

# Workbook



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# Thermochemistry

## Heat

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### Questions

1) Calculate the amount of heat, in kJ, required:

a. To raise the temperature of 267 kg of iron by 16.8 °C.

The specific heat capacity of iron =  $0.449 \frac{\text{J}}{\text{g}^\circ\text{C}}$ .

b. To lower the temperature of 5.85 L of water from 45 °C to 31 °C.

The specific heat capacity of water =  $4.18 \frac{\text{J}}{\text{g}^\circ\text{C}}$ .

2) A 289 g piece of aluminum is removed from an oven and placed into 525 g water,

in an insulated container. The temperature of the water increases from, 25 °C to 64 °C. What is the original temperature of the aluminum?

The specific heat capacity of water =  $4.18 \frac{\text{J}}{\text{g}^\circ\text{C}}$ .

The specific heat capacity of aluminum is  $0.903 \frac{\text{J}}{\text{g}^\circ\text{C}}$ .

3) A 850 g piece of copper at 58 °C is added to 500 mL of water maintained at 35 °C,

in an insulated container. What will be the final temperature, of the Cu-H<sub>2</sub>O mixture?

The specific heat capacity of water =  $4.18 \frac{\text{J}}{\text{g}^\circ\text{C}}$ .

The specific heat capacity of copper =  $0.385 \frac{\text{J}}{\text{g}^\circ\text{C}}$ .

## General Chemistry Workbook

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- 4) A 128.5 g sample of magnesium at 127.9 °C is added to 236 g of water at 25 °C, in an insulated vessel. The final temperature = 37.1 °C.

The specific heat capacity of water =  $4.18 \frac{\text{J}}{\text{g}^\circ\text{C}}$ .

What is the molar heat capacity of magnesium?

- 5) 125.4 kJ, in the form of heat, is transferred to a 2L sample of water ( $d = 1 \frac{\text{g}}{\text{mL}}$ ), at 25 °C. The final temperature of the water is 40 °C.

What is the heat capacity of water in  $\frac{\text{J}}{\text{K}}$  ?

### Answer Key

1) a. 2014 kJ      b. -342.34 kJ

2) 392 °C

3) 38 °C

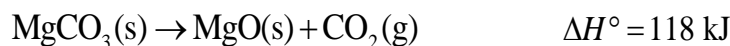
4)  $24.87 \frac{\text{J}}{\text{mol}^\circ\text{C}}$

5)  $8.36 \cdot 10^3 \frac{\text{J}}{\text{K}}$

### Enthalpy

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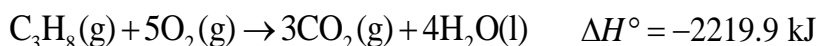
- 1) How much heat, in kJ, is associated with the decomposition of 367 g of  $\text{MgCO}_3$ ?



- 2) How much heat, in kJ, is associated with the complete combustion of:

a. 33.2L  $\text{C}_3\text{H}_8(\text{g})$  at STP?

b. 15.4L  $\text{C}_3\text{H}_8(\text{g})$  at 35.2 °C and 624 mmHg?



- 3)  $\text{C}_4\text{H}_{10}(\text{g}) + \frac{13}{2}\text{O}_2(\text{g}) \rightarrow 4\text{CO}_2(\text{g}) + 5\text{H}_2\text{O}(\text{l}) \quad \Delta H^\circ = -2877 \text{ kJ}$

a. What mass of butane,  $\text{C}_4\text{H}_{10}(\text{g})$ , must be burned to liberate  $3.45 \cdot 10^5 \text{ kJ}$ , of heat?

b. What volume of water, in liters, could be heated from 20 °C to 45 °C, if the  $3.45 \cdot 10^5 \text{ kJ}$  of heat are transferred to water?

- 4) 0.5 g of  $\text{NH}_4\text{Cl}$  are added to 22 g water in a Styrofoam coffee cup.

The water temperature decreases from 26 °C to 24.5 °C.

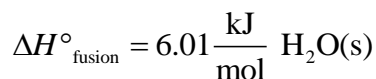
Calculate the heat of solution of  $\text{NH}_4\text{Cl}$  (in kJ per mole of  $\text{NH}_4\text{Cl}$ ).

Assume that the specific heat capacity of dilute  $\text{NH}_4\text{Cl}(\text{aq})$  is the same, as that of water.

- 5) What mass of  $\text{KOH}$  needs to be dissolved in 73 g of water in order to raise, the water temperature by 2.5 °C?

The heat of solution of potassium hydroxide is  $-57.61 \frac{\text{kJ}}{\text{mol}}$ .

- 6) What mass of ice can be melted with the same amount of heat required to raise, the temperature of 5.4 mol  $\text{H}_2\text{O}(\text{l})$  by 23 °C?



### Answer Key

- 1) a. 513.3 kJ
- 2) a. - 3,285.45 kJ  
b. - 844,094.78 kJ
- 3) a. 6,972.15 g  
b. 3301.44 L
- 4)  $\Delta H_{\text{sol}} = 14.7 \frac{\text{kJ}}{\text{mol}}$
- 5)  $m_{\text{KOH}} = 0.75\text{g}$
- 6)  $m_{\text{ice}} = 27.53\text{g}$