

CHEM 188 – Spring, 2012

Hour Exam 4 (Early)

May 2, 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	$N_A = 6.022 \times 10^{23} \text{ mol}^{-1}$
Gas constant	$R = 8.314 \text{ J}\cdot\text{K}^{-1}\cdot\text{mol}^{-1} = 0.0821 \text{ L}\cdot\text{atm}\cdot\text{K}^{-1}\cdot\text{mol}^{-1}$
Boltzmann constant	$k = 1.38 \times 10^{-23} \text{ J}\cdot\text{K}^{-1}$
Planck's constant	$h = 6.626 \times 10^{-34} \text{ J}\cdot\text{s}$
Speed of light	$c = 3.00 \times 10^8 \text{ m}\cdot\text{s}^{-1}$
Conversion factors:	$1 \text{ atm} = 760 \text{ mm Hg}$ $1 \text{ L}\cdot\text{atm} = 101.3 \text{ J}$ $1 \text{ amu} = 1.66 \times 10^{-27} \text{ kg}$ $1 \text{ watt} = 1 \text{ J/s}$
Gibbs Free Energy	$\Delta G = \Delta G^\circ + RT \ln Q$
First-order kinetics	$N = N_0 \exp(-kt)$

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1. Calculate ΔG at 298 K for the reaction



given that $\Delta G_f^\circ [\text{N}_2\text{O}_4(g)] = 98.3 \text{ kJ/mol}$ and $\Delta G_f^\circ [\text{NO}_2(g)] = 51.8 \text{ kJ/mol}$ at 298K.

- A. -46.5 kJ B. -5.3 kJ C. 0 kJ **D. 5.3 kJ** E. 46.5 kJ

2. Given the following data at 25°C,



deduce the **standard free energy of formation**, ΔG_f° , of $\text{CO}(g)$ at 25°C.

- A. -257.1 kJ/mole **B. -137.3 kJ/mole** C. 0 kJ/mole
D. 137.3 kJ/mole E. 257.1 kJ/mole

3. For the reaction



$\Delta H^\circ = -267.1 \text{ kJ}$ and $\Delta S^\circ = -171.8 \text{ J/K}$ at 25°C . Estimate the **minimum temperature** at which this reaction will be spontaneous under standard state conditions.

- A. 0 K B. 273 K C. 838 K D. 1555 K E. 1711 K

4. For the reaction



$\Delta G^\circ = +209.2 \text{ kJ/mol}$ at 25°C . If $P(\text{H}_2) = 100. \text{ atm}$, and $P(\text{C}_2\text{H}_2) = 0.10 \text{ atm}$, calculate ΔG for this reaction at this temperature.

- A. +207.8 kJ/mol B. +226.3 kJ/mol C. +192.1 kJ/mol
D. +17.3 kJ/mol E. -16.9 kJ/mol

5. A saturated solution of magnesium hydroxide was found to have a pH of 10.46 at 25°C . What is the value of ΔG° (in kJ/mol) at 25°C for the reaction



- A. 29 B. 62 C. 79 D. 110 E. 190

6. Hydrogen peroxide (H_2O_2) decomposes according to the equation



Estimate K_p for this reaction at 0°C . You may assume that $\Delta H^\circ = -98.2 \text{ kJ/mol}$ and $\Delta S^\circ = 70.1 \text{ J/K}\cdot\text{mol}$ at this temperature.

- A. 3.6×10^{26} B. 2.9×10^{20} C. 3.5×10^{19} D. 7.5×10^{20} E. 2.8×10^{22}

7. How many **neutrons and protons** (nucleons) does an atom with the symbol P have?

- A. 15 B. 16 C. 31 D. 46 E. None of these

8. The symbol for an **electron** is

- A. n B. e^- C. e^+ D. He E. ${}^1_1\text{H}$

9. As a result of **alpha decay**, the product nucleus is

- A. one atomic number lower than the original element.
 B. two atomic numbers higher than the original element.
 C. one atomic number higher than the original element.
 D. two atomic numbers lower than the original element.
 E. four atomic numbers lower than the original element.
10. A radioisotope decays to give a beta particle and Nb-97. What was the **original element**?
- A. Y B. Zr C. Mo D. Ru E. none of these
11. A typical atomic nucleus has a **mass** of about
- A. 1×10^{14} g B. 1×10^{18} g C. 1×10^{22} g D. 1×10^{26} g E. 1×10^{30} g
12. The only stable isotopes of carbon are C-12 and C-13. Predict the **mode of decay** of $^{11}_{6}\text{C}$.
- A. alpha emission
 B. beta emission
 C. proton emission
 D. neutron emission
 E. positron emission
13. Which of the following nuclides has the highest **nuclear binding energy per nucleon**?
- A. H B. He C. C D. $^{16}_{8}\text{O}$ E. $^{35}_{17}\text{Cl}$
14. What is the **nuclear binding energy per nucleon** for ^7_3Li (atomic mass 7.016005 amu).
 Data: H (atomic mass) = 1.007825 amu; n (mass) = 1.008665 amu; 1 kg = 6.022×10^{26} amu; c = 3.00×10^8 m/s.
- A. 4.04×10^{13} J/nucleon
 B. 8.55×10^{13} J/nucleon
 C. 8.99×10^{13} J/nucleon
 D. 1.04×10^{12} J/nucleon
 E. 6.29×10^{12} J/nucleon
15. In the Th decay series there are six radioisotopes that decay by alpha emission, including Th-232 itself, and four radioisotopes that decay by beta emission. The final product of this series is a stable isotope. The symbol for this product is
- A. W B. W C. Pb D. Pb E. Pt
16. Calculate the **energy released** in MeV ($1 \text{ MeV} = 1.6022 \times 10^{-13}$ joules) when one atom of Li-10 decays according to the reaction