ANSWER KEY. Final answers are in bold.

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6.4 Heat Capacity and Calorimetry

AP Chemistry | ANSWER KEY

Show work with units and sig figs.

$q = mc\Delta T$ $q = nC\Delta T$ $q_{system} = -q_{surroundings}$	Specific heat, J/(g·°C): water 4.18 | Al 0.897 | Fe 0.449 | Cu 0.385

1. How much heat, in kJ, is needed to warm 125 g of water from 18.5°C to 72.0°C?

$q = mc\Delta T = (125\text{ g})(4.18\text{ J/(g·°C)})(72.0°C - 18.5°C) = 2.80 \times 10^4\text{ J}$

q = +28.0 kJ (positive: the water absorbs energy)

2. An 85.0 g sample of aluminum at 24.0°C absorbs 2,150 J of heat. What is its final temperature? (c = 0.897 J/(g·°C))

$\Delta T = q / (mc) = 2{,}150\text{ J} / [(85.0\text{ g})(0.897\text{ J/(g·°C)})] = 28.2°C$

$T_{final} = 24.0°C + 28.2°C =$ **52.2°C**

3. A 32.5 g piece of an unknown metal absorbs 694 J while warming from 21.0°C to 76.5°C. Calculate its specific heat and use the table to identify the metal.

$c = q / (m\Delta T) = 694\text{ J} / [(32.5\text{ g})(76.5°C - 21.0°C)] =$ **0.385 J/(g·°C)**

The metal is copper (0.385 J/(g·°C)).

4. A 150.0 g piece of iron at 98.0°C is dropped into 100.0 g of water at 21.0°C in an insulated coffee-cup calorimeter. Calculate the final temperature of the iron and water. Assume no energy is lost to the cup.

$q_{iron} = -q_{water}$

$(150.0\text{ g})(0.449\text{ J/(g·°C)})(T_f - 98.0°C) = -(100.0\text{ g})(4.18\text{ J/(g·°C)})(T_f - 21.0°C)$

$(67.35\text{ J/°C})T_f - 6600.3\text{ J} = -(418\text{ J/°C})T_f + 8778\text{ J}$

$T_f = 15378\text{ J} / 485.35\text{ J/°C} =$ **31.7°C**

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5. The molar heat capacity of liquid water is 75.3 J/(mol·°C). How much heat is released when 2.50 mol of water cools from 60.0°C to 25.0°C?

$q = nC\Delta T = (2.50\ \text{mol})(75.3\ \text{J/(mol·°C)})(25.0°\text{C} - 60.0°\text{C}) = -6590\ \text{J}$

q = −6.59 kJ (negative: the water releases energy)

6. A student dissolves a salt in 75.0 g of water in a coffee-cup calorimeter. The temperature rises from 20.5°C to 32.9°C. Assume that only the water changes temperature.

(a) Calculate q for the water.
(b) Calculate q for the dissolving process.
(c) Is dissolving endothermic or exothermic?

(a) $q_{water} = mc\Delta T = (75.0\ \text{g})(4.18\ \text{J/(g·°C)})(32.9°\text{C} - 20.5°\text{C}) =$ **+3890 J**

(b) $q_{dissolving} = -q_{water} =$ **−3890 J**

(c) **Exothermic.** The water gained energy, so the dissolving process released it.

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