Specific Heat

DIRECTIONS: Use q = (m)(ΔT)(Cp) to solve the following problems. Show all work and units.

1. A 15.75-g piece of iron absorbs 1086.75 joules of heat energy, and its temperature changes from 25°C to 175°C. Calculate the specific heat capacity of iron.

2. How many joules of heat are needed to raise the temperature of 10.0 g of aluminum from 22°C to 55°C, if the specific heat of aluminum is 0.90 J/g°C?

3. To what temperature will a 50.0 g piece of glass raise if it absorbs 5275 joules of heat and its specific heat capacity is 0.50 J/g°C? The initial temperature of the glass is 20.0°C.

4. Calculate the heat capacity of a piece of wood if 1500.0 g of the wood absorbs 6.75×10^4 joules of heat, and its temperature changes from 32°C to 57°C.

5. 100.0 mL of 4.0°C water is heated until its temperature is 37°C. If the specific heat of water is 4.18 J/g°C, calculate the amount of heat energy needed to cause this rise in temperature.

6. 25.0 g of mercury is heated from 25°C to 155°C, and absorbs 455 joules of heat in the process. Calculate the specific heat capacity of mercury.

7. What is the specific heat capacity of silver metal if 55.00 g of the metal absorbs 47.3 **calories** of heat and the temperature rises 15.0°C?

8. If a sample of chloroform is initially at 25°C, what is its final temperature if 150.0 g of chloroform absorbs 1.0 **kilojoules** of heat, and the specific heat of chloroform is 0.96 J/g°C?

9. How much energy must be absorbed by 20.0 g of water to increase its temperature from 283.0 °C to 303.0 °C? (Cp of H_2O = 4.184 J/g °C)

10. When 15.0 g of steam drops in temperature from 275.0 °C to 250.0 °C, how much heat energy is released? (Cp of H_2O = 4.184 J/g °C)

11. How much energy is required to heat 120.0 g of water from 2.0 °C to 24.0 °C? (Cp of H_2O = 4.184 J/g °C)

12. How much heat (in J) is given out when 85.0 g of lead cools from 200.0 °C to 10.0 °C? (Cp of Pb = 0.129 J/g °C)

13. If it takes 41.72 joules to heat a piece of gold weighing 18.69 g from 10.0 °C to 27.0 °C, what is the specific heat of the gold?

14. A certain mass of water was heated with 41,840 Joules, raising its temperature from 22.0 °C to 28.5 °C. Find the mass of the water, in grams. (Cp of H_2O = 4.184 J/g °C)

15. How many joules of heat are needed to change 50.0 grams of ice at -15.0 °C to steam at 120.0 °C? (Cp of H_2O = 4.184 J/g °C)

16. Calculate the number of joules given off when 32.0 grams of steam cools from 110.0 °C to ice at -40.0 °C. (Cp of H_2O = 4.184 J/g °C)

17. The specific heat of ethanol is 2.46 J/g °C. Find the heat required to raise the temperature of 193 g of ethanol from 19°C to 35°C.

18. When a 120 g sample of aluminum (Al) absorbs 9612 J of energy, its temperature increases from 25°C to 115°C. Find the specific heat of aluminum.

Specific heat handout

1) $m = 15.75\,g$ $\quad Q = 1086.75\,J$ $\quad \Delta T = 175^\circ C - 25^\circ C = 150^\circ C$

$c = ?$

$Q = m\,c\,\Delta T$

$1086.75 = (15.75)(c)(150^\circ C)$

$\frac{1086.75}{2362.5} = c$ $\quad \rightarrow \quad c = 0.46\,J/g^\circ C.$

2) $Q = ?$ $\quad m = 10\,g$ $\quad \Delta T = 55 - 22^\circ C = 33^\circ C$ $\quad c = 0.9\,J/g^\circ C$

$Q = m\,c\,\Delta T$

$= (10)(0.9)(33)$

$\rightarrow Q = 297\,J.$

3) $m = 50\,g$ $\quad Q = 5275\,J$ $\quad c = 0.5\,J/g^\circ C$ $\quad T_1 = 20^\circ C$ $\quad T_2 = ?$

$Q = m\,c\,\Delta T$

$Q = m\,c\,(T_2 - T_1)$

$5275 = 50\,(0.5)\,(T_2 - 20)$

$5275 = 25\,(T_2 - 20)$

$5275 = 25T_2 - 500$

$5275 + 500 = 25T_2$

$5775 = 25T_2$

$\frac{5775}{25} = T_2$

$\rightarrow T_2 = 231^\circ C$

4) $c = ?$ $\quad m = 1500\,g$ $\quad Q = 6.75 \times 10^4\,J$ $\quad \Delta T = 57 - 32 = 25^\circ C$

$Q = m\,c\,\Delta T$

$6.75 \times 10^4\,J = (1500)(c)(25)$

$6.75 \times 10^4 = (c)(37500)$ $\quad \rightarrow \quad c = \frac{6.75 \times 10^4}{37500}$

$\rightarrow c = 180\,J/g^\circ C$

5) 100mL → 100g water $\Delta T = 37 - 4 = 33^\circ C$ $c = 4.18 J/g^\circ C$ $Q = ?$

$Q = mc\Delta T$

$Q = (100)(4.18)(33)$

→ $Q = 13794\ J.$

6) $m = 25g$ $\Delta T = 155 - 25 = 130^\circ C$ $Q = 455J$ $c = ?$

$Q = mc\Delta T$

$455 = (25)(c)(130)$

$455 = (c)(3250)$

$\frac{455}{3250} = c$ → $c = 0.14 J/g^\circ C$

7) $c = ?$ $m = 55g$ $Q = 47.3$ calories (1 calorie = 4.184 joules)

$\Delta T = 15^\circ C$

1st convert calories to joules!

1 cal = 4.184 joules.
47.3 cal = x joules
} ⇒ 197.90 J = Q.

$Q = mc\Delta T$

$197.90 = (55)(c)(15)$

$197.90 = (c)(825)$

$\frac{197.90}{825} = c$ → $c = 0.24 J/g^\circ C.$

8) $T_1 = 25^\circ C$ $T_2 = ?$ $m = 150g$ $Q = 1 kJ$ $c = 0.96 J/g^\circ C$

1st convert KJ → J 1 KJ ⟶ 1000 J

$Q = mc\Delta T$

$1000J = (150g)(0.96 J/g^\circ C)(T_2 - 25)$

$1000 = 144(T_2 - 25)$

$1000 = 144T_2 - 3600$

$1000 + 3600 = 144T_2$ → $4600 = 144T_2$

$\frac{4600}{144} = T_2$

→ $T_2 = 31.94^\circ C$

9) $Q=?$ $m=20g$ $\Delta T = 303-283 = 20^\circ C$ $c = 4.184 J/g^\circ C$

$Q = mc\Delta T$
$Q = (20)(4.184)(20)$
→ $Q = 1673.6 J$

10) $m=15g$ $\Delta T = 250-275 = -25^\circ C$ $Q=?$ $c = 4.184 J/g^\circ C$

$Q = mc\Delta T$
$Q = (15)(4.184)(-25)$
→ $Q = -1569 J$

11) $Q=?$ $m=120g$ $\Delta T = 24-2 = 22^\circ C$ $c = 4.184 J/g^\circ C$

$Q = mc\Delta T$
$Q = (120)(4.184)(22)$
→ $Q = 11045.76 J$

12) $Q=?$ $m=85g$ $\Delta T = 10-200 = -190^\circ C$ $c = 0.129 J/g^\circ C$

$Q = mc\Delta T$
$Q = (85)(0.129)(-190)$
→ $Q = -2083.35 J$

13) $Q = 41.72 J$ $m = 18.69g$ $\Delta T = 27-10 = 17^\circ C$ $c = ?$

$Q = mc\Delta T$
$41.72 = (18.69)(c)(17)$
$41.72 = (c)(317.73)$
$\frac{41.72}{317.73} = c$ → $c = 0.13131 J/g^\circ C$

14) $Q = 41840J$ $\Delta T = 28.5 - 22 = 6.5^\circ C$ $c = 4.184\ J/g^\circ C$
$m = ?$

$Q = mc\Delta T$
$41840J = (m)(4.184)(6.5)$
$41840 = (m)(27.196)$
$\frac{41840}{27.196} = m$ → $m = 1538.46\ g$

15) $Q = ?$ $m = 50g$ $\Delta T = 120 - (-15) = 135^\circ C$ $c = 4.184 J/g^\circ C$

$Q = mc\Delta T$
$Q = (50)(4.184)(135)$
→ $Q = 28242J$

16) $Q = ?$ $m = 32g$ $\Delta T = -40 - 110 = -150^\circ C$ $c = 4.184 J/g^\circ C$

$Q = mc\Delta T$
$= (32g)(4.184)(-150)$
→ $Q = -20083.2J$

17) $c = 2.46 J/g^\circ C$ $Q = ?$ $\Delta T = 35 - 19 = 16^\circ C$ $m = 193g$

$Q = mc\Delta T$
$Q = (193)(2.46)(16)$
→ $Q = 7596.48J$

18) $m = 120g$ $Q = 9612J$ $\Delta T = 115 - 25 = 90^\circ C$ $c = ?$
$Q = mc\Delta T$
$9612 = (120)(c)(90)$ → $9612 = (c)(10800)$
$\frac{9612}{10800} = c$
→ $c = 0.89 J/g^\circ C$