

Name _____

ID # _____

INSTRUCTIONS:

- PRINT your name and ID# above.
- Code the answers to the True-False and Multiple-Choice questions on the scantron form. Mark **A** for true and **B** for false. There is only *one* correct answer for each multiple choice question. There is no partial credit given for this section.
- Show all work on the problems section because partial credit is awarded for this section.
- On the scantron form, write the color of your exam above your name.
- Below your ID# above, answer the following question. Who is your favorite actor or actress? You will receive 1 bonus pt.
- There are **99** points on this exam.

GOOD LUCK! ENJOY!!

PART I: True-false statements (3 points each)

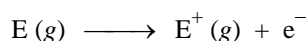
1. Magnesium atoms have a **smaller** atomic radius than sulfur atoms.
2. A Ca^{2+} ion is **smaller** than a Ca atom.
3. Lone pairs on the central atom of a molecule prevent the molecular geometry from being the same as the electron pair arrangement.
4. Consider the following reaction: $2 \text{NO} (g) + \text{O}_2 (g) \rightarrow 2 \text{NO}_2 (g)$. If 8.82 L of $\text{NO}(g)$ are reacted with $\text{O}_2(g)$, 4.41 L of $\text{O}_2(g)$ would be required for complete reaction.

PART II: Multiple Choice (3 points each)

5. The sulfide ion, S^{2-} , is **isoelectronic** with which one of the following?

[a] F^- [b] O^{2-} [c] Na^+ [d] Al^{3+} [e] K^+

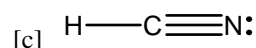
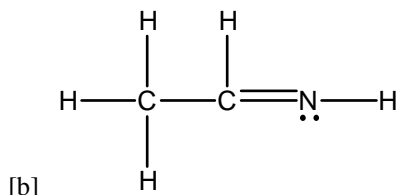
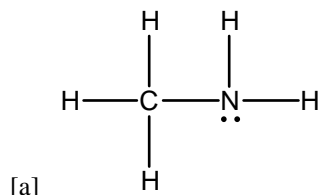
6. Which element has the **largest** energy for the process (ionization):



[a] Na [b] Rb [c] Al [d] Cl [e] S

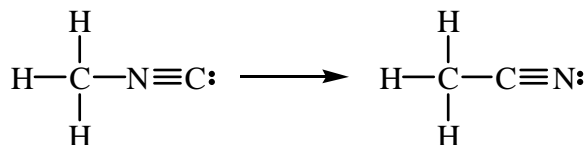
7. Which element will display an unusually large jump in ionization energy values between its second and third ionization energies?
- [a] Na [b] Mg [c] Al [d] Si [e] P
8. Consider an element (X) with a valence electron configuration of ns^2np^4 . What is the most likely formula of the ionic compound formed between this element and sodium (Na)?
- [a] Na_2X [b] NaX [c] NaX_2 [d] Na_4X [e] Na_2X_3
9. Which of the following is a **correct** electronegativity trend?
- [a] $Se > S > O$ [b] $Se > As > Ge$ [c] $Ge > Si > C$
[d] $Sb > Se > Cl$ [e] $Al > Si > P$
10. Which one of the following compounds is most likely to have **covalent** bonding?
- [a] K_2S [b] $CaCl_2$ [c] SF_4 [d] CaO [e] MgI_2
11. Which one of the following molecules or ions would exhibit **resonance**?
- [a] CN^- [b] SO_2^{2-} [c] SO_3 [d] H_2O [e] PH_3
12. Which of the following elements would form an XF_6^{2-} ion that has **no** lone pairs of electrons on the central atom?
- [a] Ca [b] C [c] Si [d] S [e] P
13. What is the **formal charge** on the chlorine atom in ClO_3^- if the Lewis structure is drawn with three single bonds?
- [a] -2 [b] -1 [c] 0 [d] +2 [e] +3
14. Which of the following is **not** assumed in the VSEPR theory?
- [a] Lone pair electrons exert a stronger repulsive effect on adjacent electron pairs than do bonding pairs.
[b] As far as electron-repulsion is concerned, double and triple bonds can be treated as though they were single bonds between neighboring atoms.
[c] Electron pairs in the valence shell of an atom are arranged around that atom in a way that minimizes electron repulsions.
[d] The core electrons do not influence the shape of the molecule.
[e] All of the above are correct assumptions of VSEPR theory.
15. Which of the following statements is **incorrect**?
- [a] Ionic bonding results from the complete transfer of electrons from one atom to another.
[b] Dipole moments are the result of unequal electron distribution in a molecule.
[c] The electrons in a polar bond are found nearer to the more electronegative element.
[d] A molecule with very polar bonds can be nonpolar.
[e] Linear molecules are always nonpolar molecules.

16. Which compound contains the **longest** carbon-to-nitrogen bond distance?



[d] all C-to-N bond distances are the same because the number of valence electrons is the same.

17. Use the bond dissociation energies given below to predict ΔH for the isomerization of methyl isocyanide, CH_3NC , to acetonitrile, CH_3CN .



Bond	Bond dissociation energy (kJ/mol)
C-H	414
C-C	347
C-N	276
C≡N	891

[a] 0 kJ

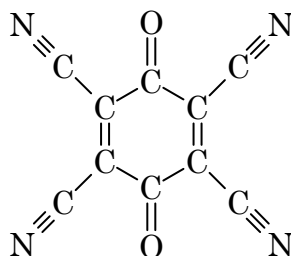
[b] -544 kJ

[c] -71 kJ

[d] +71 kJ

[e] +544 kJ

TCNQ, tetracyanoquinone ($\text{C}_{10}\text{N}_4\text{O}_2$), is an important compound in the search for materials with high electrical conductivity. The skeletal structure for TCNQ is below. A skeletal structure shows the connectivity of the atoms, but it is not a complete Lewis structure. Complete the Lewis structure and answer the following *two* questions.



18. How many lone pairs of electrons are in the **complete** Lewis structure?

[a] 0

[b] 4

[c] 6

[d] 8

[e] 12

19. How many σ and π bonds are in the molecule?

[a] 28 σ , 0 π

[b] 6 σ , 8 π

[c] 16 σ , 8 π

[d] 6 σ , 12 π

[e] 16 σ , 12 π

20. The physical properties of which of the following compounds is influenced primarily by **ion-ion** attractive forces?

[a] CO_2

[b] H_2O

[c] CO

[d] KF

[e] NH_3

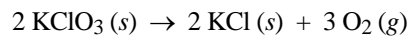
21. A sample of gas occupies 30.0 L at 1.800 atm and 298 K. How many **moles** of gas are in the sample?
 [a] 217.9 mol [b] 2.21 mol [c] 0.453 mol [d] 0.00459 mol [e] 22.4 mol
22. A gas at 25.0°C and 680 torr occupies 345 mL. What is the **volume** of the gas at STP?
 [a] 353 mL [b] 283 mL [c] 306 mL [d] 421 mL [e] 336 mL
23. If equal masses of O₂ and N₂ are placed in identical containers at the same temperature, which of the following statements is **true**? [Molar masses: N₂ = 28 g/mol, O₂ = 32 g/mol]
 [a] Both flasks contain the same number of molecules.
 [b] The pressure in the flask that contains N₂ will be greater than the pressure in the flask that contains O₂.
 [c] There will be more molecules in the flask that contains O₂ than the flask that contains N₂.
 [d] This question cannot be answered unless you know the masses of O₂ and N₂ in the flasks.

PART III: Problems

24. Complete the following table. [16 pts]

	NO ₂ ⁻	IF ₅
Total number of valence electrons in the molecule		
Lewis Structure(s)		
e⁻ pair arrangement		
molecular geometry		
bond angle(s)		
molecular polarity Polar or nonpolar?		
Hybrid orbitals used by central atom in bonding		

25. When KClO_3 is strongly heated, it decomposes to give KCl and oxygen gas.



When 4.289 g of KClO_3 (molar mass = 122.55 g/mol) are heated until no more gas is evolved, how many **liters of oxygen gas** (measured at 22.4°C and 754.0 torr) are produced? [7 pts]

26. A gaseous compound is 30.4% N and 69.6% O by mass. A 5.25 g sample of the gas occupies a volume of 1.00 L and exerts a pressure of 1.26 atm at 269 K. Determine the **molecular formula** of this compound? [**Hint:** First, determine the empirical formula.] [7 pts]

Potentially Useful Information

$$\text{Avogadro's \#} = 6.022 \times 10^{23} \text{ particles/mol}$$
$$PV = nRT$$

$$R = 0.0821 \frac{\text{L} \cdot \text{atm}}{\text{mol} \cdot \text{K}}$$

$$1 \text{ atm} = 760 \text{ mmHg} = 760 \text{ torr} = 101.325 \text{ kPa}$$

$$\text{STP} = 0^\circ\text{C} \text{ and } 1 \text{ atm pressure}$$

$$\text{K} = ^\circ\text{C} + 273^\circ$$

$$\text{molar mass} = \frac{\text{mass of substance (in g)}}{\text{moles of substance}}$$

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

Answer Key

- 1) F 2) T 3) T 4) T 5) e 6) d 7) b 8) a 9) b
 10) c 11) c 12) c 13) d 14) e 15) e 16) a 17) c 18) d
 19) e 20) d 21) b 22) b 23) b

24)

	NO_2^-	IF_5
Total number of valence electrons in the molecule	18	42
Lewis Structure(s)	$\left[\begin{array}{c} \ddot{\text{O}}=\ddot{\text{N}}-\ddot{\text{O}}: \\ \updownarrow \\ :\ddot{\text{O}}-\ddot{\text{N}}=\ddot{\text{O}}: \end{array} \right]^-$	
e⁻ pair arrangement	trigonal planar	octahedral
molecular geometry	bent or v-shaped	square pyramidal
bond angle(s)	$\approx 120^\circ$	$\approx 90^\circ$ and 180°
molecular polarity Polar or nonpolar?	polar	polar
Hybrid orbitals used by central atom in bonding	sp^2	sp^3d^2

25) $V = 1.283 \text{ L}$

26) N_2O_4