

University of Canterbury

Mid Year Examination and Test Period 2008

Prescription Number(s):	CHEM 224
Paper Title:	Analytical & Environmental Chemistry

Time Allowed: 75 MINUTES

Number of pages: FIVE

Answer **ALL** questions.

Total marks = 75.

(You should allocate about 1 minute per mark.)

1. (3 marks)

The chemical composition of an oil spill in water can change over time. List three processes which can alter the composition of an oil spill.

2. (5 marks)

Accredited analytical chemistry laboratories maintain robust quality assurance and quality control programmes. Using examples, explain the difference between quality assurance and quality control.

3. (15 marks)

The regional council monitors nitrate (NO_3^-) concentrations in surface and groundwater.

- (a) Describe an anthropogenic process that leads to the production or release of NO_3^- in the environment. Include equations for relevant redox reactions as appropriate.
- (b) Explain why nitrate accumulation in surface waters and groundwater is of concern.

4. (10 marks)

- (a) Sodium carbonate is used to standardize acid solutions. Explain why it can be used as a primary standard, and what procedures should be carried out to ensure an accurate standardization.
- (b) The concentration of calcium in a urine sample was determined as follows:
- (i) The calcium was precipitated with excess oxalate ($\text{C}_2\text{O}_4^{2-}$) in basic solution.
 - (ii) The precipitated calcium oxalate was filtered, washed, and then redissolved in hot sulphuric acid.
 - (iii) The acidic solution was titrated with standardised KMnO_4 .

A 5.00 mL sample of urine required 12.50 mL of $0.00140 \text{ mol L}^{-1} \text{ KMnO}_4$.

Write down balanced equations for all the reactions involved in this procedure.

Calculate the concentration of Ca^{2+} that was present in the urine, in ppm

5. (12 marks)

- (a) Explain the essential features of weathering processes, including the important weathering agents and the formation of different types of products.
- (b) Using diagrams, explain the difference between a 1:1 and a 2:1 layer aluminosilicate clay mineral.

6. (10 marks)

Describe the important properties of humic substances. Your answer should refer to both fulvic and humic acids, their origin, and their important properties in soils.

7. (20 marks)

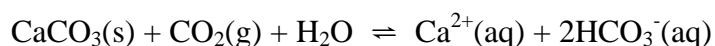
(a) For histidine (H_3X), the acid dissociation constants are:

$$pK_{a1} = 1.7, pK_{a2} = 6.02, pK_{a3} = 9.08.$$

Sketch the speciation diagram (relative concentrations vs pH) for histidine species. Label **all** curves. Ensure that curve crossings and maxima are at the correct pH.

(b) (i) Explain the meaning of the terms: $K_H(CO_2)$, $K_s(CaCO_3(s))$, $K_{a1}(H_2CO_3)$, and $K_{a2}(H_2CO_3)$.

(ii) Derive an expression for the equilibrium constant for the reaction:



using the terms in (i).

(c) What is a *conditional equilibrium constant*? Why are they used?

(d) The burning of fossil fuels containing sulphur can ultimately effect fish in a lake.

What perturbations of aqueous equilibria lead to the observed effects?

END OF PAPER