Homework Answers
States of Matter Worksheet
Student Due Date 3/4/10

1) For the following molecules, draw the dot diagram and list the intermolecular forces that would exist for each compound.

\[
\text{CH}_4 \\
\text{Dispersion}
\]

\[
\text{NH}_3 \\
\text{Dispersion, Dipole-Dipole, Hydrogen Bonding}
\]

\[
\text{CH}_3\text{Br} \\
\text{Dispersion, Dipole-Dipole}
\]

\[
\text{CH}_3\text{OH} \\
\text{Dispersion, Dipole-Dipole, Hydrogen Bonding}
\]

2) Use the phase diagram below to answer the following questions about water:

a) At atmospheric pressure, approximately what temperature will the water melt and boil at?

\text{Melt at } 0^\circ\text{C and Boil at } 100^\circ\text{C}

b) If you were in Denver, Colorado (approximate pressure 0.85 atm) what approximate temperature would water boil at?

\text{Approximately 90}^\circ\text{C}

c) What is the highest pressure possible for which water could sublimate?

\text{Approximately 0.008 atm}

3) The following compounds are tested in the lab to find their boiling points (temperature it changes from a liquid to a gas):

\text{C}_3\text{H}_8, \text{C}_2\text{H}_6, \text{C}_4\text{H}_{10}

List these from the lowest boiling point to the highest boiling point and explain why.

\text{C}_2\text{H}_6 \rightarrow \text{C}_3\text{H}_8 \rightarrow \text{C}_4\text{H}_{10}

\text{They all have dispersion forces only, so then the lowest molecular mass would boil first.}

4) These compounds are tested in the lab to find how fast they evaporate:

\text{C}_2\text{H}_6\text{Cl}, \text{C}_2\text{H}_6, \text{C}_3\text{H}_6\text{OH}

List these from the lowest boiling point to the highest boiling point and explain why.
1st - \( \text{C}_2\text{H}_6 \) (dispersion force only)
2nd - \( \text{C}_2\text{H}_5\text{Cl} \) (dispersion and dipole-dipole)
3rd - \( \text{C}_2\text{H}_5\text{OH} \) (dispersion, dipole-dipole, and hydrogen bonding)

5) If you start with 115 g of ethanol, a common gasoline additive, how much energy does it take to change it from a liquid to a gas?

\[
115 \text{ g ethanol} \rightarrow 2.50 \text{ moles ethanol}
\]

\[
q = (\text{mol})(\Delta H_{\text{vap}})
q = (2.50)(38.6)
q = 96.5 \text{ kJ}
\]

6) If you use 155 kJ of heat to melt a chunk of ice (water), how much ice did you start with? (Hint: you can quantify “how much” by finding the mass!)

\[
q = (\text{mol})(\Delta H_{\text{fus}})
155 \text{ kJ} = (\text{mol})(6.01)
\text{mol} = 25.8 \text{ mol } \text{H}_2\text{O}
\]

\[25.8 \text{ mol } \text{H}_2\text{O} \rightarrow 464 \text{ g } \text{H}_2\text{O}\]

7) If you have 100.0 g of ice at the freezing point, how much energy would it take to turn it completely into steam? (Hint: there are two phase changes and a temperature change!)

\[
100.0 \text{ g } \text{H}_2\text{O} \rightarrow 5.556 \text{ moles } \text{H}_2\text{O}
\]

\[
q = (\text{mol})(\Delta H_{\text{fus}}) + (\text{m})(\text{s})(\Delta T) + (\text{mol})(\Delta H_{\text{vap}})
q = (5.556)(6.01) + (100.0)(4.18)(100) + (5.556)(40.67)
q = 33.39 \text{ kJ} + 41.80 \text{ kJ} + 226.0 \text{ kJ}
q = 301.2 \text{ kJ}
\]

8) If you have 100.0 g of trapped steam (water) right at the boiling point and you remove 245 kJ of energy, what is the final temperature of your water?

Use moles from previous question
\[
q = (\text{mol})(\Delta H_{\text{vap}})
q = (5.556)(40.67)
q = 226.0 \text{ kJ}
\]

This leaves 245 kJ - 226 kJ = 19.0 kJ left to be removed
\[
q = (\text{m})(\text{s})(\Delta T)
19000 = (100.0)(4.18)(\Delta T)
\Delta T = 45.5 \degree \text{C}
\]

So your final temperature is \(100 \degree \text{C} - 45.5 \degree \text{C} = 54.5 \degree \text{C}\)