Benodigdhede vir hierdie vraestel/Requirements for this paper:			
Antwoordskrifte/ Answer scripts:		Multikeusekaarte (A5)/ Multi-choice cards (A5):	
Presensiestrokies (Invulvraestel)/ Attendance slips (Fill-in paper):		Multikeusekaarte (A4)/ Multi-choice cards (A4):	
Rofwerkpapier/ Scrap paper:		Grafiekpapier/ Graph paper:	

Sakrekenaars/Calculators:	Ja/Yes
Ander hulpmiddels/Other resources:	

Tipe assessering/ Type of assessment:	**Semester test**	Kwalifikasie/ Qualification:	**B.Sc., B.Pharm, B.Ing.**
Modulekode/ Module code:	**NCHE111**	Tydsduur/ Duration:	**1½ uur / 1½ hours**
Modulebeskrywing/ Module description:	**Introduction to Inorganic and Physical Chemistry**	Maks/ Max:	**45**
Eksaminator(e)/ Examiner(s):	**Dr. CE Read**	Datum/ Date:	**19 April 2023**
Interne/Internal moderator(s):		Tyd/ Time:	**08:00 – 09:30**

Inhandiging van antwoordskrifte/Submission of answer scripts: **Gewoon/Ordinary**

Titel: **Van:** **MEMORANDUM**

Title: **Surname:**

Volle voorletters: **Universiteitsnommer:**

Full initials: **University number:**

Eksamenvoorskrifte / Examination instructions

1. Studente mag in die eerste halfuur van 'n sessie tot die lokaal toegelaat word, maar geen ekstra tyd word toegestaan nie.
2. Geen student word toegelaat om die lokaal te verlaat binne die eerste halfuur van 'n eksamensessie nie.
3. Studente bring sakke na lokaal op **eie risiko**, en moet dit voor in die lokaal neersit.
4. Studente mag nie selfone/elektroniese toestelle by hulle hê en/of hanteer nie.
5. Geen verversings word in 'n eksamenlokaal toegelaat nie.
6. Studente mag nie die lokaal verlaat om te gaan rook nie.
7. Skryf op beide kante van die bladsye.
8. Skryf slegs in swart of blou ink.
9. Geen bladsye mag uit die antwoordskrif verwyder word nie.
10. Studente mag nie ontoelaatbare materiaal by hulle hê tydens 'n sessie nie, bv. notas en/of objekte wat notas bevat nie.
11. Geen items mag tydens die sessie geleen word nie.
12. Studente mag nie 'n ander student probeer help of probeer om hulp te kry nie.
13. Studente **moet** hul antwoordskrifte aan toesighouers oorhandig voordat hulle die lokaal verlaat.
14. Die presensiestrokie op die agterblad, wat ook as onderneming geld, **moet** voltooi en ingegee word.

1. Students are allowed into the venue in the first half hour of a session, but no extra time is granted.
2. No student is allowed to leave the venue before half an hour of the examination session has elapsed.
3. Students bring bags to the venue at **own risk**, and must put them in front of the room.
4. Students may not have cell phones/electronic devices with them and/or handle them.
5. No refreshments are allowed in the examination venue.
6. Students may not leave the room for a smoke break.
7. Write on both sides of each page.
8. Write in black or blue ink only.
9. No pages may be removed from the answer scripts.
10. Students may not have unauthorized material with them during a session, e.g. notes and/or objects that contain notes.
11. No items may be borrowed during the session.
12. Students may not attempt to assist another student, or attempt to obtain assistance.
13. Students **must** hand in their answer scrips to invigilators before they leave the venue.
14. The attendance slip on the back cover that also serves as an undertaking, **must** be completed and handed in.

LEES DIE VOLGENDE INSTRUKSIES DEEGLIK

Antwoorde op vrae moet in die oopgelate ruimtes by elke vraag gegee word.

Die vraestel moet in pen voltooi word.

Jy mag die bladsy agter met die periodieke tabel en oplosbaarheidstabel daarop afskeur.

Die sakrekenaarfunksie van selfone mag nie gebruik word nie. Jy mag wel 'n normale nie-programmeerbare sakrekenaar gebruik.

Die volgende tabelle is aangeheg:

- 'n Periodieke tabel
- 'n Oplosbaarheidstabel

READ THE FOLLOWING INSTRUCTIONS THOROUGHLY

Answers to questions must be given in the blank spaces below each question.

The paper must be completed in pen.

You may tear off the page at the back with the periodic table and the solubility table on it.

The calculator function on cell phones may not be used. You may use a normal non-programmable calculator.

The following tables are attached:

- *A periodic table*
- *A table of solubilities*

For ALL calculations in this paper allow for a small deviation in the answers because of different ways of rounding of the answers. Also, if the answer is correct you don't have to give marks for steps. If an answer is correct and a method was followed you can give full marks for that question. Only look for individual marks when the answer is wrong.

Vraag 1. / *Question 1.*

Gee die naam en lading van die katioon en die anioon in $PbCO_3$. / *Give the name and charge of the cation and anion in $PbCO_3$.* **[4]**

Naam en lading van katioon: / *Name and charge of cation:*

Name: **Lood(II)ioon or Lead(II) ion** ✓

Charge; **Pb^{2+} (or just 2+)** ✓

Naam en lading van anioon: / *Name and charge of anion:*

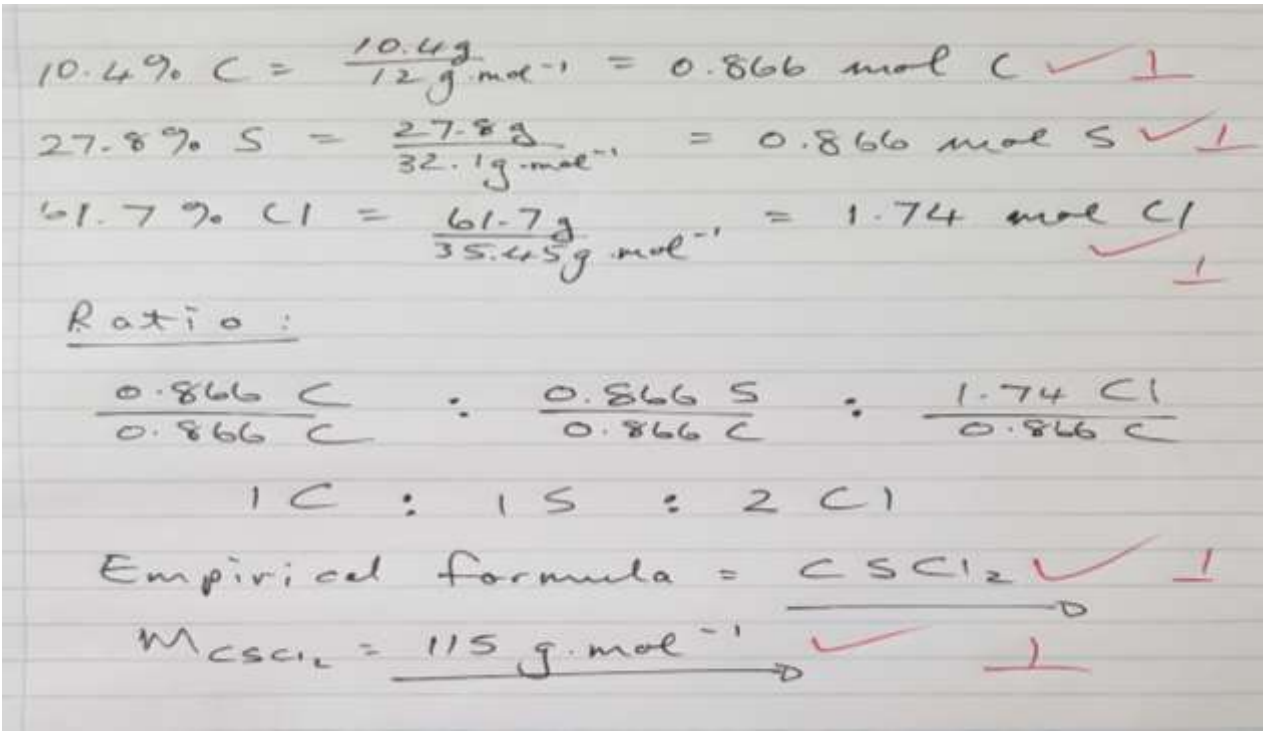
Name: **Karbonaatioon or Carbonate ion** ✓

Charge: **CO_3^{2-} (or just 2-)** ✓

Vraag 2. / *Question 2.*

Bepaal die empiriese formule van 'n verbinding met die volgende massa samestelling. Bereken dan ook die molêre massa van die empiriese formule. / *Determine the empirical formula of a compound with the following mass composition. Then also calculate the molar mass of the empirical formula.* **[5]**

10.4% C, 27.8% S and 61.7% Cl.



Vraag 3. / *Question 3.*

Voltooi die volgende tabel deur die oop spasies in te vul. / *Complete the following table by filling the gaps.*

[6 x ½ = 3]

Simbool: ***Symbol:***	$^{59}Co^{3+}$	$^{80}Se^{2-}$
Protone: ***Protons:***	**27**	34
Neutrone: ***Neutrons:***	**32**	46
Elektrone: ***Electrons:***	**24**	36
Netto lading: ***Netto charge:***	**+ 3**	**- 2**

Vraag 4. / *Question 4.*

Kapsaisien, die verbinding wat die warm smaak aan chilliepepers gee, het die formule $C_{18}H_{27}NO_3$. Bereken die massapersentasie koolstof in die verbinding **en** bereken dan die massa koolstof (in milligram) in 55 mg kapsaisien.

*Capsaicin, the compound that gives the hot taste to chili pepers, has the formula $C_{18}H_{27}NO_3$. Calculate the mass percentage of carbon in the compound **and** also calculate the mass of carbon (in milligram) in 55 mg of capsaicin.*

[3]

$M_{C18H27NO3}$= 305.27 g.mol^{-1}

Mass % C = 18(12) / 305.27 x 100/1 = 70.75 % C

Mass C in 55 mg

Mass C = (55 mg)0.7075 = 38.9 mg C

Vraag 5. / *Question 5.*

Skryf 'n gebalanseerde reaksievergelyking vir die volledige verbranding van butaan, C_4H_{10}, neer. / *Write down a balanced reaction equation for the complete combustion of butane, C_4H_{10}.* **[2]**

$2\ C_4H_{10}\ (g) + 13\ O_2\ (g) \rightarrow 8\ CO_2\ (g) + 10\ H_2O\ (g)$

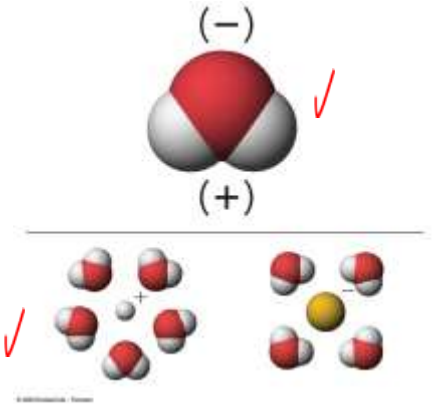
A student do not have to give the physical states of the products and reagents. One mark for the reagent side and one mark for the product side. Everything on the side must be correct to receive the mark.

Vraag 6. / *Question 6.*

Teken 'n watermolekule waarop jy die eienskappe wat van water 'n goeie oplosmiddel maak aantoon. Teken dan ook 'n voorstelling om die interaksie van watermolekules met wateroplosbare katione en anione te illustreer. / *Draw a*

watermolecule on which you indicate the properties that make water a good solvent. Also draw a representation to illustrate the interaction of water molecules with water soluble cations and anions. **[3]**

Any 3 of the 6 marks are good.



H_2O is polar because of the bent structure (hoekige struktuur)

H_2O is amfiprotic (amfiproties) (can act as an acid or as a base).

H_2O can undergo auto protolysis (outoprotoliese).

Take note of the direction of the polar water molecule. For cations the negative O-atom side of the water molecule should be in the direction of the cations and for the anions the positive H-atoms should be in the direction of the anion.

Vraag 7. / *Question 7.*

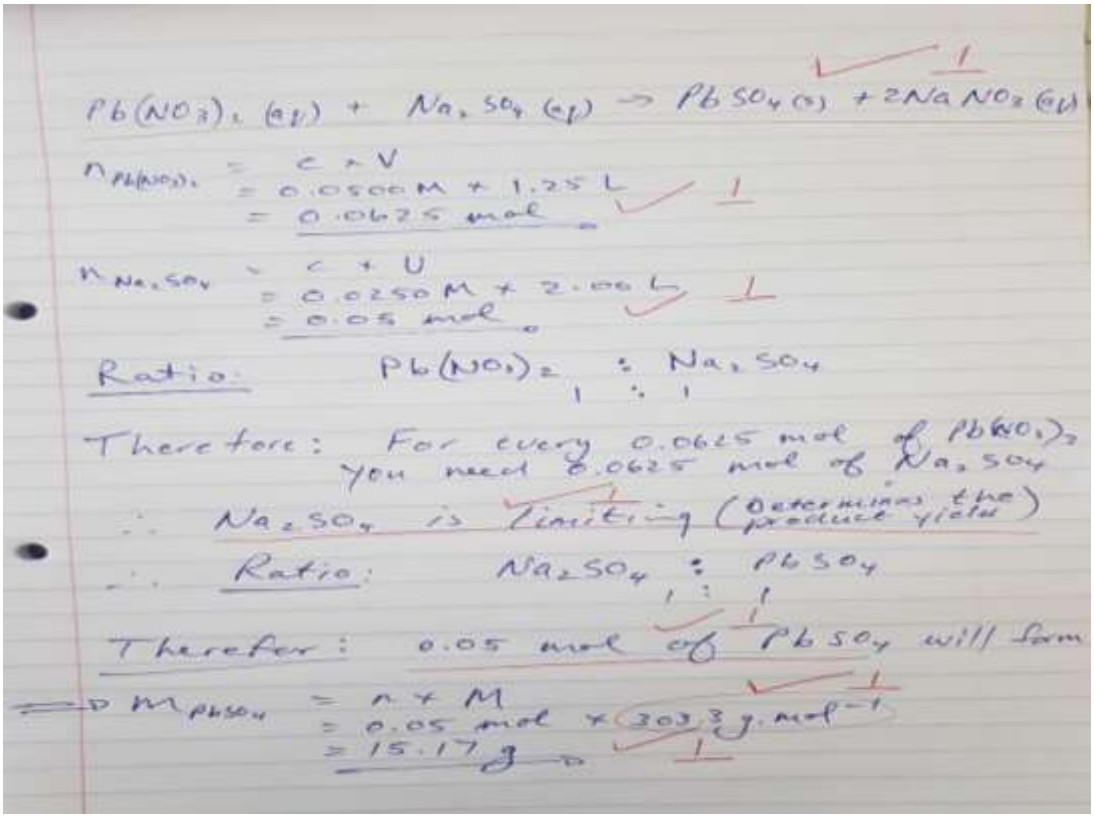
Voltooi die volgende tabel met betrekking tot wateroplosbaarheid. Die oplosbaarheidstabel is agter aan die vraestel vasgeheg. Jy mag dit afskeur en hou. / *Complete the following table with regards to water solubility. The solubility table is attached at the back of the paper. You may tear it of and keep it.* **[4 x ½ = 2]**

Verbinding. *Compound.*	**Wateroplosbaar.** *Water soluble.*		**Dui die ione wat in die oplossing teenwoordig is aan.** *Indicate the ions that is present in the solution.*
	Ja. / *Yes.*	**Nee. / *No.***	
CaF_2		**X**	**No ions because CaF_2 is not soluble.**
Na_2CrO_4	**X**		**Na^+ and CrO_4^{2-}**

Vraag 8. / *Question 8.*

Wanneer waterigeoplossings van Na_2SO_4 en $Pb(NO_3)_2$ gemeng word, presipiteer $PbSO_4$ uit. Bereken die massa $PbSO_4$ (in gram) wat vorm wanneer 1.25 L van 'n 0.0500 M $Pb(NO_3)_2$ oplossing en 2.00 L van 'n 0.0250 M Na_2SO_4 oplossings gemeng word. / *When aqueous solutions of Na_2SO_4 and $Pb(NO_3)_2$ are mixed, $PbSO_4$ precipitates. Calculate the mass of $PbSO_4$ (in grams) formed when a 1.25 L solution of 0.0500 M $Pb(NO_3)_2$ and a 2.00 L solution of 0.0250 M Na_2SO_4 are mixed.* **[4]**

To get 4 marks the final answer must be correct and then any 3 extra marks can be allocated. If the final answer is wrong a student can not get 4 marks but at most 3 marks.

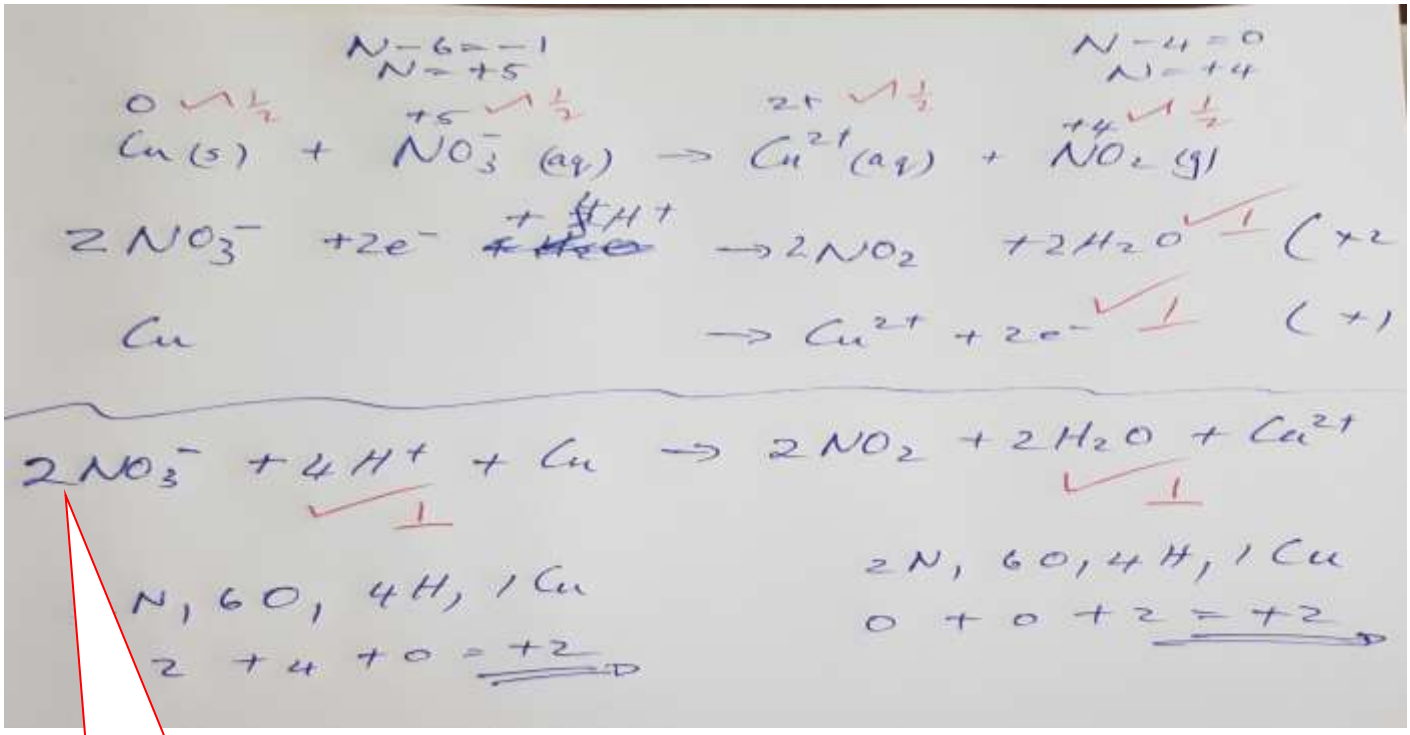

$Pb(NO_3)_2(aq) + Na_2SO_4(aq) \rightarrow PbSO_4(s) + 2NaNO_3(aq)$
$n_{Pb(NO_3)_2} = c \times V$
$= 0.0500\ M \times 1.25\ L$
$= 0.0625\ mol$
$n_{Na_2SO_4} = c \times V$
$= 0.0250\ M \times 2.00\ L$
$= 0.05\ mol$
Ratio: $Pb(NO_3)_2 : Na_2SO_4$
1 : 1
Therefore: For every 0.0625 mol of $Pb(NO_3)_2$ you need 0.0625 mol of Na_2SO_4
$\therefore Na_2SO_4$ is limiting (Determines the product yield)
$\therefore$ Ratio: $Na_2SO_4 : PbSO_4$
1 : 1
Therefor: 0.05 mol of $PbSO_4$ will form
$\Rightarrow m_{PbSO_4} = n \times M$
$= 0.05\ mol \times 303.3\ g.mol^{-1}$
$= 15.17\ g$

Vraag 9. / *Question 9.*

Balanseer die volgende redoksreaksie in 'n suurmedium. / *Balance the following redox reaction occuring in acidic solution.* **[5]**

$$Cu\ (s) + NO_3^-\ (aq) \rightarrow Cu^{2+}\ (aq) + NO_2\ (g)$$

No marks are given for the mass and charge balance. A student does not have to show all the steps. If the final equation is correctly balanced and there are a method that was followed you can give the student the full 5 marks. The physical states of the reagents and products do not have to be shown. If the final reaction is not correctly balanced, then you can look for marks in the steps.



FINAL EQUATION

Vraag 10. / *Question 10.*

'n Mengsel van $Ba(OH)_2$ en $Ba(OH)_2{\cdot}8H_2O$ het 'n massa van 2.300 g. Nadat die mengsel genoegsaam verhit is om al die water af te dryf, was die massa slegs 1.830 g. Bereken die persentasie $Ba(OH)_2{\cdot}8H_2O$ in die oorspronklike mengsel.

A mixture of $Ba(OH)_2$ and $Ba(OH)_2{\cdot}8H_2O$ has a mass of 2.300 g. After sufficient heating to drive off all the water, the mass is only 1.830 g. Calculate the percentage of $Ba(OH)_2{\cdot}8H_2O$ in the original mixture. **[5]**

(**Gegee: / *Given:*** M_{H2O} = 18.02 g.mol^{-1}; $M_{Ba(OH)2}$ = 171.32 g.mol^{-1}; $M_{Ba(OH)2.8H2O}$ = 315.5 g.mol^{-1})

m_{H2O} = 2.300 g – 1.830 g = 0.470 g H_2O ✓

n_{H2O} = 0.470 g / 18.02 g.mol^{-1} = 0.026 mol (2.6 x 10^{-2} mol) ✓

From the formula the ratio between $Ba(OH)_2$ and H_2O in $Ba(OH)_2{\cdot}8H_2O$ is: 1 $Ba(OH)_2{\cdot}8H_2O$: 8 H_2O

Therefor: 0.026 mol of water equates to 0.026 / 8 = 0.00325 mol $Ba(OH)_2{\cdot}8H_2O$ ✓

$m_{Ba(OH)2.8H2O}$ = 0.00325 mol x 315.5 g.mol^{-1} = 1.025 g $Ba(OH)_2 \cdot 8H_2O$

% $Ba(OH)_2 \cdot 8H_2O$ in mixture = (1.025 g / 2.300 g) x 100 = 44.56 % ✓

Vraag 11. / *Question 11.*

Beskou die volgende reaksie: / *Consider the following reaction:*

$$2Sb\ (s) + 3I_2\ (s) \rightarrow 2SbI_3\ (s)$$

Bereken die beperkende reagens en die teoretiese opbrengs indien 1.20 mol van Sb en 1.20 mol van I_2 gemeng word.
Calculate the limiting reactant and the theoretical yield when 1.20 mol of Sb and 1.20 mol of I_2 are mixed. **[3]**

From equation the mol ratio between Sb and I_2 = 2 Sb : 3 I_2
Therefor: for each 1.20 mol Sb: (1.20 x 3) / 2 = 1.80 mol I_2 is needed. There are only 1.20 mol I_2 available en therefor the I_2 is the limiting reagent. ✓
OR
From the equation the mol ratio between Sb and I_2 = 2 Sb : 3 I_2
Therefor: for each 1.20 mol I_2 : (1.20 x 2) / 3 = 0.80 mol Sb is needed. There are 1.20 mol of Sb, meaning that Sb is in excess. Therefor I_2 is the limiting reagent.

Theoretical yiel: From equation the mol ration between I_2 and SbI_3 = 3 I_2 : 2 SbI_3 ✓
Therefor: for each 1.20 mol of I_2 there will vorm (1.20 x 2) / 3 = 0.80 mol of SbI_3 will vorm.
m_{SbI3} = 0.80 mol x 505.3 g.mol^{-1} = 404.24 g SbI_3 will vorm. ✓

Vraag 12. / *Question 12.*

Bereken die molêre konsentrasie van 'n 250 mL natriumkarbonaatoplossing indien jy 3.65 g natriumkarbonaat opgelos het. / *Calculate the molar concentration of a 250 mL sodium carbonate solution if you dissolved 3.65 g of sodium carbonate.* **[3]**

n_{Na2CO3} = 3.65 g / 106 g.mol^{-1} = 0.0344 mol ✓ ✓

[Na_2CO_3] = 0.0344 mol / 0.25 L = 0.137 M (0.14 M) ✓

Vraag 13. / *Question 13.*

Bereken die **molaliteit** van die volgende oplossing: / *Calculate the **molality** of the following solution:*

0.0167 g Na_3PO_4 word opgelos in 100 mL water. Die digtheid van water is 0.98 $g.mL^{-1}$ en die molêre massa van natriumfosfaat is 164 $g.mol^{-1}$.

0.0167 g of Na_3PO_4 is dissolved in 100 mL of water. The density of water is 0.98 $g.mL^{-1}$ and the molar mass of sodium phosphate is 164 $g.mol^{-1}$. **[3]**

100 mL water = (100) 0.98 = 98.0 g water = 0.098 kg water ✓

n_{Na3PO4} = 0.0167 g / 164 $g.mol^{-1}$ = 1.018 x 10^{-4} mol Na_3PO_4 ✓

Molality (m) = n / mass solvent in kg = 1.018 x 10^{-4} mol / 0.098 kg = 0.00104 m (1.04 x 10^{-3} m) ✓