

Iced-Tea Problem

It's hot and I want a glass of iced tea as soon as possible. The directions for my tea say to boil some water, add 2 tea bags (these are the big bags), steep for 4-5 minutes, then add enough water to make 2 quarts which turns out to be a pitcher of tea. However, if I make this tea the exact concentration I want now, when I pour it over ice the ice will melt (because the tea will still be quite warm) and my tea will be too dilute. So I calculate how much stronger I should make the tea KNOWING I will pour the warm tea over ice to make my glass of iced tea.

220 g of 35°C tea (water) is poured over 250 g of -10°C ice.

- What is the final temperature and composition of the glass of iced-tea?
- What will be the concentration of the tea relative to the original concentration?
- How concentrated should I mix the tea knowing that it will be diluted when poured over the ice?

What happens...

The warm water (tea) will cool down to 0°C. As it cools the ice will heat up to 0°C and then start to melt. There is plenty of ice however and only a portion of it will melt. Find the amount of ice that melts into water and you'll know the final composition and even the dilution factor on the tea.

- (a)** Cool tea water down to 0°C

$$4.184 \text{ J/g}^\circ\text{C} \cdot 220 \text{ g} \cdot 35^\circ\text{C} = \mathbf{32216.8 \text{ J}}$$
 removed to cool tea to 0°C

Warm ice up to 0°C

$$2.09 \text{ J/g}^\circ\text{C} \cdot 250 \text{ g} \cdot 10^\circ\text{C} = \mathbf{5225 \text{ J}}$$
 to heat ice up to 0°C

This heat comes from the cooling water, so subtract this amount off the total above

$$32216.8 - 5225 = 26991.8 \text{ J of heat that will MELT the ice}$$

$$\text{mass of ice melted} = 26991.8 / 334 = 80.8 \text{ g of ice melted}$$

$$220 \text{ g} + 80.8 =$$

$$250 \text{ g} - 80.8 =$$

300.8 g of water final mixture for my glass of iced tea all at 0°C
169.2 g of ice



- (b)** The dilution factor is simply the original volume over the final volume (or masses here).
- $$\frac{220.0 \text{ g original tea}}{300.8 \text{ g final tea}} = .731 \text{ or } \mathbf{73.1\%}$$
- of the original concentration

- (c)** If I'm going to get a dilution of 73.1%, I should compensate by mixing my tea in 73.1% LESS volume than the directions state. So I will not dilute the tea to 2 quarts (64 oz), but rather to 1.462 quarts (46.8 oz).

