

# Chem 103, Section F0F

## Example Problem Exercise

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**PROBLEM** Copper can be drawn into thin wires. How many meters of 34-gauge wire (diameter =  $6.304 \times 10^{-3}$  in) can be produced from the copper in 5.01 lb of covellite, an ore of copper that is 66% copper by mass? (*Hint:* Treat the wire as a cylinder:  $V$  of cylinder =  $\pi r^2 h$ ;  $d$  of copper =  $8.95 \text{ g/cm}^3$ .)

### PLAN

- First list what is known and unknown in this problem:

#### Knowns

diameter of 34-gauge wire =  $6.304 \times 10^{-3}$  in

5.01 lb of covellite

covellite = 66% Cu

$V = \pi r^2 h$  ( $V$ =volume,  $r$ =radius,  $h$ =length)

$$r = \frac{\text{diameter}}{2}$$

$$d_{\text{Cu}} = 8.95 \frac{\text{g}}{\text{cm}^3}$$

#### Unknowns

$h$  = the length of the 34-gauge wire in meters

- Convert the knowns to metric units:

$$\text{diameter} = 6.304 \times 10^{-3} \text{ in} \left( \frac{2.54 \text{ cm}}{1 \text{ in}} \right) = 1.601 \times 10^{-2} \text{ cm}$$

$$m_{\text{covellite}} = 5.01 \text{ lb} \left( \frac{2.205 \text{ kg}}{1 \text{ lb}} \right) \left( \frac{1000 \text{ g}}{1 \text{ kg}} \right) = 1.105 \times 10^4 \text{ g}$$

Work backwards through the problems by deriving equations that can be used to solve the unknowns from the knowns.

- Derive an equation for determining the length of the wire ( $h$ ) [unknown] from the volume ( $V$ ) [unknown] of copper available:

$$V = \pi r^2 h$$

$$= \pi \left( \frac{\text{diameter}}{2} \right)^2 h$$

$$h = \frac{V}{\pi \left( \frac{\text{diameter}}{2} \right)^2}$$

- Derive an equation for determining the volume ( $V$ ) [unknown] of copper available from its mass ( $m_{Cu}$ ) [unknown] and density ( $d_{Cu}$ ) [known]:

$$V = \frac{m_{Cu}}{d_{Cu}}$$

- Derive an equation for determining the mass of the copper available ( $m_{Cu}$ ) [unknown] from the mass of the covellite ore ( $m_{covellite}$ ) [known] and the percent by mass of copper (%Cu) [known] in covellite:

$$m_{Cu} = m_{covellite} \left( \frac{66 \text{ g Cu}}{100 \text{ g covellite}} \right)$$

### SOLUTION

- By combining the equations derived above, derive an equation for determining the length of 34-gauge wire ( $h$ ) that can be drawn from the copper that is contained in 5.01 lb of covellite ore:

$$\begin{aligned} h &= m_{covellite} \left( \frac{66 \text{ g Cu}}{100 \text{ g covellite}} \right) \left( \frac{1}{d_{Cu}} \right) \left( \frac{1}{\pi (\text{diameter}/2)^2} \right) \\ &= 2.272 \times 10^3 \text{ g covellite} \left( \frac{66 \text{ g Cu}}{100 \text{ g covellite}} \right) \left( \frac{1 \text{ cm}^3 \text{ Cu}}{8.95 \text{ g Cu}} \right) \left( \frac{1}{\pi ((1.601 \times 10^{-2} \text{ cm Cu})/2)^2} \right) \left( \frac{1 \text{ m Cu}}{100 \text{ cm Cu}} \right) \\ &= 8.3225 \times 10^3 \text{ m} \\ h &= 8.3 \times 10^3 \text{ m (Limited to 2 significant figures by the 66\% copper in covellite)} \end{aligned}$$

(Be sure to round your answer to the correct number of significant figures.)

**FOLLOW UP QUESTION** The statement “Copper can be drawn into thin wires.” is a statement of what physical property that is exhibited by copper?

Copper is *ductile*.