LESSON MAKER PRO

Where Heat Goes

Calculate heat flow as materials warm, cool, and melt.

HIGH SCHOOL · CHE.10

CHE.10 "Enrichment: Students will understand that energy is exchanged or transformed in all chemical reactions. Enrichment: Construct explanations to explain how temperature and heat flow in terms of the motion of molecules (or atoms)..."

NAME _____ DATE _____

TRACK THE ENERGY

For a temperature change, use q = mc(Tfinal - Tinitial), where m is mass, c is specific heat, and q is heat gained or lost by the material. A positive q means the material gains heat; a negative q means it loses heat. During melting at a constant temperature, use q = mL, where L is the heat needed to melt one gram.

WORKED EXAMPLE

A 7 g sample has a specific heat of 3 J/(g°C). It warms from 12°C to 16°C. How much heat does it gain?

1. Find the temperature change: 16°C - 12°C = 4°C.
2. Substitute: q = (7 g)(3 J/(g°C))(4°C).
3. Multiply: q = 84 J.

Answer: The sample gains 84 J.

PRACTICE 6 problems

1 A 10 g sample of water warms from 20°C to 30°C. Use c = 4.2 J/(g°C). How much heat does it gain?

ANSWER _____

2 A 50 g piece of aluminum warms from 20°C to 40°C. Use c = 0.90 J/(g°C). How much heat does it gain?

ANSWER _____

3 A 25 g sample with c = 2 J/(g°C) cools from 40°C to 32°C. Find q for the sample. Does it gain or lose heat?

ANSWER _____

4 A 60 g sample with c = 0.5 J/(g°C) gains 150 J. What is its temperature change?

ANSWER _____

5 An 80 g sample of water starts at 35°C and loses 336 J. Use c = 4.2 J/(g°C). What is its final temperature?

ANSWER _____

6 A 24 g sample absorbs 144 J as it warms from 22°C to 28°C. What is its specific heat?

ANSWER _____

APPLY IT Show your work

1 A reusable hand warmer transfers 840 J of heat to its 40 g metal casing. The casing starts at 19°C and has a specific heat of 0.70 J/(g°C). What is its final temperature?

WORK SPACE

ANSWER _____

2 At a café, a 100 g sports drink starts at 9°C and loses 2,100 J as it chills. Model the drink as water with c = 4.2 J/(g°C). What is its final temperature?

WORK SPACE

ANSWER _____

CHALLENGE One step up

A 50 g piece of ice at 0°C melts completely. The resulting water then warms to 5°C. Use the values in the table to find the total heat absorbed. Why does the temperature stay at 0°C during melting?

HEAT VALUES

Quantity	Value
Heat of melting, L	334 J/g
Specific heat of water, c	4.2 J/(g°C)

WORK SPACE AND ANSWER

Where Heat Goes

PART 1 · PRACTICE

#	PROBLEM	ANSWER
1	A 10 g sample of water warms from 20°C to 30°C. Use c = 4.2 J/(g°C). How much heat does it gain?	**420 J**
2	A 50 g piece of aluminum warms from 20°C to 40°C. Use c = 0.90 J/(g°C). How much heat does it gain?	**900 J**
3	A 25 g sample with c = 2 J/(g°C) cools from 40°C to 32°C. Find q for the sample. Does it gain or lose heat?	**q = -400 J; the sample loses heat.**
4	A 60 g sample with c = 0.5 J/(g°C) gains 150 J. What is its temperature change?	**5°C increase**
5	An 80 g sample of water starts at 35°C and loses 336 J. Use c = 4.2 J/(g°C). What is its final temperature?	**34°C**
6	A 24 g sample absorbs 144 J as it warms from 22°C to 28°C. What is its specific heat?	**1 J/(g°C)**

PART 2 · APPLY IT

1. **49°C** The temperature increase is 840 / (40 × 0.70) = 30°C. Add 30°C to the starting temperature of 19°C.
2. **4°C** The temperature change is -2,100 / (100 × 4.2) = -5°C. Subtract 5°C from 9°C.

CHALLENGE

17,750 J total: (50 g)(334 J/g) + (50 g)(4.2 J/(g°C))(5°C) = 16,700 J + 1,050 J. During melting, the absorbed energy separates water molecules rather than raising their average kinetic energy.

Accept equivalent calculations with correct units. For cooling problems, a negative q describes heat lost by the material.