Name: _____ Date: _____

CONTENT 11.1

# 11.1 Using the Heat Equation

**READ**

You can solve real-world heat and temperature problems using the following equation:

***HEAT EQUATION***

$$E = mC_p(T_2 - T_1)$$

*Heat energy* (joules) = $E$; *Mass* (kg) = $m$; *Specific heat* ($\frac{\text{joule}}{\text{kg°C}}$) = $C_p$; *Change in temperature* (°C) = $(T_2 - T_1)$

Below is a table that provides the specific heat of six everyday materials.

| Material | Specific Heat (J/kg °C) | Material | Specific Heat (J/kg °C) |
|---|---|---|---|
| water (pure) | 4,184 | concrete | 880 |
| aluminum | 897 | gold | 129 |
| silver | 235 | wood | 1,700 |

**EXAMPLE**

- How much heat does it take to raise the temperature of 10 kg of water by 10 °C?

  **Solution:**

  Find the specific heat of water from the table above: 4,184 J/kg °C. Plug the values into the equation.

$$\text{Thermal Energy (J)} = 10\ \text{kg} \times 10\ °C \times 4{,}184\ \text{J/kg} \bullet °C$$
$$= 418{,}400\ \text{joules}$$

**PRACTICE**

**Use the specific heat table to answer the following questions. Don't forget to show your work.**

1. How much heat does it take to raise the temperature of 0.10 kg of gold by 25 °C?
2. How much heat does it take to raise the temperature of 0.10 kg of silver by 25 °C?
3. How much heat does it take to raise the temperature of 0.10 kg of aluminum by 25 °C?
4. Which one of the three materials above would cool down fastest after the heat was applied? Explain.
5. A coffee maker heats 2 kg of water from 15 °C to 100 °C. How much thermal energy was required?
6. The Sun warms a 100-kg slab of concrete from 20 °C to 25 °C. How much thermal energy did it absorb?
7. 5,000 joules of thermal energy were applied to 1-kg aluminum bar. What was the temperature increase?
8. In the 1920's, many American homes did not have hot running water from the tap. Bath water was heated on the stove and poured into a basin. How much thermal energy would it take to heat 30 kg of water from 15 °C to a comfortable bath temperature of 50 °C?

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CONTENT 11.1

# 11.1 Specific Heat

READ

**Specific heat** is the amount of thermal energy needed to raise the temperature of 1 gram of a substance 1 °C.

The higher the specific heat, the more energy is required to cause a change in temperature. Substances with higher specific heats must lose more thermal energy to lower their temperature than substances with a low specific heat. Some sample specific heat values are presented in the table below:

| Material | Specific Heat (J/kg °C) |
|---|---|
| water (pure) | 4,184 |
| aluminum | 897 |
| silver | 235 |
| oil | 1,900 |
| concrete | 880 |
| gold | 129 |
| wood | 1,700 |

Water has the highest specific heat of the listed types of matter. This means that water is slower to heat but is also slower to lose heat.

PRACTICE

**Using the table above, solve the following heat problems.**

1. If 100 joules of energy were applied to all of the substances listed in the table at the same time, which would have the greatest temperature change? Explain your answer.
2. Which of the substances listed in the table would you choose as the best thermal insulator? A thermal insulator is a substance that requires a lot of heat energy to change its temperature. Explain your answer.
3. Which substance—wood or silver—is the better thermal conductor? A thermal conductor is a material that requires very little heat energy to change its temperature. Explain your answer.
4. Which has more thermal energy, 1 kg of aluminum at 20 °C or 1 kg of gold at 20 °C?
5. How much heat in joules would you need to raise the temperature of 1 kg of water by 5 °C?
6. How does the thermal energy of a large container of water compare to a small container of water at the same temperature?