

CHEMISTRY 224

Class Examination

Wednesday, May 10, 2006

NAME:

Instructions: Answer **ALL** questions in the spaces provided

Total marks: 80

Time Allowed: 80 minutes

1. [32 marks]

a) Explain the term "titration error".

b) A sample of water was found to contain 0.020 ppm Pb^{2+} . What is the concentration of Pb^{2+} in the solution expressed in mol L^{-1} ? Assume that the density of the solution is 1.00 g mL^{-1} . [M(Pb) = 207.2 g mol^{-1} .]

c) Explain how Fe^{3+} functions as an indicator in the Volhard titration of a halide ion with AgNO_3 and KSCN.

d) Explain why KMnO_4 is not a primary standard for volumetric analysis.

e) Fe^{2+} is titrated with Ce^{4+} in a potentiometric titration. Sketch the E versus titrant volume curve and describe which redox pair gives rise to the cell potential at representative points.
 $E^\circ(\text{Ce}^{4+}/\text{Ce}^{3+}) = 1.61 \text{ V}$; $E^\circ(\text{Fe}^{3+}/\text{Fe}^{2+}) = 0.77 \text{ V}$.

f) Calculate the pH of:

(i) a sample of $0.10 \text{ mol L}^{-1} \text{ Na}_2\text{SO}_3$, and

(ii) a sample formed by mixing 10.0 mL of $0.10 \text{ mol L}^{-1} \text{ Na}_2\text{SO}_3$ and 20 mL of $0.15 \text{ mol L}^{-1} \text{ NaHSO}_3$.

$[K_{a1}(\text{H}_2\text{SO}_3) = 1.7 \times 10^{-2}; K_{a2}(\text{HSO}_3^-) = 6.4 \times 10^{-8}. K_w = 1.0 \times 10^{-14}]$

4. (9 marks).

By reference to the following Figure for the weathering of a feldspar:

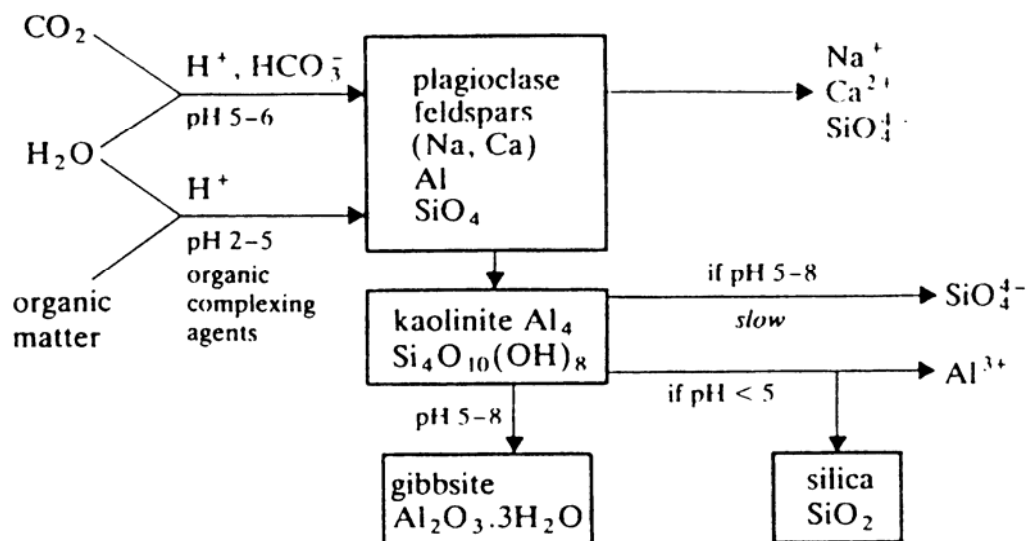


Figure The chemical weathering of a number of common minerals found initially in igneous rocks.

- (a) Explain the essential features of the weathering process (including the important weathering agents and the formation of different types of products).
- (b) Identify a common weathering product that is *not shown in the Figure*. Use a box to indicate this product and its position on the diagram above.
- (c) Explain why the pH for the weathering process leads to different solid phase end-products (Al_2O_3 or SiO_2).

5. (20 marks)

For **either** S **or** C **or** N describe the important reservoirs, reactions and fluxes in this element's geochemical cycle.

Your answer should include reference to the sources and impact of anthropogenic inputs to this cycle, and indicate the related consequences (e.g. the effect of organic C on the redox reactions in a river or lake; the effect of stocking on the production of NH_3 ; the effect of S emissions on fish death).

As appropriate, use diagrams and chemical equations to amplify your answer.

6. (10 marks)

The following questions (a) - (c) refer to the properties of 'layered aluminosilicates':

(a) Sketch and label a simple diagram to illustrate the general features of a 2:1 layered aluminosilicate.

(b) Explain the term 'isomorphous replacement'. Label your diagram above to show the site(s) for, and types of isomorphous replacement that might occur.

(c) Isomorphous replacement gives properties to layered aluminosilicates which may be beneficial in terms of soil/plant chemistry. Explain.

7. (9 marks)***Either:***

What are the important properties of humic substances? What is their origin and what is their role in soils?

As appropriate, use diagrams to illustrate your answer.

Or:

Explain the formation of amorphous $\text{Fe}(\text{OH})_3$ and $\text{Al}(\text{OH})_3$ in soils. Clearly describe their cation and anion exchange properties, and any other beneficial properties.

As appropriate, use diagrams and equations to illustrate your answer.