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 non-multiple choice 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} $^{\text{units}}/_{\text{mol}}$
$32.00^{o}F = 0.000^{o}C = 273.15K$
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 = $1.000\,^{g}/_{mL}$
$R = 0.08206\ ^{L \cdot atm}/_{mol \cdot K}$
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	71 **Lu** 174.97	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	103 **Lr** (260)	104 **Rf** (261)	105 **Db** (262)	106 **Sg** (263)	107 **Bh** (262)	108 **Hs** (265)	109 **Mt** (266)	110 **Ds** (269)	111 **Rg** (272)	112 **Cn** (277)	113	114	115	116	117	118

57 **La** 138.91	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
89 **Ac** 227.03	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)

Score

Multiple Choice: Circle the letter of the most correct response. (5pts per question)

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

2. The specific heat capacity of any substance is:
   a. The amount of energy required to increase the temperature of one mole of the substance 1°C
   b. The amount of energy required to increase the temperature of one gram of the substance 1°C
   c. $4.184\ ^{J}/_{g\bullet^{o}C}$
   d. The amount of energy required to increase the temperature of one pound of the substance 1°C
   e. The amount of energy required to increase the temperature of one gram of the substance 1°F

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

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

For each of the following, write out a correct electron configuration. You may use noble gas shorthand notation for species below the 2nd row of the Periodic Table. (7pts each)

5. Arsenic (At.# = 33)

6. Bromide ion (At.# = 35)

7. Molybdenum(III) ion (At.# = 42)

Score

Problems:

8. The specific heat capacity of limestone is $0.908\,^{J}/_{g\cdot{}^{o}C}$. How much energy is needed to heat 25.00kg of limestone from 19.61°C to 23.94°C? (15pts)

Answer 8:

9. How much energy is required to vaporize 964.28g of ethanol at its boiling point (78.37°C)? ($\Delta H^{o}_{vaporization} = 38.56\,^{kJ}/_{mol}$ for ethanol) (15pts)

Answer 9:

10. You have determined that $\Delta H^{o}_{reaction}$ for the reaction of hydrogen and oxygen to produce liquid water is $-571.66\,^{kJ}/_{mol}$.

$$2\,H_2(g) + O_2(g) \rightarrow 2\,H_2O(l)$$

What is $\Delta H^{o}_{reaction}$ for the following reaction? Explain your answer. (15pts)

$$6\,H_2O(l) \rightarrow 6\,H_2(g) + 3\,O_2(g)$$

11. One potential source of hydrogen gas for use as a fuel is methane by the following reaction:

$$CH_4(g) \rightarrow 2\,H_2(g) + C(s)$$

What is $\Delta H^{o}_{reaction}$ for this process? $\{\Delta H_f^{o} = -74.87\,^{kJ}/_{mol}$ for $CH_4(g)\}$ How many kJ of energy must be transferred to produce 15.00g of $H_2(g)$? Is the energy transferred *in* or *out* of the system? Explain. (20pts)

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:

$$A \rightarrow B \quad -18.39\,^{kJ}/_{mol}$$
$$C \rightarrow B \quad -26.92\,^{kJ}/_{mol}$$
$$A \rightarrow D \quad +4.27\,^{kJ}/_{mol}$$

What is ΔH^{o}_{rxn} for the the third step, C → D? Is C → D endothermic or exothermic? Draw a qualitatively correct reaction coordinate diagram for the entire stepwise process, A → B → C → D. (20pts)

13. You have burned 25.00g of liquid cyclopentane {$C_5H_{10}(l)$} in excess oxygen to produce carbon dioxide and water. If all of the energy from this reaction is transferred to a 41.93kg block of nickel initially at 6.38°C, what is the final temperature of the nickel block? (The specific heat capacity of Ni(s) is $0.461\,^{J}/_{g\cdot{}^{o}C}$) (25pts)

Material	**ΔH_f^o ($^{kJ}/_{mol}$)**
$C_5H_{10}(l)$	-105.77
$CO_2(g)$	-393.509
$H_2O(g)$	-241.818

Score