An experiment to determine the molecular weight of an unknown solid was done by first measuring the freezing temperature of 20.0 mL of pure cyclohexane. This freezing temperature was measured as 6.5 C. Then, an 0.250 gram sample of the unknown solid was dissolved into the cyclohexane and the freezing temperature remeasured. The freezing temperature of the solution was 4.9 C. What is the molecular weight of the unknown solid?

* Kf for cyclohexane is 20.5 C/m, and the density of cyclohexane when the volume was measured is 0.779 g/mL

$\Delta T_f = K_f \times C_m$

K_f: 20.5 °C/m

ΔT_f: 6.5 °C − 4.9 °C = 1.6 °C

Since we can easily find the freezing point depression by subtraction and we could look the Kf up in the lab manual, it looks like we should start by finding Cm ...

$1.6\,°C = (20.5\,°C/m)\,C_m$

$C_m = \dfrac{\text{moles unknown}}{\text{kg cyclohexane}}$

$C_m = 0.0780487805\ m$

We want to use the value of Cm to find out how many moles of unknown we have. Before we can use the definition above, we need to find out how many kilograms of cyclohexane were used. Start with the volume and density ...

$20.0\ \text{mL cyclohexane} \times \dfrac{0.779\ \text{g}}{\text{mL}} = 15.58\ \text{g} = 0.01558\ \text{kg cyclohexane}$

$$C_m = \frac{\text{moles unknown}}{\text{kg cyclohexane}}$$

Now let's plug the value of Cm we calculated and the mass of cyclohexane into this definition.

$$0.07804878805 = \frac{\text{mol unknown}}{0.01558}, \quad \text{mol unknown} = 0.001216 \text{ mol}$$

Now, find the molecular weight by dividing ...

$$MW = \frac{\text{g unknown}}{\text{mol unknown}} = \frac{0.250\text{g unknown}}{0.001216 \text{ mol unknown}} = 205.5921052 \text{ g/mol}$$

Since the temperature difference is known to only two significant figures, we will round the final molecular weight to two significant figures.

$$\boxed{210 \text{ g/mol}}$$