Laney College Chem 30A
Professor Scott Beaver

Homework #9
4/23/2016

Name: Scott Beaver, PhD

1. Draw Lewis structures for each. Indicate any polarity using δ^+ and δ^-.

Indicate the strongest intermolecular force (IMF) present. Choose from:

- hydrogen bonding,
- dipole-dipole forces,
- or London dispersion forces (also known as van der Walls forces).

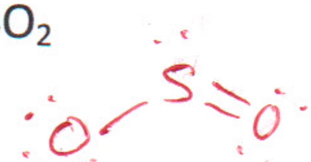
H bond: H on O, N, or F

a) O_2

symmetric, nonpolar

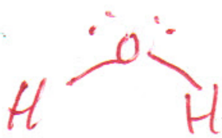
London/van der Waals

b) SO_2



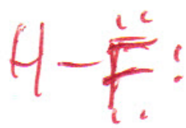
bent, polar, ~~dipole~~ dipole-dipole

c) H_2O



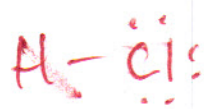
bent polar + −OH Hydrogen bond

d) HF (g), hydrogen fluoride gas (not an acid)



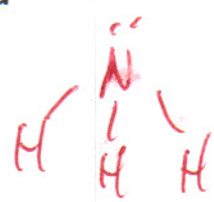
Hydrogen bond

e) HCl (g)



dipole-dipole

f) NH_3, ammonia



Hydrogen bond

g) CO_2

linear, symmetric, nonpolar

London/van der Waals

Name: ______________________

2. Circle the chemical species in each pair that you would expect to have the <u>higher boiling</u> point. Provide a brief explanation (1 sentence max.) using IMF concepts.

a) HF vs. F_2

Why: H bond vs. London

b) NO vs. O_2

slightly asymmetric / slightly polar — completely symmetric + completely nonpolar

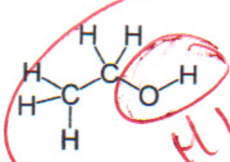
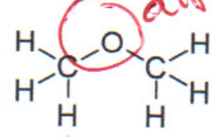
Why: dipole vs. London

c) Cl_2 vs. F_2

Why: Cl_2 is bigger, more surface area, more charge separation, stronger IMF, higher b.p.

d) C_2H_6 vs. CH_4

Why: more surface area — both nonpolar

e)  H bond vs.  dipole

Why: H bond vs. dipole

3. What is responsible for the high boiling point of HF (19.7 °C) relative to HCl (-84.8 °C) and HBr (-66.4 °C)?

- a. hydrogen bonding
- b. dipole/induced dipole force
- c. induced dipole/induced dipole force
- d. covalent bonding
- e. dipole-dipole force

4. Which one of the following molecules has the lowest boiling point?

a. CH_4 b. $CHCl_3$ c. CH_2Cl_2 d. CH_3Cl e. CCl_4

polar – highest b.p.s
larger – higher b.p.
non polar/symmetric
smallest

5. Which of the following boils at the lowest temperature?

a. C_4H_{10} b. C_5H_{12} c. C_6H_{14} d. C_7H_{16} e. C_8H_{18}

smallest hydrocarbon in series

6. Arrange Cl_2, ICl, and Br_2 in order from lowest to highest boiling point.

Cl_2, Br_2 – non polar
Br_2 bigger, higher b.p.
I–Cl polar
highest b.p.; lowest b.p.

$Cl_2 < Br_2 < ICl$ highest b.p.

Name: ______________________

7. Calculate the heat, in Joules, required for the following. Indicate as exothermic or endothermic.

a. heating 25.0 g of water from 20.0 °C to 60.0 °C (c_p = 4.184 J/°C g for water)

$\Delta H = m\, C_p\, \Delta T$
$= (25.0g)(4.184 \frac{J}{°C g})(40.0°C) = 4184\ J$

b. heating 25.0 g water from 60.0 °C to 100.0 °C

same as a) 4184 J

oops... It's 2260 kJ/g

c. boiling 25.0 g of water at 100 °C into steam (ΔH_{vap} = 2260 kJ/mol)

$\Delta H = m\, \Delta H_{vap} = (25.0g)(\frac{2260\ kJ}{g})$
$= 56{,}500\ kJ$

d. condensing 25.0 g of steam at 100 °C into water

$\Delta H = -56{,}500\ kJ$ (same as c, negative)

e. heating 25.0 g of water from 20.0 °C to 100 °C and boiling into steam

= a) + b) + c) = 4184 J + 4184 J + 56,500,000 J = ~56,500,000 J

f. heating 25.0 g copper from 60.0 °C to 100.0 °C (c_p = 0.385 J/°C g for copper)

$\Delta H = m\, C_p\, \Delta T = (25.0g)(0.385 \frac{J}{°C g})(40.0°C)$
$= 385\ J$

g. cooling 25.0 g copper from 20.0 °C to -20.0 °C

same, negative as a) −385 J