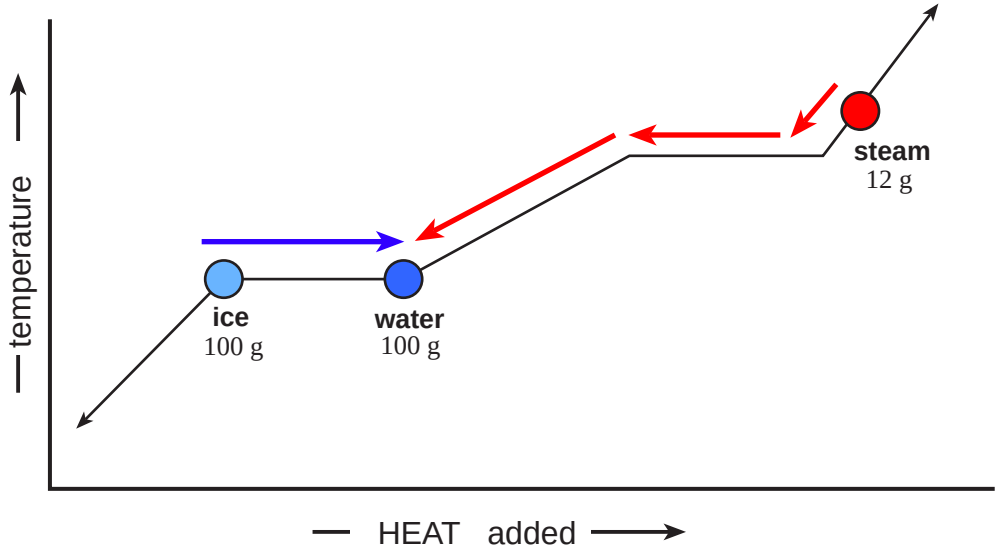
The Ice, Water, and Steam Problem

100 g of ice and 100 g of water are at equilibrium. 12 g of steam at 110˚C is added to the mixture. What is the final composition and temperature of this system?

Pull all components to 0˚C. The water is already at 0˚C. The ice just needs to be melted. The steam must be cooled, condensed, and then cooled again.



HOT SIDE

2.03 J/g˚C · 12 g · 10˚C = 243.6 J
2260 J/g · 12 g = 27120.0 J
4.184 J/g˚C · 12 g · 100˚C = 5020.8 J

32384.4 J

COLD SIDE

334 J/g · 100 g = 33400.0 J

33400.0 J

difference = 1015.6 J

cold side wins! This heat is equivalent to the mass of ice that did NOT get melted by the hot side.

solve for m

$q = \Delta H \cdot m$

$m = q/\Delta H$

$m = 1015.6 / 334$

m = 3.0 grams of ice

Final composition is 3 grams of ice and 209 grams of water all at 0˚C

Follow-up Questions

(b) How much steam should be used so that you DO end up with ALL water at 0˚C ?

(c) Now work this same problem using 25 g of steam. What is the final composition and temperature?