60 g of gold pellets are removed from a 350°C oven and immediately dropped into 200 mL of water at 25°C in an insulated cup. What is the final temperature of the water?

Given:

Mass of Gold: $m_g = 60\ g = 0.06\ kg$

Initial temperature of gold: $T_{ig} = 350^{\circ}\ C$

Volume of water: $V_w = 200\ ml = 2 \times 10^{-4}\ m^3$

Initial temperature of water: $T_{iw} = 25^{\circ}\ C$

Determine: final temperature of water: $T_f$

Assuming there is no exchange of energy with the environment, (according to the law of conservation of energy), all the heat energy leaving the gold pellets is transferred to the water. So the sum of the energies leaving the pellets ($Q_1$) and entering the water ($Q_2$) is zero.

$$Q_1 + Q_2 = 0 \quad \text{----------(1)}$$

Also, the heat transfer happens until the final temperature of the gold pellets and the water is the same.

Use formula:

$$Q_1 = m_g c_g (\Delta T_g) \quad \text{----------(2)}$$

**$c_g$ is the specific heat of gold and has the value 129 J/ kg.$^{\circ}$C.**

$\Delta T_g$ is the difference in final & initial temperatures of gold: $(T_f - T_{ig})$

Substituting for $m_g$ , $c_g$ , & $\Delta T_g$ in (2):

$$Q_1 = 0.06 \times 129 \times ( T_f - 350 ) = 7.74T_f - 2709$$

Also

$$Q_2 = m_w c_w (\Delta T_w) \text{ ----------(3)}$$

**$c_w$ is the specific heat of water and has the value 4190 J/ kg.$^0$C.**

$\Delta T_w$ is the difference in final & initial temperatures of water: $(T_f - T_{iw})$

Mass of water:

$$m_w = V_w \rho \text{ ----------(4)}$$

$\rho$ is the density of water and has the value 1000 kg / $m^3$.

Then:

$$m_w = 2 \times 10^{-4} \times 1000 = 0.2 \text{ kg}$$

Substituting for $m_w$ , $c_w$ , & $\Delta T_w$ in (3):

$$Q_2 = 0.2 \times 4190 \times ( T_f - 25 ) = 838T_f - 20950$$

Rearranging (1) & substituting for $Q_1$ & $Q_2$ in (1):

$$7.74T_f - 2709 = 20950 - 838T_f \text{ ----------(5)}$$

Rearranging (5):

$$\mathbf{T_f = 23659 / 845.74 = 28^0\ C}$$