Assignment 1: General hydrogeology review (ERTH656/CEE623/ERTH654)

(due in 2 weeks)

For help, check class slide sets 1 and 2, publication by Heath (1983), and the textbook: Applied Hydrogeology by C.W. Fetter, 2001, 4th ed., Prentice Hall

1. A steady state water flow is maintained in a vertical sand column of 200 cm long and 200 cm^2 area at 20°C. The water depth above the column is 20 cm and it drains in a tank with water depth of 10 cm above the column bottom (Figure 1). Calculate:
   (i) the hydraulic gradient along the column,
   (ii) the specific discharge if hydraulic conductivity was 10 m/day, and
   (iii) the approximate change in the value of specific discharge at 30°C. Hint: Water properties are functions of temperature as shown in Figure 2.

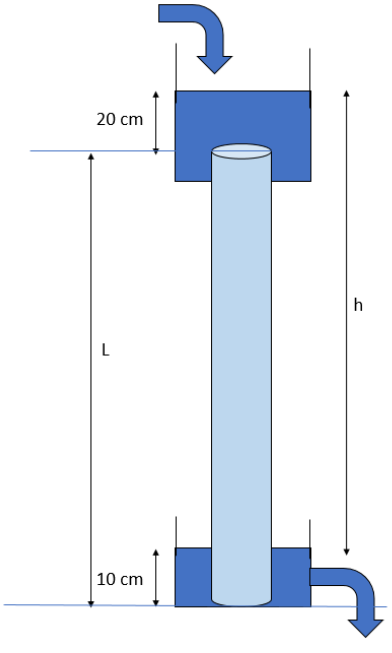

Figure 1 (Problem 1)

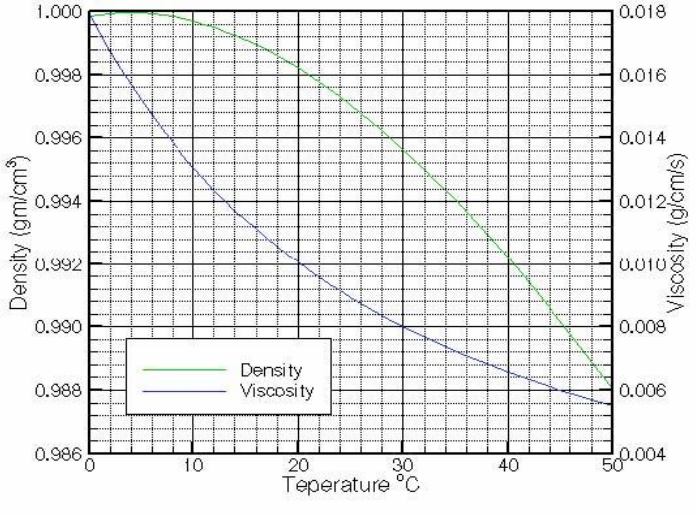

Figure 2 (Problem 1)

2. a. Calculate the total daily flow in a confined aquifer, given: aquifer thickness is 33 m thick; the head in two observation wells that are 1 km apart is 90 m and 75 m; hydraulic conductivity is 0.000023 m/s
   b. What is the head value at a point between the two wells which is located at 400 m from the higher head well?

3. Figure 3 shows a plan view and a cross section of a hydrogeologic system. Choose the definition of elements A, B, etc. from the following list:
   (i) Confined aquifer
   (ii) Unconfined aquifer
   (iii) Specified flux condition
   (iv) Source/sink
   (v) No flow condition
   (vi) Specified head condition
   (vii) Aquitard

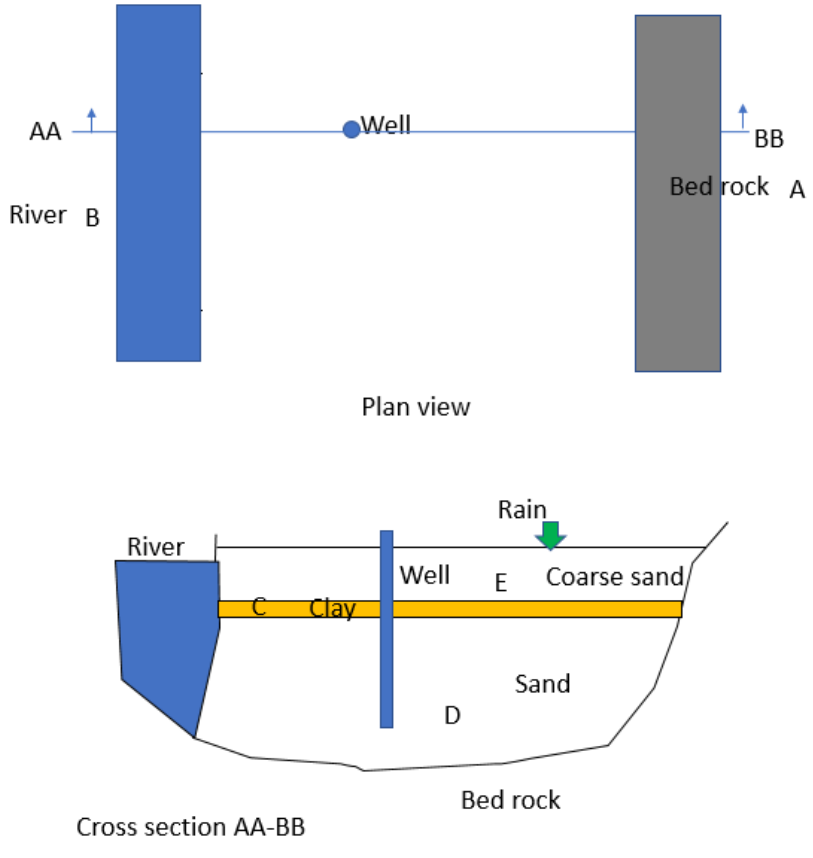

Figure 3 (Problem 3)

4. Given a potentiometric surface with a regional slope of 7 m/km, calculate the natural rate of groundwater discharge through a confined aquifer (in $m^3/s/m$) with transmissivity of 0.002 m^2/s.

5. A schematic diagram of a gas-oil-water reservoir is Figure 4. Zones are saturated with an individual fluid as shown. Two piezometers are installed: A in the oil-saturated zone and B in the water-saturated zone. The pressure in the gas cap is known to be 90 atm and the temperature is 15°C. There is no evidence of

fluid motion. The specific gravity of oil equals 0.8. (1 atm = 1.013 x 105 N/m^2 @ 15^{o}C, Specific weight of water = 9800 N/m^3.) Estimate the respective of height of fluid in piezometers A and B (h_A and h_B).

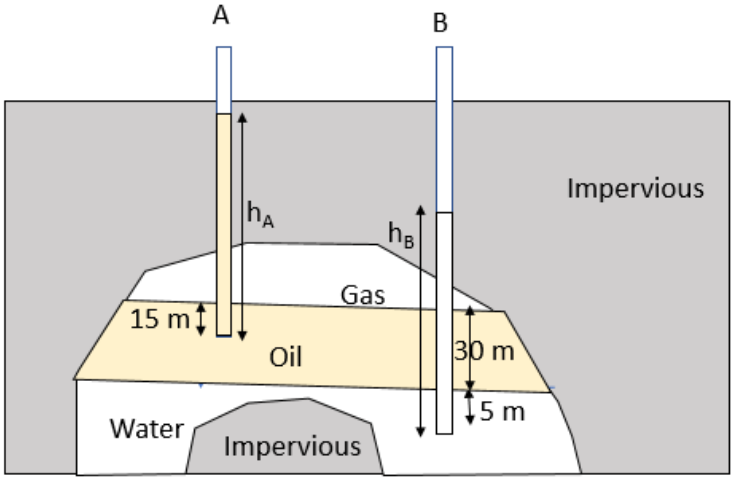

Figure 4 (Problem 5)

6. Assume the aquifer in Figure 5 to be homogeneous and isotropic with hydraulic conductivity K = 10^{-4} m/s and specific yield Sy = 0.1. Furthermore, assume that the drawdown caused by pumping will be small relative to the initial saturated thickness (50 m). The wetlands are an important recreational and ecological resource and are maintained by the high-water table.
   (i) Calculate the maximum possible pumping rate so as to not drain the wetlands for at least 5 years.
   (ii) Repeat part (i) for a time span of 50 years. Provide answers in m^3/sec.

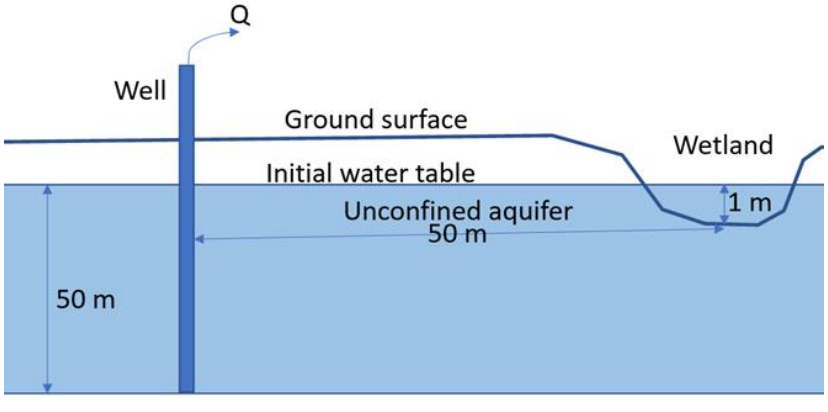

Figure 5 (Problem 6)

7. Shown in Figure 6 a leaky aquifer system consisting of a confined and unconfined aquifer separated by an aquitard. The hydraulic conductivity of the aquifer and aquitard are 10^{-4} and 10^{-7} cm/sec, respectively. Porosity of each is 0.3. From the piezometer measurements shown, and assuming steady-state flow, calculate the following:

(i) the discharge per unit area (Darcy's flux) through the aquitard (in cm/sec).
(ii) if a conservative chemical is introduced at the water table, calculate the time of warning (to the nearest full year) before the lower aquifer is contaminated (ignore spreading). Hint: Contaminant velocity equals Darcy's flux divided by porosity).

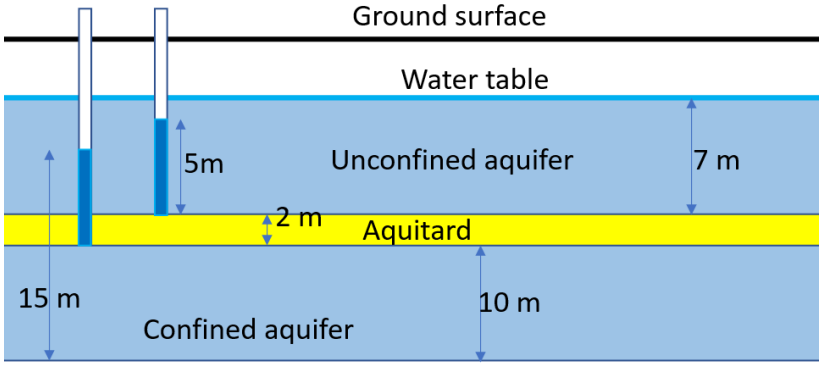

Figure 6 (Problem 7)

8. Figure 7 shows a nest of 3 closely located piezometers. The depths to water in piezometers A, B, and C are 80, 77, and 60 m, respectively. The depths to the bottoms of the wells are shown in the graph (in meters). Considering the ground surface to be at 225 m above mean sea level, calculate the following.
   (i) the hydraulic head at each point
   (ii) the pressure head at each point
   (iii) the elevation head in each well
   (iv) the vertical gradient between piezometers A and B

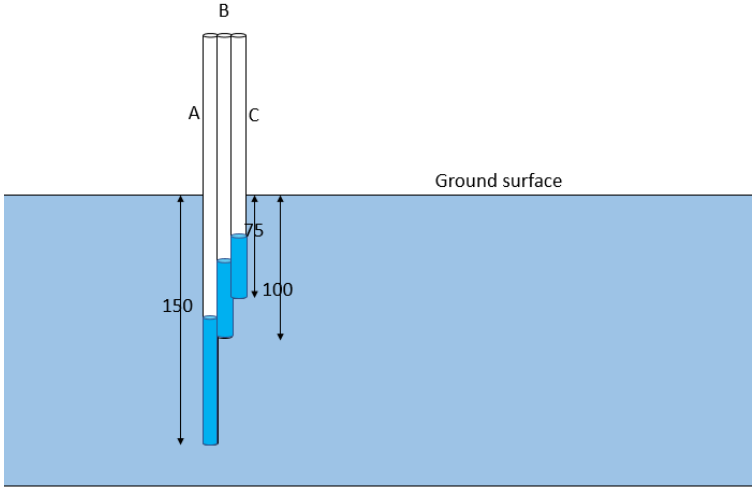

Figure 7 (Problem 8)

9. The well field shown in Figure 8 consists of three equally spaced wells. Each well is pumped at the rate of 500 gpm. Considering aquifer transmissivity of 50,000 gpd/ft, a well radius of 0.5 ft, and a radius of influence of 10,000 ft, calculate the minimum spacing D, such that the maximum draw down at the central well is 35 ft. The aquifer is large, confined, homogeneous, and isotropic.

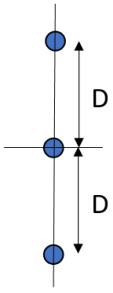

Figure 8 (Problem 9)

10. A well is pumped at a rate of 0.004 m^3/sec in a homogeneous, isotropic, confined aquifer. If transmissivity is 0.0023 m^2/sec and storage coefficient is 0.000075, estimate the following.
    (i) drawdown at an observation point 55 m away from the well after 6 hours.
    (ii) calculate the steady state drawdown at the same point, given a radius of influence of 10,000 m.
    (iii) estimate the time for the drawdown to reach 95% of the steady state value (in days).