UNIT CONVERSIONS
FY 75
UNIT IV

MASS AND VOLUME

Learning Objectives

The student should be able to:

1. Use the metric units of mass and volume; and also to convert from the English units of mass and volume.

2. Convert grams to milligrams and vice-versa; and also milliliters to liters and vice-versa.

3. Mass and volume are quantities frequently used in chemistry to measure matter. As is the case for all quantities, they are expressed in 2 parts, a number and a dimensional unit.

4. The various units of mass and volume are subject to the same conversion procedures used in the study of length.

5. The conversion is made by multiplying the given quantity by a fraction which is based on a known relationship.

6. The same unit as in the given quantity is in the denominator and the unit which is desired in the answer is in the numerator.

\[
\text{Conversion Fraction} = \frac{\text{no. units (desired)}}{\text{no. units (given)}}
\]

7. The working unit of mass in the metric system is the gram, g. Several important related units are obtained by using prefixes which stand for fractions or multiples.
8. Thus:

- decigram (dg) = \( \frac{1}{10} \) gram
- centigram (cg) = \( \frac{1}{100} \) gram
- milligram (mg) = \( \frac{1}{1000} \) gram
- kilogram (kg) = 1000 grams

9. From the above, are obtained the following relationships which are useful for making conversions. They should be learned.

- 10 decigrams = 1 g
- 100 centigrams = 1 g
- 1000 milligrams = 1 g
- Also: 1,000,000 micrograms = 1 g

**Problem**
Find the number of mg equal to 1.25 g

**Answer**
The given units are g and unknown units: mg. The relationship which must be used is: 1000 mg = 1 g

The given quantity is multiplied by the fraction \( \frac{1000 \text{ mg}}{1 \text{ g}} \) with the grams in the denominator:

\[
1.25 \text{ g} \times \frac{1000 \text{ mg}}{1 \text{ g}} = 1250 \text{ mg}
\]

10. **Problem**
Find the number of g contained in 378 mg.
Answer
The given units are mg and unknown units: g. The relationship is: 1000 mg = 1 g. However since the unit of the given quantity is mg, this is now in the denominator of the fraction:

\[
\frac{378 \text{ mg}}{1000 \text{ mg}} \times \frac{1 \text{ g}}{1000} = \frac{378 \text{ g}}{1000} = 0.378 \text{ g}
\]

11. **Problem**
Find the number of kg equal to 70 g.

**Answer**
The given units are g and unknown units: kg. The relationship used is: 1 kg = 1000 g. The 70 g are multiplied by a fraction in which 1000 g are in the denominator:

\[
\frac{70 \text{ g}}{1000 \text{ g}} \times \frac{1 \text{ kg}}{1000} = \frac{0.07 \text{ kg}}{1000} = 0.07 \text{ kg}
\]

12. **Problem**
Find the number of g contained in 68 mg.

**Answer**
The given units are mg and unknown units: g. The relationship is: 1000 = 1 g

\[
\frac{68 \text{ mg}}{1000 \text{ mg}} \times \frac{1 \text{ g}}{1000} = \frac{68 \text{ g}}{1000} = 0.068 \text{ g}
\]

13. **Conversion may be made from the metric to the English system or vice-versa by the use of a known conversion relationship:**

\[
454 \text{ g} = 1 \text{ lb}
\]

**Problem**
How many lbs are contained in 113.5 g?

**Answer**
The given quantity 113.5 g is multiplied by a fraction in which 454 g is in the denominator:

\[
\frac{113.5 \text{ g}}{454 \text{ g}} \times \frac{1 \text{ lb}}{454} = 0.25 \text{ lb}
\]
14. **Problem**  
Find the number of grams equal to 175 micrograms.

**Answer**  
The given units are \( M \) g and unknown units: g. The relationship is: 1 million \( M \) g = 1 g with the \( M \)g in the denominator.

\[
\frac{175 \, Mg}{1,000,000 \, M} \times \frac{1 \, g}{1 \, M} = \frac{175}{1,000,000} = 0.000175 \, g
\]

15. **Problem**  
Find the number of mg equal to 0.024 kg.

**Answer**  
The given units are kg and unknown units: mg. Two fractions are necessary. The first fraction converts kg to g by the relationship: 1000 g = 1 kg. The second fraction converts g into mg by the relationship: 1000 mg = 1 g.

\[
0.024 \, kg \times \frac{1000 \, g}{1 \, kg} \times \frac{1000 \, mg}{1 \, g} = 0.024 \times 1,000,000 = 24,000 \, mg
\]

**Review Questions**

1. Give the relationships:
   \[1 \, g = ? \, mg\]
   \[1 \, g = ? \, og\]
   \[1 \, kg = ? \, g\]

2. Given that 100 cg = 1 g and 10 dg = 1 g, find the number of cg equal to 1 dg.

3. Given that 1 million \( M \) g = 1 g and 1000 mg = 1 g, find the number of \( M \) g equal to 1 mg.

4. The unit of volume used in chemistry is the liter, L. An important unit derived from the liter is the milliliter, mL.
   \[1 \, mL = \frac{1}{1000} \, L \text{ and } 1000 \, mL = 1 \, L\]
5. **Problem**
Find the number of mL contained in 0.24 L.

**Answer**
The given quantity 0.24 L is multiplied by the fraction based on the relationship: 1 L = 1000 mL with the unit L in the denominator:

\[
\frac{0.24 \text{ L}}{1} \times \frac{1000 \text{ mL}}{1 \text{ L}} = 240 \text{ mL}
\]

6. **Problem**
Find the number of L contained in 25 mL

**Answer**
The given quantity 25 mL is multiplied by a fraction based on the relationship: 1 L = 1000 mL:

\[
\frac{25 \text{ mL}}{1000 \text{ mL}} \times \frac{1 \text{ L}}{1000 \text{ mL}} = \frac{25}{1000} \text{ L} = 0.025 \text{ L}
\]

7. **Problem**
Find the number of mL equal to 50 M L.

**Answer**
The given units are M L and unknown units: mL. Two fractions are necessary. The first converts M L to L by the relationship: 1,000,000 M L = 1 L. The second fraction converts L into mL by the relationship: 1 L = 1000 ml:

\[
\frac{50 \text{ M L}}{1,000,000 \text{ M L}} \times \frac{1 \text{ L}}{1 \text{ L}} \times \frac{1000 \text{ mL}}{1 \text{ L}} = \frac{50 \text{ mL}}{1000} = 0.050 \text{ mL}
\]

8. **Problem**
There is a relationship used for conversion from the metric to the English system: 946 mL = 1 qt or vice versa.

**Problem**
Find the number of mL in 2.5 qts.
Answer
The given units are qts. and unknown units: mL. The relationship 946 mL = 1 qt is used in the fraction:

\[
\frac{2.5 \text{ qt}}{1 \text{ qt}} \times \frac{946 \text{ mL}}{1 \text{ qt}} = 2365 \text{ mL}
\]

9. Problem
Find the number of liters contained in 2 gallons (gal.).

Answer
The given units are gal and unknown units are L. Two fractions are needed. The first fraction converts gal into qt by the relationship: 1 gal = 4 qt. The second fraction converts qts to L by the relationship: 1 qt = 0.946 L

\[
\frac{2 \text{ gal}}{1 \text{ gal}} \times \frac{4 \text{ qt}}{1 \text{ qt}} \times \frac{0.946 \text{ L}}{1 \text{ qt}} = 7.57 \text{ L}
\]

**Review Questions**

1. Give the relationships: 1 L = ? mL; 1 qt = ? mL

2. Given that 1000 mL = 1 L and that 10 deciliters, dL = 1 L, find the number of mL = 1 dL.

3. Test your understanding of the principles involved in making mass and volume conversions by working out the Practice Exercises at the back of the Study Guide.