TRANSLATION

UNIVERSITI SAINS MALAYSIA

Second Semester Examination
Academic Session of 2005/2006

April/May 2006

EBS 432/3 – Environmental Chemistry For Engineering Practice

Time : 3 hours

Please ensure that this paper consists of NINE printed pages before you proceed with the examination.

This paper contains 7 questions.

Answer any FIVE questions. If a candidate answer more than five questions, only the first five answered will be examined and awarded marks.

Answer to any question must start on a new page.

All questions must be answered in Bahasa Malaysia.

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1. [a] Distinguish between *dissolved substances, suspended solids and colloidal substances* based on their size and the mechanism by which they can be removed from water.

(20 marks)

[b] Briefly explain the effect of various chemical additions to the *carbonate buffer system.* Your explanation should include the effect on the displacement of the reaction (left to right), effect on CO_2 (into or out of solution) and effect on pH (increase, decrease or no change).

(30 marks)

[c] The following data shown in Table 1, were obtained for an irreversible elementary reaction. Plot the data, determine the order of the reaction and the rate constant.

Table 1: Data showing the change in concentration of reactant A for an irreversible elementary reaction with respect to time

Time (min)	Reactant A (Concentration, mmoles/L)
0	2.80
1	2.43
2	2.12
5	1.39
10	0.69
20	0.17

(50 marks)

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2. [a] Explain the difference between part per million (ppm) in air pollution and part per million (ppm) in water pollution.

(20 marks)

[b] A one-cubic-centimeter sample of air was found to contain 80 $\mu g/m^3$ of SO_2. The temperature and pressure were 25°C and 103.193 kPa respectively when the air sample was taken. What was the SO_2 concentration in ppm?

Given: Atomic. *wt. S = 32.06 g/mol and O = 15.99 g/mol*

(20 marks)

[c] The combustion of fossil fuels containing sulfur yields sulfur dioxide in direct proportion to the sulfur content of the fuel. Because the combustions is not 100 % efficient, it is assumed that 5 percent of the sulfur in the fuel ends up in the ash. An Indonesian coal is burned at a rate of 1.00 kg per second. The analysis of the coal reveals a sulfur content of 3.00 percent.

(i) Using the mass balance approach, draw the mass balance diagram for sulfur.

(10 marks)

(ii) Write the mass balance equation for sulfur. Then calculate the mass of "sulfur in" in units of kg/s and kg/y.

(30 marks)

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(iii) From the proportional weights of the oxidation reaction,

$$S + O_2 \rightarrow SO_2$$

What is the annual rate of emission of SO_2?

Given: *Atomic. wt. S = 32.06 and O = 15.99 g/mol*

(20 marks)

3. [a] Define the term *acid rain* and how it occurs. Explain why acid rain is of concern.

(30 marks)

[b] A sample of air contains 8.563 moles/m^3 of oxygen and 15.93 moles/m^3 of nitrogen at STP. Determine the *partial pressures of oxygen and nitrogen* in 1.0 m^3 of the air.

Given: *Atomic. wt. N = 14.0 and O = 15.99 g/mol*
R = 8.314 J/K-mole , T = 273.16 K,
Units of J = (N)(m) and units of Pa = N/m^2

(25 marks)

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[c] Given the concentration and flow rate of NaOH as shown in Table 2 below,

Table 2: Concentration and flow rate of NaOH

Constituent	Concentration, mg/L	Flow, L/min
NaOH	250	20

(i) Write a *balance equation* for the neutralization of sodium hydroxide with sulfuric acids

(5 marks)

(ii) Determine the quantities (in kg/day) of sulfuric acid required to neutralize the waste.

Given: *Atomic. wt. Na = 23, S = 32, O = 15.99, H = 1.00 g/mole*

(20 marks)

(iii) Estimate the *total dissolved solids* (TDS) after neutralization. Report your answer in mg/L.

(20 marks)

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4. [a] Define *leachate* and explain why it occurs

(30 marks)

[b] List the ***five*** ways a waste can be found to be hazardous and briefly explain each.

(20 marks)

[c] Briefly explain the phenomenon of stratospheric ozone depletion.

(30 marks)

[d] A chemical is placed in a beaker containing 20 g of soil and 500 mL of water. At equilibrium, the chemical is found in the soil at a concentration of 100 mg kg^{-1} of soil. The equilibrium concentration of this chemical in water is 250 µg L^{-1}. What is the partition coefficient for this chemical on the soil?

(20 marks)

5. [a] Describe the process of *stratification* due to the changes in the water temperature that results from the annual cycle of air temperature changes. Define *epilimnion, hypolimnion, thermocline* and *mesolimnion.*

(40 marks)

[b] Sketch and explain the *hydrological cycle*, labeling all the parts.

(40 marks)

[c] Define the terms *nitrification* and *denitrification.*

(20 marks)

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6. [a] What are *greenhouse gases*?
Show a schematic diagram of the behavior of solar radiation in the Earth's atmosphere, indicating the influence of the *ozone layer* and the *greenhouse effect*.

(40 marks)

[b] The atmosphere plays several key roles in maintaining the global ecosystem. Briefly describe the ***5*** principal roles of the atmosphere.

(30 marks)

[c] A metal plating firm is installing a precipitation system to remove zinc. They plan to use a pH meter to control the feed of hydroxide solution to the mixing tank. What pH should the controller be set at to achieve a zinc effluent concentration of 0.80 mgL^{-1} ? The K_{sp} of $Zn(OH)_2$ is 7.68×10^{-17}.

The zinc hydroxide equation:

$$Zn^{2+} + 2OH^- = Zn(OH)_2$$

Given: *At.wt. Zn = 65.38 g/mole*

(30 marks)

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7. Choose any **two** of the following topics:

[a] Differentiate between *waste minimization, waste exchange and recycling*. There are a large number of *treatment technologies* available such as biological treatment, chemical precipitation, ion exchange, carbon adsorption and oxidation-reduction processes. Discuss briefly any ***one*** of these processes as they apply to hazardous waste treatment.

(50 marks)

[b] What is the distinction between wind and air currents? How might these phenomena be involved in air pollution?

What is Microclimate?

Explain briefly why the climatic conditions in nearby rural surroundings are cooler and humid compared to the city climate which is warmer, froggier and subjected to more precipitation.

What are the effects of urbanization on Microclimate?

(50 marks)

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[c] Define *hazardous wastes.* Hazardous materials normally caused problems when they enter the environment and have detrimental effects on organisms or other parts of the environment. Discuss briefly the *distribution, transport and effects* of these wastes with respect to their physical and chemical properties.

(50 marks)

[d] The properties of soil have a strong influence on any contaminants present. Discuss briefly the important *environmental properties of soils* principally the clay and soil organic matter. Human exposure to soil contaminants can also have important adverse effects. With the aid of a *diagram*, briefly show the *distribution pattern* of soil contaminants in the soil ecosystem.

(50 marks)

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