36.41 **A $7lb_m$ cast iron pan ($c_p = 0.1\frac{Btu}{lb_m{}^\circ F}$) is heated uniformly to $500^\circ F$ during cooking, then placed in a sink filled with $4\ gallons$ of $60^\circ F$ water. Neglecting losses, what is the final equilibrium temperature?**

A. $69^\circ F$

B. $79^\circ F$

C. $89^\circ F$

D. $99^\circ F$

All of the heat released from the pan is added to the water. Express both quantities of heat as the product of mass, specific heat capacity, and ΔT. Set them equal.

$$(mc_p\Delta T)_{iron} = (mc_p\Delta T)_{water}$$

In the case of water, the volume was given instead of the mass. Use the density of water to calculate the mass.

$$m_{water} = \rho V = \left(62.4\frac{lb_m}{ft^3}\right)\left(\frac{1ft^3}{7.48gal}\right)(4gal) = 33.4lb_m$$

Substitute into the first equation and solve for the final equilibrium temperature, T_f, which is the same for the pan and the water.

$$(7lb_m)\left(0.1\frac{Btu}{lb_m{}^\circ F}\right)(500^\circ F - T_f) = (33.4lb_m)\left(1\frac{Btu}{lb_m{}^\circ F}\right)(T_f - 60^\circ F)$$

Since the units are all consistent, it is fine to ignore the units while solving for the unknown temperature.

$$(0.7)(500 - T_f) = (33.4)(T_f - 60)$$

$$350 - 0.7T_f = 33.4T_f - 2002$$

$$2352 = 34.1T_f$$

$$T_f = 69^\circ F$$

Answer A