

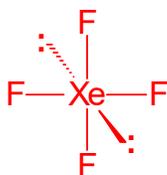
Chem 10113, Quiz 5

November 7, 2018

Answer Key

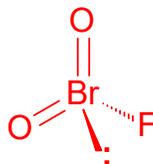
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|---|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|
| | IA (1) | | | | | | | | | | | | | | | | | VIIIA (18) |
| 1 | 1 H 1.0080 | | | | | | | | | | | | | | | | | 2 He 4.0026 |
| 2 | 3 Li 6.9410 | IIA (2) | 4 Be 9.0122 | | | | | | | | | 5 B 10.811 | 6 C 12.011 | 7 N 14.007 | 8 O 15.999 | 9 F 18.998 | 10 Ne 20.179 | |
| 3 | 11 Na 22.990 | 12 Mg 24.305 | IIIB (3) | IVB (4) | VB (5) | VIB (6) | VII B (7) | VIII B (8) | VIII B (9) | VIII B (10) | IB (11) | II B (12) | 13 Al 26.982 | 14 Si 28.086 | 15 P 30.974 | 16 S 32.066 | 17 Cl 35.453 | 18 Ar 39.948 |
| 4 | 19 K 39.098 | 20 Ca 40.078 | 21 Sc 44.956 | 22 Ti 47.880 | 23 V 50.942 | 24 Cr 51.996 | 25 Mn 54.938 | 26 Fe 55.847 | 27 Co 58.933 | 28 Ni 58.690 | 29 Cu 63.546 | 30 Zn 65.380 | 31 Ga 69.723 | 32 Ge 72.610 | 33 As 74.922 | 34 Se 78.960 | 35 Br 79.904 | 36 Kr 83.800 |
| 5 | 37 Rb 85.468 | 38 Sr 87.620 | 39 Y 88.906 | 40 Zr 91.224 | 41 Nb 92.906 | 42 Mo 95.940 | 43 Tc 98.907 | 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 121.75 | 52 Te 127.60 | 53 I 126.90 | 54 Xe 131.29 |
| 6 | 55 Cs 132.91 | 56 Ba 137.33 | 57 La 138.91 | 72 Hf 178.49 | 73 Ta 180.95 | 74 W 183.85 | 75 Re 186.21 | 76 Os 190.20 | 77 Ir 192.22 | 78 Pt 195.09 | 79 Au 196.97 | 80 Hg 200.59 | 81 Tl 204.38 | 82 Pb 207.20 | 83 Bi 208.98 | 84 Po 208.98 | 85 At 209.99 | 86 Rn 222.02 |
| 7 | 87 Fr 223.02 | 88 Ra 226.03 | 89 Ac 227.03 | 104 Unq 261.11 | 105 Unp 262.11 | 106 Unh 263.12 | 107 Uns 262.12 | | | | | | | | | | | |

1. (9 points) Apply **VSEPR** concepts to the following molecules. For each one, draw a clear 3-D structure and give a *description* of the shape (i.e., bent, trigonal planar, etc.). Also, *state* whether each molecule is *polar* or *non-polar*.



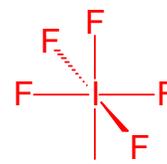
square planar

non-polar



pyramidal

polar

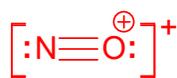


square pyramidal

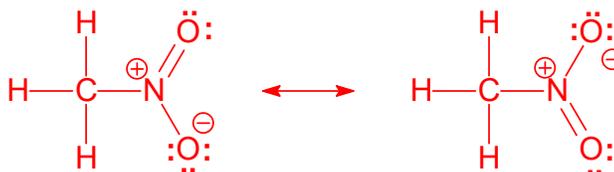
polar

2. (9 points) For each of the following molecules or ions, write the *complete* Lewis electron dot formula. Include formal charges and/or resonance forms where appropriate.

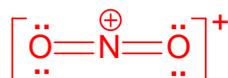
(a) NO^+



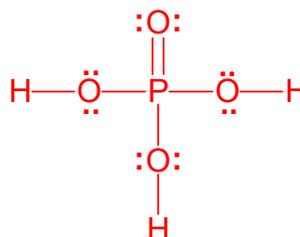
(b) H_3CNO_2



(c) NO_2^+



(d) H_3PO_4



3. (a) (2 points) Based on your answers above, what is the N–O bond order in each species?

NO_2^+ 2 NO^+ 3 H_3CNO_2 1.5

(b) (1 point) Of the three species above, the longest N–O bond is found in H_3CNO_2

4. (4 points) **SHOW ALL WORK.** Using the table of bond energies, estimate the enthalpy change (ΔH°) for the following "hydrogenation" reaction.

Bond Energy (kJ/mole)

| | |
|-----|------|
| C–H | 414 |
| O–H | 464 |
| N–H | 389 |
| H–H | 436 |
| C–C | 347 |
| C=C | 611 |
| C–O | 361 |
| C=O | 736 |
| C≡O | 1072 |
| C–N | 305 |
| C=N | 615 |
| C≡N | 891 |



$$\begin{aligned} \text{Bonds broken} &= 4 \text{ H-H} + 1 \text{ C=O} + 1 \text{ C}\equiv\text{N} \\ &= 4(436) + 736 + 891 = 3,371 \text{ kJ} \end{aligned}$$

$$\begin{aligned} \text{Bonds formed} &= 4 \text{ C-H} + 2 \text{ N-H} + 2 \text{ O-H} + 1 \text{ C-N} \\ &= 4(414) + 2(389) + 2(464) + 305 = 3,667 \end{aligned}$$

$$\Delta H^\circ \approx \sum \text{BE (bonds broken)} - \sum \text{BE (bonds formed)}$$

$$\Delta H^\circ \approx 3,371 - 3,667 \approx -296 \text{ kJ}$$