

Test 3 Review Questions Answers

1. Who did what?

Schrödinger - Wave mechanical description of the electron in atoms and molecules; $\mathcal{H}\Psi = E\Psi$.

Born - "Copenhagen interpretation" of the wave equation in terms of electron probability related to Ψ^2 .

Pauli - The Pauli Exclusion Principle requires that no two electrons in the same atom have all four quantum numbers the same (n, l, m_l, m_s); if two electrons are in the same orbital, they must have paired spins.

Hund - Hund's Rule of Maximum Multiplicity identifies the ground state configuration of an atom as that configuration that places individual electrons in separate orbitals within a subshell to the extent allowed by the Pauli Exclusion Principle.

Pauling - Studies of the nature of the chemical bond lead to the first successful scale of electronegativities. (Also, not covered on this test, he was a principal developer of the Valence Bond Theory.)

Lewis - Along with Langmuir, developed the first model of bonding in molecules based on the idea of electron sharing between bonded atoms.

2. Which of the following is exothermic and which is endothermic?

$\text{K}(g) \rightarrow \text{K}^+(g) + e^-$ Endothermic (All ionization energies are endothermic.)

$\text{N}^-(g) + e^- \rightarrow \text{N}^{2-}(g)$ Endothermic (All second and higher electron affinities are endothermic.)

$\text{F}(g) + e^- \rightarrow \text{F}^-(g)$ Exothermic (Nonmetals tend to have exothermic electron affinities.)

$\text{Ca}^{2+}(g) + e^- \rightarrow \text{Ca}^+(g)$ Exothermic (This is the reverse of the second ionization energy of Ca; i.e., the negative of an endothermic enthalpy.)

3. Which of the following bonds is most polar and which is least polar?

F–O

As–F

Se–Br

S–S

P–N

As–F is most polar ($\delta\chi = |2.0 - 4.0| = 2.0$), being a semi-metal and nonmetal combination. All others are pairings of adjacent nonmetals, for which the electronegativities are similar. The S–S bond is least polar, being a nonpolar homonuclear bond.

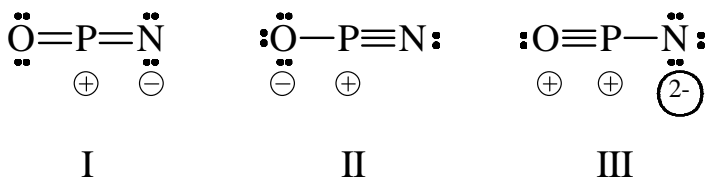
8. Write the complete electronic configuration of $_{80}\text{Hg}$.

Aufbau order: $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6 6s^2 4f^{14} 5d^{10}$

Shell order: $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 4d^{10} 4f^{14} 5s^2 5p^6 5d^{10} 6s^2$

9. Draw Lewis models and assign formal charges for the three resonance forms of the molecule OPN.

Electron count: $6 + 5 + 5 = 16$



Which form is the least contributor to the resonance description of OPN?

Form III, because it has high formal charges and adjacent like charges when other forms are available that avoid these.

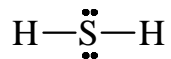
On the basis of the two principal forms, describe the length and strength of (a) the P-O bond, and (b) the P-N bond.

From Forms I and II, the OP bond should be shorter and stronger than a O-P single bond and longer and weaker than a O=P double bond. The PN bond should be shorter and stronger than a P=N double bond and longer and weaker than a P≡N triple bond.

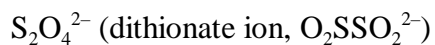
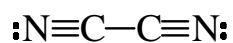
10. Draw Lewis structures for the following and assign formal charges:



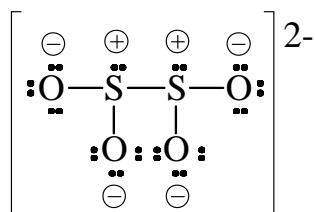
$$\text{Electron count} = (2)(1) + 6 = 8$$



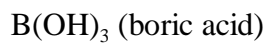
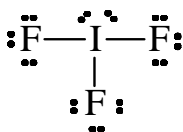
$$\text{Electron count} = (2)(5) + (2)(4) = 18$$



$$\text{Electron count} = (4)(6) + 2(6) + 2 = 38$$



$$\text{Electron count} = 7 + (3)(7) = 28$$



$$\text{Electron count} = 3 + (3)(6) + (3)(1) = 24$$

