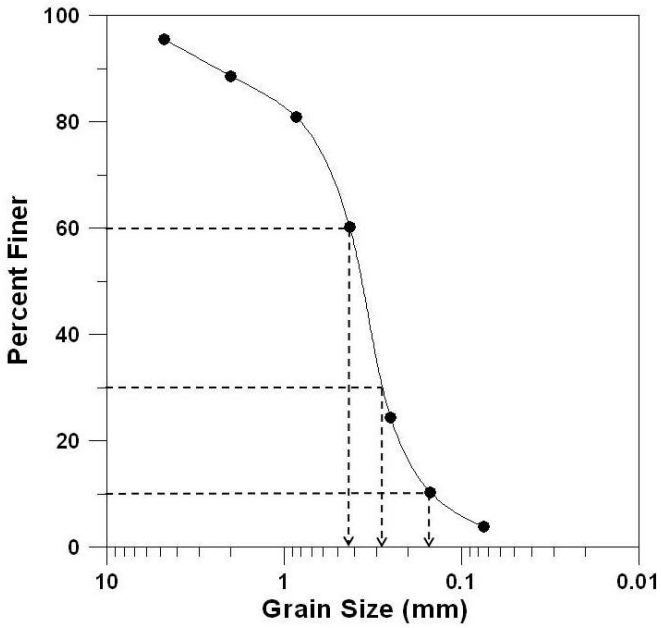
Chapter 2

2.1 $$C_u = \frac{D_{60}}{D_{10}} = \frac{0.42}{0.16} = 2.625 \approx \mathbf{2.63}\,;\; C_c = \frac{D_{30}^2}{(D_{60})(D_{10})} = \frac{0.21^2}{(0.42)(0.16)} = 0.656 \approx \mathbf{0.66}$$

2.2 $$C_u = \frac{D_{60}}{D_{10}} = \frac{0.81}{0.27} = \mathbf{3.0}\,;\; C_c = \frac{D_{30}^2}{(D_{60})(D_{10})} = \frac{0.41^2}{(0.81)(0.27)} = 0.768 \approx \mathbf{0.77}$$

2.3 a.

Sieve no.	Mass of soil retained on each sieve (g)	Percent retained on each sieve	Percent finer
4	28	4.54	**95.46**
10	42	6.81	**88.65**
20	48	7.78	**80.88**
40	128	20.75	**60.13**
60	221	35.82	**24.31**
100	86	13.94	**10.37**
200	40	6.48	**3.89**
Pan	24	3.89	**0.00**
	Σ 617 g		



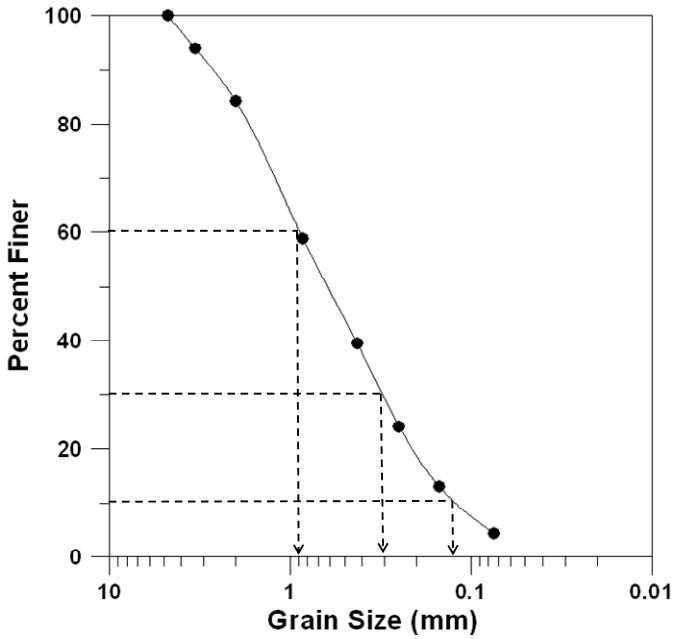
b. D_{10} = **0.16 mm**; D_{30} = **0.29 mm**; D_{60} = **0.45 mm**

c. $C_u = \dfrac{D_{60}}{D_{10}} = \dfrac{0.45}{0.16} = 2.812 \approx \mathbf{2.81}$

d. $C_c = \dfrac{D_{30}^2}{(D_{60})(D_{10})} = \dfrac{0.29^2}{(0.45)(0.16)} = 1.168 \approx \mathbf{1.17}$

2.4 a.

Sieve no.	Mass of soil retained on each sieve (g)	Percent retained on each sieve	Percent finer
4	0	0.0	**100.00**
6	30	6.0	**94.0**
10	48.7	9.74	**84.26**
20	127.3	25.46	**58.80**
40	96.8	19.36	**39.44**
60	76.6	15.32	**24.12**
100	55.2	11.04	**13.08**
200	43.4	8.68	**4.40**
Pan	22	4.40	**0.00**
	Σ 500 g		



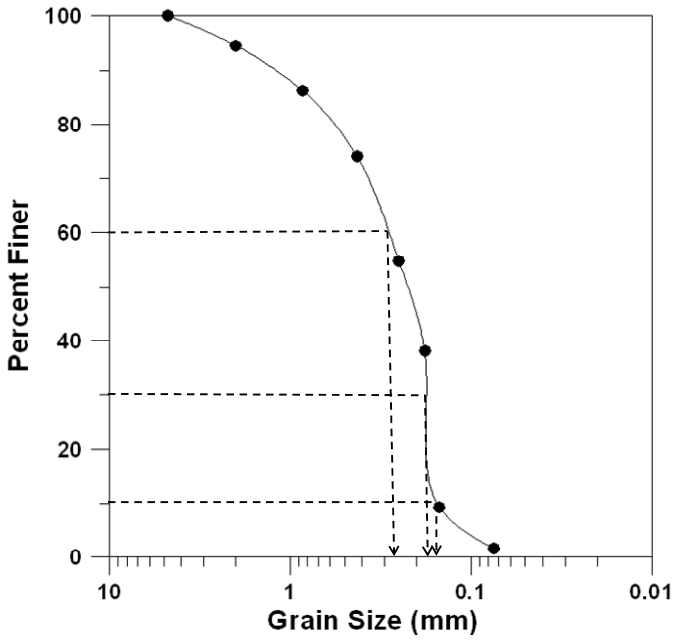
b. D_{10} = **0.13 mm**; D_{30} = **0.3 mm**; D_{60} = **0.9 mm**

c. $C_u = \dfrac{D_{60}}{D_{10}} = \dfrac{0.9}{0.13} = 6.923 \approx \mathbf{6.92}$

d. $C_c = \dfrac{D_{30}^2}{(D_{60})(D_{10})} = \dfrac{0.3^2}{(0.9)(0.13)} = 0.769 \approx \mathbf{0.77}$

2.5 a.

Sieve no.	Mass of soil retained on each sieve (g)	Percent retained on each sieve	Percent finer
4	0	0.0	**100.00**
10	40	5.49	**94.51**
20	60	8.23	**86.28**
40	89	12.21	**74.07**
60	140	19.20	**54.87**
80	122	16.74	**38.13**
100	210	28.81	**9.33**
200	56	7.68	**1.65**
Pan	12	1.65	**0.00**
	Σ 729 g		



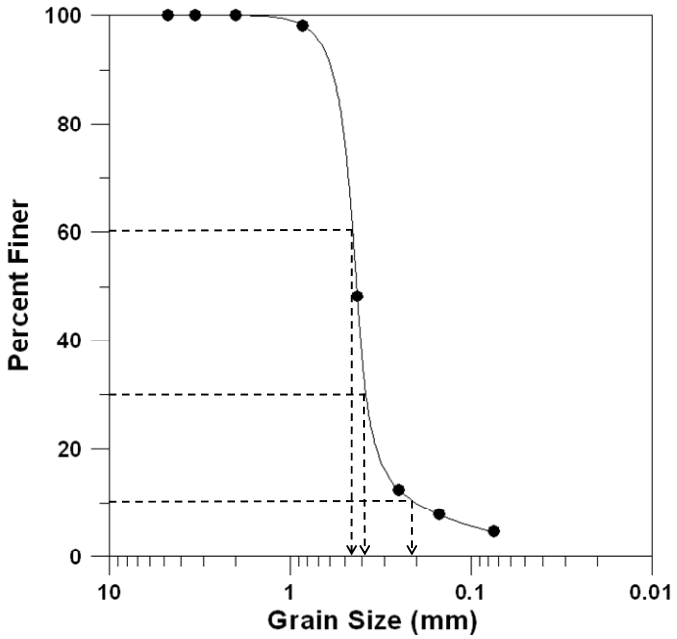
b. D_{10} = **0.17 mm**; D_{30} = **0.18 mm**; D_{60} = **0.28 mm**

c. $C_u = \dfrac{D_{60}}{D_{10}} = \dfrac{0.28}{0.17} = 1.647 \approx \mathbf{1.65}$

d. $C_c = \dfrac{D_{30}^2}{(D_{60})(D_{10})} = \dfrac{0.18^2}{(0.28)(0.17)} = \mathbf{0.68}$

2.6 a.

Sieve no.	Mass of soil retained on each sieve (g)	Percent retained on each sieve	Percent finer
4	0	0.0	**100.00**
6	0	0.0	**100.00**
10	0	0.0	**100.00**
20	9.1	1.82	**98.18**
40	249.4	49.88	**48.3**
60	179.8	35.96	**12.34**
100	22.7	4.54	**7.8**
200	15.5	3.1	**4.7**
Pan	23.5	4.7	**0.00**
	Σ 500 g		

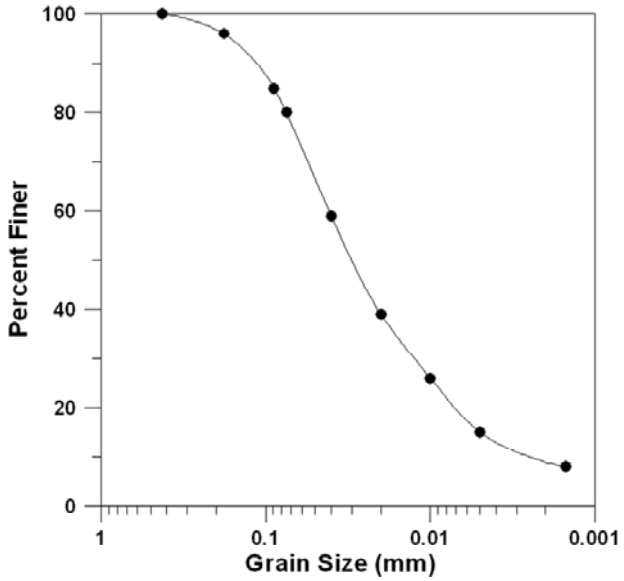


b. D_{10} = **0.21 mm**; D_{30} = **0.39 mm**; D_{60} = **0.45 mm**

c. $C_u = \dfrac{D_{60}}{D_{10}} = \dfrac{0.45}{0.21} = 2.142 \approx \mathbf{2.14}$

d. $C_c = \dfrac{D_{30}^2}{(D_{60})(D_{10})} = \dfrac{0.39^2}{(0.45)(0.21)} = 1.609 \approx \mathbf{1.61}$

2.7 a.



b. Percent passing 2 mm = 100
Percent passing 0.06 mm = 73
Percent passing 0.002 mm = 9

GRAVEL: 100 – 100 = **0%**
SAND: 100 – 73 = **27%**
SILT: 73 – 9 = **64%**
CLAY: 9 – 0 = **9%**

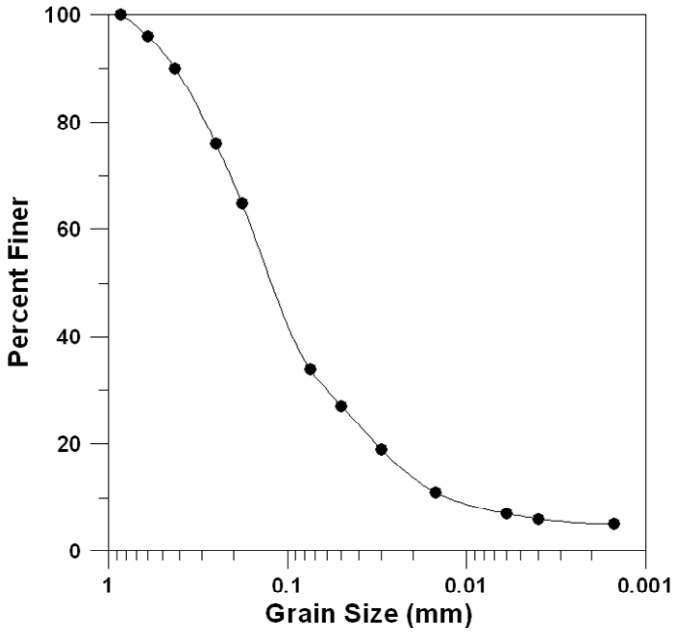
c. Percent passing 2 mm = 100
Percent passing 0.05 mm = 68
Percent passing 0.002 mm = 9

GRAVEL: 100 – 100 = **0%**
SAND: 100 – 68 = **32%**
SILT: 68 – 9 = **59%**
CLAY: 9 – 0 = **9%**

d. Percent passing 2 mm = 100
Percent passing 0.075 mm = 80
Percent passing 0.002 mm = 9

GRAVEL: 100 – 100 = **0%**
SAND: 100 – 80 = **20%**
SILT: 80 – 9 = **71%**
CLAY: 9 – 0 = **9%**

2.8 a.



b. Percent passing 2 mm = 100
Percent passing 0.06 mm = 30
Percent passing 0.002 mm = 5

GRAVEL: 100 – 100 = **0%**
SAND: 100 – 30 = **70%**
SILT: 70 – 5 = **65%**
CLAY: 5 – 0 = **5%**

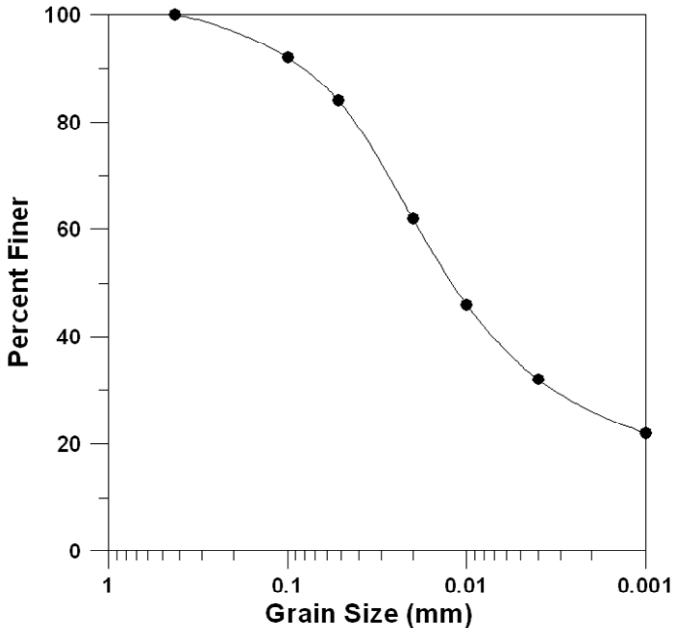
c. Percent passing 2 mm = 100
Percent passing 0.05 mm = 28
Percent passing 0.002 mm = 5

GRAVEL: 100 – 100 = **0%**
SAND: 100 – 28 = **72%**
SILT: 72 – 5 = **67%**
CLAY: 5 – 0 = **5%**

d. Percent passing 2 mm = 100
Percent passing 0.075 mm = 34
Percent passing 0.002 mm = 5

GRAVEL: 100 – 100 = **0%**
SAND: 100 – 34 = **66%**
SILT: 66 – 5 = **61%**
CLAY: 5 – 0 = **5%**

2.9 a.



b. Percent passing 2 mm = 100
Percent passing 0.06 mm = 84
Percent passing 0.002 mm = 28

GRAVEL: 100 – 100 = **0%**
SAND: 100 – 84 = **16%**
SILT: 84 – 28 = **56%**
CLAY: 28 – 0 = **28%**

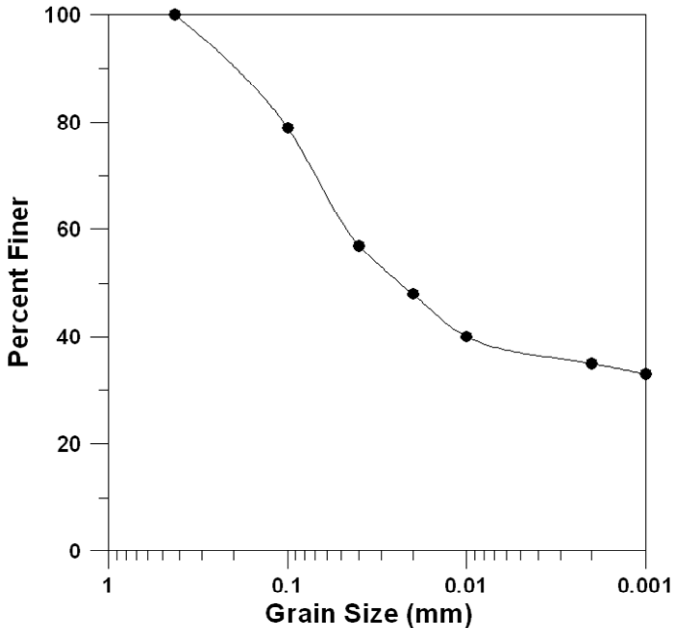
c. Percent passing 2 mm = 100
Percent passing 0.05 mm = 83
Percent passing 0.002 mm = 28

GRAVEL: 100 – 100 = **0%**
SAND: 100 – 83 = **17%**
SILT: 83 – 28 = **55%**
CLAY: 28 – 0 = **28%**

d. Percent passing 2 mm = 100
Percent passing 0.075 mm = 90
Percent passing 0.002 mm = 28

GRAVEL: 100 – 100 = **0%**
SAND: 100 – 90 = **10%**
SILT: 90 – 28 = **62%**
CLAY: 28 – 0 = **28%**

2.10 a.



b. Percent passing 2 mm = 100 — GRAVEL: 100 – 100 = **0%**
Percent passing 0.06 mm = 65 — SAND: 100 – 65 = **35%**
Percent passing 0.002 mm = 35 — SILT: 65 – 35 = **30%**
CLAY: 35 – 0 = **35%**

c. Percent passing 2 mm = 100 — GRAVEL: 100 – 100 = **0%**
Percent passing 0.05 mm = 62 — SAND: 100 – 62 = **38%**
Percent passing 0.002 mm = 35 — SILT: 62 – 35 = **27%**
CLAY: 35 – 0 = **35%**

d. Percent passing 2 mm = 100 — GRAVEL: 100 – 100 = **0%**
Percent passing 0.075 mm = 70 — SAND: 100 – 70 = **30%**
Percent passing 0.002 mm = 35 — SILT: 70 – 35 = **35%**
CLAY: 35 – 0 = **35%**

2.11 G_s = 2.7; temperature = 24°; time = 60 min; L = 9.2 cm

Eq. (2.5): $D\,(\text{mm}) = K\sqrt{\dfrac{L\,(\text{cm})}{t\,(\text{min})}}$

From Table 2.6 for G_s = 2.7 and temperature = 24°, K = 0.01282

$$D = 0.01282\sqrt{\frac{9.2}{60}} = \mathbf{0.005\,mm}$$

2.12 G_s = 2.75; temperature = 23°C; time = 100 min; L = 12.8 cm

Eq. (2.5): $D\,(\text{mm}) = K\sqrt{\dfrac{L\,(\text{cm})}{t\,(\text{min})}}$

From Table 2.6 for G_s = 2.75 and temperature = 23°, K = 0.01279

$$D = 0.01279\sqrt{\frac{12.8}{100}} = \mathbf{0.0046\,mm}$$

CRITICAL THINKING PROBLEM

2.C.1 a. Soil A: $C_u = \dfrac{D_{60}}{D_{10}} = \dfrac{11}{0.6} = \mathbf{18.33}$; $C_c = \dfrac{D_{30}^2}{(D_{60})(D_{10})} = \dfrac{5^2}{(11)(0.6)} = \mathbf{3.78}$

Soil B: $C_u = \dfrac{D_{60}}{D_{10}} = \dfrac{7}{0.2} = \mathbf{35}$; $C_c = \dfrac{D_{30}^2}{(D_{60})(D_{10})} = \dfrac{2.1^2}{(7)(0.2)} = \mathbf{3.15}$

Soil C: $C_u = \dfrac{D_{60}}{D_{10}} = \dfrac{4.5}{0.15} = \mathbf{30}$; $C_c = \dfrac{D_{30}^2}{(D_{60})(D_{10})} = \dfrac{1^2}{(4.5)(0.15)} = \mathbf{1.48}$

b. Soil A is coarser than Soil C. A higher percentage of soil C is finer than any given size compared to Soil A. For example, about 15% is finer than 1 mm for Soil A, whereas almost 30% is finer than 1 mm in case of soil C.

c. Particle segregation may take place in aggregate stockpiles such that there is a separation of coarser and finer particles. This makes representative sampling difficult. Therefore Soils A, B, and C demonstrate quite different particle size distribution.

d. Soil A:

Percent passing 4.75 mm = 29	GRAVEL: 100 – 29 = **71%**
Percent passing 0.075 mm = 1	SAND: 29 – 1 = **28%**
	FINES: 1 – 0 = **1%**

Soil B:

Percent passing 4.75 mm = 45	GRAVEL: 100 – 45 = **55%**
Percent passing 0.075 mm = 2	SAND: 45 – 2 = **43%**
	FINES: 2 – 0 = **2%**

Soil C:

Percent passing 4.75 mm = 53	GRAVEL: 100 – 53 = **47%**
Percent passing 0.075 mm = 3	SAND: 47 – 3 = **44%**
	FINES: 3 – 0 = **3%**