

Chem. 145, Problem Set, Chapter 1.

Marathon Problem:

Adapted from Zumdahl Chemistry, 1993. Page 39

A cylindrical bar of gold that is 1.5 in high and 0.25 in in diameter has a mass of 23.1964 g, as determined on an analytical balance. An empty graduated cylinder is weighed on a triple beam balance and has a mass of 73.47 g. After pouring a small amount of liquid into the graduated cylinder, the mass is 79.16 g. When the gold cylinder is placed in the graduated cylinder (the liquid covers the top of the gold cylinder), the volume indicated on the graduated cylinder is 8.5 mL. Assume that the temperatures of the gold bar and the liquid are 86°F.

What is the density of the gold at 30°C?

What is the density of the liquid at 86°F?

What is the density of the liquid at 300 K?

The first part of answering this question is to determine what information is required, and decide how you want to solve the question. Start with finding the density of the gold at 30 °C. What information do you need?

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

Since you are looking for the density, you need the mass and the volume to solve the problem.

The mass is easy, that is given in the problem:

$$\text{mass}_{\text{gold}} = 23.1964 \text{ gm} \quad (\text{NOTE: gm stands for gram in Mathematica.})$$

So next we need the volume. But, first what is the point of the temperature? Is mass constant with temperature? Is volume constant with temperature? Think about some examples in everyday life. Why does a Hot Air Balloon work? Why do they place expansion joints in the highway?

Yes, volume changes with temperature. So, first what temperature is the gold bar in the problem?

A cylindrical bar of gold that is 1.5 in high and 0.25 in in diameter.... Assume that the temperatures of the gold bar and the liquid are 86°F.

So, is 86 °F the same as 30 °C?

$$T_{\text{temp}_F} = 86$$

$$T_{\text{temp}_C} = (T_{\text{temp}_F} - 32) \cdot \frac{5}{9}$$

$$T_{\text{temp}_C} = 30$$

Zumdahl Marathon Problems Answers

Steven S. Zumdahl, Susan A. Zumdahl



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