Exam 4a
Chem 1141
Spring 2008

Name:_____

MULTIPLE CHOICE. [2.5 pts ea.] Circle the best response. [**45 pts total.**]

Q1. How many valence electrons does an atom of boron contain?
a) 1 b) 2 c) 3 d) 4 e) 5

Q2. How many core electrons does an atom of boron contain?
a) 1 b) 2 c) 3 d) 4 e) 5

Q3. The electron configuration of Ca^{2+} is:
a) $1s^2$ b) $1s^22s^2$ c) $1s^22s^22p^63s^2$ d) $1s^22s^22p^63s^23p^6$ e) $1s^22s^22p^63s^23p^64s^2$

Q4. The relative sizes of carbon, oxygen, and sulfur atoms would be:
a) C < O < S b) S < O < C c) O < S < C d) S < C < O e) O < C < S

Q5. An element has the following ionization energies: I_1 = 312 kJ/mol, I_2 = 422 kJ/mol, I_3 = 12430 kJ/mol, I_4 = 14100 kJ/mol. Which element would it be most likely to be?
a) Si b) Al c) Mg d) Na e) Ne

Q6. The chemical equation corresponding to the first electron affinity of sodium is:
a) $Na(g) \rightarrow Na^+(g) + e^-$
b) $Na(s) \rightarrow Na^+(aq) + e^-$
c) $e^- + Na(g) \rightarrow Na^-(g)$
d) $e^- + Na(s) \rightarrow Na^+(s)$

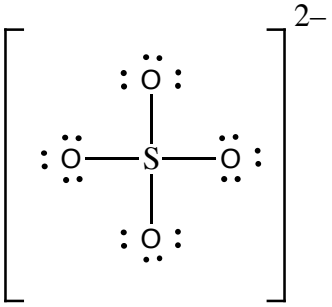
Q7. The total number of valence electrons in the NO^+ cation is:
a) 16 b) 14 c) 12 d) 11 e) 10

Q8. The type of bond formed by the sharing of 4 electrons is:
a) Ionic b) Polar covalent c) single bond d) double bond e) triple bond

Q9. The number of lone pairs on the ammonia molecule, NH_3 is:
a) 0 b) 1 c) 2 d) 3 e) 4

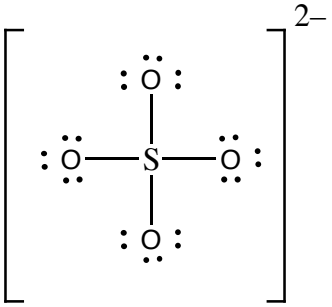
Q10. Which bond would be the most polar: B—C, B—N, B—O, B—F, or B—Cl?
a) B—C b) B—N c) B—O d) B—F e) B—Cl

Q11. The formal charge on the sulfur atom in the following molecule is:



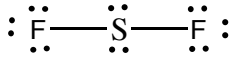
a) –2 b) –1 c) 0 d) +1 e) +2

Q12. The formal charge on each oxygen atom in the following molecule is:



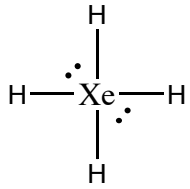
a) –2 b) –1 c) 0 d) +1 e) +2

Q13. The molecular geometry of the following molecule is:



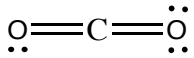
a) Linear b) Bent c) Square Planar d) Tetrahedral e) Trigonal bipyramidal

Q14. The molecular geometry of the following molecule is:



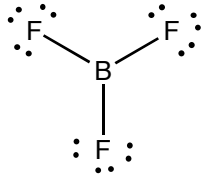
a) Linear b) Bent c) Square Planar d) Tetrahedral e) Trigonal bipyramidal

Q15. What type of hybrid orbital would be found on the carbon atom in the following molecule:



a) sp b) sp^2 c) sp^3 d) sp^3d e) sp^3d^2

Q16. Given that BF_3 has the geometry below, identify the correct statement:

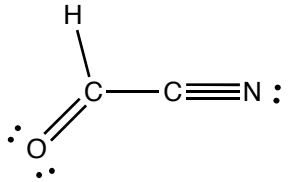


a) The B—F bonds are polar, and the molecule is polar
b) The B—F bonds are polar, and the molecule is non-polar
c) The B—F bonds are non-polar, and the molecule is non-polar

Q17. An XY_3 molecule (where X and Y represent different elements) is found to be non-polar. Therefore its molecular geometry must be:

a) Linear b) Trigonal planar c) Trigonal pyramidal d) T-Shaped e) Tetrahedral

Q18. How many sigma (σ) and pi (π) bonds are there in the following molecule:



a) 2 σ, 4 π b) 2 σ, 5 π c) 3 σ, 2 π d) 4 σ, 4 π
e) 4 σ, 3 π f) 6 σ, 2 π g) 7 σ, 0 π

Short Response.

Show ALL work to receive credit. Use the conversion factor method for all problems to receive full credit.

Q19. [10 pts.] Write full electron configurations for the following ions:

a) Cu^{+}

b) Al^{3+}

c) Sc^{2+}

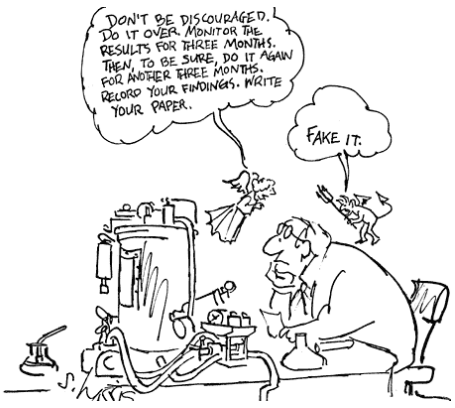
d) Fe^{3+}

Q20. [6 pts.] What does the term *isoelectronic* mean? Give three examples of atoms/ions that are isoelectronic with argon, Ar.

Q21. [5 pts.] Draw a valid Lewis structure for the nitrite ion, NO_2^-.

Q22. [6 pts.] Draw all possible resonance structures for ozone, O_3.

Q23. [12 pts.] Predict the *molecular* geometry of PCl_3 using VSEPR theory. Be sure to include (1) a valid Lewis structure, (2) a sketch of the molecular geometry, (3) the name of the molecular geometry, and (4) approximate bond angles.



Q24. [6 pts.] Is BeF_2 polar or non-polar? Explain.

Q25. [10 pts.] Describe the bonding inside acetylene, HC≡CH using valence-bond theory. Be sure to include an orbital diagram for each type of atom, the types of hybrid orbitals required (if any), a sketch of any orbital overlaps, and the type of each bond formed (sigma or pi).

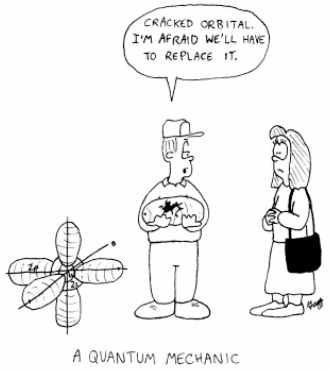
BONUS: Predict ΔH^o for the reaction:

$$2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$$

Given the following table of bond energies:

Type of Bond	**Bond Energy / kJ·mol^{-1}**
H–H	436.4
O=O	498.7
O–H	460

How much heat would be produced/absorbed if 12.0 g of water was formed?



Useful Information

Periodic Table of the Elements

IA	IIA											IIIA	IVA	VA	VIA	VIIA	VIIIA
1																	*18*
1 H 1.01	*2*											*13*	*14*	*15*	*16*	*17*	2 He 4.00
3 Li 6.94	4 Be 9.01											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	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	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 47.87	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.39	31 Ga 69.72	32 Ge 72.61	33 As 74.92160	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 [98]	44 Ru 101.07	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.71	51 Sb 121.76	52 Te 127.60	53 I 126.90	54 Xe 131.29
55 Cs 132.91	56 Ba* 137.33	71 Lu 174.97	72 Hf 178.49	73 Ta 180.95	74 W 183.84	75 Re 186.21	76 Os 190.23	77 Ir 192.22	78 Pt 195.08	79 Au 196.97	80 Hg 200.59	81 Tl 204.38	82 Pb 207.20	83 Bi 208.98	84 Po [210]	85 At [210]	86 Rn [222]
87 Fr [223]	88 Ra** [226]	103 Lr [262]	104 Rf [261]	105 Db [262]	106 Sg [266]	107 Bh [264]	108 Hs [265]	109 Mt [268]	110 [269]	111 [272]	112 [277]	113	114 [285]	115	116 [289]	117	118 [293]

*	57 La 138.91	58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm [145]	62 Sm 150.36	63 Eu 151.96	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.04
**	89 Ac [227]	90 Th 232.04	91 Pa 231.04	92 U 238.03	93 Np [237]	94 Pu [244]	95 Am [243]	96 Cm [247]	97 Bk [247]	98 Cf [251]	99 Es [252]	100 Fm [257]	101 Md [258]	102 No [259]