CHEM 188 – Spring, 2012

Hour Exam 3 (Early)

April 4, 2012

Instructions:

Your scantron answer sheet must show your **NAME**, **7-DIGIT KU ID NUMBER**, and **LAB SECTION**. (Begin these entries at the LEFT end of the space provided.) In answering the questions, be careful to fill in the corresponding circles on the answer sheet according to the number of the question on the exam. **USE A SOFT (No. 2) PENCIL**.

Note that a **periodic table** of the elements is attached at the end of the exam.

Useful information:

Avogadro's Number $\mathbf{N_A = 6.022 \times 10^{23}\ mol^{-1}}$

Gas constant $\mathbf{R = 8.314\ J\,K^{-1}\,mol^{-1} = 0.0821\ L\,atm\,K^{-1}\,mol^{-1}}$

Boltzmann constant $\mathbf{k = 1.38 \times 10^{-23}\ J\,K^{-1}}$

Conversion factor: **1 L atm = 101.3 J**

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1. A 75 kg person drinks 250 g of milk, which has a "caloric" value of approximately 3.0 kJ/g. If only 17% of the energy in milk is converted to mechanical work, how **high (in meters)** can the person climb based on this energy intake? [Hint: The work done in ascending is given by *mgh*, where *m* is the mass (in kilograms), *g* the gravitational acceleration (9.8 m/s^2), and *h* the height (in meters.)]

A. 170 B. 260 C. 350 D. 450 E. 560

2. An ideal gas is allowed to expand at constant temperature from a volume of 1.00 L to 5.00 L against a constant external pressure of 2.00 atm. What is the value of **w**, the work done on the gas?

A. -810 J B. – 8.00 J C. 0 J D. +8.00 J E. +810 J

3. Calculate **w**, the work done on the system, when 80.0 g of potassium reacts with water to form hydrogen gas at 2.00 atm and 40°C. (Assume ideal gas behavior.)

$$2K(s) + H_2O(l) \rightarrow 2KOH(aq) + H_2(g)$$

A. –0.333 kJ B. –0.666 kJ C. –1.33 kJ D. –2.66 kJ E. none of these

4. A gas expands and does *P*-*V* work on the surroundings equal to 400 J. At the same time, it releases 150 J of heat to the surroundings. What is the change, □**U**, in the internal energy of the gas?

A. 550 J B. 250 J C. 0 J D. –150 J E. –550 J

5. Given the thermochemical equation

$$H_2(g) + Cl_2(g) \rightarrow 2HCl(g) \qquad \Delta H = -184.2 \text{ kJ}$$

calculate the enthalpy change, □**H**, for the reaction

$$HCl(g) \rightarrow \tfrac{1}{2} H_2(g) + \tfrac{1}{2} Cl_2(g)$$

A. –184.6 kJ B. –92.3 kJ C. 0 kJ D. 92.3 kJ E. 184.6 kJ

6. The combustion of methane produces heat according to the equation

$$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(l) \qquad \Delta H^\circ_{rxn} = -890 \text{ kJ}$$

How much **heat** is generated by the combustion of 20 g of methane?

A. 890 kJ B. 1,100 kJ C. 2,800 kJ D. 4,200 kJ E. 5,600 kJ

7. Given the following thermochemical equation, calculate the value of □**U** for the formation of 3 moles of NH_3 at 1.00 atm and 25°C?

$$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g) + 92.6 \text{ kJ}$$

A. –131.4 kJ B. –135.2 kJ C. –138.9 kJ D. –142.5 kJ E. –146.4 kJ

8. If 325 g of water at 4.2°C absorbs 12.3 kJ of heat, what is the **final temperature** of the water? The specific heat of water is 4.184 J/g·°C.

A. 10.0°C B. 12.2°C C. 13.2°C D. 15.6°C E. 18.0°C

9. A 1.75 g sample of octane (C_8H_{18}) was burned in an oxygen bomb calorimeter. The total heat capacity of the calorimeter plus water was 11.5 kJ/°C. If the temperature rise of the calorimeter with water was 7.30°C, calculate the molar value of □**U** for the combustion of octane.

A. □5,650 kJ/mol B. □5,470 kJ/mol C. –3,230 kJ/mol

D. –2,810 kJ/mol E. □1,370 kJ/mol

10. To which one of the following reactions occurring at 25°C and 1.00 atm pressure does the symbol $\Delta H^\circ_f[CO_2(g)]$ refer?

A. $C(g) + O_2(g) \rightarrow CO_2(s)$

B. $C(s) + O_2(g) \rightarrow CO_2(g)$

C. $CO(g) + \frac{1}{2} O_2(g) \rightarrow CO_2(g)$

D. $C(s) + 2O(g) \rightarrow CO_2(g)$

E. $CO_2(g) \rightarrow C(s) + O_2(g)$

11. All of the following have a **standard enthalpy of formation** value of zero at 25°C and 1.00 atm, except …

1. $He(g)$
2. $Fe(s)$
3. $O_3(g)$
4. $NO(g)$

A. 2 only B. 3 only C. 4 only D. 2 & 4 E. 3 & 4

12. Determine the standard enthalpy of formation, ΔH°_f, for $HBr(g)$, given the following thermochemical equation:

$$H_2(g) + Br_2(l) \rightarrow 2HBr(g) + 72.4 \text{ kJ}$$

A. –72.4 kJ B. –36.2 kJ C. 0 kJ D. 36.2 kJ E. 72.4 kJ

13. Octane (C_8H_{18}) undergoes combustion according to the following thermochemical equation:

$$2C_8H_{18}(l) + 25O_2(g) \rightarrow 16CO_2(g) + 18H_2O(l) \qquad \Delta H^\circ_{rxn} = -11{,}020 \text{ kJ/mol.}$$

Given that $\Delta H^\circ_f[CO_2(g)] = -393.5$ kJ/mol and $\Delta H^\circ_f[H_2O(l)] = -285.8$ kJ/mol, calculate the **standard enthalpy of formation** of octane.

A. −210 kJ/mol B. −11,230 kJ/mol C. 22,040 kJ/mol

D. −420 kJ/mol E. 420 kJ/mol

14. Consider the following two reactions:

(1) $A \rightarrow 2B$ $\Delta H_1 = 200$ kJ