CHM 101 Exam 4

MULTIPLE CHOICE (3pts each): Write the ONE letter corresponding to the correct answer on the line next to each question. The LETTER ASSOCIATED WITH THE CORRECT ANSWER MUST BE WRITTEN ON THE LINE NEXT TO THE QUESTION in order to receive full credit.

1.) The attraction between like molecules is referred to as   1.) __D__
   a.) adhesion   b.) viscosity   c.) tension   d.) cohesion

2.) Which type of crystal is hard with very high melting points and lattice points   2.) __A__
   occupied by atoms?
   a.) covalent   b.) ionic   c.) metallic   d.) molecular

3.) Which of the following molecules would have the highest boiling point?   3.) __B__
   a.) CH_3CH_3 b.) CH_3CH_2OH c.) H_3COCH_3 d.) CH_3CH_2Cl

4.) If the enthalpy of the reaction $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$ is -92.6 kJ/mol, what   4.) __C__
   is the energy change when 0.250 mol NH_3 decomposes into nitrogen and
   hydrogen gas?
   a.) + 23.2 kJ/mol   b.) – 23.2 kJ/mol   c.) + 11.6 kJ/mol   d.) – 11.6 kJ/mol

   $0.250\,mol \left(\dfrac{+92.6\,kJ}{2\,mol} \right) = +11.6\,kJ/mol$

5.) How much heat is released by a compound that raises the temperature of water   5.) __A__
   from 20.00°C to 45.00°C when it is burned in a calorimeter with a heat capacity
   of 18.58 J/°C.
   a.) 464.5 J   b.) 1.943×10^3 J   c.) 7.432×10^3 J   d.) 111.0 J

   $18.58\,J/°C\,(45.00°C - 20.00°C) = 464.5\,J$

6.) What is the enthalpy of the overall process if 0.500 mol of solid NaOH is   6.) __D__
   dissolved in an aqueous solution of acid and is then neutralized by the acid
   (NaOH+HA $\rightarrow$ H_2O + NaCl). $\Delta H_{solv} = -44.51$ kJ/mol; $\Delta H_{rxn} = -60.2$ kJ/mol
   a.) –7.75 kJ/mol   b.) –15.5 kJ/mol   c.) –105 kJ/mol   d.) –52.4 kJ/mol

   $0.500\,mol\,(-44.51\,kJ/mol)$

7.) What is the v_{rms} speed of diatomic oxygen at 35°C? R = 8.314 J/molK   7.) __B__
   a.) 7.387 m/s   b.) 490.1 m/s   c.) 15.50 m/s   d.) 165.2 m/s

   $\sqrt{\dfrac{(3)(8.314)(308.15)}{0.0319988}}$

8.) How many liters of $SO_3(g)$ could be made from 2.3L of $O_2(g)$ according to the   8.) __C__
   reaction: $2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$?
   a.) 2.3 L   b.) 1.2 L   c.) 4.6 L   d.) 9.7 L

   $2.3L \left(\dfrac{2\,SO_3}{1\,O_2} \right)$

9.) After two chemicals were mixed in a beaker, the beaker felt very cold. What type   9.) __D__
   of reaction has occurred?
   a.) exomeric   b.) exothermic   c.) endomeric   d.) endothermic

10.) How much energy is released when a molecule of C_2H_4 is formed? (See cover   10.) __A__
   sheet for a table of bond enthalpies; you will not use all of them.)
   a.) 2276 kJ/mol   b.) 2003 kJ/mol   c.) 2468 kJ/mol   d.) 2629 kJ/mol

   $H\diagdown C = C \diagup H$ with H below C atoms

   $414\,(4) + 620 = 2276$

2022F_D
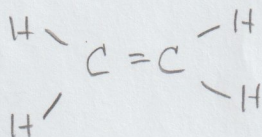
SHORT ANSWER (10 pts each): Completely answer all of the following questions. Read all questions carefully!!! <u>SHOW ALL WORK</u>. If your work is in a different location, you must make a note of this in the given work area for the problem in order for the work to be considered for partial credit. Make sure to include units and report all mathematical answers to the correct number of significant figures. Write final answers in designated locations when indicated.

1.) What volume of carbon dioxide can be produced from the decomposition of 24.8g dinitroanisole ($C_7H_6N_2O_5$, 198.135g/mol) at 150.0°C and 1.624atm?

$$C_7H_6N_2O_5 \text{ (s)} + 6\ O_2 \text{ (g)} \rightarrow 7\ CO_2 \text{ (g)} + 3\ H_2O \text{ (g)} + N_2 \text{ (g)}$$
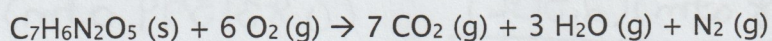
Answer: ___18.7 L___

$$24.8g \left(\frac{1 mol}{198.135g} \right) = 0.125167 \text{ mol DNAN} \left(\frac{7 mol\ CO_2}{1 mol\ DNAN} \right)$$

$$= 0.876 17 \text{ mol } CO_2$$

$$(1.624\ atm)(V) = (0.876 17\ mol)(0.0821\ \tfrac{L atm}{mol\ K})(423.15 K)$$

$$V = 18.743\ L$$

2.) How much energy, in kJ, is required to convert 95.4g ice (18.01528g/mol) at −8.5°C to water at 87.0°C? ΔH_{fus} = 6.01 kJ/mol

Answer: ___68.2 kJ___

ice $q = (95.4g)(2.03\ \tfrac{J}{g\ °C})(0.0°C - (-8.5°C) = 1646.127 J = 1.646\ kJ$

$95.4g \left(\frac{1 mol}{18.01528g} \right) = 5.2955\ mol \left(\frac{6.01 kJ}{mol} \right) = $ $31.826\ kJ$

water $q = (95.4g)(4.184\ \tfrac{J}{g\ °C})(87.0°C - 0.0°C) = 34726.4 J = 34.726\ kJ$

+

$68.198\ kJ$

3.) A 2.50L container of gas at 22.1°C and 0.9958 atm was moved to a room with a temperature of 38.5°C and connected to a larger container so that the final pressure of the gas was 632 torr. What was the final volume of the gas in the combined containers?

$632 \, torr \left(\dfrac{1 atm}{760 \, torr} \right) = 0.831579 \, atm$ Answer: __3.16L__

$$\dfrac{(0.9958 \, atm)(2.50L)}{295.25K} = \dfrac{(0.831579 \, atm)(V_2)}{311.65K}$$

$$0.0084318 \, \dfrac{atm \cdot L}{K} = \dfrac{(0.831579 \, atm)(V_2)}{311.65K}$$

$$2.62778 \, L \cdot atm = (0.831579 \, atm)(V_2)$$

$$V_2 = 3.15999L$$

4.) a.) How much heat is released or absorbed if dissolving 5.87g of a compound with a molar mass of 129.46g/mol changes the temperature of 25.00g of water from 20.00°C to 25.36°C? Make sure to include the correct sign with your answer.

$q_w = (25.00g + 5.87g)(4.184 \, J/g°c)(25.36°c - 20.00°c)$ Answer: __−692J__

$q_w = 692.298 \, J$ $q_c = -692.298 J$

b.) Is this process exothermic or endothermic?   Answer: __exothermic__
   Briefly explain your answer.

   either q is negative

   or   temp of water/environment increased

c.) What is the enthalpy change per mol of compound in kJ/mol? Make sure to include the correct sign with your answer.

$5.87g \left(\dfrac{1 \, mol}{129.46g} \right) = 0.045342 \, mol$ Answer: __−15.3 kJ/mol__

$$\dfrac{-692.298 \, J}{0.045342 \, mol} = -15275.77 \, J/mol \left(\dfrac{1 kJ}{1000J} \right)$$

$$= -15.276 \, kJ/mol$$

5.) a.) A reaction occurs in a piston which produces 0.782mol of gas at 25.0°C in a volume of 6.65mL. What is the pressure in the piston?

Answer: __2880 atm__

$$(P)(0.00665L) = (0.782 mol)(0.0821 \frac{L \cdot atm}{mol \cdot K})(298.15 K)$$

$$P = 2878.479 \, atm$$

b.) If the volume of the piston before the reaction was 1.03mL, how much work was done? Make sure to report your answer in appropriate units for work.
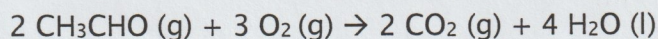
$-1.64 kJ$

Answer: __-1640 J__

$$W = -P\Delta V = -(2878.479 atm)(0.00665L - 0.00103L)$$

$$= -16.177 \, L \cdot atm \left(\frac{101.32 J}{L \cdot atm} \right) = -1639.06 \, J$$

6.) Use the provided enthalpies of formation to calculate the enthalpy of the following reaction. ΔH_f: $CH_3CHO = -166.35$ kJ/mol; $CO_2 = -393.5$ kJ/mol; $H_2O = -285.8$kJ/mol

$$2 \, CH_3CHO \, (g) + 3 \, O_2 \, (g) \rightarrow 2 \, CO_2 \, (g) + 4 \, H_2O \, (l)$$

Answer: __-1597.5 kJ__

$$Prod: 2(-393.5 \, kJ/mol) + 4(-285.8 \, kJ/mol)$$

$$= -787.0 \, kJ - 1143.2 \, kJ$$

$$= -1930.2 \, kJ$$

$$Reac: 2(-166.35 \, kJ/mol) + 3(0 \, kJ/mol)$$

$$= -332.7 \, kJ$$

$$\Delta H_{rxn} = \Sigma \Delta H \, prod - \Sigma \Delta H \, reac$$

$$= -1930.2 \, kJ - (-332.7 \, kJ)$$

$$= -1597.5 \, kJ$$

7.) List the strongest intermolecular attractive force that can be used by each of the following molecules, then answer the questions provided:

H bond

Molecule A

Molecule C
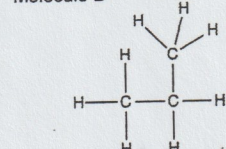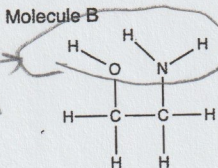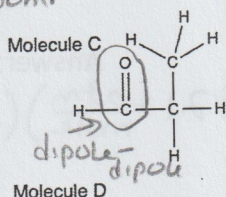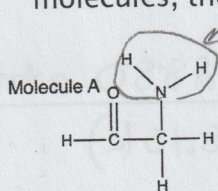
dipole-dipole

Strongest IMAF Molecule A: __H bond__.

Strongest IMAF Molecule B: __H bond__

Molecule B

Molecule D

both → H bond

Strongest IMAF Molecule C: __dipole-dipole__

Strongest IMAF Molecule D: __dispersion__

just dispersion

a.) Which molecule has the highest vapor pressure? __molecule D (weakest IMAF)__

b.) Which molecule has the highest melting point? __molecule B (strongest IMAF)__

c.) Which molecule has the highest surface tension? __molecule B (strongest IMAF)__