Solutions to the Extra Problems for Chapter 1

1. a. The "1" and "6" are significant, which makes the "0" between them significant, so this number has three significant figures.

b. The "1" and "2" are significant. The zero is also significant, because it is at the end of the number and to the right of the decimal. You don't worry about what follows the "×" sign, so there are three significant figures.

c. The "3" and "4" are significant. The zeroes are also significant, because they are at the end of the number and to the right of the decimal. Thus, there are four.

d. The "6" and "7" are significant. The first four zeroes are not, because they are not at the end of the number or between significant figures. The last three are, however, as they are at the end of the number and to the right of the decimal. Thus, there are five significant figures.

2. Remember that when we add measurements, we must look at precision. The first measurement has its last significant figure in the ones place. The second is more precise, because its last significant figure is in the ten thousandths place. Thus, the answer must be reported to the ones place. When you do the addition, you get 19.6912 g, but it must be rounded to the ones place, which gives us 20 g. However, that zero must be made significant, so the answer is 2.0×10 g. You can also say 2.0×10^{1} g.

3. The answer is 25.8 mm. We put the measurement over "1" to make it a fraction, then multiply by the conversion relationship so that m cancel. You get the conversion relationship by replacing the prefix with its meaning. Since "milli" means "0.001," 1 mm = 0.001 m.

$$\frac{0.0258\ \cancel{\text{m}}}{1}\times\frac{1\ \text{mm}}{0.001\ \cancel{\text{m}}} = 25.8\ \text{mm}$$

4. The answer is 56,100 g. Since "kilo" means "1,000," the relationship is 1 kg = 1,000 g.

$$\frac{56.1\ \cancel{\text{kg}}}{1}\times\frac{1{,}000\ \text{g}}{1\ \cancel{\text{kg}}} = 56{,}100\ \text{g}$$

5. The answer is 5,000 mL. We don't have a relationship between mL and kL, but we do know that 1 mL = 0.001 L, while 1 kL = 1,000 L. So we just have to convert from kL to L and then from L to mL:

$$\frac{0.005\ \cancel{\text{kL}}}{1}\times\frac{1{,}000\ \text{L}}{1\ \cancel{\text{kL}}} = 5\ \text{L}$$

$$\frac{5\ \cancel{\text{L}}}{1}\times\frac{1\ \text{mL}}{0.001\ \cancel{\text{L}}} = 5{,}000\ \text{mL}$$

6. The answer is 136 in. We don't have a relationship between inches and meters, but the problem gives us a relationship between inches and cm (2.54 cm = 1 inch). We can therefore convert to cm and then convert cm into inches:

$$\frac{3.45\ \cancel{\text{m}}}{1} \times \frac{1\ \text{cm}}{0.01\ \cancel{\text{m}}} = 345\ \text{cm}$$

$$\frac{345\ \cancel{\text{cm}}}{1} \times \frac{1\ \text{in}}{2.54\ \cancel{\text{cm}}} = 136\ \text{in}$$

7. a. You have to move the decimal to get it to the right of the first significant figure in the number. In this case, you have to move the decimal four places to the left to get it right of the "1." Since the number is large, the exponent on the "10" is positive, so the answer is 1.700×10^4 kg. The two zeroes are there to give the number four significant figures, as the problem requests.

b. To get the decimal right of the "1," you need to move it two spaces to the right. The number is small, so the exponent is negative. To have four significant figures (as the problem asks), you need to keep one of the zeroes: 1.670×10^{-2} m.

c. To get the decimal right of the "8," you need to move it three spaces to the right. The number is small, so the exponent is negative: 8.761×10^{-3} mg.

d. To get the decimal right of the "1," you need to move it two spaces to the left. The number is large, so the exponent is positive: 1.200×10^2 km. The two zeroes are there to give the number four significant figures, as the problem requests.

8. a. The exponent is positive, so the number is large. Therefore, you move the decimal three spaces to the right: 7,210 km.

b. The exponent is negative, so the number is small. Therefore, you move the decimal five spaces to the left: 0.0000117 mL.

c. The exponent is positive, so the number is large. Therefore, you move the decimal eight spaces right: 311,200,000 kg.

d. The exponent is negative, so the number is small. Therefore, you move the decimal seven spaces to the left: 0.000000512 m.

9. The answer is 0.75 liters. We don't have a relationship between liters and cm^3, but we do know that cm^3 and mL are the same, so we know it is also 750 mL. Now all we have to do is convert to liters:

$$\frac{750\ \cancel{\text{mL}}}{1} \times \frac{0.001\ \text{L}}{1\ \cancel{\text{mL}}} = 0.75\ \text{L}$$

10. The answer is 13 liters. We don't have a relationship between liters and cm^3, but we do know that mL and cm^3 are the same. Thus, this question requires us to convert from m^3 to cm^3, which is the same as mL. At that point, we can then convert from mL to liters:

$$\frac{0.013\ \text{m}^3}{1} \times \left(\frac{1\ \text{cm}}{0.01\ \text{m}}\right)^3$$

We cube the conversion relationship because we have to cancel m^3, and the conversion relationship has only m in it. Cubing everything in the fraction gives us:

$$\frac{0.013\ \cancel{\text{m}}^3}{1} \times \frac{1\ \text{cm}^3}{0.000001\ \cancel{\text{m}}^3} = 13{,}000\ \text{cm}^3$$

Since mL and cm^3 are the same, that means we have 13,000 mL

$$\frac{13{,}000\ \cancel{\text{mL}}}{1} \times \frac{0.001\ \text{L}}{1\ \cancel{\text{mL}}} = 13\ \text{L}$$

11. The answer is 750 mL. The density is given in g/mL, but the mass is given in kg. To use Equation (1.1), all the units have to be consistent, so we need to convert kg into g:

$$\frac{1.72\ \cancel{\text{kg}}}{1} \times \frac{1{,}000\ \text{g}}{1\ \cancel{\text{kg}}} = 1{,}720\ \text{g}$$

Now we can use Equation (1.1), because the mass unit is grams, and the density unit also has grams in it.

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

$$\text{volume} \cdot \text{density} = \frac{\text{mass}}{\cancel{\text{volume}}} \cdot \cancel{\text{volume}}$$

$$\text{volume} \cdot \text{density} = \text{mass}$$

$$\text{volume} \cdot \cancel{\text{density}} \cdot \frac{1}{\cancel{\text{density}}} = \text{mass} \cdot \frac{1}{\text{density}}$$

$$\text{volume} = \frac{\text{mass}}{\text{density}}$$

$$\text{volume} = \frac{1{,}720\ \cancel{\text{g}}}{2.3\ \frac{\cancel{\text{g}}}{\text{mL}}} = 750\ \text{mL}$$

The mass has three significant figures, while the density has two significant figures, so the answer must have two significant figures.

12. The answer is 1.0×10^3 g. The density of silicon is given in problem #11. To determine the mass, we can use Equation (1.1), but the volume unit needs to be consistent. I will convert L to mL to make that happen:

$$\frac{0.45\ \cancel{\text{L}}}{1}\times\frac{1\ \text{mL}}{0.001\ \cancel{\text{L}}} = 450\ \text{mL}$$

Now we can use Equation (1.1):

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

$$\text{mass} = \text{density} \times \text{volume} = 2.3\ \frac{\text{g}}{\cancel{\text{mL}}} \times 450\ \cancel{\text{mL}} = 1.0\times10^3\ \text{g}$$

The mass and density both have two significant figures, so the answer can have only two. Since 1,035 turns into "1,000" when we dropped the "3," we must use scientific notation to make the first zero significant.