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Chapter 2

2.1 $C_u = \frac{D_{60}}{D_{10}} = \frac{0.41}{0.08} = \mathbf{5.13}$

$$C_c = \frac{(D_{30})^2}{(D_{10})(D_{60})} = \frac{(0.22)^2}{(0.08)(0.41)} = \mathbf{1.48}$$

2.2 $C_u = \frac{D_{60}}{D_{10}} = \frac{1.81}{0.24} = \mathbf{7.54}$

$$C_c = \frac{(D_{30})^2}{(D_{10})(D_{60})} = \frac{(0.82)^2}{(0.24)(1.81)} = \mathbf{1.55}$$

2.3 a.

Sieve no.	Mass of soil retained on each sieve (g)	Percent retained on each sieve	Percent finer
4	0.0	0.0	**100.0**
10	18.5	4.4	**95.6**
20	53.2	12.6	**83.0**
40	90.5	21.5	**61.5**
60	81.8	19.4	**42.1**
100	92.2	21.9	**20.2**
200	58.5	13.9	**6.3**
Pan	26.5	6.3	**0**
	Σ 421.2 g		

The grain-size distribution is shown in the figure.

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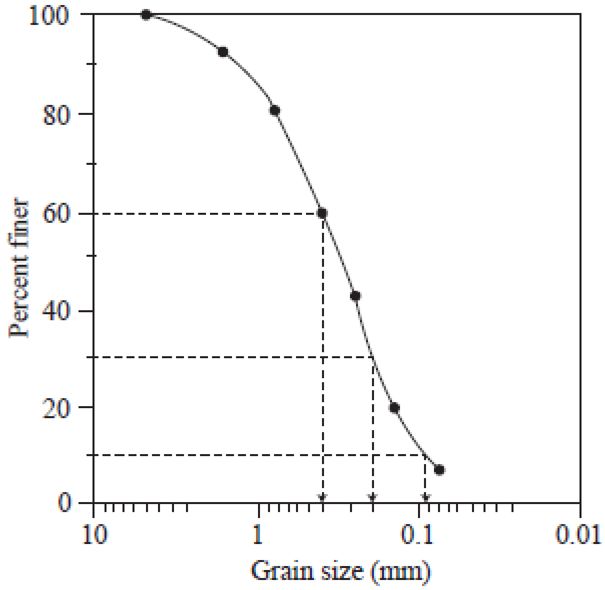

b. D_{60} = **0.4 mm**; D_{30} = **0.2 mm**; D_{10} = **0.095 mm**

c. $C_u = \frac{D_{60}}{D_{10}} = \frac{0.4}{0.095} = \mathbf{4.21}$

d. $C_c = \frac{(D_{30})^2}{(D_{10})(D_{60})} = \frac{(0.2)^2}{(0.4)(0.095)} = \mathbf{1.05}$

2.4 a.

Sieve no.	Mass of soil retained on each sieve (g)	Percent retained on each sieve	Percent finer
4	0.0	0.0	**100**
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**
	Σ 500 g		

The grain-size distribution is shown in the figure.

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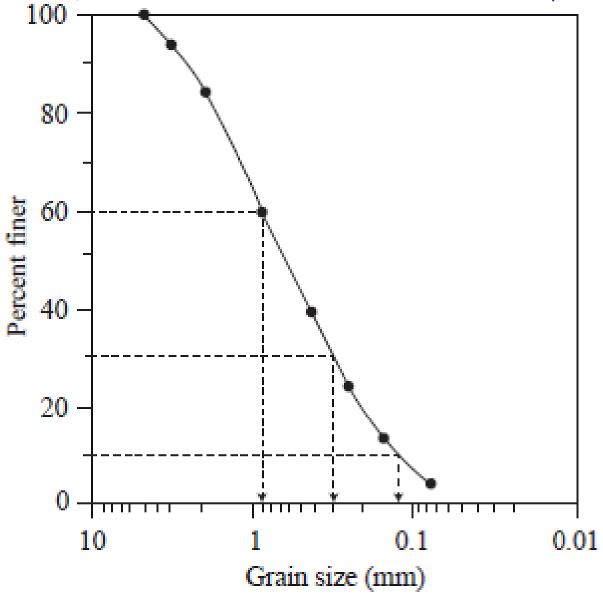

b. D_{10} = **0.13 mm**; D_{30} = **0.3 mm**; D_{60} = **0.9 mm**

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

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

2.5 a.

Sieve no.	Mass retained (g)	Percent retained on each sieve	Percent finer
4	28	4.54	95.46
10	42	6.81	88.65
20	48	7.78	80.87
40	128	20.75	60.12
60	221	35.82	24.3
100	86	13.94	10.36
200	40	6.48	3.88
Pan	24	3.88	0
	$\sum$ 617 g		

The graph for percent finer versus grain size is shown.

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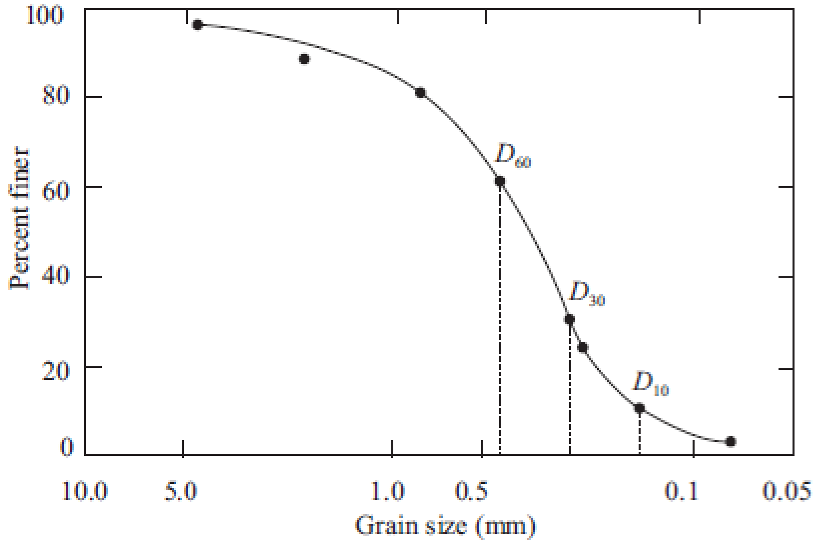

b. From the graph, D_{10} = **0.14 mm**, D_{30} = **0.27 mm**, D_{60} = **0.42 mm**

c. $C_u = \dfrac{D_{60}}{D_{10}} = \dfrac{0.42}{0.14} = \mathbf{3}$

d. $C_c = \dfrac{(D_{30})^2}{(D_{60})(D_{10})} = \dfrac{(0.27)^2}{(0.42)(0.14)} = \mathbf{1.24}$

2.6 a.

The grain-size distribution is shown in the figure.

Sieve no.	Mass of soil retained on each sieve (g)	Percent retained on each sieve	Percent finer
4	0	0.0	**100**
6	0	0.0	**100**
10	0	0.0	**100**
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**
	Σ 500 g		

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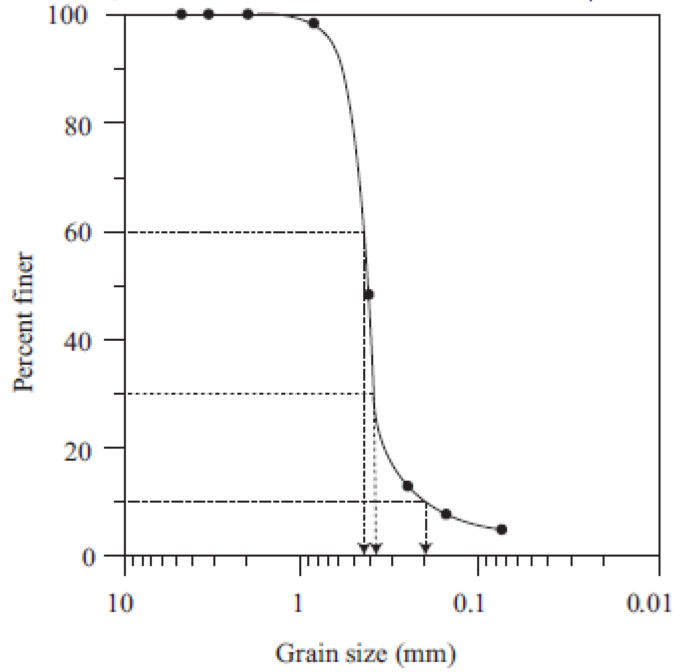
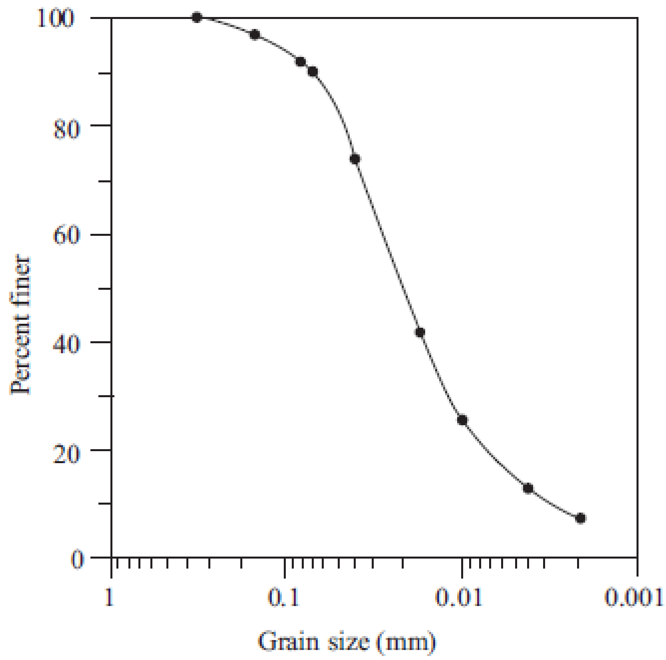


b. D_{10} = **0.21 mm**; D_{30} = **0.39 mm**; D_{60} = **0.45 mm**

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

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

2.7 a. The grain-size distribution curve is shown in the figure.



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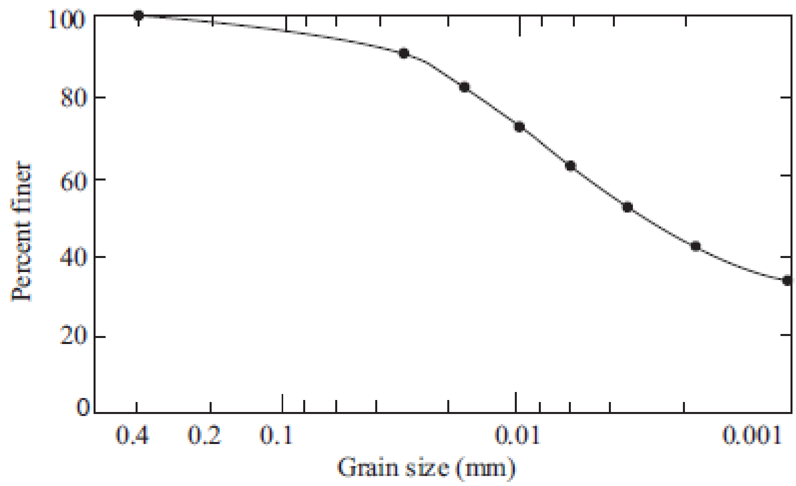
b. Percent passing 2 mm = 100	GRAVEL: 100 – 100 = **0%**
Percent passing 0.06 mm = 84	SAND: 100 − 84 = **16%**
Percent passing 0.002 mm = 11	SILT: 84 − 11 = **73%**
	CLAY: 11 − 0 = **11%**
c. Percent passing 2 mm = 100	GRAVEL: 100 − 100 = **0%**
Percent passing 0.05 mm = 80	SAND: 100 − 80 = **20%**
Percent passing 0.002 mm = 11	SILT: 80 − 11 = **69%**
	CLAY: 11 − 0 = **11%**
d. Percent passing 2 mm = 100	GRAVEL: 100 − 100 = **0%**
Percent passing 0.075 mm = 90	SAND: 100 − 90 = **10%**
Percent passing 0.002 mm = 11	SILT: 90 − 11 = **79%**
	CLAY: 11 − 0 = **11%**

2.8 The grain-size distribution curve is shown in the figure.



a. Percent passing 2 mm = 100	GRAVEL: 100 − 100 = **0%**
Percent passing 0.05 mm = 94	SAND: 100 − 94 = **6%**
Percent passing 0.002 mm = 42	SILT: 94 − 42 = **52%**
	CLAY: 42 − 0 = **42%**
b. Percent passing 2 mm = 100	GRAVEL: 100 − 100 = **0%**
Percent passing 0.075 mm = 97	SAND: 100 − 97 = **3%**
Percent passing 0.002 mm = 42	SILT: 97 − 42 = **55%**
	CLAY: 42 − 0 = **42%**

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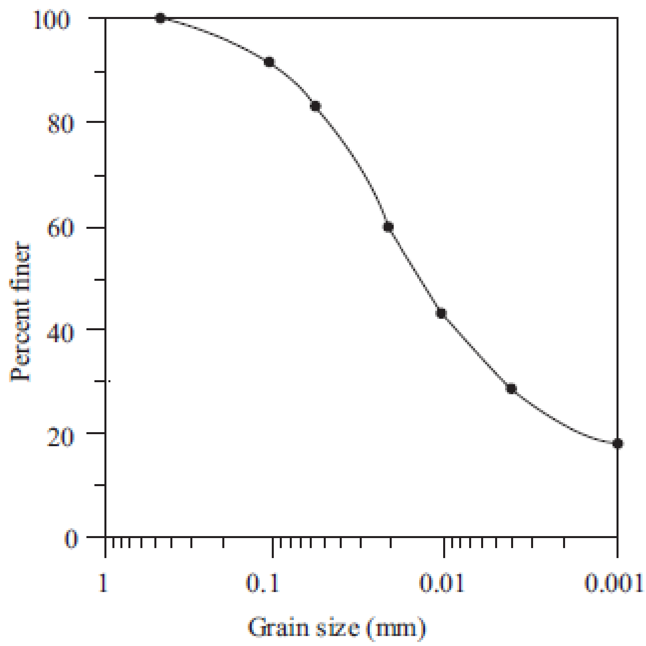
2.9 a. The grain-size distribution curve is shown below.



b. Percent passing 2 mm = 100 — GRAVEL: 100 − 100 = **0%**

Percent passing 0.06 mm = 84 — SAND: 100 − 84 = **16%**

Percent passing 0.002 mm = 28 — SILT: 84 − 28 = **56%**

CLAY: 28 − 0 = **28%**

c. Percent passing 2 mm = 100 — GRAVEL: 100 − 100 = **0%**

Percent passing 0.05 mm = 83 — SAND: 100 − 83 = **17%**

Percent passing 0.002 mm = 28 — SILT: 83 − 28 = **55%**

CLAY: 28 − 0 = **28%**

d. Percent passing 2 mm = 100 — GRAVEL: 100 − 100 = **0%**

Percent passing 0.075 mm = 90 — SAND: 100 − 90 = **10%**

Percent passing 0.002 mm = 28 — SILT: 90 − 28 = **62%**

CLAY: 28 − 0 = **28%**

2.10 $G_s = 2.60$; temperature = 24°; $R = 43$; time = 60 min. Referring to Table 2.10, $L = 9.2$.

Eq. (2.6): $D\ (\text{mm}) = K\sqrt{\frac{L(\text{cm})}{t(\text{min})}}$

From Table 2.9 for $G_s = 2.60$ and temperature = 24°, $K = 0.01321$.

$$D = 0.01321\sqrt{\frac{9.2}{60}} = \mathbf{0.0052\ mm}$$

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2.11 For $G_s = 2.70$ and temperature = 23°, $K = 0.01297$ (Table 2.9); $R = 25$, $L = 12.2$ (Table 2.10).

$$D(\text{mm}) = K\sqrt{\frac{L(\text{cm})}{t(\text{min})}} = 0.01297\sqrt{\frac{12.2}{120}} = \mathbf{0.0041\ mm}$$

2.12 a. Total mass in the ternary mix = $8000 \times 3 = 24{,}000$ kg

Percent of each soil in the mix = $\dfrac{8000}{24{,}000} \times 100 = 33.33\%$

Mass of each soil used in the sieve analysis, $\Sigma m_A = \Sigma m_B = \Sigma m_C = 500\,\text{g}$

If a sieve analysis is conducted on the ternary mix using the same set of sieves, the percent of mass retained on each sieve, m_M (%), can be computed as follows:

$$m_M(\%) = 0.333\left(\frac{m_A}{500}\times 100\right) + 0.333\left(\frac{m_B}{500}\times 100\right) + 0.333\left(\frac{m_C}{500}\times 100\right)$$

The calculated values are shown in the following table.

Sieve size (mm)	Mass retained				Percent passing for the mixture
	m_A (g)	m_B (g)	m_C (g)	m_M (%)	
25.0	0.0	0	0	**0.0**	**100**
19.0	60	10	30	**6.66**	**93.34**
12.7	130	75	75	**18.65**	**74.69**
9.5	65	80	45	**12.65**	**62.04**
4.75	100	165	90	**23.64**	**38.4**
2.36	50	25	65	**9.32**	**29.08**
0.6	40	60	75	**11.65**	**17.43**
0.075	50	70	105	**14.98**	**2.45**
Pan	5	15	15	**2.33**	≈ **0**

b. The grain-size distribution curve for the mixture is drawn below.

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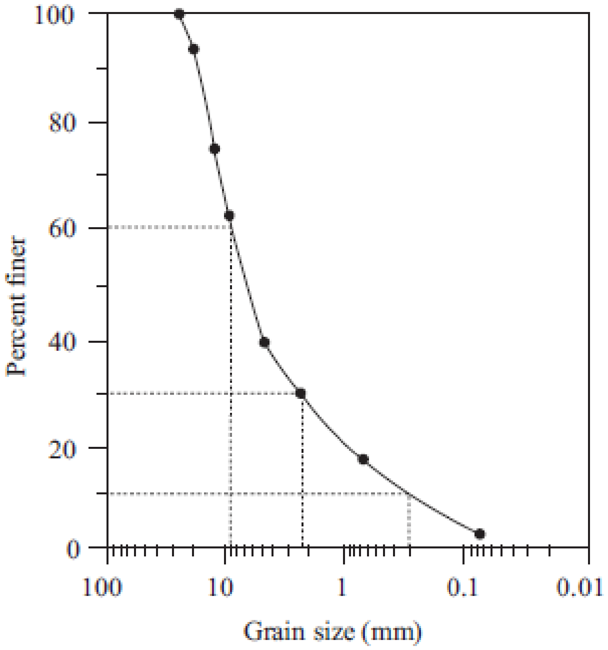

From the curve, $D_{10} = 0.21$; $D_{30} = 2.5$; $D_{60} = 9.0$;

$$C_u = \frac{D_{60}}{D_{10}} = \frac{9.0}{0.21} = \mathbf{42.85}; \quad C_x = \frac{D_{30}^2}{(D_{60})(D_{10})} = \frac{2.5^2}{(9.0)(0.21)} = \mathbf{3.31}$$

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