

**Chem 111****9:05a section****Evening Exam #2v2**

This exam is composed of **25** questions. Go initially through the exam and answer the questions you can answer *quickly*. Then go back and try the ones that are more challenging to you and/or that require calculations.

As discussed on the course syllabus, honesty and integrity are absolute essentials for this class. In fairness to others, dishonest behavior will be dealt with to the full extent of University regulations.

$$E = h\nu = \frac{hc}{\lambda}$$

$$1 \text{ mL} = 1 \text{ cm}^3$$

$$\text{Hz} = \text{s}^{-1}$$

$$h = 6.626 \times 10^{-34} \text{ J s}$$

$$c = 2.998 \times 10^8 \text{ m s}^{-1}$$

$$N = 6.022 \times 10^{23} \text{ mol}^{-1}$$

1. How many valence electrons are in the C atom?

- 1) 4                      2) 6                      3) 8                      4) 16                      5) 0

**(1)  $1s^2 2s^2 2p^2$  n=2 is the valence level. It has 4 electrons**

2. Which atom(s) has/have completely filled 3s, 3p, and 3d orbitals?

- 1) Ar                      2) Zn                      3) Kr                      4) Kr & Zn                      5) Ar & Zn

**(4) Ar:  $1s^2 2s^2 2p^6 3s^2 3p^6$                       Zn:  $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2$**

**Kr:  $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6$**

3. Which element is represented by:  $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 4d^{10} 5s^2 5p^3$

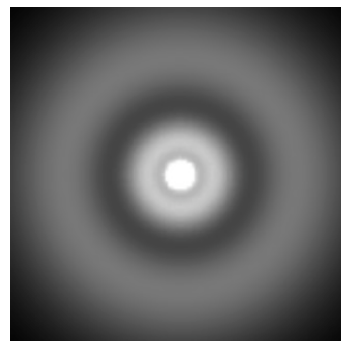
- 1) As                      2) Se                      3) Br                      4) Sb                      5) Te

**(4) See p297 to check, but you can read this off the organization of the periodic table.**

4. The orbital depicted at right is:

- 1) 1s    2) 2p    3) 3p    4) 3s    5) 4p

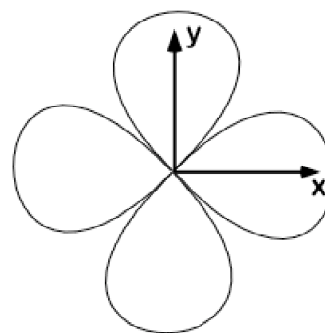
**(4) 3s – 2 spherical nodes, 0 planar nodes**



5. The orbital depicted at right is:

- 1)  $p_{xy}$     2)  $d_{xy}$     3)  $d_{x^2-y^2}$     4)  $d_{z^2}$     5)  $f_{xy}$

**(3)**



6. Which of the following quantum number sets is **not** allowed?

- 1)  $n=+3$   $l=+3$   $m_l = -1$   $m_s = +1/2$     2)  $n=+2$   $l=+1$   $m_l = -1$   $m_s = +1/2$   
 3)  $n=+3$   $l=+1$   $m_l = -1$   $m_s = -1/2$     4)  $n=+2$   $l=0$   $m_l = 0$   $m_s = +1/2$   
 5)  $n=+3$   $l=0$   $m_l = 0$   $m_s = -1/2$

**(1)  $l = 0 \dots n-1$  therefore, with  $n=3$ ,  $l$  cannot be 3**

7. What is the maximum number of orbitals that can be identified by the set of quantum numbers  $n=+3$   $l=+2$  ?

- 1) 2                    2) 3                    3) 5                    4) 7                    5) 10

**(3) for  $l = 2$ , one can have  $m_l = -2, -1, 0, +1, +2$  (5 orbitals, with 10 electrons)**

8. Which of the following has the shortest bond length?

- 1)  $H_2O$             2)  $CH_4$             3)  $NH_3$             4)  $HF$

**(4) F is smallest of F, O, N, and C. This allows H and F to approach closest, given that all are *single* bonds.**

9. Which of the following has the highest bond energy?

- 1) B<sub>2</sub>                      2) N<sub>2</sub>                      3) C<sub>2</sub>                      4) O<sub>2</sub>                      5) F<sub>2</sub>

**(2) N<sub>2</sub> – triple bond      OWL 9-xx**

10. The CO bond in the molecule CH<sub>3</sub>OF is best described as a:

- 1) single bond    2) double bond  
3) triple bond    4) ionic bond  
5) the molecule doesn't exist

**(1) From OWL units 9-1d and 9-2b. See Study Questions 13-14, Chapter 9 of K&T. This and the following 3 questions are basic exercises in drawing Lewis structures.**

11. Consider the molecule SO<sub>3</sub><sup>x</sup>, where x is the charge on the molecule. Two bonds are single bonds, one is a double bond. Which value of x yields the stable molecule? (Hint: draw Lewis structures to figure this one out)

- 1) +2                      2) +1                      3) 0                      4) -1                      5) -2

**(3)**

12. For the SO<sub>3</sub><sup>x</sup> molecule above, how many equal-energy resonance structures can you draw?

- 1) 1                      2) 2                      3) 3                      4) 4                      5) 6

**(3)**

13. The NO bond in HNO is a:

- 1) ionic bond      2) single bond      3) double bond      4) triple bond

**(3) From OWL units 9-1d and 9-2b. See Study Questions 13-14, Chapter 9 of K&T**

14. If an element with the valence configuration **4s<sup>2</sup>3d<sup>2</sup>** loses **2** electron(s), these electron(s) would be removed from the following **subshell(s)**.

- 1) 3d                      2) 3p                      3) 4s and 3d                      4) 4s                      5) 4p

**(4) From OWL Unit 8-7d**

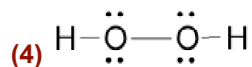
15. Which molecule below does not exist?

- 1) LiF<sub>2</sub>                      2) CaF<sub>2</sub>                      3) MgO                      4) KCl                      5) BCl<sub>3</sub>

**(1) See Study Question 33, Chapter 9 of K&T – think about ionization required to make ionic compounds (Chapt 9.3)**

16. Draw a stable Lewis structure for the symmetrical molecule **hydrogen peroxide**  $\text{O}_2\text{H}_2$ . In this structure, how many **lone pair electrons** are on **each** O?

1) 1                      2) 2                      3) 3                      4) 4                      5) 6



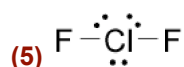
17. Draw a stable Lewis structure for the molecule **OCS**. In this structure (with C at the center), what is the bond order between C and S?

1) 0.5                      2) 1                      3) 1.5                      4) 2                      5) 3

(4) This is isoelectronic with  $\text{CO}_2$

18. Draw the best Lewis structure for  $\text{ClF}_2^-$ . How many **lone pair electrons** are located on Cl?

1) 1                      2) 2                      3) 3                      4) 4                      5) 6



19. For the molecule  $\text{ClF}_2^-$ , what is the electron group geometry of Cl?

1) linear                      2) tetrahedral                      3) trigonal planar  
4) trigonal bipyramidal                      5) octahedral

(4)

20. In the molecule  $\text{NO}_2^+$ , the actual bond order for each NO bond is:

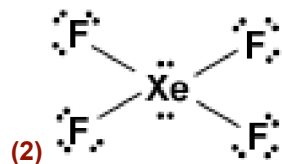
1) 1                      2) 2                      3) 3                      4) 1.5

5) 1 for one bond and 2 for the other

(2) see above                      OWL 9-4

21. Draw the Lewis structure for  $\text{XeF}_4$ . The electron group geometry is:

1) square planar                      2) octahedral                      3) trigonal bipyramidal  
4) square pyramidal                      5) none of the above



OWL 9-xx

Bond Dissociation Energies (kJ mol<sup>-1</sup>) (gas phase)

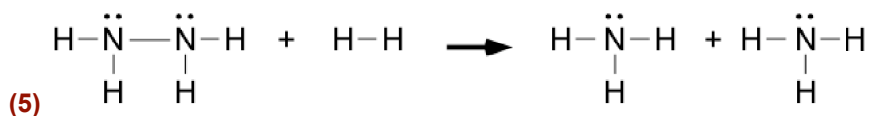
Bond	D	Bond	D	Bond	D
H-H	436	C-C	346	N-N	163
C-H	413	C=C	610	N=N	418
N-H	391	O-O	146	C-O	358
O-H	463	O=O	498	C=O	745

22. Consider the reaction:  $\text{H}_2\text{NNH}_2(\text{g}) + \text{H}_2(\text{g}) \rightarrow 2 \text{NH}_3(\text{g})$

What is the energy ( $\Delta H^\circ$ , in kJ mol<sup>-1</sup>) for this reaction?

- 1) -273      2) +163      3) -163      4) +183      5) -183

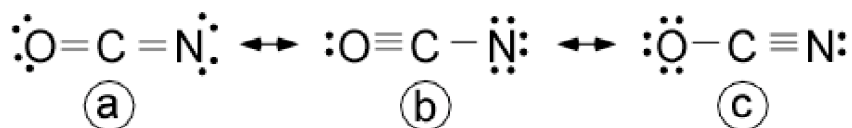
5) -1 for one O and 0 for the other O



$$\Delta H^\circ = (\text{Bonds Broken}) - (\text{Bonds Formed})$$

$$\Delta H^\circ = (D_{\text{N-N}} + D_{\text{H-H}}) - (2D_{\text{N-H}}) = (163 + 436) - 2(391) = -183 \text{ kJ mol}^{-1}$$

(Questions 23-24) Consider the following resonance forms for the ion  $\text{OCN}^-$



23. In resonance structure **c**, what is the formal charge on O?

- 1) -3      2) -2      3) -1      4) 0      5) +1

(3)

24. Which resonance structure is higher in energy, **b** or **c**?

- 1) c      2) b      3) neither, they have the same energy

(2)

25. The correct designator for this course is:

- 1) Chem 363    2) Chem 111    3) Econ 3.33    4) Sports 01

(2)

