

SI Geology - Full Discipline Demo

Groundwater

Final Report - Answer Guide

Institution	Science Interactive University
Session	SI Geology - Full Discipline Demo
Course	SI Geology - Full Discipline Demo
Instructor	Sales SI Demo

Test Your Knowledge

Match the terms to their definition.

⌘ Aquifer	Process by which water migrates above and below the Earth's surface	1
⌘ Aquitard	Fresh water stored beneath the Earth's surface	2
⌘ Discharge	Permeable volume of rock, soil, or sediment that allows for the free flow of groundwater	3
⌘ Groundwater	The top of an aquifer	4
⌘ Hydrologic Cycle	Movement of water into an aquifer	5
⌘ Recharge	Movement of water out of an aquifer	6
⌘ Water Table	Impermeable rock that restricts the flow of water from one aquifer to another	7

Correct answers:

- 1 Hydrologic Cycle 2 Groundwater 3 Aquifer 4 Water Table
5 Recharge 6 Discharge 7 Aquitard

Classify the following statements as true or false.

⚡ A material's porosity is a measure of its ability to hold fluids.	
⚡ Permeability is a measure of a material's resistance to shear stress.	
⚡ Permeability is the ease with which fluids can flow through a material, and is dependent on the connections between pore spaces.	
⚡ Porosity is calculated by dividing the total volume by the volume of the pore space.	
⚡ The higher the porosity of a material, the lower the amount of water it can hold.	
⚡ The porosity of a material is impacted by grain shape, sorting, and cementation, but not by grain size.	
True	False
1	2

Correct answers:

1 A material's porosity is a measure of its ability to hold fluids.

The porosity of a material is impacted by grain shape, sorting, and cementation, but not by grain size.

Permeability is the ease with which fluids can flow through a material, and is dependent on the connections between pore spaces.

2 Permeability is a measure of a material's resistance to shear stress.

Porosity is calculated by dividing the total volume by the volume of the pore space.

The higher the porosity of a material, the lower the amount of water it can hold.

Exploration

In the hydrologic cycle, water that is heated on the surface of the earth _____, leaving behind impurities and forming pure water vapor.

- ☐ condenses
- ☐ precipitates
- ☒ evaporates ✓
- ☐ infiltrates

Groundwater is water found on the surface of the earth, including rivers, streams, and lakes.

- ☐ True
- ☒ False ✓

Which of the following factors does not influence porosity?

- ☐ Grain shape
- ☐ Grain sorting
- ☐ Cementation
- ☒ Grain size ✓

Permeability is a measure of a material's resistance to fluid flow, and is dependent on the connections between pore spaces in the material.

- ☒ True ✓
- ☐ False

Hydraulic flow is used to calculate how easily water flows through a particular medium.

- ☐ True
- ☒ False ✓

The top of an aquifer is called the ____.

- ☐ zone of recharge
- ☒ water table
- ☐ aquitard
- ☐ zone of discharge



Exercise 1

Did the results of the exercise support your theories recorded in Panel 1? Explain your answer.

Based on your results, which material would make the best aquifer? Explain your answer.

Based on your results, would any of the materials make a good aquitard? Explain your answer.

Data Table 1: Porosity and Permeability Measurements
(SAMPLE ANSWER BELOW)

Measurement	Gravel	Sand	Silt
Sample Volume (mL)	100	100	100
Added Water Volume (mL)	44	35	53
Porosity (%)	44	35	53

Released Water Volume (mL)	33	1	0
Permeability (%)	75	2.9	0

Panel 1: Relative Porosity and Permability Theories
(SAMPLE ANSWER BELOW)

Theories will vary but should reference both particle sizes and arrangements

Exercise 2

For each experiment on your graph, do the data points follow any relationship or trend (linear, exponential, parabolic, etc.)?

What do the trends you described in Question 1 suggest about the relationship between Q/A (water flux) and $\Delta h/\Delta l$ (hydraulic gradient)?

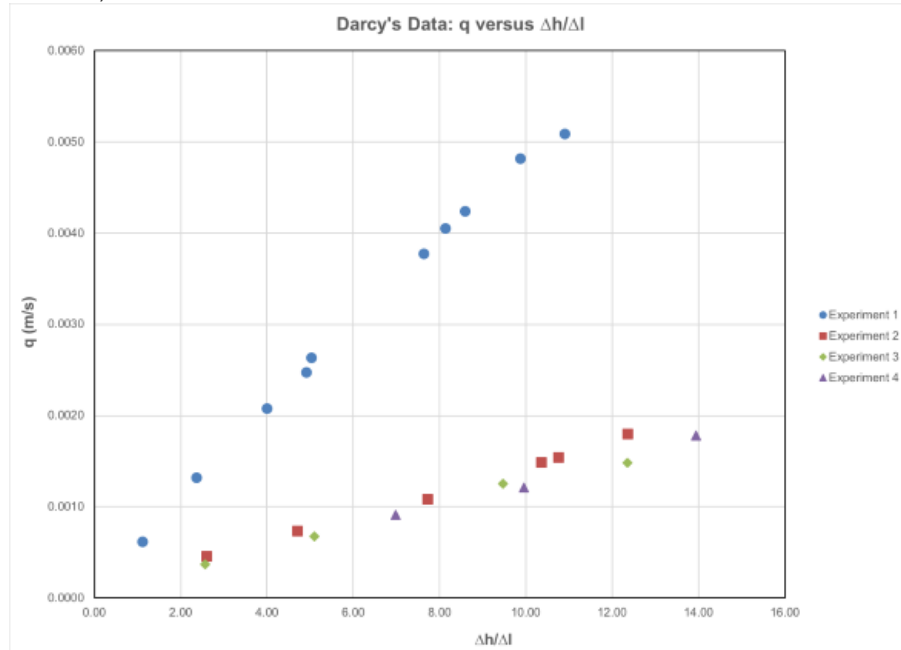
Write the rearranged Darcy equation that you used to complete Data Table 2 below.

What are the units for K?

All experimental data are subject to experimental error, or uncertainty. This uncertainty may be due to limitations on our ability to accurately measure variables in the lab, changes in environmental conditions, variations in the physical properties of materials, or other factors beyond our control. Based on what you know Darcy's experimental setup, list two possible sources of error in Darcy's experiments.

In Darcy's set of four experiments, the diameter of the sand grains (i.e., grain size) was constant. Based on what you have learned about the relationship between hydraulic conductivity and grain size and your results from Exercise 1, how would the value of K change if Darcy performed identical experiments but used a much larger grain size?

Photo 1: Darcy's Data Graph
(SAMPLE ANSWER BELOW)



Data Table 2: Average Hydraulic Conductivity
(SAMPLE ANSWER BELOW)

Experiment	Average Hydraulic Conductivity (K)
1	5.12×10^{-4}
2	1.52×10^{-4}
3	1.32×10^{-4}
4	1.27×10^{-4}

Competency Review

The majority of fresh water on earth is found in groundwater.

- ☐ True
- ☒ False



Which of the following factors influences permeability?

- ☐ Grain size
- ☐ Grain shape
- ☐ Grain sorting
- ☒ All of the above.

Which of the following materials exhibits the highest porosity?

- ☐ Gravel
- ☐ Sand
- ☒ Silt

In Exercise 1, percent permeability was calculated by dividing the released water volume by the added water volume, then multiplying by 100.

- ☒ True
- ☐ False

A(n) ____ is a permeable volume of rock, soil, or sediment that allows for the free flow of groundwater.

- ☒ aquifer
- ☐ aquitard
- ☐ water table
- ☐ soil zone

Based on the results of Exercise 1, which material would be least likely to form an aquifer?

- ☐ Gravel
- ☐ Sand
- ☒ Silt

How are water flux and hydraulic gradient related?

- ☒ As hydraulic gradient increases, water flux increases. ✓
- ☐ As hydraulic gradient decreases, water flux decreases.
- ☐ As hydraulic gradient increases, water flux decreases.
- ☐ There is no relationship between hydraulic gradient and water flux.

_____ is a measure of a material's ability to hold fluids.

- ☐ Permeability
- ☐ Hydraulic conductivity
- ☒ Porosity ✓
- ☐ Hydraulic gradient

Extension Questions

Saltwater intrusion is a process threatening many coastal aquifers used for drinking water. Research this topic and describe the saltwater intrusion process, its causes (both natural and human-induced), and mitigation actions that can be taken. (SAMPLE ANSWER BELOW)

Saltwater intrusion is the migration of seawater into freshwater aquifers. Saltwater is more dense than freshwater and can push inland beneath freshwater. Human activities, such as groundwater extraction from coastal freshwater wells, have increased the rates of saltwater intrusion in many areas. Engineered navigational and agricultural channels also lead to saltwater intrusion. Natural events like hurricanes and storm surges magnify the process. Collection basins can be used to trap saltwater that is then pumped back into the sea.