Directions:

This test is closed note/book, but one 8.5 x 11 handwritten crib sheet (one sided) is permitted.

Please silence all cell phones.

Calculators are permitted; however, computers, PDAs, and other electronic devices with a keyboard are not permitted. Cell phones may not be used as calculators.

Complete the Scantron card as shown below. **Identify your version as indicated to received credit.**

A total of 50 minutes will be allotted for the exam. Answer every question. There is no guessing penalty for this exam.

The exam is 25 multiple choice and will be valued equally at 4 points each for a total of 100 possible points. Partial credit will NOT be awarded.

If you have a question, please ask Dr. Cox or the supporting instructors for clarification.

Submit the both the scantron cards and this exam packet to your specific instructor at the end of the exam.

Section	Instructor
C1/D1	Dash
C2/D2	Overfield
C3/D3/D4	Mackey
C4	John

1. Given the following structures and associated names, identify the ones that are correct as written including the correct structure and name.

I.	$Fe(NO_2)_2$	iron (II) nitrite
II.	$SnOCl_2$	tin (II) hypochlorite
III.	H_2SO_3 (aq)	sulfurous acid
IV.	P_2O_5	phosphorus pentoxide

A. I and II
B. II and III
C. III and IV
D. I, II, and IV
E. I and III

Not counted

2. Given the following combustion reaction, calculate the theoretical yield of carbon dioxide (CO_2) using the data in the table. Select the BEST answer from the choices provided.

	C_2H_5OH +	$3O_2$	→ $2CO_2$ (g) +	$3H_2O$ (g)
Molecular Weight	46 g/mol	32 g/mol	44 g/mol	18 g/mol
Amount Reacted	2.5 g	1.01 g		

A. 4.7 grams of CO_2
B. 0.90 grams of CO_2
C. 2.3 grams of CO_2
D. 1.4 grams of CO_2
E. 3.1 grams of CO_2

answer B:

C_2H_5OH: $(2.5g)(46g/mol)^{-1}=0.054$ mol will consume $3(0.054 \text{ mol}) = 0.16$ mol O_2

Available O_2: $(1.01g)(32g/mol)^{-1}=0.032$. Since $0.032< 0.16$, O_2 is limiting.

CO_2: $(2/3)(0.032 \text{ mol})(44g/mol)=0.94$ (the 2/3 comes from the stoic coeffs)

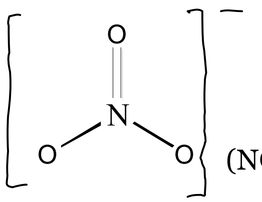
3. What are the appropriate quantum numbers for a d orbital in Nickel (Ni, Z=28).

	n	l	m_l	m_s
A.	4	2	-2	+½
B.	3	2	-2	-1
C.	4	3	-1	-1/2

D.	3	2	-1	-1/2
E.	3	3	-2	+1/2

answer D: [The first row d orbitals (trans metals) are n=3, for d orbitals, l=2 (fyi for s, l=0; for p, l=1). For d oribials,m_l=-2,-1,0,1, or +1. m_s for an orbital can only be -1/2, 0 or ½. Note that for an electron m_s can be -1/2 or +1/2)

4. Calculate the formal charge on the nitrogen in the structure below:



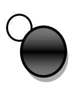
(NOTE: None of the formal charges are listed for any atom)

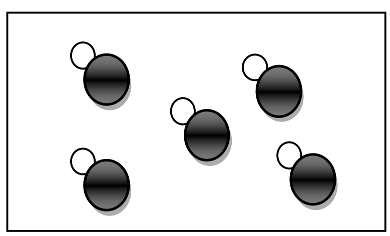
Also note there are several resonance forms fo this molecule.

A. -1
B. 0
C. +1
D. +2
E. Insufficient Information

answer C: Also the FC = O on the top oxygen. The FC = -1 and on each of the bottom oxygens.

5. Given a 1000-mL container of HCl as shown below, what is the molar concentration?

 = one mole of HCl



A. 50 M
B. 5 M
C. 2.5 M
D. 25 M
E. 10 M

answer B: 5 mol/1L = 5 M

6. Given the molecular formula for glucose, $C_6H_{12}O_6$, what is the empirical formula?

A. $C_2H_4O_2$

B. $C_3H_6O_3$

C. $C_6H_{12}O_6$

D. CH_2O

E. $C_{12}H_{24}O_{12}$

answer D:

7. Benzaldehyde (C_7H_6O) is a flavoring additive for lifesavers. If 3.93 nL are used in a lifesaver, how many MOLECULES of benzaldehyde are present if the density of benzaldehyde is 1.042 g/mL. Note: 1 nL = 10^{-9} L

A. 2.3×10^{16} molecules

B. 2.3×10^{17} molecules

C. 4.6×10^{15} molecules

D. 6.9×10^{16} molecules

E. 7.7×10^{14} molecules

answer A: $(3.93\text{x}10^{-6}\text{ml})(1.04\text{g/ml})(7\text{x}12+6+16\text{g/mol})^{-1}(6.02\text{x}10^{23}\text{molecules/mol})$

8. What is the correct electron configuration for the **ion** Ti^{2+}?

A. $[Ar]4s^2$

B. $[Ar]4d^2$

C. $[Ar]4s^24d^2$

D. $[Ar]3d^2$

E. $[Ar]4s^23d^2$

Answer A or E: The correct answer is $[Ar]3d^2$, but it is not explained in the book and maybe not in lecture either, so $[Ar]4s^2$ will be accepted.

9. Elements with _________________ first ionization energies and ____________ electron affinities generally form cations.

A. low, very negative

B. high, positive or slightly negative

C. low, positive or slightly negative

D. high, very negative

Answer C

10. According to the Heisenberg uncertainty principle, if the uncertainty in the speed of an electron is 3.5×10^3 m/s, the uncertainty in its position (in m) is at least

A. 1.7×10^{-8} m

B. 6.6×10^{-8} m

C. 17 m

D. 66 m

answer A:

11. The shape of an atomic orbital is associated with

A. the principal quantum number (n).

B. the angular momentum quantum number (l).

C. the magnetic quantum number (m_l).

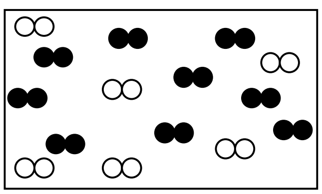
D. the spin quantum number (m_s).

E. the magnetic and spin quantum numbers, together.

answer B: for l=0 (s) the orbitals are spherical, for l=1 (p) the orbitals are orthogonal rabbit ears, etc.

12. Given the following pictoral representation for the chemical reaction of Cl_2 and F_2 to form ClF_3, answer the proceeding question.

$Cl_2 + 3F_2 \rightarrow 2ClF_3$



 = 1 mole of F_2

 = 1 mole of Cl_2

What is the theoretical yield of ClF_3?

A. 2.33 moles

B. 2.67 moles
C. 7.33 moles
D. 4.33 moles
E. 6.00 moles

answer E: This is a limiting reagent problem. You have 9 mol F_2 and 6 mol Cl_2. 6 mol of Cl2 will react with 18 mol of F_2. So F_2 is limiting.

13. Given the MOLECULAR EQUATION below.

$NH_4Cl\ (aq) + AgNO_3\ (aq) \rightarrow AgCl\ (s) + NH_4NO_3\ (aq)$

What are the spectator ions?

A. NH_4^+ and NO_3^-

B. Ag^+ and NO_3^-

C. NH_4^+ and Cl^-

D. Ag^+ and Cl^-

E. NH_4^+ and Ag^+

answer A: The species that stay aqueous.

14. What is the correct oxidation state of the nitrogen in $HONO_2$?

A. +1

B. +2

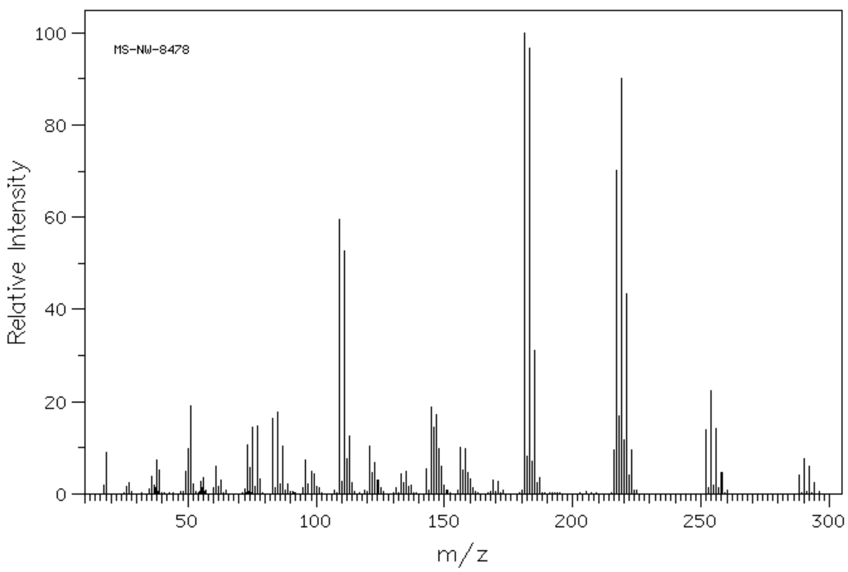
C. +3

D. +4

E. +5

answer E: Assume O is -2 and H is +1. The molecule has no net charge. So $0=3(-2)+1+OxSt^N$

15. The mass spectrum of a powerful insecticide, Lindane is shown below.



The percent composition data is as follows:

Carbon: 24.76%

Hydrogen: 2.06%

Chlorine: 73.18%

How many carbon atoms are present in Lindane?

A. 4
B. 5
C. 6
D. 7
E. 8

answer C: First, you need relative numbers of moles. Assume you have 24.8 g of C (12g/mol) to get 2 moles C. Assume 2 g of H (1g/mol) to get 1 moles of H, etc. Then use the molecular wt to get the molecular formula.

16. Indium has atomic number 49 and atomic mass 114.8 g. Naturally occurring indium contains a mixture of indium-112 and indium-115, respectively, in an atomic ratio of approximately

	Indium-112	Indium-115
A.	6	94
B.	25	75
C.	50	50
D.	75	25
E.	94	6

answer A:

17. Which element below would have the HIGHEST **second** ionization energy?

A. Na

B. Mg

C. B

D. C

E. N

answer A:

Use the atoms listed for problems 18 – 19.

I. Carbon II. Nitrogen III. Oxygen

18. Which order below correctly lists these atoms in order of **decreasing** atomic radius?

A. I > II > III

B. II > III > I

C. III > II > I

D. I > III > II

E. II > I > III

answer A:

19. Which order below correctly lists these atoms in order of **decreasing** ionization energy?

A. I > II > III

B. II > III > I

C. III > II > I

D. I > III > II

E. II > I > III

answer B: This question was not counted

20. Which of the following atoms would have the greatest electronegativity?

A. carbon (C, Z=6)

B. magnesium (Mg, Z=12)

C. chlorine (Cl, Z=17)

D. chromium (Cr, Z=24)

E. aluminum (Al, Z=13)

answer C:

For 21 – 22, use the following options as answers. Identify the molecular geometries.

A. Seesaw

B. Bent

C. Trigonal Planar

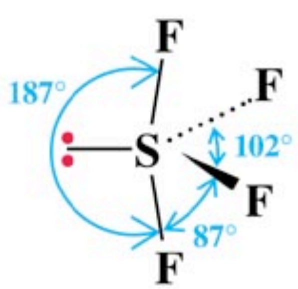
D. Trigonal Pyramidal

E. Trigonal Bipyramidal

21. PCl_3

answer D:

22.



answer A:

23. According to Coulomb's Law, which of the following will form the strongest bonds?

A. KCl

B. $CaCl_2$

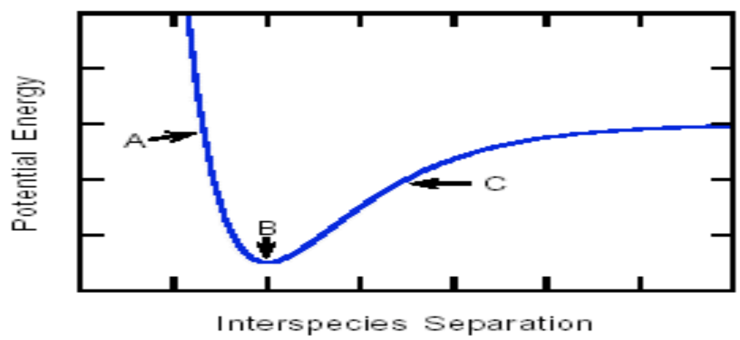
C. $GaCl_3$

D. GaN

E. KO

answer D: Coloumb's law says that force varies with the product of the charges and inversely with the distance between them. And so that leads to answer D (not). This problem is in progress...

24. Refer to the potential energy curve shown. This curve could represent the dependence of the potential energy on separation for a pair of ions, atoms, or molecules. In the portion of the curve labeled A,



A. attractive forces dominate over repulsive forces.

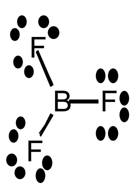
B. repulsive forces dominate over attractive forces.

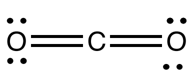
C. attractive and repulsive forces roughly balance.

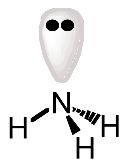
D. dispersion forces dominate over dipole-dipole.

answer B:

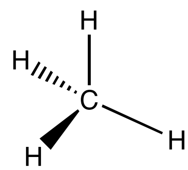
25. Which of the following is polar?

A.


B.


C.


D. Oxygen Gas (O_2)

E. 

answer C: The bonds are polar in some of these (ex B) but because of symmetry the molecules are not polar.

$$Density = \frac{mass}{volume}$$

$$Molarity = M = \frac{\text{mole of solute}}{\text{L of solvent}}$$

$$\text{n (number of moles)} = \frac{\text{mass}}{\text{Molar Mass}}$$

$$M_1V_1 = M_2V_2$$

Quantum Mechanics

$$c = \lambda\nu$$

$$E = mc^2$$

$$\lambda = \frac{h}{p}$$

$$\hat{H}\psi = E\psi$$

$$\Delta x * m\Delta v \geq \frac{h}{4\pi}$$

$$\text{Maximum Occupancy} = 2n^2$$

Constants:

$1\text{ mole} = 6.022 \times 10^{23}\ atoms$

$1\text{ mole} = 6.022 \times 10^{23}$ molecules

$1\text{ mole} = 6.022 \times 10^{23}\ ions$

$h = 6.626x10^{-34}\ Js$

$1\text{ J (Joule)} = 1\text{ kg}\frac{\text{m}^2}{s^2}$

$c = 3.0x10^8\ m/s$

$\text{Mass of an Electron} = 9.10939 \times 10^{-31}\ kg$

$\text{Mass of a Proton} = 1.67 \times 10^{-27}\ kg$

$\text{Mass of a Neutron} = 1.67 \times 10^{-27}\ kg$

$R = 0.0821\frac{Latm}{molK}$

$R = 8.31\frac{J}{molK}$

Stoichiometry:

Solubility Rules

1. All alkali metal salts are soluble.
2. All ammonium (NH_4^+) salts are soluble.
3. All chlorides, bromides, and iodides are soluble except those of Ag^+, Hg_2^{2+}, and Pb^{2+}.
4. All nitrates, chlorates, and perchlorates are soluble.
5. All sulfates except those of Ca^{2+}, Sr^{2+}, Ba^{2+}, Pb^{2+}, Hg_2^{2+}, and Ag^+.
6. All carbonates, chromates, oxalates, and phosphates are insoluble except those of the alkali metals and ammonium.

7. All hydroxides are insoluble except those of the alkali metals.

Bonding

Formal Charge = V – (L + 0.5 S)

V = Number of Valence Electrons

L = The Number of Lone Pair Electrons

S = The Number of Shared Electrons

Coulomb's Law

$V = (Q_1Q_2)/(4\pi\varepsilon r)$