

INTRO LAB PART 1 - FROM THE "CHAPTER 1 - BASIC PROPERTIES OF ROCK"
LAB PACKET, COMPLETE THE FOLLOWING QUESTIONS ON P. 19-21

LAB 1 INTRO TO PROBLEMS
IN GEOLOGIC ENGINEERING

Q 1, 2, 3, 4, 5,
6, 9, 11, 12, 18

EQUATION LIST

(1) DENSITY

$$\rho = \frac{M}{V}$$

ρ = density (mass/length³)

M = mass

V = Vol = $L \times L \times L$ = length³

(2) SPECIFIC GRAVITY

$$G = \frac{\rho}{\rho_w}$$

ρ = density of substance (m/L³)

ρ_w = density of water (m/L³)

ρ_w STANDARD = 1 g/cm³ = 1000 kg/m³

(3) UNIT WEIGHT

$$\gamma = \frac{W}{V}$$

W = weight

V = volume (L³)

$$W = Mg$$

M = mass

g = acceleration due to gravity = 9.8 m/sec²

so,

$$\gamma = \frac{W}{V} = \frac{Mg}{V} = \rho g$$

where ρ = density

g = 9.8 m/sec²

→ OVER

(4) Porosity = percent of rock or sediment volume occupied by open pore space

$$n = \frac{V_{\text{pores}}}{V_t} \times 100\%$$

n = porosity in % ($n < 100\%$)

V_{pores} = volume of pore space

V_t = total volume

(5) VOLUME OF A SPHERE

$$Vol = \frac{4}{3} \pi r^3$$

$\pi = 3.14$

r = radius

1.9 Problems

1. A cylindrical sample of rock has a length of 37.7 cm and a diameter of 7.50 cm. The mass of the sample is 4747 g. Find the unit weight of the rock, in kN/m^3 .
2. Find the unit weight of rock with a specific gravity of 3.08.
3. Calculate the volume of a rock slab with unit weight 29.5 kN/m^3 and mass 4570 kg.
4. A block of granite has edge lengths 1.24 m, 0.820 m, 0.933 m. It weighs 24.7 kN. (a) Find the unit weight of the granite. (b) Find its specific gravity.
5. A block of rock has edge lengths 45.0 cm, 37.2 cm, 12.8 cm. Its porosity is 38.4%. Find the total volume of the pores in the block.
6. The specific gravity of a rock is 2.94. The porosity of the rock is 0.344. Calculate the specific gravity of the grains.
7. A 12.74 m^3 block of rock has a porosity of 26.40%. What is the volume of this rock after the block is crushed just sufficiently to close all the pores?
8. A block of rock has edge lengths 1.22 m, 2.40 m, 1.81 m. When dry its mass is 14.7 Mg; when saturated with water its mass is 16.6 Mg. Find the porosity of the rock. (The SI prefix M stands for 1×10^6 .)
9. A slab of rock has a volume of 5.56 m^3 and a porosity of 0.417. It is saturated with oil of density 0.620 g/cm^3 . Find the weight of the oil in the slab.
10. A rock saturated with oil has a unit weight of 29.3 kN/m^3 . When dry the rock has a unit weight of 26.4 kN/m^3 . The porosity of the rock is 0.370. Determine the density of the oil.
11. Calculate the porosity of a 92.0 cm^3 sample of rock containing 1270 spherical pores, each with a diameter of 3.82 mm.
12. A sample of rock has a very irregular shape for which there is no formula for the volume. When placed into a graduated cylinder containing water filled to the 65.0 mL mark, the water level rises to the 107.5 mL mark. Immediately upon removal from the water, the sample is found to have a mass of 118.3 g. The sample is then dried in an oven, thereby

driving out any water that seeped into the rock while it was submerged. When reweighed, the mass of the rock sample is found to be 116.9 g. Find (a) the volume of the sample, (b) its density and (c) its specific gravity.

13. A cube of chalk with porosity 38.4% has an edge length of 1.40 m. The chalk is crushed, closing all the pores, and then reshaped into a cube. What is the edge length of the new cube?

14. Dry surface Bermuda limestone has a porosity of 42.0%. Dry dense Bermuda limestone, porosity 5.00%, has a density of 2.72 g/cm^3 . The two limestones have the same grain density. Find the mass of a 2.50 m^3 block of surface Bermuda limestone saturated with water.

15. A cylindrical sample of rock has a diameter of 8.48 cm and a length of 14.6 cm. When dry it weighs 22.8 N; when saturated with water it weighs 28.0 N. (a) Find the porosity of the rock. (b) What is the volume of the water in the sample when saturated with water?

16. A particular dry oil shale has a density of 2.13 g/cm^3 . When saturated with oil of specific gravity 0.600, the rock yields 30.0 gallons of oil per 1.00 ton of saturated rock. Find the porosity of the shale. (1 U.S. fluid gallon = 3786 cm^3 ; 1 ton = 8896 N.)

17. Mine spoils of porosity n_0 are dumped into a triangular trench to depth H_0 , as shown in Fig.(1.6). Over time, the spoils become compacted under their own weight until the porosity is reduced to n . Show that the subsidence ΔH of the surface of the spoils is given by the expression

$$\Delta H = H_0 \left[1 - \sqrt{\frac{1-n_0}{1-n}} \right].$$

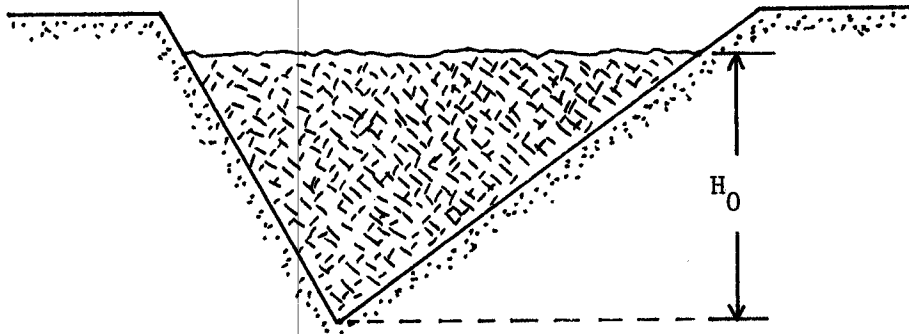


Fig.(1.6) Problem 17

(Hint: Draw a diagram for the compacted spoils and then make use of the properties of similar triangles.)

18. A cylindrical sample of rock has a diameter of 6.57 cm and a length of 15.8 cm. The rock has a unit weight of 36.2 kN/m^3 . Find the mass of the rock sample.

19. A rock has a density of 2.77 g/cm^3 . The grains of the rock have a density of 3840 kg/m^3 . Calculate the porosity of the rock.

20. A block of dimension stone has edge lengths 1.13 m, 2.26 m, 1.30 m. When dry the mass of the block is 10,300 kg. The porosity of the stone is 26.4%. Find the mass of the block when it is saturated with liquid mercury.

21. A dry oil shale has a unit weight of 26.3 kN/m^3 . When saturated with oil of unit weight 5.80 kN/m^3 , the shale has a unit weight of 28.9 kN/m^3 . How many gallons of oil can be extracted from $4.72 \times 10^6 \text{ m}^3$ of saturated oil shale?

22. A rectangular slab of rock has edge lengths 28.2 cm, 1.46 m, 1.88 m. When dry, the unit weight of the rock is 25.7 kN/m^3 . When saturated with oil of unit weight 6.40 kN/m^3 , the unit weight of the rock becomes 28.1 kN/m^3 . Find the total volume of the pores in the rock.

23. A block of oil shale with a volume of 0.774 m^3 is saturated with 0.311 m^3 of oil. The unit weight of the saturated oil shale is 27.8 kN/m^3 . After all of the oil has been driven out of the rock, the unit weight of the rock is 25.2 kN/m^3 . Find the specific gravity of the oil.

24. A 2.74 m^3 block of rock saturated with water has a unit weight of 32.4 kN/m^3 . The rock has a porosity of 0.276. Find the weight of the rock when dry.

25. A dry oil shale has a unit weight of 25.8 kN/m^3 . When saturated with oil of specific gravity 0.650, the shale has a unit weight of 29.3 kN/m^3 . How many barrels of oil can be extracted from 7400 m^3 of this saturated oil shale? (1 barrel = $119,300 \text{ cm}^3$.)

26. A dry rock has a density of 2730 kg/m^3 and a grain density of 4.82 g/cm^3 . (a) Find the porosity of the rock. (b) Find the unit weight of the rock.

27. A block of rock saturated with water has edge lengths of 1.20 m, 1.47 m, 1.35 m. The porosity of the rock is 28.4%. Find the volume of water squeezed out of the rock when it is crushed so that all the pores are closed.

28. A 2420 kg block of rock has edge lengths 0.94 m, 1.26 m, 1.15 m. The grain density is 2.87 g/cm^3 . Find the porosity of the rock.
29. A block of rock has a volume of 5.30 m^3 . When dry its mass is 14,700 kg. When saturated with water its mass is 16,600 kg. Find the porosity of the rock.
30. Mine tailings saturated with water form a triangular prism 15.2 m wide, 15.2 m high and 83.0 m long when dumped on the ground. Later, after the tailings have settled, squeezing out all the water, they form a triangular prism of the same length but now 19.5 m wide and 8.70 m high. Find the porosity of the freshly-dumped tailings.
31. Clay sediment of porosity 48.2% is deposited into a triangular trench to a depth equal to 7.26 m. (a) Find the porosity of the clay when it has settled by 54.4 cm. (b) Find the greatest possible settlement that can occur due to compaction.
32. Dry mine spoils of porosity 60% are dumped into a triangular trench to a depth equal to 2.87 m. Find the depth of the spoils when they have compacted to a porosity of 30%.
33. Material with a porosity n_0 is stored in a rectangular trench, filling the trench to depth H_0 . Show that the porosity n of the material after settling a distance equal to $\frac{1}{2}H_0$ is given by $n = 2n_0 - 1$.
34. A rock with porosity 37.5% and bulk density 1.70 g/cm^3 consists only of orthoclase and pyroxene. Find the abundances of these minerals in the rock.
35. Calculate the porosity of a rock that is 50.0% quartz, 50.0% muscovite and that has a bulk density of 2.00 g/cm^3 .
36. Calculate the porosity of a rock that is 50.0% quartz, 50.0% muscovite, and that has a bulk density of 2.00 g/cm^3 when saturated with water.
37. A sample of rock has a volume of 27.6 cm^3 . Its composition is 36.2% orthoclase and 17.4% pyrite; the rest is galena. The porosity of the rock is 21.0%. Find the mass of the rock sample if it is saturated in oil of specific gravity 0.600.
38. Derive Eq.(1.24). *Hint*: Draw a diagram; label the slope angle of the line and the quantities y_p and $mx_p + b$.
39. On a triangular composition diagram for rocks composed of the minerals R, S and T,

locate the regions occupied by rocks with compositions (a) 20% R, 40% T; (b) 60% S, 10% T; (c) 100% R.

40. On a triangular composition diagram for rocks made of the minerals P, Q, R, locate the region containing rocks with compositions in the range 10% → 30% P, 20% → 50% Q.