

KEY

Specific Heat Calculations Worksheet  
Chemistry

Name: \_\_\_\_\_

Date: \_\_\_\_\_

\*\*\*\*\*YOU MUST SHOW YOUR WORK TO RECEIVE CREDIT!!!!\*\*

Here is a chart of specific heat capacities for your use:

Material	Specific Heat Capacity (J/g·°C)	Material	Specific Heat Capacity (J/g·°C)
aluminum (Al)	0.9025	lead (Pb)	0.1276
concrete	0.84	mercury (Hg)	0.13950
ethyl alcohol (CH <sub>3</sub> CH <sub>2</sub> OH)	2.4194	rhodium (Rh)	0.2427
gold (Au)	0.12905	solid steel	0.4494
helium (He)	5.1931	titanium (Ti)	0.5526
hydrogen (H <sub>2</sub> )	14.304	vanadium (V)	0.4886
iron (Fe)	0.4494	water (H <sub>2</sub> O)	4.184

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- 1) In order to make tea, 322,000 J of energy were added to 1000.0 g of water. What was the temperature change of the water? [77.0 °C]

$$Q = 322,000 \text{ J}$$

$$s = 4.184 \text{ J/g}\cdot\text{°C}$$

$$m = 1000.0 \text{ g}$$

$$\Delta T = 77\text{°C}$$

$$Q = sm\Delta T$$

$$322,000 \text{ J} = \left( \frac{4.184 \text{ J}}{\text{g}\cdot\text{°C}} \right) \cdot \frac{1000.0 \text{ g}}{1} (\Delta T)$$

$$\frac{322,000 \text{ J}}{4.184 \frac{\text{J}}{\text{g}\cdot\text{°C}} \cdot 1000.0 \text{ g}} = \Delta T = 76.95 = 77\text{°C}$$

- 2) A 32.07 gram sample of vanadium was heated to 75.00 °C (its initial temperature). It was then dumped into a calorimeter. The initial temperature of the calorimeter's water was 22.50 °C. After the metal was allowed to release all its heat to the calorimeter's water, 26.30 °C was the final temperature. What mass of distilled water was in the calorimeter? [~~48.0~~ g] 47.80

SYSTEM (-760.0J)

$$Q = -760.0$$

$$s = 0.4886 \text{ J/g}\cdot\text{°C}$$

$$m = 32.07 \text{ g}$$

$$T_{\text{final}} = 26.30\text{°C}$$

$$T_{\text{initial}} = 75.00\text{°C}$$

$$\Delta T = -48.70\text{°C}$$

$$Q = 0.4886 \cdot 32.07 \cdot 48.70 = 759.98 \text{ J}$$

$$\frac{760.0}{0.4886} = 1555.67$$

SURROUNDINGS (+760.0J)

$$Q = +760.0$$

$$s = 4.184 \text{ J/g}\cdot\text{°C}$$

$$m =$$

$$T_{\text{final}} = 26.30\text{°C}$$

$$T_{\text{initial}} = 22.50\text{°C}$$

$$\Delta T = 3.80\text{°C}$$

$$Q = sm\Delta T$$

$$\frac{Q}{s\Delta T} = m$$

$$\frac{760.0}{4.184 \cdot 3.80} = 47.80 \text{ g}$$

4 s.f.

3) What is specific heat capacity? amount of heat needed to raise the temperature of 1 gram of substance 1°C

4) What are the units of specific heat? J/g°C

5) What is the symbol for specific heat? s

6) Look at the specific heat capacity chart on the first page of this worksheet.

Which chemical has the highest specific heat capacity? hydrogen

Which chemical has the lowest specific heat capacity? lead

How do the specific heat capacities of metals compare with those of liquids? liquids are water & ethyl alcohol - have higher heat capacities than metals

① 7) A 49.2 g sample of solid steel was heated from 24.1 °C to 67.3 °C. What was the energy change? (must show work for credit) [955 J]

$$Q = \underline{955 \text{ J}} \quad Q = (0.4494)(49.2)(43.2) = 955 \text{ J}$$

$$s = \underline{0.4494 \text{ J/g}^\circ\text{C}}$$

$$m = \underline{49.2 \text{ g}}$$

$$\Delta T = \underline{67.3 - 24.1 = 43.2^\circ\text{C}}$$

8) A piece of unknown metal with mass 17.19 g is heated to an initial temperature of 92.50 °C and dropped into 25.00 g of water (with an initial temperature of 24.50 °C) in a calorimeter. The final temperature of the system is 30.05 °C. What is the specific heat of the metal?

SYSTEM ( )

$$Q = \underline{-580.5 \text{ J}}$$

$$s = \underline{0.5407 \text{ J/g}^\circ\text{C}}$$

$$m = \underline{17.19 \text{ g}}$$

$$T_{\text{final}} = \underline{30.05^\circ\text{C}}$$

$$T_{\text{initial}} = \underline{92.50^\circ\text{C}}$$

$$\Delta T = \underline{-62.45}$$

SURROUNDINGS ( )

$$Q = \underline{580.5 \text{ J}}$$

$$s = \underline{4.184 \text{ J/g}^\circ\text{C}}$$

$$m = \underline{25.00 \text{ g}}$$

$$T_{\text{final}} = \underline{30.05^\circ\text{C}}$$

$$T_{\text{initial}} = \underline{24.50^\circ\text{C}}$$

$$\Delta T = \underline{5.55^\circ\text{C}}$$

$$Q = sm \Delta T \text{ so } \frac{Q}{m \Delta T} = s$$

$$Q = sm \Delta T$$

- 9) How much heat is required to raise the temperature of 7.89 g of ethyl alcohol from 25.0 °C to 72.7 °C? (must show work for credit) [911 J]

$$Q = \underline{911 \text{ J}}$$

$$s = \underline{2.4194 \text{ J/g}\cdot\text{C}}$$

$$m = \underline{7.89 \text{ g}}$$

$$\Delta T = \underline{47.7 \text{ }^\circ\text{C}}$$

$$Q = (2.4194)(7.89)(47.7) = 916.5$$

$$\underline{911 \text{ J}}$$

- 10) How much heat is released when 432 g of aluminum cool from  $T_i$  71.0 °C to  $T_f$  18.0 °C?

$$Q = \underline{-2.07 \times 10^4 \text{ J}}$$

$$s = \underline{0.9025 \text{ J/g}\cdot\text{C}}$$

$$m = \underline{432 \text{ g}}$$

$$\Delta T = \underline{18.0 - 71.0 = -53 \text{ }^\circ\text{C}}$$

$$Q = (0.9025)(432)(-53.0) = -20663.6 \text{ J}$$

$$\underline{-2.07 \times 10^4 \text{ J} = -20700 \text{ J}}$$

- 11) How many joules of heat are needed to increase the temperature of 250.0 g of mercury by 26.0 °C?

$$Q = \underline{907 \text{ J}}$$

$$s = \underline{0.13950}$$

$$m = \underline{250.0 \text{ g}}$$

$$\Delta T = \underline{26 \text{ }^\circ\text{C}}$$

$$Q = \left(0.13950 \frac{\text{J}}{\text{g}\cdot\text{C}}\right)(250 \text{ g})(26 \text{ }^\circ\text{C}) = 906.75$$

$$\underline{907 \text{ J}}$$

- 12) What mass of lead is needed to absorb 54 000 J of energy if its temperature is to increase by only 2.5 °C? [170 000 g]

$$Q = \underline{54,000 \text{ J}}$$

$$s = \underline{0.1276 \text{ J/g}\cdot\text{C}}$$

$$m = \underline{170,000 \text{ g}}$$

$$\Delta T = \underline{2.5 \text{ }^\circ\text{C}}$$

$$Q = sm\Delta T$$

$$\frac{Q}{s\Delta T} = m$$

$$\frac{54000}{0.1276 \cdot 2.5} = 169278.997 \text{ g}$$

$$\underline{170,000}$$

a.s.f.

- 13) A piece of rhodium with a mass of 24.50 g and an initial temperature of 96.00 °C was dropped into a calorimeter containing 30.08 g of distilled water. The final temperature of the metal and water in the calorimeter was 30.07 °C. What was the initial temperature of the water?

SYSTEM ( )

$$Q = \underline{-392.0 \text{ J}}$$

$$s = \underline{0.2427 \frac{\text{J}}{\text{g} \cdot ^\circ\text{C}}}$$

$$m = \underline{24.50 \text{ g}}$$

$$T_{\text{final}} = \underline{30.07^\circ\text{C}}$$

$$T_{\text{initial}} = \underline{96.00^\circ\text{C}}$$

$$\Delta T = \underline{-65.93^\circ\text{C}}$$

SURROUNDINGS ( )

$$Q = \underline{+392.0 \text{ J}}$$

$$s = \underline{4.184 \frac{\text{J}}{\text{g} \cdot ^\circ\text{C}}}$$

$$m = \underline{30.08 \text{ g}}$$

$$T_{\text{final}} = \underline{30.07^\circ\text{C}}$$

$$T_{\text{initial}} = \underline{26.96^\circ\text{C}}$$

$$\Delta T = \underline{3.115^\circ\text{C}}$$

$$Q = Sm \Delta T$$

$$Q = (0.2427) \cdot (24.50) \cdot (-65.93)$$

$$= -392.03$$

$$= -392.0 \text{ J}$$

$$Q = Sm \Delta T$$

$$\frac{Q}{Sm} = \Delta T = 3.115^\circ\text{C}$$

$$\Delta T = T_f - T_i$$

$$3.115 = 30.07 - T_i$$

$$+ T_i$$

$$+ T_i$$

$$T_i + 3.115 = 30.07$$

$$T_i = 30.07 - 3.115 = 26.955$$

$$26.96$$

- 14) (a) A 25.0 g sample of titanium is heated from  $25.25^\circ\text{C}$  to  $75.25^\circ\text{C}$ . Determine the amount of energy this requires.

$$Q = \underline{691 \text{ J}}$$

$$s = \underline{0.5526}$$

$$m = \underline{25.0 \text{ g}}$$

$$\Delta T = \underline{50^\circ\text{C}}$$

$$Q = (0.5526)(25.0)(50) = 690.75$$

$$691 \text{ J}$$

- (b) Was energy absorbed or lost during this process? Explain your answer. \_\_\_\_\_

absorbed - Q is positive so this is an endothermic process