

(10) 1. **True/False. Circle one.** We will count your best ten of 11.

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| T F | A. The species S^{2-} , Cl^- , Ar, K^+ , and Ca^{2+} are isoelectronic – they all have 36 electrons. |
| T F | B. A diatomic molecule like NO has no dipole moment because it has an odd number of electrons |
| T F | C. Electronegativity increases going from At to Li because the charge to size ratio becomes smaller. |
| T F | D. Bond polarities arise from electronegativity differences. |
| T F | E. VSEPR is based on the assumption that orbitals in molecules are oriented as far apart as possible. |
| T F | F. Young people who spend more time on social networks show an increased rate of alcohol abuse. |
| T F | G. Molecules with central atoms from elements with atomic numbers 1-7 are always electron deficient because it takes 8 electrons to satisfy the octet rule. |
| T F | H. If a species is neutral, then the sum of the formal charges on all the atoms are equal to zero. |
| T F | I. In most species, the electronegative elements are the central atoms and the others are the terminal atoms. |
| T F | J. Electron affinity describes the energy released or absorbed when one mole of neutral atoms in the gaseous state form positive ions. |
| T F | K. A resonance structure is known to fluctuate between two or more different isotopes. |

- (9) 2. **Orbital Notation.** Answer 3 of 4. Write the orbital notation (like $1s$, $2p$, $5f$...) for each of the following sets of quantum numbers and state if the orbital notation is allowed or not. If it is not allowed, explain why. We will grade all and keep your best three.

Quantum numbers	Orbital Notation	Allowed (Y/N)	Explanation
(a) $n = 3, \ell = 1, m_l = 0$			
(b) $n = 3, \ell = 3, m_l = -1$			
(c) $n = 4, \ell = 2, m_l = +2$			
(d) $n = 4, \ell = 4, m_l = +1$			

- (4) 3. **Orbitals.** Identify these orbitals from the electron density diagrams. You will receive full credit for identifying s , p , d , f ... You may be able to further identify the orbitals and will receive bonus credit if you do.

A

B

Write your answers here

A.

B.

- (9) 4. **Electron Configuration.** Write the electron configuration for any three. You can use an inert gas core if you wish. We will grade your best three answers but do not waste time.

Species	Electron configuration
(a) V	
(b) V^{3+}	
(c) As^{3-}	
(d) Cu	

- (2) 5. **Periodic Table.** List the symbols for all the *d*-block elements in the 4th row of the periodic table.

- (6) 6. **Periodic Properties.**

A. Arrange in order of size. Write the number 1 for the lowest, 2, and 3 for the largest.

Fe	Fe^{3+}	Fe^{2+}
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B. Arrange in order of ionization energy. Write the number 1 for the lowest, 2, and 3 for the highest.

Sr	Ca	N
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- (4) 7. **Ionization Energies.** Consider the elements calcium and aluminum. **ANSWER ONLY ONE.**

A. Which will have the higher second ionization energy? Explain.

B. Which will have the highest third ionization energy? Explain.

- (5) 8. **Ionic bonding.** Write Lewis structures for these chemical equations. Do not overthink – you know how to draw atoms and ions.

$Mg \rightarrow Mg^{2+} + 2e^{-}$	
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$\text{Cl} + \text{e}^- \rightarrow \text{Cl}^-$	
$\text{Mg} + 2\text{Cl} \rightarrow \text{MgCl}_2$	

- (5) 9. **Lattice Energy.** Rank in order of lattice energy, from lowest to highest. Write the number 1 for the lowest, 2, 3, and 4 for the highest.

MgO	NaCl	MgCl ₂	CaO
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- (5) 10. **Bonding.** Explain how scientists know that single, double, and triple bonds exist.
- (15) 11. **Lewis Structures.** Draw complete Lewis structures (that means formal charge in case you have not been paying attention) for **three** of the following species. Resonance structures are not needed – if they exist, show the one that is most favored. **Show all your work.**

A. Dimethylamine (CH ₃) ₂ NH	
B. Sulfur dioxide	
C. Silicon tetrabromide	
D. Phosphorus trichloride	

E. Dinitrogen monoxide (N ₂ O)	
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- (6) 12. **Resonance Structures.** Draw all resonance structures for **two**. Indicate which are the most meaningful and explain why. Your best two will be graded but watch the time carefully.

A. Nitrite ion (NO ₂ ⁻)	B. Ozone (O ₃)	C. Carbonate ion (CO ₃ ²⁻)	D. Sulfate ion
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- (10) 13. **Bond Energies** Calculate an approximate enthalpy change for the reaction

$$\text{C}_2\text{H}_6(\text{g}) \rightarrow \text{C}_2\text{H}_4(\text{g}) + \text{H}_2(\text{g})$$

Bond Energies

C-H 414 kJ/mol H-H 436 kJ/mol

C-C 348 kJ/mol C=C 611 kJ/mol

- (10) 14. **VSEPR.** (I lifted this question directly from a MCAT practice test.) Use VSEPR theory to determine the shapes of **three** molecules. Unlike the MCAT, you can earn partial credit by solving the problem as you were taught; also I count your best 3. Use your time carefully.

A. SF ₆	B. PCl ₃	C. XeF ₄	D. BrF ₅
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