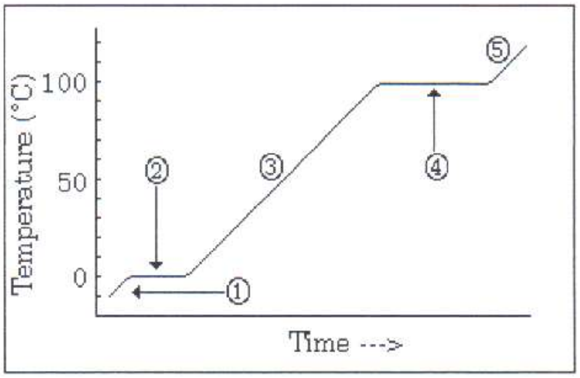
South Pasadena • AP Chemistry

Name Key

Period __ Date __/__/__

# 6 • Energy and Chemical Reactions

## HEATING CURVE CALCULATIONS




In the heating and cooling curves we learned that energy is **absorbed** by a substance as it **warms up**, **melts** (fusion) or **boils** (vaporization) and energy is **released** from a substance as it **cools down**, **condenses**, or **freezes**.

**Calorimetry** ($q=mC\Delta T$) allows us to calculate the energy changes as a substance **warms or cools**. (1, 3, & 5)

The energies involved in **phase changes** (areas 2 & 4) are the **Heat of Vaporization** (liquid → gas) and the **Heat of Fusion** (solid → liquid). These energies will be used as conversion factors.

| Heat of Vaporization or Heat of Condensation of water | Heat of Fusion (melting) or Heat of Solidification of water |
|---|---|
| $H_{vap} = \frac{2330\text{ J}}{\text{gram}}$ | $H_{fus} = \frac{335\text{ J}}{\text{gram}}$ |

Joules (J) are energy units. It takes 4.184 Joules of energy to heat 1 gram of water by 1 °C.

**Examples:**

Calculate the energy needed to vaporize 10.0 g of water.

$$10.0\text{ g } H_2O \times \frac{2330\text{ J}}{\text{gram}} = 23{,}000\text{ J} = 23.0\text{ kJ}$$

Calculate the energy released when 10.0 kg of water melts.

$$10.0\text{ kg } H_2O \times \frac{1000\text{ g}}{1\text{ kg}} \times \frac{335\text{ J}}{\text{gram}} = 3{,}350{,}000\text{ J} = 3{,}350\text{ kJ}$$

Do the following calculations. Show your equation for each problem. $\boxed{\text{Box}}$ your answers.

1. Calculate the energy needed to vaporize…

a) 15.0 g of water $\times \frac{2330\text{ J}}{1\text{ g}} = \boxed{34{,}950\text{ J}} = \cancel{35}\ \boxed{34.95\text{ kJ}}$ $\boxed{35.0\text{ kJ}}$ S.F.

b) 5.75 kg of water $\times \frac{1000\text{ g}}{1\text{ kg}} \times \frac{2330\text{ J}}{1\text{ g}} = \boxed{13{,}397{,}500\text{ J}} = \boxed{13{,}400\text{ kJ}}$

c) 3.88 moles of water $\times \frac{18.02\text{ g}}{1\text{ mole}} \times \frac{2330\text{ J}}{1\text{ g}} = \boxed{162{,}908\text{ J}} = \boxed{163\text{ kJ}}$

2. Calculate the mass of water (in grams) that will be vaporized by…

a) 20.0 kJ of energy $\times \frac{1000\,J}{1\,kJ} \times \frac{1\,g}{2330\,J} = \boxed{8.58\,g}$

b) 175 kJ of energy $\times \frac{1000\,J}{1\,kJ} \times \frac{1\,g}{2330\,J} = \boxed{75.1\,g}$

c) 135 J of energy $\times \frac{1\,g}{2330\,J} = \boxed{0.0579\,g}$

3. Calculate the energy needed to melt…

a) 23.0 g of water $\times \frac{335\,J}{1\,g} = 7{,}705\,J = \boxed{7{,}710\,J} = \boxed{7.71\,kJ}$

b) 8.75 kg of water $\times \frac{1000\,g}{1\,kg} \times \frac{335\,J}{1\,g} = 2{,}931{,}250\,J = \boxed{2{,}930\,kJ}$

c) 3.25 moles of water $\times \frac{18.02\,g}{1\,mol} \times \frac{335\,J}{1\,g} = 19{,}619\,J = \boxed{19.6\,kJ}$

4. Calculate the mass of water (in grams) that will be melted by… $89.55\,g = \boxed{89.6\,g}$

a) 30.0 kJ of energy $\times \frac{1000\,J}{1\,kJ} \times \frac{1\,g}{335\,J} = \cancel{10{,}050{,}000\,g} = \boxed{\cancel{10{,}100{,}000\,g}}$

b) 7.60 kJ of energy $\times \frac{1000\,J}{1\,kJ} \times \frac{1\,g}{335\,J} = \boxed{22.6\,g}$

c) 133 J of energy $\times \frac{1\,g}{335\,J} = \boxed{0.397\,g}$

5. Calculate the energy…

a) absorbed by 35.8 g of ice melting $\times \frac{335\,J}{g} = 11{,}993\,J = \boxed{12.0\,kJ}$

b) released as 88.5 g of water vapor condenses $\times \frac{2330\,J}{1\,g} = 206{,}205\,J = \boxed{206\,kJ}$

c) released as 92.2 g of water freezes $\times \frac{335\,J}{g} = 30{,}887\,J = \boxed{30.9\,kJ}$

d) absorbed as 13.6 g of water vaporizes $\times \frac{2330\,J}{1\,g} = 31{,}688\,J = \boxed{31.7\,kJ}$

e) absorbed when 2.25 moles of ice melts $\times \frac{18.02\,g}{1\,mol} \times \frac{335\,J}{1\,g} = 13{,}582.6\,J = \boxed{13.6\,kJ}$

f) absorbed when 2.25 moles of water vaporizes $\times \frac{18.02\,g}{1\,mol} \times \frac{2330\,J}{1\,g} = 94{,}469\,J = \boxed{94.5\,kJ}$

6. A 25.00 gram sample of ice at 0.0°C melts and then warms up to 20.0°C. How much energy is absorbed?

TWO STEPS

MELTS $25.00\,g \times \frac{335\,J}{1\,g} = 8{,}375\,J$

WARMS $q = mc\Delta T$

$= (25.00\,g)\left(4.184\,\frac{J}{g\,°C}\right)(20.0\,°C) = 2{,}092\,J$

FROM the SUMMER!

TOTAL: $10{,}467\,J = \boxed{10.47\,kJ}$