Name: _____

Chemistry 150 Exam 3

Be sure to put your name on each page. This page can be removed from your exam so that you will have a Periodic Table handy throughout the exam, it does not need to be turned in. Show all your work for problems which require any sort of calculation, no credit will be given for answers without work shown. If you have shown a significant amount of work or multiple drawings for a problem, draw a box around what you consider your final answer.

Avogadro's Number = 6.022×10^{23} units/mol
$32.00^{o}F = 0.000^{o}C = 273.15K$
1 foot = 12 inches
1 inch = 2.54cm (exactly)
1 pound = 453.6 g = 16 ounces
1 amu = 1.6605×10^{-24} g
Masses of subatomic particles:
Proton 1.00728amu = 1.6726×10^{-24} g
Neutron 1.00866amu = 1.6749×10^{-24} g
Electron 0.000549amu = 9.1094×10^{-28} g
Density of Water = 1.000 g/mL
$R = 0.08206$ L•atm/mol•K
PV=nRT
1 calorie = 4.184 J = 0.001Calorie

1 **H** 1.0079																	2 **He** 4.0026
3 **Li** 6.941	4 **Be** 9.0122											5 **B** 10.811	6 **C** 12.011	7 **N** 14.007	8 **O** 15.999	9 **F** 18.998	10 **Ne** 20.180
11 **Na** 22.990	12 **Mg** 24.305											13 **Al** 26.982	14 **Si** 28.086	15 **P** 30.974	16 **S** 32.066	17 **Cl** 35.453	18 **Ar** 39.948
19 **K** 39.098	20 **Ca** 40.078	21 **Sc** 44.956	22 **Ti** 47.88	23 **V** 50.942	24 **Cr** 51.996	25 **Mn** 54.938	26 **Fe** 55.847	27 **Co** 58.933	28 **Ni** 58.69	29 **Cu** 63.546	30 **Zn** 65.39	31 **Ga** 69.723	32 **Ge** 72.61	33 **As** 74.922	34 **Se** 78.96	35 **Br** 79.904	36 **Kr** 83.80
37 **Rb** 85.468	38 **Sr** 87.62	39 **Y** 88.906	40 **Zr** 91.224	41 **Nb** 92.906	42 **Mo** 95.94	43 **Tc** (98)	44 **Ru** 101.07	45 **Rh** 102.91	46 **Pd** 106.42	47 **Ag** 107.87	48 **Cd** 112.41	49 **In** 114.82	50 **Sn** 118.71	51 **Sb** 121.76	52 **Te** 127.60	53 **I** 126.90	54 **Xe** 131.29
55 **Cs** 132.91	56 **Ba** 137.33	57 **La** 138.91	72 **Hf** 178.49	73 **Ta** 180.95	74 **W** 183.84	75 **Re** 186.21	76 **Os** 190.23	77 **Ir** 192.22	78 **Pt** 195.08	79 **Au** 196.97	80 **Hg** 200.59	81 **Tl** 204.38	82 **Pb** 207.2	83 **Bi** 208.98	84 **Po** (209)	85 **At** (210)	86 **Rn** (222)
87 **Fr** (223)	88 **Ra** 226.03	89 **Ac** 227.03	104 **Rf** (261)	105 **Db** (262)	106 **Sg** (263)	107 **Bh** (262)	108 **Hs** (265)	109 **Mt** (266)	110 (269)	111 (272)	112 (277)		114		116		

58 **Ce** 140.12	59 **Pr** 140.91	60 **Nd** 144.24	61 **Pm** (145)	62 **Sm** 150.36	63 **Eu** 151.97	64 **Gd** 157.25	65 **Tb** 158.93	66 **Dy** 162.50	67 **Ho** 164.93	68 **Er** 167.26	69 **Tm** 168.94	70 **Yb** 173.04	71 **Lu** 174.97
90 **Th** 232.04	91 **Pa** 231.04	92 **U** 238.03	93 **Np** 237.05	94 **Pu** (244)	95 **Am** (243)	96 **Cm** (247)	97 **Bk** (247)	98 **Cf** (251)	99 **Es** (252)	100 **Fm** (258)	101 **Md** (258)	102 **No** (259)	103 **Lr** (260)

Score

Multiple Choice: Circle the letter of the most correct response. (6pts. per question)

1. The First Law of Thermodynamics states that:
   a. Kinetic energy is stored in chemical bonds
   b. Energy cannot be created or destroyed
   c. Potential energy is a measure of the speed of molecular movement
   d. Electrostatic energy is another name for electricity
   e. An element in its "normal" state has no energy

2. The specific heat capacity of a substance is:
   a. The amount of energy required to increase the temperature of one mole of the substance one degree Celsius
   b. The amount of energy required to increase the temperature of one pound of the substance one degree Celsius
   c. $4.184\ ^{J}/_{g\bullet^{o}C}$
   d. The amount of energy required to increase the temperature of one gram of the substance one degree Celsius
   e. The amount of energy required to increase the temperature of one gram of the substance one degree Fahrenheit

3. Each of the following describes an ***exothermic*** process *except*:
   a. Chemical bonds are formed
   b. ΔH is negative
   c. The system liberates heat to the surroundings
   d. The reactants have a higher energy than the products of a reaction
   e. The system absorbs heat from the surroundings

4. Which of the following processes/quantities is ***not*** a state function?
   a. Change in longitude
   b. Change in latitude
   c. The number of stairs you must step on to get from the front of SL104 to the lab
   d. The difference in altitude between the front of SL104 and the lab
   e. ΔH for a reaction

5. Is each of the following processes exothermic or endothermic? (4pts each)

Splitting water to form $H_2(g)$ and $O_2(g)$	*Exothermic*	*Endothermic*
Burning methane in air	*Exothermic*	*Endothermic*
Freezing diesel fuel	*Exothermic*	*Endothermic*
Boiling water	*Exothermic*	*Endothermic*

Score

Multiple Choice Calculations: (12pts each)

6. Bismuth(III) oxide (Bi_2O_3) can be converted to bismuth by the following reaction:

$$2\ Bi_2O_3(s) \rightarrow 4\ Bi(s) + 3\ O_2(g)$$

What is $\Delta H^o_{reaction}$ for this process? ($\Delta H_f^o = -573.9\ ^{kJ}/_{mol}$ for Bi_2O_3.)

a. $+1147.8\ ^{kJ}/_{mol}$
b. $+573.9\ ^{kJ}/_{mol}$
c. $+287.0\ ^{kJ}/_{mol}$
d. $-287.0\ ^{kJ}/_{mol}$
e. $-573.9\ ^{kJ}/_{mol}$
f. $-1147.8\ ^{kJ}/_{mol}$

7. The specific heat capacity of liquid water is $4.184\ ^{J}/_{g\cdot^oC}$. How much energy is released by cooling 150.0g of liquid water from 26.813ºC to 12.193ºC?

a. $1.683x10^4$ J
b. $9.176x10^3$ J
c. $7.652x10^3$ J
d. 4.184 J
e. $1.91x10^{-3}$ J

8. Propane (C_3H_8) is often stored and transported in its liquid form. How much energy is required to boil 428.37g of propane at its boiling point (-42ºC)? ($\Delta H^o_{vaporization} = 15.7\ ^{kJ}/_{mol}$ for propane)

a. 6725 kJ
b. 659 kJ
c. 153 kJ
d. 1.62 kJ
e. 0.0367 kJ

9. You have determined that $\Delta H^o_{reaction}$ for the following reaction is $+98.26\ ^{kJ}/_{mol}$.

$$2\ A(g) + 8\ B(g) \rightarrow 4\ C(g) + 6\ D(g)$$

What is $\Delta H^o_{reaction}$ for the reaction:

$$2\ C(g) + 3\ D(g) \rightarrow A(g) + 4\ B(g)$$

a. $+196.52\ ^{kJ}/_{mol}$
b. $+98.26\ ^{kJ}/_{mol}$
c. $+49.13\ ^{kJ}/_{mol}$
d. $-49.13\ ^{kJ}/_{mol}$
e. $-98.26\ ^{kJ}/_{mol}$
f. $-196.52\ ^{kJ}/_{mol}$

Score

Problems: (22pts each)

10. Hexane burns according to the following equation:

$$2\ C_6H_{14}(g)\ +\ 19\ O_2(g)\ \rightarrow\ 12\ CO_2(g)\ +\ 14\ H_2O(g)$$

You perform an experiment in which you burn 9.842g of hexane and determine that the reaction generated 442.83kJ of heat. Based upon this experiment, what is the value of ΔH_f^o for hexane?

Material	**ΔH_f^o ($^{kJ}/_{mol}$)**
$CO_2(g)$	-393.509
$H_2O(g)$	-241.818

11. The specific heat capacity of graphite is $0.715\ ^{J}/_{g\bullet^oC}$ and the specific heat capacity of ethylene glycol (a component of antifreeze) is $2.38\ ^{J}/_{g\bullet^oC}$. You have cooled a 38.64g block of graphite to 1.394ºC and dropped it into a beaker of ethylene glycol at 21.516ºC. When the system reaches thermal equilibrium, the temperature of the graphite and ethylene glycol is 18.619ºC. If the system is perfectly insulated, how many grams of ethylene glycol were in the beaker?

Score

12. You have been studying a series of reactions:

$$A \rightarrow B \rightarrow C \rightarrow D$$

So far, you have determined the following ΔH^{o}_{rxn} values:

$A \rightarrow B \quad +6.842\ ^{kJ}/_{mol}$

$B \rightarrow C \quad +32.675\ ^{kJ}/_{mol}$

And ΔH^{o}_{rxn} for the whole process ($A \rightarrow D$) is $-11.923\ ^{kJ}/_{mol}$.

What is ΔH^{o}_{rxn} for the reaction $C \rightarrow D$? Draw a qualitatively correct reaction coordinate diagram for the entire stepwise process, $A \rightarrow B \rightarrow C \rightarrow D$.

Score