

### Task

Determine how many grams of resin are needed to remove the calcium ions from 200 mL of water that has 15.4 grains/gallon of hardness, if the resin exchange capacity is 2.78 millimoles of divalent cation per gram of resin.

### Given

Water volume:  $V = 200 \text{ mL} = 0.2 \text{ L}$

Water hardness:  $H = 15.4 \text{ grains/gallon}$

Cation exchange capacity of resin:  $\text{CEC} = 2.78 \text{ mmol (Ca}^{2+}\text{)}/\text{g}$

Mass of resin:  $m = ?$

### Solution

1. Conversion of hardness from grains/gallon to mg/L (1 grains/gallon = 17.118061 mg/L):

$$H = 15.4 \cdot 17.118061 = 263.6181 \text{ mg/L}$$

2. Calculation of mass of calcium carbonate in given volume of water:

$$m(\text{CaCO}_3) = H \cdot V = 263.6181 \cdot 0.2 = 52.7236 \text{ mg} = 0.052736 \text{ g}$$

3. Calculation of number of moles of  $\text{Ca}^{2+}$  in given volume of water (molar weight of calcium carbonate  $M(\text{CaCO}_3) = 100.0869 \text{ g/mol}$ ):

$$n(\text{Ca}^{2+}) = n(\text{CaCO}_3) = m(\text{CaCO}_3)/M(\text{CaCO}_3) = 0.052736 / 100.0869 = 0.0005268 \text{ mol} = 0.5269 \text{ mmol}$$

4. Calculation of needed mass of the resin:

$$m = n(\text{Ca}^{2+})/\text{CEC} = 0.5269 / 2.78 = 0.1895 \text{ g}$$

**Answer:** 0.1895 g