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.

(a). What is the final temperature and composition of the glass of iced-tea?

(b). What will be the concentration of the tea relative to the original concentration?

(c). 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 J/g˚C · 220 g · 35˚C = **32216.8** J removed to cool tea to 0˚C

Warm ice up to 0˚C

2.09 J/g˚C · 250 g · 10˚C = **5225** J to heat ice up to 0˚C

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

32216.8 - 5225 = 26991.8 J of heat that will MELT the ice

mass of ice melted = 26991.8 / 334 = 80.8 g of ice melted

220 g	+	80.8	=	**300.8 g of water**	final mixture for my glass of iced tea all at 0˚C
250 g	-	80.8	=	**169.2 g of ice**	

(b) The dilution factor is simply the original volume over the final volume (or masses here).

$$\frac{220.0 \text{ g original tea}}{300.8 \text{ g final tea}} = .731$$ or **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 26.9% 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).