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| Benodigdhede vir hierdie vraestel/Requirements for this paper: | | | |
|---|---|---|---|
| Antwoordskrifte/ Answer scripts: | | Multikeusekaarte (A5)/ Multi-choice cards (A5): | |
| Presensiestrokies (Invulvraestel)/ Attendance slips (Fill-in paper): | X | 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: | **Examination 1st opportunity Paper/Vraestel 1** | Kwalifikasie/ Qualification: | **B.Sc., B.Pharm, B.Ing.** |
| Modulekode/ Module code: | **NCHE111** | Tydsduur/ Duration: | **3 uur 3 hour** |
| Modulebeskrywing/ Module description: | **Introduction to Inorganic and Physical Chemistry** | Maks/ Max: | **100** |
| Eksaminator(e)/ Examiner(s): | **Dr CE Read Prof. CA Strydom Dr. E Mashuga** | Datum/ Date: | **19 June 2019** |
| Interne/Internal moderator(s): | **Prof. CGCE van Sittert** | Tyd/ Time: | **09:00** |

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

**Titel:** **Title:** _____ **Van:** **Surname:** **MEMORANDUM**

**Volle voorletters:** **Full initials:** _____ **Universiteitsnommer:** **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 rugkante van bladsye kan ook gebruik word, maar dan moet dit duidelik by die vraag aangedui word. Dit kan ook vir rofwerk gebruik word.

Die vraestel moet in pen voltooi word.

'n Periodiek tabel is aangeheg en jy mag die bladsy afskeur vir gebruik.

Sakrekenaars is toelaatbaar. Die sakrekenaarfasiliteit op selfone is nie toegelaat nie.

Avogadrogetal ($N_A$): 6,022 x $10^{23}$ $mol^{-1}$

Alle berekeninge moet getoon word!

***READ THE FOLLOWING INSTRUCTIONS THOROUGHLY***

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

*The back of pages can also be used, but it should then be indicated at each question. It can also be used for own scribbling.*

*The paper must be completed in pen.*

*A periodic table is attached and you may tear it off for use.*

*Calculators are allowed. The calculator facility on mobile phones is not allowed.*

*Avogadro's number ($N_A$): 6,022 x $10^{23}$* $mol^{-1}$

*All calculations must be shown!*

√ $= \frac{1}{2}$ **punt**

√ $= 1$ **punt**

**For ALL calculations in this paper allow for a small deviation on 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.*** **[40 PUNTE. / *40 MARKS*.]**

**STUDY UNITS 2, 3, 4 AND 5 (THIS IS NOT GOING TO STAND IN THE PAPER).**

**Beide kampusse se studente antwoord vraag 1.1 / *Students from both campuses answer question 1.1***

1.1 Skryf die formules of name van die volgende verbindings neer. / *Write down the formulas or names of the following compounds.* **[4]**

**No half marks. The answer is correct or incorrect.**

1.1.1 Tin(IV)fluoried. / Tin(IV) fluoride. **$SnF_4$** ✓

1.1.2 $PbO_2$ **Lood(IV)oksied. / *Lead(IV) oxide.*** ✓

1.1.3 Kaliumperchloraat. / *Potassium perchlorate.* **$KClO_4$** ✓

1.1.4 KCl **Kaliumchloried. / *Potassium chloride.*** ✓

**Beide kampusse se studente antwoord vraag 1.2 / *Students from both campuses answer question 1.2***

1.2 Wat is die simbool vir die ioon met 63 protone, 60 elektrone en 89 neutrone? / *What is the symbol for the ion with 63 protons, 60 electrons and 89 neutrons?* **[1]**

**$Eu^{3+}$** ✓

**Beide kampusse se studente antwoord vraag 1.3 / *Students from both campuses answer question 1.3***

1.3 Bereken die massapersentasie aluminium in $Ca_3Al_2O_6$ (Trikalsiumaluminaat). / *Calculate the mass percentage aluminium in $Ca_3Al_2O_6$ (Tricalcium aluminate).* **[2]**

**$M_{Ca3Al2O6} = 270.3\ g.mol^{-1}$**

**$M_{Al2} = 54\ g.mol^{-1}$**

**% Al = $M_{Al}$ / $M_{Ca3Al2O6}$ = (54 g.mol$^{-1}$ / 270.3 g.mol$^{-1}$) x 100 = 19.98 % Al (20% Al)** ✓ ✓

**Beide kampusse se studente antwoord vraag 1.4 / *Students from both campuses answer question 1.4***

1.4 'n Element X Het vyf hoof isotope wat hieronder saam met hul persentasie voorkoms gelys word. Bereken die gemiddelde relatiewe atoommassa en identifiseer dan die element. / *An element X has five main isotopes, which are listed below along with their percentage abundances. Calculate the average relative atomic mass **and** then identify the element.* **[2]**

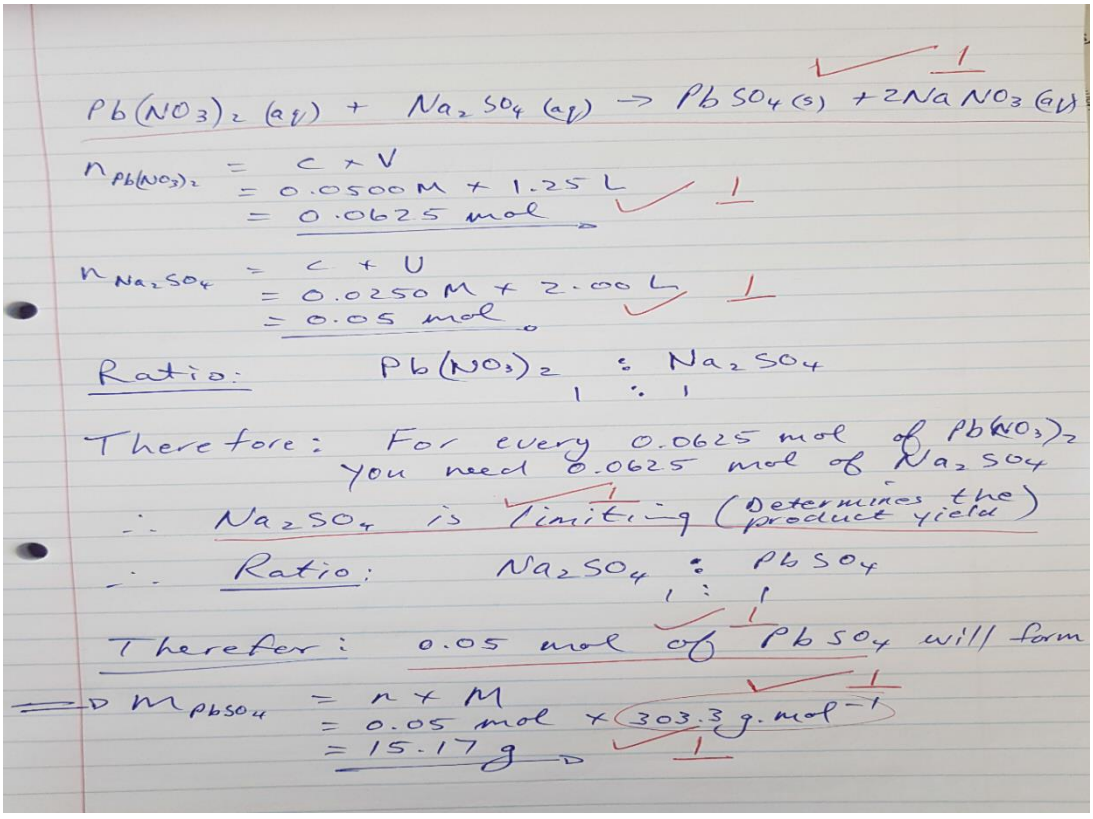
| Isotope | % Abandance | Relative mass (amu) |
|---|---|---|
| $^{46}X$ | 8.00 | 45.95269 |
| $^{47}X$ | 7.30 | 46.951764 |
| $^{48}X$ | 73.80 | 47.947947 |
| $^{49}X$ | 5.50 | 48.947841 |
| $^{50}X$ | 5.40 | 49.944792 |

**Average relative mass = (45.95269 x 0.08) + (46.951764 x 0.073) + (47.947947 x 0.738) + (48.947841 x 0.055) + (49.944792 x 0.054) = 47.88 (47.9)** ✓

**Element = Ti** ✓

**Beide kampusse se studente antwoord vraag 1.5 / *Students from both campuses answer question 1.5***

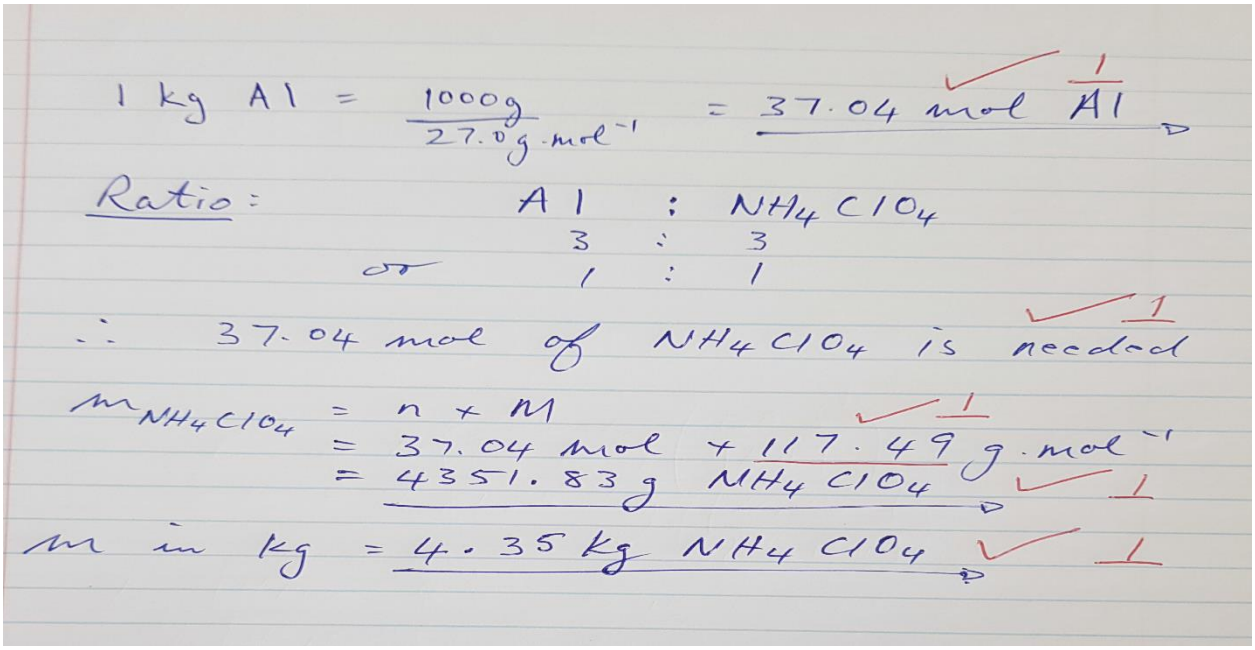
1.5 Wanneer waterigeoplossings van $Na_2SO_4$ en $Pb(NO_3)_2$ gemeng word, presipiteer $PbSO_4$ uit. Bereken die massa $PbSO_4$ (in gram) wat vorm wanneer 1.25 L van 'n 0.0500 M $Pb(NO_3)_2$ oplossing en 2.00 L van 'n 0.0250 M $Na_2SO_4$ oplossings gemeng word. / *When aqueous solutions of $Na_2SO_4$ 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.* **[7]**



**Beide kampusse se studente antwoord vraag 1.6 / *Students from both campuses answer question 1.6***

1.6 Bereken die massa $NH_4ClO_4$ (in kg) wat nodig is vir 1 kg Al. / *Calculate the mass of $NH_4ClO_4$ (in kg) that is nessessary for 1 kg of Al.* **[5]**

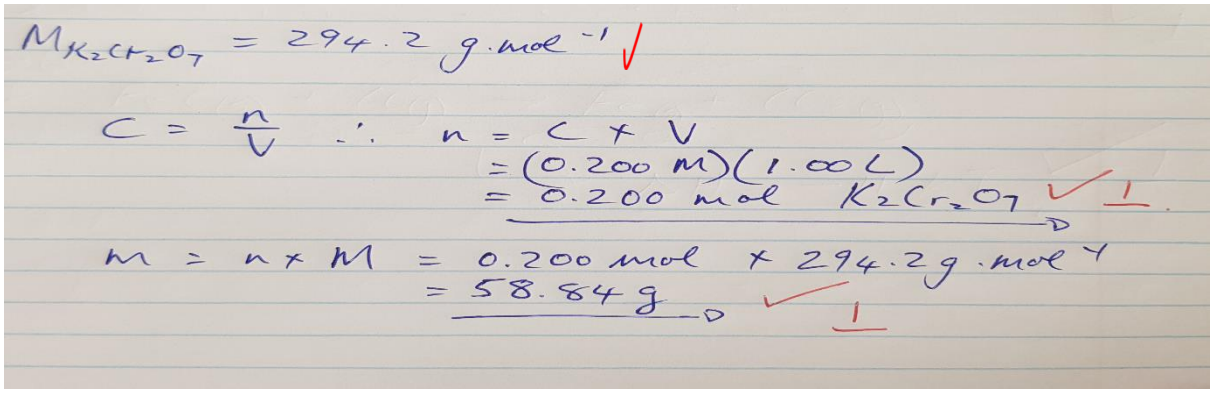
$$3Al\ (s) + 3NH_4ClO_4\ (s) \rightarrow Al_2O_3\ (s) + AlCl_3\ (s) + 3NO\ (g) + 6H_2O\ (g)$$




**Beide kampusse se studente antwoord vraag 1.7 / *Students from both campuses answer question 1.7***

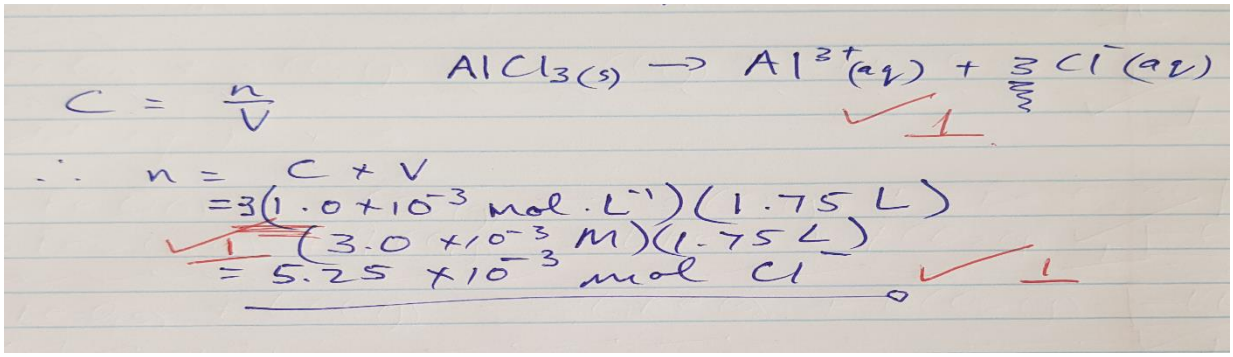
1.7 Om die alkohol inhoud van 'n sekere wyn te bepaal het 'n chemikus 1.00 L van 'n waterige oplossing 0.200 M $K_2Cr_2O_7$ (kaliumdichromaat) nodig. Bereken die massa (in gram) soliede $K_2Cr_2O_7$ wat afgeweeg moet word om hierdie oplossing voor te berei? / *To analyze the alcohol content of a certain wine, a chemist needs 1.00 L of an aqueous 0.200 M $K_2Cr_2O_7$ (potassium dichromate) solution. Calculate the mass (in gram) of solid $K_2Cr_2O_7$ that must be weighed out to make this solution?*

**[3]**



**Beide kampusse se studente antwoord vraag 1.8 / *Students from both campuses answer question 1.8***

1.8 Bereken die molhoeveelheid $Cl^-$ ione in 1.75 L van 'n 1.0 x $10^{-3}$ M $AlCl_3$ oplossing. / *Calculate the mole amount of $Cl^-$ ions in 1.75 L of a 1.0 x $10^{-3}$ M $AlCl_3$ solution.* **[3]**




**Beide kampusse se studente antwoord vraag 1.9 / *Students from both campuses answer question 1.9***

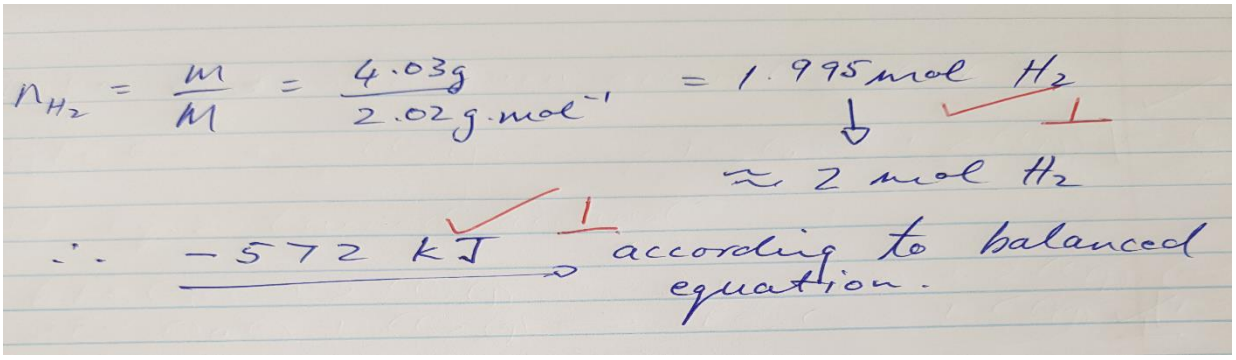
1.9 Beskou die volgende reaksie en beantwoord dan die daaropvolgende vrae: / *Consider the following reaction and then answer the following questions:*

$$2H_2\,(g) + O_2\,(g) \rightarrow 2H_2O\,(\ell) \qquad \Delta H = -\,572\ kJ$$

1.9.1 Hoeveel hitte word vrygestel vir die vorming van 1.00 mol $H_2O$ ($\ell$)? / *How much heat is evolved for the production of 1.00 mol $H_2O$ ($\ell$)?* **[1]**

**- 572/2 = - 286 kJ** ✓

1.9.2 Hoeveel hitte word vrygestel wanneer 4.03 g waterstof met 'n oormaat suurstof reageer? / *How much heat is evolved when 4.03 g hydrogen is reacted with excess oxygen?* **[2]**



**Beide kampusse se studente antwoord vraag 1.10 / *Students from both campuses answer question 1.10***

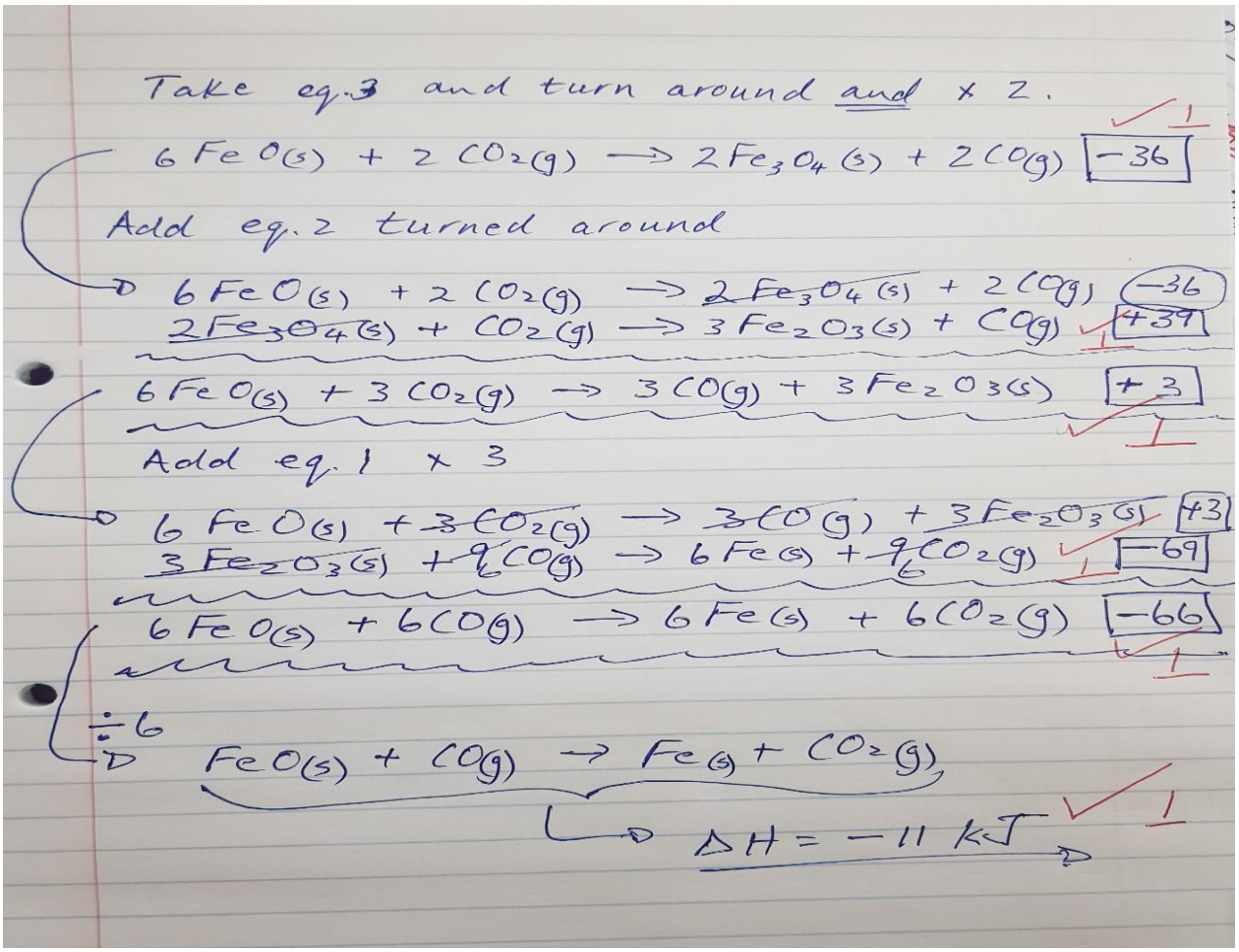
1.10 Gegewe die volgende data: / *Given the following data:*

1. $Fe_2O_3$ (s) + 3CO (g) → 2Fe (s) + $3CO_2$ (g) ΔH = - 23 kJ
2. $3Fe_2O_3$ (s) + CO (g) → $2Fe_3O_4$ (s) + $CO_2$ (g) ΔH = - 39 kJ
3. $Fe_3O_4$ (s) + CO (g) → 3FeO (s) + $CO_2$ (g) ΔH = 18 kJ

Bereken ΔH vir die volgende reaksie: / *calculate ΔH for the following reaction:* **[6]**

4. FeO (s) + CO (g) → Fe (s) + $CO_2$ (g) **ΔH = ?**

**There are more than one way to tackle this problem. If the student has an answer of - 11 kJ he/she must have worked correctly and can get the full 6 marks. So, if a method was followed and the answer is correct give full marks. Only look for extra marks when the answer is incorrect.**



**Beide kampusse se studente antwoord vraag 1.11 / *Students from both campuses answer question 1.11***

1.11 Voltooi die volgende reaksievergelykings deur van die oplosbaarheidstabel aan die einde van hierdie vraestel gebruik te maak. Balanseer die vergelykings en wys die fisiese toestande van al die produkte.

*Using the solubility table at the back of this paper, complete the following reaction equations. Balance the equations and show the physical states of all the products.* **[4]**

1.11.1 ____$Na_2SO_4$ (aq) + ____$Pb(NO_3)_2$ (aq) → **____$PbSO_4$ (s) + __$2NaNO_3$ (aq)**

1.11.2 ____$SrCl_2$ (aq) + ____$Ag_2SO_4$ (aq) → **__2AgCl (s) + ____$SrSO_4$ (s)**

**Both products in eq. 1.11.2 are insoluble!! The formula and balancing and physical state must be correct to get a mark.**

**VRAAG 2. / *QUESTION 2.*** **[21 PUNTE. / 21 *MARKS*.]**

**ONLY STUDY UNIT 7 (THIS IS NOT GOING TO STAND IN THE PAPER).**

**Beide kampusse se studente antwoord vraag 2.1 / *Students from both campuses answer question 2.1***

2.1 Steenkool wat hoofsaaklik koolstof is, kan na natuurlike gas,metaangas ($CH_4$), omgeskakel word deur die volgende eksotermiese reaksie. / *Coal, which is primarily carbon, can be converted to natural gas, primarily methane gas ($CH_4$), by the following exothermic reaction.*

$$C(s) + 2H_2(g) \leftrightarrows CH_4(g)$$

Indien die reaksie in ewewig is, voorspel die effek van: / *If this reaction mixture is at equilibrium, predict the effect of:* **[3]**

| | |
|---|---|
| Voeg nog C by die reaksiemengsel.<br>*Adding more C to the reaction mixture.* | **No effect** ✓ |
| Voeg nog $H_2$ by die reaksiemengsel.<br>*Adding more $H_2$ to the reaction mixture.* | **Move towards products to decrease [H]** ✓ |
| Verhoog die temperatuur van die reaksiemengsel.<br>*Raising the temperature of the reaction mixture.* | **Move towards reactants to decrease the temp** ✓ |

**Beide kampusse se studente antwoord vraag 2.2 / *Students from both campuses answer question 2.2***

2.2 Veronderstel 0.0864 mol $Br_2$ word in 'n 1.44 L fles geplaas en dan verhit tot 1756 K, 'n temperatuur waar die halogeen begin dissosieer na atome: $Br_2$ (g) $\leftrightarrows$ 2Br (g).
*Suppose 0.0864 mol of $Br_2$ is placed in a 1.44 L flask and heated to 1756 K, a temperature at which the halogen starts to dissociate to atoms: $Br_2(g) \leftrightarrows 2Br(g)$*

Indien $Br_2$ slegs 12.3% gedissosieer is by hierdie temperatuur wat is $K_c$? / *If $Br_2$ is only 12.3% dissociated at this temperature, what is $K_c$.* **[4]**

**$[Br_2] = 0.0864 / 1.44 =$ <u>0.060 mol/dm$^3$</u>** ✓

**If $Br_2$ is dissociated 12.3% of $[Br_2] = (0{,}060) \times (0{,}123) =$ <u>0.00738 M</u>** ✓ **(7.38 x $10^{-3}$ M)**

| | $Br_2(g)$ | $\leftrightarrows$ | 2 Br(g) |
|---|---|---|---|
| **A** | **0.06** | | **0** |
| **V** | **-0.00738** | | **2(+0.00738)** |
| **E** | **0.0526** ✓ | | **0.0147** ✓ |

**$K = [Br]^2 / [Br_2] = (0.0147)^2 / (0.0526) =$ <u>4.12 x $10^{-3}$</u>** ✓

**Beide kampusse se studente antwoord vraag 2.3 / *Students from both campuses answer question 2.3***

2.3 Gebruik die gegewe inligting hieronder om die daarop volgende vrae te beantwoord.
*Use the given information below to answer the questions that follow.*

$$2Fe^{3+}(aq) + 3I^{-}(aq) \leftrightarrows 2Fe^{2+}(aq) + I_3^{-}(aq)$$

| | $2Fe^{3+}$ (aq) | $3I^{-}$ (aq) | $2Fe^{2+}$ (aq) | $I_3^{-}$ (aq) |
|---|---|---|---|---|
| A (I) | 0.300 M | 0.200 M | **0** | **0** |
| V (C) | **-2x** ✓ | **-3x** ✓ | **+2x** ✓ | +x **(0.025)** |
| E (E) | **0.300 – 2x**<br>**= 0.300 -2(0.025)**<br>**= 0.25** ✓ | **0.200 – 3x**<br>**= 0.200 – 3(0.025)**<br>**= 0.125** ✓ | **2(0.025) = 0.05** ✓ | 0.025 M |

2.3.1 Bereken die ewewigskonsentrasies van al die reagense en oorblywende produk. / *Calculate the equilibrium concentrations of all the reagents and remaining product.* **[3]**

**SEE TABLE ABOVE**

2.3.2 Bereken die ewewigskonstante, $K_c$. / *Calculate the equilibrium constant, $K_c$.* **[2]**

**$K = [Fe^{2+}]^2[I_3^-] / [Fe^{3+}]^2[I^-]^3$** ✓

**$= [0.05]^2[0.025] / [0.25]^2[0.125]^3$**

**$= 0.512$** ✓

2.3.3 Is bogenoemde reaksie 'n reagensbevoordeelde of produkbevoordeelde reaksie? / *Is the reaction above a reagent favoured or a product favoured reaction?* **[1]**

**Reagent favoured** ✓

**Beide kampusse se studente antwoord vraag 2.4 / *Students from both campuses answer question 2.4***

2.4 'n Mengsel van stikstof, waterstof en ammoniak is tot ewewig gebring. Wanneer die vergelyking geskryf word deur van heelgetal koëffisiente gebruik te maak, soos volg, is die waarde van K = 3.5 x $10^8$.
*A mixture of nitrogen, hydrogen and ammonia is brought to equilibrium. When the equation is written using whole-number coefficients, as follows, the value of K is 3.5 x $10^8$.*

**Vergelyking 1. / *Equation 1.*** $N_2$ (g) + $3H_2$ (g) ⇆ $2NH_3$ (g) $K_1 = 3.5 \times 10^8$

2.4.1 Wat is die waarde van K vir die volgende reaksie? / *What is the value of K for the following reaction?* **[1]**

**Vergelyking 2. / *Equation 2.*** ½$N_2$ (g) + 1½$H_2$ (g) ⇆ $NH_3$ (g) **$K_2$ = ?**

**$K_2 = (K_1)^{½} = \sqrt{K} = \sqrt{3.5 \times 10^8} = 1.9 \times 10^4$** ✓

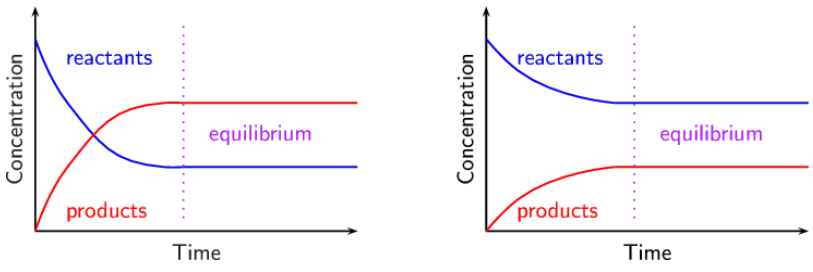
2.4.2 Wat is die waarde van K vir die volgende reaksie? / *What is the value of K for the following reaction?* **[1]**

**Vergelyking 3. / *Equation 3.*** $2NH_3$ (g) ⇆ $N_2$ (g) + $3H_2$ (g) **$K_3$ = ?**

**$K_3 = 1 / K_1 = 1 / 3.5 \times 10^8 = 2.9 \times 10^{-9}$** ✓

**Beide kampusse se studente antwoord vraag 2.5 / *Students from both campuses answer question 2.5***

2.5 Beskou die volgende twee chemiese ewewigsgrafieke. / *Look at the following two chemical equilibrium graphs.*




**A** **B**

2.5.1 In watter grafiek is die reaksie produkbevoordeeld? / *In which graph is the reaction product favoured?* **[1]**

**A** ✓

2.5.2 In watter grafiek is die reaksie reagensbevoordeeld? / *In which graph is the reaction reactant favoured?* **[1]**

**B** ✓

**Beide kampusse se studente antwoord vraag 2.6 / *Students from both campuses answer question 2.6***

2.6 Die ewewigskonstante, $K_c$ vir die volgende reaksie is: / *The equilibrium constant $K_c$ for the reaction is:*

$$2NOCl(g) \rightleftharpoons 2NO(g) + Cl_2(g) \qquad K_c = 3.9 \times 10^{-3} \text{ at } 300\ ^0C.$$

'n Mengsel bevat die gasse by die volgende konsentrasies: / *A mixture contains the gases at the following concentrations:*

$[NOCl] = 5.0 \times 10^{-3}$ mol/dm$^3$

$[NO] = 2.5 \times 10^{-3}$ mol/dm$^3$

$[Cl_2] = 2.0 \times 10^{-3}$ mol/dm$^3$

Is die reaksie in ewewig by 300 $^0$C? Indien nie, in watter rigting sal die reaksie verloop om ewewig te bereik? / *Is the reaction at equilibrium at 300 $^0$C? If not, in which direction does the reaction proceed to come to equilibrium?* **[4]**

**$Q = (2.5 \times 10^{-3})^2 (2.0 \times 10^{-3}) / (5.0 \times 10^{-3})^2$** ✓

**$Q = 5 \times 10^{-4} < K = 3.9 \times 10^{-3}$** ✓

**Not yet at equilibrium; moving towards more products** ✓

✓

**VRAAG 3. / *QUESTION 3.*** **[19 PUNTE. / 19 *MARKS*.]**

**ONLY STUDY UNIT 8 (THIS IS NOT GOING TO STAND IN THE PAPER).**

**Beide kampusse se studente antwoord vraag 3.1 / *Students from both campuses answer question 3.1***

3.1 Vir die volgende reaksie, identifiseer die suur, die basis, die gekonjugeerde basis en die gekonjugeerde suur. / *For the following reaction, identify the acid, the base, the conjugate base and the conjugate acid.* **[2]**

$C_5H_5NH^+ (aq) + H_2O (\ell) \leftrightarrows C_5H_5N (aq) + H_3O^+ (aq)$

**Acid** **Base** **Conjugate Base** **Conjugate Acid**

**Beide kampusse se studente antwoord vraag 3.2 / *Students from both campuses answer question 3.2***

3.2 Skryf die gebalanseerde dissosiasiereaksievergelyking **en** die ewewigskonstanteuitdrukking, $K_a$ vir die volgende suur in water neer. / *Write down the balanced dissociation reaction equation **and** the equilibrium constant expression, $K_a$ for the following acid in water.* **[3]**

$CH_3NH_3^+ (aq)$ **+ $H_2O (\ell) \leftrightarrows CH_3NH_2 (aq) + H_3O^+ (aq)$**

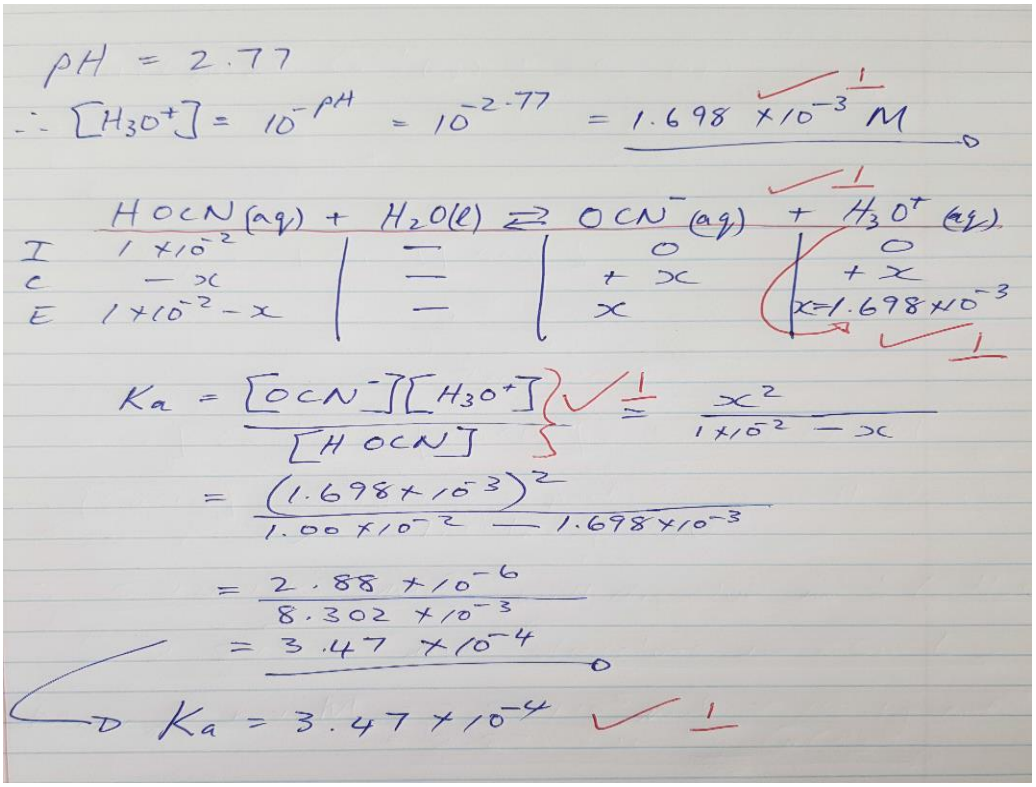
**The students does not have to show the physical states of the reagents and the products. Water does not get a mark.**

$$K_a = \frac{[CH_3NH_2][H_3O^+]}{[CH_3NH_3^+]}$$ 1

**Beide kampusse se studente antwoord vraag 3.3 / *Students from both campuses answer question 3.3***

3.3 Die pH van 'n waterige oplossing van 1.00 x $10^{-2}$ M HOCN is 2.77 by 25 $^0$C. Bereken $K_a$ vir HOCN.
*The pH of an aqueous solution of 1.00 x $10^{-2}$ M HOCN is 2.77 at 25 $^0$C. Calculate $K_a$ for HOCN.*

**[5]**




**Beide kampusse se studente antwoord vraag 3.4 / *Students from both campuses answer question 3.4***

3.4 Bereken die [$OH^-$] van 'n oplossing met 'n [$H^+$] gelyk aan 8.3 x $10^{-16}$ M. Klassifiseer dan ook die oplossing as neutral, suur of basies deur die opsie te omkring wat jy dink korrek is. / *Calculate the [$OH^-$] of a solution with a [$H^+$] equal to 8.3 x $10^{-16}$ M. Then also classify the solution as neutral, acidic or basic by circling the option that you think is correct.* **[2]**

**Berekening: / *Calculation:***

**[$OH^-$][$H^+$] = 1.00 x $10^{-14}$**

**[$OH^-$] = 1.00 x $10^{-14}$ / [$H^+$] = 1.00 x $10^{-14}$ / 8.3 x $10^{-16}$ = <u>12.05 M</u>**

**Klassifikasie: / *Classification:***

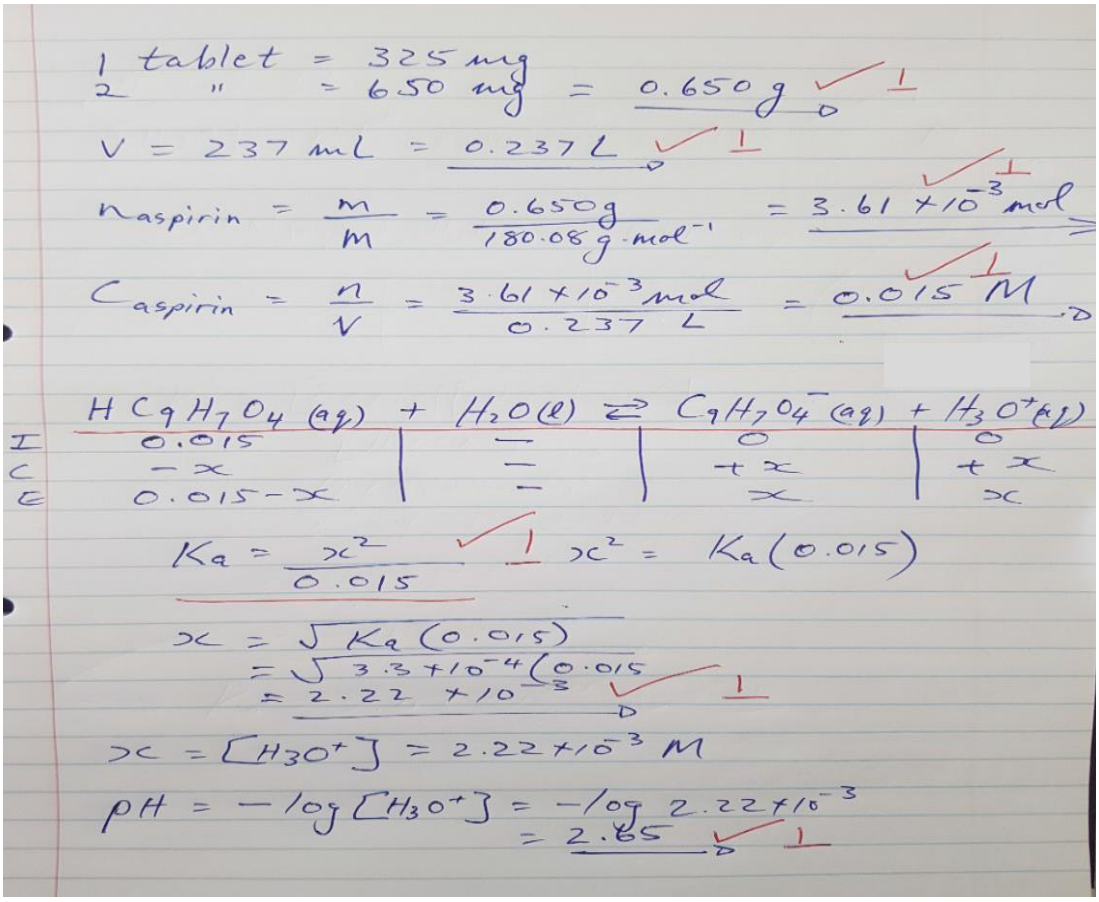
Neutraal. / *Neutral.* Suur. / *Acidic.* **Basies. / *Basic.***

**Beide kampusse se studente antwoord vraag 3.5 / *Students from both campuses answer question 3.5***

3.5 'n Tipiese aspirientablet bevat 325 mg asetielsalisielsuur acid ($HC_9H_7O_4$; $M_{HC9H7O4}$ = 180.08 g.mol$^{-1}$). Bereken die pH van 'n oplossing wat berei is deur twee aspirientablette in een koppie water (237 mL) op te los. Aanvaar dat die aspirientablette suiwer asetielsalisielsuur is. Die $K_a$ waarde van asetielsalisielsuur is 3.3 x 10$^{-4}$.

*A typical aspirin tablet contains 325 mg of acetylsalicylic acid ($HC_9H_7O_4$; $M_{HC9H7O4}$ = 180.08 g.mol$^{-1}$). Calculate the pH of a solution that is prepared by dissolving two aspirin tablets in one cup (237 mL) of water. Assume the aspirin tablets are pure acetylsalicylic acid. The $K_a$ value for acetylsalicylic acid is 3.3 x 10$^{-4}$.* **[7]**

$$HC_9H_7O_4\ (aq) + H_2O\ (\ell) \leftrightarrows C_9H_7O_4^-\ (aq) + H_3O^+\ (aq)$$



**VRAAG 4. / *QUESTION 4.*** **[20 PUNTE. / 20 *MARKS*.]**

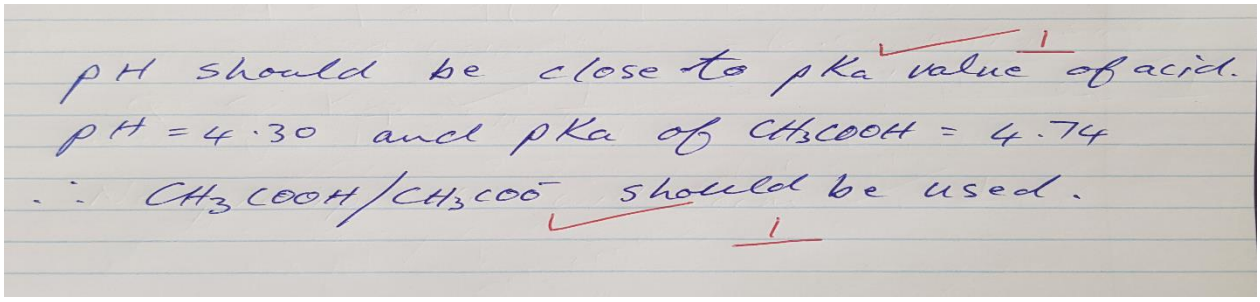
**ONLY STUDY UNIT 9 (THIS IS NOT GOING TO STAND IN THE PAPER).**

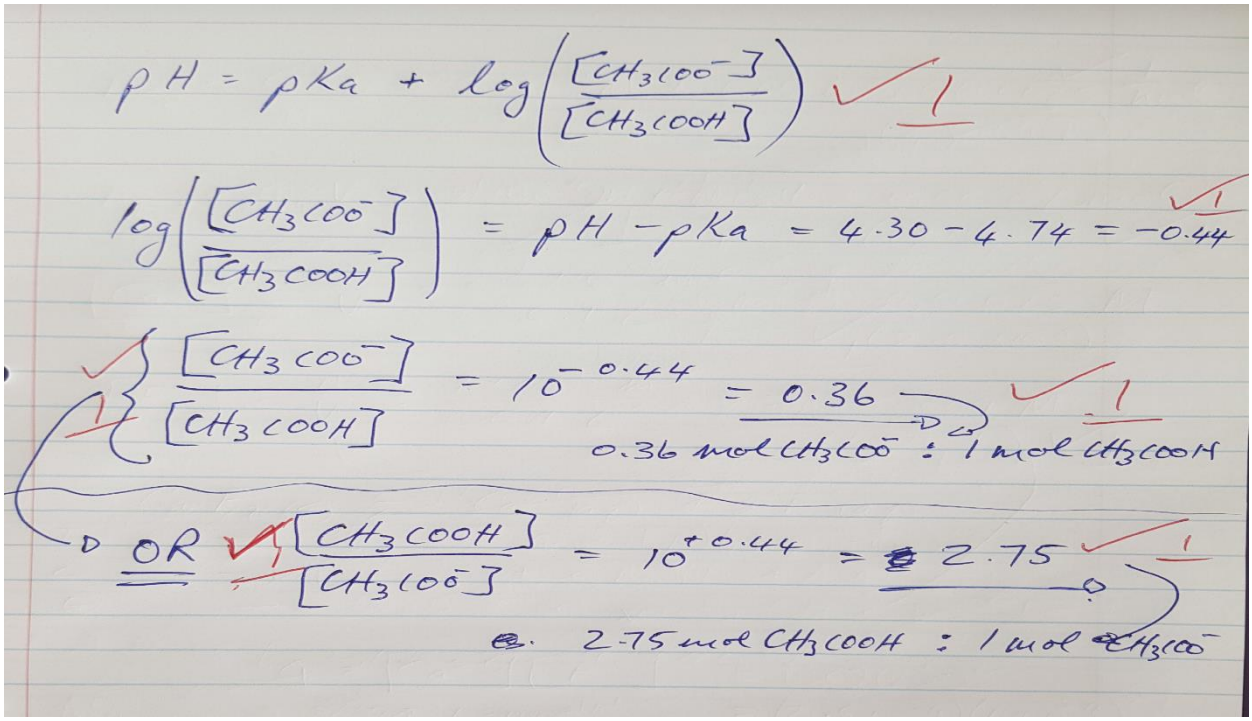
**Beide kampusse se studente antwoord vraag 4.1 / *Students from both campuses answer question 4.1***

4.1 Jy wil 'n 1.0 L bufferoplossing met 'n pH van 4.30 berei. 'n Lys van moontlike sure (en hul gekonjugeerde basisse) word gegee: / *You wish to prepare 1.0 L of a buffer solution with a pH of 4.30. A list of possible acids (and their conjugate bases) is given:*

| **Suur. / *Acid.*** | **Gekonjugeerde basis. *Conjugate base.*** | **$K_a$** | **$pK_a$** |
|---|---|---|---|
| $HSO_4^-$ | $SO_4^{2-}$ | $1.2 \times 10^{-2}$ | 1.92 |
| $CH_3COOH$ | $CH_3COO^-$ | $1.8 \times 10^{-5}$ | 4.74 |
| $HCO_3^-$ | $CO_3^{2-}$ | $4.8 \times 10^{-11}$ | 10.32 |

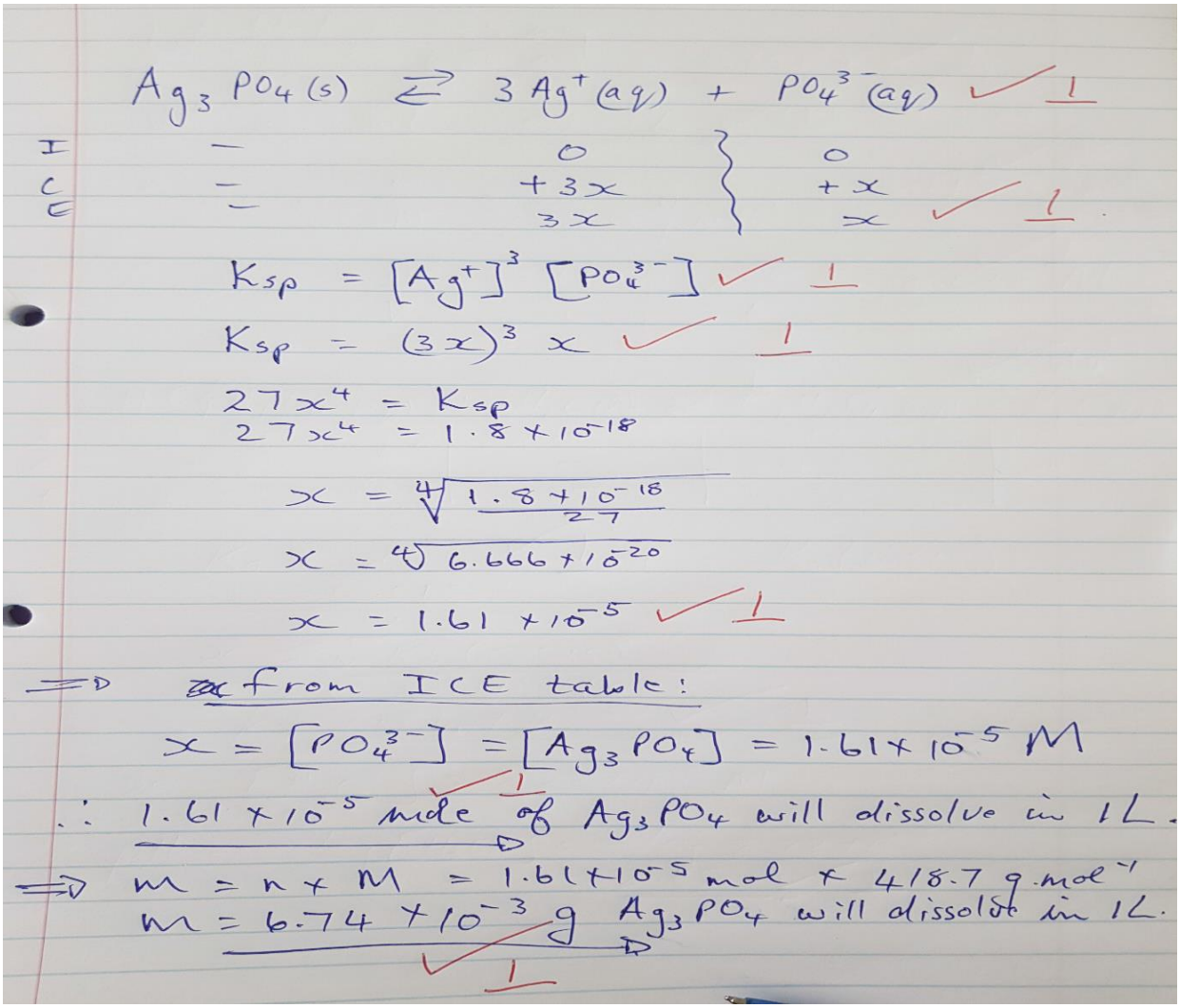
Watter suur/basis kombinasie moet gebruik word as buffer **en** wat moet die verhouding van die suur en gekonjugeerde basis wees? / *Which combination should be selected as a buffer solution **and** what should be the ratio of the acid to conjugate base?* **[6]**



**Beide kampusse se studente antwoord vraag 4.2 / *Students from both campuses answer question 4.2***

4.2 Bereken die wateroplosbaarheid van $Ag_3PO_4$ ($K_{sp}$ = 1.8 x $10^{-18}$ and $M_{Ag3PO4}$ = 418.7 g.mol$^{-1}$) in mol per liter **en** in gram per liter. / *Calculate the water solubility of $Ag_3PO_4$ ($K_{sp}$ = 1.8 x $10^{-18}$ and $M_{Ag3PO4}$ = 418.7 g.mol$^{-1}$) in moles per litre **and** in grams per litre.* **[7]**



**Beide kampusse se studente antwoord vraag 4.3 / *Students from both campuses answer question 4.3***

4.3 Sal 'n presipitaat vorm wanneer 50 $cm^3$ van 'n 5 x $10^{-4}$ mol/$dm^3$ $Ca(NO_3)_2$ oplossing by 'n 50 $cm^3$ van 'n 2 x $10^{-4}$ mol/$dm^3$ NaF oplossing gevoeg word? ($K_{sp}$ ($CaF_2$) = 1.7 x $10^{-10}$). / *Will a precipitate form when 50 $cm^3$ of a 5 x $10^{-4}$ mol/$dm^3$ $Ca(NO_3)_2$ solution is added to 50 $cm^3$ of a 2 x $10^{-4}$ mol/$dm^3$ NaF solution? ($K_{sp}$ ($CaF_2$) = 1.7 x $10^{-10}$).* **[7]**

$$CaF_2\,(s) \leftrightarrows Ca^{2+}\,(aq) + 2F^-\,(aq)$$

$n_{Ca} = C \times V = 5\times10^{-4}\,M \times 0.05\,L = 0.000025\ mol$ ✓ 1
$(2.5\times10^{-5})$

$n_F = C \times V = 2\times10^{-4}\,M \times 0.05\,L = 0.00001\ mol$
$(1\times10^{-5})$ ✓ 1

$[Ca^{2+}] = \frac{n}{V} = \frac{2.5\times10^{-5}\ mol}{0.1\,L} = 0.00025\ M$ ✓ 1
$(2.5\times10^{-4})$

$[F^-] = \frac{n}{V} = \frac{1\times10^{-5}\ mol}{0.1\,L} = 0.0001\ M$
$(1\times10^{-4})$ ✓ 1

| | $CaF_2(s)$ | $\rightleftarrows$ | $Ca^{2+}(aq)$ | + | $2F^-(aq)$ |
|---|---|---|---|---|---|
| I | — | | 0 | | 0 |
| C | — | | $+x$ | | $+2x$ |
| E | — | | $x$ | | $2x$ |

$Q = [Ca^{2+}][F^-]^2 = (x)(2x)^2$
$= (2.5\times10^{-4})(1\times10^{-4})^2$
$= 2.5\times10^{-12}$ ✓ 1

$Q < K_{sp}$ ✓ 1
$2.5\times10^{-12} < 1.7\times10^{-10}$

No precipitate will form ✓ 1

**TOTAAL/TOTAL: 100**

**JY MAG HIERDIE BLADSY AFSKEUR!**

***YOU MAY TEAR OF THIS PAGE!***

# PERIODIC TABLE OF THE ELEMENTS
# PERIODIEKE INDELING VAN DIE ELEMENTE

| IA (1) | | | | | | | | | | | | | IIIA (13) | IVA (14) | VA (15) | VIA (16) | VIIA (17) | 0 (18) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 **H** 1,01 | IIA (2) | | | | | | | | | | | | | | | | | 2 **He** 4,00 |
| 3 **Li** 6,94 | 4 **Be** 9,01 | | | | | | | | | | | | 5 **B** 10,8 | 6 **C** 12,0 | 7 **N** 14,0 | 8 **O** 16,0 | 9 **F** 19,0 | 10 **Ne** 20,2 |
| 11 **Na** 23,0 | 12 **Mg** 24,3 | IIIB (3) | | IVB (4) | VB (5) | VIB (6) | VIIB (7) | (8) | VIII (9) | (10) | IB (11) | IIB (12) | 13 **Al** 27,0 | 14 **Si** 28,1 | 15 **P** 31,0 | 16 **S** 32,1 | 17 **Cl** 35,45 | 18 **Ar** 39,9 |
| 19 **K** 39,1 | 20 **Ca** 40,1 | 21 **Sc** 45,0 | | 22 **Ti** 47,9 | 23 **V** 50,9 | 24 **Cr** 52,0 | 25 **Mn** 54,9 | 26 **Fe** 55,9 | 27 **Co** 58,9 | 28 **Ni** 58,7 | 29 **Cu** 63,4 | 30 **Zn** 65,4 | 31 **Ga** 69,7 | 32 **Ge** 72,6 | 33 **As** 74,9 | 34 **Se** 79,0 | 35 **Br** 79,9 | 36 **Kr** 83,8 |
| 37 **Rb** 85,5 | 38 **Sr** 87,6 | 39 **Y** 88,9 | | 40 **Zr** 91,2 | 41 **Nb** 92,9 | 42 **Mo** 95,9 | 43 **Tc** (98) | 44 **Ru** 101,1 | 45 **Rh** 102,9 | 46 **Pd** 106,4 | 47 **Ag** 107,9 | 48 **Cd** 112,4 | 49 **In** 114,8 | 50 **Sn** 118,7 | 51 **Sb** 121,6 | 52 **Te** 127,6 | 53 **I** 127,9 | 54 **Xe** 131,3 |
| 55 **Cs** 132,9 | 56 **Ba** 137,3 | 57 **La** 138,9 | * | 72 **Hf** 178,5 | 73 **Ta** 180,9 | 74 **W** 183,9 | 75 **Re** 186,2 | 76 **Os** 190,2 | 77 **Ir** 192,2 | 78 **Pt** 195,1 | 79 **Au** 197,0 | 80 **Hg** 200,6 | 81 **Tl** 204,4 | 82 **Pb** 207,2 | 83 **Bi** 209,0 | 84 **Po** (209) | 85 **At** (210) | 86 **Rn** (222) |
| 87 **Fr** (223) | 88 **Ra** 226,0 | 89 **Ac** 227,0 | # | 104 **Rf** (261) | 105 **Db** (262) | 106 **Sg** (263) | 107 **Bh** (262) | 108 **Hs** (265) | 109 **Mt** (266) | | | | | | | | | |

atomic number / atoomgetal
symbol / simbool
atomic mass / atoommassa

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| lanthanides* / lantaniede | 58 **Ce** 140,1 | 59 **Pr** 140,9 | 60 **Nd** 144,2 | 61 **Pm** (145) | 62 **Sm** 150,4 | 63 **Eu** 152,0 | 64 **Gd** 157,3 | 65 **Tb** 158,9 | 66 **Dy** 162,5 | 67 **Ho** 164,9 | 68 **Er** 167,3 | 69 **Tm** 168,9 | 70 **Yb** 173,0 | 71 **Lu** 175,0 |
| actinides# / aktiniede | 90 **Th** 232,0 | 91 **Pa** 231,0 | 92 **U** 238,0 | 93 **Np** 237,0 | 94 **Pu** (244) | 95 **Am** (234) | 96 **Cm** (247) | 97 **Bk** (247) | 98 **Cf** (251) | 99 **Es** (252) | 100 **Fm** (257) | 101 **Md** (258) | 102 **No** (258) | 103 **Lr** (260) |

**TABEL 1: Oplosbaarheidstabel.**

***TABLE 1: Solubility Table.***

| **Soluble compounds** | | **Exceptions** |
|---|---|---|
| Almost all salts of $Na^+$, $K^+$ and $NH_4^+$ | | |
| All salts of $Cl^-$, $Br^-$ and $I^-$ | ⇔ | Halides of $Ag^+$, $Hg_2^{2+}$ and $Pb^{2+}$ |
| Compounds containing $F^-$ | ⇔ | Fluorides of $Mg^{2+}$, $Ca^{2+}$, $Sr^{2+}$, $Ba^{2+}$ and $Pb^{2+}$ |
| Salts of nitrate, $NO_3^-$; chlorate, $ClO_3^-$; perchlorate, $ClO_4^-$; acetate, $CH_3COO^-$ | | $KClO_4$ |
| Salts of sulphate, $SO_4^{2-}$ | ⇔ | Sulphates of $Sr^{2+}$, $Ba^{2+}$ and $Pb^{2+}$ |

| **Insoluble compounds** | | **Exceptions** |
|---|---|---|
| All salts of carbonate, $CO_3^{2-}$;<br>phosphate, $PO_4^{3-}$<br>oxalate, $C_2O_4^{2-}$;<br>chromate, $CrO_4^{2-}$;<br>sulphide, $S^{2-}$<br>Most metal hydroxides $OH^-$ and oxides, $O^{2-}$ | ⇔ | Salts of $NH_4^+$ and alkali metal cations |