

Mixing Temperature Evidence

Use mass and temperature data to predict thermal equilibrium.

HIGH SCHOOL • HS-PS3-4

HS-PS3-4 "Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components..."

NAME _____

DATE _____

ENERGY BALANCES OUT

When samples of the same substance combine in an insulated container, thermal energy moves from warmer material to cooler material until they reach one final temperature. Find that temperature with $T_f = (m_1 \times T_1 + m_2 \times T_2) / (m_1 + m_2)$, assuming no energy leaves the system.

WORKED EXAMPLE

Combine 16 g of water at 11 C with 24 g of water at 31 C. Find T_f .

1. $T_f = (16 \times 11 + 24 \times 31) / (16 + 24)$

2. $T_f = 920 / 40$

3. $T_f = 23 \text{ C}$

Answer: 23 C

PRACTICE 5 problems

- 1** Equal masses of water at 20 C and 36 C are combined. Find T_f .

ANSWER _____

- 2** Combine 10 g of water at 18 C with 30 g of water at 38 C. Find T_f .

ANSWER _____

- 3** Combine 25 g of water at 52 C with 25 g of water at 20 C. Find T_f .

ANSWER _____

- 4** Combine 30 g of water at 15 C with 10 g of water at 45 C. Find T_f .

ANSWER _____

- 5** Combine 28 g of water at 48 C with 28 g of water at 32 C. How many degrees does each sample change?

ANSWER _____

APPLY IT Show your work

- 1** For a sports drink test, a student mixes 200 g of cold water at 10 C with 100 g of warm water at 40 C in an insulated cup. Predict the final temperature.

WORK SPACE

ANSWER _____

- 2** A robotics team tests a cooling loop by combining 150 g of water at 60 C with 50 g of water at 20 C in an insulated container. A sensor reads 50 C. Is the reading consistent with the calculation?

WORK SPACE

ANSWER _____

CHALLENGE One step up

CHALLENGE

Three water samples are combined in an insulated container: 10 g at 12 C, 20 g at 27 C, and 30 g at 42 C. Find T_f , then state which samples transfer thermal energy.

PART 1 • PRACTICE

#	PROBLEM	ANSWER
1	Equal masses of water at 20 C and 36 C are combined. Find Tf.	28 C
2	Combine 10 g of water at 18 C with 30 g of water at 38 C. Find Tf.	33 C
3	Combine 25 g of water at 52 C with 25 g of water at 20 C. Find Tf.	36 C
4	Combine 30 g of water at 15 C with 10 g of water at 45 C. Find Tf.	22.5 C
5	Combine 28 g of water at 48 C with 28 g of water at 32 C. How many degrees does each sample change?	The warmer water cools 8 C, and the cooler water warms 8 C.

PART 2 • APPLY IT

- 20 C** $T_f = (200 \times 10 + 100 \times 40)/(200 + 100) = 6000/300 = 20 \text{ C}$.
- Yes. The predicted final temperature is 50 C.** $T_f = (150 \times 60 + 50 \times 20)/(150 + 50) = 10000/200 = 50 \text{ C}$. The measured value matches the prediction.

CHALLENGE

$T_f = 32 \text{ C}$. The 42 C water transfers thermal energy to the 12 C and 27 C water.

Accept equivalent calculations and 22.5 C as 22 1/2 C. For explanations, accept wording that correctly identifies energy moving from warmer water to cooler water until the temperatures become uniform.