VRAAG 1. / *QUESTION 1.* **[21 PUNTE. / *MARKS*.]**

1.1 Gee die naam of die formule van die volgende verbindings. / *Give the name or the formula of the following compounds.* **[5]**

$NaHCO_3$

NH_4NO_2

$KClO_4$

Koper(II) asetaat. / *Copper(II) acetate.*

Difosfortetrafluoried. / *Diphosphorus tetrafluoride.*

1.2 Balanseer die volgende redoksreaksie in 'n **basiese medium**: / *Balance the following redox reaction in **basic medium**:* **[6]**

$$MnO_4^-(aq) + CN^-(aq) \rightarrow MnO_2(s) + CNO^-(aq)$$

1.3 Identifiseer die volgende reaksies in 'n waterige medium as redoks-, presipitasie of suur-basis reaksies. Gee 'n rede vir jou antwoord. / Identify the following reactions in an aqueous medium as redox, precipitation or acid-base reactions. Give a reason for your answer. **[10]**

1.3.1 $CH_4 + 2\ O_2 \rightarrow CO_2 + 2\ H_2O$

1.3.2 $NH_4OH + HBr \rightarrow H_2O + NH_4Br$

1.3.3 $Pb + O_2 \rightarrow PbO_2$

1.3.4 $AgNO_3 + NaCl \rightarrow NaNO_3 + AgCl$

1.3.5 $HCl + NaOH \rightarrow H_2O + NaCl$

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

2.1 Die ontbranding van petrol produseer koolstofdioksied en water. Aanvaar dat petrol suiwer oktaan (C_8H_{18}) is en bereken hoeveel kilogram koolstofdioksied in die atmosfeer gevoeg word per 1.0 kg oktaan wat verbrand word. (**Wenk:** Begin deur 'n gebalanseerde vergelyking vir die verbrandingsreaksie neer te skryf.) / *The combustion of gasoline produces carbon dioxide and water. Assume gasoline to be pure octane (C_8H_{18}) and calculate how many kilograms of carbon dioxide are added to the atmosphere per 1.0 kg of octane burned. (**Hint:** Begin by writing a balanced equation for the combustion reaction.)* **[3]**

(**Gegee: / *Given*:** M_{C8H18} = 114.18 g.mol^{-1}; M_{CO2} = 44 g.mol^{-1})

$$2C_8H_{18} + 25O_2 \rightarrow 16CO_2 + 18H_2O$$

2.2 Gekonsentreerde swaelsuur het 'n digtheid van 1.84 g/cm^3 en is 95.0% H_2SO_4 per gewig. Die res is water. Bereken die molaliteit sowel as die molariteit van die suur. / *Concentrated sulfuric acid has a density of 1.84 g/cm^3 and is 95.0% by weight H_2SO_4. The rest is water. Calculate the molality as well as the molarity of the acid.* **[5]**

2.3 'n Webtuiste oor vuurwerke verskaf aanwysings vir die bereiding van kaliumnitraat, KNO_3 (M_{KNO3} = 101 g/mol). Volgens die webtuiste moet jy 1.00 kg kaliumkarbonaat (M_{K2CO3} = 138 g/mol) en 2.00 kg ammoniumnitraat (M_{NH4NO3} = 80 g/mol) meng volgens die volgende gebalanseerde reaksievergelyking: / *A website on fireworks provides directions for preparing potassium nitrate, KNO_3 (M_{KNO3} = 101 g/mol). According to the website you must mix 1.00 kg of potassium carbonate (M_{K2CO3} = 138 g/mol) and 2.00 kg of ammonium nitrate (M_{NH4NO3} = 80 g/mol), according to the following balanced reaction equation:*

$$K_2CO_3 + 2\ NH_4NO_3 \rightarrow 2\ KNO_3 + CO_2 + H_2O + 2\ NH_3$$

2.3.1 Bereken die beperkende reagens. / *Calculate the limiting reagent.* **[3]**

2.3.2 Bereken die massa KNO_3 (in gram en in kilogram) wat berei kan word. / *Calculate the mass of KNO_3 (in gram and in kilogram) that can be prepared.* **[3]**

2.4 'n Chemiestudent vind 'n blink klip wat sy vermoed goud is. Sy weeg die klip op 'n balans en verkry 'n massa van 14.3 g. Dan kom sy agter dat die temperatuur van die klip van 25 ^oC na 52 ^oC styg wanneer dit 174 J se hitte absorbeer. Is die klip goud? Antwoord ja of nee. (Die hittekapasiteit van goud = 0.128 J/g ^oC).
A chemistry student finds a shiny rock that she suspects is gold. She weighs the rock on a balance and obtains the mass, 14.3 g. She then finds that the temperature of the rock rises from 25 ^oC to 52 ^oC upon absorption of 174 J of heat. Is the rock gold? Answer yes or no. (The heat capacity of gold =0.128 J/g ^oC). **[3]**

2.5 Entalpieveranderinge kan eksperimenteel vir die volgende reaksies verkry word: / *Enthalpy changes for the following reactions can be determined experimentally:*

Vergelyking 1: / *Equation 1:* $CH_4\ (g) + 2\ O_2\ (g) \rightarrow CO_2\ (g) + 2\ H_2O\ (g)$ $\Delta_rH^o = -802.4$ kJ/mol-rxn

Vergelyking 2: / *Equation 2:* $CH_3OH\ (g) + 1.5\ O_2(g) \rightarrow CO_2\ (g) + 2\ H_2O(g)$ $\Delta_rH^o = -676$ kJ/mol-rxn

Gebruik hierdie vergelykings en waardes en Hess se wet om die verandering in entalpie vir die volgende reaksie te bepaal: (**Wenk:** Manipileer die gegewe vergelykings.). / *Usee these equations and values and Hess's law to determine the enthalpy change for the following reaction: (**Hint:** Manipulate the given reactions.)* **[4]**

Vergelyking 3: / *Equation 3:* $CH_4\ (g) + ½O_2\ (g) \rightarrow CH_3OH\ (g)$ **Δ_rH^o = ?**

VRAAG 3. / *QUESTION 3.* **[20 PUNTE. / *MARKS*.]**

3.1 Wat dui 'n klein ewewigskonstante vir 'n reaksie aan? / *What does a small equilibrium constant indicate for a reaction?* **[2]**

3.2 Skryf 'n ewewigsuitdrukking vir die volgende reaksie neer. / *Write down an equilibrium expression for the following reaction.* **[1]**

$$CH_4\ (g) + 2H_2S\ (g) \rightleftharpoons CS_2\ (g) + 4H_2\ (g)$$

3.3 Teken 'n vryhand grafiek om die verloop van die volgende produkbevoordeelde ewewigsreaksie by 425 ^oC voor te stel. Benoem die asse van die grafiek en gee volledige byskrifte om die verandering in konsentrasie van die reagense en produk aan te dui. / *Draw a free hand graph to illustrate the progress of the following product-favoured equilibrium reaction at 425 ^oC. Name the axis of the graph and give full captions to indicate the change in concentration of the reagents and the product.* **[10 x ½ = 5]**

	$2H_2$ (g)	**+**	**O_2 (g)**	**⇌**	**$2H_2O$ (g)**
A *(I)*	0.0175		0.0175		0
V *(C)*	- 0.0138		- 0.0138		+ 0.0276
E *(E)*	0.0037		0.0037		0.0276

3.4 'n 50.0 L reaktor bevat 0.0200 M N_2, 0.0600 M H_2 en 0.0100 M NH_3. Sal meer ammoniak vorm of sal die ammoniak ontbind wanneer die mengsel ewewig nader by 400 ^oC? Die reaksievergelyking is: / *A 50.0 L reactor contains 0.0200 M N_2, 0.0600 M H_2 and 0.0100 M NH_3. Will more ammonia be formed or will the ammonia decompose when the mixture goes to equilibrium at 400 ^oC? The reaction equation is:* **[3]**

$$N_2\,(g) + 3H_2\,(g) \rightleftharpoons 2NH_3\,(g)$$

Kc is 0.500 by/*at* 400 ^oC.

3.5 Die reaksie vir die produksie van ammoniak kan op verskillende maniere geskryf word: / *The reaction for the production of ammonia can be written in a number of ways:*

(a) $N_2\,(g) + 3H_2\,(g) \rightleftharpoons 2NH_3\,(g)$

(b) $\frac{1}{2}N_2\,(g) + 1\frac{1}{2}H_2\,(g) \rightleftharpoons NH_3\,(g)$

(c) $\frac{1}{3}N_2\,(g) + H_2\,(g) \rightleftharpoons \frac{2}{3}NH_3\,(g)$

Skryf die ewewigskonstanteuitdrukking vir elke formulering neer. / *Write down the equilibrium constant expression for each formulation.* **[3]**

3.6 Gegewe die volgende ewewigsreaksies en konstantes: / *Given the following equilibrium reactions and constants:*

(1) $\frac{1}{4}S_8\,(s) + 2\,O_2(g) \rightleftharpoons 2\,SO_2\,(g)$ $\qquad K_{c1} = 1.86 \times 10^{105}$

(2) $\frac{1}{8}S_8\,(s) + \frac{3}{2}\,O_2\,(g) \rightleftharpoons SO_3(g)$ $\qquad K_{c2} = 1.77 \times 10^{53}$

Bereken die ewewigskonstante, K_{c3}, vir die volgende reaksie wat belangrik is in die vorming van suurreënlugbesoedeling. *Calculate the equilibrium constant, K_{c3}, for the following reaction which is important in the formation of acid rain air pollution.* **[6]**

$$2SO_2\,(g) + O_2\,(g) \rightleftharpoons 2SO_3\,(g) \qquad \mathbf{K_{c3} = ?}$$

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

4.1 Skryf die gekonjugeerde suur-basispare in die volgende reaksie neer. / *Write down the conjugated acid-base pairs in the following reaction.* **[2]**

$$Mg(OH)_2\,(s) + 2H_3O^+\,(aq) \rightleftharpoons Mg^{2+}\,(aq) + 4H_2O\,(l)$$

4.2 Identifiseer die gekonjugeerde suur-basispare in die volgende reaksie. / *Identify the conjugated acid-base pairs in the following reaction.* **[1]**

$$HF\ (aq) + CH_3CO_2^-\ (aq) \rightleftharpoons F^-\ (aq) + CH_3CO_2H\ (aq)$$

(a) $HF/CH_3CO_2^-$ en/*and* F^-/CH_3CO_2H

(b) HF/CH_3CO_2H en/*and* $F^-/CH_3CO_2^-$

(c) HF/F^- en/*and* $CH_3CO_2H/CH_3CO_2^-$

4.3 Word die volgende verbindings as sure, basisse of amfiproties geklasifiseer? / *Are the following compounds classified as acids, basses or amphiprotic?* **[2]**

(a) H_2O

(b) $NaHCO_3$

4.4 Wat is die pH van 'n 1.2 x 10^{-3} M NaOH oplossing? / *What is the pH of a 1.2 x 10^{-3} M NaOH solution?* **[1]**

4.5 Onderstreep die korrekte keuse in die volgende stelling: / *Underline the correct choice in the following statement:* **[1]**

Deur NaH_2PO_4 by water te voeg sal die pH laat (a) toeneem of (b) afneem of (c) dieselfde bly. / *Adding NaH_2PO_4 to water will cause the pH to (a) increase or (b) to decrease or (c) to stay the same.*

4.6 Wat is die pH en die ioon konsentrasies in 'n oplossing van 0.10 M natriumformaat, $NaCHO_2$? K_b vir die formaatioon, HCO_2^- is 5.6 x 10^{-11}. Wys al jou berekeninge. / *What are the pH and ion concentrations in a solution of 0.10 M sodium formate, $NaHCO_2$? K_b for the formate ion, HCO_2^- is 5.6 x 10^{-11}. Show all your calculations.* **[5]**

$$NaCHO_2\ (aq) + H_2O\ (l) \rightleftharpoons OH^-\ (aq) + CHO_2H\ (aq)$$

4.7 Bereken die ewewigskonstante van 'n 5.20 M natriumkarbonaatoplossing met 'n pH van 12.52 by 25^0C.
Calculate the equilibrium constant for a 5.20 M sodium carbonate solution with a pH of 12.52 at 25^0C.

[8]

$$Na_2CO_3\ (s) + H_2O\ (l) \rightleftharpoons HCO_3^-\ (aq) + OH^-\ (aq) + 2Na^+\ (aq)$$

$Na_2CO_3\ (s) + H_2O\ (l) \rightleftharpoons HCO_3^-\ (aq) + OH^-\ (aq) + 2Na^+\ (aq)$

VRAAG 5. / *QUESTION 5.* **[17 PUNTE. / *MARKS*.]**

5.1 Wanneer 50.00 mL van 'n 1.000 M HCl-oplossing getitreer word met 'n 0.7450 M NaOH-oplossing sal die pH toeneem. Hoeveel mL NaOH is nodig om die ewewigspunt en 'n pH van 7 te bereik? / *When 50.00 mL of a 1.000 M HCl solution is titrated with a 0.7450 M NaOH solution the pH will increase. How many mL of NaOH are required to reach the equilibrium point and a pH of 7?* **[3]**

5.2 Wat is die K_{sp} uitdrukking vir silwerkarbonaat? / *What is the K_{sp} expression for silver carbonate?* **[2]**

5.3 Bereken die oplosbaarheid van MgF_2-sout in (a) mol per liter water en (b) in gram per liter water deur van die volgende data gebruik te maak. / *Calculate the solubility of MgF_2 salt in (a) mol per litre water and (b) gram per litre water by using the following data.* (**Gegee: / *Given*:** $M_{MgF2} = 62.3\ g.mol^{-1}$) **[4]**

$$MgF_2\ (s) \rightleftharpoons Mg^{2+}\ (aq) + 2F^-\ (aq) \qquad K_{sp} = [Mg^{2+}][F^-]^2 = 5.2 \times 10^{-11}$$

	MgF_2 (s)	⇌	**Mg^{2+} (aq)**	**+**	**$2F^-$ (aq)**
Aanvangskonsentrasie. (M) *Initial concentration. (M)*			0		0
Verandering in konsentrasie. (M) *Change in concentration. (M)*			+x		+2x
Ewewigskonsentrasie. (M) *Equilibrium concentration. (M)*			x		2x

5.4 Bereken of die $BaSO_4$ gaan presipiteer wanneer jy 100.0 mL van 'n 0.0200 M $BaCl_2$ oplossing en 50.0 mL van 'n 0.0300 M Na_2SO_4 oplossing vermeng deur van die volgende data gebruik te maak. / *Calculate whether the $BaSO_4$ will precipitate when you mix 100.0 mL of a 0.0200 M $BaCl_2$ solution with a 0.0300 M Na_2SO_4 solution by using the following data.* **[3]**

$[Ba^{2+}]$ na vermenging / *after mixing* = 0.0133 M

$[SO_4^{2-}]$ na vermenging / *after mixing* = 0.0100 M

$BaSO_4$ (s) $\rightleftharpoons$ Ba^{2+} (aq) + SO_4^{2-} (aq) $K_{sp} = [Ba^{2+}][SO_4^{2-}] = 1.1 \times 10^{-10}$

5.5 Bereken die pH van die volgende bufferoplossing: / *Calculate the pH of the following buffer solution:*

[3]

$H_2PO_4^-$ (0.10 M) / HPO_4^{2-} (0.25 M)

Die pK_a waarde van die diwaterstoffosfaatioon is 7.20. / *The pK_a value of the dihydrogen phosphate ion is 7.20.*

5.6 Definieer die term bufferoplossing. / *Define the term buffer solution.* **[2]**

TABEL 5: Ionisasiekonstantes vir sommige sure en hul gekonjugeerde basisse by 25 °C.

TABLE 5: Ionization constants for some acids and their conjugate bases at 25 °C.

K_a and K_b Values

Name of Acid	Acid	K_a	Name of Base	Base	K_b
Sulfuric acid	H_2SO_4	large	hydrogen sulfate ion	HSO_4^-	very small
Hydrochloric acid	HCl	large	chloride ion	Cl^-	very small
Nitric acid	HNO_3	large	nitrate ion	NO_3^-	very small
Hydronium ion	H_3O^+	55.5	water	H_2O	1.8×10^{-16}
Hydrogen sulfate ion	HSO_4^-	1.2×10^{-2}	sulfate ion	SO_4^{2-}	8.3×10^{-13}
Phosphoric acid	H_3PO_4	7.5×10^{-3}	dihydrogen phosphate ion	$H_2PO_4^-$	1.3×10^{-12}
Hexaaquairon(III) ion	$Fe(H_2O)_6^{3+}$	6.3×10^{-3}	pentaaquahydroxoiron(III) ion	$Fe(H_2O)_5OH^{2+}$	1.6×10^{-12}
Hydrofluoric acid	HF	7.4×10^{-4}	fluoride ion	F^-	1.4×10^{-11}
Formic acid	HCO_2H	1.8×10^{-4}	formate ion	HCO_2^-	5.6×10^{-11}
Benzoic acid	$C_6H_5CO_2H$	6.3×10^{-5}	benzoate ion	$C_6H_5CO_2^-$	1.6×10^{-10}
Acetic acid	CH_3CO_2H	1.8×10^{-5}	acetate ion	$CH_3CO_2^-$	5.6×10^{-10}
Hexaaquaaluminum ion	$Al(H_2O)_6^{3+}$	7.9×10^{-6}	pentaaquahydroxoaluminum ion	$Al(H_2O)_5OH^{2+}$	1.3×10^{-9}
Carbonic acid	H_2CO_3	4.2×10^{-7}	hydrogen carbonate ion	HCO_3^-	2.4×10^{-8}
Hydrogen sulfide	H_2S	1×10^{-7}	hydrogen sulfide ion	HS^-	1×10^{-7}
Dihydrogen phosphate ion	$H_2PO_4^-$	6.2×10^{-8}	hydrogen phosphate ion	HPO_4^{2-}	1.6×10^{-7}
Hypochlorous acid	HClO	3.5×10^{-8}	hypochlorite ion	ClO^-	2.9×10^{-7}
Ammonium ion	NH_4^+	5.6×10^{-10}	ammonia	NH_3	1.8×10^{-5}
Hydrocyanic acid	HCN	4.0×10^{-10}	cyanide ion	CN^-	2.5×10^{-5}
Hexaaquairon(II) ion	$Fe(H_2O)_6^{2+}$	3.2×10^{-10}	pentaaquahydroxoiron(II) ion	$Fe(H_2O)_5OH^+$	3.1×10^{-5}
Hydrogen carbonate ion	HCO_3^-	4.8×10^{-11}	carbonate ion	CO_3^{2-}	2.1×10^{-4}
Hydrogen phosphate ion	HPO_4^{2-}	3.6×10^{-13}	phosphate ion	PO_4^{3-}	2.8×10^{-2}
Water	H_2O	1.8×10^{-16}	hydroxide ion	OH^-	55.5
Hydrogen sulfide ion	HS^-	1×10^{-19}	sulfide ion	S^{2-}	1×10^{5}