 Exam 2 Key Name: _____

## *Chem 111* *2:30p section* *Evening Exam #2*

This exam is composed of 25 questions, 1 of which requires mathematics that *might* require a calculator. 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 in 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.*

*I hereby state that all answers on this exam are my own and that I have neither gained unfairly from others nor have I assisted others in obtaining an unfair advantage on this exam.*

_____ ..
*Signature*

| | | |
|---|---|---|
| $E = h\nu = \frac{hc}{\lambda}$<br>$E_n^{H-atom} = -\frac{R_H hc}{n^2}$<br>1 mL = 1 $cm^3$ | **Some common ions:**<br>$PO_4^{3-}$ $CN^-$ $CH_3CO_2^-$<br>$NO_2^-$ $NO_3^-$ $CO_3^{2-}$<br>$SO_3^{2-}$ $SO_4^{2-}$ | $h = 6.626x10^{-34}\ J\ s$<br>$c = 2.9998x10^8\ m\ s^{-1}$<br>$N = 6.022x10^{23}\ mol^{-1}$<br>$R_H = 1.097x10^7\ m^{-1}$ |

**PERIODIC TABLE OF THE ELEMENTS**

| 1A | 2A | 3B | 4B | 5B | 6B | 7B | 8B | 8B | 8B | 1B | 2B | 3A | 4A | 5A | 6A | 7A | 8A |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 H 1.008 | | | | | | | | | | | | | | | | | 2 He 4.003 |
| 3 Li 6.939 | 4 Be 9.012 | | | | | | | | | | | 5 B 10.81 | 6 C 12.01 | 7 N 14.01 | 8 O 16.00 | 9 F 19.00 | 10 Ne 20.18 |
| 11 Na 22.99 | 12 Mg 24.31 | | | | | | | | | | | 13 Al 26.98 | 14 Si 28.09 | 15 P 30.97 | 16 S 32.07 | 17 Cl 35.45 | 18 Ar 39.95 |
| 19 K 39.10 | 20 Ca 40.08 | 21 Sc 44.96 | 22 Ti 47.90 | 23 V 50.94 | 24 Cr 52.00 | 25 Mn 54.94 | 26 Fe 55.85 | 27 Co 58.93 | 28 Ni 58.71 | 29 Cu 63.55 | 30 Zn 65.39 | 31 Ga 69.72 | 32 Ge 72.61 | 33 As 74.92 | 34 Se 78.96 | 35 Br 79.90 | 36 Kr 83.80 |
| 37 Rb 85.47 | 38 Sr 87.62 | 39 Y 88.91 | 40 Zr 91.22 | 41 Nb 92.91 | 42 Mo 95.94 | 43 Tc (99) | 44 Ru 101.1 | 45 Rh 102.9 | 46 Pd 106.4 | 47 Ag 107.9 | 48 Cd 112.4 | 49 In 114.8 | 50 Sn 118.7 | 51 Sb 121.8 | 52 Te 127.6 | 53 I 126.9 | 54 Xe 131.3 |
| 55 Cs 132.9 | 56 Ba 137.3 | 57 La 138.9 | 72 Hf 178.5 | 73 Ta 181.0 | 74 W 183.8 | 75 Re 186.2 | 76 Os 190.2 | 77 Ir 192.2 | 78 Pt 195.1 | 79 Au 197.0 | 80 Hg 200.6 | 81 Tl 204.4 | 82 Pb 207.2 | 83 Bi 209.0 | 84 Po (209) | 85 At (210) | 86 Rn (222) |
| 87 Fr (223) | 88 Ra 226.0 | 89 Ac 227.0 | 104 Unq (261) | 105 Unp (262) | 106 Unh (263) | 107 Uns (262) | 108 Uno (265) | 109 Une (266) | | | | | | | | | |

1. Which atom or ion below is most paramagnetic?

1) Be 2) B 3) C 4) N 5) O

**(4)** **(OWL question)**

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

1) Ge 2) Sb 3) As 4) Se 5) Te

**(3) See p297 to check, but you can read this off the organization of the periodic table. [Note this question was in error as administered – everyone will get full credit for this question]**

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

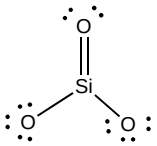
1) $H_2S$ 2) $AlH_3$ 3) $PH_3$ 4) $SiH_4$ 5) HCl

**(5) Cl is smallest of S, Al, Cl, Si, and P. This allows H and Cl to approach closest, given that all are *single* bonds.**

4. Consider the molecule $SiO_3^{x}$, 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) 0 3) -1 4) –2 5) –3

**(4)**




5. For the $SiO_3^{x}$ molecule above, how many equal-energy resonance structures can you draw?

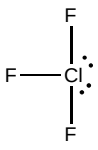
1) 1 2) 2 3) 3 4) 4 5) 6

**(3)**

6. Consider the molecule $ClF_3$ How many lone pairs are on the central atom?

1) 1 2) 2 3) 3 4) 6 5) 0

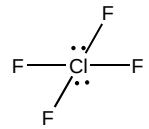
**(2)**



7. Consider the molecule $ClF_4^-$ What is the electron pair geometry?

1) Trigonal bipyramidal 2) Octahedral 3) linear

4) Trigonal planer 5) Tetrahedral

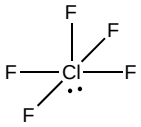



**(2)**

8. Consider the molecule $ClF_5$ What is the molecular geometry?

1) Trigonal bipyramidal 2) Octahedral 3) linear

4) square pyramidal 5) Tetrahedral




**(4)**

9. Which of the following has the longest bond length?

1) None 2) $CF_4$ 3) $CCl_4$ 4) $CBr_4$ 5) $CI_4$

**(5) I is largest of F, Cl, Br, I OWL 9-xx**

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

1) None 2) $SiF_4$ 3) $SiCl_4$ 4) $SiBr_4$ 5) $SiI_4$

**(2) – shortest bond, strongest bond OWL 9-xx**

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

1) $C_2$ 2) $N_2$ 3) $O_2$ 4) $F_2$ 5) $B_2$

**(2) $N_2$ – triple bond OWL 9-xx**

12. The electron pair geometry centered at the O atom in $CH_3COCH_3$ is:

1) Trigonal bipyramidal 2) Octahedral 3) linear

4) Trigonal planer 5) Tetrahedral

**(4) Tetrahedral**

13. In the molecule **formaldehyde** $CH_2O$, what is the approximate HCO bond angle?

1) 180° 2) 90° 3) 109° 4) 120° 5) 60°

**(4) - trigonal planar at the C**

14. What is the molecular geometry of $KrF_4$?

1) trigonal bipyramidal 2) Octahedral 3) square pyramidal

4) trigonal pyramidal 5) Square planar

**(5) - See Figure 9.11**

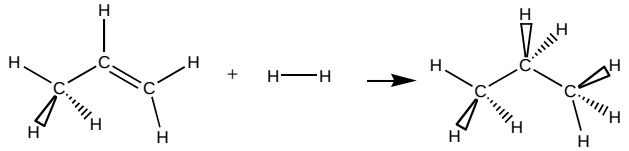
Bond Dissociation Energies (kJ $mol^{-1}$) (gas phase)

| 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 |
| C-F | 485 | F-F | 155 | | |

15. Consider the reaction: $CH_3CHCH_2$ (g) + $F_2$ (g) → $CH_3(CFH)(CH_2F)$ (g)

What is the energy ($\Delta H°$, in kJ $mol^{-1}$) for this reaction?

1) –220 2) +220 3) –126 4) –205 5) –551



**(5)**

**$\Delta H°$ = (Bonds Broken) – (Bonds Formed)**

**$\Delta H° = (D_{C=C} + D_{F-F}) – (2D_{C-F}) - D_{C-C} = (610 + 155) – 2(485) - 346 = -551$ kJ $mol^{-1}$**

16. Which of the following has the highest effective nuclear charge as seen by its outermost valence electrons?

1) Br 2) N 3) S 4) F 5) Ge

**(4) F**

17. Which of the following has the highest effective nuclear charge as seen by its outermost valence electrons?

1) $Cl^-$ 2) Ar 3) $K^+$ 4) $Ar^-$ 5) K

**(3) $K^+$ The first three are isoelectronic, 3p valence electrons**

18. Which of the following has the highest electron affinity?

1) Cl 2) S 3) P 4) Si 5) Al

**(1)**

19. From which species below is it easiest to remove an electron?

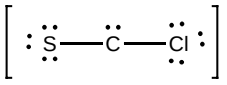
1) $Mg^{2+}$ 2) $Na^+$ 3) Ne 4) $F^-$ 5) $O^{2-}$

**(5)**

20. Which ion has the smallest radius?

1) $Al^{3+}$ 2) $Ca^{2+}$ 3) $In^{3+}$ 4) $Cs^+$ 5) $Tl^{3+}$

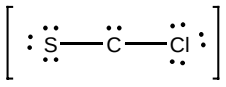
**(1)**

21. What is the formal charge on C in 

?

1) –2 2) –1 3) 0 4) +1 5) +2

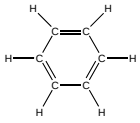
**(3)**

22. What is the overall charge on the species 

?

1) –2 2) –1 3) 0 4) +1 5) +2

**(2)**

23. Consider benzene  in all of its resonance forms. What is the C-C bond order?

1) 0.5 2) 1.0 3) 1.5 4) 2.0 5) 2.5

**(3)**

24. Which of the following molecules is most polar?

1) $CH_4$ 2) $CF_3H$ 3) $CF_4$ 4) $CBr_4$ 5) $CBr_3H$

**(2)**

25. What is the catalog number for this class?

1) 123 2) 111 3) 222 4) 3.14159 5) 68.6 g

(2)