{Key}

Unit 2- Energy and Heat Review Stations

HC

Station 1: Energy Changes, Temperature, and Heat Transfer

1. For each of the following chemical or physical changes, check off whether the change is endothermic or exothermic.

Change	Endothermic	Exothermic
a. Burning of charcoal		✓
b. Boiling of water l→g	✓	
c. Formation of frost on a window l→s		✓
d. Production of sugar by plants (photosynthesis)	✓	
e. Evaporation of water l→g	✓	
f. Sublimation of dry ice s→g	✓	
g. Condensation of water to form dew drops		✓

2. Describe how temperature and heat are different.

   temperature: measure of avg kinetic energy

   heat: transfer of energy from warmer body to cooler

3. Convert between the following temperatures:

   a. 50°C to K — 323K

   b. 456 K to °C — 183°C

   c. 43°C to K — 316K

4. If a substance changes from 45°C to 65°C, how many Kelvin degrees will the temperature change?

   20 K — For every 1°C change, there is a 1K change

5. Which of the following substances contains molecules with the highest average kinetic energy? (highest temp.)

   a) He(g) at 0°C

   b) CO_2(g) at 20°C

   c) HCl(g) at 40°C

   (d) N_2(g) at 60°C

6. Describe the transfer of heat that occurs when an ice cube is placed into a mug of hot tea.

   Heat transfers from the hot tea and to the ice cube.

7. Convert the following:

   a. 5 cal to joules

   $5\text{ cal} \times \frac{4.18\text{ J}}{1\text{ cal}} = 20\text{ J}$ (1 sf)

   b. 25 joules to calories

   $25\text{ J} \times \frac{1\text{ cal}}{4.18\text{ J}} = 6.0\text{ cal}$ (2 sf)

   c. 600 calories to kilojoules

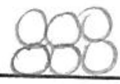
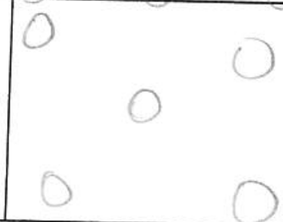
   $600\text{ cal} \times \frac{4.18\text{ J}}{1\text{ cal}} \times \frac{1\text{ kJ}}{1{,}000\text{ J}} = 3\text{ kJ}$ (1 sf)

   d. 3.5 kJ to cal

   $3.5\text{ kJ} \times \frac{1{,}000\text{ J}}{1\text{ kJ}} \times \frac{1\text{ cal}}{4.18\text{ J}} = 840\text{ cal}$ (3 sf)

Station 2: Phases of Matter and Phase Changes

1. Fill out the following chart regarding the phases of matter:

Phase	Particle Diagram (show at least 5 particles)	Spacing between particles	Particle Movement	Kinetic Energy	Strength of Intermolecular Forces
Solid (s)		tight together	vibrating in place / low	low	strong
Liquid (l)		moderate	moderate movement	moderate	moderate
Gas (g)		far apart	fast movement	high	weak

2. Name the six phase changes, say what phases they transition between, and classify them as endothermic or exothermic. The first is done for you.

Endothermic Phase Changes	Exothermic Phase Changes
Ex) melting: s → l	freezing: l → s
vaporizing: l → g	condensing: g → l
sublimation: s → g	deposition: g → s

3. In order to complete the **endothermic** phase changes, what has to be accomplished in terms of a) spacing between particles, b) kinetic energy, and c) strength of intermolecular forces?

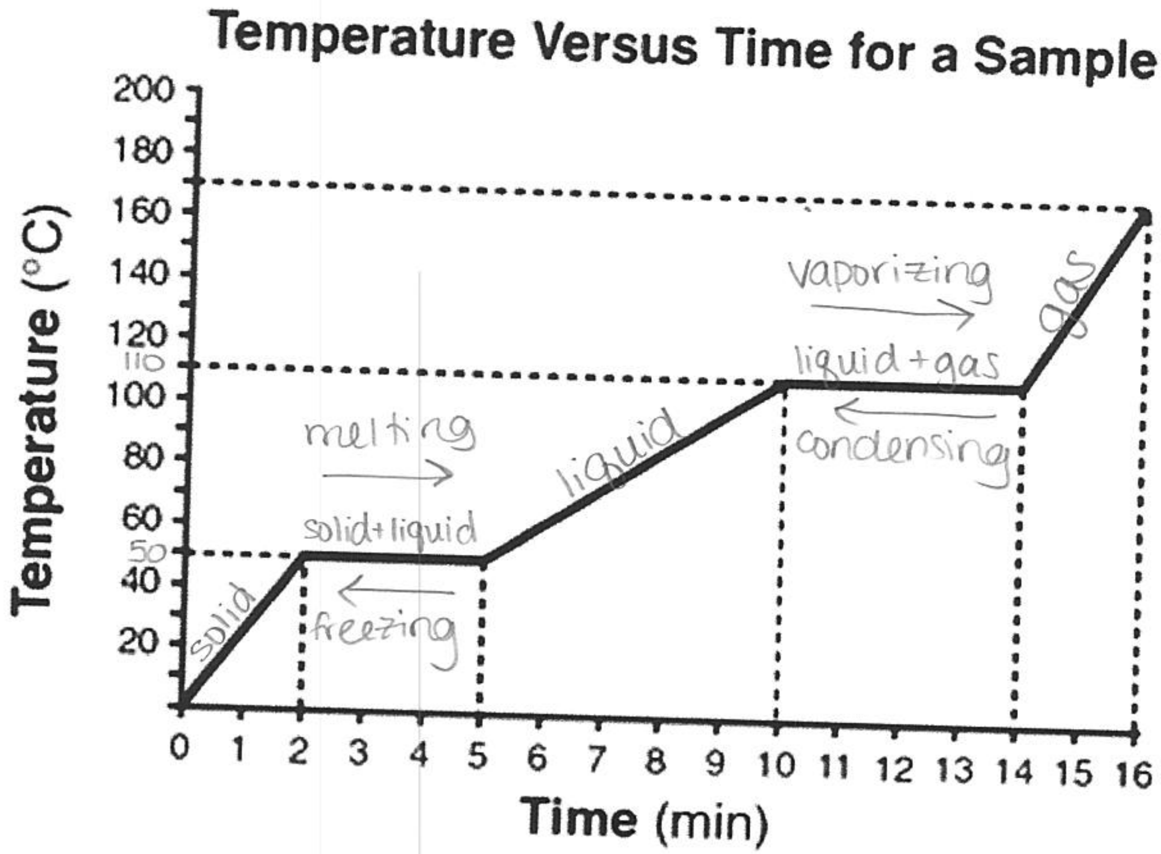
a) must increase space between particles
b) must increase KE
c) must decrease strength of IMF

4. In order to complete the **exothermic** phase changes, what has to be accomplished in terms of: a) spacing between particles, b) kinetic energy, and c) strength of intermolecular forces?

a) must decrease space between particles
b) must decrease KE
c) must increase strength of IMF

Station 3: Heating/Cooling Curve Review

1. On the heating curve below, label the phase(s) present at each segment. Then, label the phase changes that occur.



2. Describe the changes in both kinetic and potential energy that occur along each segment of the graph.
   • Along slopes: KE increases, PE remains same
   • Along plateaus: KE remains same, PE increases
3. Why does the temperature of a substance stay constant during a phase change?
   All added heat energy is being converted into PE & used to overcome the IMF
4. Use the graph to determine the freezing point and ~~melting point~~ boiling point of this substance.
   a. Freezing point: 50°C
   b. Boiling point: 110°C
5. Compare the strength of intermolecular forces in the substance represented in the graph to those in water. Give evidence from the graph to support your answer.
   The substance in the graph has stronger IMF than water, since it has a higher melting pt + boiling pt than water.
6. Why does the segment from 10-14 minutes stay at a constant temperature longer than the segment from 2-5 minutes?
   • 10-14 mins represents vaporizing, in which more IMF need to be overcome than when melting, which occurs from 2-5 minutes

Station 4: Heat Formulas Review

1. Under each heat formula, list some key phrases or words from the problem that would signal the need to use the specific formula.

$q = m c \Delta T$	$q = m H_f$	$q = m H_v$
-temp change -2 temps given -asked to find specific heat, Tf, or Ti	-freezing -melting -solid → liquid -liquid → solid	-vaporizing/boiling -condensing -liquid → gas -gas → liquid

Solve the following problems using the heat formulas above. Round final answers to the proper number of significant figures and include appropriate units.

2. How many joules of heat are needed to vaporize 100 grams of water at 100°C?

1sf 1sf

$q = mH_v = (100 g)(2260 J/g) = 226{,}000 = 200{,}000 J$ (1 sf)

a. What is this quantity in calories?

$200{,}000 J \times \frac{1 cal}{4.18 J} = 47846.88995 = 50{,}000 cal$ (1sf)

3. If it requires 450 J to completely melt 20.0 g of a substance at its melting, point, what is the heat of fusion of the substance?

2sf

$q = mH_f$

$\frac{450 J}{20.0 g} = \frac{(20.0 g)(H_f)}{20.0}$

$22.5 J/g = H_f = 23 J/g$ (2 sf)

4. How much heat is required to raise the temperature of 854 g of water from 23.5 °C to 85.0 °C?

$q = mc\Delta T$

$q = (854 g)(4.18 J/g)(85.0 - 23.5°C)$

$q = 219537.78 = 2.20 \times 10^5 J$ (3sf)

a. What is this quantity in kilojoules?

$2.20 \times 10^5 J \times \frac{1 kJ}{1000 J} = 220 kJ$

5. Calculate the specific heat capacity of copper given that 204.75 J of energy raises the temperature of 15g of copper from 25 °C to 60 °C.

$q = mc\Delta T$

$204.75 J = 15 g \cdot C \cdot (60 - 25°C)$

$204.75 = 525 C$

$0.39 J/g°C = C$

6. Calculate the amount of heat energy required to change 50.0 g liquid water at 56.0 °C to complete vapor.

For 56°C to 100°C
$q = mc\Delta T$
$(50.0)(4.18)(100 - 56)$
9196

+

To vaporize @ 100°C
$q = mH_v$
$(50.0)(2260)$
113000

122196 round to 3sf = 122,000 J

Station 5: Calorimetry

1. If a piece of iron (C_p = 0.450 J/g °C) at 100.0 °C is dropped into a beaker of water at 50.0 °C, would the final temperature be closer to 100.0 °C or 50.0 °C? Why?

The final temp will be closer to 50.0°C because water has a higher specific heat than iron.

Solve the following problems ~~using the heat formulas above.~~ Round final answers to the proper number of significant figures and include appropriate units.

2. A geologist at a mining company is trying to identify a metal sample obtained from a core sample. The unknown metal with a mass of 5.05 g is heated to 100.00 °C and dropped into 10.0 g of water at 22.00 °C. The final temperature of the system is 23.83 °C. What is the specific heat of the metal?

metal $\{ -q_{loss} = q_{gain} \}$ water

$-mc\Delta T = mc\Delta T$

$-(5.05)(c)(23.83-100.00) = (10.0)(4.18)(23.83-22.0)$

$\frac{384.6585\,c}{384.6585} = \frac{76.494}{384.6585}$

$c = 0.199\ J/g°C$ ← 3sf

3. If a piece of aluminum with a mass of 3.90 g and a temperature of 99.3 °C is dropped into 10.0 g of water at 22.6 °C, what will be the final temperature of the system?

(C_p Al = 0.900 J/g °C)

See next page

4. Determine the final temperature when a 25.0 g piece of iron at 85.0 °C is placed into 75.0 g of water at 20.0 °C. ($C_{p\ Iron}$ = 0.450 J/g °C)

See next page

5. 50.0 g of water at 15.0°C is mixed with 75.0 g of water at 80.0°C. What is the final temperature of the water?

See next page

Station 6: Homework Check

At this station, you will use the answer keys provided to check over the Energy Review HW you completed over the weekend.

Solutions: Calorimetry

(3) Al { $-q_{loss} = q_{gain}$ } water

$$-mc\Delta T = mc\Delta T$$

$$-(3.90)(0.900)(T_f - 99.3) = (10.0)(4.18)(T_f - 22.6)$$

$$-3.51(T_f - 99.3) = 41.8(T_f - 22.6)$$

$$-3.51T_f + 348.543 = 41.8T_f - 944.68$$

$$+3.51T_f \qquad + 3.51T_f$$

$$348.543 = 45.31T_f - 944.68$$

$$+944.68 \qquad +944.68$$

$$\frac{1293.223}{45.31} = \frac{45.31T_f}{45.31}$$

$$\boxed{T_f = 28.5°C}$$

(4) iron { $-q_{loss} = q_{gain}$ } water

$$-mc\Delta T = mc\Delta T$$

$$-(25.0)(0.450)(T_f - 85.0) = (75.0)(4.18)(T_f - 20.0)$$

$$-11.25(T_f - 85.0) = 313.5(T_f - 20.0)$$

$$-11.25T_f + 956.25 = 313.5T_f - 6270$$

$$+11.25T_f \qquad + 11.25T_f$$

$$956.25 = 324.75T_f - 6270$$

$$+6270 \qquad +6270$$

$$\frac{7226.25}{324.75} = \frac{324.75T_f}{324.75}$$

$$\boxed{22.30°C = T_f}$$

(5) water initially @ 80.0°C { $-q_{loss} = q_{gain}$ } water initially at 15.0°C

$$-mc\Delta T = mc\Delta T$$

$$-(75.0)(4.18)(T_f - 80.0) = (50.0)(4.18)(T_f - 15.0)$$

$$-313.5(T_f - 80.0) = 209(T_f - 15.0)$$

$$-313.5T_f + 25080 = 209T_f - 3135$$

$$+313.5T_f \qquad +313.5T_f$$

$$25080 = 522.5T_f - 3135$$

$$+3135 \qquad +3135$$

$$\frac{28215}{522.5} = \frac{522.5T_f}{522.5}$$

$$\boxed{54.0°C = T_f}$$