 Name..... ID.....

Prince of Songkla University

Faculty of Engineering

Midterm Examination: Second Semester **Academic Year 2008**

Date: December 23, 2008 **Time: 13.30-16.30น**

Subject: 223-515 HAZARDOUS WASTE MANAGEMENT AND DESIGN **Room: A205**

Name.....Surname.....ID.....

Question 1	Total Score	Score
1	5	
2	8	
3	30	
4	15	
5	12	
6	5	
7	15	
8	10	
Summation	100	

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December 2551

 Name..... ID.....

Question 1 (5 Points)

1-1 What are waste characteristics that are used to define the waste to be the hazardous waste? **(5 Points)**

Question 2 (8 Points)

2-1 Explain the meaning of following terms

Resource Conservation and Recovery Act (RCRA) **(2 Points)**

Superfund **(2 Points)**

2-2 How many types of standard that is established in Applicable or Relevant and Appropriate Requirements (ARARs) for controlling the remediation of hazardous waste site? Explain in brief detailed **(4 Points)**

 Name..... ID.....

Question 1 (30 Points)

3-1 The factory designs to use hydroxide sedimentation process to treat wastewater that consists of lead (Pb). According to standard, the concentration of lead in treated wastewater must less than 0.05 mg/L. By using the pH of 9, does concentration of lead in treated wastewater lower than standard? If your answer is no, then, what is the lowest pH value that could be used to decrease the concentration of lead in treated wastewater to be lower than standard? **(8 Points)**

Given k_{sp} of lead at 25 ^{o}C = 2.5 x 10^{-16} (the treatment process was operated at 25 ^{o}C)

Mw of Pb = 207.19 g/mol, $Pb(OH)_2(c) <------> Pb^{+2} + 2OH^-$

 Name..... ID.....

3-2 Estimate Henry's constant for m-Xylene in water at 20 $^{\circ}$C from vapor pressure and solubility data. Compare to the value that was calculated from this equation, $\ln H = A/T + B$, (the comparison should be expressed in term of percent different) **(8 Points)**

Given m-Xylene information: Vapor Pressure (P_{vp}) = 10 mmHg at 20 $^{\circ}$C,

Solubility at 20 $^{\circ}$C = 1.75×10^{2} mg/L,

Molecular weight = 106.18 g/mol,

$H = P_{vp}/S$,

$A = -3.34 \times 10^{3}$

B = 6.28,

T = Temperature in kelvins

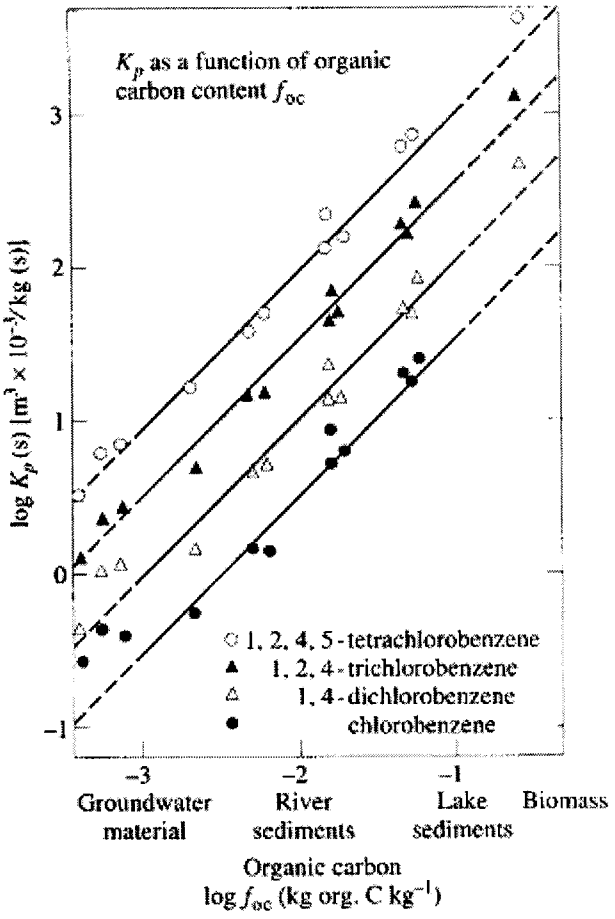
 Name..... ID.....

3-3 The concentration of cadmium in water from reservoir is found to be 100 ppb. Determine the concentration of Cadmium in the fish from this reservoir. Determine the dose of cadmium that could be uptaked in to human body within 1 year (365 days) for (1) 20 g of fish is eaten everyday and (2) 1 Liter of untreated water is drunk everyday. Compare the risk between these two activities.

Given BCF = 81 L/kg, BFC = C_{org}/C_{water} **(8 points)**

 Name..... ID.....

3-4 According to graph, (1) Examine ability of groundwater material, river sediments, lake sediment and biomass for adsorbing organic matter from high to low (2) Rank compounds (tetrachlorobenzene, trichlorobenzene, dichlorobenzene, and chlorobenzene) that easy to adsorb by material from high to low. **(6 points)**

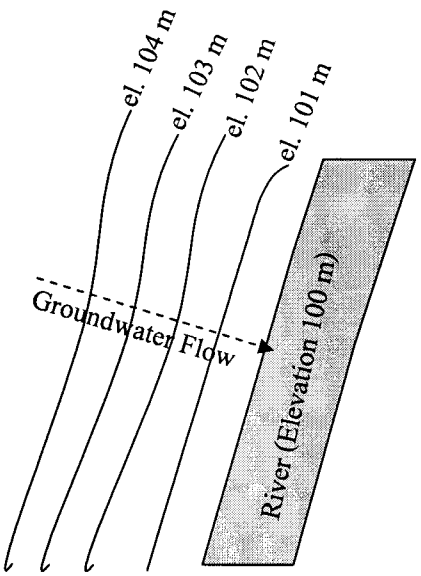


Relationship between organic carbon content of solid materials to soil-water partition coefficient for selected benzene compounds. *(After Stumms, 1992.[22])*

 Name..... ID.....

Question 4 (12 points)

4-1 The contaminant concentration has been found to be 400 mg/L for the area of a site represented in the plan view in the Figure. The ground water contour are spaced at interval of about 50 m. From the test boring, the average thickness of aquifer is 5 m and hydraulic conductivity is estimated to be 1 x 10^{-2} cm/s. For each meter of length as measured parallel to the river, what is the contaminant loading rate in kg/year? **(8 points)**



 Name..... ID.....

4-2 Draw the picture to explain the movement of Dense Nonaqueous-phase Liquid (DNAPL) and Light Nonaqueous-phase Liquid (LNAPL) in subsurface **(4 points)**

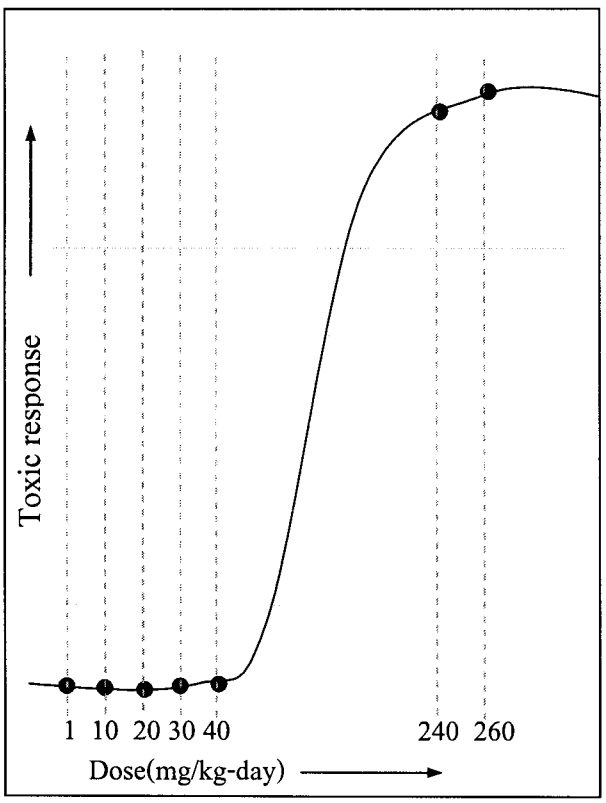
4-3 Regard to terms as shown in the following, (1) determine terms that related to retardation (2) determine terms that related to attenuation

(3 points)

- Sorption
- Biodegradation
- Hydrolysis
- Cosolvation
- Biological Uptake
- Complexation

Question 5 (12 points)

5-1 According to the subchronic oral toxicology experiment in animal test as present in the Figure and the data in the table , determine (1) no observed adverse effect Level (NOAEL) (2) lowest observed adverse effect level (LOAEL) and (3) reference dose (RfD) **(7 points)**

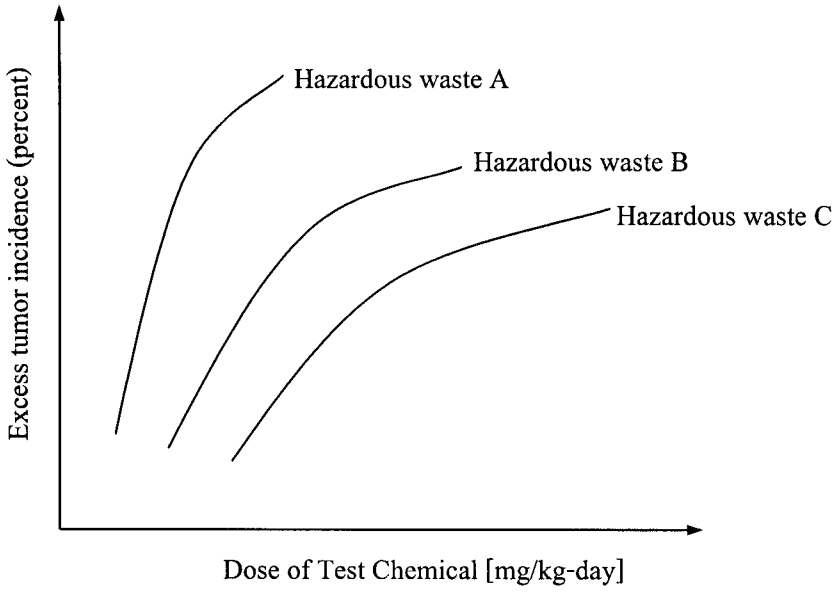


Given

Area of uncertainty	**Uncertainty factor**
Variation within a population	10
Extrapolation from animals to humans	10
Extrapolation from subchronic to chronic	10
Extrapolation from LOAEL to NOAEL	10
Modifying factor	1

 Name..... ID.....

5-2 From hypothetical dose-response curve for a typical complete carcinogen of hazardous waste A B and C, Express the possibility to create the cancer of hazardous waste A B and C from high to low. **(5 points)**



Question 6 Draw the diagram of waste management cycle. The diagram must demonstrate types for shipping of hazardous waste from factory to final destination **(5 points)**

Question 7 (15 points)

7-1 Draw the diagram to explain the handling process of hazardous waste that start from waste generation, followed by recovery/recycling, treatment and land disposal. In addition, express two sub processes in each mentioned processes **(5 points).**

 Name..... ID.....

7-2 According to the following information, how many containments those are required to construct for storage the hazardous wastes A-J? **(10 points)**

Given

Hazardous Waste A: Acids, Mineral Oxidizing Agents (2) *

Hazardous Waste B: Caustics (10)

Hazardous Waste C: Ethers (14)

Hazardous Waste D: Hydrocarbon, Aromatic (16)

Hazardous Waste E: Metal and Metal Compound Toxic (24)

Hazardous Waste F: Nitride (25)

Hazardous Waste G: Epoxides (34)

Hazardous Waste H: Oxidizing Agents, Strong (104)

Hazardous Waste I: Reducing Agents, Strong (105)

Hazardous Waste J: Waste Reactive Substances (107)

*( ) = Reactivity group as shown in Page 15

Question 8 (10 points)

Groundwater is contaminated with m-Xylene (C_8H_{10}) 5 mg/L. Design air striping column for removing m-Xylene in groundwater to lower than 200 μg/L. Determine liquid loading rate [mol/(s-m^2)], stripping factor (R), height of transfer unit (HTU), number of transfer units (NTU) and height of packing column

Given

$K_La = 0.0155\ s^{-1}$

$Q_W = 10$ L/s

Density of water = 1.0 kg/L

Molar density of water = 55600 mol/m^3

Temperature = 20 ^0C

Column diameter = 0.61 m (2 ft)

Air to water ratio (Q_A/Q_W) = 30

H' = H/RT, เมื่อ R = 8.205×10^{-5} (atm –m^3/(mol-K)

ln H = A/T + B เมื่อ A = -3.34×10^3 B = 6.28

$R = H' (Q_A/Q_W)$

$Z = HTU \times NTU$

$$HTU = \frac{L}{M_W K_L a}$$

$$NTU = \left(\frac{R}{R-1}\right)\ln\left(\frac{(C_{in}/C_{out})(R-1)+1}{R}\right)$$

Name..... ID.....

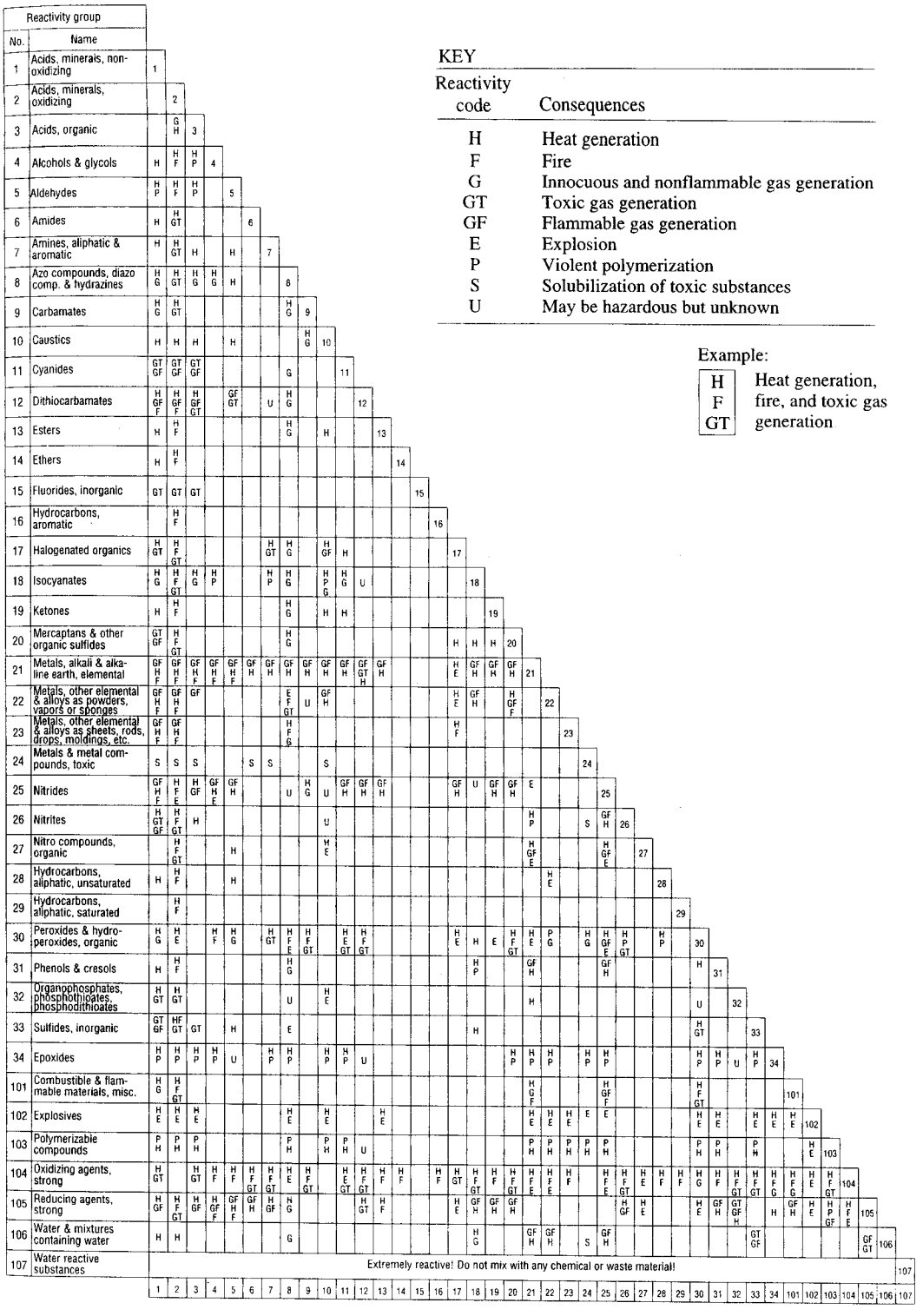


FIGURE 8-10
Compatibility chart for storage of hazardous waste.[9]