A 1 meter thick clay liner has a 30-cm head of leachate. The hydraulic conductivity of the liner is 1×10^{-7} cm/s, the total porosity is 0.45 and the effective diffusion coefficient is 1.2×10^{-10} m^2/s. The SSA of the clay liner material is 35 m^2/g, the dry density is 1.55 g/cm^3 and the organic carbon content of the clay is 0.25%. You can use an average particle size for the clay of 0.0025 mm.

This clay is permeated with a PCB compound, Aroclor 1260. For this compound the Log K_{OW} = 6.91.

1) What is the retardation factor for this chemical?
2) When will this chemical reach a C/C_0 of 0.25 with advection?
3) When will this chemical reach a C/C_0 of 0.25 with diffusion?
4) When will this chemical reach a C/C_0 of 0.25 with advection - diffusion transport?
5) Estimate the Peclet number for these conditions. Which type of transport is important for the Peclet number that you have obtained?

Regression equations for estimating K_{OC}[1] are valid for $f_{OC} > f^{*}_{OC}$

Regression Equation	Applicable Compounds
Log K_{OC} = 1.029 log K_{OW} – 0.18	Herbicides and Insecticides
Log K_{OC} = 0.544 log K_{OW} + 1.377	PCBs
Log K_{OC} = log K_{OW} - 21	PAHs

[1]Watts, R. J. (1998) Hazardous Wastes: Sources, Pathways, Receptors, John Wiley & Sons, Inc., NY.

6) What will be the theoretical estimate of landfill gas generation for 1000 kg of rapidly decomposable waste? Take the density of methane as being 0.7177 kg/m^3.

7) A leaching column experiment was conducted to determine the effective diffusion coefficient for chloride through a loam soil. The leaching column was 10 cm in diameter and 10 cm long and the seepage velocity was 0.025 cm/hour. The effluent leachate concentration ratio against time is as given below. Determine the effective diffusion coefficient, if possible to the nearest 3%, using the leaching column method (the Ogata solution). Is the value you obtained realistic? Why or why not?

C/C_0	0.042	0.126	0.337	0.568	0.726	0.853	0.954	1.000
Time (hours)	175	200	300	400	500	600	700	782

Chemical Name	Log K_{OW}	Number
Polycylic Aromatic Hydrocarbons (PAHs)		
Acenaphthene	3.92	1
Anthracene	4.34	2
Benzo(a)anthracene	5.91	3
Benzo(a)pyrene	6.06	4
Benzo(b)fluoranthene	6.57	5
Chrysene	5.71	6
Fluorene	4.38	7
Fluoroanthene	5.22	8
Indeno(1,2,3-c,d)pyrene	6.84	9
Naphthalene	3.51	10
Phenanthrene	4.52	11
Pyrene	5.32	12
Insecticides and hericides		
Alachlor	2.92	13
Aldrin	5.17	14
Atrazine	2.68	15
Carbaryl	2.38	16
Carbofuran	1.62	17
Chlorodane	6.00	18
2,4-D	2.94	19
DDT	6.11	20
Dieldrin	5.16	21
Diuron	2.42	22
Endrin	5.02	23
Hexachlorobenzene	5.65	24
Kepone	4.07	25
Lindane	3.76	26
Malathion	2.84	27

Methoxychlor	3.40	28
Methyl parathion	1.91	29
Parathion	3.43	30
2,4,5-T	3.40	31
Trifluralin	5.31	32
Polychlorinated Biphenyls (PCBs)		
Aroclor 1016	5.58	33
Aroclor 1221	2.80	34
Aroclor 1232	3.87	35
Aroclor 1248	6.11	36
Aroclor 1254	6.31	37
Aroclor 1260	6.91	38