

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} units/mol

$h = 6.626 \times 10^{-34}$ Jsec

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

$\lambda = h/mv$

1 foot = 12 inches

1 J = 1 kg (m/sec)²

1 inch = 2.54cm (exactly)

$c = \lambda\nu = 3.00 \times 10^8$ m/sec

1 pound = 453.6 g = 16 ounces

$E_{\text{photon}} = h\nu$

1 amu = 1.6605×10^{-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 = $1.000^{\text{g}}/\text{mL}$

$R = 0.08206$ L \cdot atm/mol \cdot K

$PV = nRT$

1 calorie = 4.184 J = 0.001 Calorie

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)

Fall 2011

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

- The First Law of Thermodynamics states that:
 - Kinetic energy is stored in chemical bonds
 - Electrostatic energy is another name for electricity
 - An element in its “standard” state has no energy
 - Energy cannot be created or destroyed
 - Potential energy is a measure of the speed of molecular movement
- The specific heat capacity of any substance is:
 - The amount of energy required to increase the temperature of one mole of the substance 1°C
 - The amount of energy required to increase the temperature of one gram of the substance 1°C
 - 4.184 J/g·°C
 - The amount of energy required to increase the temperature of one pound of the substance 1°C
 - The amount of energy required to increase the temperature of one gram of the substance 1°F
- Each of the following describes an *endothermic* process *except*:
 - Chemical bonds are broken
 - The reactants have a lower energy than the products of a reaction
 - The system absorbs heat from the surroundings
 - ΔH is positive
 - The system liberates heat to the surroundings

Problems:

- The specific heat capacity of wood is 1.76 J/g·°C. How much energy is needed to heat 450.0g of wood from 7.61°C to 29.19°C? (15pts)

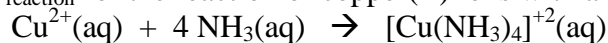
Answer 4:

- How much energy is released when 800.0g of acetone is frozen at its freezing point (-94°C)? ($\Delta H^\circ_{\text{fusion}} = 5.691 \text{ kJ/mol}$ for acetone) (15pts)

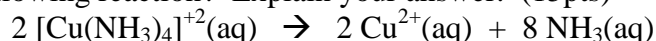
Answer 5:

Fall 2011

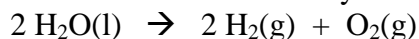
6. You have determined that $\Delta H^\circ_{\text{reaction}}$ for the reaction of copper(II) ions with ammonia is -28.16 kJ/mol .



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

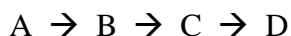


7. One potential source of hydrogen gas for use as a fuel is water by the following reaction:



What is $\Delta H^\circ_{\text{reaction}}$ for this process? $\{\Delta H_f^\circ = -285.83 \text{ kJ/mol}$ for $2 \text{H}_2\text{O}(\text{l})\}$ How many kJ of energy must be transferred to produce 15.00g of $\text{H}_2(\text{g})$? Is the energy transferred *in* or *out* of the system? Explain. (20pts)

8. You have been studying a series of reactions:



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



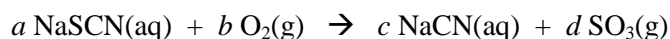
What is $\Delta H^\circ_{\text{rxn}}$ for the the third step, $\text{C} \rightarrow \text{D}$? Is $\text{C} \rightarrow \text{D}$ endothermic or exothermic? Draw a qualitatively correct reaction coordinate diagram for the entire stepwise process, $\text{A} \rightarrow \text{B} \rightarrow \text{C} \rightarrow \text{D}$. (20pts)

Fall 2011

9. You have burned 25.00g of ethane gas {C₂H₆(g)} in excess oxygen to produce carbon dioxide and water. If all of the energy from this reaction is transferred to a 39.67kg block of copper initially at 6.38°C, what is the final temperature of the copper block? (The specific heat capacity of Cu(s) is 0.385 J/g°C) (25pts)

Material	ΔH_f° (kJ/mol)
C ₂ H ₆ (g)	-84.68
CO ₂ (g)	-393.509
H ₂ O(g)	-241.818

10. You have reacted 5.382L of oxygen at 37.32°C and 0.912atm with 250.0mL of 0.773M sodium thiocyanate solution by the following reaction:



How much heat is transferred by this reaction? Is the reaction endothermic or exothermic? (25pts)

Material	ΔH_f° (kJ/mol)
Na ⁺ (aq)	-240.12
SCN ⁻ (aq)	-22.92
CN ⁻ (aq)	-183.62
SO ₃ (g)	-395.72