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# Units of Weights and Measures

## Final Assessment (Post-Quiz)

### Instructor Guide

#### Note to Instructor

The objective of the final assessment on the Units of Weights and Measures is to evaluate the participant's knowledge and understanding of the information covered in the related primary knowledge unit and activities. The results of this assessment can be compared with the results of the KP to determine the level of learning as a result of completing the supporting PK and activities.

The *Weights & Measures Learning Module* includes the following units:

- Knowledge Probe (KP)
- Units of Weights and Measures Primary Knowledge (PK)
- Research Activity
- Conversion Activity
- **Final Assessment**

This companion Instructor Guide (IG) contains both the questions and answers for the assessment questions. The answers to each problem are in **red**.

There are 15 assessment questions and a Bonus Problem.

#### Introduction

The purpose of this assessment is to determine your knowledge of weights and measures history, the International Standards of Units, and your ability to convert from one unit of measurement to another.

Answer the following questions to the best of your knowledge and ability.

1. In what country is it believed that the first units of weights and measures were standardized?
  - a. **Egypt**
  - b. England
  - c. France
  - d. Italy
  - e. United States
2. Which of the following measurement systems is the International Standard of Units?
  - a. British system
  - b. English system
  - c. **Metric system**
  - d. Roman system
3. How many base units are in the International Standard of Units (SI)?
  - a. 14
  - b. 12
  - c. 9
  - d. **7**
4. The Egyptian measurement that was the length of an average person's arm from elbow to the outstretched fingertips was called a \_\_\_\_\_.
  - a. Arm's length
  - b. Crown
  - c. **Cubit**
  - d. Throw
5. What was one of the main factors that influenced the standardization of units?
  - a. **Increase in commerce and trade**
  - b. Population growth
  - c. The fall of the Roman empire
  - d. World War I
6. When was the original metric system developed?
  - a. **1790's**
  - b. 1840's
  - c. 1890's
  - d. 1920's
7. Which of the following industrial countries has NOT adopted the metric system as its standard measurement system?
  - a. Brazil
  - b. England
  - c. Russia
  - d. **United States**

8. Which of the following is NOT one of the seven fundamental units of the SI?
- Ampere
  - Fahrenheit**
  - Meter
  - Candela
9. The metric system is the standard unit of measure for science and technology. Which of the following micro-sized devices would use the metric unit  $\mu\text{liters/sec}$ ?
- Output of an insulin micropump**
  - Resonance of an oscillating microcantilever
  - Tensile strength of a micro-spring
  - Thickness of gold thin film on a micro-sensor
10. Micro is \_\_\_\_\_ and nano is \_\_\_\_\_.
- $10^3, 10^{-6}$
  - $10^{-3}, 10^{-6}$
  - $10^{-6}, 10^{-9}$**
  - $10^{-6}, 10^{-12}$
11. How many feet are 688 cm? (Hint: 1 in = 2.54 cm)
- 0.044 feet
  - 22.6 feet**
  - 146 feet
  - 3250 feet
12. How many picoliters in 2.04 ounces? (Hint: 1 liter = 1.057 fluid quarts U.S.)
- $60.3 \times 10^6$  picoliters
  - $60.3 \times 10^9$  picoliters**
  - $60.3 \times 10^{12}$  picoliters
  - $67.5 \times 10^9$  picoliters
13. How many grams in 1.3 kg?
- 13 grams
  - 130 grams
  - 1300 grams**
  - 13,000 grams
14. How many nanometers (nm) in  $0.5 \mu\text{m}$ ?
- 0.0005 nm
  - 500 nm**
  - 5,000 nm
  - 500,000 nm

15. How many kiloliters (kl) in 12,500  $\mu\text{m}$ ?

- a. 12,500,000 kl
- b. 12.5 kl
- c. 0.0125 kl
- d. 0.0000125 kl

### BONUS QUESTION

A brick of gold weighs 30.9lbs. For certain applications, a microcantilever may require as little as 6 attograms ( $10^{-18}$ ) of gold on its tip. Microsystems fabrication uses an evaporation process to deposit gold on the wafers' surfaces. Later in the fabrication process, those wafers are patterned and etched to remove the gold, leaving only the 6 attograms of gold/cantilever (*this is called "functionalizing the surface"*). During the evaporation process, the gold coats the entire chamber, wafer surfaces, and any internal chamber components.

Assuming that only 0.02% of the gold deposited during the evaporation process actually remains on the cantilevers, how many cantilevers can one bar of gold functionalize?

**Answer:**

**Approximately  $467 \times 10^{15}$  cantilever surfaces**

*Calculate percentage of "gold used" for cantilever coating.*

$$0.02\% \text{ of } 30.9 \text{ pounds} = 0.00618 \text{ pounds}$$

Convert to attograms.

$$0.00618 \text{ lb} * \frac{453 \text{ grams}}{1 \text{ lb}} * \frac{1 \times 10^{18} \text{ agrams}}{1 \text{ gram}} = 2.80 \times 10^{18} \text{ agrams}$$

Calculate number of cantilever surfaces in  $2.80 \times 10^{18}$  agrams

$$\frac{2.80 \times 10^{18} \text{ agrams}}{6 \text{ agrams per cantilever}} = 467 \times 10^{15} \text{ cantilevers}$$

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