NAME:_____ **PERIOD:**_____ **DATE:**_____

LAB PARTNERS: _____ **LAB #** **30**

Porosity and Permeability Lab

Claim: Sediment size and sorting affects the rate of infiltration in the ground

SEP's: Throughout this lab, the following SEP's (science engineering practices) will be touched upon:

1. Asking questions and defining problems
2. Developing and using models
3. Analyzing and interpreting data
4. Constructing explanations

Phenomena:

1. Demonstration on how sediment size affect permeability and not porosity (must be opening in internet explorer)

https://hmxearthscience.com/Warehouse/geology/surface_processes/animations/perm.poros.swf

Introduction:

Water supply is becoming an endangered resource in many areas on Earth. Due to this growing problem, scientists are expanding their studies about the fate of water as it infiltrates the ground. Water that flows over the land surface in streams, or lies in lakes & marshes is called surface water. The water that lies beneath the land surface, occupying the open spaces in the soil or bedrock is called subsurface or ground water.

In this lab you will observe the factors that affect the rate at which water passes through particles and how those factors affect how much water soil will retain, or hold onto.

Directions:

For each station, find the information needed. You will be finding the information for each station THREE times.

Height of beads: Use a meter stick to measure how tall the beads are in the tube
Rate of infiltration: Use a stop water to time how fast the water will move through the beads
Permeability: Divide the height of beads by the rate of infiltration
Water Required to Fill Pores: Use a graduated cylinder to measure how much water will go into the tube with the beads
Volume of beads: Given
% porosity: Formula is found under each table

After you have found this information, take the average of each piece of information. **DO NOT MOVE TO NEXT STATION UNTIL TOLD BY TEACHER!!**

Station 1: Determine the following information

Data Table 1

Small Bead Tube- 4mm

	Trial 1	Trial 2	Trial 3	Average
Height of beads (cm)				
Rate of infiltration (sec)				
Permeability (cm/sec)				
Water required to fill pores (mL)				
Volume of beads (mL)	800	800	800	
% porosity **				

** % porosity= volume of pore space (amount of water required to fill pores) / Volume of beads x 100

Station 2: Determine the following information

Data Table 2

Medium Bead Tube- 7mm

	Trial 1	Trial 2	Trial 3	Average
Height of beads (cm)				
Rate of infiltration (sec)				
Permeability (cm/sec)				
Water required to fill pores (mL)				
Volume of beads (mL)	800	800	800	
% porosity **				

** % porosity= $\frac{\text{volume of pore space (amount of water required to fill pores)}}{\text{Volume of beads}}$ x 100

Station 3: Determine the following information

Data Table 3

Large Bead Tube- 12 mm

	Trial 1	Trial 2	Trial 3	Average
Height of beads (cm)				
Rate of infiltration (sec)				
Permeability (cm/sec)				
Water required to fill pores (mL)				
Volume of beads (mL)	800	800	800	
% porosity **				

** % porosity= volume of pore space (amount of water required to fill pores) x 100
Volume of beads

Station 4: Determine the following information

Data Table 4

Mixed Bead Tube

	Trial 1	Trial 2	Trial 3	Average
Height of beads (cm)				
Rate of infiltration (sec)				
Permeability (cm/sec)				
Water required to fill pores (mL)				
Volume of beads (mL)	800	800	800	
% porosity **				

** % porosity= $\frac{\text{volume of pore space (amount of water required to fill pores)}}{\text{Volume of beads}}$ x 100

Station 5: Determine the following information

Data Table 5

Angular Bead Tube

	Trial 1	Trial 2	Trial 3	Average
Height of beads (cm)				
Rate of infiltration (sec)				
Permeability (cm/sec)				
Water required to fill pores (mL)				
Volume of beads (mL)	800	800	800	
% porosity **				

** % porosity= $\frac{\text{volume of pore space (amount of water required to fill pores)}}{\text{Volume of beads}}$ x 100

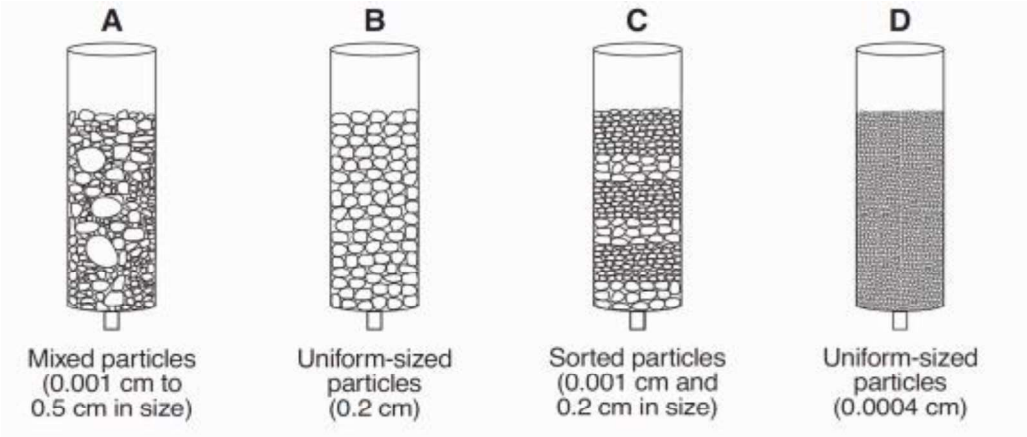
Station 6: Answer the following questions using your notes and knowledge of Earth Science

1. Water moves upward through the soil because of
   (A)Capillary action (B) Permeability
   (C) Porosity (D) Infiltration

2. Which surface soil type has the slowest permeability rate and is most likely to produce flooding?
   (A)Pebbles (B) Sand
   (C) Silt (D) Clay

3. Sand sediments are usually more permeable than silt sediments because sand grains are
   (A)Larger (B) Smoother
   (C) Rounder (D) more soluble

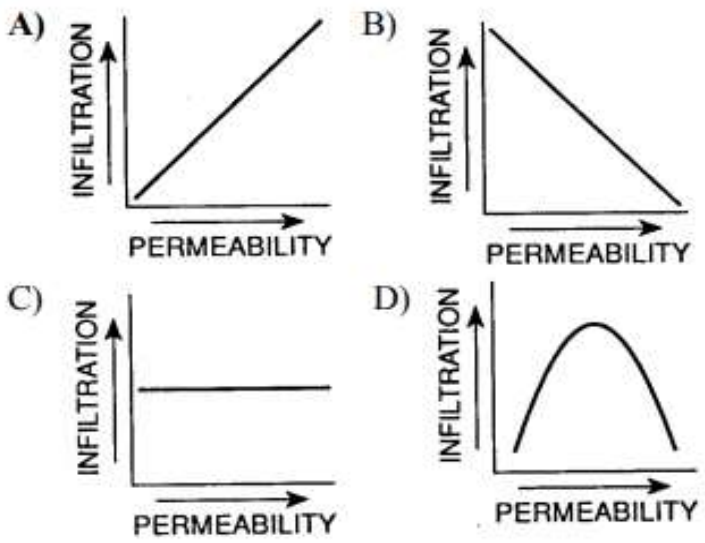
4. The diagram below shows columns A,B,C and D that contain different sediments



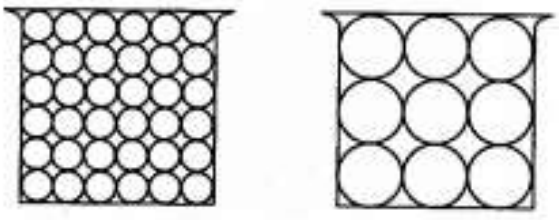
Equal volumes of water were poured through each column.
Which column of sediment retained the most water

(A)A (B) B (C) C (D) D

5. Which graph best represents the relationship between soil permeability rate and infiltration when all other conditions are the same?



6. The diagrams below represent two containers, each filled with a sample of non porous particles of uniform size.



Compared to the sample of larger particles, the sample of smaller particles has

(A)Higher permeability (B) Lower Permeability

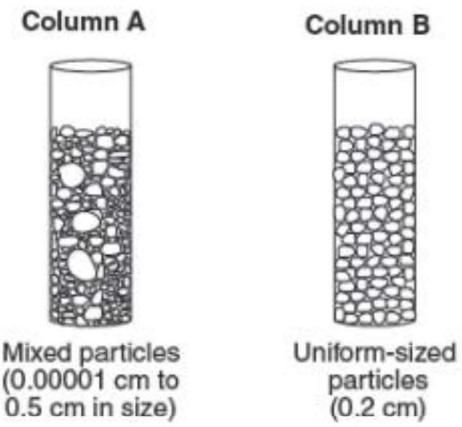
(C) Less Porosity (D) More Porosity

7. Water can pass through a sandstone sample because the sample is

(A) Well Compacted and Cemented (B) Organic in origin

(C) Composed of pebble-sized particles (D) Permeable

8. Which of the 2 columns to the right contain sediments with the best capillarity?
Column _____



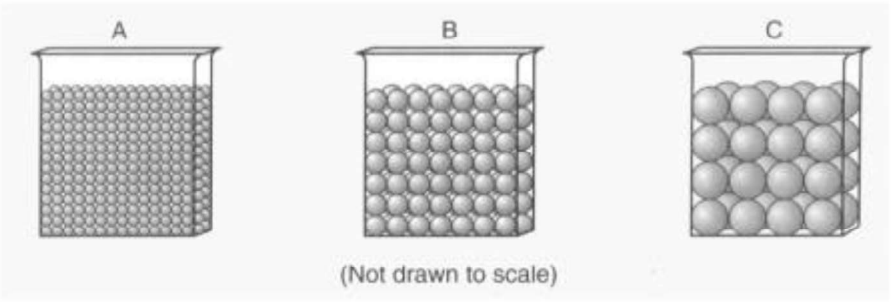
9. Give a reason for your answer. Be sure to Compare both tubes

_____
_____
_____
_____
_____

10. Compare the permeability of the sediments in Both tubes with supporting explanations

_____
_____
_____
_____

11. The diagrams below represent three containers A,B, and C which were filled with equal volumes of uniformly sorted plastic beads. Water was poured into each container to determine porosity and infiltration time



Which data table best represents the porosity and infiltration time of the beads in the three containers?

Beaker	Porosity (%)	Infiltration Time (sec)
A	20	5.2
B	30	2.8
C	40	0.4

(1)

Beaker	Porosity (%)	Infiltration Time (sec)
A	40	0.4
B	40	2.8
C	40	5.2

(2)

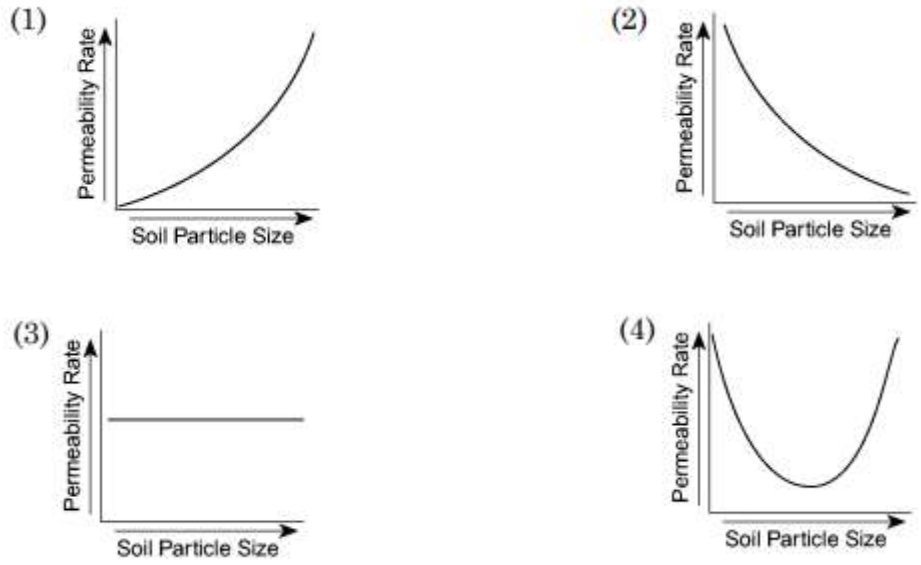
Beaker	Porosity (%)	Infiltration Time (sec)
A	40	5.2
B	40	2.8
C	40	0.4

(3)

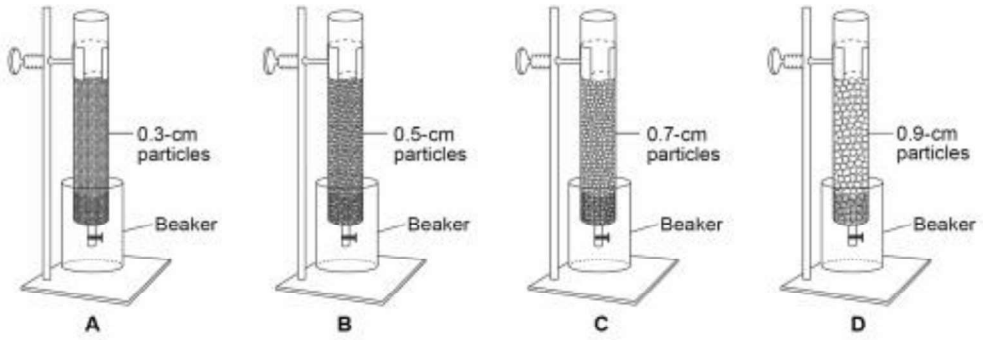
Beaker	Porosity (%)	Infiltration Time (sec)
A	20	0.4
B	30	2.8
C	40	5.2

(4)

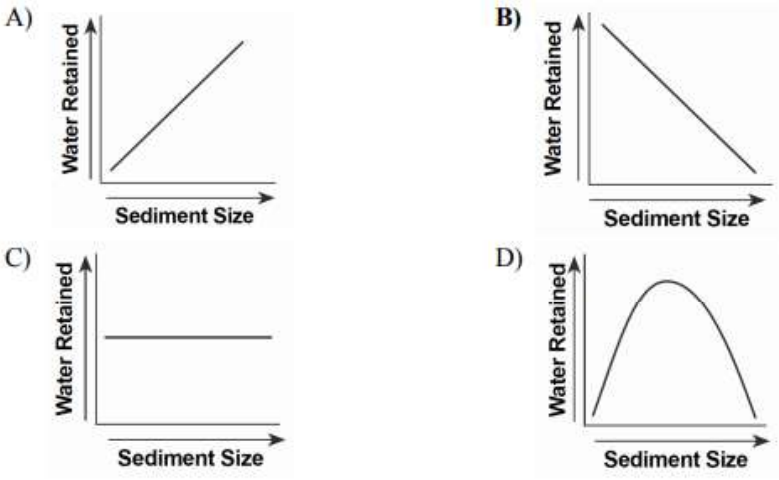
12. Which graph best represents the general relationship between soil particle size and the permeability rate of infiltrating rainwater?



13. The diagram below represents the setup for an experiment for studying groundwater. Tubes A, B, C, and D contain equal volumes of sediments. Within each tube, the sediments are uniform in size, shape, and packing. A test for water retention was conducted by first filling each tube with water and then draining the water into beakers

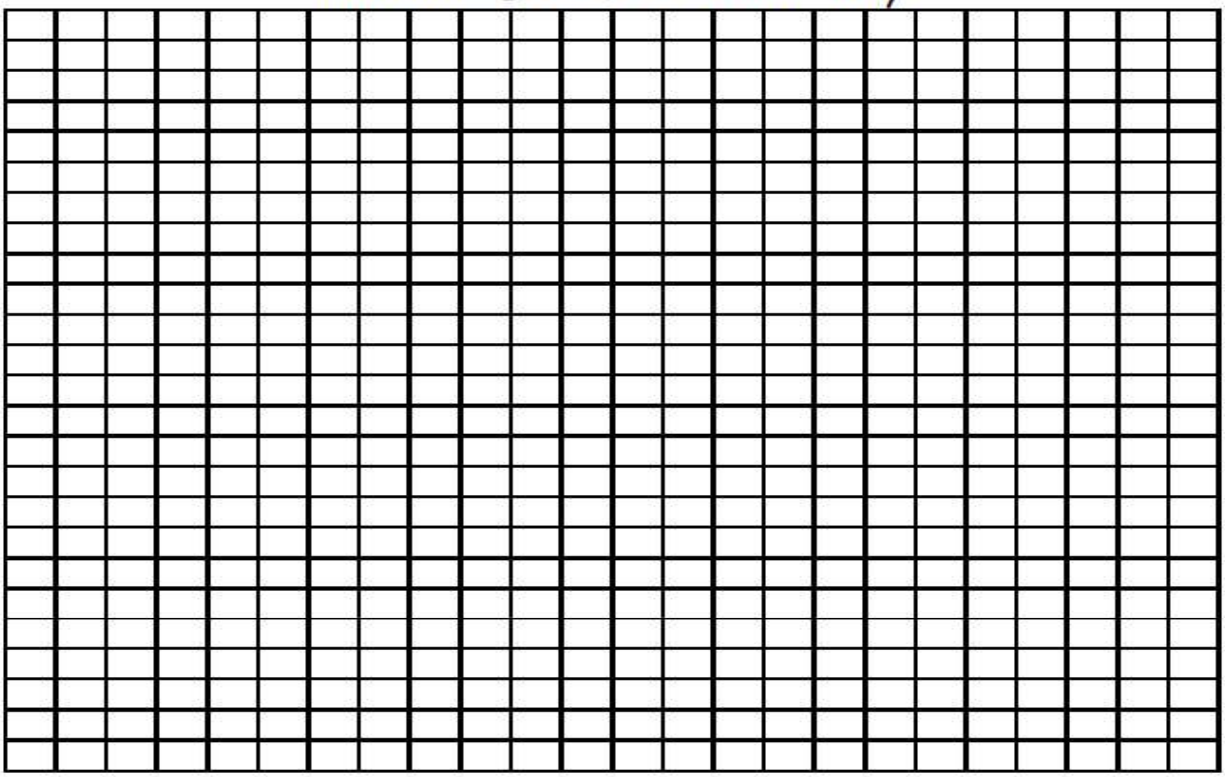


Which graph represents the general relationship between the sediment size and the amount of water retained by the sediments after the tubes had drained?



Conclusion: Use the information from each station to graph particle size versus permeability and porosity.

Particle Size vs Permeability



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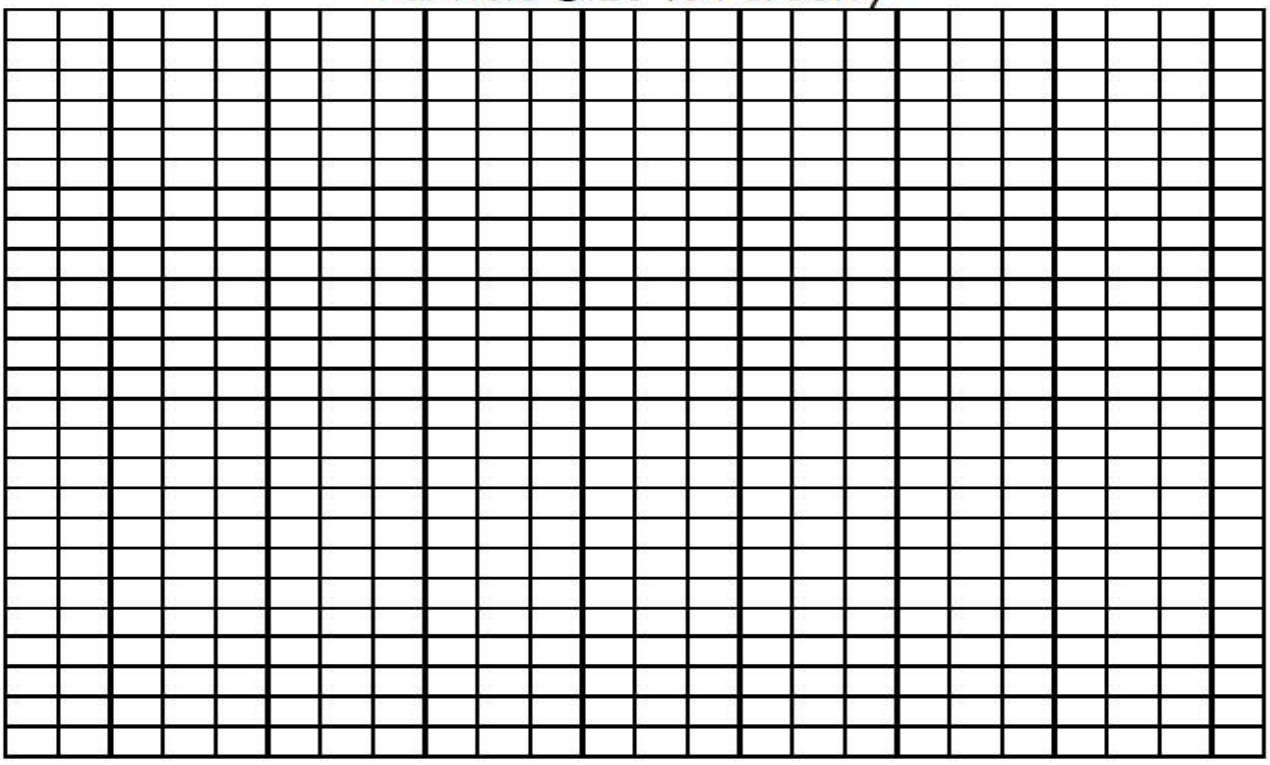
Particle Size (mm)

Particle Size vs Porosity



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Particle Size (mm)

Questions:

1. As you increase particle size, what happens to porosity?

2. As you increase particle size, what happens to the rate of infiltration?

3. When particle sizes are mixed, what happens to porosity?

4. When particle sizes are mixed, what happens to permeability?

5. If the soil in an area is composed of very small particles, what effect would it have on infiltration ?

   What effect would it have on runoff?

6. What could cause soil to be impermeable?

7. What factors control how water moves through the ground?