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

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

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)									

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1. Which atom or ion below is most paramagnetic?

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

    (3)   (OWL question)

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

    1) Ge   2) Pb   3) Sb   4) Bi   5) As

    (1) 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) HF   2) NH_3 3) H_2O 4) CH_4 5) BH_3

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

4. Consider the molecule PO_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)

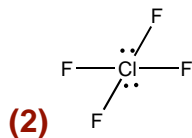   1) +2   2) 0   3) -1   4) –2   5) –3

    (3)
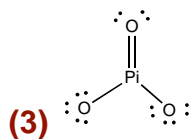
5. For the PO_3^x molecule above, how many equal-energy resonance structures can you draw?

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

    (3)

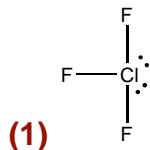6. Consider the molecule ClF_4^- How many lone pairs are on the central atom?

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

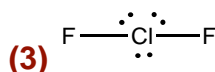   **(2)**

7. Consider the molecule ClF_3 What is the electron pair geometry?

   1) Trigonal bipyramidal   2) Octahedral   3) linear

   4) Trigonal planer   5) Tetrahedral

   (1)

8. Consider the molecule ClF_2^{-} What is the molecular geometry?

   1) Trigonal bipyramidal   2) bent   3) linear

   4) Trigonal planer   5) Tetrahedral

   (3)

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

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

   (1) F is smallest of F, Cl, Br, I   OWL 9-xx

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

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

    (1) – shortest bond, strongest bond   OWL 9-xx

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

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

    (4) N_2 – triple bond   OWL 9-xx

12. The electron pair geometry centered at the O atom in CH_3OCH_3 is:

    1) Trigonal planar   2) Tetrahedral   3) linear

    4) Trigonal bipyramidal   5) Octahedral

    (2) Tetrahedral

13. In the symmetrical molecule **hydrogen peroxide** HOOH, what is the approximate HOO bond angle?

    1) 120°   2) 109°   3) 90°   4) 180°   5) 60°

    (2) H–O—O–H   **- tetrahedral at the O**

14. What is the molecular geometry of $XeCl_2$?

    1) trigonal bipyramidal   2) Octahedral   3) square pyramidal

    4) linear   5) Seesaw
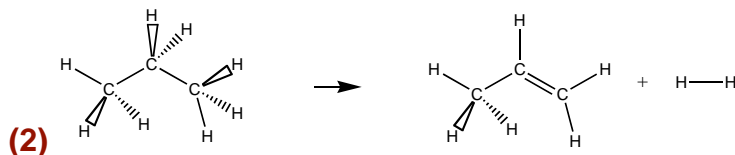
    (4) - See Figure 9.11

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: $CH_3CH_2CH_3$ (g) → CH_3CHCH_2 (g) + H_2 (g)

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

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

    (2)

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

    $\Delta H°$ = [(2D_{C-H}) + D_{C-C}] - ($D_{C=C}$ + D_{H-H}) = 2(413) + 346 -(610 + 436) = +126 kJ mol^{-1}

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

    1) F   2) Si   3) S   4) As   5) N

    (1) F

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

    1) Ca^{2+} 2) Ca   3) Cl^- 4) Ar   5) K^+

    (1) Ca^{2+} All but Ca^0 are isoelectronic, 3p valence electrons

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

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

    (1)

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

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

    (5)

20. Which ion has the largest radius?

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

    (2)

21. What is the formal charge on S in $\left[:\ddot{\underset{..}{S}}—\ddot{C}=\underset{..}{Cl}: \right]$?

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

    (2)

22. What is the overall charge on the species $\left[:\ddot{\underset{..}{S}}—\ddot{C}=\underset{..}{Cl}: \right]$?

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

    (2)
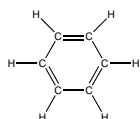
23. Consider benzene in all of its resonance forms. What is the C-C bond order?

    1) 2   2) 1.5   3) 1.0   4) 0.5   5) 0

    (2)

24. Which of the following molecules is most polar?

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

    (5)

25. What is the catalog number for this class?

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

    (3)