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APPENDIX A

Observation and Interview Schedule

Event and/or observation	Question	Clarification (of question; expectation; intention; action; activity)	Response (by either first (S_1) or second (S_2) respondents

APPENDIX B

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Prior Knowledge State Test

Instruction: Answer all the questions and explain (or elaborate on) your answers where applicable.

1. You are told that an aqueous solution is *acidic*. What does this mean?

2 Which 0.1 M solution among HBr (aq); CO_2 (aq); LiOH (aq); CH_3OH (aq) will turn phenolphthalein pink?

3. As the hydrogen ion concentration of an aqueous solution increases, the hydroxide ion concentration of this solution will (1) increase (2) decrease (3) remain the same.

4 Calculate the pH of a solution with a hydronium ion concentration of 0.01 moles per liter.

5. Differentiate between a *dilute* solution of a weak acid and a *concentrated* solution of a *weak* acid? Illustrate your answer with a relevant example.

6. Differentiate between an Arrhenius and a Bronsted-Lowry acid.

7 Why does ammonia behave both as an Arrhenius base and as a Bronsted-Lowry base when dissolved in water?

8 In terms of Bronsted-Lowry definition of acids and bases what is a strong acid and a weak acid?

9 What is meant by *an amphoteric* substance? Use the hydrogen oxalate ion ($HC_2O_4^-$) in water for your explanation.

10 An unknown salt is NaF, NaCl, or NOCl. When 0.05 mol of salt is dissolved in water to form 0.500 dm^3 of solution, the pH of solution is 8.08. Identify the salt and explain your choice.

11 When HCl (aq) is exactly neutralized by NaOH (aq), the hydrogen ion concentration in the resulting solution is (1) always less than the concentration of the hydroxide ions (2) always greater than the concentration of the hydroxide ions (3) always equal to

the concentration of the hydroxide ions (4) sometimes greater and sometimes less than the concentration of the hydroxide ions.

12 Presume that you are titrating a weak acid and a strong base (e.g. NaOH). What would the expression "equivalence point" mean in this process?

13 A 25.0 cm^3 0.10 M CH_3COOH (aq) was titrated with 0.20 M NaOH (aq). Calculate the total volume at the equivalence point was reached?

14 Solutions which contain a weak conjugate acid-base pair can resist drastic changes in pH upon the addition of small amounts of strong acid or base. What are these solutions called and how do they resist the change in pH?

15 Calculate the molality of 49.0 mg of H_2SO_4 in 10.0ml of solution.

16 Calculate the molarity of HCl, density 1.057 g/ml, 12.0% by mass.

17 Calculate the concentration of a 150 ml of a 0.1200 M solution diluted to 200.0ml

18. A 20 ml sample of vinegar having a density of 1.055 g/ml requires 40.34 ml of 0.3024 M NaOH base for titration. Calculate the percentage of acetic acid ($HC_2H_3O_2$) in the sample.

19 Define the term *standardization.*

20. Illustrate how a 500 ml 6 M solution of an acid is diluted by a factor of 25.

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APPENDIX C

Practical work task

Practical Work Task
Aim   To determine % content of ethanoic acid in a solution of commercial vinegar.
Objective   ❑ To determine the % content of ethanoic acid in commercial vinegar by titrimetric methods.   **Useful information**   ❑ Commercial vinegar generally contains % ethanoic acid of between 4% and 6%.   ❑ Density of vinegar is 1.045g/cm^3 ❑ Ethanoic acid is a weak acid.   ❑ Estimate end-point at 25.00 cm^{-3} ❑ Determinations should be in duplicate.   **Experimental**   ❑ Work in pairs   ❑ Prepare an experimental plan that outlines how you are going to :   o Perform the experiment.   o Analyse the data in order to extract the required information.   ❑ Have your plan reviewed before you start with your practical work   ❑ Analyse results (Individually)   ❑ Write report (Individually). In your report include: o Title.   o Aim.   o The procedure or method.   o Observation and/or explanation of phenomena.   o Results of weighing and titrations (in tabular form and calculations).   o Conclusions.   **Summary of the activity**   ➢ **Formulate plan.**   ➢ **Discuss plan with the instructor before proceeding.**   ➢ **Perform the task.**   ➢ **Analyse results.**   ➢ **Write report.**

APPENDIX D

Propositional statements representing knowledge of acids and bases and titration processes

PCKS 1: Early known facts about acids

1.1 Acids when dissolved in water have a sour taste (The name acid comes from the Latin word *acidus*, which means "sour").

1.2 Acids cause the dye litmus to change from a blue to a red colour. (Litmus is a naturally occurring vegetable dye obtained from linchens).

1.3 When certain metals, such as zinc and iron, are placed in acids, they dissolve with the liberation of gas.

PCKS 2: **Early known characteristics of bases**

2.1 Water solutions of bases feel slippery or soapy to the touch and have a bitter taste.

2.2 Bases cause the dye litmus to change from a red to a blue colour.

2.3 When certain greases are placed in a base solution, they dissolve.

PCKS 3: **Definitions of acids and bases**

3.1 Arrhenius definition: Acid is a substance that releases the hydrogen ions (H^+) in aqueous solution (water).

e.g. $$HNO_3 (l) + H_2O \rightarrow H^+ (aq) + NO_3^- (aq)$$

Arrhenius acids when in the pure state (not in solution) are covalent compounds, that is, they do not contain H^+ ions. These ions are formed through a chemical reaction, when the acid is mixed with water.

Base is a substance that releases hydroxide ions (OH^-) in aqueous solution (aq).

e.g. $$NaOH (s) + H_2O \rightarrow Na^+ (aq) + OH^- (aq)$$

Arrhenius bases are usually ionic in the pure state, in direct contrast to acids. When bases dissolve in water, the ions separate to yield OH^- ions.

3.2 Bronsted- Lowry definitions:

Acid is a substance that donates a proton (H^+) to some other substance.
Base is any substance that can accept a proton from some other substance. Bronsted – Lowry acid is therefore a proton donor and a Bronsted – Lowry base is a proton acceptor.

e.g. $HCl\ (g) + H_2O\ (l) \rightarrow H_3O^+\ (aq) + Cl^-\ (aq)$

The HCl behaves like a Bronsted – Lowry acid by donating a proton to a water molecule. The hydronium ion is formed in this reaction:

$$H^+ + H_2O \rightarrow H_3O^+$$

The base in this reaction is water since it has accepted a proton; no hydroxide ions are involved.

4 A substance that behaves both as an acid and a base (a substance that can donate and accept a proton) is an amphoteric substance

e.g. $H_2O\ (l) + H_2O\ (l) \rightleftharpoons H_3O^+\ (aq) + OH^-\ (aq)$

PCKS 4: **Strengths of acids and bases:**

4.1 Acids may be classified as strong or weak depending on the number of H^+ ions (or H_3O^+ ions) they produce in aqueous solution

4.2 A strong acid dissociates 100% (completely) in solution; that is, all of the acid molecules present dissociate into ions. Because of this extensive dissociation, many hydrogen ions are present in the solution of a strong acid

4.3 A weak acid dissociates only slightly (partially) in solution; that is, most of the acid molecules are present in solution in un-dissociated form.

PCKS 5: Ionic and net ionic equations

5.1 Soluble acids and soluble bases and soluble salts all produce ions in aqueous solution

5.2 An ionic equation is an equation in which the formulas of the predominant form of each compound in aqueous solution are used; dissociated compound are written as ions, un-dissociated compounds are written in molecular form

e.g. $CH_3COOH + H_2O\ (l) \rightleftharpoons CH_3COO^-(aq) + H_3O^+\ (aq)$

5.3 A net ionic equation is an ionic equation from which nonparticipating (spectator) species have been eliminated

e.g. $AgNO_3\ (aq) + KCl\ (aq) \rightarrow KNO_3\ (aq) + AgCl\ (s)$

Molecular equation

Three substances $AgNO_3$, KCl and AgCl are soluble salts and thus exist in solution in dissociated ionic form.

Potassium and nitrate ions appear on either side of the equation, that is, they did not undergo any chemical change. They are spectator ions.

Net ionic equation is written by canceling all spectator ions from the ionic equation:

$$\mathbf{Ag^{+}\,(aq) + Cl^{-}\,(aq) \rightarrow AgCl\,(s)}$$

Net ionic equation

PCKS 6: Reactions of acids, bases, salts and water

6.1 When acids and bases are mixed they react with each other. Their acidic and basic properties disappear when equivalent amounts have reacted to produce a neutral solution

6.2 Neutralization is the reaction between equivalent amounts of an acid and a base to form a salt and water

6.3 The hydrogen ions from the acid combine with the hydroxide ions from the base to form water

e.g. $\mathbf{HNO_3 + NaOH \rightarrow NaNO_3 + H_2O}$

Molecular equation

$$\mathbf{H^{+} + OH^{-} \rightarrow H_2O}$$

Net ionic equation

6.4 Reactions of acids with salts result in the formation of weaker acid, a new insoluble salt or a gaseous compound is formed

e.g. $\mathbf{AgNO_3\,(aq) + HCl\,(aq) \rightarrow AgCl\,(s) + HNO_3\,(aq)}$

6.5 When an acid neutralises a base an ionic compound called a salt is formed. Salt solutions can be acidic, or basic depending on the acid base properties of the constituent cations and anions

6.6 Salts that yield basic solutions: Salts such as NaF that are derived from a strong base (NaOH) and a weak acid (HF) yield basic solutions. In this case the cation is neither an acid nor a base but the anion is a weak base

e.g. $\mathbf{F^{-}(aq) + H_2O\,(l) \rightleftharpoons F\,(aq) + OH^{-}(aq)}$

PCKS 7: Dissociation of water:

7.1 In a sample of pure water a small percentage of the water molecules undergo dissociation to produce ions

7.2 The dissociation reaction of water involves the transfer of a proton from one water molecule to another H_2O^{+}

$\mathbf{H_2O \rightleftharpoons H_3O^{+} + OH^{-}}$ **(Bronsted-Lowry theory)**

or

$H_2O \rightleftharpoons H^+ + OH^-$ (Arrhenius theory)

7.3 The dissociation of water molecules is part of an equilibrium situation. Individual water molecules are continually dissociating.

7.4 At equilibrium (at 25°C), the H^+ and OH^- ion concentration 1.00 X 10^{-7} M

7.5 At any given temperature the product of the concentrations of H^+ ion and OH^- ion in water is a constant.

$$[H^+] \times [OH^-] = \text{constant} = (1.00\times10^{-7})\ (1.00\times10^{-7}) = 1.0\times10^{-14}$$

7.6 All acidic solutions have a higher $[H^+]$ than $[OH^-]$. In a similar manner, a base is a substance that increases the OH^- ion concentration in water.

7.7 All basis solutions have a higher $[OH^-]$ than $[H^+]$. In a neutral solution the concentrations of both the H^+ ions and OH^- ions are equal.

PCKS 8: The pH scale:

8.1 The term **pH** is derived from the French puissance *d'hydrogene* ("power of hydrogen") and refers to the power of 10 (the exponent) used to express the molar H_3O^+ concentration.

8.2 The pH of a solution is defined as the negative base-10 logarithm (log) of the molar hydronium ion concentration.

$$pH = -\log [H_3O^+] \text{ or } H_3O^+(-pH) = 10^{-pH}$$

thus and acidic solution having $[H_3O^+] = 10^{-2}$ M has a pH of 2, a basic solution having $[OH^-] = 10^{-2}$M has a pH of 12 and a neutral solution having $[H_3O^+] = 10^{-7}$ has a pH of 7.

PCKS 9: Acid-Base titrations:

9.1 The concentration of an acid or base in a solution and the pH of the solution are two different entities.

9.2 The pH of a solution gives information about the concentration of hydrogen ions in solution. Only dissociated molecules influence the pH value.

9.3 The concentration of an acid or base solution gives information about the total number of acid/base molecules present: both dissociated and un-dissociated molecules are counted.

9.4 The procedure most frequently used to determine the concentration of an acidic or basic solution is that of titration.

9.5 Titration is the gradual adding of one solution to another until the solute in the first solution has reacted completely with the solute in the second solution.

9.6 In order to complete a titration successfully the endpoint must be detected. Endpoint is detected with the help of an indicator.

9.7 An indicator is a compound that exhibits different colours depending on the pH of the surroundings.

9.8 Typically, an indicator is one colour in basic solutions and another colour in acidic solutions.

9.9 An indicator is selected based on the pH at which it will change colour.

PCKS 10: Acid – base calculations (expressed in molarity and/ or percent).

10.1 Concentration refers (in molarity) to the number of moles per given volume of solution

C= n/v where

n= number of moles, v= volume

Molarity = n/dm^3

10.2 Concentration can also be expressed as % mass/mass; % mass/volume; % volume/volume.

10.3 A concentrated solution is a solution with more moles per given volume whereas a dilute solution is a solution with less number of moles per given volume.

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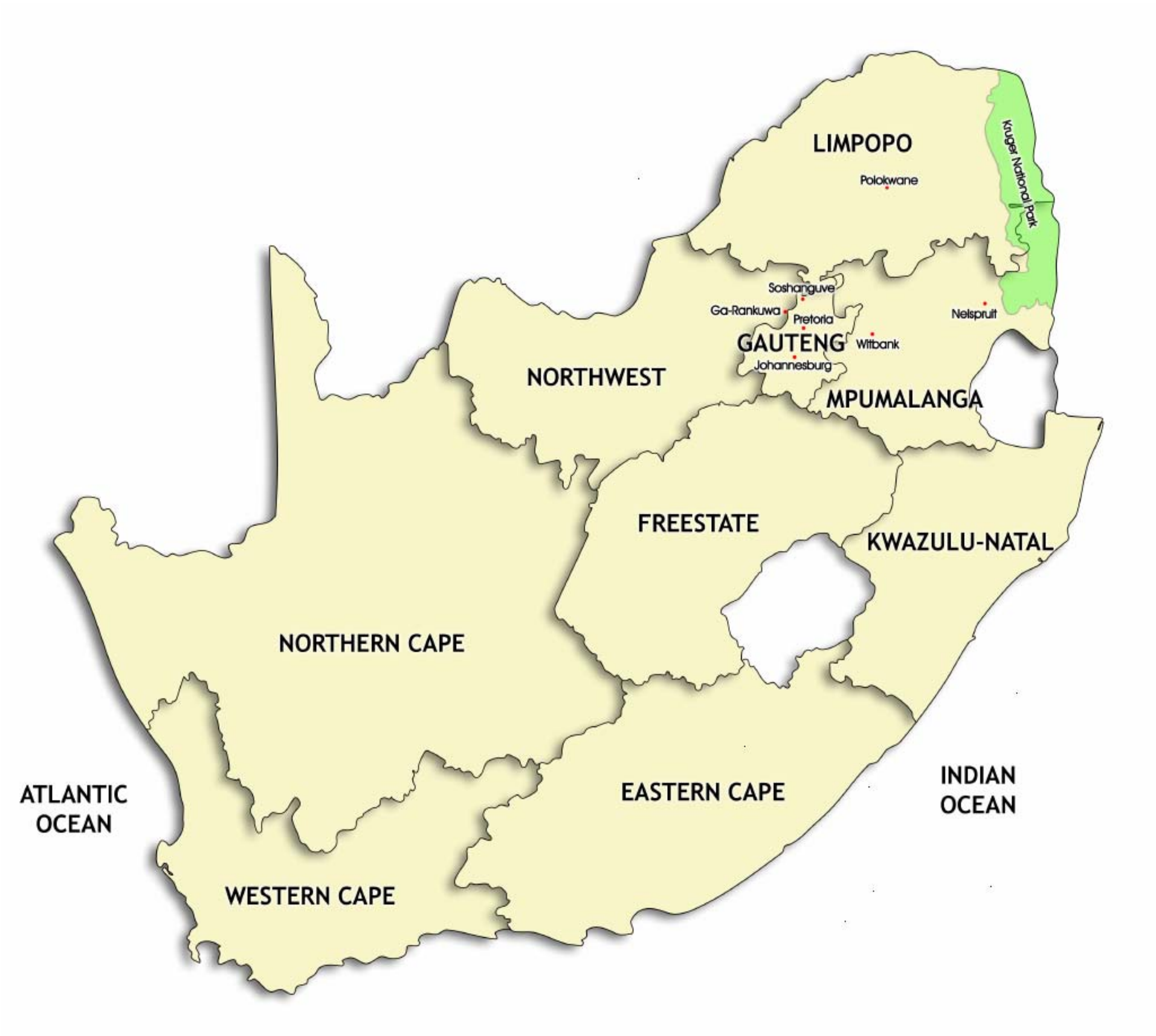
APPENDIX E

Geographical map of South Africa



APPENDIX F
Approval to conduct interviews

Tshwane University of Technology

Directorate of Research of Directorate

Department of Focus Area Support
Department of R&D Administrative Support
Department of Statistical Support

Ref. number: CRIC Q4/06
Enquiries: Mrs Dilla Wright
Tel. (012) 318-5154
wrightd@tut.ac.za

04 May 2006

Mr TDT Sedumedi
Department of Chemistry
Faculty of Natural Sciences
Tshwane University of Technology
Garankuwa Campus

Dear Mr Sedumedi,

APPLICATION TO CONDUCT INTERVIEWS WITH FIRST YEAR CHEMISTRY STUDENTS

We refer to your request for the approval to conduct interviews with first year chemistry students on the Garankuwa Campus to determine the effect of prior knowledge in practical work.

We are pleased to confirm that the study is approved. Kindly furnish the Directorate of Research & Development with a copy of your findings on completion of the study.

Please direct all enquiries to the undersigned.

Yours faithfully,

PDF Kok

PDF Kok (Prof)
Acting Director of Research & Development

cc. Prof Pieter Marais, Dean: Faculty of Natural Sciences
Ms Tanya Coetzee, Faculty Research Officer
Prof Danie du Toit, Chairperson: Ethics Committee

TSedumedi evaluation feedback 040506

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APPENDIX G

Ethics clearance certificate

UNIVERSITY OF PRETORIA

FACULTY OF EDUCATION

RESEARCH ETHICS COMMITTEE

CLEARANCE CERTIFICATE	**CLEARANCE NUMBER :** CS06/10/07
DEGREE AND PROJECT	PhD Curriculum Studies A study of first year students' use of prior knowledge in the learning of chemistry
INVESTIGATOR(S)	Thomas Sedumedi - 24428389
DEPARTMENT	Curriculum Studies
DATE CONSIDERED	16 March 2007
DECISION OF THE COMMITTEE	APPROVED

This ethical clearance is valid for a period of 3 years and may be renewed upon application

CHAIRPERSON OF ETHICS COMMITTEE	Dr S Human-Vogel
DATE	19 March 2007
CC	Prof A Hattingh Jeannie Beukes

This ethical clearance certificate is issued subject to the following conditions:

1. A signed personal declaration of responsibility
2. If the research question changes significantly so as to alter the nature of the study, a new application for ethical clearance must be submitted
3. It remains the applicant's responsibility to ensure that all the necessary forms for permission and informed consent are kept for future queries.

Please quote the clearance number in all enquiries.