Worksheet: Heat and Heat Calculations **Name** *KEY*

1. What is the difference in temperature and heat?

   Temperature is a measure of the average kinetic energy and does not depend upon the amount of matter in the sample. Heat is the total kinetic energy that flows because of a difference in temperature and does depend on the amount of matter.

2. *Kinetic Energy* is energy in motion. *Potential Energy* is stored energy and *cannot* be measured. *Changes in energy* can be measured.

3. When you heat a substance and the temperature rises, how much it rises depends upon its *specific heat capacity*.

4. The definition of specific heat capacity is the amount of *heat* required to do what? *Raise 1 gram of a substance* $1^{O}C$.

5. You can touch the aluminum pan of a TV dinner soon after is has been taken from the oven, but you will burn your hand if you touch the food it contains. Explain.

   The aluminum has a lower specific heat than the food (specifically the water in the food) and it therefore heats up and cools off more quickly. A lot of heat must be released before the water will change its temperature even one degree.

6. Why doesn't the temperature of water (for example) continually increase as it is heated?

   The temperature will NOT increase during phase changes. During a phase change, the heat is making the solid turn to liquid or the liquid turn to steam rather than increasing the temperature.

7. What equations must be used to calculate the heat associated with a phase change? $Q = m \times \Delta H_{vap}$ or $Q = m \times \Delta H_{fus}$

   Why can't the specific heat equation be used?

   Because there is no change in temperature.

Use these charts as needed in the following calculations: You will need your own paper to complete your calculations.

Substance	Specific Heat (J/g°C)
H_2O (l)	4.184
H_2O (steam)	2.02
Al (s)	0.89
Fe (s)	0.45

Water

ΔH_{fus} = 334 J/g

ΔH_{vap} = 2260 J/g

8. How much heat is required to warm 275 g of water from 76 °C to 87 °C?

$Q = m \times C \times \Delta t \qquad \Delta t = 87°C - 76°C = 11°C$

$Q = 275\ g \times 4.184\ J/g°C \times 11°C = 13000\ J$

9. PCl_3 is a compound used to manufacture pesticides. A reaction requires that 96.7 g of PCl_3 be raised from 31.7 °C to 69.2°C. How much energy will this require given that the specific heat of PCl_3 is 0.874 J/g °C?

$Q = m \times C \times \Delta t \qquad \Delta t = 69.2°C - 31.7°C = 37.5°C$

$Q = 96.7\ g \times 0.874\ J/g°C \times 37.5°C = 3170\ J$

10. A quantity of water is heated from 25.0 °C to 36.4 °C by absorbing 325 J of heat energy. What is the mass of the water?

$Q = m \times C \times \Delta t \qquad \Delta t = 36.4°C - 25.0°C = 11.4°C$

$$325\ J = (m)(4.184\ J/g°C)(11.4°C)$$

$$m = \frac{325\ J}{(4.184\ J/g°C)(11.4\ °C)} = \boxed{6.81g}$$

11. A 500. g sample of an unknown metal releases 6.4×10^2 J as it cools from 55.0 °C to 25.0 °C. What is the specific heat of the sample?

$Q = m \times C \times \Delta t \qquad \Delta t = 25.0°C - 55.0°C = -30.0°$

$$-6.4x10^2\ J = (500\ g)(C)(-30.0\ °C)$$

$$C = \frac{-6.4x10^2\ J}{(500\ g)(-30.0\ °C)} = \boxed{0.0427\ J/g°C}$$

12. In a household radiator, 1000.g of steam at 100. °C condenses (changes from gas to liquid). How much heat is released?

$Q = m \times \Delta H_{vap}$ $Q = 1000.\ g \times 2260\ J/g = 2{,}260{,}000\ J$

13. How much heat is necessary to change a 52.0 g sample of water at 33.0°C into steam at 110.0 °C? This problem requires several steps since temperature changes and a phase change takes place. Use the hints to solve.

1) Solve for the heat required to increase the water temperature from 33.0 °C to 100.0 °C. Stop here because the water will change phase at this temperature.

   $Q = m \times C \times \Delta t$
   $Q = 52.0\ g \times 4.184\ J/g^oC \times 67°C = 14577\ J$ *(Don't round until end)*

2) Solve for the heat required to change the water into steam (no change in temp).

   $Q = m \times \Delta H_{vap}$ $Q = 52.0\ g \times 2260\ J/g = 117520\ J$

3) Calculate the heat required to change the temperature of the steam from 100.0 °C to 110.0 °C.

   $Q = m \times C \times \Delta t$ $Q = 52.0\ g \times 2.02\ J/g^oC \times 10°C = 1050.4\ J$ *(Note – a different C is used here because the chemical is steam, not liquid water.)*

4) To get the heat required for the whole process, ___*add*___ the calculated heats from above.

   $Q = 14577\ J + 117520\ J + 1050.4\ J = 133{,}000\ J$