0,85 \text{ mol} \ ✓\text{(g)}$$

No K_c expression, correct substitution/*Geen K_c-uitdrukking, korrekte substitusie*: Max./*Maks.* $^6/_8$

Wrong K_c expression/
Verkeerde K_c-uitdrukking: Max./*Maks.* $^5/_8$

OPTION2/*OPSIE 2:*

$K_c = \frac{[PQ_2]^2}{[P_2Q]}$ ✓✓

$0,49$ ✓(b) $= \frac{(0,35)^2}{P_2Q}$ ✓(c)

$P_2Q = 0,25 \text{ mol·dm}^{-3}$

No K_c expression, correct substitution/*Geen K_c-uitdrukking, korrekte substitusie*: Max./*Maks.* $^6/_8$
Wrong K_c expression/ *Verkeerde K_c-uitdrukking*: Max./*Maks.* $^5/_8$

	P_2Q	PQ_2
Initial concentration (mol·dm^{-3}) *Aanvangskonsentrasie (mol·dm^{-3})*	✓(d) 0,425	0
Change in concentration (mol·dm^{-3}) *Verandering in konsentrasie (mol·dm^{-3})*	-0,175	✓(e) 0,35
Equilibrium concentration (mol·dm^{-3}) *Ewewigskonsentrasie (mol·dm^{-3})*	0,25	0,35

$n(P_2Q) = cV$
$= 0,425(2)$ ✓(f)
$= 0,85 \text{ mol}$ ✓(g)

CALCULATIONS USING NUMBER OF MOLES
OPTION 3/*OPSIE 3:*

	P_2Q	PQ_2
Initial quantity (mol) Aanvangshoeveelheid (mol)	x	0
Change (mol) *Verandering (mol)*	✓(e) 0,35	0,7
Quantity at equilibrium (mol) *Hoeveelheid by ewewig (mol)*	✓(d) x – 0,35	0,7
Equilibrium concentration (mol·dm^{-3}) Ewewigskonsentrasie (mol·dm^{-3})	✓(f) $\frac{x - 0,35}{2}$	0,35

$K_c = \frac{[PQ_2]^2}{[P_2Q]}$ ✓✓(a)

$0,49$ ✓(b) $= \frac{(0,35)^2}{(\frac{x - 0,35}{2})}$ ✓(c)

$x = 0,85 \text{ mol}$ ✓(g)

No K_c expression, correct substitution/*Geen K_c-uitdrukking, korrekte substitusie*: Max./*Maks.* $^6/_8$
Wrong K_c expression/ *Verkeerde K_c- uitdrukking*: Max./*Maks.* $^5/_8$

OPTION 4/*OPSIE 4:*

$K_c = \frac{[PQ_2]^2}{[P_2Q]}$ ✓✓ **(a)**

$0,49$ ✓ **(b)** $= \frac{(0,35)^2}{[P_2Q]}$ ✓ **(c)**

$[P_2Q] = 0,25 \text{ mol·dm}^{-3}$

Wrong K_c expression/
Verkeerde K_c-uitdrukking: Max./*Maks.* $^5/_8$

No K_c expression, correct substitution/*Geen K_c-uitdrukking, korrekte substitusie*: Max./*Maks.* $^6/_8$

	P_2Q	PQ_2
Initial quantity (mol) *Aanvangshoeveelheid (mol)*	✓ **(g)** 0,85	0
Change (mol) *Verandering (mol)*	✓ **(e)** -0,35	0,7 ✓ **(d)**
Quantity at equilibrium (mol) *Hoeveelheid by ewewig (mol)*	0,5 ✓ **(f)**	0,7
Equilibrium concentration ($mol·dm^{-3}$) *Ewewigskonsentrasie ($mol·dm^{-3}$)*	0,25	0,35

METHOD 2/*METODE 2:* Using labels/*Gebruik byskrifte*

OPTION 1/*OPSIE 1:*

	P_2Q	PQ_2
Initial concentration ($mol·dm^{-3}$) *Aanvangskonsentrasie ($mol·dm^{-3}$)*	x	0
Change in concentration ($mol·dm^{-3}$) ✓ *Verandering in konsentrasie ($mol·dm^{-3}$)*	**(e)** -0,207	0,414 ✓ **(d)**
Equilibrium concentration ($mol·dm^{-3}$) *Ewewigskonsentrasie ($mol·dm^{-3}$)*	0,35	0,414

$K_c = \frac{[PQ_2]^2}{[P_2Q]}$ ✓✓ **(a)**

(b) ✓ $0,49 = \frac{[PQ_2]^2}{(0,35)}$ ✓ **(c)**

$[PQ_2] = 0,414 \text{ mol·dm}^{-3}$

initial $n(P_2Q) = (0,35 + 0,207)(2)$ ✓ **(f)**
$= 1,11$ mol ✓ **(g)**

No K_c expression, correct substitution/*Geen K_c- uitdrukking, korrekte substitusie*: Max./*Maks.* $^6/_8$

Wrong K_c expression/
Verkeerde K_c-uitdrukking: Max./*Maks.* $^5/_8$

OPTION 2/*OPSIE 2:*

	P_2Q	PQ_2
Initial quantity (mol) *Aanvangshoeveelheid (mol)*	x	0
Change (mol) *Verandering (mol)*	0,414	0,828 ✓**(e)**
Quantity at equilibrium (mol) *Hoeveelheid by ewewig (mol)*	0,7	0,828
Equilibrium concentration ($mol \cdot dm^{-3}$) *Ewewigskonsentrasie ($mol \cdot dm^{-3}$)*	0,35 ✓ **(f)**	0,414

$K_c = \frac{[PQ_2]^2}{[P_2Q]}$ ✓✓ **(a)**

(b)✓ $0,49 = \frac{[PQ_2]^2}{(0,35)}$ ✓ **(c)**

$[PQ_2] = 0,414\ mol \cdot dm^{-3}$

$x - 0,414 = 0,7$ ✓ **(d)**

$x = 1,11\ mol\ P_2Q$ ✓ **(g)**

No K_c expression, correct substitution/*Geen K_c-uitdrukking, korrekte substitusie*: Max./*Maks.* $^6/_8$

Wrong K_c expression/
Verkeerde K_c- uitdrukking: Max./*Maks.* $^5/_8$

METHOD 3/*METODE 3:* (Equation written as reverse/*Vergelyking omgekeerd geskryf)*

$$2PQ_2 \rightleftharpoons P_2Q + 3Q$$

	PQ_2	P_2Q
Initial quantity (mol) *Aanvangshoeveelheid (mol)*	x	0
Change (mol) *Verandering (mol)*	1,4	0,7 ✓ **(e)**
Quantity at equilibrium (mol) *Hoeveelheid by ewewig (mol)* **(d)** ✓	x – 1,4	0,7
Equilibrium concentration ($mol \cdot dm^{-3}$) *Ewewigskonsentrasie ($mol \cdot dm^{-3}$)*	$\frac{x - 1,4}{2}$	0,35

$K_c = \frac{[P_2Q]}{[PQ_2]^2}$ ✓✓ **(a)**

(b)✓ $0,49 = \frac{(0,35)}{[PQ_2]^2}$ ✓ **(c)**

$\frac{x - 1,4}{2} = 0,845$ ✓ **(f)**

$x = 3,09\ mol\ P_2Q$ ✓ **(g)**

No K_c expression, correct substitution/*Geen K_c-uitdrukking, korrekte substitusie*: Max./*Maks.* $^6/_8$

Wrong K_c expression/
Verkeerde K_c- uitdrukking: Max./*Maks.* $^5/_8$

METHOD 4/*METODE 4*: Reading from graph/*Aflees van grafiek*

OPTION 1/*OPSIE 1*

$K_c = \frac{[PQ_2]^2}{[P_2Q]} = 0,49$ Initial $[P_2Q] = 0$

n = 0 (mol) ✓✓✓✓✓✓✓✓ (8/8)

OPTION 2/*OPSIE 2:*

	P_2Q	PQ_2
Initial concentration ($mol \cdot dm^{-3}$) *Aanvangskonsentrasie ($mol \cdot dm^{-3}$)*	→ 0	y
Change in concentration ($mol \cdot dm^{-3}$) *Verandering in konsentrasie ($mol \cdot dm^{-3}$)*	-0,207	0,414
Equilibrium concentration ($mol \cdot dm^{-3}$) *Ewewigskonsentrasie ($mol \cdot dm^{-3}$)*	0,35	0,414

n = 0 (mol) ✓✓✓✓✓✓✓✓ (8/8) (8)

6.7 Pressure was decreased/volume of the container was increased. ✓
Druk is verlaag/volume van die houer is vergroot. (1)

6.8 **OPTION 1/*OPSIE 1:*** Using labels/*Gebruik byskrifte*

- Favours the reaction that increases the number of moles (of gas) ✓/ *Bevoordeel die reaksie wat aantal mol (gas) laat toeneem*
- [P_2Q] increased/*neem toe* ✓ **OR/*OF*** [PQ_2] decreased/*neem af*

OPTION 2/*OPSIE 2:* Using lines/*Gebruik lyne*

- Favours the reaction that increases the number of moles (of gas) ✓/ *Bevoordeel die reaksie wat aantal mol (gas) laat toeneem*
- [PQ_2] increased/*neem toe* ✓ **OR/*OF*** [P_2Q] decreased/*neem af* (2)

[18]

QUESTION 7/*VRAAG 7*

7.1

Marking criteria:	***Nasienkriteria:***
• Any formula $c = \frac{m}{MV}$ or $n = \frac{m}{M}$ or $c = \frac{n}{V}$ ✓	• *Enige formule* $c = \frac{m}{MV}$ *of* $n = \frac{m}{M}$ *of* $c = \frac{n}{V}$ ✓
• Substitute 10, 106 and 0,7 into formula✓	• *Vervang 10, 106 and 0,7 in formula* ✓
• Final answer: 0,13 mol·dm^{-3} ✓	• *Finale antwoord: 0,13 mol·dm^{-3}* ✓

7.1.1

OPTION 1/*OPSIE 1:*	**OPTION 2/*OPSIE 2:***
$c = \frac{m}{MV}$ ✓ $= \frac{10}{(106)(0,7)}$ ✓ $= 0,13$ mol·dm^{-3} ✓	$n = \frac{m}{M}$ Any one/*Enige een* ✓ $= \frac{10}{106}$ ✓ $= 0,09$ $c = \frac{n}{V}$ $= \frac{0,09}{0,7}$ $= 0,13$ mol·dm^{-3} ✓

(3)

7.1.2 Greater than/*Groter as* ✓ (1)

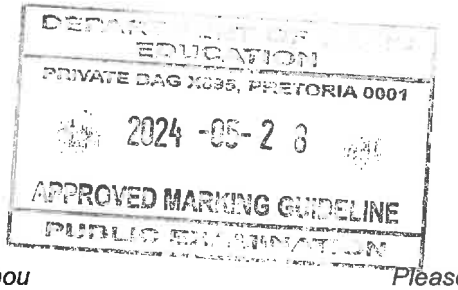
7.1.3 $CO_3^{2-}(aq) + H_2O(\ell)$ ✓ $\rightleftharpoons HCO_3^-(aq) + OH^-(aq)$ ✓
OR/*OF*
$CO_3^{2-}(aq) + 2H_2O(\ell)$ ✓ $\rightleftharpoons H_2CO_3(aq) + 2OH^-(aq)$ ✓
OR/*OF*
$Na_2CO_3(aq) + H_2O(\ell)$ ✓ $\rightleftharpoons NaHCO_3(aq) + NaOH(aq)$ ✓
OR/*OF*
$Na_2CO_3(aq) + 2H_2O(\ell)$ ✓ $\rightleftharpoons H_2CO_3(aq) + 2NaOH(aq)$ ✓

Marking criteria/*Nasienkriteria:*
• Reactants ✓ Products ✓ *Reaktanse* ✓ *Produkte* ✓
• Ignore/*Ignoreer* → and phases/*en fases*
• Marking rule 6.3.10/*Nasienreël 6.3.10*

(2)

7.1.4 P ✓
(Titration of) weak base and a strong acid./The equivalence point is lower than pH 7. ✓
(Titrasie van) 'n swak basis en 'n sterk suur./ Die ekwivalente punt is laer as 'n pH van 7.
(2)

7.2
7.2.1 Dilute acid contains small amount/number of moles of acid in proportion to the volume of water. ✓✓ **(2 or/*of* 0)**
Verdunde sure bevat 'n klein hoeveelheid/getal mol suur in verhouding met die volume water.
(2)



7.2.2

Marking criteria:	***Nasienkriteria:***
(a) USE of ratio: $n(KOH)_{reacted} = 2n(H_2SO_4)_{reacted}$/ $[KOH]_{reacted} = 2n[H_2SO_4]_{reacted}$ ✓	**(a)** *GEBRUIK verhouding:* $n(KOH)_{gereageer} = 2n(H_2SO_4)_{gereageer}$ $[KOH]_{gereageer} = 2n[H_2SO_4]_{gereageer}$ ✓
(b) Subtract: $n(KOH)_{initial} - n(KOH)_{reacted}$/ $[KOH]_{initial} - [KOH]_{reacted}$ ✓✓	**(b)** *Aftrek:* $n(KOH)_{aanvanklik} - n(KOH)_{gereageer}$ $[KOH]_{aanvanklik} - [KOH]_{gereageer}$ ✓✓
(c) Divide n by 0,20 dm^3 in $c = \frac{n}{V}$ ✓	**(c)** *Deel n deur 0,20 dm^3 in* $c = \frac{n}{V}$ ✓
(d) Either formulae: $pH = -\log[H_3O^+]$ / $pH = -\log[H^+]$ / $pOH = -\log[OH^-]$ AND $[H_3O^+][OH^-] = 10^{-14}$ / $pH + pOH = 14$ ✓	**(d)** *Enige een v formules:* $pH = -\log[H_3O^+]$ / $pH = -\log[H^+]$ / $pOH = -\log[OH^-]$ *EN* $[H_3O^+][OH^-] = 10^{-14}$ / $pH + pOH = 14$ ✓
(e) Substitute calculated $[OH^-]$ in $[H_3O^+][OH^-]$ / in $pOH = -\log[OH^-]$ ✓	**(e)** *Vervang berekende* $[OH^-]$ *in* $[H_3O^+][OH^-]$ / *in* $pOH = -\log[OH^-]$ ✓
(f) Substitute calculated $[H_3O^+]$ in pH formula/ pOH in $pH + pOH = 14$ ✓	**(f)** *Vervang berekende* $[H_3O^+]$ *in pH* *formule/ pOH in* $pH + pOH = 14$ ✓
(g) Final answer: 12,3 ✓	**(g)** *Finale antwoord: 12,3* ✓

OPTION 1/*OPSIE 1:*

$n(KOH)_{reacted} = 2n(H_2SO_4)_{reacted}$
$= 2(0,01)$ ✓**(a)**
$= 0,02$

$n(KOH)_{excess} = 0,024 - 0,02$ ✓✓ **(b)**
$= 0,004$ mol

$[OH^-] = \frac{n}{V}$
$= \frac{0,004}{0,20}$ ✓**(c)**
$= 0,02$ mol·dm^{-3}

Either/ *Enige een* ✓**(d)**

$[H_3O^+][OH^-] = 10^{-14}$
$[H_3O^+]\ (0,02) = 1 \times 10^{-14}$ ✓**(e)**
$[H_3O^+] = 5 \times 10^{-13}$ mol·dm^{-3}

$pH = -\log[H_3O^+]$
$= -\log(5 \times 10^{-13})$ ✓ **(f)**
$= 12,3$ ✓ **(g)**

OPTION 2/*OPSIE 2:*

$[KOH] = \frac{n}{V}$
$= \frac{0,024}{0,20}$
$= 0,12$ mol·dm^{-3} ✓**(c)**

Both/ *Beide*

$[H_2SO_4] = \frac{n}{V}$
$= \frac{0,01}{0,20}$
$= 0,05$ mol·dm^{-3}

$[KOH]_{reacted} = 2[H_2SO_4]_{reacted}$
$= 2(0,05)$ ✓**(a)**
$= 0,1$ mol·dm^{-3}

$[KOH]_{excess} = 0,12 - 0,1$ ✓✓ **(b)**
$= 0,02$ mol·dm^{-3}

$[H_3O^+][OH^-] = 10^{-14}$
$[H_3O^+]\ (0,02) = 1 \times 10^{-14}$ ✓**(e)**
$[H_3O^+] = 5 \times 10^{-13}$ mol·dm^{-3}

✓**(d)** Either/ *Enige een*

$pH = -\log[H_3O^+]$
$= -\log(5 \times 10^{-13})$ ✓ **(f)**
$= 12,3$ ✓ **(g)**

OPTION 3/*OPSIE 3*

$pOH = -\log[OH^-]$
$pOH = -\log(0,02)$ ✓**(e)**
$pOH = 1,7$

Any one/*Enige een* ✓**(d)**

$pH + pOH = 14$
$pH + 1,7 = 14$ ✓**(f)**
$pH = 12,3$ ✓ **(g)**

(8)
[18]

Please turn over/Blaai om asseblief

QUESTION 8/*VRAAG 8*

8.1 Aluminium/Aℓ ✓ (1)

8.2 0,325 (mol·dm^{-3}) ✓✓
Range/*Gebied:* 0,32 – 0,33 (mol·dm^{-3}) (2)

8.3 Decreases / *Neem af*✓
M^{2+} is reduced/ M^{2+} used up/M^{2+} is the oxidising agent. ✓ (2)
M^{2+} word gereduseer/ M^{2+} opgebruik/M^{2+} is die oksideermiddel.

8.4 M ✓ (1)

8.5

OPTION 1/*OPTION 1*	**NOTE/*LET WEL***
$E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$ ✓ 2 ✓✓= $E^{\theta}_{cathode}$ – (-1,66) ✓ $E^{\theta}_{cathode}$ = 0,34 (V) ✓ M is copper/Cu/*koper* ✓	• Accept any other correct formula from the data sheet. */Aanvaar enige ander korrekte formule vanaf gegewensblad.* • Any other formula using unconventional abbreviations, e.g. $E°_{cell} = E°_{OA} - E°_{RA}$ followed by correct substitutions:/*Enige ander formule wat onkonvensionele afkortings gebruik, bv. $E°_{sel} = E°_{OM} - E°_{RM}$ gevolg deur korrekte vervangings* $^{5}/_{6}$

OPTION 2/*OPSIE 2*	
$M^{2+}(aq) + 2e^- \rightarrow M(aq)$	E = +x V
$Aℓ(s) \rightarrow Aℓ^{3+}(aq) + 3e^-$ ✓	E = +1,66 V ✓
$2Aℓ(s) + 3M^{2+}(aq) \rightarrow 2Aℓ^{3+}(aq) + 3M(s)$	E = 2,00 (V) ✓✓
x = 0,34 (V) ✓	
M is copper/Cu/*koper* ✓	

(6)

8.6.1 Magnesium/Mg ✓ (1)

8.6.2 $Aℓ^{3+}$ is a stronger oxidising agent than Mg^{2+}✓, therefore, Mg will be oxidised ✓ (to Mg^{2+})./
Mg^{2+} is a weaker oxidising agent than $Aℓ^{3+}$✓, therefore, Mg will be oxidised ✓ (to Mg^{2+}).

$Aℓ^{3+}$ is 'n sterker oksideermiddel as Mg^{2+}, daarom sal Mg geoksideer word (tot Mg^{2+})./
Mg^{2+} is 'n swakker oksideermiddel as $Aℓ^{3+}$, daarom sal Mg geoksideer word (tot Mg^{2+}).
ACCEPT/*AANVAAR*:
Mg ion and Aℓ ion/*Mg ioon en Aℓ ioon* (2)
[15]

QUESTION 9/*VRAAG 9*

9.1 Electrical to chemical (energy)/*Elektriese na chemiese (energie)* ✓ (1)

9.2 P ✓ (1)

9.3 $Ag^+ + e^- \rightarrow Ag$ ✓✓

Marking criteria/*Nasienkriteria:*

$Ag \leftarrow Ag^+ + e^-$ $(2/2)$

$Ag^+ + e^- \rightleftharpoons Ag$ $(1/2)$

$Ag \rightleftharpoons Ag^+ + e^-$ $(0/2)$

$Ag^+ + e^- \leftarrow Ag$ $(0/2)$

Ignore if charge omitted on electron./*Ignoreer indien lading weggelaat op elektron.* (2)

9.4

Marking criteria:	***Nasienkriteria:***
(a) Substitute 3,25 and 108 in the formula $n = \frac{m}{M}$ ✓	**(a)** *Vervang 3,25 en 108 in die formule* $n = \frac{m}{M}$ ✓
(b) Substitute $6,02 \times 10^{23}$ in $n(e^-) = \frac{N}{N_A}$ ✓	**(b)** *Vervang* $6,02 \times 10^{23}$ *in* $n(e^-) = \frac{N}{N_A}$ ✓
(c) Substitute 0,03 mol in $n(e^-) = \frac{N}{N_A}$ ✓ (Substitute 96 500 in formula Q = nF)	**(c)** *Vervang 0,03 mol in* $n(e^-) = \frac{N}{N_A}$ ✓ (*Vervang 96 500 in formule Q = nF*)
(d) Substitute 30(60) OR 1 800 ✓	**(d)** *Vervang 30(60) OF 1 800* ✓
(e) Final answer: 1,61 A ✓	**(e)** *Finale antwoord: 1,61 A* ✓

OPTION 1/*OPSIE 1:*

$n(Ag) = \frac{m}{M}$

$= \frac{3,25}{108}$ ✓(a)

$= 0,03$ mol

$n(e^-) = \frac{N}{N_A}$

(c) ✓ $0,03 = \frac{N}{6,02 \times 10^{23}}$ ✓(b)

$N\ e^- = 1,81 \times 10^{22}$

$N\ e^- = \frac{Q}{e}$ **OF/OR** $\frac{Q}{q_e}$

$1,81 \times 10^{22} = \frac{Q}{1,6 \times 10^{-19}}$

$Q = 2\,889,6$ C

$I = \frac{Q}{\Delta t}$

$= \frac{2\,889,6}{30(60)}$ ✓(d)

$= 1,61$ A ✓(e)

OPTION 2/*OPSIE 2:*

$n(Ag) = \frac{m}{M}$

$= \frac{3,25}{108}$ ✓(a)

$= 0,03$ mol $= n\ e^-$

✓(b)

$Q = 0,03 \times 96\,500$ ✓(c)

$= 2\,895$ C

$I = \frac{Q}{\Delta t}$

$= \frac{2\,895}{30(60)}$ ✓(d)

$= 1,61$ A ✓(e)

(5)
[9]

TOTAL/*TOTAAL:* 150