INSTRUCTIONS/SUGGESTIONS.
READ THIS CAREFULLY!

OMIT ANY TWO (2) OF THE SEVEN 20 POINT QUESTIONS.
OMIT ANY THREE (3) OF THE FOURTEEN 8 POINT QUESTIONS.

INDICATE ON THE NEXT PAGE WHICH **5** QUESTIONS ARE NOT TO BE GRADED BY WRITING DNG (DO NOT GRADE) NEXT TO THE PROBLEM NUMBER.

NO PARTIAL CREDIT on any question except where indicated by the statement SHOW WORK. When work is requested, set up equations (with numbers substituted in appropriate units) in space provided, but do the calculations on scrap sheet.

IF QUESTION STATES "SHOW WORK" AND YOU GUESS CORRECTLY WITHOUT SHOWING WORK - YOU GET 1/2 CREDIT.

CHECK FRONT BLACKBOARD FOR CORRECTIONS/CHANGES.

IF ANY QUESTION IS NOT CLEAR - ASK DAVID OR ME ABOUT IT!

CONSTANTS AND CONVERSION FACTORS ARE ON THE PAGE FOLLOWING THE LAST PROBLEM. PLEASE LOOK THERE!
LAST THREE PAGES ARE FOR SCRAP WORK.
FEEL FREE TO TEAR THESE PAGES OFF.

***SUGGESTION*: IF YOU HAVE TO COMBINE TWO EQUATIONS TO SOLVE FOR SOME QUANTITY, SUBSTITUTE NUMBERS ONLY AT THE END.**
ie. IF YOU WANT THE VELOCITY, v, OF A PARTICLE WITH A deBROGLIE WAVELENGTH, λ, THEN SOLVE IN THE FOLLOWING MANNER;

$$\lambda = \frac{h}{p} \quad \text{AND} \quad p = mv \qquad \therefore\ \lambda = \frac{h}{mv}$$

SOLVING FOR VELOCITY, $v = \frac{h}{m\lambda}$

NOW SUBSTITUTE THE NUMERICAL VALUES INTO THE EQUATION. THIS WAY YOU ARE LESS LIKELY TO MAKE A MISTAKE. IT IS ALSO EASIER FOR US TO FOLLOW YOUR LINE OF REASONING.

REMOVE THIS PAGE PRIOR TO STARTING EXAM.

CHEMISTRY F14O4 SECOND EXAM 3/22/00
PROFESSOR J. MORROW

PRINT NAME, LAST: ____________________________

FIRST: ____________________________

I.D.# : ____________________________

MAXIMUM POINT VALUE IS IN PARENTHESES

1. ________ (20)	8. ________ (8)	15. ________ (8)
2. ________ (20)	9. ________ (8)	16. ________ (8)
3. ________ (20)	10. ________ (8)	17. ________ (8)
4. ________ (20)	11. ________ (8)	18. ________ (8)
5. ________ (20)	12. ________ (8)	19. ________ (8)
6. ________ (20)	13. ________ (8)	20. ________ (8)
7. ________ (20)	14. ________ (8)	21. ________ (8)

COLUMN TOTALS (MAXIMUM):

________(100)	________(56)	________(56)

EXAM TOTAL (188 pts) ___________ ___________
OUT OF 1OO

1) Hydrogen atoms are excited from n = 1 —> n =2. The electron in the n = 2 shell then returns to n = 1 emitting a photon. These emitted photons hit a piece of copper (work function, Φ = 2.40 eV = 3.85x10^{-19}J) causing electrons to be ejected. Calculate the energy of these ejected electrons in joules. SHOW WORK (20 pts)

a) 1.63x10^{-18}J b) 0.384x10^{-18}J c) 2.18x10^{-18}J d) 0.161x10^{-18}J e) 1.25x10^{-18}J

ANSWER IS: _______

2) A typical golf ball weighs 40.0 g. If it is moving with a velocity of 20.0 $\frac{\text{m}}{\text{sec}}$, its deBroglie wavelength (in nm) is , (20 pts)

a) 1.66x10^{-34}nm b) 8.28x10^{-32}nm c) 8.28x10^{-25}nm
d) 1.66x10^{-24}nm e) 3.31x10^{-21}nm

ANSWER IS: _______

3) According to quantum mechanics, the energy of a particle in a 1 dimensional box is, $\varepsilon_n = \frac{n^2h^2}{8m\lambda^2}$

where n is the quantum number, h is Planck's constant, m is the mass of the particle, and λ is the length of the box. This is the equation that allows us to predict the color of dyes.

What is the wavelength (in nm) of photon required to excite an electron from n = 1 to n = 2 in a box of λ = 5.0 Å ? SHOW WORK (20 pts)

a) 1236 nm b) 618 nm c) 412 nm d) 332 nm e) 206 nm f) 824 nm

ANSWER IS: _______

4) The kinetic energy, ε, of a electron is related to the kelvin temperature through the equation, $\varepsilon = \frac{3}{2}$ kT where k = $1.38\text{x}10^{-23}$ $\frac{\text{J}}{\text{particle·degK}}$.

You are given an electron with a deBroglie wavelength of λ = 76.3 nm . What is the Kelvin temperature of this electron? SHOW WORK (20 pts)

a) 0.50 b) 1.00 c) 1.50 d) 2.00 e) 2.50 f) 3.00

ANSWER IS: _______

5) When the surface of a piece of potassium is irradiated with light of wavelength, λ_1 = 5000 Å, the value of the stopping potential (voltage) necessary to stop the emitted electrons is, V_1 = 0.200 volts. When the wavelength is changed to, λ_2 = 4000 Å, the required stopping potential is, V_2 = 0.600 volts. In this problem, YOU DO NOT KNOW the value of Planck's constant. Using this information calculate Planck's constant. SHOW WORK
(20 pts)

a) $4.27\text{x}10^{-34}$	b) $3.60\text{x}10^{-34}$	c) $2.14\text{x}10^{-34}$
d) $7.48\text{x}10^{-34}$	e) $1.57\text{x}10^{-34}$	f) $6.63\text{x}10^{-34}$

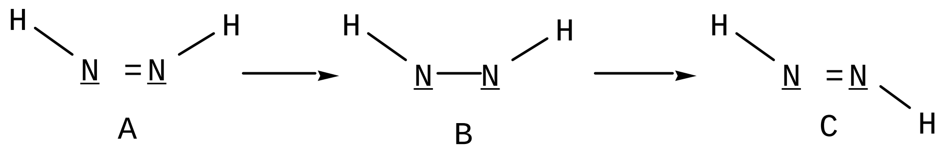
(20 pts) ANSWER IS: _______

6) Using any information from question 5 and your calculated value of planck's constant (also from question 5), calculate the work function, Φ, of potassium in electron volts (eV). If you did not do question 5 but want to answer this question, use h = $6.63\text{x}10^{-34}$ J·sec SHOW WORK (20 pts)

ANSWER IS: _______

7) Given the following bond enthalpies,

N=N (711 kJ/mol) and N - N (163 kJ/mol)



A B C

Molecule A has the above configuration. To make it have the configuration of molecule C, the π bond in molecule A must be broken thereby forming molecule B where rotation around the N to N single bond occurs. The π bond then reforms giving you molecule C. What is the wavelength of light, λ (in nm), required to initiate this process?SHOW WORK (20 pts)

a) 168 nm b) 733 nm c) 310 nm d) 218 nm e) 425nm

ANSWER IS: ______

8) Which of the following molecules would have the shortest bond length? All have single bonds. (8 pts)

a) Na_2 b) F_2 c) Li_2 d) Cl_2

ANSWER IS: _______

9) Which of the following ions has the largest radius? (8 pts)

a) Be^{2+} b) Li^+ c) N^{3-} d) O^{2-} e) F^-

ANSWER IS: _______

10) The order of increasing ionization energies for the atoms neon, nitrogen, phosphorus, and sodium is; (8 pts)

a) Na < P < N < Ne b) N < Ne < Na < P c) N < Na < Ne < P

d) Na < N < P < Ne e) N < Na < P < Ne

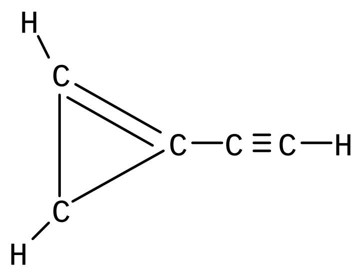
ANSWER IS: _______

11) A beam of incoming cosmic radiation has a wave number,
$\bar{\nu}$ (nu bar) = $2.5 \times 10^4 \frac{1}{cm}$.
Calculate the wavelength of this radiation (in nm). (8 pts)

a) 650 nm b) 125 nm c) 250 nm d) 400 nm e) 350 nm

ANSWER IS: _____

12) Given the following molecule;



This molecule contains the following number of σ and π bonds

a) four π bonds and six σ bonds
b) seven σ bonds and three π bonds
c) six σ bonds and four π bonds
d) two π bonds and eight σ bonds
e) three π bonds and eight σ bonds
f) none of the above

(8 pts)

ANSWER IS: ________

13) Which of these molecules is/are nonpolar ; IF_3 , BF_3 , NF_3 , CF_4 , and, SF_4 (8 pts)

ANSWER: ______________________

14) Circle the stronger acid in each of the following pairs. (8 pts)

a) H_2SO_3 or H_2SeO_3 (4 pts)

b) H_2SO_4 or $H_2S_2O_7$ (4 pts)

15) Give the electronic configuration ($1s^2$ etc) <u>and</u> the number of unpaired electrons in each of the following gaseous atoms/ions.
Atomic number of nickel is 28. UE = number of unpaired electrons.
(4 pts each: 3 pts plus 1 pt)

Ni UE =

Ni^{3+} UE =

16) List the following ions in order of decreasing ionic radius.
Li^{2+}, Be^{2+}, and B^{2+} (8 pts)

_____ > _____ > _____

17) List the following atoms in order of increasing 2nd ionization energy: O, F, and S. (8 pts)

______ < _____ < _____

18) Which atom has the following successive values of ionization energy, IE, (in kJ/mol)? (8 pts)

IE_1 = 575, IE_2 = 1,811 , IE_3 = 2,733 , IE_4 = 11,548 , IE_5 = 14,800

a) N b) Mg c) C d) Na e) Al_

ANSWER IS: _______

19) Match up the following bond enthalies (in kJ/mol), 514, 837, 949, 1076 with the indicated molecules; (8 pts)

N+N _______ C+C _______ C+O _______ P+P _______

20) In a multi-electron atom, how many electrons can have the following sets of quantum numbers? (8 pts - 2 pts each)

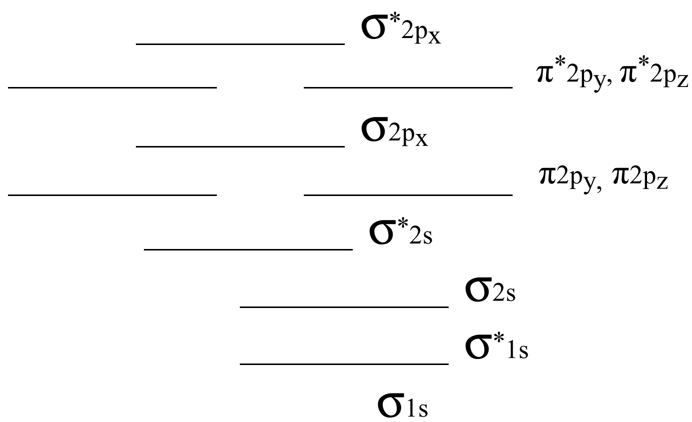
a) $n = 2$, $m_\lambda = -2$, $m_s = -\frac{1}{2}$ _______

b) $n = 4$, $m_s = +\frac{1}{2}$ _______

c) $n = 3$, $m_\lambda = 0$, $m_s = -\frac{1}{2}$ _______

d) $n = 3$, $\lambda = 2$, $m_s = -\frac{1}{2}$ _______

21) Use the MO correlation diagram below to answer this question.



Compare the anticipated bond order (BO), bond length (BL), and bond enthalpy (BE) of the following species. Where possible, give the numerical value, otherwise use <, or =, or >.

a) B_2^+ with F_2^- (6 pts)

	____ B_2^+ ____	____ F_2^- ____
BO		
BL		
BE		

b) Will the following reaction be exothermic or endothermic?

(2 pts) $O_2^+ + O \longrightarrow O_2 + O^+$

ANSWER: _______

CONSTANTS, CONVERSION FACTORS, AND EQUATIONS

$C = 3.00 \times 10^{8}$ m/sec $= 3.00 \times 10^{10}$ cm/sec

$h = 6.626 \times 10^{-34}$ J·sec $= 6.626 \times 10^{-27}$ erg·sec

$m_e = 9.108 \times 10^{-28}$ g $= 9.108 \times 10^{-31}$ kg (electron)

$m_p = 1.673 \times 10^{-24}$ g $= 1.673 \times 10^{-27}$ kg (proton)

$\varepsilon = h\nu$

$\lambda\nu = c$

1 Å = 0.1 nm = 10^{-8} cm = 10^{-10} m

$\lambda = \frac{h}{p}$ (deBroglie equation) where $p = mv$

Heisenberg Uncertainty principle: $\Delta p \Delta x = \frac{h}{4\pi}$ where $p = mv$

kinetic energy: $\varepsilon = qV = \frac{1}{2} mv^2 = \frac{p^2}{2m}$

where $p = mv$, q = electron charge , and V = voltage

$q = e = 1.6022 \times 10^{-19}$ coulombs $= 4.806 \times 10^{-10}$ esu

$k = 8.99 \times 10^{9} \ \frac{N \cdot m^2}{C^2}$

1 eV $= 1.6022 \times 10^{-19}$ J

1 rydberg, Ry, $= 2.179 \times 10^{-18}$ J

$$\varepsilon_n = - \frac{2.179 \times 10^{-18}}{n^2} \text{ J} \quad \text{(Bohr Equation)}$$

$$\Delta\varepsilon = \varepsilon_{photon} = 2.179 \times 10^{-18}\left(\frac{1}{n_1^{\,2}} - \frac{1}{n_2^{\,2}}\right) \text{ J} \quad \text{(Bohr Equation with } n_2 > n_1\text{)}$$

$\varepsilon = qV = h\nu - \Phi$ where Φ = work function

UNIT RELATIONSHIPS

1 erg = 1 $\frac{g \cdot cm^2}{sec^2}$, 1 esu^2 = 1 erg.cm , 1 Joule = 1×10^{7} erg = 1 volt·coulomb, 1 amp = 1 $\frac{coulomb}{sec}$, 1 Watt = 1 $\frac{joule}{sec}$, 1 Joule = 1 $\frac{kg \cdot m^2}{sec^2}$

SCRAP WORK SHEET

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