1. How many Joules of heat are given off when 5.00 grams of water cool from 75 °C to 25 °C?
   \[ Q = m \cdot C_p \cdot \Delta T \]
   \[ Q = 5.00 \text{ g} \cdot 4.18 \text{ J/g}^\circ \text{C} \cdot (75 - 25 \circ \text{C}) = 1045 \text{ J} \]

2. If 575 Joules of heat are added to 45.0 grams of water at 25.0 °C, what will the new temperature be?
   \[ Q = m \cdot C_p \cdot \Delta T \]
   \[ 575 \text{ J} = 45.0 \text{ g} \cdot 4.18 \text{ J/g}^\circ \text{C} \cdot \Delta T \]
   \[ \Delta T = 3.06 \circ \text{C} \]
   therefore, new temp would be 28.06 °C.

3. How many Joules does it take to boil 35.0 g of water at 100.0 °C?
   \[ Q = m \cdot H_v \]
   \[ Q = 35.0 \text{ g} \cdot 2260 \text{ J/g} = 79,100 \text{ J} \]

4. When 1550 Joules of heat are added to a 30.7 gram sample of \( \text{H}_2\text{O} \), the temperature changes from 70.0 °C to 95.0 °C. Is the \( \text{H}_2\text{O} \) in solid, liquid, or gas form?
   \[ Q = m \cdot C_p \cdot \Delta T \]
   \[ 1550 \text{ J} = 30.7 \text{ g} \cdot C_p \cdot (95.0 - 70.0 \circ \text{C}) = 2.02 \text{ J/g}^\circ \text{C} \] (gas/steam)

5. How many Joules of heat are necessary to raise the temperature of 25.0 grams of water from 10.0 °C to 60.0 °C?
   \[ Q = m \cdot C_p \cdot \Delta T \]
   \[ Q = 25.0 \text{ g} \cdot 4.18 \text{ J/g}^\circ \text{C} \cdot (60.0 - 10.0 \circ \text{C}) = 5225 \text{ J} \]

6. How many Joules are given off when 55.0 grams of water at 0.00 °C freezes?
   \[ Q = m \cdot H_f \]
   \[ Q = 55.0 \text{ g} \cdot 334 \text{ J/g} = 18,370 \text{ J} \]

7. In a lab experiment, students were given a sample of water at 22.5 °C. The students added 935 Joules of heat to the sample, and the temperature increased to 49.2 °C. What is the mass of the sample of water?
   \[ Q = m \cdot C_p \cdot \Delta T \]
   \[ 935 \text{ J} = m \cdot 4.18 \text{ J/g}^\circ \text{C} \cdot (49.2 - 22.5 \circ \text{C}) = 8.38 \text{ g} \]

8. If 4,550 Joules of heat are added to 17.5 grams of water, by how many degrees Celsius would the water increase?
   \[ Q = m \cdot C_p \cdot \Delta T \]
   \[ 4,550 \text{ J} = 17.5 \text{ g} \cdot 4.18 \text{ J/g}^\circ \text{C} \cdot \Delta T \]
   \[ \Delta T = 62.2 \circ \text{C} \]

9. How many Joules of heat are required to change 25.0 grams of water at 83.2 °C to steam at 100.0 °C?
   
   **Step 1:** water at 83.2 °C to water at 100 °C
   \[ Q = 25.0 \text{ g} \cdot 4.18 \text{ J/g}^\circ \text{C} \cdot (100 - 83.2 \circ \text{C}) = 1755.6 \text{ J} \]
   
   **Step 2:** water at 100 °C to steam at 100 °C
   \[ Q = 25.0 \text{ g} \cdot 2260 \text{ J/g} = 56,500 \text{ J} \]
   
   TOTAL HEAT = 58,255.6 J

10. How much heat (in Joules) is required to change a 23.0 gram ice cube from -12.7 °C to liquid water at 19.4 °C?
    
    **Step 1:** ice at -12.7 °C to ice at 0 °C
    \[ Q = 23.0 \text{ g} \cdot 2.05 \text{ J/g}^\circ \text{C} \cdot 12.7 \circ \text{C} = 598.805 \text{ J} \]
    
    **Step 2:** ice at 0 °C to water at 0 °C
    \[ Q = 23.0 \text{ g} \cdot 334 \text{ J/g} = 7682 \text{ J} \]
    
    **Step 3:** water at 0 °C to water at 19.4 °C
    \[ Q = 23.0 \text{ g} \cdot 4.18 \text{ J/g}^\circ \text{C} \cdot 19.4 \circ \text{C} = 1865.116 \text{ J} \]
    
    TOTAL HEAT = 10,145.921 J

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**Specific Heat of H\(_2\text{O}\) (l) = 4.18 J/g\(^\circ\text{C}\)  \( \text{Heat of Fusion for H\(_2\text{O}\)} = 334 \text{ J/g}\)**

**Specific Heat of H\(_2\text{O}\) (g) = 2.02 J/g\(^\circ\text{C}\)  \( \text{Heat of Vaporization for H\(_2\text{O}\)} = 2260 \text{ J/g}\)**

**Specific Heat of H\(_2\text{O}\) (s) = 2.05 J/g\(^\circ\text{C}\)**
1. Study the phase diagram of water. What two units are plotted against each other in a phase diagram graph? °C (temperature) vs. atm (pressure)

2. Give the state or states of matter present at each of the following conditions:

   (A) 100 °C and 1 atm liq & gas
   (B) 0 °C and 1 atm solid & liq
   (C) 100 °C and 218.3 atm liq
   (D) 50 °C and 1 atm liq
   (E) 50 °C and 0.0060 atm gas
   (F) 150 °C and 200 atm liq
   (G) 400 °C and 220 atm gas
   (H) 375 °C and 230 atm gas
   (I) -50 °C and 0.003 atm solid (probably – not the best graph)
   (J) 0.01 °C and 0.006 atm solid, liq, & gas

3. After a substance passes a certain temperature (critical temperature), it cannot be liquefied. Regardless of the amount of pressure applied, the substance will remain a gas. What is the critical temperature of water? 374 °C
Define critical temperature: temperature above which a substance cannot be liquefied

4. When a substance reaches its critical temperature, it can be liquefied if enough pressure is applied. The pressure necessary to do this is called critical pressure. What is the critical pressure of water? 225 atm
Define critical pressure: minimum pressure required to liquefy a substance at its critical temperature

5. Give the temperature and pressure for the triple point of water. 0.01 °C and 0.006 atm

6. What unique condition occurs at the triple point? all three states of matter exist