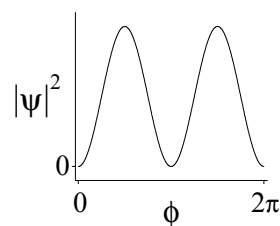**Part 1: Multiple Choice.**
(5 pts each, 40 pts total)
Instructions: Bubble in the correct answer on your Scantron[TM] form AND circle the answer on your exam. Each question has one correct answer.

1.) The answer to question 1 is **A**. Bubble in **A** on your Scantron[TM] 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^-

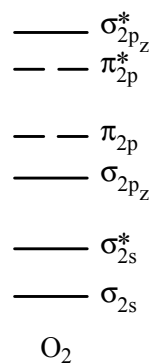**5.)** Which has the largest atomic or ionic radius?

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

Name: _____

6.)   Which is the most electronegative?

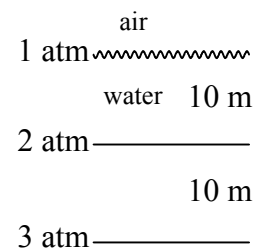   A.) H   B.) Na   C.) K   D.) Cl   E.) Br

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

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

$$\underline{\quad\quad} \; \sigma^*_{2p_z}$$
$$-\;- \; \pi^*_{2p}$$
$$-\;- \; \pi_{2p}$$
$$\underline{\quad\quad} \; \sigma_{2p_z}$$
$$\underline{\quad\quad} \; \sigma^*_{2s}$$
$$\underline{\quad\quad} \; \sigma_{2s}$$

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

air
1 atm 〜〜〜〜〜〜〜〜〜
    water   10 m
2 atm ─────────
                10 m
3 atm ─────────

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)?

Answer:

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

Answer:

(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:

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

n: l:

m_l: m_s:

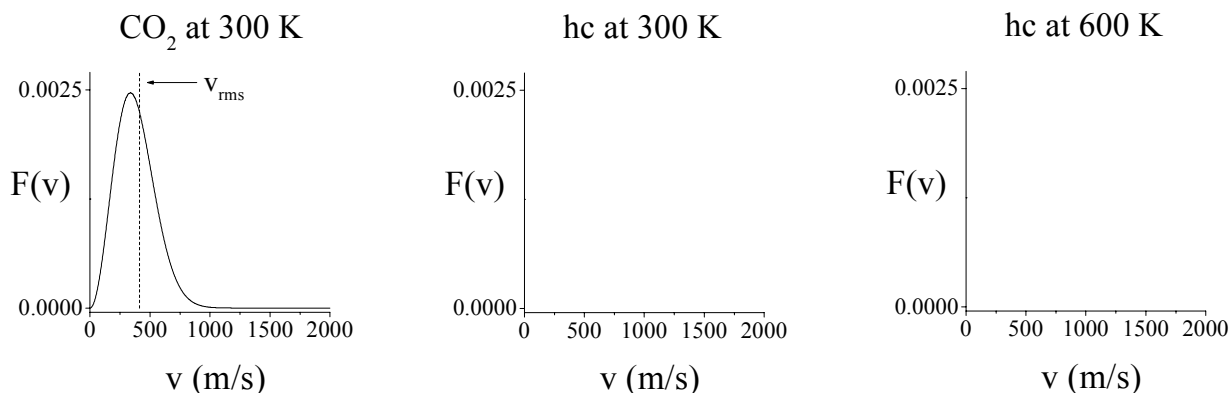c)   Sketch the highest occupied atomic orbital and indicate number and type of nodes.

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?

Answer:

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.

CO_2 at 300 K

hc at 300 K

hc at 600 K

0.0025 — v_{rms}

0.0025

0.0025

F(v)

F(v)

F(v)

0.0000

0.0000

0.0000

0   500 1000 1500 2000

0   500 1000 1500 2000

0   500 1000 1500 2000

v (m/s)

v (m/s)

v (m/s)

(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?

Answer:

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?

Answer: