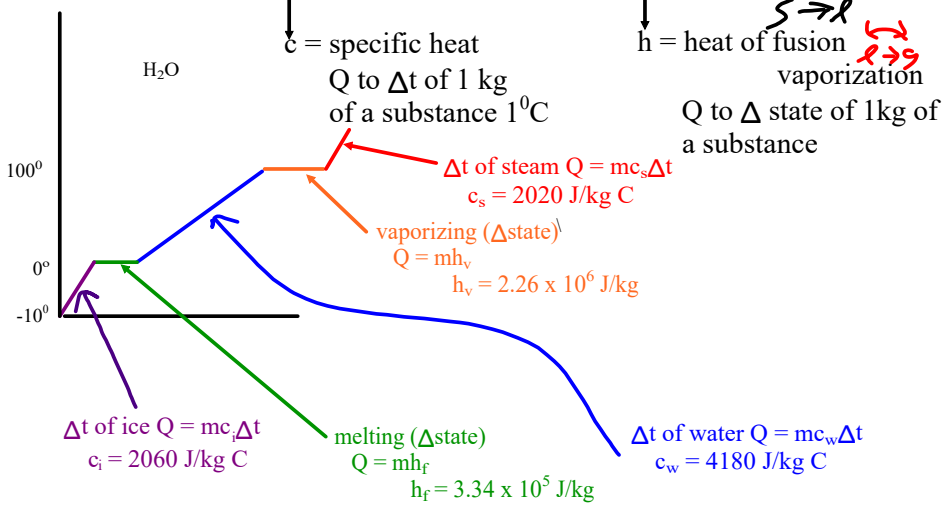
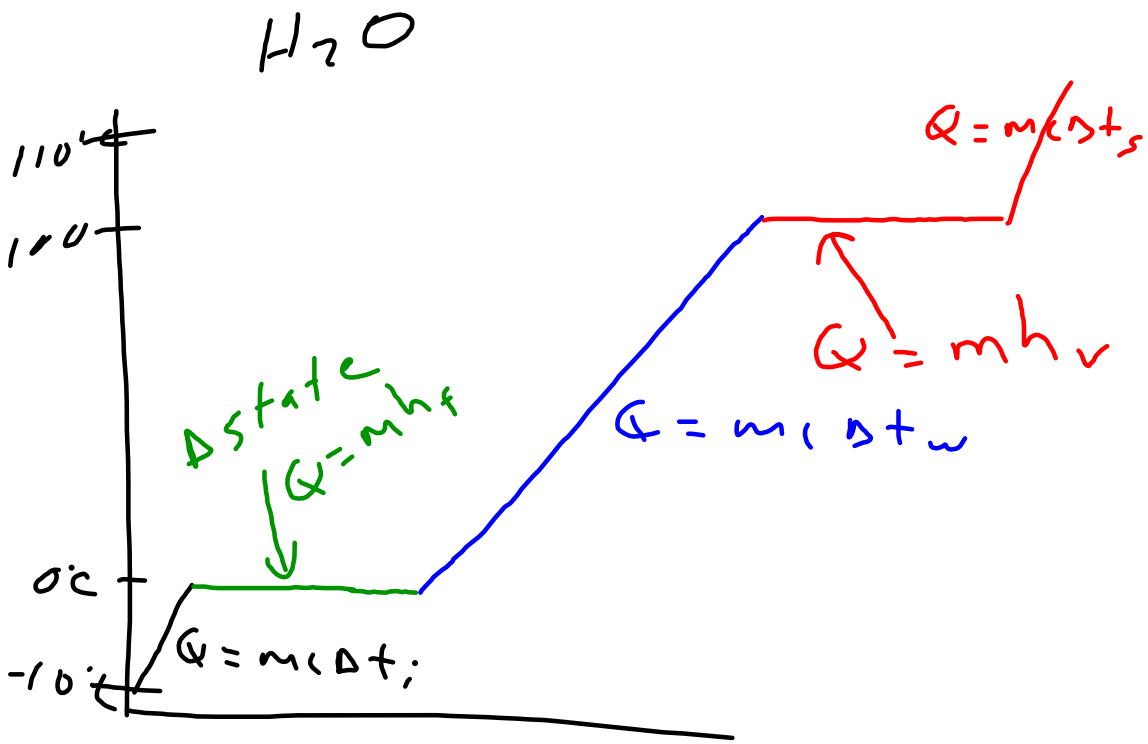
Q will either:

Δt or Δstate (phase)

Δ KE of particles → Q = mcΔt → c = specific heat Q to Δt of 1 kg of a substance 1^0C

Break bonds ΔPE → Q = mh → h = heat of fusion (s→l), vaporization (l→g) Q to Δ state of 1kg of a substance





100.0 g of ice at -10.0° C is placed in 1.00 kg of water at 90.0° C. What is the final temperature of the mixture?

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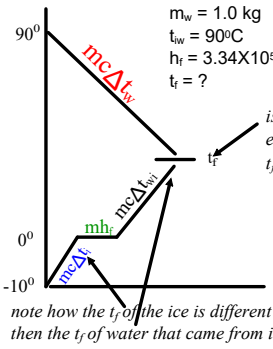
m_i = .10 kg
t_{ii} = -10°C
m_w = 1.0 kg
t_{iw} = 90°C
$h_f = 3.34X10^5$ J/kg
t_f = ?



note how the t_f of the ice is different then the t_f of water that came from ice

isolate for equilibriium t_f

expand Δt

$$Q_L + Q_g = 0$$

$$mc\Delta t_w + mc\Delta t_i + mh_f + mc\Delta t_{wi} = 0$$

$$mc\Delta t_w + mc\Delta t_{wi} = -mc\Delta t_i - mh_f$$

$$mct_{fw} - mct_{iw} + mct_{fwi} - mct_{iwi} = -mc\Delta t_i - mh_f$$

$$mct_{fw} + mct_{fwi} = -mc\Delta t_i - mh_f + mct_{iw} + mct_{iwi}$$

$$t_f(mc_w + mc_{wi}) = -mc\Delta t_i - mh_f + mct_{iw} + mct_{iwi}$$

$$t_f = \frac{-mc\Delta t_i - mh_f + mct_{iw} + mct_{iwi}}{(mc_w + mc_{wi})}$$

$$t_f = \frac{-.10\ kg(2060\ J/kgC)10°C - .10\ kg\ (3.34X10^5\ J/kg) + 1\ kg(4180\ J/kgC)90.0°C) + .10\ kg(4180\ J/kgC)0°C}{((\ 1\ kg(4180\ J/kgC) + .10\ kg(4180\ J/kgC))}$$

[0° - (-10°C)]

$$t_f = 74.1° C$$

$$Q_L = mc\Delta t_w = 1kg(4180J/kgC)(74.1° - 90°C) = -66,500J$$

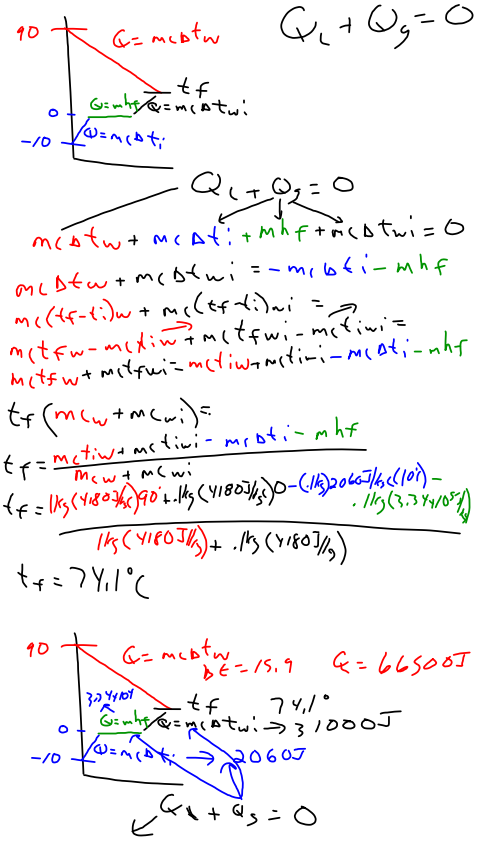
$$Q_g = mc\Delta t_i = .1kg(2060J/kgC)[0 - (-10°C)] = +2060J$$

$$Q_g = mh_f = .10\ kg\ (3.34X10^5\ J/kg) = 33,400$$

$$Q_g = mc\Delta t_{wi} = .1kg(4180J/kgC)(74.1 - 0°C) = +31000J$$

$$Q_g = +66,500$$

100.0 g of ice at -10.0° C is placed in 1.00 kg of water at 90.0° C. What is the final temperature of the mixture?



A 150.0 g block of ice at -20.0°C is placed in 880.0 g of water at 95.0°C.
What is the final temperature of the mixture.

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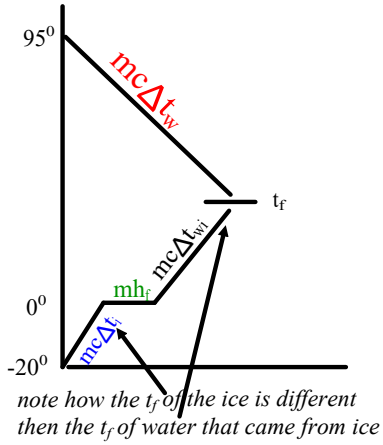
What is the final temperature of the mixture.

$$Q_L + Q_g = 0$$



note how the t_f of the ice is different then the t_f of water that came from ice

$$mc\Delta t_w + mc\Delta t_i + mh_f + mc\Delta t_{wi} = 0$$

$$mc\Delta t_w + mc\Delta t_{wi} = -mc\Delta t_i - mh_f$$

$$mct_{fw} - mct_{iw} + mct_{fwi} - mct_{iwi} = -mc\Delta t_i - mh_f$$

$$mct_{fw} + mct_{fwi} = -mc\Delta t_i - mh_f + mct_{iw} + mct_{iwi}$$

$$t_f(mc_w + mc_{wi}) = -mc\Delta t_i - mh_f + mct_{iw} + mct_{iwi}$$

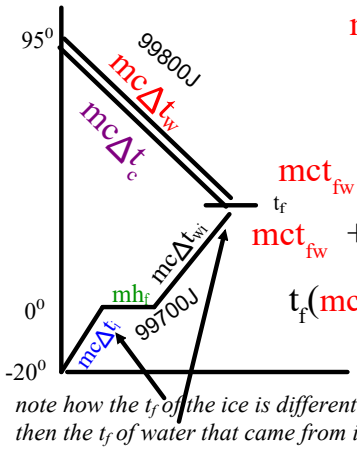
$$t_f = \frac{-mc\Delta t_i - mh_f + mct_{iw} + mct_{iwi}}{(mc_w + mc_{wi})}$$

$$t_f = \frac{-.15\ kg(2060\ J/kgC)20°C - .15\ kg\ (3.34X10^5\ J/kg) + .88\ kg(4180\ J/kgC)95°C) + .15\ kg(4180\ J/kgC)0°C}{((.88\ kg(4180\ J/kgC) + .15\ kg(4180\ J/kgC))}$$

$$t_f = 68.1°\ C$$

A 150.0 g block of ice at -20.0°C is placed in 880.0 g of water at 95.0°C. What is the final temperature of the mixture. Oh no, the water is in a 225 g aluminum cup!

$$Q_L + Q_g = 0$$



note how the t_f of the ice is different then the t_f of water that came from ice

$$mc\Delta t_w + mc\Delta t_c + mc\Delta t_i + mh_f + mc\Delta t_{wi} = 0$$

$$mc\Delta t_w + mc\Delta t_c + mc\Delta t_{wi} = -mc\Delta t_i - mh_f$$

$$mct_{fw} - mct_{iw} + mct_{fc} - mct_{ic} + mct_{fwi} - mct_{iwi} = -mc\Delta t_i - mh_f$$

$$mct_{fw} + mct_{fc} + mct_{fwi} = -mc\Delta t_i - mh_f + mct_{iw} + mct_{ic}\ mct_{iwi}$$

$$t_f(mc_w + mc_c + mc_{wi}) = -mc\Delta t_i - mh_f + mct_{iw} + mct_{ic} + mct_{iwi}$$

$$t_f = \frac{-mc\Delta t_i - mh_f + mct_{iw} + mct_{ic} + mct_{iwi}}{(mc_w + mc_c + mc_{wi})}$$

$$t_f = \frac{-.15\ kg(2060\ J/kgC)20°C - .15\ kg\ (3.34X10^5\ J/kg) + .88\ kg(4180\ J/kgC)95°C) + .225kg(903\ J/kgC)95C\ .15\ kg(4180\ J/kgC)0°C}{((.88\ kg(4180\ J/kgC) + .225\ kg(903\ J/kgC) + .15\ kg(4180\ J/kgC))}$$

$$t_f = 69.3°\ C$$

TE needed to change 1 kg water from 0°C → 100°C

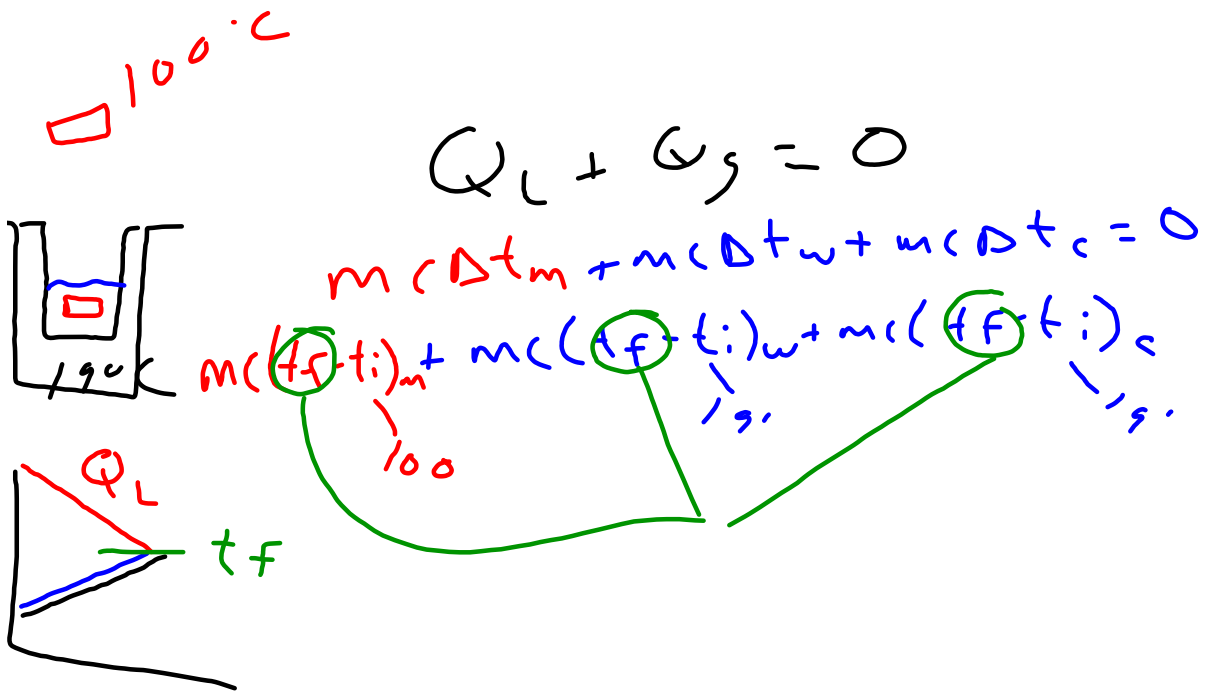
$$Q = mc\Delta t$$
$$Q = mc(t_f - t_i)$$
$$Q = 1\,kg\,(4180\,J/kg\,C)(100C - 0C)$$
$$Q = 1\,kg\,(4180\,J/kg\,C)\,100C$$
$$Q = 418{,}000\,J$$

$$P = \frac{Q}{t} \qquad t = \frac{Q}{P} = \frac{mc\Delta t}{P}$$

$t_i = 19°C$

$t_f = 40°C$
$P = 25\,W$
$t = ?$
$c_c = 3870\,J/kg\,C$
$m = 175\,ml$
$\hookrightarrow 175\,g$
$1g = 1\,cm^3 = 1\,ml$

$$t = \frac{.175\,kg\,(3870\,J/kg\,C)\,21}{25\,W}$$
$$t = 569\,s$$
$\hookrightarrow 9.48\,min$


100°C
$Q_L + Q_S = 0$
$mc\Delta t_m + mc\Delta t_w + mc\Delta t_c = 0$
$m(t_f - t_i)_m + mc(t_f - t_i)_w + mc(t_f - t_i)_c$
100
19°C
Q_L
t_f