ANSWERS

GEOL 3060 Groundwater
Final Exam W2010

Name _____ ID# _____

Part A.

Select the most correct answer. Answer the questions on the exam sheet and on the computer card. Each question is worth one mark. Total 40 marks.

1. True or false, a funnel and gate system consists of high permeability cut-off walls with a narrow gate that contains reactors that remove contaminants by biological processes or promote volatilization.

a) True
b) False

2. Land subsidence due to over-pumping of groundwater is a serious problem in Mexico City, why?

a) pumping increases fluid pressure and reduces total stress leading to consolidation
b) pumping drains pores and solid grains compress
c) pumping reduces fluid pressure, therefore effective stress must increase leading to consolidation
d) fluid compressibility is much greater than solid material compressibility.

3. What property is estimated using the following equation: $K_i = C\ d^2$?

a) permeability
b) hydraulic conductivity
c) porosity
d) distribution coefficient.

4. True or false, Reynolds' number is used to determine the validity of Darcy's Law for low velocity groundwater flow systems?

a) True
b) False.

5. Groundwater flows from zones of high to low energy,

a) near a pumping well
b) in a capture zone
c) if hydraulic conductivity is high
d) all of the above.

6. The acronym GPR represents

a) groundwater pumping regime
b) groundwater pumping rate
c) ground penetrating radon
d) ground penetrating radar.

7. Which of the following geological features influence groundwater flow direction?

a) layers
b) faults
c) folds
d) all of the above

8. True or false, glaciofluvial sediments generally have greater hydraulic conductivity than till?

a) True
b) False

9. Poiseuille's Law is used to estimate

a) hydraulic conductivity of layered sediments
b) amount of water flow through cylindrical fractures
c) hydraulic conductivity of folded sediments
d) none of the above

10. True or false, variation in local topography can determine locations of groundwater recharge and discharge?

a) True
b) False

11. The equation of continuity is

a) an expression of conservation of mass of groundwater
b) an expression of solute distribution between solid and liquid (water) phases
c) an expression relating K and K_i
d) an expression used to calculate continuous groundwater flow

12. Groundwater flow is parallel to which of the following boundary conditions?

a) constant hydraulic head
b) impermeable
c) water table
d) open

13. What does the letter p represent in the following equation: $q' = pKh/f$

a) the number of increasing steps in hydraulic head
b) the number of decreasing steps in hydraulic head
c) the number of stream tubes
d) none of the above

14. True or false, one of the assumptions of Dupuit's formula is the hydraulic gradient is equal to the slope of the water table for groundwater flow in a confined aquifer?

a) True
b) False

15. True or false, for estimating groundwater flow direction in anisotropic materials, $1/(K_z)^{1/2}$ is always greater than $1/(K_x)^{1/2}$?

a) True
b) False

16. Which of the following methods is used to remediate contaminated groundwater?

a) enhanced bioremediation by delivering nutrients to the contamination plume
b) air sparging by bubbling air thru groundwater to strip non-volatile organics
c) pumping and treat above-ground
d) all of the above

17. True or false, in 1935 Theis developed a pumping test for ideal unconfined aquifers?

a) True
b) False.

18. Which of the following are geochemical indicators of natural attenuation of contaminants in groundwater?

a) consumption of electron acceptors
b) production of metabolic by-products
c) presence of appropriate redox\microbial environments
d) all of the above

19. Select the developers of this equation (Leakage = $K'(h_0 - h)/b'$) for leakage through an aquitard.

a) Hantush and Jacob.
b) Neuman and Witherspoon.
c) Darcy and Poiseuille.
d) Theis and Jacob.

20. Which of the following is not one of the stages in drawdown when pumping from an unconfined aquifer?

a) initially reacts as a confined aquifer.
b) water table begins to decline.
c) water table begins to rise.
d) drawdown follows Theis with $S = S_y$.

21. True or false, when using the Theis pumping test method, both T and S are estimated?

a) True
b) False.

22. For the Cooper-Jacob method,

a) represent u by a truncated infinite series
b) represent W(u) by a truncated infinite series
c) represent T by a truncated infinite series
d) represent S by a truncated infinite series

23. True or false, even after pumping groundwater for a long time drawdown in an observation well never reaches a nearly steady value?

a) True
b) False

24. True or false, an impermeable boundary across a confined aquifer increases the amount of drawdown in an observation well during a pumping test?

a) True.
b) False.

25. Which of the following is not an advantage of a pumping test?

a) measure parameters in situ.
b) average parameters over a small, localized volume.
c) measure T and S simultaneously.
d) average parameters over a large volume.

26. Which of the following is an assumption of the Hvorslev test?

a) homogeneous and anisotropic conditions
b) geological material and water are compressible
c) geological material and water are incompressible
d) heterogeneous and isotropic conditions

27. The main contaminant at the Seymour Recycling Corporation hazardous waste site is

a) heavy metals.
b) bacteria.
c) organic compounds.
d) acid.

28. The main components of a groundwater monitoring well are

a) the non-ventilated well cap
b) the bentonite seal around the well screen
c) the sand filter pack around the screen
d) the sand filter pack above the screen

29. True or false, bentonite swelling is inhibited by high TDS and organic matter concentrations.

a) True
b) False

30. Which well pipe material is least desirable in a groundwater contamination study near a mine with acidic groundwater?

a) carbon steel
b) stainless steel
c) PVC plastic
d) Teflon

31. Solute transport processes in groundwater include

a) diffusion
b) advection
c) dispersion
d) all of the above

32. True or false, diffusion coefficient can be approximated as 1/10 the distance of travel, L, in a groundwater flow system?

a) True
b) False

33. Anions tend to adsorb to soil particles in southwestern Ontario more often than cations.

a) True
b) False

34. Which of the following is calculated using $1+ K_d \rho_b/n$?

a) retardation coefficient
b) Reynolds number
c) dispersivity
d) distribution coefficient

35. True or false, chloride travels faster than lead in local groundwater systems?

a) True
b) False

36. Denitrification in groundwater is an example of

a) Biological Degradation
b) Precipitation
c) Oxidation
d) Reduction

37. True or false, a capture zone of a confined aquifer includes both up- and down-gradient areas that drain into a pumping well.

a) True
b) False

38. Which of the following concepts are used to determine a safe groundwater travel time for determining a capture zone "length?

a) advection
b) dispersion
c) retardation
d) all of the above

39. The average annual amount of precipitation in Guelph is

a) 850 m
b) 850 cm
c) 850 mm
d) 850 inches.

40. If the bulk attenuation rate of an organic compound in groundwater is 2.0 yr^{-1}, the attenuation half-life of the compound is:

a) 0.035 years
b) 0.35 years
c) 3.5 years
d) 35 years.

Part B. Answer all questions in the space provided (use back of page if necessary). Marks are given in brackets after each question number. Total 25 marks.

1. (5) A well that pumps at a constant rate of 500 m^3 per day has achieved equilibrium so that there is no change in the drawdown with time. The well taps a confined aquifer that is 24 m thick. An observation well 20 m away has a head of 220 m above sea level; another observation well 40 m away has a head of 230 m above sea level. Compute the value of aquifer transmissivity.

$$T = \frac{Q}{2\pi(h_2 - h_1)} \ln \frac{r_2}{r_1} \quad (1)$$

$$= \frac{500}{2\pi(230-220)} \ln \frac{40}{20} \quad (2)$$

$$= 5.5 \ m^2/day \quad (1)$$

2. (5) A capture well is pumping at a rate of 1500 m^3/day from a confined aquifer with a hydraulic conductivity of 425 m/day, an initial hydraulic gradient of 0.00098, and a saturated thickness of 22 m. What is the maximum width of the capture zone? What is the distance from the well to the stagnation point?

$y_{max} = \pm Q/2Kbi$ (1)

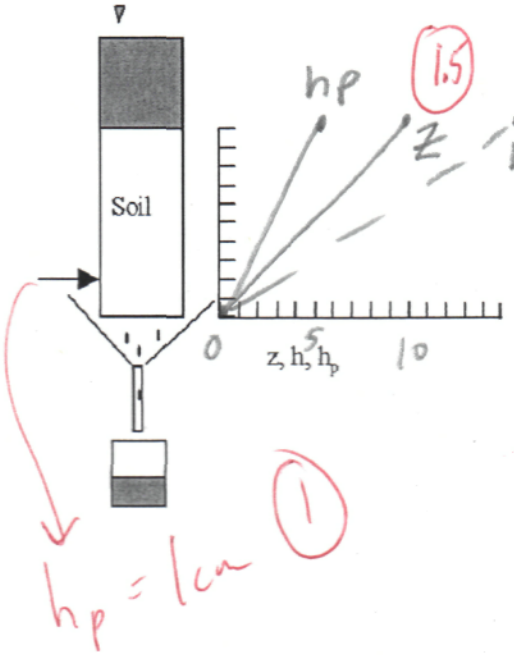
$= \pm 1500/2 \times 425 \times .00098 \times 22$ (1)

$= \pm 81.9\ m$ (1)

$X_o = -Q/2Kbi\pi$ (1)

$= -26.1\ m$ (1)

3. (5) The radius and length of the cylindrical constant head permeameter shown below are 2.2 cm and 10 cm, respectively. The constant depth of water ponding on the soil surface is 5 cm. If the hydraulic conductivity of the soil in the permeameter is 2.0 cm/hr, calculate the volume of water flowing out of the bottom of the permeameter in litres\hour. Plot the elevation, pressure, and hydraulic heads versus height on the axes provided. Determine the value of the pressure head of the soil water at the level indicated by the arrow in the diagram below.



$h_p = 1cm$ (1)

$K = 2\ cm/hr$

$q = -K\frac{dh}{dl}$ (1.5)

$= -2\ \frac{(15-0)}{10-0}$ (1)

$= -3\ cm/hr$ (1)

$Q = 3 \times \pi\ 2.2^2 = 45.6\ cm^3/hr$ (1)

$= 4.6 \times 10^{-2}\ litres/hr$ (1)

4. (5) Water is being pumped from a well installed in a confined aquifer of hydraulic conductivity 20 cm/hr, specific storage 10^{-6} cm^{-1}, and thickness 15 m. After three hours of pumping at a rate of 1000 litres\hour, a drawdown of 0.18 m was recorded in an observation well installed in the same confined aquifer. Calculate the distance between the pumping well and the observation well.

$T = 0.2 \times 5 = 3 m^2/h$ $\quad S = 10^{-6} \times 1500 = 1.5 \times 10^{-3}$

$Q = 1 m^3/h$

$h_0 - h = \frac{Q}{4\pi T} W(u)$ (1)

$.18 = \frac{1}{4 \times \pi \times 3} W(u)$ (1) ; $W(u) = 6.78$ (1)

$u = 6.4 \times 10^{-4} = \frac{r^2 S}{4Tt}$ (1)

$r = 4m$ (1)

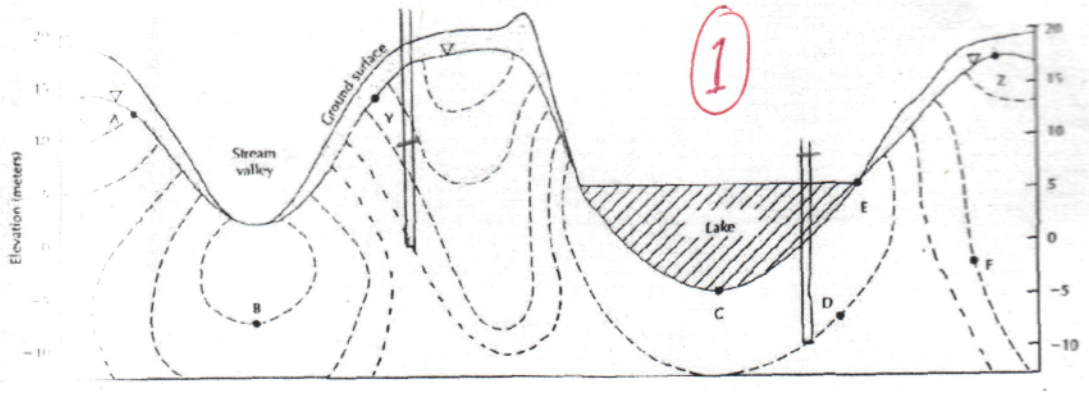
5. (5) Answer the following questions based on the figure given below.

A. Fill in the heads at the locations labelled on the diagram.

B. Draw the water levels in the two piezometers drawn on the figure.

	Pressure Head	Gravitational Head	Hydraulic Head
A	0	13	13
B	9	-6	3
C	10	-5	5
D	15	-7	8
E	0	5	5
F	15	-2	13

(4)



(1)

Part A /40 Part B /25 Total /65