มหาวิทยาลัยสงขลานครินทร์
คณะวิศวกรรมศาสตร์

การสอบกลางภาค ประจำภาคการศึกษาที่ 2 **ปีการศึกษา** 2548
สอบวันที่ 15 ธันวาคม 2548 **เวลา** 09:00-12:00 น
วิชา 220-524 Waste Geotechnics **ห้องสอบ** A205

ชื่อ..... รหัส.....

คำชี้แจง

1. ข้อสอบมี 4 ข้อ 100 คะแนน ให้ทำทุกข้อ
2. อนุญาตให้นักศึกษานำเครื่องคิดเลขเข้าห้องสอบได้
3. **ไม่**อนุญาตให้นักศึกษานำเอกสารใดๆ เข้าห้องสอบ

ออกข้อสอบโดย ผศ. ดร. ธนิต เฉลิมยานนท์

Problem 1: Short Answers (15 points)

a. What is the purpose of using geosynthetic clay liner (GCL) in Landfill, Explain?
b. Explain the process of how contaminants from waste containment may affect the people?
c. Explain the theory of diffuse double layer, why it affects the hydraulic conductivity of clay?

Problem 2: Cation Exchange (15 points)

A local soil in Hatyai of 500 g in weight contains 70 % of clay with CEC of 150 meq/100g.

a. What is the weight of Zn that will satisfy the CEC?
b. What is the weight of Na that will satisfy the CEC?
c. if this soil was first mixed with 500 ml of Na-Solution of 5000 ppm, what is the weight of Cd required to satisfy the CEC?

Problem 3: Transport-Based Liner Design (45 points)

A composite liner consists of a 0.6 m compacted clay ($K = 1x10^{-7}$ cm/s) overlain by a 1.5-mm thick HDPE geomembrane with a maximum depth of leachate of 0.3 m. Leachate of concern contains zinc and toluene. The concentrations of zinc and toluene in the leachate are 200 and 20 mg/L.

The soil partitioning coefficients of zinc is 0.26L/kg. Toluene is not adsorbed in clay. The soil diffusion coefficient for zinc and toluene are $2x10^{-6}$ and $4x10^{-6}$ cm^2/s respectively. The porosity of clay is 0.4, specific gravity is 2.7, and the dry density is 1.84 g/cc. Determine the mass flux (kg/ha/yr) of zinc and

toluene at 20 years. Assume the diameter of the holes is 5 mm and 10 holes/ha. Note that for organic analysis, ignore the mass flux through the holes.

Problem 4: Adsorption (25 points)

Batch adsorption tests were conducted on a sample of moderately to highly plastic clay that is being considered as a lining material for a pond used to contain process water containing cadmium chloride. The batch tests were conducted by adding 1 g of dry clay to 40 ml of solution prepared with deionized water and copper chloride, $CdCl_2$ (atomic weight of Cd (2 positive ions) = 112.41 g, atomic weight of Cl = 35.453 g). Four flasks were prepared. The following concentrations were measured before the soil was added (C_o) and after tumbling the flasks for 48 hours (C_f).

Sample	C_o (mg/l)	C_f (mg/l)
1	3542	2599
2	3042	2100
3	2151	1466
4	1151	781
5	0	0

Plot the isotherm. Estimate the partition coefficient (l/kg) for cadmium with the soil. Estimate CEC (meq/100 g).

$$M_g = (C_0 - C_f)V$$

$$\gamma_d = \frac{\gamma}{1+\omega}$$

$$q = M_g / M_s$$

$$A_e = Q_c / Ki$$

$$Q_c = F_R K \Delta H r$$

$$F_R = 4 + 3.35(r/L)$$

$$v_s = Ki/n$$

$$i = \Delta H / L$$

$$J = J_{A-D} \times A_e \times n_{h.}$$

$$\text{at } v_s = 0 \Rightarrow J = n C_0 \frac{\exp\left[-\frac{L^2 R}{4tD}\right]}{\sqrt{\frac{\pi t}{DR}}}$$

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Periodic Chart of the Elements

1 (1 IA IA)	2 (2 IIA IIA)	3 (3d IIIA IIIB)	4 (4d IVA IVB)	5 (5d VA VB)	6 (6d VIA VIB)	7 (7d VIIA VIIB)	8 (8d VIIIA VIIIB)	9 (9d VIIIA VIIIB)	10 (10d VIIIA VIIIB)	11 (11d IB IB)	12 (12d IIB IIB)	•13 (◆ ■ IIIB IIIA)	14 (14 IVB IVA)	15 (15 VB VA)	16 (16 ‡ VIB VIA)	17 (17 VIIB VIIA)	18 (18 0 VIIIA)
1 **H** 1.00794△																1 **H** 1.00794△	2 **He** 4.002602*
3 **Li** 6.941*	4 **Be** 9.01218											5 **B** 10.811△	6 **C** 12.011	7 **N** 14.0067	8 **O** 15.9994†	9 **F** 18.998403	10 **Ne** 20.179
11 **Na** 22.98977	12 **Mg** 24.305											13 **Al** 26.98154	14 **Si** 28.0855†	15 **P** 30.97376	16 **S** 32.066△	17 **Cl** 35.453	18 **Ar** 39.948
19 **K** 39.0983	20 **Ca** 40.078△	21 **Sc** 44.95591	22 **Ti** 47.88†	23 **V** 50.9415	24 **Cr** 51.9961△	25 **Mn** 54.9380	26 **Fe** 55.847†	27 **Co** 58.9332	28 **Ni** 58.69	29 **Cu** 63.546†	30 **Zn** 65.39*	31 **Ga** 69.723△	32 **Ge** 72.59†	33 **As** 74.9216	34 **Se** 78.96†	35 **Br** 79.904	36 **Kr** 83.80
37 **Rb** 85.4678†	38 **Sr** 87.62	39 **Y** 88.9059	40 **Zr** 91.224*	41 **Nb** 92.9064	42 **Mo** 95.94	43 **Tc** (98)	44 **Ru** 101.07*	45 **Rh** 102.9055	46 **Pd** 106.42	47 **Ag** 107.8682†	48 **Cd** 112.41	49 **In** 114.82	50 **Sn** 118.710△	51 **Sb** 121.75†	52 **Te** 127.60†	53 **I** 126.9045	54 **Xe** 131.29†
55 **Cs** 132.9054	56 **Ba** 137.33	57 ****La** 138.9055†	72 **Hf** 178.49†	73 **Ta** 180.9479	74 **W** 183.85†	75 **Re** 186.207	76 **Os** 190.2	77 **Ir** 192.22†	78 **Pt** 195.08†	79 **Au** 196.9665	80 **Hg** 200.59†	81 **Tl** 204.383	82 **Pb** 207.2	83 **Bi** 208.9804	84 **Po** (209)	85 **At** (210)	86 **Rn** (222)
87 **Fr** (223)	88 **Ra** 226.0254	89 **▼Ac** 227.0278	104 **Unq§** (261)	105 **Unp§** (262)	106 **Unh§** (263)												

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- Former IUPAC
- ◆ New Chemical Abstract Service
- ★ Former Chemical Abstract Service

**Lanthanides

58	59	60	61	62	63	64	65	66	67	68	69	70	71
Ce 140.12	**Pr** 140.9077	**Nd** 144.24†	**Pm** (145)	**Sm** 150.36†	**Eu** 151.96	**Gd** 157.25†	**Tb** 158.9254	**Dy** 162.50†	**Ho** 164.9304	**Er** 167.26†	**Tm** 168.9342	**Yb** 173.04†	**Lu** 174.967

▼Actinides

90	91	92	93	94	95	96	97	98	99	100	101	102	103
Th 232.0381	**Pa** 231.0359	**U** 238.0289	**Np** 237.0482	**Pu** (244)	**Am** (243)	**Cm** (247)	**Bk** (247)	**Cf** (251)	**Es** (252)	**Fm** (257)	**Md** (258)	**No** (259)	**Lr** (260)

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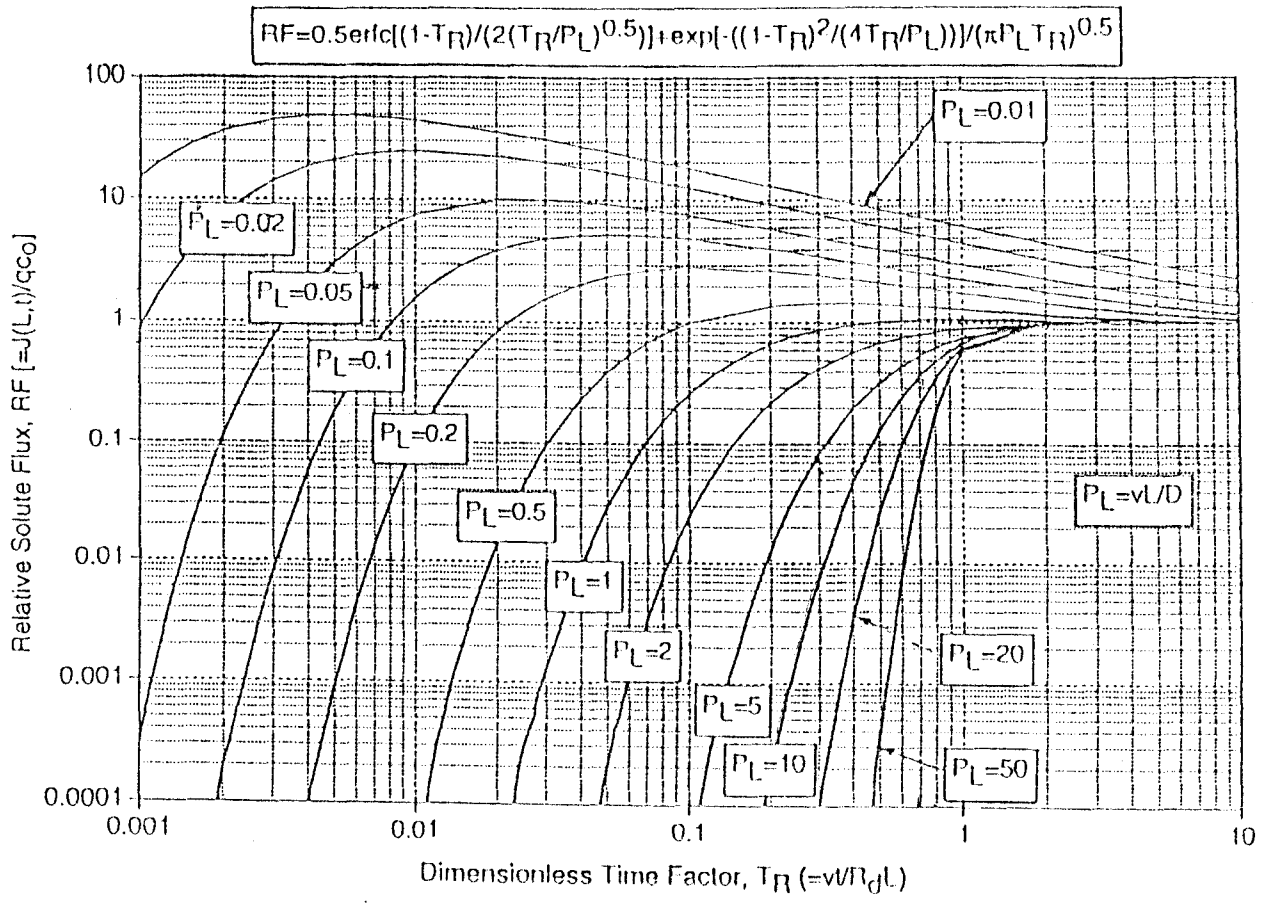
§The International Union of Pure and Applied Chemistry (IUPAC) has not adopted official names or symbols for these elements.

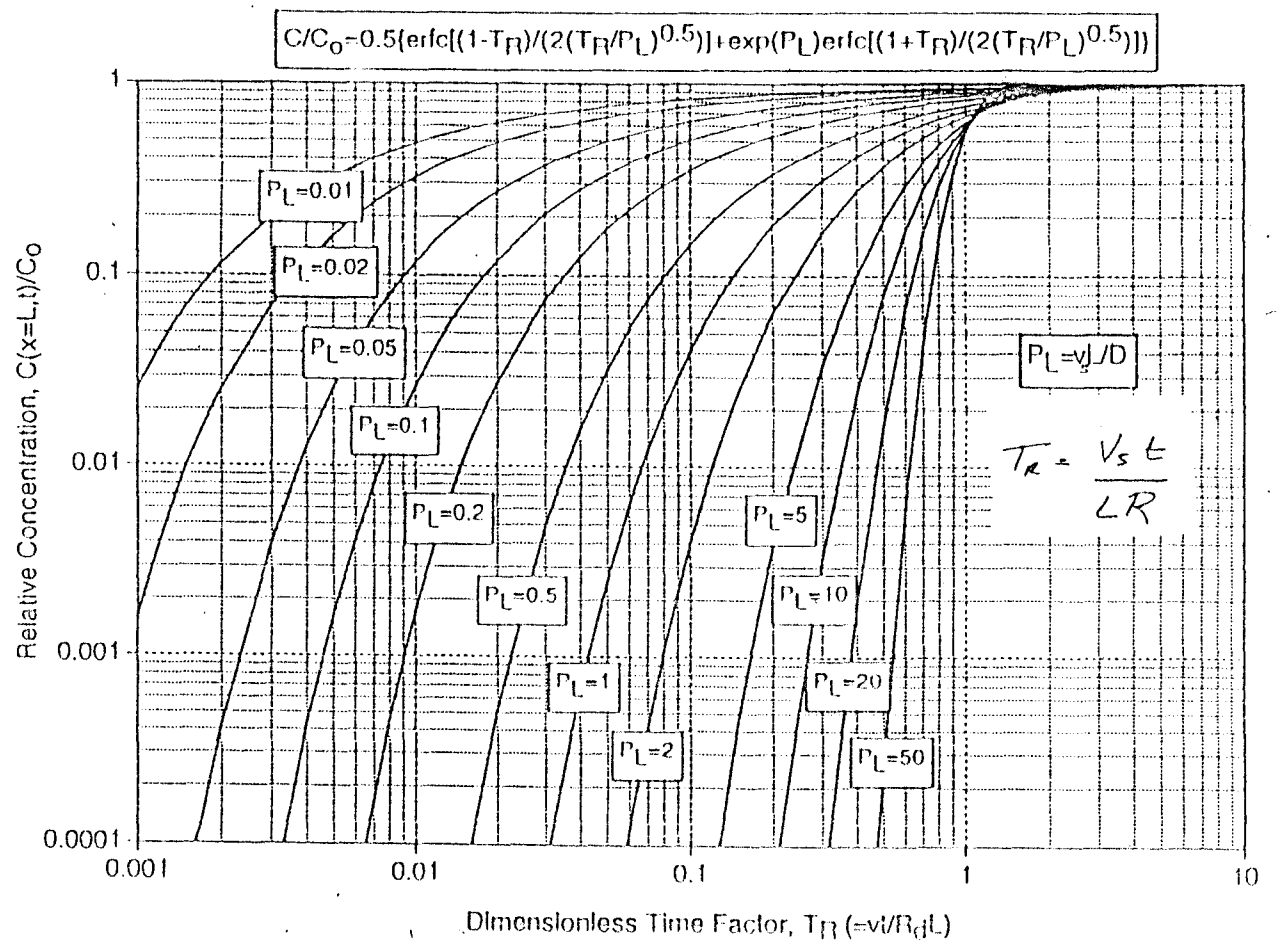
*These weights are considered reliable to ± 2 in the last place.

†These weights are considered reliable to ± 3 in the last place.

△These weights are considered reliable in the last place, as follows: Calcium and Gallium ± 4; Boron ± 5; Chromium and Sulfur ± 6; Hydrogen and Tin ± 7.
All other weights are reliable to ± 1 in the last place. All reliabilities are based on an uncertainty scale of ± 1 to 9.

Atomic weights corrected to conform to the most recent values of the Commission on Atomic Weights. Column nomenclature conforms to IUPAC system and data in this chart have been checked by the National Bureau of Standards' Office of Standard Reference Data.


RF=0.5erfc[(1-T_R)/(2(T_R/P_L)^0.5)]+exp[-((1-T_R)^2/(4T_R/P_L))]/(πP_L T_R)^0.5
Relative Solute Flux, RF [=J(L,t)/qC_o]
Dimensionless Time Factor, T_R (=vt/R_d L)
100
10
1
0.1
0.01
0.001
0.0001
0.001
0.01
0.1
1
10
P_L=0.01
P_L=0.02
P_L=0.05
P_L=0.1
P_L=0.2
P_L=0.5
P_L=1
P_L=2
P_L=5
P_L=10
P_L=20
P_L=50
P_L=vL/D


C/C_o=0.5{erfc[(1-T_R)/(2(T_R/P_L)^0.5)]+exp(P_L)erfc[(1+T_R)/(2(T_R/P_L)^0.5)]}
Relative Concentration, C(x=L,t)/C_o
Dimensionless Time Factor, T_R (=vt/R_d L)
1
0.1
0.01
0.001
0.0001
0.001
0.01
0.1
1
10
P_L=0.01
P_L=0.02
P_L=0.05
P_L=0.1
P_L=0.2
P_L=0.5
P_L=1
P_L=2
P_L=5
P_L=10
P_L=20
P_L=50
P_L=vL/D
T_R = V_s t / L R