

# 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 =  $6.022 \times 10^{23}$  units/mol

$32.00^\circ\text{F} = 0.000^\circ\text{C} = 273.15\text{K}$

1 foot = 12 inches

1 inch = 2.54cm (exactly)

1 pound = 453.6 g = 16 ounces

1 amu =  $1.6605 \times 10^{-24}$  g

Masses of subatomic particles:

Proton  $1.00728\text{amu} = 1.6726 \times 10^{-24}$  g

Neutron  $1.00866\text{amu} = 1.6749 \times 10^{-24}$  g

Electron  $0.000549\text{amu} = 9.1094 \times 10^{-28}$  g

Density of Water =  $1.000 \frac{\text{g}}{\text{mL}}$

$R = 0.08206 \frac{\text{L}\cdot\text{atm}}{\text{mol}\cdot\text{K}}$

$PV = nRT$

1 calorie = 4.184 J = 0.001 Calorie

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

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

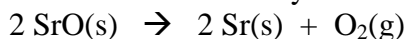
**Multiple Choice:** Circle the letter of the most correct response. (6pts. per question)

1. The First Law of Thermodynamics states that:
  - a. Kinetic energy is stored in chemical bonds
  - b. Electrostatic energy is another name for electricity
  - c. An element in its “normal” 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 a 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°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. 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 absorbs heat from the surroundings
  - d.  $\Delta H$  is negative
  - e. The system liberates heat to the surroundings
  
4. Is each of the following processes endothermic or exothermic? (3pts each)

Splitting water to form H <sub>2</sub> (g) and O <sub>2</sub> (g)	<i>Endothermic</i>	<i>Exothermic</i>
Burning propane in air	<i>Endothermic</i>	<i>Exothermic</i>
Freezing apple juice	<i>Endothermic</i>	<i>Exothermic</i>
Boiling water	<i>Endothermic</i>	<i>Exothermic</i>

**Single Calculations:** (15pts each)

5. Strontium oxide (SrO) can be converted to strontium metal by the following reaction:



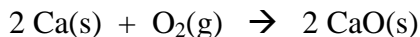
What is  $\Delta H^\circ_{\text{reaction}}$  for this process? ( $\Delta H^\circ_f = -592.0 \text{ kJ/mol}$  for SrO.)

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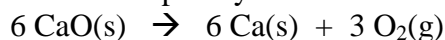
6. The specific heat capacity of liquid water is  $4.184 \text{ J/g}\cdot\text{C}$ . How much energy is released by cooling 450.0g of liquid water from  $38.16^\circ\text{C}$  to  $19.35^\circ\text{C}$ ?

7. How much energy is required to boil 750.0g of water at its boiling point ( $100^\circ\text{C}$ )?  
 ( $\Delta H^\circ_{\text{vaporization}} = 40.64 \text{ kJ/mol}$  for water)

8. You have determined that  $\Delta H^\circ_{\text{reaction}}$  for the reaction of calcium metal with oxygen gas is  $-1270 \text{ kJ/mol}$ .

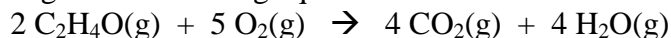


What is  $\Delta H^\circ_{\text{reaction}}$  for the following reaction? Explain your answer.



**Problems:** (20pts each)

9. Acetaldehyde burns according to the following equation:

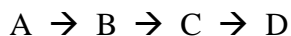


You perform an experiment in which you burn 12.617g of acetaldehyde and determine that the reaction generated 316.35kJ of heat. Based upon this experiment, what is the value of  $\Delta H^\circ_f$  for acetaldehyde?

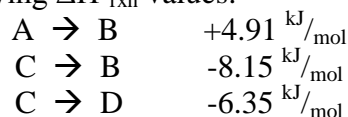
Material	$\Delta H^\circ_f$ ( $\text{kJ/mol}$ )
$\text{CO}_2\text{(g)}$	-393.509
$\text{H}_2\text{O(g)}$	-241.818

10. The specific heat capacity of graphite is  $0.715 \text{ J/g}\cdot^\circ\text{C}$  and the specific heat capacity of ethylene glycol (a component of antifreeze) is  $2.38 \text{ J/g}\cdot^\circ\text{C}$ . You have heated a block of graphite to  $68.19^\circ\text{C}$  and dropped it into a beaker containing  $500.0 \text{ g}$  ethylene glycol at  $19.92^\circ\text{C}$ . When the system reaches thermal equilibrium, the temperature of the graphite and ethylene glycol is  $22.17^\circ\text{C}$ . If the system is perfectly insulated, what was the mass of the graphite block?

11. You have been studying a series of reactions:



So far, you have determined the following  $\Delta H^\circ_{\text{rxn}}$  values:



What is  $\Delta H^\circ_{\text{rxn}}$  for the overall reaction,  $\text{A} \rightarrow \text{D}$ ? Is  $\text{A} \rightarrow \text{D}$  endothermic or exothermic? Draw a qualitatively correct reaction coordinate diagram for the entire stepwise process,  $\text{A} \rightarrow \text{B} \rightarrow \text{C} \rightarrow \text{D}$ .