Name	
Date	Per

PROBLEM SET: 17.3 – Heat in Changes of State

Equations:

 $\begin{array}{l} q = mc \Delta t \\ q = (mass) \mbox{ (heat of fusion)} \\ q = (mass) \mbox{ (heat of vaporization)} \end{array}$

Constants:

specific heat of ice = $2.09 \text{ J/g} \cdot ^{\circ}\text{C}$ specific heat of water = $4.18 \text{ J/g} \cdot ^{\circ}\text{C}$ specific heat of steam = $2.03 \text{ J/g} \cdot ^{\circ}\text{C}$ heat of fusion of water = 334 J/g = 6.01 kJ/molheat of vaporization of water = 2260 J/g = 40.7 kJ/mol

1) How many grams of ice at 0°C could be melted by the addition of 0.455 kJ of heat?

2) How many kJ of heat are required to melt a 115.7 g icicle at 0°C?

3) How much heat (in kJ) is absorbed when 63.7 g of liquid water at 100°C is converted to steam at 100°C?

4) The molar heat of vaporization for chloroethane is 26.4 kJ/mol. How many kJ of heat are absorbed when 0.46 g of chloroethane (C_2H_5CI) vaporizes at its boiling point?

5) Consider the dissolution of NaOH_(s) in water as shown below: NaOH_(s) + H₂O_(l) \rightarrow Na⁺_(aq) + OH⁻_(aq) Δ H = -445.1 kJ/mol How much heat (in kJ) is released when 0.677 g of NaOH_(s) is dissolved in water?

6) Consider the dissolution of NH₄NO_{3(s)} in water is shown below:

 $NH_4NO_{3(s)} + H_2O_{(l)} \rightarrow NH_4^+(aq) + NO_3^-(aq) \Delta H = 25.7 \text{ kJ/mol}$

What mass of $NH_4NO_{3(s)}$ must be dissolved in liquid water so that 88.0 kJ of heat is absorbed from the surrounding water?

7) How much energy is needed to heat a 35.5 g sample of ice at -17.5 °C to liquid water at 77.3 °C?

8) How much energy is needed to heat a 68.9 g sample of water at 88.5 °C to steam at 103.7 °C?

10) How much heat is released when 472.0 g of steam at 212.0°C is cooled all the way to ice at 0.00°C?

	m.p. °C	b.p. ∘C	C _{solid} J/gºC	Cliquid J/gºC	c _{gas} J/gºC	∆H _{fus} J/g	∆H _{vap} J/g
ethanol	-117	78		2.46	0.954	109	855
cesium	28	678	0.246	0.252	0.156	15.7	514
oxygen	-218	-183			0.916	445	6810
gold	1064	2807	0.128	0.150		64	
hydrogen	-259	-253		3.4	14.3		117
copper	1083	2570	0.385			205	4799

Use the following table to answer the questions below:

11) How much heat energy is required to melt 10.0 g of Cu metal if the Cu is at room temperature (25.0°C)?

12) How much heat energy must be added to 2.00 g of gaseous hydrogen to take it from its boiling point to room temperature (25.0°C)?

13) How much heat energy is required to heat 45.3 g of cesium from 15.0°C to 453.0°C?

14) How much heat energy is used to warm 15 g of ethanol from 10.0°C to 60.0°C?

15) How much heat energy is required to melt 84.0 g of oxygen at -218.0°C?

16) How much heat energy is required to heat 146 g of gold from 255.0°C to 1530.0°C?