Final Exam- Geoenvironmental Engineering

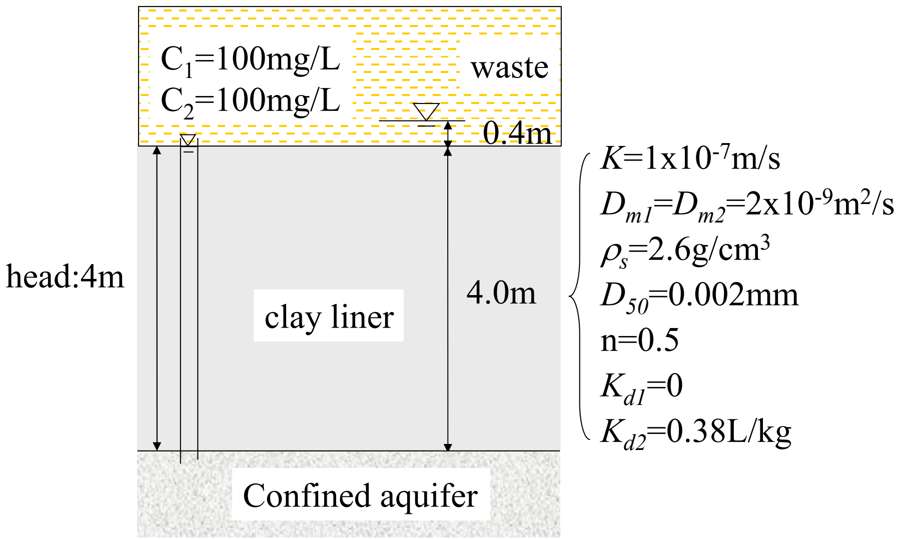
Answer the following questions as much as you can. (you can use the backside of the answer sheet)

1. Briefly explain the following terms about hydrogeology and geo-environment. For the explanation you may draw a key sketch about the terms. (20)

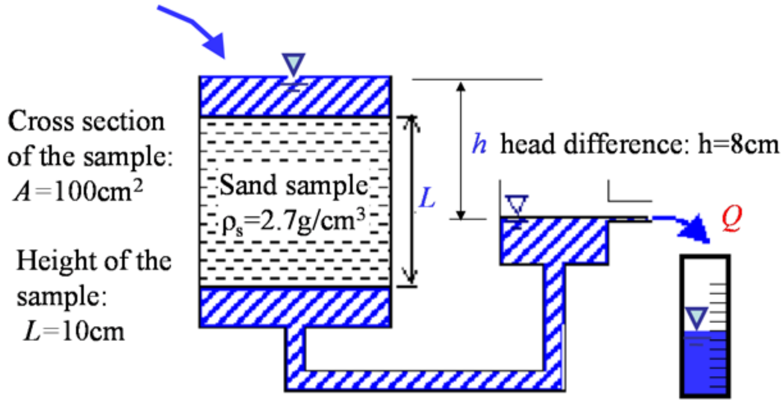
   1) confined aquifer, 2) Dacry's law, 3) hydrodynamic dispersion coefficient

2. Consider a natural saturated clay barrier (liner) of waste landfill overlaying an aquifer as shown in the bottom figure. Using the following conditions and assuming that the concentration of two pollutant chemicals C_1, C_2 will be kept constant (100mg/L) at the top surface of the clay and concentrations of these chemical is zero in the clay at time t=0, answer the following questions. (40)
   - Thickness of clay liner: L=4m,
   - Leachate height over the clay liner: 0.4m,
   - Hydraulic head of the bottom aquifer below the liner: 0m from the surface of the clay liner,
   - Hydraulic conductivity of clay: $K=10^{-7}$ m/s,
   - Effective diffusion coefficient of clay: $D_m=2\text{x}10^{-9}\text{m}^2/\text{s}$,
   - Porosity of clay: n=0.5; density of soil grain: $\rho_s=2.6\text{g/cm}^3$,
   - Liner equilibrium sorption with partitioning coefficient K_{d2}=0.38L/Kg for pollutant C_2
   - No sorption takes place for pollutant C_1, namely $K_{d1}=0$

   (1) How much are the void ratio (e) and moisture content (w) of the clay?
   (2) How much is the hydraulic gradient of downward seepage flow in the clay?
   (3) How much is the interstitial velocity of the downward flow in the clay?
   (4) Calculate the time (years) for the pollutant C_1 to reach the bottom of liner in the case with no dispersion condition, i.e., D_m=0.
   (5) How much is the retardation factor (R_d) of the pollutant C_2
   (6) Draw the approximate* concentration profile of the two pollutants, C_1 and C_2 with depth at t= 5 years.
   (7) Draw the approximate* breakthrough curves at the depth of 2m.
   (8) Explain why the mechanical dispersion can be negligible in the process of contaminant transport in the clay.
   **note: not necessary to calculate the exact solution, but drawn the curves satisfying the boundary condition, shape and relative position of C1 and C2 with approximate time or depth.*



3. A constant head permeameter test was conducted using the setup shown in the figure with the conditions below.
   - mass of the dry sand sample M_s:1600g
   - mass of the water in the sample M_w: 400g
   - soil particle density ρ_s: 2.7g/cm^3
   - density of water ρ_w: 1.0g/cm^3



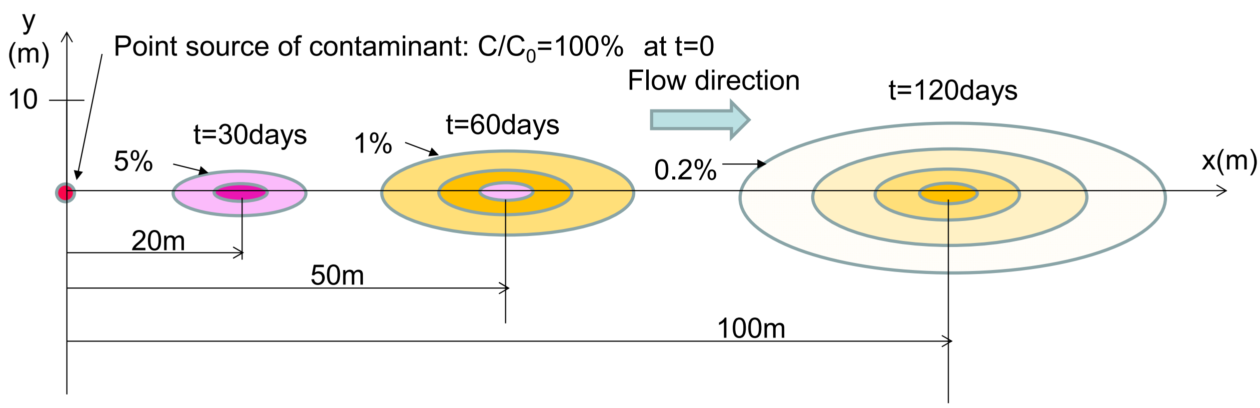
The following result was obtained at time t.

t (min)	Q (cm^3)
1	49
2	99
5	250

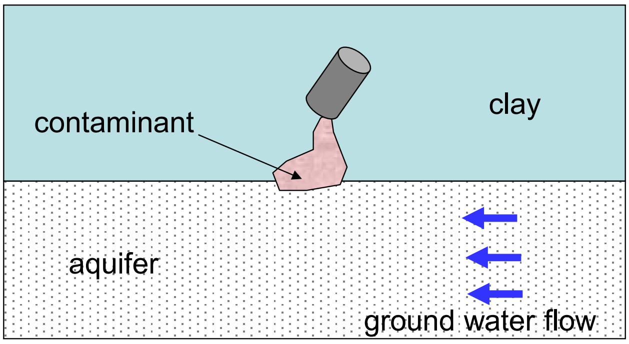
Answer the following questions. (30)

(1) How much is the porosity of the sand sample?
(2) How much is the degree of saturation of the sand sample?
(3) How much is the hydraulic conductivity (K) of the sand sample?
(4) Howe much is the interstitial velocity (v_{int}) of the water?
(5) How much is the discharge volume of water at t=10 mins?
(6) If the degree of saturation of the sample can be made by 100%, does the measured hydraulic conductivity increase or decrease? Also explain the reason of the answer.

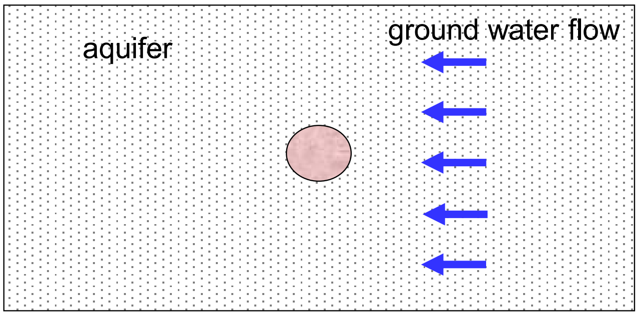
4. The figure below shows a result of tracer test as a form of concentration contours of tracer plume obtained at different times (30days, 60days, 120days). Non-reactive and conservative tracer was used. Two dimensional, advective-dispersive and non-reactive transport under a steady state ground water flow in a homogeneous and isotropic confined aquifer with constant thickness can be assumed in this test site.
   Discuss the dominant transport mechanisms of the pollutant (among advection, molecular diffusion, and mechanical dispersion) in this specific site with proper reasons. (20)



5. As shown in the figure below, a risk of ground water contamination by the leakage of pollutant from a buried drum in a clay layer was found. To prevent the expansion of the pollution in the aquifer underlying the clay, a single well shall be urgently installed for pumping the water from the aquifer. Indicate the appropriate location of the well and explain the reason of the well location. (20)



Cross section



Plan

6. Explain typical properties of DNAPLs and typical migration mechanism of contaminant in the vadose zone and the ground water in the subsurface by using an illustration. (20)

7. In the remediation project of Toyosu, Tokyo, for the relocation of the fresh foods market from Tsukiji there have been so many processes and technologies applied under various conditions. (20)

1) Selects two specific technologies applied in the project and explain each, such as objective, reason of the selection for the site, limitations, the others

2) Give your own view about the projects both in technical points of view and social points of view.

8. After Great Tohoku Earthquake, 2011.3.11, we have faced serious disaster waste problems, such as huge volume of debris and soils, wastes and sewage sludge contaminated with radionuclide, and radioactive contaminated water from the Fukushima Daiichi Nuclear Power Plant. Select one specific problem and give your own view about how to deal with the specific problem in short term and long term prospects and also the preparation for the expected huge disaster in near future (20)