Bonding, 2012.

A) CaO B) CH2CH2 (ethene) C) SeO3 D) CH2Cl2 E) NBr3

Base your answers on the compounds listed above. ( for questions 1 to 7)

1. Has the highest melting point of these substances

2. Molecular geometry is trigonal planar.

3. Molecule contains a single π bond, with no resonance

4. Molecule demonstrates resonance.

5. Molecular geometry is different from the electron geometry

6. The polar molecules listed above are A) B and C B) C and D

 C) D and E D) B and E E) C and E

7. sp3 hybridization can be used to explain the bonding in molecules

 A) A and B B) B and C C) C and D D) D and E E) B and E

8. Which ionic solid has the greatest lattice energy?

 A) KF B) MgO C) NaF D) CaO E) MgS

A) Linear B) see-saw C) trigonal pyramid D) square based pyramid E) T shape

Questions 9 to 13 are based on the molecular geometries listed above.

9. SeCl4

10. XeF2

11. ICl5

12. BrF3

13. C2H2

14. For which of the following is the concept of resonance considered LEAST

 relevant in explaining the shape and the bond length?

 A) SO3 B) SO2 C) C6H6  D) CO2 E) CO32-

15. Which molecule has the smallest dipole moment?

 A) COCl2 B) HBr C) CS2 D) ICl3 E) NI3

16. Which molecule is pictured as containing the fewest π bonds?

 A) HNO2 B) HCN C) C3H4 D) CO E) C6H6

17. sp2 hybridization provides an explanation for the structure of

 A) O3 B) I3− C) H2SO3 D) PH3 E) OF2

18. Molecules that have a T shaped molecular structure, generally have an electron geometry that is A) T-shaped B) octahedral C) trigonal bipyramid

 D) tetrahedral E) trigonal planar

19. An octahedral electron geometry, when there are two lone pairs on the central atom, generally produces a molecular geometry that is A) tetrahedral B)see-saw shaped C) square planar D) square based pyramidal E) trigonal planar

20. The general rule that atoms with larger atomic radii have smaller ionization energies does not apply when comparing A) P atoms and S atoms

 B) B atoms and C atoms C) O atoms and S atoms

 D) Ne atoms and Ar atoms E) Na atoms and Mg atoms

21. Which equation best illustrates what is meant by the electron affinity of a chlorine atom?

 A) Cl2(g) + energy ➞ 2 Cl(g) B) Cl(g) + energy ➞ Cl+((g) + e−

 C) Cl(g) + e− ➞ Cl- (g) + energy

 D) Cl+(g) + e- ➞ Cl(g) E) Cl(g) ➞ Cl(l) + energy

22. What is the formal charge on the nitrogen atom in nitric acid, HNO3 ?

 A) 0 B) +1 C) +2 D) +3 E) +5

Answer the remaining questions in your essay booklet.

I. The values of the first three ionization energies (I1, I2, I3) for magnesium and argon are as follows:

|  |  |  |  |
| --- | --- | --- | --- |
|  | I1 | I2 | I3 |
|  | (kJ/mol) |
| Mg | 735 | 1443 | 7730 |
| Ar | 1525 | 2665 | 3945 |

(a) Give the electronic configurations of Mg and Ar.

(b) In terms of these configurations, explain why the values of the first and second ionization energies of Mg are significantly lower than the values for Ar, whereas the third ionization energy of Mg is much larger than the third ionization energy of Ar.

(c) If a sample of Ar in one container and a sample of Mg in another container are each heated and chlorine is passed into each container, what compounds, if any, will be formed? Explain in terms of the electronic configurations given in part (a).

(d) Element Q has the following first three ionization energies:

|  |  |  |  |
| --- | --- | --- | --- |
|  | I1 | I2 | I3 |
|  | (kJ/mol) |
| Q | 496 | 4568 | 6920 |

 What is the formula for the most likely compound of element Q with chlorine? Explain the choice of formula on the basis of the ionization energies.

II . NO2 NO2- NO2+

Nitrogen is the central atom in each of the species given above.

(a) Draw the Lewis electron-dot structure for each of the three species.

(b) List the species in order of increasing bond angle. Justify your answer.

(c) Select one of the species and give the hybridization of the nitrogen atom in it.

(d) Identify the only one of the species that dimerizes and explain what causes it to do so. ( Dimerizes means bonding to itself to form a larger molecule)

III. A. Given the structural formula for propyne below,



 (i) indicate the hybridization of the middle carbon atom in the structure above;

 (ii) indicate the total number of sigma (s) bands and the total number of pi (π) bonds in the molecule

B. The ionization energies of a silicon atom are given below: (kJ/mol)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| I1 | I2 | I3 | I4 | I5 |
| 786 | 1577 | 3232 | 4356 | 16091 |

(i) Explain why the difference in ionization energy is greater between I2 and I3 than it is

 between I1 and I2 or I3 and I4

(ii) Predict whether the first ionization energy of a carbon atom would be larger than or smaller than the first ionization energy of a silicon atom. Explain your prediction.

IV. Answer the following questions that relate to chemical bonding

Draw the complete Lewis structure (electron-dot diagram) for each of the three molecules represented below.

 CF4 PF5 SF4

(b) On the basis of the Lewis structures drawn above, answer the following questions about the particular molecule indicated.

(i) What is the F-C-F bond angle in CF4?

(ii) What is the electron geometry around the P in PF5?

(iii) What is the geometric shape formed by the atoms in SF4?

(c) Two Lewis structures can be drawn for the OPF3 molecule, as shown below.

 

 Structure 1 Structure 2

(i) How many sigma bonds and how many pi bonds are in structure 1?

(ii) Based on formal charge which one of the two structures best repre­sents a molecule of OPF3?

V. A. Draw the dot structure of nitrous acid, HNO2

 B. Determine the formal charge on each atom

 C. Compare the two nitrogen to oxygen bond lengths, and explain your answer.

 D. Nitrous acid will react with bases to form the nitrite ion, NO2−

 (1) what is the hybridization on the nitrogen atom?

 (2) compare the bond lengths in the nitrite ion with the bond lengths previously discussed in nitrous acid. Explain any differences in bond length.

VI. Given the following bond energies: (per mole)

 O2 495 kJ  799 kJ  1072 kJ

 Find the enthalpy change, ΔH° for the reaction

 2 CO(g) + O2(g) → 2 CO2(g)