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| 1. Use the expression for the Coulomb potential energy to calculate the energy for formation of 1 mole of sodium chloride ion-pairs, that is, the energy change for the following reaction:  ​  Na+(g) + Cl–(g) → Na+Cl–(g)  ​  Use r12 = 283 pm.   |  |  | | --- | --- | | *ANSWER:* | –491 kJ·mol–1 | |

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| 2. If 491 kJ·mol–1 is released in the reaction Na+(g) + Cl–(g) → Na+Cl–(g), what is the energy change for the reaction Na(g) + Cl(g) → Na+Cl–(g)? (Hint: See the discussion in the text and apply Hess's Law.)   |  |  | | --- | --- | | *ANSWER:* | –346 kJ·mol–1 | |

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| 3. If 346 kJ·mol–1 is released in the reaction Na(g) + Cl(g) → Na+Cl–(g), is the energy change for the reaction Na+Cl–(g) → NaCl(s) endothermic or exothermic?   |  |  |  | | --- | --- | --- | |  | a. | Endothermic | |  | b. | Exothermic |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 4. The Madelung constant is different for all crystals.   |  |  |  | | --- | --- | --- | |  | a. | True | |  | b. | False |  |  |  | | --- | --- | | *ANSWER:* | a | |

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| 5. Use the expression for the Coulomb potential energy to calculate the energy for formation of 1 mole of rubidium chloride ion-pairs, that is, the energy change for the following reaction:  ​  Rb+(g) + Cl–(g) → Rb+Cl–(g)  ​  Use r12 = 330 pm.   |  |  | | --- | --- | | *ANSWER:* | –421 kJ·mol–1 | |

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| 6. Which of the following has the lowest lattice energy?   |  |  |  | | --- | --- | --- | |  | a. | KBr | |  | b. | KCl | |  | c. | KI | |  | d. | LiCl | |  | e. | NaCl |  |  |  | | --- | --- | | *ANSWER:* | c | |

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| 7. Which of the following has the highest lattice energy?   |  |  |  | | --- | --- | --- | |  | a. | BaO | |  | b. | CaO | |  | c. | KI | |  | d. | MgO | |  | e. | NaCl |  |  |  | | --- | --- | | *ANSWER:* | d | |

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| 8. Which of the following has the highest melting point?   |  |  |  | | --- | --- | --- | |  | a. | KBr | |  | b. | KCl | |  | c. | KF | |  | d. | KI | |  | e. | RbF |  |  |  | | --- | --- | | *ANSWER:* | c | |

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| 9. Metals rarely lose electrons in chemical reactions because   |  |  |  | | --- | --- | --- | |  | a. | their electron affinities are too high. | |  | b. | their ionic radii become too small. | |  | c. | their ionization energies are too small. | |  | d. | their ionization energies are too high. | |  | e. | their size is too small. |  |  |  | | --- | --- | | *ANSWER:* | d | |

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| 10. An element, E, has the electronic configuration [Ne] 3s23p1. Write the formula of its compound with sulfate.   |  |  | | --- | --- | | *ANSWER:* | E2(SO4)3 | |

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| 11. Predict the electronic configuration in the oxide ion in CaO.   |  |  |  | | --- | --- | --- | |  | a. | [He]2s22p6 or [Ne] | |  | b. | [He]2s22p5 | |  | c. | [He]2s22p63s2 | |  | d. | [Ne]3s13p3 | |  | e. | [Ne]3s23p3 |  |  |  | | --- | --- | | *ANSWER:* | a | |

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| 12. Write the formula of magnesium phosphide.   |  |  | | --- | --- | | *ANSWER:* | Mg3P2 | |

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| 13. Which of the following metal ions has the ground-state electron configuration [Ar]3d6?   |  |  |  | | --- | --- | --- | |  | a. | Ca2+ | |  | b. | Cu+ | |  | c. | Fe2+ | |  | d. | Mn2+ | |  | e. | Ni3+ |  |  |  | | --- | --- | | *ANSWER:* | c | |

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| 14. For the ground-state ion Pb2+, what type of orbital do the electrons with highest energy reside in?   |  |  |  | | --- | --- | --- | |  | a. | 4f | |  | b. | 5d | |  | c. | 5p | |  | d. | 6p | |  | e. | 6s |  |  |  | | --- | --- | | *ANSWER:* | e | |

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| 15. For the ground-state ion Sn4+, what type of orbital do the electrons with highest energy reside in?   |  |  |  | | --- | --- | --- | |  | a. | 4d | |  | b. | 4f | |  | c. | 4p | |  | d. | 5p | |  | e. | 5s |  |  |  | | --- | --- | | *ANSWER:* | a | |

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| 16. For the ground-state ion Bi3+, what type of orbital do the electrons with highest energy reside in?   |  |  |  | | --- | --- | --- | |  | a. | 4f | |  | b. | 5d | |  | c. | 5p | |  | d. | 6p | |  | e. | 6s |  |  |  | | --- | --- | | *ANSWER:* | e | |

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| 17. For the ground-state ion I–, what type of orbital do the electrons with highest energy reside in?   |  |  |  | | --- | --- | --- | |  | a. | 4d | |  | b. | 5d | |  | c. | 5p | |  | d. | 5s | |  | e. | 6s |  |  |  | | --- | --- | | *ANSWER:* | c | |

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| 18. Because of the octet rule, the gaseous O2– ion is stable. True or false?   |  |  |  | | --- | --- | --- | |  | a. | True | |  | b. | False |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 19. All the following elements exist as diatomic gases at room temperature and atmospheric pressure except   |  |  |  | | --- | --- | --- | |  | a. | Ar. | |  | b. | Cl. | |  | c. | H. | |  | d. | N. | |  | e. | O. |  |  |  | | --- | --- | | *ANSWER:* | a | |

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| 20. How many lone pairs of electrons are found in the Lewis structure of the interhalogen compound ICl3?   |  |  |  | | --- | --- | --- | |  | a. | 10 | |  | b. | 4 | |  | c. | 8 | |  | d. | 6 | |  | e. | 7 |  |  |  | | --- | --- | | *ANSWER:* | a | |

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| 21. How many lone pairs of electrons are found in the Lewis structure of urea, (NH2)2CO?   |  |  |  | | --- | --- | --- | |  | a. | 2 | |  | b. | 3 | |  | c. | 6 | |  | d. | 4 | |  | e. | 8 |  |  |  | | --- | --- | | *ANSWER:* | d | |

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| 22. How many lone pairs of electrons are found in the Lewis structure of hydrazine, H2NNH2?   |  |  |  | | --- | --- | --- | |  | a. | 8 | |  | b. | 4 | |  | c. | 1 | |  | d. | 0 | |  | e. | 2 |  |  |  | | --- | --- | | *ANSWER:* | e | |

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| 23. Draw the Lewis structure of xenon difluoride and give the number of lone pairs electrons around the central atom.   |  |  | | --- | --- | | *ANSWER:* | Three | |

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| 24. Draw the Lewis structure of the format ion and indicate whether resonance forms are possible.   |  |  | | --- | --- | | *ANSWER:* | Two resonance forms are possible. | |

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| 25. Draw the "best" Lewis structures of hydrogen azide, HN1N2N3, and the azide ion, N1N2N3– . The subscripts are used for identification. For each, match the following bond lengths to the correct N–N bond. The bond lengths can be used more than once.  ​   |  |  |  | | --- | --- | --- | | ​ | N–N bond | Bond length, pm | | hydrogen azide | N1–N2 | 113 | | ​ | N2–N3 | 116 | | azide ion | N1–N2 | 124 | | ​ | N2–N3 | ​ |   ​   |  |  | | --- | --- | | *ANSWER:* | hydrogen azide: N1–N2, 124 pm; N2–N3, 113 pm; azide ion: N1–N2, 116 pm; N2–N3, 116 pm | |

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| 26. Which of the following do not have resonance structures?   |  |  |  | | --- | --- | --- | |  | a. | CH3CONH– | |  | b. | CH2COCH3– | |  | c. | H2CO | |  | d. | All have resonance structures. |  |  |  | | --- | --- | | *ANSWER:* | c | |

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| 27. For dinitrogen monoxide, the arrangement of the atoms is N-N-O. In the Lewis structure with a double bond between NN and NO, the formal charges on N, N, and O, respectively, are   |  |  |  | | --- | --- | --- | |  | a. | 0, –1, +1. | |  | b. | –1, +1, 0. | |  | c. | 0, +1, –1. | |  | d. | 0, 0, 0. | |  | e. | –2, +1, +1. |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 28. For dinitrogen monoxide, the arrangement of the atoms is N-N-O. In the Lewis structure with a single bond between NN and a triple bond between NO, the formal charges on N, N, and O, respectively, are   |  |  |  | | --- | --- | --- | |  | a. | –1, +1, 0. | |  | b. | 0, 0, 0. | |  | c. | 0, +1, –1. | |  | d. | 0, –1, +1. | |  | e. | –2, +1, +1. |  |  |  | | --- | --- | | *ANSWER:* | e | |

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| 29. In the "best" Lewis structure of XeO4, there are two double bonds and the formal charge on Xe is zero. True or false?   |  |  |  | | --- | --- | --- | |  | a. | True | |  | b. | False |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 30. Write three Lewis structures for the cyanate ion, NCO–, where the arrangement of atoms is N-C-O. In the most plausible structure,   |  |  |  | | --- | --- | --- | |  | a. | the formal charge on N is –1. | |  | b. | the formal charge on O is +1. | |  | c. | there are two double bonds. | |  | d. | there is a triple bond between C and O. | |  | e. | there is a triple bond between N and C. |  |  |  | | --- | --- | | *ANSWER:* | e | |

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| 31. Predict the N-O bond lengths in NO2–, given the N-O and N=O bond lengths of 140 and 120 pm, respectively.   |  |  | | --- | --- | | *ANSWER:* | Both ~ 130 pm | |

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| 32. Why are the N-O bond lengths in NO3– the same?   |  |  | | --- | --- | | *ANSWER:* | The explanation is resonance. | |

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| 33. Which of the following species are radicals?   |  |  |  | | --- | --- | --- | |  | a. | CO2 | |  | b. | HNO3 | |  | c. | NO2 | |  | d. | NO3– | |  | e. | HNO3 |  |  |  | | --- | --- | | *ANSWER:* | c | |

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| 34. Which of the following species are radicals?   |  |  |  | | --- | --- | --- | |  | a. | CH2O | |  | b. | ClO | |  | c. | ClONO2 | |  | d. | HClO | |  | e. | HCN |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 35. In the most plausible Lewis structure of XeOF2, there are   |  |  |  | | --- | --- | --- | |  | a. | 2 single bonds, 1 double bond, and 1 lone pair of electrons around Xe. | |  | b. | 3 single bonds and 1 lone pair of electrons around Xe. | |  | c. | 2 single bonds, 1 double bond, and 3 lone pairs of electrons around Xe. | |  | d. | 2 single bonds, 1 double bond, and 2 lone pairs of electrons around Xe. | |  | e. | 3 single bonds and 2 lone pairs of electrons around Xe. |  |  |  | | --- | --- | | *ANSWER:* | d | |

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| 36. How many electrons are in the expanded valence in XeOF2?   |  |  |  | | --- | --- | --- | |  | a. | 14 | |  | b. | 12 | |  | c. | 8 | |  | d. | 10 | |  | e. | 6 |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 37. How many electrons are in the expanded valence in I3–?   |  |  |  | | --- | --- | --- | |  | a. | 12 | |  | b. | 6 | |  | c. | 10 | |  | d. | 14 | |  | e. | 8 |  |  |  | | --- | --- | | *ANSWER:* | c | |

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| 38. How many electrons are in the expanded valence in H2SO4?   |  |  |  | | --- | --- | --- | |  | a. | 12 | |  | b. | 14 | |  | c. | 8 | |  | d. | 6 | |  | e. | 10 |  |  |  | | --- | --- | | *ANSWER:* | a | |

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| 39. How many electrons are in the expanded valence in XeO4?   |  |  | | --- | --- | | *ANSWER:* | 16 | |

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| 40. Consider the following equilibrium:  S2O42–(aq) ⇌ 2SO2–(aq) K ~ 10–9  Write a Lewis structure for each species.   |  |  | | --- | --- | | *ANSWER:* | The arrangement of atoms in S2O42– is O2S—SO2. The latter has a Lewis structure that obeys the octet rule, but SO2– is a radical. | |

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| 41. Which of the following species has bonds with the most ionic character?   |  |  |  | | --- | --- | --- | |  | a. | CO2 | |  | b. | NO2 | |  | c. | PCl3 | |  | d. | P4O10 | |  | e. | SiO2 |  |  |  | | --- | --- | | *ANSWER:* | e | |

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| 42. Write all possible Lewis structures of sulfur dioxide. Which structure is most feasible?   |  |  | | --- | --- | | *ANSWER:* | The structure with the expanded valence is favored. | |

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| 43. Which of the following species has bonds with the most ionic character?   |  |  |  | | --- | --- | --- | |  | a. | CO2 | |  | b. | NO2 | |  | c. | PCl3 | |  | d. | P4O10 | |  | e. | SnO2 |  |  |  | | --- | --- | | *ANSWER:* | e | |

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| 44. Which of the following statements is true?   |  |  |  | | --- | --- | --- | |  | a. | Atoms with high ionization energies and high electron affinities are highly electronegative. | |  | b. | Atoms with high ionization energies and high electron affinities have low electronegativities. | |  | c. | The electronegativity of an atom depends only on the value of the ionization energy of the atom. | |  | d. | Atoms with low ionization energies and low electron affinities have high electronegativities. | |  | e. | The electronegativity of an atom is defined as half the electron affinity of the atom. |  |  |  | | --- | --- | | *ANSWER:* | a | |

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| 45. Which of the following statements is true?   |  |  |  | | --- | --- | --- | |  | a. | The electronegativity of an atom is defined as electron affinity of the atom. | |  | b. | The electronegativity of an atom depends only on the value of the ionization energy of the atom. | |  | c. | Atoms with high ionization energies and high electron affinities have low electronegativities. | |  | d. | Atoms with low ionization energies and low electron affinities have low electronegativities. | |  | e. | Atoms with low ionization energies and low electron affinities have high electronegativities. |  |  |  | | --- | --- | | *ANSWER:* | d | |

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| 46. Which of the compounds below has bonds with the least covalent character?   |  |  |  | | --- | --- | --- | |  | a. | AgCl | |  | b. | AgF | |  | c. | AgI | |  | d. | AlCl3 | |  | e. | BeCl2 |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 47. Which of the compounds below has bonds with the most covalent character?   |  |  |  | | --- | --- | --- | |  | a. | BeCl2 | |  | b. | CaCl2 | |  | c. | LiCl | |  | d. | MgCl2 | |  | e. | NaCl |  |  |  | | --- | --- | | *ANSWER:* | a | |

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| 48. Which of the compounds below has bonds with the most covalent character?   |  |  |  | | --- | --- | --- | |  | a. | CaO | |  | b. | CaS | |  | c. | Li2O | |  | d. | MgO | |  | e. | MgS |  |  |  | | --- | --- | | *ANSWER:* | e | |

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| 49. Use the bond enthalpies given to estimate the heat released when 1-bromobutene, CH3CH2CH=CH2, reacts with bromine to give CH3CH2CHBrCH2Br. Bond enthalpies (kJ·mol–1): C-H, 412; C-C, 348; C=C, 612; C-Br, 276; Br-Br, 193.   |  |  |  | | --- | --- | --- | |  | a. | 181 kJ·mol–1 | |  | b. | 317 kJ·mol–1 | |  | c. | 288 kJ·mol–1 | |  | d. | 95 kJ·mol–1 | |  | e. | 507 kJ·mol–1 |  |  |  | | --- | --- | | *ANSWER:* | d | |

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| 50. Use the bond enthalpies given to estimate the heat released when ethene, CH2=CH2, reacts with HBr to give CH3CH2Br. Bond enthalpies (kJ·mol–1): C-H, 412; C-C, 348; C=C, 612; C-Br, 276; Br-Br, 193; H-Br, 366.   |  |  |  | | --- | --- | --- | |  | a. | 1036 kJ·mol–1 | |  | b. | 200 kJ·mol–1 | |  | c. | 470 kJ·mol–1 | |  | d. | 424 kJ·mol–1 | |  | e. | 58 kJ·mol–1 |  |  |  | | --- | --- | | *ANSWER:* | e | |

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| 51. Use the bond enthalpies given to estimate the heat released when 2-methyl-1-propene, (CH3)2C=CH2, reacts with HBr to give (CH3)2CBrCH3. Bond enthalpies (kJ·mol–1):  C-H, 412; C-C, 348; C=C, 612; C-Br, 276; H-Br, 366.   |  |  |  | | --- | --- | --- | |  | a. | 58 kJ·mol–1 | |  | b. | 507 kJ·mol–1 | |  | c. | 317 kJ·mol–1 | |  | d. | 288 kJ·mol–1 | |  | e. | 181 kJ·mol–1 |  |  |  | | --- | --- | | *ANSWER:* | a | |

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| 52. Use the bond enthalpies given to estimate the heat released when ethene, CH2=CH2, reacts with hydrogen to give CH3CH3. Bond enthalpies (kJ·mol–1): C-H, 412; C-C, 348; C=C, 612; C-Br, 276; H-H, 436.   |  |  |  | | --- | --- | --- | |  | a. | 124 kJ·mol–1 | |  | b. | 342 kJ·mol–1 | |  | c. | 288 kJ·mol–1 | |  | d. | 148 kJ·mol–1 | |  | e. | 560 kJ·mol–1 |  |  |  | | --- | --- | | *ANSWER:* | a | |

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| 53. Which of the following compounds contains the weakest bonds to hydrogen?   |  |  |  | | --- | --- | --- | |  | a. | CH4 | |  | b. | HF | |  | c. | H2O | |  | d. | H2S | |  | e. | SiH4 |  |  |  | | --- | --- | | *ANSWER:* | e | |

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| 54. Which of the following compounds contains the strongest bonds to hydrogen?   |  |  |  | | --- | --- | --- | |  | a. | CH4 | |  | b. | HF | |  | c. | H2O | |  | d. | H2S | |  | e. | SiH4 |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 55. Which of the following compounds is the least stable?   |  |  |  | | --- | --- | --- | |  | a. | CH4 | |  | b. | GeH4 | |  | c. | PbH4 | |  | d. | SiH4 | |  | e. | SnH4 |  |  |  | | --- | --- | | *ANSWER:* | c | |

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| 56. Estimate the CO bond length in acetone, CH3COCH3. Given: covalent radii (pm) of C–, 77; C=, 67; O–, 74; O=, 60; H, 37.   |  |  |  | | --- | --- | --- | |  | a. | 75.5 pm | |  | b. | 127 pm | |  | c. | 63.5 pm | |  | d. | 151 pm | |  | e. | 137 pm |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 57. Estimate the CN bond length in urea, NH2CONH2. Given: covalent radii (pm) of C–, 77; C=, 67; N–, 75; N=, 60; O–, 74; O=, 60; H, 37.   |  |  |  | | --- | --- | --- | |  | a. | 71 pm | |  | b. | 127 pm | |  | c. | 76 pm | |  | d. | 152 pm | |  | e. | 142 pm |  |  |  | | --- | --- | | *ANSWER:* | d | |

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| 58. If the following all crystallize in the same type of structure, which has the highest lattice energy?   |  |  |  | | --- | --- | --- | |  | a. | KBr | |  | b. | KCl | |  | c. | KF | |  | d. | LiCl | |  | e. | LiF |  |  |  | | --- | --- | | *ANSWER:* | e | |

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| 59. If the following all crystallize in the same type of structure, which has the highest lattice energy?   |  |  |  | | --- | --- | --- | |  | a. | KF | |  | b. | NaBr | |  | c. | NaCl | |  | d. | NaF | |  | e. | NaI |  |  |  | | --- | --- | | *ANSWER:* | d | |

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| 60. If the following all crystallize in the same type of structure, which has the lowest lattice energy?   |  |  |  | | --- | --- | --- | |  | a. | BaO | |  | b. | BaS | |  | c. | CaO | |  | d. | SrO | |  | e. | SrS |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 61. If the following all crystallize in the same type of structure, which has the lowest lattice energy?   |  |  |  | | --- | --- | --- | |  | a. | KCl | |  | b. | KI | |  | c. | LiCl | |  | d. | NaCl | |  | e. | NaI |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 62. White phosphorus is composed of tetrahedral molecules of P4 in which every P atom is connected to three other P atoms. In the Lewis structure of P4, there are   |  |  |  | | --- | --- | --- | |  | a. | 3 bonding pairs and 4 lone pairs of electrons. | |  | b. | 6 bonding pairs and 2 lone pairs of electrons. | |  | c. | 5 bonding pairs and 4 lone pairs of electrons. | |  | d. | 6 bonding pairs and no lone pairs of electrons. | |  | e. | 6 bonding pairs and 4 lone pairs of electrons. |  |  |  | | --- | --- | | *ANSWER:* | e | |

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| 63. Which of the following is a radical?   |  |  |  | | --- | --- | --- | |  | a. | BF4– | |  | b. | BrO | |  | c. | CH3+ | |  | d. | CH3– |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 64. If dinitrogen oxide has a dipole moment, what is the arrangement of atoms?   |  |  | | --- | --- | | *ANSWER:* | N-N-O | |

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| 65. The electronegativity of an element can be expressed as ½(I + Ea) where I is the ionization energy and Ea is the electron affinity. True or false?   |  |  |  | | --- | --- | --- | |  | a. | True | |  | b. | False |  |  |  | | --- | --- | | *ANSWER:* | a | |

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| 66. The best Lewis structures of SO2 and O3 include expanded valence structures such as O=S=O and O=O=O. True or false?   |  |  |  | | --- | --- | --- | |  | a. | True | |  | b. | False |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 67. Which of the following has resonance structures?   |  |  |  | | --- | --- | --- | |  | a. | XeOF2 | |  | b. | N2H4 | |  | c. | CH3CONH– | |  | d. | H2CO |  |  |  | | --- | --- | | *ANSWER:* | c | |

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| 68. How many resonance structures can be drawn for N2O?   |  |  |  | | --- | --- | --- | |  | a. | 0 | |  | b. | 3 | |  | c. | 2 | |  | d. | 1 |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 69. What is the formal charge on the Xe atom in XeF4?   |  |  |  | | --- | --- | --- | |  | a. | 0 | |  | b. | –4 | |  | c. | +2 | |  | d. | +4 |  |  |  | | --- | --- | | *ANSWER:* | a | |

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| 70. There are three resonance structures of the sulfate ion. A resonance structure can be written where the formal charge on sulfur is 0. True or false?   |  |  |  | | --- | --- | --- | |  | a. | True | |  | b. | False |  |  |  | | --- | --- | | *ANSWER:* | a | |

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| 71. How many double bonds are present in the "best" resonance structure of the phosphate ion?   |  |  |  | | --- | --- | --- | |  | a. | 2 | |  | b. | 3 | |  | c. | 1 | |  | d. | 0 |  |  |  | | --- | --- | | *ANSWER:* | c | |

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| 72. How many lone pairs of electrons are there in the Lewis structure of Al2Cl6?   |  |  |  | | --- | --- | --- | |  | a. | 24 | |  | b. | 12 | |  | c. | 4 | |  | d. | 16 |  |  |  | | --- | --- | | *ANSWER:* | d | |

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| 73. Match each of the following compounds with its lattice energy (2961, 1046, 759, 645 kJ/mol).  ​   |  |  | | --- | --- | | KI | \_\_\_\_\_\_\_\_ | | LiF | \_\_\_\_\_\_\_\_ | | MgF2 | \_\_\_\_\_\_\_\_ | | LiI | \_\_\_\_\_\_\_\_ |  |  |  | | --- | --- | | *ANSWER:* | KI (645 kJ/mol), LiF (1046), MgF2 (2961), LiI (759) | |

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| 74. White phosphorus is composed of tetrahedral molecules of P4 in which each P atom is bonded to three others. In this molecule the formal charge on each P atom is \_\_\_\_\_\_\_.   |  |  | | --- | --- | | *ANSWER:* | 0 | |

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| 75. Of the following molecules, which has the strongest bonds?   |  |  |  | | --- | --- | --- | |  | a. | H2O | |  | b. | H2S | |  | c. | H2Se | |  | d. | H2Te |  |  |  | | --- | --- | | *ANSWER:* | a | |

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| 76. An element E has the electronic configuration 1s22s22p4. What is the formula of its compound with lithium?   |  |  |  | | --- | --- | --- | |  | a. | LiE2 | |  | b. | LiE | |  | c. | Li2E | |  | d. | Li4E |  |  |  | | --- | --- | | *ANSWER:* | c | |

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| 77. How many valence electrons are present in W4+?   |  |  | | --- | --- | | *ANSWER:* | 2 | |

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| 78. What is wrong with the following Lewis structure?   |  |  |  | | --- | --- | --- | |  | a. | The charge on the carbon atom | |  | b. | The dipole of the molecule | |  | c. | The distribution of valence electrons | |  | d. | The positioning of the carbon atom | |  | e. | The valence electron count |  |  |  | | --- | --- | | *ANSWER:* | c | |

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| 79. Sulfur is more electronegative than oxygen. True or false?   |  |  |  | | --- | --- | --- | |  | a. | True | |  | b. | False |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 80. What is the electronic configuration of Ag?   |  |  | | --- | --- | | *ANSWER:* | 1s2 2s2 2p6 3s2 3p6 4s2 3d10 4p6 5s1 4d10 | |

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| 81. What is the formal charge of S in the molecule H2SO4?   |  |  | | --- | --- | | *ANSWER:* | 0 | |

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| 82. Why is the bond dissociation energy of C—C greater than that of C—H?   |  |  |  | | --- | --- | --- | |  | a. | Because multiple bonds are always stronger than single bonds | |  | b. | Because the bond is electrostatically stronger | |  | c. | Because of the decreased bond dipole | |  | d. | Because of enhanced sigma bond overlap | |  | e. | It isn't, the dissociation energy is greater for C—H |  |  |  | | --- | --- | | *ANSWER:* | e | |

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| 83. List the chalcogens in order of increasing electronegativity.   |  |  | | --- | --- | | *ANSWER:* | tellurium < selenium < sulfur < oxygen. | |

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| 84. Which has the greater ionic character: H2S or H2O?   |  |  | | --- | --- | | *ANSWER:* | H2O | |

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| 85. Name all the angles in a trigonal bipyramidal geometry.   |  |  | | --- | --- | | *ANSWER:* | 90°, 120°, and 180° | |

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| 86. Name all the angles in a trigonal planar geometry.   |  |  | | --- | --- | | *ANSWER:* | 120° | |

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| 87. Predict the HNH bond angle in NH2–.   |  |  | | --- | --- | | *ANSWER:* | ~109o | |

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| 88. Predict the electron arrangement in NO2–.   |  |  | | --- | --- | | *ANSWER:* | trigonal planar | |

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| 89. The electron arrangement and shape in IF4+, respectively, are   |  |  | | --- | --- | | *ANSWER:* | trigonal bipyramidal; seesaw. | |

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| 90. Predict the electron arrangement in ClF3.   |  |  | | --- | --- | | *ANSWER:* | Trigonal bipyramidal | |

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| 91. Predict the electron arrangement in IF5.   |  |  | | --- | --- | | *ANSWER:* | Octahedral | |

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| 92. What is the shape of AlH4–?   |  |  |  | | --- | --- | --- | |  | a. | Seesaw | |  | b. | Square planar | |  | c. | T-shaped | |  | d. | Tetrahedral | |  | e. | Trigonal bipyramidal |  |  |  | | --- | --- | | *ANSWER:* | d | |

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| 93. What is the shape of BrO4–?   |  |  |  | | --- | --- | --- | |  | a. | Seesaw | |  | b. | Square planar | |  | c. | T-shaped | |  | d. | Tetrahedral | |  | e. | Trigonal bipyramidal |  |  |  | | --- | --- | | *ANSWER:* | d | |

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| 94. What is the shape of AsF3?   |  |  |  | | --- | --- | --- | |  | a. | T-shaped | |  | b. | Trigonal planar | |  | c. | Trigonal pyramidal | |  | d. | Tetrahedral | |  | e. | Seesaw |  |  |  | | --- | --- | | *ANSWER:* | c | |

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| 95. What is the shape of SO32–?   |  |  |  | | --- | --- | --- | |  | a. | Seesaw | |  | b. | T-shaped | |  | c. | Tetrahedral | |  | d. | Trigonal planar | |  | e. | Trigonal pyramidal |  |  |  | | --- | --- | | *ANSWER:* | e | |

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| 96. What is the shape of CS32–?   |  |  |  | | --- | --- | --- | |  | a. | Trigonal pyramidal | |  | b. | Trigonal planar | |  | c. | T-shaped | |  | d. | Tetrahedral | |  | e. | Seesaw |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 97. What is the shape of COCl2?   |  |  |  | | --- | --- | --- | |  | a. | T-shaped | |  | b. | Trigonal planar | |  | c. | Trigonal pyramidal | |  | d. | Tetrahedral | |  | e. | Seesaw |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 98. What is the shape of XeF4?   |  |  |  | | --- | --- | --- | |  | a. | Seesaw | |  | b. | Square planar | |  | c. | T-Shaped | |  | d. | Tetrahedral | |  | e. | Trigonal bipyramidal |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 99. What is the shape of ICl4–?   |  |  |  | | --- | --- | --- | |  | a. | Seesaw | |  | b. | Square planar | |  | c. | T-Shaped | |  | d. | Tetrahedral | |  | e. | Trigonal bipyramidal |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 100. What is the shape of IF4+?   |  |  |  | | --- | --- | --- | |  | a. | Seesaw | |  | b. | Square planar | |  | c. | T-shaped | |  | d. | Tetrahedral | |  | e. | Trigonal bipyramidal |  |  |  | | --- | --- | | *ANSWER:* | a | |

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| 101. What is the shape of ClF3?   |  |  |  | | --- | --- | --- | |  | a. | Seesaw | |  | b. | Square planar | |  | c. | T-shaped | |  | d. | Tetrahedral | |  | e. | Trigonal bipyramidal |  |  |  | | --- | --- | | *ANSWER:* | c | |

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| 102. All the following have a linear shape except   |  |  |  | | --- | --- | --- | |  | a. | BeCl2. | |  | b. | CS2. | |  | c. | I3–. | |  | d. | O3. | |  | e. | XeF2. |  |  |  | | --- | --- | | *ANSWER:* | d | |

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| 103. All the following have an angular shape except   |  |  |  | | --- | --- | --- | |  | a. | ClO2–. | |  | b. | HOCl. | |  | c. | I3–. | |  | d. | NH2–. | |  | e. | S32–. |  |  |  | | --- | --- | | *ANSWER:* | c | |

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| 104. All the following have a linear shape except   |  |  |  | | --- | --- | --- | |  | a. | CS2. | |  | b. | I3–. | |  | c. | I3+. | |  | d. | IF2-. | |  | e. | XeF2. |  |  |  | | --- | --- | | *ANSWER:* | c | |

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| 105. All the following have an angular shape except   |  |  |  | | --- | --- | --- | |  | a. | ClO2–. | |  | b. | HOCl. | |  | c. | N3–. | |  | d. | NH2–. | |  | e. | S32–. |  |  |  | | --- | --- | | *ANSWER:* | c | |

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| 106. Which of the following has bond angles slightly less than 109°?   |  |  |  | | --- | --- | --- | |  | a. | BH4– | |  | b. | BrO3– | |  | c. | ClO4– | |  | d. | NH4+ | |  | e. | PO43– |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 107. Which of the following has bond angles of 180°?   |  |  |  | | --- | --- | --- | |  | a. | ClO2– | |  | b. | HO2– | |  | c. | I3– | |  | d. | NH2– | |  | e. | O3 |  |  |  | | --- | --- | | *ANSWER:* | c | |

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| 108. Which of the following has bond angles of 180°?   |  |  |  | | --- | --- | --- | |  | a. | ClO2– | |  | b. | HO2– | |  | c. | NH2– | |  | d. | N2O | |  | e. | O3 |  |  |  | | --- | --- | | *ANSWER:* | d | |

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| 109. Which of the following has bond angles slightly less than 120°?   |  |  |  | | --- | --- | --- | |  | a. | I3– | |  | b. | NO3– | |  | c. | O3 | |  | d. | SF2 | |  | e. | SO3 |  |  |  | | --- | --- | | *ANSWER:* | c | |

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| 110. Which of the following has bond angles slightly less than 109°?   |  |  |  | | --- | --- | --- | |  | a. | CH2– | |  | b. | HOCl | |  | c. | I3– | |  | d. | NO2– | |  | e. | O3 |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 111. Which of the following has bond angles slightly less than 109°?   |  |  |  | | --- | --- | --- | |  | a. | AsF3 | |  | b. | COCl2 | |  | c. | COS | |  | d. | CS32– | |  | e. | SO2 |  |  |  | | --- | --- | | *ANSWER:* | a | |

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| 112. Which of the following has bond angles slightly less than 120°?   |  |  |  | | --- | --- | --- | |  | a. | CS32– | |  | b. | HO2– | |  | c. | I3+ | |  | d. | NO2– | |  | e. | NO3– |  |  |  | | --- | --- | | *ANSWER:* | d | |

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| 113. Which of the following has bond angles of 120°?   |  |  |  | | --- | --- | --- | |  | a. | CS32– | |  | b. | HO2– | |  | c. | NO2– | |  | d. | O3 | |  | e. | S32– |  |  |  | | --- | --- | | *ANSWER:* | a | |

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| 114. Which of the following has bond angles of 90°, 120°, and 180°?   |  |  |  | | --- | --- | --- | |  | a. | ICl4– | |  | b. | IF5 | |  | c. | PF6– | |  | d. | SF4 | |  | e. | XeF4 |  |  |  | | --- | --- | | *ANSWER:* | d | |

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| 115. Which of the following only has bond angles of 90°?   |  |  |  | | --- | --- | --- | |  | a. | IF5 | |  | b. | IF4+ | |  | c. | IO2F3 | |  | d. | SF4 | |  | e. | XeF2 |  |  |  | | --- | --- | | *ANSWER:* | a | |

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| 116. Which of the following only has bond angles of 90° and 180°?   |  |  |  | | --- | --- | --- | |  | a. | BCl3 | |  | b. | BrF3 | |  | c. | ICl4+ | |  | d. | IF5 | |  | e. | NO3– |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 117. Which of the following is polar?   |  |  |  | | --- | --- | --- | |  | a. | CO32– | |  | b. | I3– | |  | c. | NON | |  | d. | O3 | |  | e. | XeF2 |  |  |  | | --- | --- | | *ANSWER:* | d | |

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| 118. Which of the following is polar?   |  |  |  | | --- | --- | --- | |  | a. | I3– | |  | b. | ICl4– | |  | c. | NON | |  | d. | XeF2 | |  | e. | XeO2 |  |  |  | | --- | --- | | *ANSWER:* | e | |

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| 119. Which of the following is polar?   |  |  |  | | --- | --- | --- | |  | a. | ICl4– | |  | b. | IF5 | |  | c. | PCl5 | |  | d. | SF6 | |  | e. | XeF4 |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 120. All of the following are polar except   |  |  |  | | --- | --- | --- | |  | a. | I3–. | |  | b. | I3+. | |  | c. | NH2–. | |  | d. | O3. | |  | e. | S32–. |  |  |  | | --- | --- | | *ANSWER:* | a | |

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| 121. All of the following are polar except   |  |  |  | | --- | --- | --- | |  | a. | ClF3. | |  | b. | ClO2–. | |  | c. | IF4+. | |  | d. | SF4. | |  | e. | XeF4. |  |  |  | | --- | --- | | *ANSWER:* | e | |

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| 122. Which of the following is polar?   |  |  |  | | --- | --- | --- | |  | a. | AsF6– | |  | b. | ICl4– | |  | c. | SF4 | |  | d. | SF6 | |  | e. | XeF4 |  |  |  | | --- | --- | | *ANSWER:* | c | |

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| 123. All the following are polar except   |  |  |  | | --- | --- | --- | |  | a. | BO33–. | |  | b. | BrO3–. | |  | c. | ClF3. | |  | d. | COCl2. | |  | e. | O3. |  |  |  | | --- | --- | | *ANSWER:* | a | |

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| 124. All of the following are polar except   |  |  |  | | --- | --- | --- | |  | a. | BrO3–. | |  | b. | ClF3. | |  | c. | COCl2. | |  | d. | CS32–. | |  | e. | O3. |  |  |  | | --- | --- | | *ANSWER:* | d | |

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| 125. All of the following are polar except   |  |  |  | | --- | --- | --- | |  | a. | ClF3. | |  | b. | SOCl2. | |  | c. | XeF4. | |  | d. | XeO2. | |  | e. | XeO3. |  |  |  | | --- | --- | | *ANSWER:* | c | |

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| 126. The molecule *cis*-dichloroethene is nonpolar. True or false?   |  |  |  | | --- | --- | --- | |  | a. | True | |  | b. | False |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 127. How many σ- and π-bonds, respectively, are there in acrolein, CH2=CHCHO?   |  |  |  | | --- | --- | --- | |  | a. | 4 and 2 | |  | b. | 7 and 2 | |  | c. | 5 and 2 | |  | d. | 5 and 4 | |  | e. | 7 and 1 |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 128. How many σ- and π-bonds, respectively, are there in peroxyacetylnitrate, CH3C(O)O-ONO2?   |  |  |  | | --- | --- | --- | |  | a. | 9 and 2 | |  | b. | 10 and 2 | |  | c. | 10 and 1 | |  | d. | 8 and 4 | |  | e. | 8 and 2 |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 129. How many σ- and π-bonds are present in diazomethane, CH2NN?   |  |  | | --- | --- | | *ANSWER:* | 4 σ-bonds and 2 π-bonds | |

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| 130. Draw the Lewis structure of formamide, NH2CHO, and give the number of lone pairs of electrons, and the number of σ- and π-bonds.   |  |  | | --- | --- | | *ANSWER:* | 3 lone pairs, 5 σ-bonds, and 1 π-bond | |

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| 131. Draw the Lewis structure of the cyanamide ion, NCNH–, and give the number of lone pairs of electrons and the number of σ- and π-bonds.   |  |  | | --- | --- | | *ANSWER:* | 3 lone pairs, 3 σ-bonds, and 2 π-bonds | |

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| 132. Identify the hybrid orbitals used by the underlined atom in acetone, CH3COCH3.   |  |  |  | | --- | --- | --- | |  | a. | sp | |  | b. | sp2 | |  | c. | sp3 | |  | d. | sp3d | |  | e. | None; pure pz-orbitals are used in bonding. |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 133. The hybrid orbitals used by the underlined atoms in CH3CHCHCN, from left to right, respectively, are   |  |  |  | | --- | --- | --- | |  | a. | sp3 and sp. | |  | b. | sp2 and sp. | |  | c. | sp2 and sp3. | |  | d. | sp2 and sp2. | |  | e. | sp and sp3. |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 134. The hybrid orbitals used by the underlined atoms in CH3CH2OCH2CH3, from left to right, respectively, are   |  |  |  | | --- | --- | --- | |  | a. | sp and sp. | |  | b. | sp3 and sp. | |  | c. | sp3 and sp3. | |  | d. | sp and sp3. | |  | e. | sp2 and sp3. |  |  |  | | --- | --- | | *ANSWER:* | c | |

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| 135. The hybrid orbitals used by the underlined atoms in CH2CHCHO, from left to right, respectively, are   |  |  |  | | --- | --- | --- | |  | a. | sp3 and sp2. | |  | b. | sp2 and sp2. | |  | c. | sp2 and sp. | |  | d. | sp and sp. | |  | e. | sp3 and sp. |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 136. For the Lewis structure of the cyanamide ion that contains two double bonds, N=C=NH–, the hybrid orbitals used by the underlined nitrogen atom and the carbon atom, respectively, are   |  |  |  | | --- | --- | --- | |  | a. | sp2 and sp3. | |  | b. | sp and sp. | |  | c. | sp2 and sp2. | |  | d. | sp and sp3. | |  | e. | sp2 and sp. |  |  |  | | --- | --- | | *ANSWER:* | e | |

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| 137. The NCO bond angle in formamide, H2NCHO, is \_\_\_\_\_\_\_\_\_\_.   |  |  | | --- | --- | | *ANSWER:* | ~ 120° (120° is an acceptable answer) | |

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| 138. All the following are paramagnetic except   |  |  |  | | --- | --- | --- | |  | a. | N22–*.* | |  | b. | N22+*.* | |  | c. | O2–*.* | |  | d. | O2+*.* | |  | e. | O2*.* |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 139. Which of the following is diamagnetic?   |  |  |  | | --- | --- | --- | |  | a. | O22– | |  | b. | O2+ | |  | c. | O2– | |  | d. | S2 |  |  |  | | --- | --- | | *ANSWER:* | a | |

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| 140. What is the ground-state electron configuration of O2–?   |  |  | | --- | --- | | *ANSWER:* | (σ2s)2(σ2s\*)2(σ2p)2(π2p)4(π2p\*)2(π2p\*)1 | |

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| 141. Which of the following is paramagnetic?   |  |  |  | | --- | --- | --- | |  | a. | B22– | |  | b. | B2 | |  | c. | C22– | |  | d. | N2 | |  | e. | O22– |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 142. Which of the following would have the longest bond?   |  |  |  | | --- | --- | --- | |  | a. | B2 | |  | b. | C2 | |  | c. | C22– | |  | d. | N2 | |  | e. | N22– |  |  |  | | --- | --- | | *ANSWER:* | a | |

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| 143. The bond order of N22+ is   |  |  |  | | --- | --- | --- | |  | a. | 2.5. | |  | b. | 1. | |  | c. | 2. | |  | d. | 1.5. | |  | e. | 3. |  |  |  | | --- | --- | | *ANSWER:* | c | |

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| 144. The bond order of O22+ is   |  |  |  | | --- | --- | --- | |  | a. | 1. | |  | b. | 2. | |  | c. | 3. | |  | d. | 2.5. | |  | e. | 1.5. |  |  |  | | --- | --- | | *ANSWER:* | d | |

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| 145. Which of the following has the longest bond?   |  |  |  | | --- | --- | --- | |  | a. | N2 | |  | b. | N22+ | |  | c. | N22– | |  | d. | NO– | |  | e. | O22– |  |  |  | | --- | --- | | *ANSWER:* | e | |

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| 146. Which of the following is paramagnetic?   |  |  |  | | --- | --- | --- | |  | a. | N2 | |  | b. | N22+ | |  | c. | N22– | |  | d. | NO+ | |  | e. | O22– |  |  |  | | --- | --- | | *ANSWER:* | c | |

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| 147. Which of the following species has the shortest bond length?   |  |  |  | | --- | --- | --- | |  | a. | NO2– | |  | b. | NO2+ | |  | c. | NO– | |  | d. | NO | |  | e. | NO+ |  |  |  | | --- | --- | | *ANSWER:* | e | |

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| 148. Which of the following species has two unpaired electrons?   |  |  |  | | --- | --- | --- | |  | a. | CF+ | |  | b. | CO+ | |  | c. | NF+ | |  | d. | NO+ | |  | e. | OF+ |  |  |  | | --- | --- | | *ANSWER:* | e | |

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| 149. Which of the following is a p-type semiconductor?   |  |  |  | | --- | --- | --- | |  | a. | GaAs with arsenic in excess of gallium | |  | b. | Germanium doped with arsenic | |  | c. | Selenium doped with indium | |  | d. | Silicon doped with arsenic | |  | e. | Silicon doped with phosphorus |  |  |  | | --- | --- | | *ANSWER:* | c | |

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| 150. Which of the following is an n-type semiconductor?   |  |  |  | | --- | --- | --- | |  | a. | GaAs with gallium in excess of arsenic | |  | b. | Germanium doped with indium | |  | c. | Selenium doped with indium | |  | d. | Silicon doped with boron | |  | e. | Silicon doped with phosphorus |  |  |  | | --- | --- | | *ANSWER:* | e | |

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| 151. Germanium is a semiconductor. Which of the following should be added in small amounts to produce a p-type semiconductor?   |  |  |  | | --- | --- | --- | |  | a. | As | |  | b. | B | |  | c. | Bi | |  | d. | P | |  | e. | Sb |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 152. Gallium is a semiconductor. Which of the following should be added in small amounts to produce a p-type semiconductor?   |  |  |  | | --- | --- | --- | |  | a. | As | |  | b. | B | |  | c. | P | |  | d. | Sb | |  | e. | Si |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 153. How many lone pairs of electrons are there in the Lewis structure of azidocarbonamide, H2NC(O)NNC(O)NH2?   |  |  |  | | --- | --- | --- | |  | a. | 8 | |  | b. | 12 | |  | c. | 10 | |  | d. | 16 | |  | e. | 6 |  |  |  | | --- | --- | | *ANSWER:* | a | |

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| 154. What is the approximate **NNC** bond angle in azidocarbonamide, H2NC(O)**NNC**(O)NH2?   |  |  |  | | --- | --- | --- | |  | a. | 118° | |  | b. | 180° | |  | c. | 90° | |  | d. | 107° | |  | e. | 109° |  |  |  | | --- | --- | | *ANSWER:* | a | |

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| 155. What is the hybridization of the bolded atoms **NNC,** from left to right, in azidocarbonamide, H2NC(O)**NNC**(O)NH2?   |  |  |  | | --- | --- | --- | |  | a. | sp3, sp, sp2 | |  | b. | sp2, sp, sp3 | |  | c. | sp2, sp, sp2 | |  | d. | sp, sp, sp2 | |  | e. | sp2, sp2, sp2 |  |  |  | | --- | --- | | *ANSWER:* | e | |

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| 156. How many σ- and π-bonds, respectively, are there in the Lewis structure of azidocarbonamide, H2NC(O)NNC(O)NH2?   |  |  |  | | --- | --- | --- | |  | a. | 14 and 3 | |  | b. | 15 and 3 | |  | c. | 14 and 2 | |  | d. | 8 and 3 | |  | e. | 11 and 3 |  |  |  | | --- | --- | | *ANSWER:* | e | |

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| 157. Two Lewis structures can be written for diazomethane, where the arrangement of atoms is H2**C**-**N**-N. The hybrid orbitals used by the bold atoms in these Lewis structures are   |  |  |  | | --- | --- | --- | |  | a. | sp3 or sp2, and sp. | |  | b. | sp2 and sp. | |  | c. | sp3 and sp. | |  | d. | sp3 or sp2, and sp2. |  |  |  | | --- | --- | | *ANSWER:* | a | |

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| 158. The fact that B2 has two unpaired electrons means the 2*p*π molecular orbitals have higher energy than the 2pσ molecular orbitals. True or false?   |  |  |  | | --- | --- | --- | |  | a. | True | |  | b. | False |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 159. How many peaks would you predict for the photoelectron spectrum of water using 1) the molecular orbital model and 2) the VSEPR model?   |  |  | | --- | --- | | *ANSWER:* | molecular orbital, 4; VSEPR, 2; the experimental result is 4 peaks | |

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| 160. The OSO bond angle in the sulfite ion is \_\_\_\_\_\_\_ (greater than/equal to/ less than) 109.5°.   |  |  | | --- | --- | | *ANSWER:* | less than | |

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| 161. An AX3E2 molecule has a trigonal planar shape. True or false?   |  |  |  | | --- | --- | --- | |  | a. | True | |  | b. | False |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 162. Which of the following molecules is (are) polar?  (a) AsCl4+     (b) I3+     (c) I3–     (d) N3–     (e) S32–   |  |  |  | | --- | --- | --- | |  | a. | (b) and (e) | |  | b. | (b) and (c) | |  | c. | (c) and (e) | |  | d. | only (e) |  |  |  | | --- | --- | | *ANSWER:* | a | |

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| 163. What is the bond order in the OH radical?   |  |  | | --- | --- | | *ANSWER:* | 0.5 | |

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| 164. When two atoms are brought together along the *x*-axis, what is the number of σ bonds that can be formed by overlap of p-orbitals on each atom?   |  |  |  | | --- | --- | --- | |  | a. | 0 | |  | b. | 1 | |  | c. | 2 | |  | d. | 3 |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 165. What hybrid orbitals are used by the N atoms in urea, H2NCONH2?   |  |  |  | | --- | --- | --- | |  | a. | sp | |  | b. | sp2 | |  | c. | sp3 | |  | d. | dsp3 |  |  |  | | --- | --- | | *ANSWER:* | c | |

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| 166. In the NO molecule, which atom makes the larger contribution to the lowest energy molecular orbital?   |  |  | | --- | --- | | *ANSWER:* | O | |

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| 167. For A2, the LCAO-MO, ψ = *c*AψA + *c*BψB, has *c*A = *c*B. True or false?   |  |  |  | | --- | --- | --- | |  | a. | True | |  | b. | False |  |  |  | | --- | --- | | *ANSWER:* | a | |

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| 168. For HF, the LCAO-MO, ψ = *c*HψH + *c*FψF, has *c*H = *c*F. True or false?   |  |  |  | | --- | --- | --- | |  | a. | True | |  | b. | False |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 169. For peroxyacetylnitrate, CH3C(O)**O**—ONO2, what hybrid orbitals are used by the oxygen atom in bold?   |  |  |  | | --- | --- | --- | |  | a. | dsp | |  | b. | sp | |  | c. | sp2 | |  | d. | sp3 |  |  |  | | --- | --- | | *ANSWER:* | d | |

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| 170. The molecules OF2 and O3 both have bent shapes. What are the approximate bond angles in OF2 and O3, respectively?   |  |  |  | | --- | --- | --- | |  | a. | 109o and 120o | |  | b. | Both 109o | |  | c. | Both 120o | |  | d. | Both 180o | |  | e. | 109o and 180o |  |  |  | | --- | --- | | *ANSWER:* | a | |

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| 171. What are the electron arrangements around the central atom and the shape, respectively, of SF4?   |  |  |  | | --- | --- | --- | |  | a. | Both square pyramidal | |  | b. | Both tetrahedral | |  | c. | Octahedral and square pyramidal | |  | d. | Seesaw | |  | e. | Trigonal bipyramidal and seesaw |  |  |  | | --- | --- | | *ANSWER:* | e | |

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| 172. What is the shape of the molecule AX4E2?   |  |  |  | | --- | --- | --- | |  | a. | Octahedral | |  | b. | Seesaw | |  | c. | Square planar | |  | d. | Square pyramidal | |  | e. | Tetrahedral |  |  |  | | --- | --- | | *ANSWER:* | c | |

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| 173. The molecules OF2 and O3 both have bent shapes. What is the hybridization of the central atom in OF2 and O3, respectively?   |  |  |  | | --- | --- | --- | |  | a. | sp3 and sp2 | |  | b. | both sp3 | |  | c. | both sp2 | |  | d. | sp3 and sp | |  | e. | both sp |  |  |  | | --- | --- | | *ANSWER:* | a | |

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| 174. Dinitrogen monoxide has a dipole moment. Draw the arrangement of atoms and indicate the shape of dinitrogen monoxide.   |  |  | | --- | --- | | *ANSWER:* | N-N-O; linear | |

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| 175. The structure of Tylenol is given below:  Estimate the C-N-H bond angle.   |  |  |  | | --- | --- | --- | |  | a. | ~ 109o | |  | b. | ~ 120o | |  | c. | > 109o | |  | d. | > 120o | |  | e. | ~ 90o |  |  |  | | --- | --- | | *ANSWER:* | a | |

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| 176. The structure of Tylenol is given below:  What hybrid orbitals are used on the N atom and the carbonyl carbon, respectively?   |  |  |  | | --- | --- | --- | |  | a. | sp3 and sp2 | |  | b. | sp2 and sp2 | |  | c. | sp3 and sp3 | |  | d. | sp2 and sp | |  | e. | sp3 and sp |  |  |  | | --- | --- | | *ANSWER:* | a | |

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| 177. All of the following are polar except   |  |  |  | | --- | --- | --- | |  | a. | NO2–. | |  | b. | N2O (N is the central atom). | |  | c. | NO3–. | |  | d. | NO2Cl. | |  | e. | SO32–. |  |  |  | | --- | --- | | *ANSWER:* | c | |

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| 178. In NO, the unpaired electron occupies what type of molecular orbital?   |  |  |  | | --- | --- | --- | |  | a. | 3σ | |  | b. | 4σ\* | |  | c. | 2π\* | |  | d. | 1π | |  | e. | The oxygen 2p orbital. |  |  |  | | --- | --- | | *ANSWER:* | c | |

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| 179. Both C2 and C22– are diamagnetic. True or false?   |  |  |  | | --- | --- | --- | |  | a. | True | |  | b. | False |  |  |  | | --- | --- | | *ANSWER:* | a | |

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| 180. What are the electron arrangements and the shape around the central atom of SeCl4?   |  |  |  | | --- | --- | --- | |  | a. | Both square pyramidal | |  | b. | Both tetrahedral | |  | c. | Octahedral and square pyramidal | |  | d. | Seesaw | |  | e. | Trigonal bipyramidal and seesaw |  |  |  | | --- | --- | | *ANSWER:* | e | |

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| 181. Why does the best Lewis structure for sulfuric acid (H2SO4) have the sulfur atom formally possessing five bonds?   |  |  |  | | --- | --- | --- | |  | a. | It is the best expanded octet structure for the molecule. | |  | b. | It doesn't; it should possess four bonds. | |  | c. | It doesn't; it should possess six bonds. | |  | d. | This configuration gives all atoms in the molecule a formal charge of 0. |  |  |  | | --- | --- | | *ANSWER:* | c | |