education
MPUMALANGA PROVINCE
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: CHEMISTRY (P2)

SEPTEMBER 2024

MEMO

MARKS/PUNTE: 150

This memorandum consists of 13 pages.
Hierdie memorandum bestaan uit 13 bladsye.

QUESTION 1 / VRAAG 1

1.1 A ✓✓

1.2 D ✓✓

1.3 A ✓✓

1.4 B ✓✓

1.5 B ✓✓

1.6 B ✓✓

1.7 A ✓✓

1.8 D ✓✓

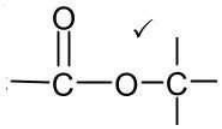
1.9 B ✓✓

1.10 B ✓✓ **[20]**

QUESTION 2 / VRAAG 2

2.1.1 methyl ✓ethanoate ✓ / metielethanoeaat (2)

2.1.2

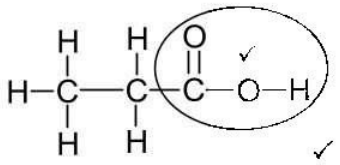


(1)

2.1.3 methanol/*metanol* ✓ (1)

2.1.4 Organic compound with the same molecular formula, but different functional groups on the parent chain✓✓/ *Organiese verbinding met dieselfde molekulêre formule, maar verskillende funksionele groepe op die stamketting*. **(2/0)** (2)

2.1.5



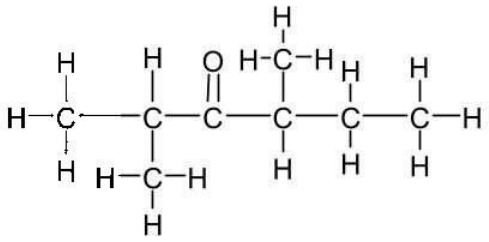
Marking Criteria

- **Functional Group**
- **Whole structure correct**

(2)

2.2.1 Ketone / ketoon ✓ (1)

2.2.2



Marking criteria:

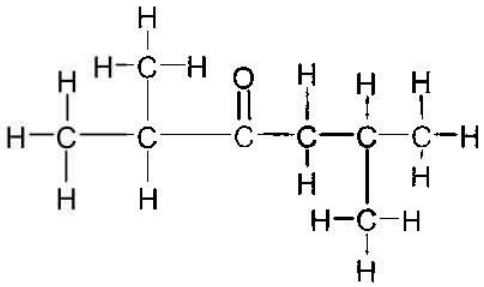
- Correct functional group. ✓
- All side chains (methyl) on 2 and 4 ✓
- Whole structure correct. ✓

Nasienkriteria:

- *Korrekte funksionele groep.* ✓
- *Alle substituente (metiel) op 2 en 4* ✓
- *Res van die ketting korrek.* ✓

(3)

2.2.3



Marking criteria:

- Correct functional group on carbon **2** OR **3**. ✓
- All side chains (methyl) on **2** and **5** OR **2** and **2** OR **3** and **5** OR **5** and **5.**✓

  Note: *The position of the functional group or side chain(s) or both can be changed.*

Nasienkriteria:

- *Korrekte funksionele groep op koolstof **2** OF **3**.* ✓
- *Alle substituente (metiel) op **2** en **5** OF* **2** en **2** OF **3** en **5** OF **5** en **5** ✓.

  Nota: *Die posisie van die funksionele groep of substituente of beide kan verander word.*

(2)

2.3.1 Combustion/oxidation Verbranding/ ✓ (1)

2.3.2 Butane / *butaan* ✓ (1)

2.3.3 **Marking criteria:**

(a) Substitution of 58 in the formula n = $\frac{m}{M}$ ✓
(b) Use of mol ratio 2:8 ($2C_4H_{10} : 8CO_2$)✓
(c) Use of mol ratio 1:1 ($CO_2 : CaCO_3$) ✓
(d) Substitution of 100 in the formula n = $\frac{m}{M}$ ✓
(e) Final answer (415,17 g) ✓

Nasienkriteria:

(a) Vervang 58 in die formule n = $\frac{m}{M}$ ✓
(b) Gebruik van verhouding 2:8 ($2C_4H_{10} : 8CO_2$)✓
(c) Gebruik van verhouding 1:1 ($CO_2 : CaCO_3$) ✓
(d) Vervang 100 in die formule n = $\frac{m}{M}$ ✓
(e) Finale antwoord (415,17 g) ✓

$$n = \frac{m}{M}$$
$$= \frac{60,2}{58} \checkmark (a)$$
$$= 1,0379 \text{ mol}$$

$$nCO_2 = \frac{8}{2} nC_4H_{10}$$
$$= \frac{(1,0379)(8)}{2} \checkmark (b)$$
$$= 4,1517 \text{ mol}$$

$$n(CaCO_3) = nCO_2$$
$$= 4,1517 \text{ mol} \checkmark (c)$$

$$n = \frac{m}{M}$$
$$4,1517 = \frac{m}{100} \checkmark (d) \quad m = 415,17 \text{ g} \checkmark (e)$$

(5)
[21]

QUESTION 3 / VRAAG 3

3.1

Marking criteria/*Nasienriglyne*
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 pressure exerted by a vapour at equilibrium with its liquid in a closed system ✓✓
Die druk uitgeoefen deur 'n damp in ewewig met sy vloeistof in 'n geslote sisteem. (2)

3.2.1 Type of organic compound/surface area/chain length
Tipe organiese verbinding/oppervlakarea/ketting lengte ✓ (1)

3.2.2

Marking criteria:
- Compare the structures of the compounds A and B
- Compare the strength of intermolecular forces
- Compare the energy required to overcome intermolecular forces
- Conclusion

Nasienkriteria:
- *Vergelyk die struktuur van die verbindings A en B*
- Vergelyk die sterkte van intermolekulêre kragte
- *Vergelyk die energie benodig om intermolekulêre kragte te oorkom*
- *Gevolgtrekking*

- **A** is the branched/more spherical alkane **and B** is the straight chain alkane / *A is die vertakte/meer sferiese alkaan **en B** is die reguitketting alkaan*✓
- **A** will have weaker London/intermolecular forces than **B** / ***A** het swakker London kragte as **B***✓
- Less energy is needed to overcome the London forces of **A**/ *Minder energie word benodig om die Londonkragte/intermolekulêre kragte van **B** te oorkom* ✓
- **A** will have the lower boiling point or higher vapour pressure. / ***A** het laer kookpunt of die hoogste dampdruk.*✓

OR

- **B** is the straight chain alkane and **A** is the branched/more spherical alkane / ***B** is die reguitketting alkaan*✓en ***A** is die vertakte/meer sferiese alkaan*
- **B** will have stronger London/intermolecular forces than **A** / **B** *het sterker London kragte as **A***✓
- More energy is needed to overcome the London forces of **B**/ *Meer energie word benodig om die Londonkragte/intermolekulêre van **B** te oorkom* ✓
- B will have the higher boiling point or lower vapour pressure. / **B** *het die hoër kookpunt of 'n laer dampdruk.*✓ (4)

3.3 118-120 (°C) ✓ (1)

3.4 D ✓
D has the lowest vapour pressure/highest boiling point/the strongest intermolecular forces/ *D het die laagste dampdruk/die hoogste kookpunt.*✓ (2)

3.5.1 Molecular mass / Molekulêre massa ✓ ACCEPT: Number of C atoms (1)

3.5.2

Marking criteria:
- Identify the type of intermolecular forces for C and D
- Compare the strength of intermolecular forces
- Compare the energy required to overcome intermolecular forces

Nasienkriteria:
- *Identifiseer die tiepe intermolekulêre kragte vir C en D*
- Vergelyk die sterkte van intermolekulêre kragte
- *Vergelyk die energie benodig om intermolekulêre kragte te oorkom*

- C have dipole-dipole forces / *C het dipool-dipool kragte* ✓
  and D has hydrogen bonds / ***en** D het waterstofbindings*. ✓
- Hydrogen bonds are stronger than Dipole-dipole forces/the intermolecular forces in D are stronger/C has weaker intermolecular forces / *Waterstofbindings is sterker as dipool-dipool kragte/die intermolekulêre kragte van D is sterker*. ✓

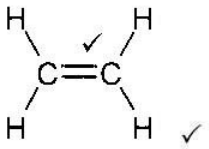
OR

- More energy is needed to overcome the intermolecular forces of D/less energy is needed to overcome the forces in C / *Meer energie word benodig om die intermolekulêre kragte van D te oorkom.* (3)

[14]

QUESTION 4/ *VRAAG 4*

4.1.1 Cracking/Elimination / *Kraking/Eliminasie* ✓ (1)

4.1.2 

Marking Criteria/ *Nasienkriteria*
- Functional group/ *Funksionele groep* ✓
- Whole structure correct/ *Hele struktuur korrek* ✓

(2)

4.2.1 Addition/ halogenation / *Addisie / Halogenering*✓ (1)

4.2.2 B/ ethene is unsaturated/has multiple bonds✓, The colour change will be from orange brown to colourless/ Br_2 decolourises✓
B/ eteen is onversadig, die kleur verander van rooi-bruin na kleurloos/ Br_2 word kleurloos (2)

4.3.1 Substitution/halogenation/bromination / *Substitusie/ halogenering/brominasie* ✓ (1)

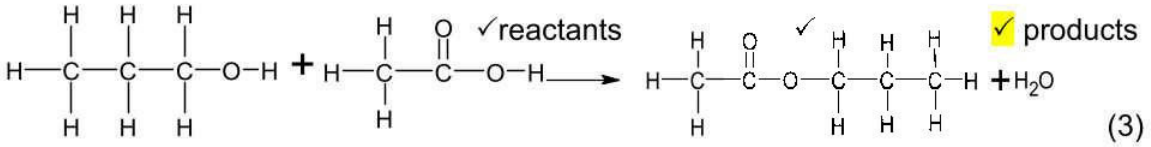
4.3.2 HBr/ hydrogen bromide/ waterstofbromied ✓ (1)

4.4 $CH_3CHBrCH_3 + NaOH \rightarrow CH_2CHCH_3$ ✓ + $NaBr + H_2O$ **REMOVE: Refer to Table 1**

NOTE/LET WEL
- Penalise only once for the use of structural formulae or molecular formulae
- *Penaliseer slegs een keer vir die gebruik van struktuurformules of molekulêre formule*

(2)

4.5 Primary alcohol is when the –OH group is attached/bonded to a carbon that is attached/bonded to one other carbon.
'n Primêre alkohol is waar die –OH groep gebind is aan 'n koolstof wat slegs met een ander koolstof gebind is.✓✓ (2)

4.6 

(3)

[15]

QUESTION 5/ *VRAAG 5*

5.1 A – 3 ✓
B – 1 ✓
C – 2 ✓ (3)

5.2

Marking criteria:
(a) Substitute 64 in formula n = $\frac{m}{M}$
(b) Substitution of 0,0078
(c) Substitution of (2x60)
(d) Final answer 6,5104 x 10^{-5} / 0,000065

$n = \frac{m}{M}$ tempo = $\frac{\Delta n}{\Delta t}$

$= \frac{0,5}{64✓(a)}$ $= \frac{0,0078✓(b)-0}{(2)(60)✓(c)}$

= 0,0078 mol = 6,5104 x 10^{-5} (mol·s^{-1}) / 0,000065 (mol·s^{-1})(d)✓ (4)

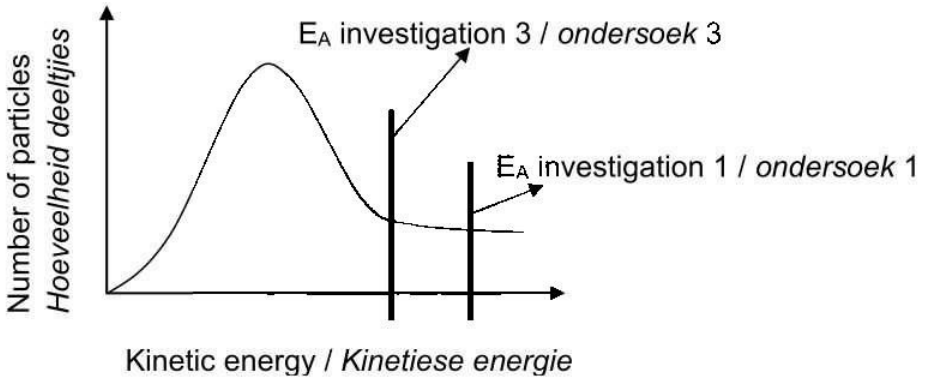
5.3 Concentration of HCℓ / *Konsentrasie van HCℓ* ✓ (1)

5.4.1 Remain the same / *Bly dieselfde* ✓ (1)

5.4.2 Remain the same / *Bly dieselfde* ✓ (1)

5.5
- A catalyst was added to Investigation 3 / *'n Katalisator is by ondersoek 3 gevoeg.*✓
- A catalyst lowers the activation energy/provides an alternative route with a lower activation energy / *'n Katalisator verlaag die aktiverings enegie* ✓
- More particles have enough E_k to overcome the E_A / *Meer deeltjies het genoeg E_k om die E_A te oorkom.* ✓
- More effective collisions per second/ per unit time take place/frequency of effective collisions increases/ *Meer effektiewe botsings per sekonde sal plaasvind.* ✓ (4)

5.6



Marking criteria:
- Labelling of x and y axes ✓
- Shape of the graph ✓
- E_A for investigation 1 and 3 correctly indicated ✓✓

Nasienkriteria:
- *Benoem x – en y – asse korrek*
- *Vorm van grafiek korrek*
- *E_A vir ondersoek 1 en 3 reg benoem*

(4)
[18]

QUESTION 6 / *VRAAG 6*

6.1 A reaction is reversible when products can be converted back to reactants (and vice versa). ✓
'n Reaksie is omkeerbaar wanneer produkte terug na reaktanse, en omgekeerd, omgeskakel kan word. (1)

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

6.2.2 Decreases / *Afneem* ✓ (1)

6.2.3
- A decrease in the pressure favours the reaction that produces the higher number of moles/number of molecules/volume of gas ✓
  'n Afname in druk bevoordeel die reaksie wat die groter aantal mol/aantal molekules/ volume gas lewer.
- The reverse reaction was favoured ✓
  Die terugwaartse reaksie is bevoordeel. (2)

6.3 **Marking criteria / Nasienkriteria:**
a. Subsitute $9{,}03 \times 10^{22}$ in formula $n = \frac{N}{N_A}$ ✓
   Vervang $9{,}03 \times 10^{22}$ *in formule* $n = \frac{N}{N_A}$
b. Use mol ratio / *Gebruik mol verhouding* : CO: O_2 : CO_2 = 2:1:2 ✓
c. $n(CO_2)_{change} = n(CO_2)_{equilibrium}$/ $n(CO_2)_{verandering} = n(CO_2)_{ewewig}$ ✓
d. Divide and multiply by the volume (2)/ *Deel en vermenigvuldig deur die volume (2)* ✓
e. Correct K_c expression / *Korrekte K_c uitdrukking* ✓
f. Substitution of equilibrium concentrations into K_c expressions/ *Vervanging van ewewigskonsentrasies in K_c-uitdrukking*✓
g. Substitution of K_c value/*Vervanging van ewewigskonsentrasie in K_c-uitdrukking* ✓
h. $nO_{2(initial)}$ / $nO_{2(aanvanklik)} = nO_{2(equilibrium/ewewig)} + nO_{2\ (reacted/\ reageer)}$ ✓
i. Final answer / Finale antwoord (5,4 g) *Range (5,40 – 5,47)*✓

$$n = \frac{N}{N_A}$$
$$= \frac{9{,}03 \times 10^{22}\checkmark(a)}{6{,}02 \times 10^{23}}$$
$$= 0{,}15 \text{ mol}$$

	$CO(g)$	$O_2(g)$	$CO_2(g)$
Initial mol Aanvanklike mol	0,35	$m = 0{,}169 \times 32$ $= 5{,}4$ g ✓(i)	0
Change in mol Verandering in mol	-0,2	-0,1	+0,2
Equilibrium mol Ewewigs mol	0,15	0,069 ✓(h)	0,2 ✓(c)
Equilibrium concentration Ewewigskonstante	0,075	0,0348	0,1

Ratio ✓(b)

Divide and multiply by/*deel en vermenigvuldig deur 2*✓(d)

$$K_c = \frac{[CO_2]^2}{[CO]^2[O_2]}\checkmark(e)$$
$$51\checkmark(g) = \frac{(0{,}1)^2}{(0{,}075)^2[O_2]}\checkmark(f)$$
$$[O_2] = 0{,}0348 \text{ mol·d}m^{-3}$$

(9)

6.4 Endothermic/ *Endotermies*✓

- The K_c value decreases, thus the reverse reaction is favoured. ✓
- If temperature decrease the exothermic reaction will be favoured✓

- *Die K_c waarde verlaag met 'n verlaging in temperatuur, dus word die terugwaartse reaksie bevoordeel.*
- *As die temperatuur verlaag word die eksotermiese reaksie bevoordeel* (3)

[17]

QUESTION 7 / VRAAG 7

7.1.1 *A substance that can act as either acid or base* ✓✓
'n Stof wat as óf 'n suur óf 'n basis kan reageer (2)

7.1.2 Acid/*Suur*✓
It donates a proton/H^+/*Was 'n protonskenker* ✓ (2)

7.1.3 CO_3^{2-} ✓ (1)

7.2 A ✓
H_2SO_4 ionises completely in water to form a high concentration (H_3O^+) ions. OR
H_2CO_3 ionises incompletely in water to form a low concentration (H_3O^+) ions ✓
H_2SO_4 ioniseer volledig in water en vorm 'n hoë konsentrasie (H_3O^+) ione.OF
H_2CO_3 ioniseer onvolledig in water en vorm 'n lae konsentrasie (H_3O^+) ione (2)

7.3 $[H_3O^+] = 2[H_2SO_4]$
$= 2(0,25 \times 10^{-3})$
$= 0,5 \times 10^{-3}\ mol \cdot dm^{-3}$

$pH = -\log[H_3O^+]$ ✓
$= -\log(0,5 \times 10^{-3})$ ✓
$= 3,301$ ✓ (3)

7.4.1 Hydrolysis / *Hidrolise* ✓ (1)

7.4.2 Basic or alkaline/*Basis of alkalies* ✓ (1)

7.5

Marking criteria / Nasienkriteria:

a. Substitution of $(0,15 \times 0,1)$ in formula (n = c x v) to calculate n(HCℓ) ✓
Vervanging van $(0,15 \times 0,1)$ in formula (n = c x v) om n(HCℓ) te bereken
b. Use mole ratio/*Gebruik molverhouding:* $n(Ba(OH)_2)_{reacted}$:n HCℓ = 1:2 ✓
c. Substitution of $(0,05 \times 0,05)$ in formula $(n = c \times v)$ to calculate $n(H_2SO_4)$ ✓
Vervanging van $(0,05 \times 0,05)$ in formula $(n = c \times v)$ om $n(H_2SO_4)$ te bereken.
d. Use mol ratio/ *Gebruik molverhouding* $n(BaOH)_{2(excess)}$:H_2SO_4 = 1:1✓
e. $n(Ba(OH)_2)_{initial/aanvanklik} = n(Ba(OH)_2)_{reacted/gereageer} + n(Ba(OH)_2)_{excess/oormaat}$ ✓
f. Substitute 0,025 dm^3 to calculate $c(Ba(OH)_2)_{initial}$ ✓
Vervang 0,025 dm^3 om $c(Ba(OH)_2)_{aanvanklik}$ te bereken
g. Substitute $c(Ba(OH)_2)_{initial}$ and 171g·mol^{-1} in $c = \frac{m}{MV}$ ✓
Vervang $c(Ba(OH)_2)_{aanvanklik}$ en 171g·mol^{-1} in $c = \frac{m}{MV}$
h. Final answer / *Finale antwoord* (17,1 g)✓

$n(HCl) = cV$
$= (0,15)(0,1)$✓(a)
$= 0,015$ mol

$n(H_2SO_4) = cV$
$= (0,05)(0,05)$✓(c)
$= 0,0025$ mol

$n\left(Ba(OH)_{2(reacted)}\right) = ½n(HCl)$
$= ½(0,015)$
$= 0,0075$mol ✓(b)

$n\left(Ba(OH)_{2(excess)}\right) = n(H_2SO_4)$
$= 0,0025$mol ✓(d)

$nBa(OH)_{2(initial/aanvanklik)} = 0,0075 + 0,0025$✓ (e)
$= 0,01$ mol

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$c = \frac{n}{V}$ $= \frac{0,01}{0,025}$✓(f) $= 0,4$ mol · dm^{-3} $c = \frac{m}{MV}$ $0,4 = \frac{m}{(0,025)(171)}$✓(g) $m = 17,1$ g✓(h)	mol in 250 cm^3 $= \frac{0,01 \times 250}{25}$ $= 0,1$ mol (f)✓ $n = \frac{m}{M}$ $0,1 = \frac{m}{171}$✓(g) $= 17,1$ g ✓(h)

(8)
[20]

QUESTION 8 / VRAAG 8

8.1.1 A substance that is reduced/gains electrons/oxidation number decreases. ✓✓
'n Stof wat gereduseer word/elektrone opneem (2)

8.2 Fe^{3+} /iron (III) ions/*yster(III)ione*✓ (1)

8.3.1 $Cu(s)$✓/$Cu^{2+}(aq)$ // ✓ $Fe^{3+}(aq)$,$Fe^{2+}(aq)$/$Pt(s)$✓

NOTE/LET WEL
- If a phase separater (/) is used between Fe^{3+} and Fe^{2+} ($^2/_3$)
- *Indien 'n fasegrens (/) gebruik is tussen Fe^{3+} en Fe^{2+}* ($^2/_3$)
- Ignore phases/ *ignoreer fases* (3)

8.3.2 $Cu \rightarrow Cu^{2+} + 2e^-$ ✓✓ (Ignore phases) (2)

Notes/*Aantekeninge*

$Cu \rightleftharpoons Cu^{2+} + 2e^-$ ($^1/_2$)	$Cu^{2+} + 2e \leftarrow Cu$ ($^2/_2$)
$Cu^{2+} + 2e^- \rightleftharpoons Cu$ ($^0/_2$)	$Cu \leftarrow Cu^{2+} + 2e^-$ ($^0/_2$)

8.4.1 Decrease/*Verlaag* ✓ (1)

8.4.2
- $[Fe^{2+}]$ increases/*neem toe* ✓
- Reverse reaction is favoured/*Terugwaartse reaksie word bevoordee l*✓ (2)

8.5 Sn^{2+} is a stronger reducing agent ✓ than Cu✓
Sn^{2+} is 'n sterker reduseermiddel as Cu en dus sal Cu^{2+}/Cu ione gereduseer word/ Sn^{2+} word geoksideer
OR
Cu is a weaker reducing agent than Sn^{2+} and therefore Cu^{2+}/Cu ions are reduced/ Sn^{2+} is oxidised. ✓ (3)
[14]

QUESTION 9 / VRAAG 9

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

9.2.1 Nickel nitrate/*Nikkel nitraat*/$Ni(NO_3)_2$ /Ni^{2+}✓ (1)

9.2.2 Nickel/*Nikkel*/*Ni* ✓ (1)

9.2.3 $Ni^{2+} + 2e^- \rightarrow Ni$ ✓✓ (2)

9.3 Stays the same/ *Bly dieselfde* ✓

The rate of oxidation is equal to the rate of reduction/The rate at which Ni is oxidised is equal to the Ni^{2+} is reduced../*Die tempo van oksidasie is gelyk aan die tempo van reduksie* ✓ (2)

9.4

Marking criteria / Nasienkriteria:

- Substitute 59 in formula/ *vervanging van 59 in formule* $n = \frac{m}{M}$ ✓
- Use mol ratio / *Gebruik mol verhouding* - $2e^-$: Ni : 2:1 ✓
- Substitute $6,02 \times 10^{23}$ in formula / *Vervang* $6,02 \times 10^{23}$ *in formule* $N = nN_A$ ✓
- Final answer / *Finale antwoord* ($5,102 \times 10^{22}$ electrons) ✓

$$n(Ni) = \frac{m}{M}$$
$$= \frac{2,5}{59}\checkmark$$
$$= 0,0423 \text{ mol}$$

$$n(e^-) = 2n(Ni)\checkmark$$
$$= 2(0,0423)$$
$$= 0,085 \text{ mol}$$

$$N = nN_A$$
$$= (0,085)(6,02 \times 10^{23})\checkmark$$
$$= 5,102 \times 10^{22} \text{ electrons } \checkmark$$

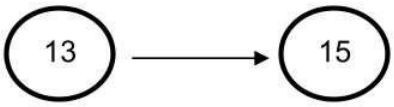
(4)
[11]

GRAND TOTAL/*GROOTTOTAAL* [150]

Table 1

QUESTION 4

Remove **Question 4.4**: Mark out of 13 and convert/scale to 15. Use the table below or formula: $\frac{\text{mark}}{13} \times 15$ e.g.



Conversion Table

Mark Obtained	Converted Mark
1	1
2	2
3	3
4	5
5	6
6	7
7	8
8	9
9	10
10	12
11	13
12	14
13	15