Name Key
(Please Print)

Last 5 of SS No. XXX–X ___ – ___ ___ ___ ___

Chem 103 - Section 1
Hour Examination II Sample

This test consists of six (6) pages, including this cover page. Be sure your copy is complete before beginning your work. If this test packet is defective, ask for another one.

Show all numeric answers to the proper number of significant digits.

A separate copy of the periodic table will be distributed with this test packet. Feel free to use it in conjunction with any test question. In addition you may need some of the following relationships and constants:

1 Å = 1 x 10^{-10} m = 0.1 nm (exact relationships) Planck's constant = 6.626 x 10^{-34} J·s
speed of light *in vacuuo* = 2.998 x 10^{8} m·s^{-1}

DO NOT WRITE BELOW THIS LINE

DISCLAIMER

This is a copy of a typical second test given in Chem 103 during the regular academic year. Your test will be different. This test is being posted to give you a sense of the format, style, scope, and level of a typical test on this material. This test may have questions on topics that will not be covered on the test you take. Moreover, your test may have questions on topics that are not covered on this test. Posting this test in no way limits the format, style, scope, or level of the test that you will take. **Do not limit your preparation to the material on this sample test.**

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1. **(10 points; 2 points each)** Who did what? Match the person with the concept or discovery.

People

Balmer	Bohr	Brackett	Einstein
Hess	Lymann	Pfund	Planck
	Rutherford	Thomson	

Concepts and Discoveries

a. Bohr Atomic model consistent with hydrogen line spectra

b. Hess Enthalpy change for a reaction is independent of path

c. Einstein Wave-particle duality for light

d. Planck $E = h\nu$

e. Balmer Empirical equation for visible hydrogen line spectrum

2. (12 points; 6 points each) Write the *net ionic equations* for the reactions that occur when the following are mixed together. Indicate all states (e.g., *s*, *l*, *g*, *aq*).

a. $Ni(OH)_2(s) + HNO_3(aq)$

$$Ni(OH)_2(s) + 2H^+(aq) \rightarrow Ni^{2+}(aq) + 2H_2O(l)$$

b. $HI(aq) + Cu(C_2H_3O_2)_2(aq)$

$$H^+(aq) + C_2H_3O_2^-(aq) \rightarrow HC_2H_3O_2(aq)$$

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3. (24 points; 3 points each) Circle the correct answer to each of the following.

a. Which one of the following is insoluble in water?

$(NH_4)_2S$ $SrCO_3$ $BaCl_2$ $CsOH$ $Pb(NO_3)_2$

b. How many milliliters of 0.100 M HCl solution are needed to neutralize 25.0 mL of a 0.320 M NaOH solution?

3.20 mL 7.81 mL 8.00 mL 25.0 mL 80.0 mL

c. Which one of the following is a weak electrolyte?

$HClO_4$ HBrO AgBr $Ca(OH)_2$ C_2H_5OH

d. Of the following, the one that will form a *gas* when treated with excess $HNO_3(aq)$

$CaSO_3(aq)$ $Pb(NO_3)_2(aq)$ $NaOH(aq)$ $CuCl_2(aq)$ $PbSO_4(s)$

e. Which of the following has the shortest wavelength?

blue light infrared red light gamma radiation radio waves

f. The following represent transitions in the line spectrum of hydrogen of the type $n_{high} \rightarrow n_{low}$. Which one of the following results in the emission of ultraviolet radiation?

6→5 5→4 4→3 3→2 2→1

g. The oxidation state of sulfur in SO_3^{2-} ion is

2– 0 3+ 4+ 6+

h. Consider the redox reaction

$$Cr_2O_7^{2-}(aq) + 3\ SO_2(g) + 5\ H^+(aq) \rightarrow 2\ Cr^{3+}(aq) + 3\ HSO_4^-(aq) + H_2O(aq)$$

In this reaction the oxidant is

$Cr_2O_7^{2-}(aq)$ $SO_2(g)$ $H^+(aq)$ $Cr^{3+}(aq)$ $HSO_4^-(aq)$

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4. (24 points; 8 points each part) Answer all parts. Show work in the spaces provided to justify your answers.

a. What is the molarity of a solution prepared by dissolving 0.112 g of glucose ($C_6H_{12}O_6$, m.w. = 180.1 u) in enough water to make 456 mL of solution?

$$M = \left(\frac{0.112\ \text{g glucose}}{0.456\ \text{L soln}}\right)\left(\frac{\text{mol glucose}}{180.1\ \text{g glucose}}\right)$$

$$= 1.36 \times 10^{-3}\ \text{M}$$

b. What is the energy in joules of a photon whose wavelength is 632 nm?

$$E = \frac{hc}{\lambda} = \frac{(6.626 \times 10^{-34}\ \text{J}\cdot\text{s})(2.998 \times 10^{8}\ \text{m}\cdot\text{s}^{-1})}{632 \times 10^{-9}\ \text{m}}$$

$$= 3.14 \times 10^{-19}\ \text{J}$$

c. Given the following thermochemical data:

Compound	ΔH°_f
$C_2H_5NH_2(l)$	–84.5 kJ
$CO_2(g)$	–393.5 kJ
$H_2O(l)$	–285.8 kJ

Calculate the enthalpy, ΔH°, for the reaction,

$$4C_2H_5NH_2(l) + 15O_2(g) \rightarrow 8CO_2(g) + 14H_2O(l) + 2N_2(g)$$

$$\Delta H^\circ_{rxn} = 8\Delta H^\circ_f(CO_2) + 14\Delta H^\circ_f(H_2O) + 2\Delta H^\circ_f(N_2) - 4\Delta H^\circ_f(C_2H_5NH_2) - 15\Delta H^\circ_f(O_2)$$

$$= (8)(-393.5) + (14)(-285.8) - (4)(-84.5)$$

$$= -6811.2\ \text{kJ}$$

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5. (14 points) A 3.751-g sample of dimethylamine (m.w. = 45.08 u) was burned in excess oxygen in the bomb of a calorimeter. The heat capacity of the apparatus (bomb and water filling the calorimeter) was 7.698 kJ/°C. The reaction caused the temperature of the water in the calorimeter to increase from 20.55 °C to 39.33 °C. From this experiment, what is the value of the enthalpy of combustion of *one mole* of dimethylamine in kilojoules? (Show work to justify your answer.)

$\Delta T = 39.33\,^{\circ}C - 20.55\,^{\circ}C = 18.78\,^{\circ}C$

$q_{cal} = C\Delta T = (7.698\ kJ/^{\circ}C)(18.78\,^{\circ}C)$

$= 144.5_{6844}\ kJ$

$\Delta H_{comb} = \left(\frac{-144.5_{6844}\ kJ}{3.751\ g}\right)\left(\frac{45.08\ g}{mol}\right)$

$= -1737.44\ kJ/mol = -1737\ kJ/mol$

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6. (16 points) Calculate the standard enthalpy of formation of $CaCO_3(s)$, given the following data:

$2Ca(s) + O_2(g) \rightarrow 2CaO(s)$	$\Delta H^\circ = -1271.0$ kJ
$CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$	$\Delta H^\circ = +178.1$ kJ
$C(s) + O_2(g) \rightarrow CO_2(g)$	$\Delta H^\circ = -393.5$ kJ

Hint: First write the "target reaction", the chemical equation that defines the standard enthalpy of formation of $CaCO_3(s)$, whose enthalpy you are trying to calculate.

$Ca(s) + C(s) + \frac{3}{2}O_2(g) \longrightarrow CaCO_3(s) \quad \Delta H^\circ_f = ?$

$\frac{1}{2}$a $Ca(s) + \frac{1}{2}O_2(g) \longrightarrow CaO(s) \quad \Delta H^\circ = (\frac{1}{2})(-1271.0) = -635.5$

−b $CaO(s) + CO_2(g) \longrightarrow CaCO_3(s) \quad \Delta H^\circ = -178.1$

c $C(s) + O_2(g) \longrightarrow CO_2(g) \quad \Delta H^\circ = -393.5$

$Ca(s) + C(s) + \frac{3}{2}O_2(g) \rightarrow CaCO_3(s) \quad \Delta H^\circ_f = -1207.1$ kJ