1. Which correctly matches the ion with its electron configuration?

   A. $F^- = 1s^2\,2s^2\,2p^6\,3s^1$
   B. $Cr^{3+} = [Ar]\,3d^3$
   C. $Zn^{2+} = [Ar]4s^2\,3d^8$
   D. $Li^+ = 1s^2\,2s^1$

2. Some elements were discovered in ancient times (thousands of years ago), whereas others were only discovered in "modern" times (within the last 300 years). What statement correctly describes the discovery of elements?
   A. All unreactive elements were discovered in ancient times since they are stable.
   B. The alkali elements were discovered in ancient times because they are reactive.
   C. The alkali elements were discovered in ancient times because they are metals.
   D. Most elements were discovered in modern times.
   E. Almost all of the elements known today were included in Mendeleev's periodic table classification (in 1869).

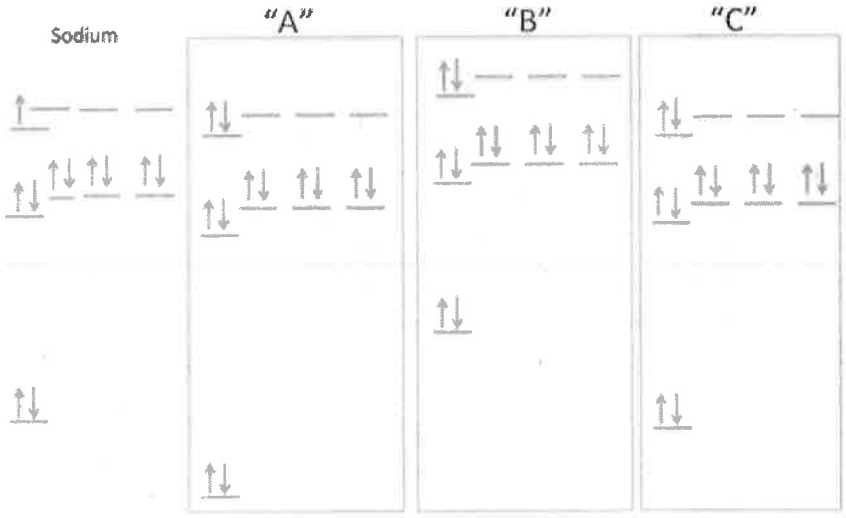
3. Electrons in which of these orbitals experience the greatest effective nuclear charge?

   A. 1s orbital in hydrogen, H
   B. 2s orbital in fluoride ion, F^-
   C. 2s orbital in oxygen, O
   D. 3s orbital in sodium, Na
   E. 1s orbital in potassium, K

4. Effective nuclear charge calculations using Slater's rules lead to better agreement with experimental values for some elements (compared with our simplified approach that only considers core electrons as shielding). Which of these elements will benefit most from using Slater's rules instead of a simplified approximation?
   A. Lithium.
   B. Boron.
   C. Oxygen.
   D. Neon.
   E. All of these are the same since they have the same principal quantum number (n).

Practice MT 3

5. The electronic energy levels for sodium are shown on the left. Which of the boxes best represents the electronic energy levels for Mg?
Hint: Perhaps consider Moseley's analysis of emitted X-rays, or the Zeff of core electrons, when answering.



A. A
B. B
C. C
D. A and C
E. B and C

6. The electron affinity values for column 4A of the periodic table (C, Si, Ge) is much more negative than the neighboring 3A (B, Al, Ga) or 5A (N, P, As) columns. What factor(s) explain this?

i. Z_{eff} is greater for 4A than 3A
ii. Electrons must be paired in 5A
iii. Z_{eff} is greater for 5A than 3A
iv. The closer an electron configuration is to an octet, the greater the electron affinity.

A. Only I
B. I and II.
C. Only IV.
D. II and III.
E. I and IV.

7. First, rank the following atoms or ions in terms of size, from smallest to largest:
He, H^+, N, Na^+, O^{2-}

Now, identify the atom or ion that is **second largest** in the ranking.

A. He
B. H^+
C. Mg^{2+}
D. Na^+
E. O^{2-}

8. Which of the following ionization energies will be the largest?

A. First ionization of lithium.
B. Third ionization of beryllium.
C. Second ionization of carbon.
D. Second ionization of magnesium.
E. First ionization of sodium.

9. Consider the operation of a discharge lamp. Which statement is TRUE?

A. The observed color of light depends on the energy of the different photons.
B. For different elements, increasing atomic number leads to more emission lines in the visible region.
C. The only way to emit IR photons is by having energy levels close to the ground state.
D. The energy that moves an electron to a higher energy level (an excited state) must be electrical.

10. Which of the following has the greatest reactivity?

A. Li
B. Na
C. Ca
D. Mg
E. K

11. What step is included, and correctly identified energetically, in the Born-Haber cycle for the formation of NaCl(s)? Be careful with the phase information.

A. $Na(s) \rightarrow Na(g)$	Exothermic
B. $Na^+(g) + \frac{1}{2} Cl_2(g) \rightarrow NaCl(g)$	Exothermic
C. $Na(g) \rightarrow Na^+(g) + electron$	Endothermic
D. $\frac{1}{2} Cl_2(g) \rightarrow Cl(g) + electron$	Endothermic
E. $Na^+(g) + Cl^-(g) \rightarrow NaCl(s)$	Endothermic

12. Rank the following compounds in terms of lattice energy.

MgO, Al_2O_3, $NaCl$, KCl, C_6H_6

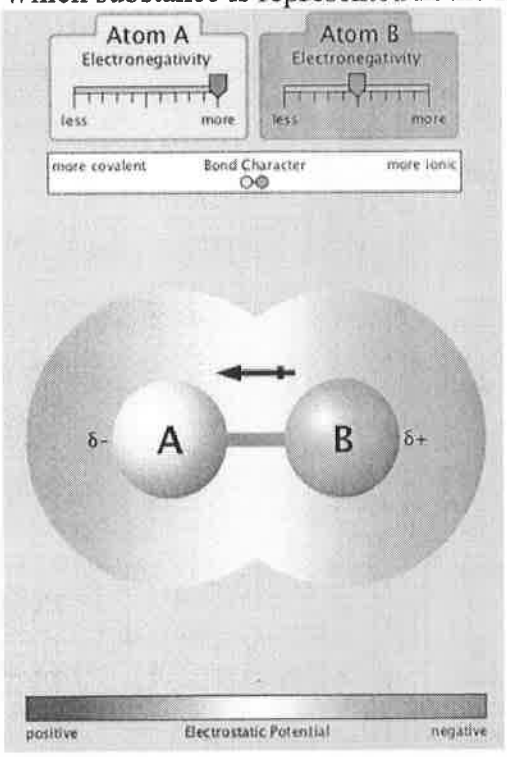
In this ranking of 5 different compounds, which one is in the third position (right in the middle) of the ranking?

A. MgO
B. Al_2O_3
C. C_6H_6
D. KCl
E. $NaCl$

13. What statement describes the development of bonding theories?

A. Bonding theories were only proposed after the discovery of the electron.
B. Lewis's theory of covalent bonding depended on Schrodinger's model of the hydrogen atom.
C. Thomson, Bohr, and Schrodinger proposed both atomic models and important bonding theories.
D. Bonding theories were developed once powerful microscopes were developed to better see electrons.
E. The conductivity of aqueous solutions supported the notion that positive and negative charges held together atoms in some compounds.

14. Which substance is represented in the figure?



A. HCl
B. NaH
C. MgO
D. O_2
E. KCl

15. Select the most electronegative atom in this set.

A. H
B. Li
C. Be
D. Na
E. Mg

16. Draw the Lewis formula for BrF_5. How many lone pairs of electrons are there in the valence shell of the central atom?

A. one
B. two
C. three
D. four
E. zero

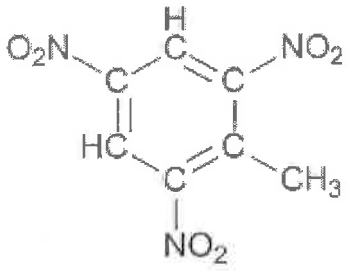
17. Consider the following species. Which contain an odd number of electrons?

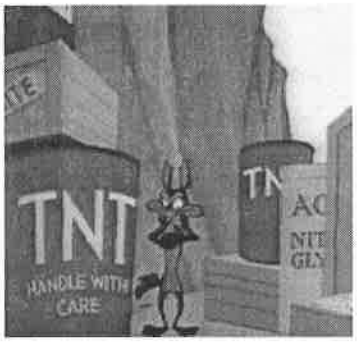
1) BrO_3 2) HO_2^- 3) N_2O 4) SO_3 5) SO_3^{2-}

A. only 1
B. only 2
C. 2 and 5
D. 3 and 4
E. 1, 3 and 4

18. The oxalate ion, $C_2O_4^{2-}$ has a single bond between the carbon atoms and each carbon atom is bonded to two oxygen atoms. What is true about the carbon-oxygen bond lengths?
A. Four identical bond lengths, similar to carbon-oxygen single bonds.
B. Four identical bond lengths, similar to carbon-oxygen double bonds.
C. Four identical bond lengths; shorter than single bonds, longer than double bonds.
D. Two large carbon-oxgyen bond lengths, and two shorter carbon-oxgyen bond lengths.
E. Four identical bond lengths; shorter than double bonds.

19. Trinitrotoluene (TNT), shown below, is an important explosive.





When TNT detonates the following reactions take place:
$2\ C_7H_5N_3O_6 \rightarrow 3\ N_2 + 5\ H_2O + 7\ CO + 7\ C$
$2\ C_7H_5N_3O_6 \rightarrow 3\ N_2 + 5\ H_2 + 12\ CO + 2\ C$

What **best explains** why these compounds release so much energy?

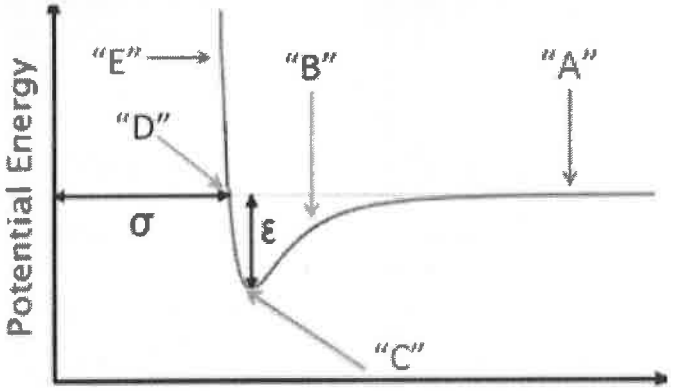
A. The breaking of the bonds in explosives (like TNT) releases energy.
B. Carbon-carbon double bonds in TNT have a large potential energy.
C. The bond enthalpy for a double bond is always endothermic.
D. Bond enthalpies are additive; the energy of two C-C single bonds equals the bond enthalpy of a C=C bond.
E. The products that form have very strong bonds.

20. Which of the following has bond angles of approximately 120°?

1) ClF_3 2) BF_3 3) NH_3 4) SF_4 5) $GeCl_4$

A. 1 and 4
B. 2 and 3
C. 2 only
D. 4 only
E. 5 only

21. Consider the potential energy curve for the formation of a H_2 molecule. Which statement is TRUE?



A. Repulsive forces dominate at position "A".
B. The potential energy is greatest at "C".
C. The two hydrogen atoms form a stable hydrogen molecule at "C".
D. The potential energy of the system is positive at "B".

22. Which of the following includes polar bonds, but has a zero dipole moment?
A. H_2
B. CH_2F_2
C. HF
D. NH_3
E. CH_4

23. Draw the Lewis formula for BrF_5. What term describes the shape of this species?

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

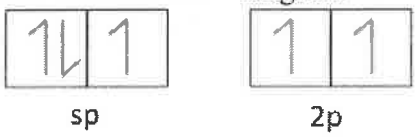
24. In the following reduction reaction the shape of the reactant is __ and the shape of the product is __.

$$SiF_4 + 2\ e^- \longrightarrow SiF_4^{2-}$$

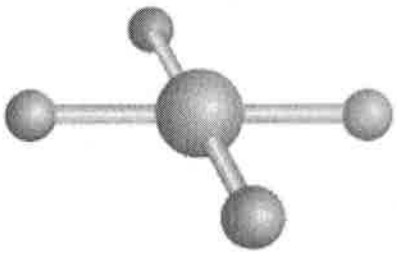
A. tetrahedral, square pyramid
B. tetrahedral, see-saw
C. T-shaped, tetrahedral
D. T-shaped, square planar
E. square planar, T-shaped

25. Which statement is TRUE when hybridization is used to describe the bonding in water?

A. The molecule includes one σ and one π bond.
B. The oxygen atom is sp^3 hybridized.
C. An oxygen-hydrogen bond is formed from an unhybridized p-orbital.
D. The correct orbital diagram is:

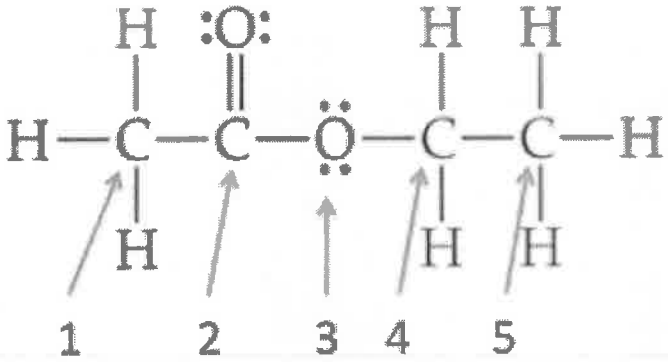


26. Determine the most likely central atom in the molecular geometry shown in the figure.



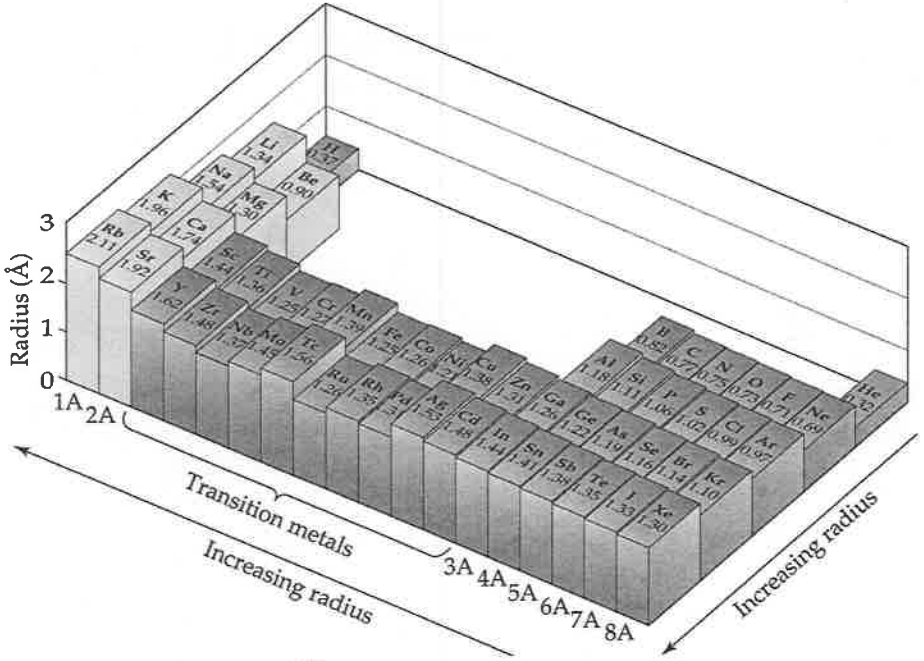
A. Xe
B. Cl
C. Si
D. C
E. B

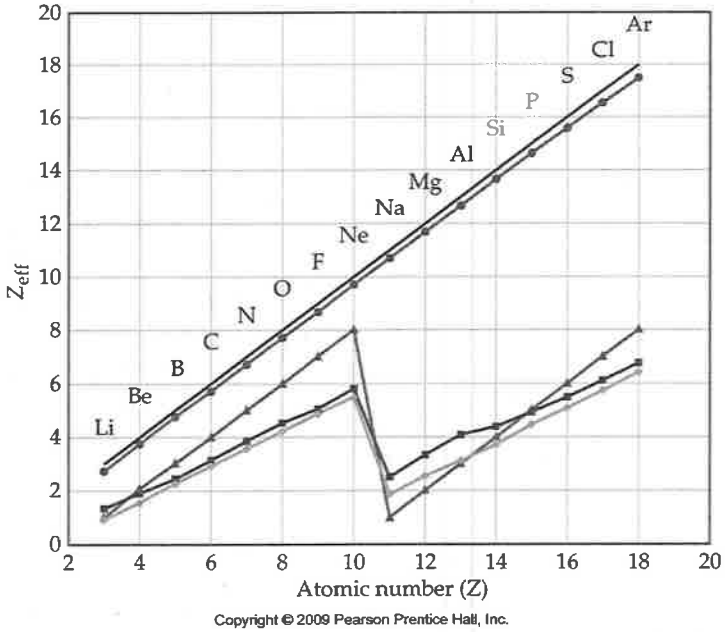
27. Consider the Lewis structure shown in the figure.

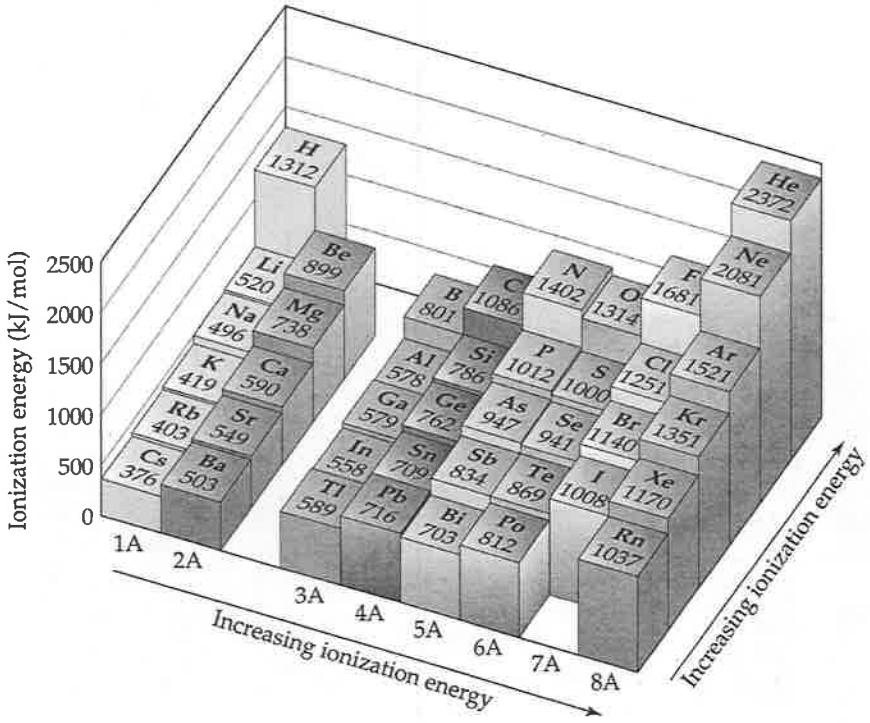


For the atoms designated 1-5, which ones have the same hybridization?

A. Only 1 and 5.
B. Only 1, 4, and 5.
C. Only 1, 3, 4, and 5.
D. Only 1, 2, 4, and 5.







Electron Affinity (kJ/mol)

1A	2A	3A	4A	5A	6A	7A	8A
H −73							He > 0
Li −60	Be > 0	B −27	C −122	N > 0	O −141	F −328	Ne > 0
Na −53	Mg > 0	Al −43	Si −134	P −72	S −200	Cl −349	Ar > 0
K −48	Ca −2	Ga −30	Ge −119	As −78	Se −195	Br −325	Kr > 0
Rb −47	Sr −5	In −30	Sn −107	Sb −103	Te −190	I −295	Xe > 0