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
$h = 6.626 \times 10^{-34}$ Jsec
$\lambda = h/mv$
1 J = 1 kg $(m/sec)^2$

$c = \lambda\nu = 3.00 \times 10^{8}$ m/sec
$E_{photon} = h\nu$

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. (5pts. per question)

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

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 gram 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 pound 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. The reactants have a higher energy than the products of a reaction
   c. The system releases heat to the surroundings
   d. ΔH is negative
   e. The system absorbs heat from the surroundings

4. Which of the following is ***not*** a possible set of quantum numbers?
   a. $n = 1$, $\ell = 0$, $m_\ell = 0$
   b. $n = 2$, $\ell = 1$, $m_\ell = -1$
   c. $n = 2$, $\ell = 2$, $m_\ell = -1$
   d. $n = 3$, $\ell = 0$, $m_\ell = 0$
   e. $n = 3$, $\ell = 2$, $m_\ell = 2$

5. Write out the correct electron configuration for a sulfur atom (6pts)

Score

Multiple Choice Calculations: (10pts each)

6. Alumina (Al_2O_3) can be converted to aluminum metal by the following reaction:

$$2\ Al_2O_3(s) \rightarrow 4\ Al(s) + 3\ O_2(g)$$

What is $\Delta H^o_{reaction}$ for this process? ($\Delta H_f^o = -1675.7\ ^{kJ}/_{mol}$ for Al_2O_3.)
   a. $-3351.4\ ^{kJ}/_{mol}$
   b. $-1675.7\ ^{kJ}/_{mol}$
   c. $-837.85\ ^{kJ}/_{mol}$
   d. $1675.7\ ^{kJ}/_{mol}$
   e. $3351.4\ ^{kJ}/_{mol}$

7. The specific heat capacity of liquid water is $4.184\ ^{J}/_{g\bullet ^oC}$. How much energy is required to heat 126.49g of liquid water from 10.34ºC to 61.92ºC?
   a. 32.77 kJ
   b. 27.30 kJ
   c. 5.472 kJ
   d. 1559 J
   e. 6.413×10^{-4} J

8. A green laser pointer emits light with a wavelength of 512nm. What is the energy of a single photon of light from a green laser pointer?
   a. 5.86×10^{5} J
   b. 3.88×10^{-19} J
   c. 1.99×10^{-25} J
   d. 3.88×10^{-28} J
   e. 3.39×10^{-40} J

9. Palmitic acid ($C_{16}H_{32}O_2$) is a saturated fatty acid found in palm oil that melts at 60.48ºC. How much energy is required to melt 50.612g of stearic acid at 60.48ºC? ($\Delta H^o_{fusion} = 163.93\ ^{J}/_{g}$ for palmitic acid)
   a. 5.0179×10^{5} J
   b. 8296.8 J
   c. 3.2390 J
   d. 0.30874 J
   e. 0 J

10. You have determined that $\Delta H^o_{reaction}$ for the following reaction is $-311.2\ ^{kJ}/_{mol}$.

$$3\ Ca(OH)_2(s) + 2\ H_3PO_4(s) \rightarrow Ca_3(PO_4)_2(s) + 6\ H_2O(l)$$

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

$$2\ Ca_3(PO_4)_2(s) + 12\ H_2O(l) \rightarrow 6\ Ca(OH)_2(s) + 4\ H_3PO_4(s)$$

   a. $622.4\ ^{kJ}/_{mol}$
   b. $311.2\ ^{kJ}/_{mol}$
   c. $155.6\ ^{kJ}/_{mol}$
   d. $-311.2\ ^{kJ}/_{mol}$
   e. $-622.4\ ^{kJ}/_{mol}$

Score

Problems:

11. Pentane burns according to the following equation:

$$C_5H_{12}(g) + 8\ O_2(g) \rightarrow 5\ CO_2(g) + 6\ H_2O(g)$$

You perform an experiment in which you burn 12.913g of pentane and determine that the reaction generated 585.6kJ of heat. Based upon this experiment, what is the value of ΔH_f^o for pentane? (20pts)

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

12. Which has the longer deBroglie wavelength, the fastest recorded tennis serve, or the fastest recorded badminton smash? The mass of a standard tennis ball is 57g and the fastest serve was measured at 73.14 $^{m}/_{sec}$ in 1931 by "Big Bill" Tilden. A badminton shuttlecock has a mass of 4.9g and the fastest smash was measured at 92.22 $^{m}/_{sec}$ in 2005 by Fu Haifeng. Show your work. {Note: those speeds are 163 and 206mph. Yikes!} (16pts)

Score

13. The specific heat capacity of gold is $0.128\,^{J}/_{g\bullet^{o}C}$ and the specific heat capacity of iron is $0.449\,^{J}/_{g\bullet^{o}C}$. You have heated a 51.294g block of gold to 49.318ºC and placed it on an iron block at 21.516ºC. When the system reaches thermal equilibrium, the temperature of the gold and iron is 34.468ºC. If the system is perfectly insulated, what was the mass of the iron block in grams? (20pts each)

14. 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:

$A \rightarrow B$ $\quad -17.39\,^{kJ}/_{mol}$

$B \rightarrow C$ $\quad -4.19\,^{kJ}/_{mol}$

And ΔH^{o}_{rxn} for the whole process ($A \rightarrow D$) is $+23.64\,^{kJ}/_{mol}$.

What is ΔH^{o}_{rxn} for the reaction $C \rightarrow D$? Draw a qualitatively correct reaction coordinate diagram for the entire stepwise process, $A \rightarrow B \rightarrow C \rightarrow D$. (18pts each)

Score