# Phase Changes and Latent Heat

**How much energy does it take to boil water?**

**PART I –Phase Changes (NOTE: Attached is a list of needed values to solve problems)**

1. What is latent heat?

2. Why does the temperature of $H_2O$ not increase when it is boiling? Explain your answer by drawing a heating/cooling curve for water.

3. Describe the difference between latent heat of fusion versus latent heat of vaporization. Which process involves energy being absorbed?

4. Water vapor condenses on the outside of a soda can.
    a. Is energy being released or absorbed by the water?
    b. What phase change is the water going through?
    c. If you wanted to calculate the heat transferred, what formula would you use and why?

5. Calculate the energy transfered when 4.6g of ice is melted at 0.0°C . Is energy absorbed or released?

6. Calculate the energy transfered when 9.8g of water vapor condenses on a soda can at 100.0°C. Is energy absorbed or released?

7. How much energy is transferred when 8.9g of liquid hydrogen changes to a gas at -253°C? See the table below. Is energy absorbed or released?

8. Calculate the the energy transfered when 89.3g of water is boiled at 100.0°C. Is energy absorbed or released?

9. Calculate the energy transfered when 36.8g of water forms an ice cube in a freezer at 0.0°C. Is energy absorbed or released?

10. Mercury is a neurotoxin that when inhaled can be highly dangerous. Calculate the amount of energy required to change 14g of liquid mercury into a gas at 357°C? See the values in the table at the end of this worksheet to solve this problem. Is energy absorbed or released?

11. Calculate the energy needed to evaporate 340.0g water from an ocean to form water vapor. Is energy absorbed or released?

12. Ethanol is used as a fuel and is the main ingredient of alcohol. Calculate the amount of energy required to evaporate 2.5g of ethanol. See the values in the table at the end of this worksheet to solve this problem. Is energy absorbed or released?

**PART II –Phase Changes and Temperature Change**

1. How much energy in joules is required to heat 25g of ice from -10.0°C to 0.0°C and change it to water? Was energy absorbed or released? The specific heat of ice is 2.09J/g°C.

2. Calculate the energy transfered in joules when 29.5g of liquid water decreases from 14°C to 0.0°C and then freezes at 0.0°C. Was energy absorbed or released?

3. Calculate the energy transfered in joules when 12g of liquid water raises from 22°C to 100.0°C and then boil? Was energy absorbed or released?

4. How much energy in joules does it take to raise 50.0g of ice at 0.0°C to 100.0°C and then boil?

5. How much energy in joules does it take to raise 50.0g of liquid ethanol at 25.0°C to 78.0°C and then evaporate? The specific heat of liquid ethanol is 2.44 J/g°C.

6. How much energy in joules does 28.5g of liquid sulfur lose when it lowers from 120°C to 115°C, then change into a solid? The specific heat of liquid sulfur is 0.71 J/g°C.

7. Draw out a heating curve for mercury and water on the same graph.

Some values for specific latent heats of fusion and vaporization:

| **Substance** | **latent heat of fusion J/g** | **°C Melting Temp.** | **latent heat of vaporization J/g** | **°C Boiling Temp.** |
|---|---|---|---|---|
| Water | 334 | 0 | 2260 | 100 |
| Ethanol | 109 | -114 | 838 | 78 |
| Ethanoic acid | 192 | 17 | 395 | 118 |
| Chloroform | 74 | -64 | 254 | 62 |
| Mercury | 11 | -39 | 294 | 357 |
| Sulphur | 54 | 115 | 1406 | 445 |
| Hydrogen | 60 | -259 | 449 | -253 |
| Oxygen | 14 | -219 | 213 | -183 |
| Nitrogen | 25 | -210 | 199 | -196 |

**More Practice with Phase Changes**

1. Calculate the energy absorbed when 8.5g of ice is melted at 0.0°C .

2. Calculate the energy released when 2.2g of water vapor condenses on a soda can at 100.0°C.

3. Calculate the the energy absorbed when 89.3g of water is boiled at 100.0°C.

4. Calculate the energy released when 20.0g of water forms an ice cube in a freezer at 0.0°C.

5. Calculate the energy needed to evaporate 400.0g water from an ocean to form water vapor.

6. How much energy is required to heat 25g of liquid water from 25°C to 100.0°C and chage it to steam at 100.0°C.

7. Calculate the energy released when 14g of liquid water lowers from 14°C to 0.0°C and then freezes at 0.0°C.

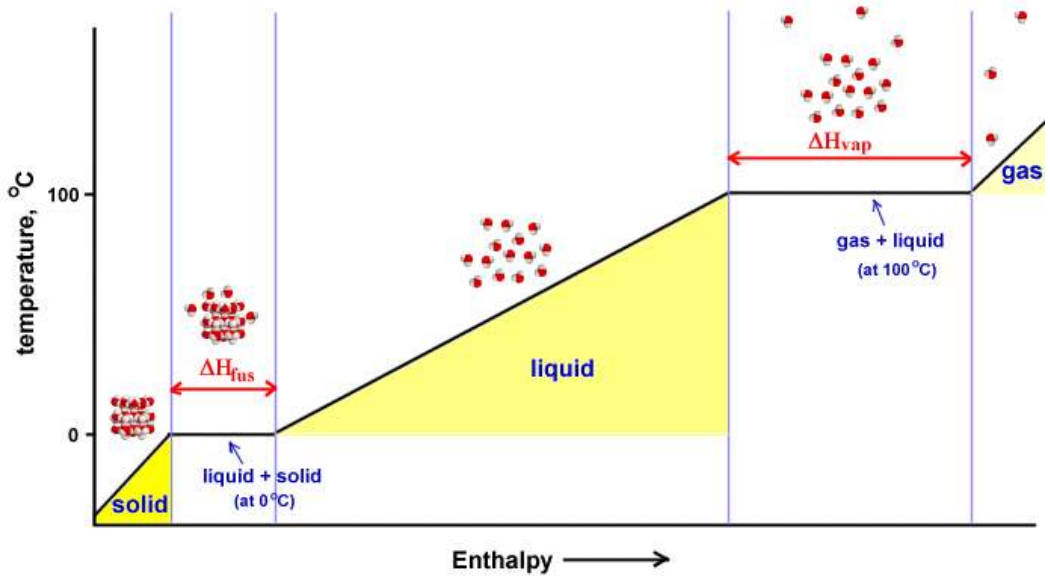
8. Calculate the energy absorbed when 12g of liquid water raises from 55°C to 100.0°C and then boils at 100.0°C.

# ANSWERS – Phase Changes and Latent Heat

1. What is latent heat?

**The amount of energy (enthalpy) required to change the phase of matter for a substance.**

2. Why does the temperature of $H_2O$ not increase when it is melting? Explain your answer by drawing a heating/cooling curve for water.




**The temperature does not increase because all the energy is going towards breaking the intermolecular forces.**

3. Describe the difference between latent heat of fusion versus latent heat of vaporization. Which process involves energy being absorbed?

**Latent heat of fusion = heat energy to take solid to a liquid.**

**Latent heat of vaporization = heat energy to take liquid to a gas.**

**Both processes involve energy being absorbed.**

4. Water vapor condenses on the outside of a soda can.
    a. Is energy being released or absorbed by the water?

    **Energy is released from the water.**

    b. What phase change is the water going through?

    **Gas to Liquid.**

    c. If you wanted to calculate the heat transferred, what formula would you use and why?

    **$Q = m\Delta H_{vap}$**

5. Calculate the energy transfered when 4.6g of ice is melted at 0.0°C . Is energy absorbed or released?

**1536.4 J → 1500J Absorbed energy.**

6. Calculate the energy transfered when 9.8g of water vapor condenses on a soda can at 100.0°C. Is energy absorbed or released?

**22148J → -22000J Released energy.**

7. How much energy is transferred when 8.9g of liquid hydrogen changes to a gas at -253°C? See the table below. Is energy absorbed or released?

**3996.1J → $4.0 \times 10^3$J Absorbed energy.**

8. Calculate the the energy transfered when 89.3g of water is boiled at 100.0°C. Is energy absorbed or released?

**201818J → 202000J Absorbed energy.**

9. Calculate the energy transfered when 36.8g of water forms an ice cube in a freezer at 0.0°C. Is energy absorbed or released?

**12291.2J → -12300J Released energy.**

10. Mercury is a neurotoxin that when inhaled can be highly dangerous. Calculate the amount of energy required to change 14g of liquid mercury into a gas at 357°C? See the values in the table at the end of this worksheet to solve this problem. Is energy absorbed or released?

**4116J → 4100J Absorbed energy.**

11. Calculate the energy needed to evaporate 340.0g water from an ocean to form water vapor. Is energy absorbed or released?

**768400J Absorbed energy.**

12. Ethanol is used as a fuel and is the main ingredient of alcohol. Calculate the amount of energy required to evaporate 2.5g of ethanol. See the values in the table at the end of this worksheet to solve this problem. Is energy absorbed or released?

# 2095J → 2100J Absorbed energy.

**PART II –Phase Changes and Temperature Change**

1. How much energy in joules is required to heat 25g of ice from -10.0°C to 0.0°C and change it to water? Was energy absorbed or released? 522.5

# 8872.5 J → 8900 J Absorbed energy.

2. Calculate the energy transfered in joules when 29.5g of liquid water decreases from 14°C to 0.0°C and then freezes at 0.0°C. Was energy absorbed or released?

# 11580.99J → -12000J Released energy.

3. Calculate the energy transfered in joules when 12g of liquid water raises from 22°C to 100.0°C and then boil? Was energy absorbed or released?

# 31036J → 31000J Absorbed energy.

4. How much energy in joules does it take to raise 50.0g of ice at 0.0°C to 100.0°C and then boil?

# 150620J → 150000J Absorbed energy.

5. How much energy in joules does it take to raise 50.0g of liquid ethanol at 25.0°C to 78.0°C and then evaporate? The specific heat of ethanol is 2.44 J/g°C.

# 48366J → 48400J Absorbed energy.

6. How much energy in joules does 28.5g of sulfur lose when it lowers from 120°C to 115°C, then change into a solid? The specific heat of sulfur is 0.71 J/g°C.

# 1640.2J → -1600J Released energy.

7. Draw out a heating curve for mercury and water on the same graph.

# More Practice with Phase Changes

1. Calculate the energy absorbed when 8.5g of ice is melted at 0.0°C .

**2839 J → 2800 J**

2. Calculate the energy released when 2.2g of water vapor condenses on a soda can at 100.0°C.

**-4972 J → -5000 J → $-5.0 \times 10^3$ J**

3. Calculate the the energy absorbed when 89.3g of water is boiled at 100.0°C.

**201818 J → 202000 J**

4. Calculate the energy released when 20.0g of water forms an ice cube in a freezer at 0.0°C.

**-6680 J → -6700 J**

5. Calculate the energy needed to evaporate 400.0g water from an ocean to form water vapor.

**904000 J → $9.040 \times 10^5$ J**

6. How much energy is required to heat 25g of liquid water from 25°C to 100.0°C and chage it to steam at 100.0°C.

**64345 J → 64000 J**

7. Calculate the energy released when 14g of liquid water lowers from 14°C to 0.0°C and then freezes at 0.0°C.

**-5496 → -5500 J**

8. Calculate the energy absorbed when 12g of liquid water raises from 55°C to 100.0°C and then boils at 100.0°C.

**29379 J → 29000 J**