CHEM 101 Exam 2 KEY

Student: _____

I Multiple Choice (30 points)

1. Which of these compounds is most likely to be ionic?
A. NCl_3
B. $BaCl_2$
C. CO
D. SO_2
E. SF_4

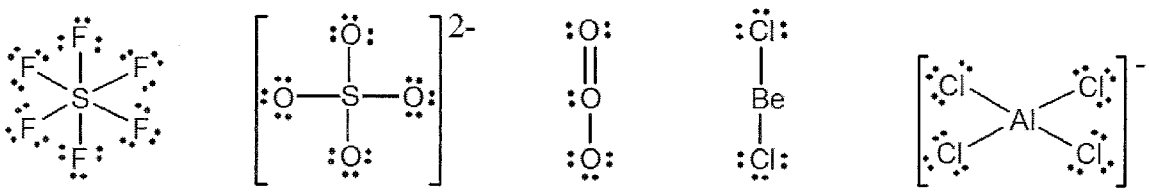
2. The lattice energy for ionic crystals increases as the charge on the ions _____ and the size of the ions _____ .
A. increases, increases
B. increases, decreases
C. decreases, increases
D. decreases, decreases
E. None of these is generally correct.

3. Which is the correct order for increasing bond strength?
A. C —C < C ═C < C ≡C
B. C —C < C ≡C < C ═C
C. C ≡C < C ═C < C —C
D. C ≡C < C —C < C ═C
E. C=C < C —C < C ≡C

4. A polar covalent bond would form in which one of these pairs of atoms?
A. Cl —Cl
B. Si —Si
C. Ca —Cl
D. Cr —Br
E. P —Cl

5. In which one of the following structures does the central atom have a formal charge of +2?

a. SF_6 b. SO_4^{2-} c. O_3 d. $BeCl_2$ e. $AlCl_4^-$

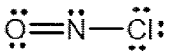


A. a
B. b
C. c
D. d
E. e

Student: _____ 3 pts. ea.

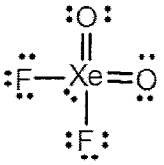
6. The number of resonance structures for the nitrate ion (NO_3^-)that satisfy the octet rule is:
A. 1
B. 2
C. 3
D. 4
E. None of these choices is correct.

7. What is the molecular shape of NOCl as predicted by the VSEPR theory?



A. linear
B. trigonal planar
C. bent
D. tetrahedral
E. trigonal pyramidal

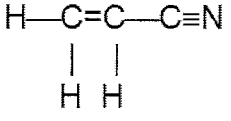
8. What is the molecular shape of XeO_2F_2 as predicted by the VSEPR theory?



A. square planar
B. tetrahedral
C. square pyramidal
D. see-saw
E. octahedral

9. What is the approximate bond angle for CCl_4?
A. 90°
B. 109.5°
C. 120°
D. 145°
E. 180°

10. The number of π bonds in the molecule below is:



A. 1
B. 2
C. 3
D. 5
E. 9

Student: _____

II. Short Answer (11 points)

11. (2 points) A triple bond arises when two atoms share 3 pairs of electrons.

12. (2 points) A π or pi bond results from parallel overlap of two p orbitals.

13. (2 points) What term describes the ability of an atom in a compound to pull the electrons to itself?
electronegativity

14. (5 points) Complete the following table.

Hybrid type	Geometry of electron pairs
a. sp	linear
b. sp^3	tetrahedral
c. sp^3d	trigonal bipyramidal
d. sp^3d^2	octahedral
e. sp^2	trigonal planar

III Lewis structures (40 points)

15. (40 points) For each of the following compounds:
- Draw the Lewis structure, including all lone pairs. For c), show all of the important (i.e. best) resonance structures.
- Determine both the electron domain geometry and the molecular geometry.
- Determine the value(s) of the bond angle(s) present in the molecule, in degrees.
- Draw dipole moments (⟶)next to each of the polar covalent bonds present in the molecule.
- Describe whether the molecule **as a whole** is polar or nonpolar by circling the appropriate word
- State the hybridization of the central atom in each molecule (e.g. sp^2, sp^3d, etc.)
-

a) H_2S

Electron geometry: tetrahedral

Molecular geometry: bent

Bond angle(s): ~109.5° (or less)

3

Circle one: (polar) nonpolar

Hybridization: sp^3

avoid double jeopardy:
if structure wrong, but other answers correct based on wrong drawing, give credit.

Student: _____

b) ClF_3

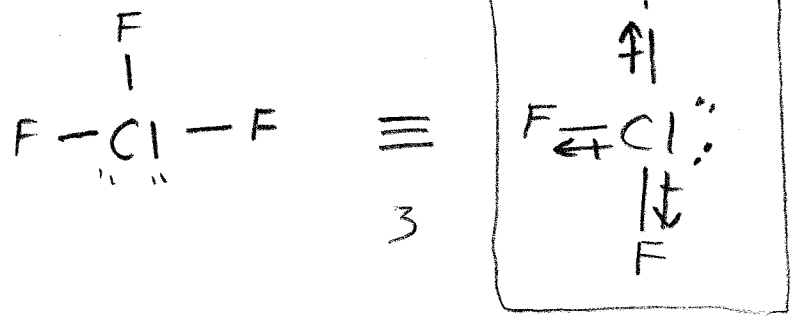
Electron geometry: trigonal bipyramid

Molecular geometry: T-shape

Bond angle(s): ~ 90°, 120°, 180°

Circle one: (polar) nonpolar

Hybridization: sp^3d



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Avoid double jeopardy: if structure wrong, but other answers correct based on wrong drawing, give credit.

c) CO_3^{2-}

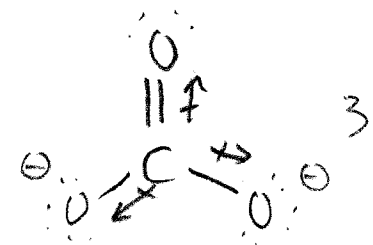
Electron geometry: trigonal planar } 1

Molecular geometry: trigonal planar }

Bond angle(s): 120° 1

Circle one: polar (nonpolar) 1

Hybridization: sp^2 1



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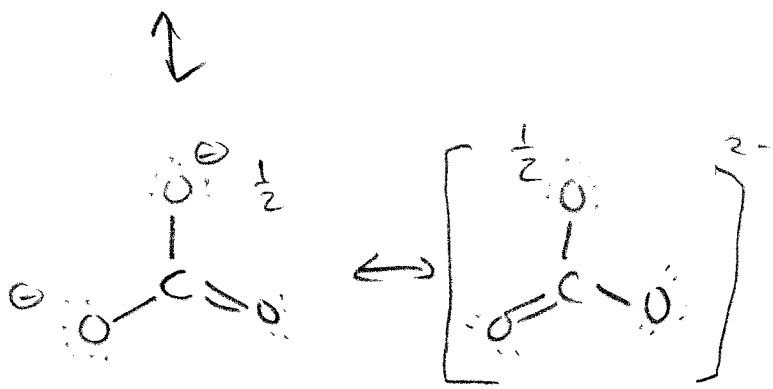

OK to use brackets + charge instead of formal charges

16

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d) PF_5

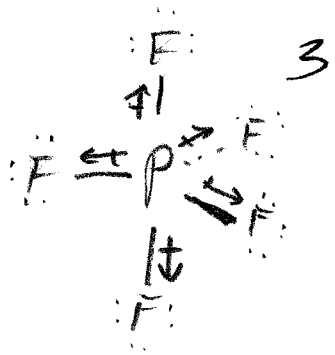
Electron geometry: trigonal bipyramid

Molecular geometry: "

Bond angle(s): 90°, 120°, 180°

Circle one: polar (nonpolar)

Hybridization: sp^3d



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Avoid double jeopardy:
if structure wrong, but other answers ✓ based on wrong structure, give credit.

e) XeF_4

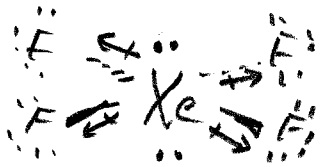
Electron geometry: octahedral

Molecular geometry: square planar

Bond angle(s): 90°, 180°

Circle one: polar (nonpolar)

Hybridization: sp^3d^2



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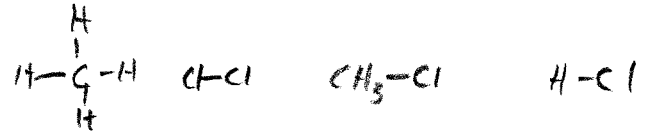
Student: _____

IV. Calculations (19 points). SHOW WORK FOR CREDIT

$\Delta H^\circ_{rxn} = \sum BE_{reactants} - \sum BE_{products}$

16. (5 points) Given the following bond enthalpies:

C-H	414 kJ/mol
C-Cl-	326 kJ/mol
Cl-Cl	243 kJ/mol
H-Cl	432 kJ/mol



calculate ΔH°_{rxn} for the reaction $CH_4(g) + Cl_2(g) \rightarrow CH_3Cl(g) + HCl(g)$

break: C-H 414 kJ/mol
Cl-Cl 243 " ×2
657 "

make: C-Cl 326 kJ/mol
H-Cl 432 " ×2
758 kJ/mol

(657 − 758 = −101) kJ/mol 1

17. (6 points) A sample of an ideal gas has its volume increase from 10.0 L to 20.0 L while its temperature remains constant. If the original pressure was 100 torr, what is the new pressure?

$P_1 V_1 = P_2 V_2$

$(100 \text{ torr})(10.0 \text{ L}) = P_2(20.0 \text{ L})$ } Setup: 4

$P_2 = 50 \text{ torr}$ (don't worry about sig figs)

execution: 2

Student: _____

18. (8 points) If 25.5 L of oxygen are cooled from 150°C to 50°C at constant pressure, what is the new volume of oxygen?

+273.15 ↓ ↓ 323.15K

423.15K

1 1

$\frac{V_1}{T_1} = \frac{V_2}{T_2}$ } 4 for setup

$\frac{25.5\,L}{423.15\,K} = \frac{V_2}{323.15\,K}$

$V_2 = 19.47\,L$ } 2 for calc.

$= 19\,L$

(don't worry about sig figs for this)