Problem 25.

Learn about at least two physical processes that can be described by the same (or similar) equation that describes flow of ground water (diffusion equation). Write these equations along with the most general (i.e., with fewest assumptions) groundwater flow equation. Define all terms in each equation. Compare the equations and parameters. For example, hydraulic conductivity and specific storage coefficient are important parameters in the groundwater flow equation. What are corresponding parameters in the other equations?

Problem 26. (from 1997 final)

An abandoned well located 400 m from a municipal water well was used by miss Magda of the Devil's Grail Enterprises, Inc. as an illegal hazardous waste disposal site. The aquifer is confined, has thickness 10 m, transmissivity $10^{-2}$ m$^2$/s, and porosity 0.2. The municipal well is 1.0 m in diameter and has been pumping steadily at 0.1 m$^3$/s for 20 days. Measured drawdown in the abandoned well is 6.2 m.

(a) On the provided map, draw a qualitative (but realistic) contour map of drawdown around the pumping well. Calculate the travel time from the abandoned well to the pumping well.

(b) A first trace of the contaminant has just been detected in a monitoring well 50 m from the municipal well. It has caused a panic among the people responsible for the quality of water. They hired an outside consultant. The consultant recommended that the pumping process be reversed. The municipal well should become an injection well. After some time, the contaminant would flow back to the abandoned well, where it would be neutralized. Will the plan work? Why or why not? Discuss qualitatively, but in detail.
**Problem 27.** (from 1997 final)

The figure shows a cross section of an aquifer system (note vertical exaggeration). The transmissivity of the confined aquifer is 10000 ft²/d and the storativity is 5E-4. Well I6-1 is an irrigation well that is used periodically during the growing season.

(a) What will be the drawdown 1000 ft away from well I6-1 if it is pumped at a constant rate of 110,000 ft³/d for 30 days?

(b) At what rate can well I6-1 be pumped for 30 days so that the drawdown will not exceed 5 ft at a distance 1 mile from it?

(c) How much time is required for well I6-1 pumping continuously at 110,000 ft³/d to cause 1 ft of drawdown 1 mile away?

(d) What assumptions did you make for parts a, b, c? Which of these assumptions are likely to be invalid in this system?

(e) Consider other existing wells in this aquifer system for drinking-water supply. Briefly describe their advantages and disadvantages.

---

**Problem 28.** (from 1997 final)

(a) You are conducting a pumping test in a confined aquifer which has transmissivity \( T = 10^{-4} \) m²/s and storativity \( S = 10^{-4} \). The observation well is 100 m from the pumping well. How long will you have to pump before you can apply the Jacob semi-log analysis of drawdown with time?

(b) A fully penetrating well is installed in a confined aquifer of thickness 12 m, hydraulic conductivity \( 10^{-3} \) m/s and storativity 0.001. The well is pumped at a rate of 100 l/min for 10 hr. The pumps are then shut down. What is the drawdown 5 m from the well when the pumping is stopped? What is it four hours later?
Problem 29.

The shape of cone of depression around a pumping well depends on several factors. For this exercise, consider transmissivity, storativity and time. Explore how each of them and their combination influence drawdown. Be quantitative in your work. Use calculations, plots, maps and other means of communicating information if you think they will make your description clearer. Be concise, but complete. There is no page limit for this problem.

*Note: Explore means that it should be original work. Don't merely report what textbooks say on this subject.*

Problem 30.

(a) Do problem 3 on p. 379 of Freeze and Cherry.

(b) For the same wells, calculate drawdown \( s = h_0 - h \) in the rectangular area 70 x 105 m centered on the wells. Plot contours (i.e., make a map) of the calculated drawdown.

Problem 31.  Do problem 5 on p. 379 of Freeze and Cherry.

Problem 32.  Do problem 6 on p. 379 of Freeze and Cherry.

Problem 33.  Do problem 7 on p. 380 of Freeze and Cherry.

Problem 34.  Do problem 8 on p. 380 of Freeze and Cherry.

Problem 35.  Do problem 9 on p. 380 of Freeze and Cherry.

Problem 36.  Do problem 11 on p. 381 of Freeze and Cherry.

Problem 37.  Do problem 14 on p. 381 of Freeze and Cherry.