ENVS 3060 Groundwater, Term Test 2, 2013

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, for a total of 75.

1. True or false, the water table is always an equipotential line?
a) True
b) False

2. True or false, flow lines are always parallel to equipotential lines in an isotropic material?
a) True
b) False

3. Which of the following statements is true?
a) an ellipse is used to sketch equipotential lines that cross a boundary between geologic layers.
b) equipotential lines are always parallel to impermeable boundaries.
c) cannot estimate groundwater flow volume using flow nets.
d) none of the above.

4. Equipotential lines in a flow net are always parallel to
a) a constant hydraulic head boundary
b) a water table boundary
c) an impermeable boundary
d) all of the above.

5. True or false, groundwater flow is generally perpendicular to aquifers and parallel to aquitards?
a) True
b) False

6. Which of the following properties can be estimated using pumping test data if the thickness of the ideal confined aquifer is known?
a) transmissivity and storativity
b) transmissivity, storativity, and specific storage
c) transmissivity, storativity, hydraulic conductivity, specific storage, and specific yield
d) transmissivity, storativity, hydraulic conductivity, and specific storage

7. Which of the following is one of the stages of drawdown versus time for an unconfined aquifer?
a) initially reacts as a confined aquifer
b) water table begins to rise
c) drawdown follows Neuman method with $S = S_y$
d) all of the above

8. Which pumping test method is appropriate for an unconfined aquifer?
a) Theis
b) Neuman-Witherspoon
c) Hantush-Jacob
d) Poisuelle

9. Which method is based on the following equation: K' $(h_0 - h)/b'$?
a) Theis
b) Neuman-Witherspoon
c) Hantush-Jacob
d) Poisuelle

10. Which of the following is not an assumption of the Theis method?
a) confined aquifer is a horizontal layer of finite extent.
b) both K and S_s are uniform.
c) only radial, horizontal water flow to the well.
d) applies to transient (time dependent) conditions.

11. What is the main difference between the Theis and Hantush\Jacob pumping test theories?
a) Hantush\Jacob theory only includes transmissivity.
b) Theis theory only applies to a leaky confined aquifer.
c) Hantush\Jacob theory only applies to an unconfined aquifer.
d) none of the above.

12. When pumping water from an unconfined aquifer,
a) both radial and vertical flow occur.
b) depth to the water table below the ground surface decreases.
c) pores are not drained.
d) all of the above are true.

13. True or false, during a pumping test, the amount of drawdown estimated in an observation well using the Theis method will be less than the amount of drawdown estimated by the Hantush-Jacob method in the same observation well?
a) True.
b) False.

14. When estimating T and S from pumping test data, one of the steps is
a) construct a plot of W(u) versus 1/u on log-log paper
b) plot drawdown versus time measurements on paper of same scale
c) match the data to the type curve
d) all of the above

15. Which of the following best represents the equation of continuity (conservation of mass) for a groundwater flow system?

a) Darcy's Law
b) Poiseuille's Law
c) Flow in – flow out = change in stored groundwater
d) Equivalent porous medium approach

16. Which system listed below describes the following groundwater flow equation:

$$K\left(\frac{\partial h}{\partial x^2} + \frac{\partial h}{\partial y^2} + \frac{\partial h}{\partial z^2}\right) = S_s \frac{\partial h}{\partial t}$$

a) homogeneous, two-dimensional, isotropic, transient
b) homogeneous, three-dimensional, isotropic, transient
c) homogeneous, three-dimensional, anisotropic, steady-state
d) homogeneous, two-dimensional, anisotropic, transient

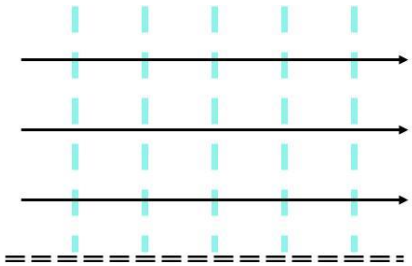
17. Which statement is false?

a) Equipotential lines are generated by solving the groundwater flow equation
b) Equipotential lines are sometimes hand-drawn
c) Flow lines are perpendicular to equipotential lines in an anisotropic medium
d) A set of flow lines and equipotential lines constitute a flow net

18. True or false, flow nets can be used to determine both groundwater flow direction and groundwater flow quantity?

a) True
b) False

19. Which type of boundary condition is shown as the dashed horizontal line in the following flow net?



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

20. Which of the following are assumptions commonly used when hand-drawing flow nets?
a) Steady-state time conditions
b) All outer boundary conditions are known
c) Homogeneous and isotropic hydraulic conductivity
d) All of the above

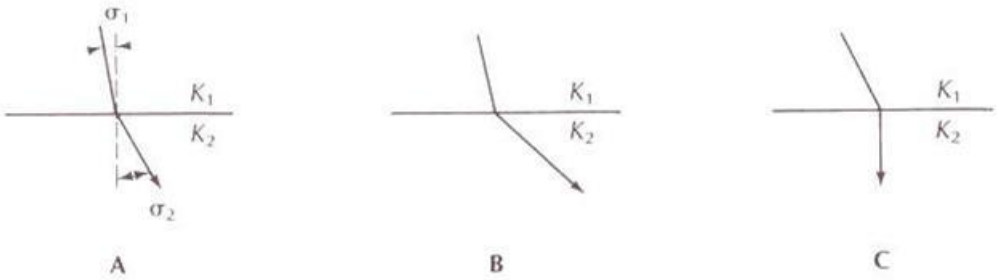
21. True or false, in the following equation, f represents the number of divisions of pressure head in a flow net: q' = pKH/f?
a) True
b) False

22. The equation shown below is used to calculate

$$K_1/K_2 = \tan \sigma_1/\tan \sigma_2$$

a) the angle of refraction of flow lines across a geologic layer boundary
b) the angle of reflection of flow lines across a geologic layer boundary
c) the true direction of groundwater flow in anisotropic materials
d) the true direction of groundwater flow in isotropic materials

23. In which of the following is $K_1 < K_2$?



a) A
b) B
c) C
d) A and B

24. True or false, if one of the principal axes of K is parallel to the hydraulic gradient (for example if groundwater flow and K_z are north\south), then groundwater flow direction will be parallel to the equipotential lines?

a) True
b) False

25. True or false, the Dupuit equation was developed for transient groundwater flow?
a) True
b) False

26. Which of the following are assumptions of Dupuit's equation?

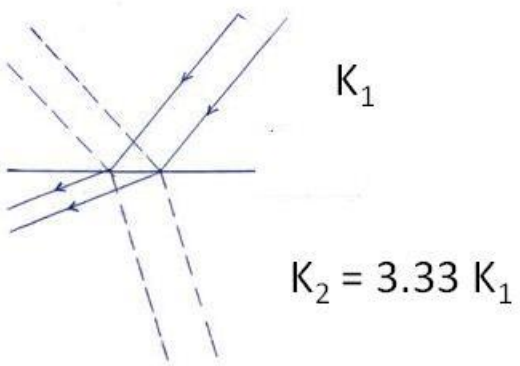
a) Hydraulic gradient > slope of water table
b) For small hydraulic gradients, flow lines are vertical and equipotential lines are horizontal
c) For small hydraulic gradients, flow lines are horizontal and equipotential lines are vertical
d) Hydraulic gradient < slope of water table

27. When determining the true direction of groundwater flow in an anisotropic material, which of the following is correct?

a) K_x is always greater than K_z
b) K_z is always greater than K_x
c) $K_x = K_z$
d) None of the above

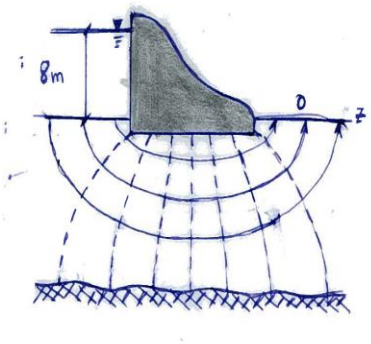
28. True or false, when sketching flow nets, the volume of groundwater flow is equal in each streamtube?
a) True
b) False

29. True or false, given the relative values of K, the two flow lines and the two equipotential lines drawn in the lower layer, as shown on the diagram below, are correct.



a) True
b) False

30. In the figure shown below, the *p* and *f* are, respectively:



a) 3 and 6
b) 5 and 9
c) 8 and 4
d) None of the above

31. At a groundwater (or water-table) divide:
a) groundwater flow is constant
b) groundwater flow is equal to zero
c) groundwater flow is parallel to the z axis
d) none of the above

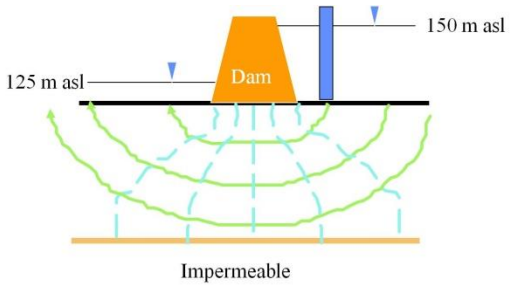
32. Soil water capacity is given by
a) $\Delta\theta/\Delta h_p$
b) $\Delta h_p/\ \Delta\theta$
c) $\Delta\theta$ x Δh_p
d) none of the above

33. Which system listed below describes the following groundwater flow equation:

$$K_x \frac{d^2h}{dx^2} = 0$$

a) homogeneous, one-dimensional, isotropic, transient
b) homogeneous, two-dimensional, isotropic, transient
c) homogeneous, one-dimensional, isotropic, steady-state
d) homogeneous, two-dimensional, anisotropic, transient

34. How many streamtubes exist in the following flow net?



a) 6
b) 5
c) 25
d) none of the above

35. What is the value of H in the flow net shown in Question 34?
a) 150 m
b) 125 m
c) 6
d) 25 m

36. Which of the following are applied when exploring for an aquifer?
a) Field mapping.
b) Existing well logs.
c) Test drilling.
d) All of the above.

37. Which of the following is an advantage of a slug test?
a) Measure S in situ.
b) No pump required.
c) Only need two wells.
d) All of the above.

38. A key assumption of the Hvorslev test is
a) Assume aquifer is horizontal
b) Impermeable upper and lower boundaries
c) Geological material and water are incompressible
d) Assume anisotropic K

39. True or false, Hvorslev test data is plotted on a semi-log scale?
a) True
b) False

40. True or false, Theis test data is plotted on a semi-log scale?
a) True
b) False

41. True or false, as distance from a pumping well increases, the amount of observed drawdown also increases?
a) True
b) False

42.Which of the following are reasons for measuring drawdown due to pumping of groundwater?
a) Land subsidence.
b) Salt water intrusion.
c) "Mining" groundwater resource.
d) All of the above.

43. Which of the following is not a key assumption of the Theis method:
a) Assume aquifer is horizontal
b) Impermeable upper and lower boundaries
c) Geological material and water are incompressible
d) Assume isotropic K

44. Which of the following is not an ingredient in the Theis solution?
a) pumping rate
b) transmissivity
c) specific yield
d) storativity

45. True or false, in the Theis equation the well function is defined by an integral expression?
a) True
b) False

46. What is aquifer transmissivity if the following information was collected during a pumping test based on the Theis method: well function value is 11.16, pumping rate is 45 m^3/day, drawdown observed 100 m from the pumping well is 10 m after 1 day of pumping?
a) 40 m^2/day
b) 4 m^2/day
c) 0.4 m^2/day
d) none of the above

47. Using the information given in Question 46, the aquifer's storativity is:
a) 1.2×10^{-8}
b) 1.2×10^{-7}
c) 1.2×10^{-6}
d) none of the above

48.True or false, based on the information given in Questions 46 and 47, after 2 days of pumping the drawdown observed at 100 m from the pumping well would be approximately 8.8 m?
a) True
b) False

49. True or false, if the Hantush-Jacob method was applied instead of Theis in Question 46, the drawdown would be approximately 12.3 m instead of 10 m?
a) True
b) False

50. Which of the following are steps in estimating T and S using Theis method?
a) Construct a plot of W(u) versus 1/u on log-log paper.
b) Plot drawdown measurements on paper of same scale.
c) Match the data to the type curve.
d) All of the above.

51. The Theis type curve is a plot of
a) W(u) versus u
b) W(u) versus 1/u
c) W(u) versus 1/log(u)
d) none of the above

52. True or false, storativity and transmissivity generally have the same units?
a) True
b) False

53. True or false, the Cooper-Jacob method is an approximation of the Theis method?
a) True
b) False

54. True or false, the Cooper-Jacob method is most often applied to long time data?
a) True
b) False

55. True or false, the t_{37} value used in the Cooper-Jacob method, is obtained using semi-log graph paper?
a) True
b) False

56. True or false, during a pumping test, after a long time drawdown at a given distance away from the pumping well approaches an equilibrium value?
a) True
b) False

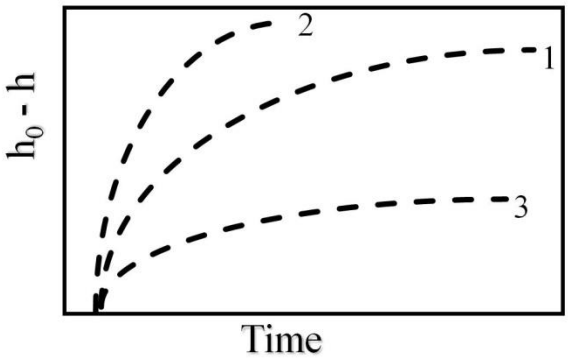
57. The following information was obtained from a pumping test under steady-state drawdown conditions: pumping rate is 40 m^3/day, an observation well 200 m away has a head of 220 m above sea level; another observation well 400 m away has a head of 230 m above sea level. The transmissivity (m^2/day) is:
a) 44.4
b) 4.4
c) 0.44
d) none of the above

58. True or false, interference between pumping wells can be easily estimated by subtracting drawdown caused by each well.
a) True
b) False

59. Which statement is correct with regards to pumping water from a confined aquifer?
a) to account for an impermeable boundary, add drawdown from image well to real well
b) to account for an impermeable boundary, subtract drawdown from image well from real well
c) to account for an impermeable boundary, multiply drawdown from image well by real well
d) to account for an impermeable boundary, divide drawdown from image well by real well

60. Which statement is correct with regards to pumping water from a confined aquifer?
a) to account for a constant head boundary, add drawdown from image well to real well
b) to account for a constant head boundary, subtract drawdown from image well from real well
c) to account for a constant head boundary, multiply drawdown from image well by real well
d) to account for a constant head boundary, divide drawdown from image well by real well

61. In the graph shown below, if curve #1 was measured in an ideal confined aquifer, which curve would apply if an impermeable boundary existed?
a) 2
b) 3
c) neither 2 or 3
d) both 2 and 3



62. In the graph shown in Question 61, if curve #1 was measured in an ideal confined aquifer, which curve represents a leaky aquitard case?
a) 2
b) 3
c) neither 2 or 3
d) both 2 and 3

63. In the graph shown in Question 61, if curve #1 was measured in an ideal confined aquifer, which curve would apply if a constant head boundary existed?
a) 2
b) 3
c) neither 2 or 3
d) both 2 and 3

64. Which of the following are advantages of pumping tests over slug tests?
a) Measure parameters in situ.
b) Average parameters over a small volume.
c) Measure T and S simultaneously.
d) All of the above.

65. Which of the following are disadvantages of pumping tests?
a) $$ High cost.
b) Non-uniqueness of T and S results.
c) Disposal of potentially contaminated water.
d) All of the above.

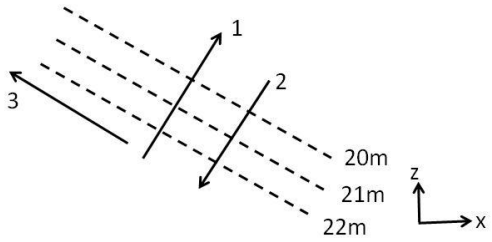
66. Which method is appropriate for a confined aquifer?
a) Theis
b) Neuman-Witherspoon
c) Hantush-Darcy
d) Poisuelle

67. True or false, the meaning of the Hvorslev parameter, t_{37}, is time for water level to recover to 37% of the initial change during a slug test?
a) True.
b) False.

68. In a plan view of equipotential lines measured at a specific time during a pumping test under Theis conditions, the pattern is:
a) a series of concentric ellipses.
b) parallel and perpendicular lines
c) a series of concentric circles
d) none of the above.

69. True or false, storativity is a dimensionless quantity?
a) True.
b) False.

The following three dashed equipotential lines were taken from an anisotropic groundwater flow system. The numbers beside each dashed line give their hydraulic head. Use the diagram to answer questions 70-72.



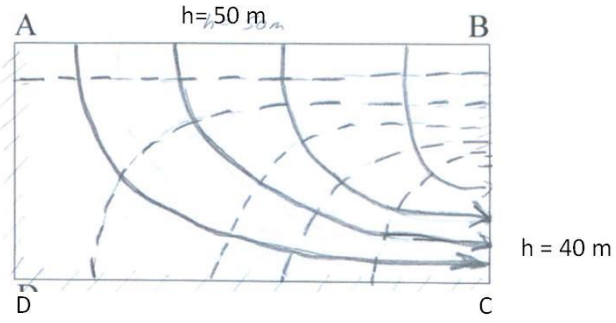
70. First assuming that the material is isotropic in K, the direction of groundwater flow is given by arrow number:
a) 1
b) 2
c) 3
d) none of the above

71. If K_x = 1 $cmhr^{-1}$ and K_z = 2 $cmhr^{-1}$, using these units, the relative lengths of semi-major and semi-minor ellipse axes for determining true direction of groundwater flow are:
a) 0.71 and 1
b) 1 and 0.71
c) 1 and 1.4
d) 1.4 and 1

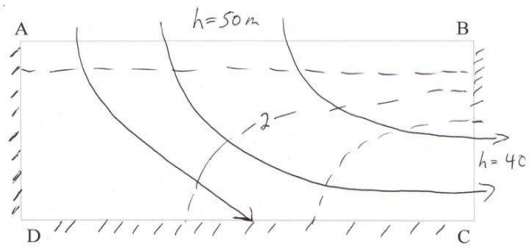
72. True or false, based on information in Question 71, the true direction of groundwater flow is oriented closer to the x axis than the z axis than for an isotropic material?
a) True.
b) False.

73. Which flow net shown below (a or b) is correct for the following conditions: AD and DC are impermeable. AB is a constant-head boundary with h = 50 m. BC is divided into two equal lengths with the upper portion impermeable and the lower portion a constant-head boundary with h = 40 m.

a)



b)



74. What is the value of the equipotential line marked as #2 in flow net b in Question 73?
a) 48 m
b) 45 m
c) 55 m
d) none of the above.

75. If the hydraulic conductivity of the geologic material within ABCD of Question 73 is 10 cm/hr, the number of m^3 of water flowing per unit width through the material in one day is:
a) 0.2
b) 2
c) 0.002
d) none of the above.

Part B. Answer each question in the space provided. Show all steps used in deriving the answer. Marks for each question are given in brackets after the question number.

1. (5). An unconfined aquifer has a hydraulic conductivity of 3.3×10^{-4} m/d. There are two observation wells 348 m apart. Both penetrate the aquifer to the bottom. In one observation well the water stands 9.88 m above the bottom, and in the other it is 8.12 m above the bottom.

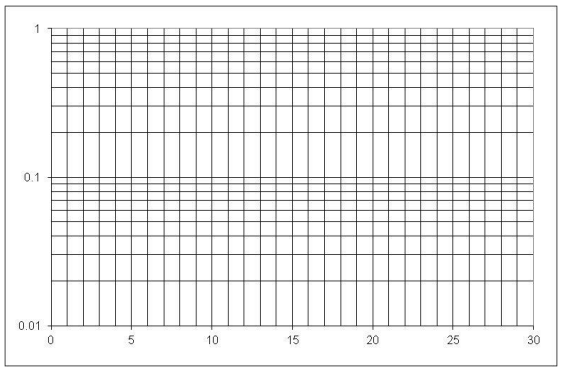
a. What is the discharge per 100-m-wide strip of the aquifer in cubic meters per day?

b. What is the water-table elevation at a point midway between the two observation wells?

See Practice Question Set 3, Question 2.

2. (5) A slug test was made using a piezometer with a casing radius of 2.54 cm and a screen of radius 2.54 cm. The well was screened fully within a confined aquifer that was 2.3 m thick. The static depth to water in the piezometer is 10.2 cm. The remaining depths to water in the piezometer versus time are given in the chart below. **Calculate the aquifer's transmissivity.**

Elapsed Time (s)	Depth to Water (cm)
0	5.4
1	6.2
2	6.8
3	7.5
5	8.4
7	9
10	9.5
13	9.8
17	10
22	10.1



See Practice Question Set 4, Question 1.

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