Chemistry 1A Fall 2000

Midterm Exam II, version A
October 17, 2000

(Closed book, 75 minutes, 145 points)

Name: ______________________ Section Number: _______________

SID: _______________________ T.A. Name: ___________________

Identification Sticker

Exam information, extra directions, and useful hints to maximize your score:

- Write your name on all ten pages.
- There are two parts to the exam: 1) multiple choice and 2) short answer problems.
- **For the multiple choice problems, fill in the Scantron™ form AND circle the answer on your exam.**
- Answer the questions you know how to do first, then work on the questions you skipped.
- Show all work for which you want credit on the short answer problems and do not forget units!
- You may use the back side of the exam pages for scratch paper.

Unit Prefixes		
milli, m (x 10^{-3})	micro, μ (x 10^{-6})	nano, n (x 10^{-9})
kilo, k (x 10^{3})	mega, M (x10^{6})	giga, G (x 10^{9})

Some possibly useful information:

$E_{photon} = h\nu = hc/\lambda$

$A = \varepsilon c \ell$

$v_{rms} = \sqrt{\dfrac{3RT}{M}}$

$E_{Kin} = \dfrac{3}{2} nRT$

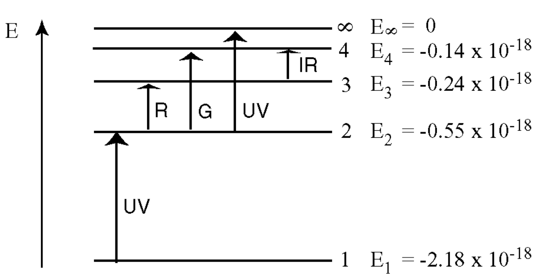
$PV = nRT$

$E_n = -\dfrac{Z^2}{n^2} R_\infty$

	Ionization Energy (kJ/mol)	Electron Affinity (kJ/mol)
Na	496	-53
Ne	2081	~0

$T(K) = T(°C) + 273.15$

H Atom



(Do not write in this box; it is for official use only.)

Page	Points
2-5	/ 60
6-7	/ 40
8-10	/ 45
Total	/ 145

Name:____

Part 1: Multiple Choice (5 pts each, 60 pts total)
Instructions: Bubble in the correct answer on your Scantron sheet 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.) What is the electron affinity of Na^+?

A.) -2081 kJ/mol

B.) -496 kJ/mol

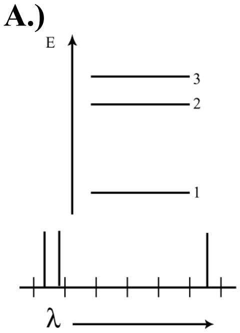
C.) ~0 kJ/mol

D.) 53 kJ/mol

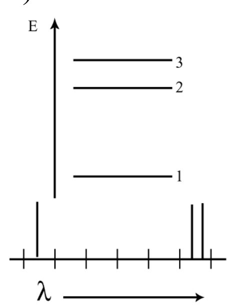
E.) 2081 kJ/mol

3.) Select the correct energy level diagram and absorption spectrum pair for He^+?

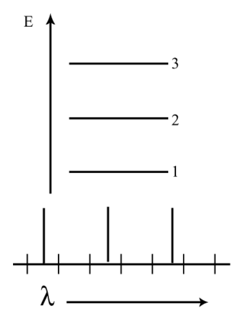
A.)



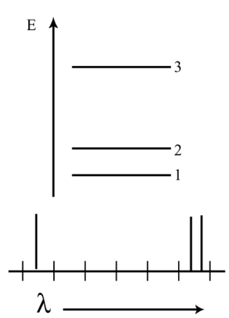
B.)



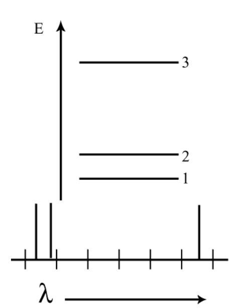
C.)



D)



E)



 Name:______________________________________

For questions 4 and 5, refer to the energy level diagram for the hydrogen atom shown on page 1.

4.) Can hydrogen atoms in the ground (lowest energy) state absorb a photon of energy 1.75×10^{-18} J?

A.) Yes, because hydrogen atoms can absorb any energy in the range from zero to 2.18×10^{-18} J.

B.) Yes, because the electron is promoted to an energy between the second and third energy levels. As the electron drops to the second level, the hydrogen atoms release the excess energy.

C.) Yes, because this represents the energy difference between the ground state and second energy level.

D.) No, because this much energy would cause the atom to be ionized.

E.) No, because this energy does not correspond to the energy difference between the ground state and any other energy level.

5.) Can hydrogen atoms in the ground (lowest energy) state absorb a photon of energy 3.00×10^{-18} J?

A.) Yes, because this energy corresponds to the energy difference between the ground state and a quantized energy level with energy greater than zero.

B.) Yes, the energy of the light is greater than what is required to ionize the atom. The excess energy would be converted into kinetic energy.

C.) No, it is impossible for atoms to absorb light whose energy is greater than their ionization energy.

D.) No, atoms can only absorb light whose energy corresponds to the difference between the ground state and another level.

E.) No, light of this energy would not be enough to excite the electron from the ground state to the first energy level.

 Name:____

6.) Which has a higher ionization energy than Ne?

A.) Ar B.) F C.) F^- **D.) Na^+** E.) Na

7.) How many unpaired electrons exist in the ground state electronic configuration $[Ar]4s^2 3d^8$?

A.) 0 B.) 1 **C.) 2** D.) 3 E.) 4

8.) Which orbital has the quantum numbers n = 3 and $\ell = 1$?

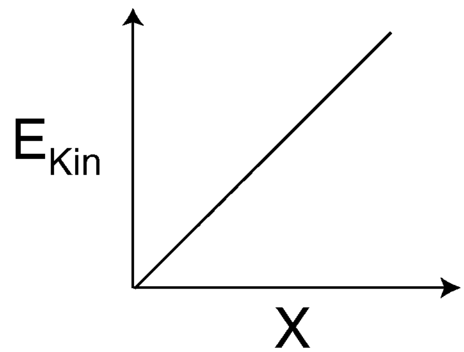
A.) 2s B.) 2p C.) 3s **D.) 3p** E.) 4d

9.) Identify X from the configuration X^+ $(1s^2 2s^2 2p^6 3s^2)$.

A.) Na B.) Mg **C.) Al** D.) Si E.) P

 Name:____

10.) For one mole of an ideal gas at constant volume, X = ?



A.) molar mass B.) v_{rms} C.) R D.) V **E.) P**

11.) Absorption of what color light will induce the 4→ 6 transition in He^+?

A.) Infrared (IR) **B.) Red** C.) Green

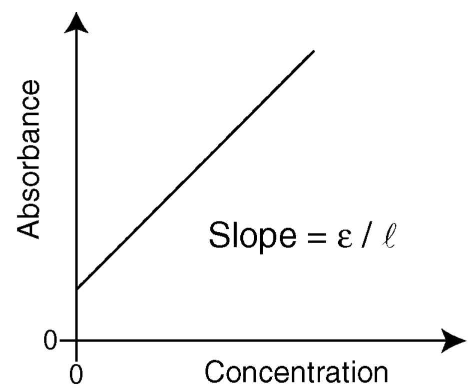
D.) Blue E.)Ultraviolet (UV)

 Name:____

Part 2: Short Answer Problems (85 pts total)
Instructions: Enter answers in the boxes provided. Show your work. Where requested write explanations in fifteen words or less.

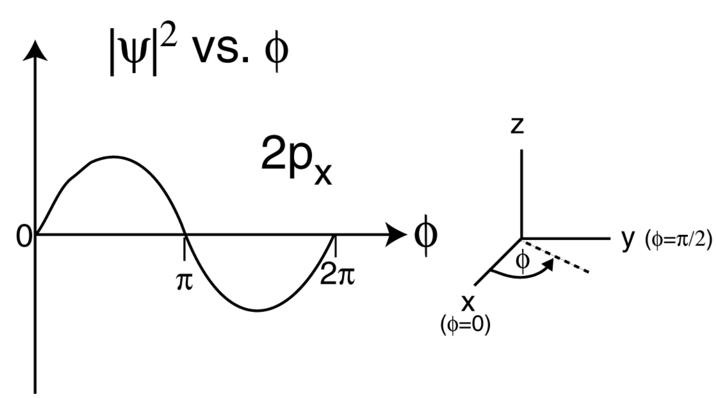
(40 pts)
1.) Each figure in parts a-d contains at least two errors. In the space provided, specify two of the errors and provide a brief explanation of each one.

a.)



Error 1:	**Slope = $\varepsilon\ell$**
Error 2:	**At zero concentration no light is absorbed. Therefore, the plot should pass through origin.**

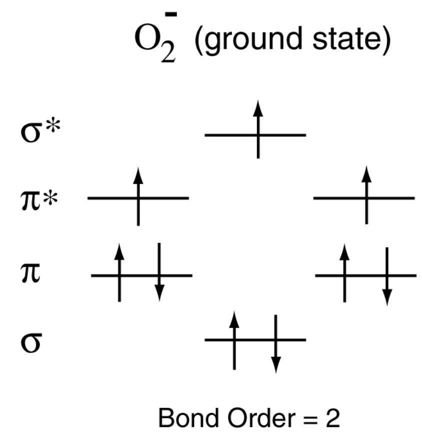
b.)



Error 1:	**Figure plots Ψ vs. ϕ**
Error 2:	**Plot corresponds to $2p_y$**

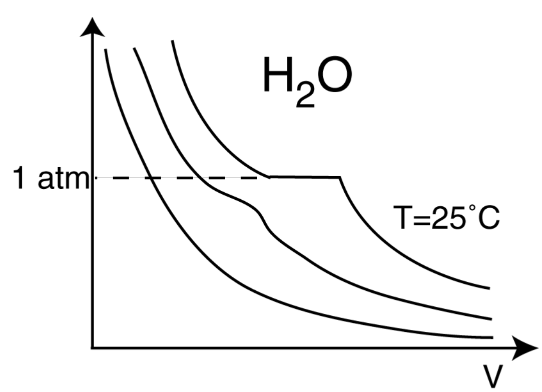
 Name:____

c.)



Error 1:	**Bond Order = 3/2**
Error 2:	**Should be three π* electrons in ground state.**

d.)



Error 1: **At 1 atm, there is no phase transition occurs at T=25 ^{o}C.**
Error 2: **Isotherm with phase transition occurs at lower temperature than isotherm with ideal behavior.**

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(45 pts)
2.)

1) Ozone (O_3) gas is placed in a 1.0 L glass vessel at a pressure of 2.0 atm and a temperature of 300 K. Assume ideal behavior.

a) What are the number of moles and the mass of ozone present?

n=PV/RT = [(2.0atm)(1.0L)]/[(0.082 atm-L/mol-K)(300K)]

Moles Ozone:
0.081 moles

m=n/ *M*
m=PV *M* /RT

Mass Ozone:
3.9 grams

b) Shining ultraviolet light on O_3 induces the following reaction:

$$2\ O_3\ (gas) \rightarrow 3\ O_2\ (gas)$$

If half of the ozone present reacts, what is the final mole fraction of each gas in the vessel?

$n(O_2)$ = 3/2 $n(O_3$ reacted) = 3/2(0.041 moles) = 0.061 moles

$n(O_3)$ = 1/2 total moles O_3 = 0.041 moles

mole fraction O_2 = $n(O_2)$ / $n(O_2)$ + $n(O_3)$

mole fraction O_3 = $n(O_3)$ / $n(O_2)$ + $n(O_3)$

Mole Fraction O_2:
0.6

Mole Fraction O_3 :
0.4

 Name:____

c.) Calculate the partial pressure of each gas and the total pressure.

$P(O_2) = n(O_2)RT/V$

$P(O_3) = n(O_3)RT/V$

Total $P = P(O_2) + P(O_3)$

Pressure O_2:	**1.5 atm**
Pressure O_3:	**1.0 atm**
Total Pressure:	**2.5 atm**

d) The graph below depicts the speed distribution of O_3 molecules at 300K. Using the same axes, sketch the distribution of O_3 at 1200K.