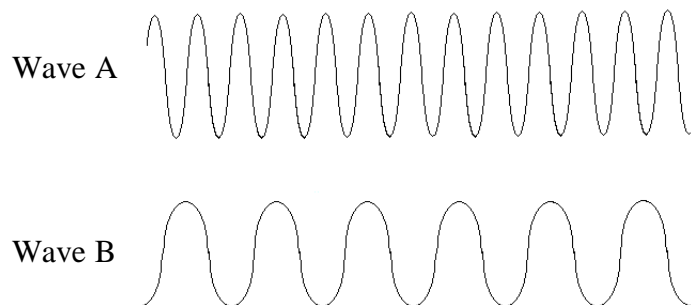


- The central atom in a molecule of the type XY_2 obeys the octet rule. Experiments show that the bond angle about the central atom X is 180° . How many π bonds does X form to the other atoms (Y) in this molecule?
 - 0 (X forms no π bonds.)
 - 1 π bond
 - 2 π bonds
 - 3 π bonds

- Consider the figure below illustrating two different types of electromagnetic radiation.

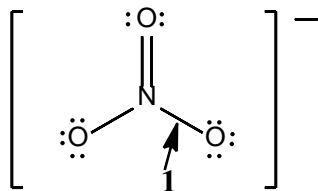


- Which of the following statements (a-d) is **true** concerning wave A and wave B?
- Wave A has a faster velocity than wave B.
 - The wavelength of wave A is longer than the wavelength of wave B.
 - The photon energy associated with wave A is smaller than the photon energy associated with wave B.
 - The frequency of wave A is lower than the frequency of wave B.
 - None of these statements (a-d) are true.
-
- Which of the following is **true**?
 - All particles in the nucleus of an atom are charged.
 - The atom is best described as a uniform sphere of matter in which electrons are embedded.
 - The mass of the nucleus is only a very small fraction of the mass of the entire atom.
 - The volume of the nucleus is only a very small fraction of the volume of the entire atom.
 - The number of neutrons in a neutral atom must equal the number of electrons.

4. Consider the following nitrogen-oxygen bond lengths which are all in some hypothetical unit.

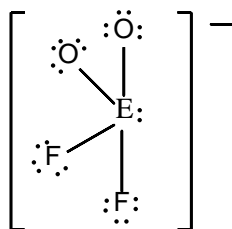
N—O is 2.00 units long. N=O is 1.00 unit long. N≡O is 0.50 units long.

A possible Lewis structure for NO_3^- is:



Which of the following values will be closest to the actual bond length for the bond labeled 1?

- a. 2.00 units b. 1.67 units c. 1.50 units d. 1.00 unit e. 0.75 units
5. In the Lewis structure below, E is a general symbol for some element.



Which of the following elements could be E?

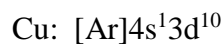
- a. S b. F c. P d. Br e. O
6. Pure aluminum oxide, Al_2O_3 , occurs in nature as a mineral called corundum, which is noted for its hardness and resistance to attack by acids. Corundum's density is 3.97 g/mL. Calculate the number of atoms of aluminum in 15.00 mL of corundum.
- a. 7.03×10^{23} atoms Al b. 6.40×10^{22} atoms Al c. 3.52×10^{21} atoms Al
d. 1.16×10^{23} atoms Al e. 3.52×10^{23} atoms Al

7. Which of the following statements is **false**?
- In general, transition metals gain electrons to form stable ions when in ionic compounds.
 - Noble gases are found on the right side of the periodic table.
 - Alkaline earth metals form stable +2 ions in compounds.
 - In general, the halogens are nonmetals.
 - In general, when a metal reacts with a nonmetal, an ionic compound is produced.
8. The -3 charged ion of an element has an excited state electron configuration of $1s^2 2s^1 2p^3 3s^1 3p^2 4s^1 3d^1$. Which of the following is the identity of the ion?
- a. B^{3-} b. O^{3-} c. Na^{3-} d. Sc^{3-} e. Si^{3-}
9. For a hydrogen atom, how many of the following five electronic transitions are **exothermic**?
- $n = 6$ to $n = 1$ $n = 2$ to $n = 3$ $n = 3$ to $n = 5$ $n = 4$ to $n = 2$ $n = 126$ to $n = 61$
- a. 1 b. 2 c. 3 d. 4 e. 5 (All are exothermic.)
10. Which of the following statements is **false**?
- The electron affinity of N is equal to the ionization energy of N^+ .
 - Br has a negative (exothermic) electron affinity.
 - The electron affinities of the noble gases are positive (endothermic).
 - Ionization energies for the various elements are positive (endothermic).
 - The radii and ionization energy general trends are opposite of each other.
11. How many of the following five compounds have a Lewis structure where the central atom has two (2) lone pairs?
- XeF₄ ICl₃ OF₂ H₂S PF₃
- a. 1 b. 2 c. 3 d. 4 e. 5 (all)

12. How many of the following four calculations (I-IV) give an answer with 3 significant figures?
- I. $10.01 + 2.3 + 0.01$ II. 27.0×0.0300
- III. $16 \times (30 + 100 - 6)$ IV. $\frac{49.1 - 40.0}{805}$
- a. 0 (none) b. 1 c. 2 d. 3 e. 4 (all)
13. Consider the combustion of $C_{12}H_{22}O_{11}$, an organic compound. What is the sum of the coefficients of all the reactants and products in the best balanced equation?
- a. 22 b. 36 c. 42 d. 56 e. 70
14. Which of the following statements is **false**?
- a. The three 5p atomic orbitals all have the same energy but have different orientations about the x, y, and z axes.
- b. 2d atomic orbitals do not exist in the quantum mechanical model of the atom.
- c. The lanthanide series elements have ground state electrons in the 5f atomic orbitals.
- d. For an atom, there is only one ground state electron configuration.
- e. For neutral atoms, the 6p atomic orbitals should be higher in energy than the 4f atomic orbitals.
15. How many of the following four statements (I-IV) is/are **true**?
- I. As successive electrons are removed from an atom, size decreases.
- II. As successive electrons are removed from an atom, ionization energy increases.
- III. For an isoelectronic series, the species with the most negative charge has the smallest ionization energy.
- IV. In general, the atomic radius of neutral atoms decreases when going left to right across a row in the periodic table.
- a. 0 (None are true.) b. 1 c. 2 d. 3
- e. 4 [All four statements (I-IV) are true.]

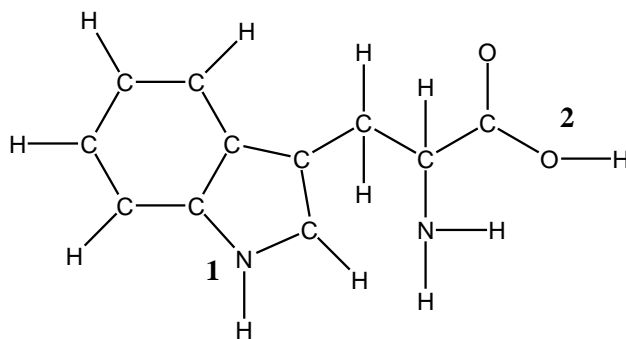
16. Which of the following bonds is expected to be the most polar covalent bond?
- a. O–N b. S–N c. P–N d. P–O e. P–H
17. Each molecule of cortisone contains 21 atoms of carbon (plus other atoms). If 10.00 g of cortisone contains 7.00 g of carbon, what is the molar mass of cortisone?
- a. 177 g/mol b. 252 g/mol c. 288 g/mol
d. 313 g/mol e. 360. g/mol
18. Which of the following is named **incorrectly**?
- a. H_2SO_4 sulfuric acid
b. Ca_3P_2 tricalcium diphosphide
c. NH_4ClO_3 ammonium chlorate
d. $\text{Cu}(\text{C}_2\text{H}_3\text{O}_2)_2$ copper(II) acetate
e. P_4O_6 tetraphosphorus hexoxide
19. Which of the following molecules exhibits delocalized π bonding?
- a. BeH_2 b. SeS_2 c. KrF_2 d. SCl_2 e. H_2O
20. How many of the following five molecules have a linear shape?
Note: these are the same molecules used in the previous question.
- BeH_2 SeS_2 KrF_2 SCl_2 H_2O
- a. 1 b. 2 c. 3 d. 4 e. 5 (all)
21. Rank the following ions from smallest radius to largest radius?
- Ca^{2+} S^{2-} As^{3-}
- a. $\text{Ca}^{2+} < \text{S}^{2-} < \text{As}^{3-}$ b. $\text{S}^{2-} < \text{As}^{3-} < \text{Ca}^{2+}$ c. $\text{S}^{2-} < \text{Ca}^{2+} < \text{As}^{3-}$
d. $\text{Ca}^{2+} < \text{As}^{3-} < \text{S}^{2-}$ e. $\text{As}^{3-} < \text{S}^{2-} < \text{Ca}^{2+}$

22. How many of the following are **correct** ground state electron configurations for the elements listed?



- a. 1 b. 2 c. 3 d. 4
e. 5 (All are correct ground state electron configurations.)

Tryptophan is the organic molecule largely responsible for the sleepy feeling you get after eating turkey. The skeletal structure of tryptophan is shown below. Complete a Lewis structure and answer the next two questions.



23. How many atoms in tryptophan are sp^3 hybridized?
a. 2 b. 3 c. 4 d. 5 e. 6
24. What are the approximate bond angles around the nitrogen atom labeled **1** and the oxygen atom labeled **2**, respectively?
a. 109° ; 109° b. 120° ; 109° c. 120° ; 120°
d. 109° ; 180° e. 90° ; 120°
-

25. How many of the following have three (3) unpaired electrons in the ground state?

- Ga N V Co Se⁻
- a. 1 b. 2 c. 3 d. 4 e. 5 (all)

26. How many of the following five statements (I-V) about hydrogen is/are **true**?

- I. H has a smaller ionization energy than He.
II. H⁻ has a smaller size than H.
III. H forms an ionic bond with F.
IV. H is considered to be a metal.
V. H does not have a second ionization energy.
- a. 1 b. 2 c. 3 d. 4
- e. 5 [All of these statements (I-V) are true.]

27. The isotope of an unknown element, X, has a mass number of 79. The most stable ion of the isotope has 36 electrons which forms a binary compound with sodium having a formula of Na₂X. Which of the following statements (a-d) is/are **true**?

- a. The binary compound formed between X and fluorine will be a covalent compound.
b. The isotope of X contains 38 protons.
c. The isotope of X contains 41 neutrons.
d. The identity of X is strontium, Sr.
e. All of the above statements (a-d) are true.

28. A certain transition metal ion (Mⁿ⁺) forms a compound with sulfur (M_xS_y). The molar mass of the compound is 298.4 g/mol. If the charge on the transition metal ion is +3, what is the identity of the transition metal, M?

- a. Ti b. Mo c. Ir d. Ru e. Cf

29. Which of the following electronic transitions for a one electron atom or ion corresponds to an emission of electromagnetic radiation having the shortest wavelength?

- a. n = 5 → n = 3 b. n = 4 → n = 2 c. n = 3 → n = 2
- d. n = 2 → n = 1 e. n = 3 → n = 1

30. Which of the following organic molecules has the carbon-carbon bond with the shortest bond length? For the skeletal structures, the two carbon atoms are bonded to each other with the other atoms bonded to the carbons. Note that the bond which is strongest will have the shortest bond length.
- a. CHCH b. CH₂CH₂ c. CH₃CH₃
d. CCl₂CCl₂ e. CH₂CCl₂
31. Consider an electron for a hydrogen atom that is in an excited state. The maximum wavelength of electromagnetic radiation that can completely remove (ionize) the electron from this H atom is 3283 nm. What is the initial excited state for the electron (n = ?)?
- a. n = 2 b. n = 3 c. n = 4 d. n = 5 e. n = 6
32. How many of the following five compounds are predicted by VSEPR to have at least one bond angle that is 120°?
- SO₃ SO₂ SF₄ KrCl₄ IF₅
- a. 1 b. 2 c. 3 d. 4 e. 5 (all)
33. How many of the following five compounds are **polar**?
Note: These are the same compounds used in the previous problem.
- SO₃ SO₂ SF₄ KrCl₄ IF₅
- a. 1 b. 2 c. 3 d. 4 e. 5 (All are polar.)