Sample Midterm 2 Exam

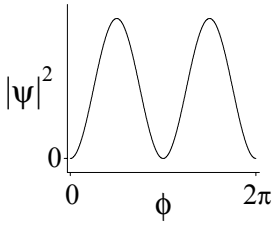
Part 1: Multiple Choice.
(5 pts each, 40 pts total)

Instructions: Bubble in the correct answer on your Scantron™ form AND circle the answer on your exam. Each question has one correct answer.

1.) The answer to question 1 is **A**. Bubble in **A** on your Scantron™ form.

2.) To which orbital does the plot of $|\psi|^2$ vs ϕ correspond?

A.) 1s B.) 2s C.) $2p_x$ **D.) $2p_y$** E.) $2p_z$



3.) The ionization of which with UV light at 90 nm will produce electrons with the longest de Broglie wavelength?

A.) H (1s) B.) H (2s) C.) H (4s) D.) He^+ (4s) E.) He^+ (8s)

4.) Identify the atom or ion with the electronic configuration [Ne]3s3p^6?

A.) Ar^+ B.) K^+ C.) Ar D.) K E.) Cl^-

5.) Which has the largest atomic or ionic radius?

A.) Ar^+ B.) K^+ C.) Ar **D.) K** E.) Cl^-

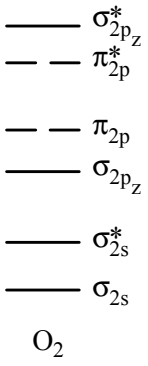
 Name: _____

6.) Which is the most electronegative?

A.) H B.) Na C.) K **D.) Cl** E.) Br

7.) Which is *not* paramagnetic in its ground state?

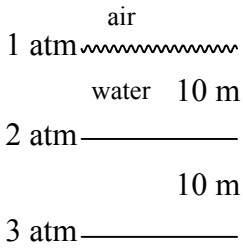
A.) O B.) O^- **C.) O^{2-}** D.) O_2 E.) O_2^-



8.) After diving, which ascent poses the gravest danger to a diver holding his or her breath?

A.) 10m→0m B.) 20m→10m C.) 40m→20m

D.) 60m→30m **E.) 100m→40m**



9.) The atoms or molecules of which ideal gas have the greatest average kinetic energy?

A.) Ar at 200 °C **B.) He at 400 °C** C.) He at 100 °C

D.) H_2 at 200 °C E.) H_2 at 100 °C

 Name: _____

Part 2: Short Answer Problems (105 pts total)
Instructions: Enter answers in the boxes provided. Show your work and justify your answer.

(25 pts)
1.) Consider the H atom and He^+ ion.

a) What is the maximum wavelength of light that will ionize H(2s)?

$$E = hc / \lambda = -R_\infty (Z^2 / n^2)$$

$$\lambda = h c n^2 / R_\infty Z^2 = 364 \text{ nm}$$

Answer:
364 nm

b) Light of what wavelength will induce the n=4 → n=8 transition in He^+?

$$\Delta E = -R_\infty Z^2 (1/n_f^2 + 1/n_i^2)$$
$$\Delta E = h c / \lambda$$

$$\lambda = h c / (-R_\infty Z^2)(1/n_f^2 + 1/n_i^2)$$
$$= 486 \text{ nm}$$

Answer:
486 nm

(30 pts)
2.) Consider an atom of the element aluminum (Al) in its ground state.

a) Write the electron configuration for an atom of Al.

Answer:
[Ne] $3s^2$ $3p^1$

b) Write down the values of the quantum numbers for an electron in the highest occupied orbital.

n: **3** l: **1**

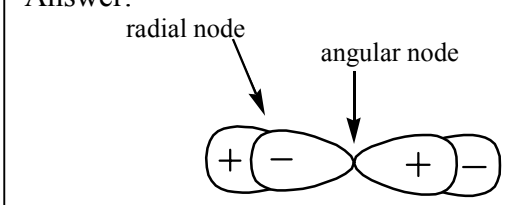
m_l: **-1 or 0 or 1** m_s: **-½ or ½**

c) Sketch the highest occupied atomic orbital and indicate number and type of nodes.

2 nodes total:

1 angular node
1 radial node

Answer:



 Name: _____

(25 pts)

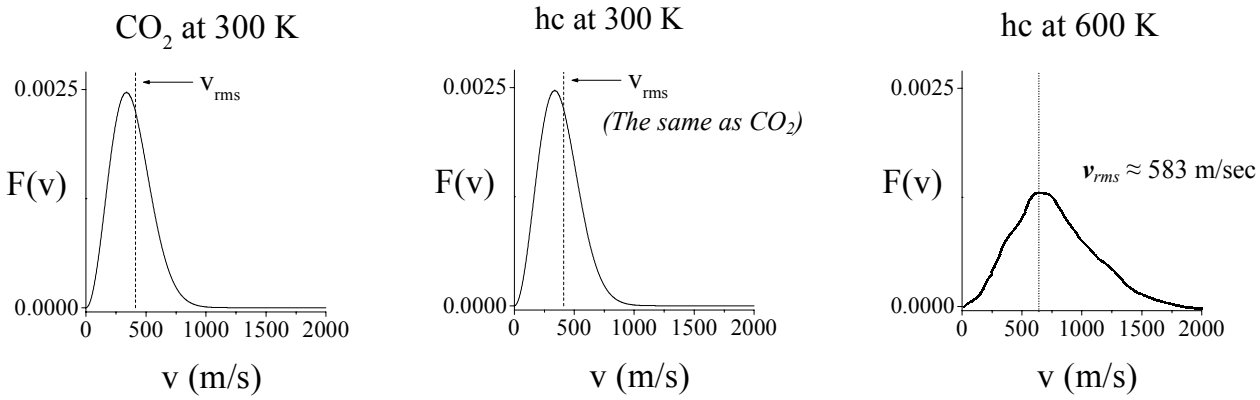
3.) Consider 4.4 g of a hydrocarbon (hc) gas with the empirical formula C_3H_8.

a) The hydrocarbon fills a balloon to 0.56 L at 4.4 atm and 300 K. What is the molecular formula of the hydrocarbon?

$$P\,V = n\,R\,T; \quad n = \text{mass} / M$$
$$P\,V = (\text{mass} / M)\,R\,T$$
$$M = \text{mass}\,R\,T / P\,V = 44\ \text{g/mol}$$

Answer: **C_3H_8**

b) Shown is a plot of the molecular speed distribution, F(v), and v_{rms} for CO_2 at 300 K. Sketch F(v) and indicate v_{rms} for the hydrocarbon gas at 300 K and 600 K.



(25 pts)

4.) Two sunscreen products (X and Y) have the following extinction coefficients, ε, at 310 nm: X = 3.0 cm^2/g and Y = 1.0 cm^2/g. For the following questions, the absorbance should be calculated for a 1 cm sample path length.

a) What is the absorbance of a 0.1 g/mL sample of X?

$$A = \varepsilon\,l\,c = 0.3$$

Answer: **0.3**

b) A 0.10 g/mL sample of either X or Y is placed in the spectrometer. The measured ratio of the intensity of the transmitted light to the intensity of the incident light is 0.80 at 310 nm. Is the sample sunscreen X or Y?

$$A = \log (I_o / I_t) = \varepsilon\,l\,c$$
$$\varepsilon = [\log (I_o / I_t)] / l\,c = 1.0\ \text{cm}^2/\text{g}$$

Answer: **Y**