$$Q = mC(T_f - T_i)$$

Symbol	Quantity	SI Unit
Q	Heat energy transferred	Joules (J)
m	mass	kilograms (kg)
C	Specific Heat of substance	$\frac{J}{kg\ °C}$
T_f	Final Temperature	K or °C
T_i	Initial Temperature	K or °C

Material	Specific Heat $\left(\frac{J}{kg\ °C}\right)$
water	4,184
oil	1900
wood	1800
aluminum	900
concrete	880
glass	800
steel	470
silver	235
gold	129

Zeroth Law of Thermodynamics When two items are in thermal contact, heat will flow between them until they reach the same temperature (thermal equilibrium).
First Law of Thermodynamics (The Conservation of Energy) When a system is closed, the total amount of energy in that system remains the same.

Part A; Review of the Heat Formula

1. You have 0.4 kg of gold. It moves from a temperature of 15 degrees Celsius to a temperature of 30 degrees Celsius. How much heat energy was added?

2. You have a mass of concrete. You add ten thousand Joules of heat energy and it moves from an initial temperature of 20 degrees Celsius to a temperature of 25 degrees Celsius. What is the mass of the concrete?

3. You have a mystery metal with a mass of 0.8 kg. You add 200 Joules of heat energy, and the temperature rises from 10 degrees Celsius to 12 degrees Celsius. What is the specific heat of this mystery metal?

4. You have 2 kg of glass at a temperature of 10 degrees Celsius. What is the final temperature if you add five thousand Joules of heat energy?

5. You have 0.8 kg of wood at a temperature of 15 degrees Celsius. What is the final temperature if you REMOVE eight thousand Joules of heat energy?

6. You have 10 kg of water. When you add nine thousand Joules of heat energy, the temperature rises to 18 degrees Celsius. What was the temperature initially?

7. You have 6 kg of water. When you REMOVE 15,000 Joules of heat energy, the temperature falls to 40 degrees Celsius. What was the temperature initially?

Part B: Mixing Problems

B1. You place a piece of steel with a mass of 0.5 kg in a bowl of water with a mass of 2 kg. The steel has an initial temperature of 30 degrees Celsius and the water has an initial temperature of 20 degrees Celsius.
They must have the same final temperature.
Explain how heat energy flows: [from what to what?]

What happens to the temperature of the steel?

What happens to the temperature of the water:

According to the 1st Law of Thermodynamics (*Conservation of Energy)*, the heat energy that *leaves* the steel must equal the heat energy that enters the water.

$$Q_W + Q_S = 0$$

Also, according the 0th Law of Thermodynamics, the water and the steel must end with the same temperature.
Create an equation that is based on these concepts.
This equation has the following variables:

$$m_s, C_s, T_{i-S}, m_W, C_W, T_{iW}, T_f$$

[Notice there are two variables for everything except the final temperature!]

You already know *seven* of these variables! Figure out the last variable, the *final temperature of the system*.

Which changed temperature more, the steel or the water? Why?

B2. You place a piece of steel with a mass of 0.8 kg in a bowl of water with a mass of 3 kg. The steel has an initial temperature of 80 degrees Celsius and the water has an initial temperature of 10 degrees Celsius.

Write an equation to determine the final temperature of the mixture. Then, figure it out.

B3. You have a 0.3 kg piece of gold with a temperature of 400 degrees Celsius. You place it in a pot of water with a temperature of 20 degrees and a mass of 5 kg.

Write an equation to determine the final temperature of the mixture. Then, figure it out.

3**.** When 350 grams of aluminum at 200. degrees Celsius is added to 2.0 kilograms of water at 20. degrees Celsius, what will be the final temperature of the mixture?

Answers

13. 27 degrees Celsius

Number 4 (heat_formula_mixture)
You are making iced coffee at Dunkin Donuts!.
You have 0.15 kg of ice at an initial temperature of 0°C.
You have 0.40 kg of coffee at an initial temperature of 85°C. Assume that the coffee has the same specific heat as WATER.
What will be the final temperature of the iced coffee.

I will give you the formula to solve this problem. You must figure out each portion and solve it.

The *released by the ice* = The heat *absorbed by the water.*

$$m_1 H_f + m_1 C_1 \left(T_f - T_{i1}\right) = -m_2 C_2 (T_f - T_{i2})$$

A B Γ

Piece A: this is the heat energy needed to melt the ice
Piece B: this is the heat energy that heats up the COLD water (after the ice is melted.
Piece Γ: This the heat energy that COOLS down the hot water (the coffee).

The FINAL TEMPERUTE T_f is the SAME for both the hot and cold parts of the equation, because two items reach thermal equilibrium at the same temperature!>

Looking for:
T_{f-} = ?

Already Know:
m_1 =
m_2 =
H_f =
C_1 =
C_2 =
T_{i1} =
T_{i2} =

When solving this problem, make sure to use the DISTRIBUTIVE PROPERTY from algebra.