Name: ____________________________________________, SSN ___________________________

LAST NAME, First
(Circle the alphabet segment of your LAST NAME): A, B, C-H, I-M, N-S, T-Z

Please answer the following questions:

**Part I: Multiple Choices (56 pts: 14 @ 4 pts each). Circle the ONE best answer:**

1. Consider four identical 1.0 L flasks containing the following gases each at 25 °C and 1 atm pressure. Which gas do the molecules have the greatest average kinetic energy?
   - a) H₂
   - b) O₂
   - c) NH₃
   - d) same for all gases

2. Which of the following equations DO NOT represent an oxidation?
   - a) SO₂ → SO₃
   - b) Mg → Mg²⁺
   - c) MnO₂ → Mn²⁺
   - d) 2 Br⁻ → Br₂

3. The oxidation states of chlorine in SO₃²⁻ and H₂S are:
   - a) +4 and -2, respectively
   - b) +6 and -2, respectively
   - c) -4 and +2, respectively
   - d) +2 and -2, respectively

4. Which set of temperature and pressure conditions will cause a gas to exhibit the greatest deviation from the ideal behavior?
   - a) 100 °C and 4 atm
   - b) 100 °C and 2 atm
   - c) -100 °C and 4 atm
   - d) 0 °C and 4 atm

5. Calculate the wavelength, in meters, of microwave radiation that corresponds to an energy of 2.63 J/mol photons.
   - a) 2.63 m
   - b) 4.55 x 10⁻² m
   - c) 1.14 x 10⁸ m
   - d) none of the above

6. Which of the following electromagnetic radiation has the shortest frequency?
   - a) X-ray
   - b) Visible light
   - c) Radio wave
   - d) Infrared

7. Which of the following isoelectronic species would have the smallest radius?
   - a) Mg²⁺
   - b) N³⁻
   - c) O²⁻
   - d) F⁻
8. The orbital of 2p electrons is often represented as being
   a) elliptical  b) square
   c) dumbbell shaped  d) spherical

9. Which of the following would cause a reduction in the volume of a gas?
   a) Increasing the number of molecules (constant P & T)
   b) Decreasing the pressure (constant n & T)
   c) Decreasing the temperature (constant n & P)
   d) Increasing the kinetic energy (constant n & P)

10. Which set of quantum numbers is correct and consistent with n = 4?
    a) $\ell = 2, m_\ell = -3, m_s = +\frac{1}{2}$
    b) $\ell = 4, m_\ell = -5, m_s = -\frac{1}{2}$
    c) $\ell = 3, m_\ell = +3, m_s = +\frac{1}{2}$
    d) $\ell = 3, m_\ell = -3, m_s = +1$

11. An Ag$^+$ ion is
    a) paramagnetic with two unpaired electrons
    b) diamagnetic with zero unpaired electrons
    c) paramagnetic with three unpaired electrons
    d) paramagnetic with one unpaired electron

12. The ground state electron configuration of iridium, Ir (Z = 77) is
    a) [Xe] 5d$^7$ 6s$^2$
    b) [Xe] 4f$^{14}$ 5d$^7$ 6s$^2$
    c) [Xe] 4f$^{14}$ 5d$^8$ 6s$^1$
    d) [Xe] 4f$^{14}$ 5d$^9$

13. The maximum number of electrons in the 4d subshell is
    a) 6  b) 14
    c) 2  d) 10

14. The ground state electron configuration of chromium atom, Ni (Z = 28) is
    a) 1s$^2$ 2s$^2$ 2p$^6$ 3s$^2$ 3p$^6$ 3d$^{10}$
    b) 1s$^2$ 2s$^2$ 2p$^6$ 3s$^2$ 3p$^6$ 4s$^2$ 3d$^8$
    c) 1s$^2$ 2s$^2$ 2p$^6$ 3s$^2$ 3p$^6$ 3d$^5$ 4s$^2$ 4p$^3$
    d) 1s$^2$ 2s$^2$ 2p$^6$ 3s$^2$ 3p$^6$ 4s$^1$ 3d$^9$
Part II. (10 pts) Equations and formulas

1. Balance the following unbalanced redox equation in acidic solution:

\[ \text{O}_2 (g) + \text{Br}^- (aq) \rightarrow \text{H}_2\text{O} (l) + \text{Br}_2 (l) \]

Then indicate:

a) The oxidation step: ____________________________

b) The reduction step: ____________________________

c) The oxidizing agent: ____________________________

d) Substance that is reduced: ____________________________

d) The number of electrons that is transferred per mole of the reducing agent: ____________

Part III. Calculations (36 pts: 3 @ 12 pts each) Show all work for full credit. Please express all answers with the proper units and correct number of significant figures.

1. a) Calculate the wavelength in nanometers in the H-atom spectrum that arises from the electron transition of \( n = 5 \) to \( n = 2 \).

\[ \lambda (\text{nm}) = \]

b) In what spectral region does this transition occur? ____________________________

c) Is energy absorbed or emitted? ____________________________

d) How many emission lines are possible for the transition from \( n = 5 \) to lower energy levels? ______

2. Calculate the density of nitric oxide gas, NO at 27°C and 700 torr.
3. Nitric acid can be prepared by bubbling dinitrogen pentoxide, N$_2$O$_5$ into water.

\[
\text{N}_2\text{O}_5 (g) + \text{H}_2\text{O} (aq) \rightarrow 2 \text{H}^+ (aq) + 2 \text{NO}_3^- (aq)
\]

(a) How many moles of H$^+$ are obtained when 1.50 L of N$_2$O$_5$ at 25º C and 1.00 atm pressure is bubbled into water?

(b) The solution obtained in (a) after reaction is complete has a volume of 437 mL. What is the molarity of the nitric acid obtained?

Density of NO =

Moles of H$^+$ =

Molarity of nitric acid =
Exam 3 – Spring 2004

You will have 70 minutes to complete this exam. The exam has 4 pages plus the Periodic Table and Reference page.

When you are told to do so, tear off the Periodic Table cover sheet and use as required during the exam.

### Equations and Constants:

- Density (d) = mass/volume
- PV = nRT
- K.E. = \( \frac{1}{2} mv^2 \)
- (Rate of effusion of B/Rate of effusion of A) = \( \left( \frac{M_A}{M_B} \right)^{1/2} \)
- \( v = \frac{R_H h}{[1/(n_{hi})^2 - 1/(n_{lo})^2]} \)
- E = h ν
- \( R_H = 2.180 \times 10^{-18} \text{ J} \)
- \( h = 6.626 \times 10^{-34} \text{ J.s} \)
- \( c = 3.00 \times 10^8 \text{ m/s} \)
- Avogadro’s Number = 6.022 \times 10^{23}
- \( R = 0.0821 \text{ L.atm/mol.K} \)
- 1 atm = 760 torr = 760 mmHg
- At STP 1 mol of a gas = 22.414 L

### General Solubility Guidelines

All nitrates are soluble.

All chlorides, bromides and iodides are soluble except Ag⁺, Hg₂²⁺, and Pb²⁺.

All sulfates are soluble except Ba²⁺, Sr²⁺, Pb²⁺ and Hg₂²⁺.

All acetates, chlorates and perchlorates are soluble.

Everything else will be considered insoluble.