

Unit 8: Atomic Structure, Periodicity & Bonding

CHAPTER 5 – 6 PRACTICE QUIZ (Sections 5.5 – 5.7, 6.1 – 6.3, 6.5 – 6.8)

 ←Linked at 10:26

MULTIPLE CHOICE – NO CALCULATOR ALLOWED

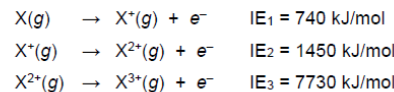
Type of electromagnetic radiation	Frequency (s ⁻¹)	Wavelength (m)	Energy (J)
X	3 × 10 ²¹	1 × 10 ⁻¹³	2 × 10 ⁻¹²
Y	3 × 10 ¹⁴	?	?

9. Two types of electromagnetic radiation, X and Y, are represented in the data table above. Which of the following are the most probable values for wavelength and energy associated with Y ?
- (A) 1 × 10⁻²⁰ m, 2 × 10⁻⁵ J
 (B) 1 × 10⁻²⁰ m, 2 × 10⁻¹⁹ J
 (C) 1 × 10⁻⁶ m, 2 × 10⁻⁵ J
 (D) 1 × 10⁻⁶ m, 2 × 10⁻¹⁹ J
10. Which of the following statements is most closely associated with the photoelectric effect?
- (A) Light shining on a clean metal surface causes the surface to emit electrons.
 (B) Energy is emitted by electrons as they travel from an higher energy state toward a lower energy state.
 (C) Electrons exist only in certain discrete energy levels, which are described by quantum numbers.
 (D) The solution to Schrodinger's equation for the hydrogen atom yields a set of wave functions called orbitals.
11. Which of the following represents the ground state electron configuration and an excited state electron configuration for the same element?

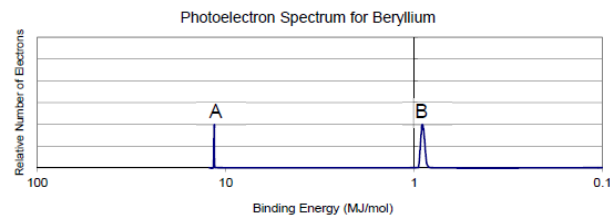
	Ground State	Excited State
(A)	1s ² 2s ² 2p ¹	1s ² 2s ² 2d ¹
(B)	1s ² 2s ² 2p ⁶	1s ² 2s ² 2p ⁵ 3s ¹
(C)	1s ² 2s ² 2p ⁵	1s ² 2s ² 2p ⁶
(D)	1s ² 2s ² 2p ⁶ 3s ²	1s ² 2s ² 2p ⁵ 3s ³

12. There are eight elements located in Period 3 of the periodic table. How many of these elements have a ground state electron configuration that contains exactly two unpaired electrons?
- (A) one (B) two (C) three (D) four
13. When electrons are removed from an atom to form a cation, they are always removed first from the occupied orbitals having the largest principal quantum number (*n*). Which of the following represents the ground state electron configuration for the Co²⁺ ion?
- (A) [Ar] 3d⁷ (B) [Ar] 3d⁵4s² (C) [Ar] 3d⁶4s¹ (D) [Ar] 3d⁷4s²

Name: _____ Pd_____

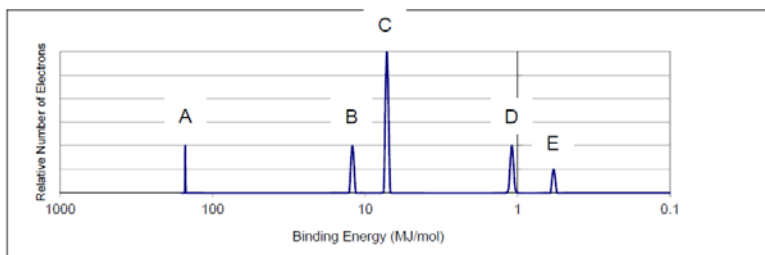


14. For element X represented above, which of the following is the most likely explanation for the large difference between the second and third ionization energies?
- (A) The effective nuclear charge decreases with successive ionizations.
 (B) The shielding of outer electrons increases with successive ionizations.
 (C) The electron removed during the third ionization is, on average, much closer to the nucleus than the first two electrons were.
 (D) The electron removed during the third ionization is located in a higher energy level than the first two electrons were.



15. The diagram above represents the photoelectron spectrum for beryllium. Which of the following statements is correct concerning Peak A and Peak B?
- (A) The electrons represented by Peak A require more energy to remove because they are located in a full s orbital.
 (B) The electrons represented by Peak B require more energy to remove because they are located in a full s orbital.
 (C) The electrons represented by Peak A require more energy to remove because they are closer to the nucleus.
 (D) The electrons represented by Peak B require more energy to remove because they are closer to the nucleus.

2. A certain light source produces yellow light with a wavelength of 580 nm.
- Calculate the frequency of this light in units of s^{-1} . Show your work below in order to receive full credit.
 - Calculate the energy of a single photon of this light in units of joules. Show your work below in order to receive full credit.
 - The Br–Br bond has a bond energy of 192 kJ/mol. Does light with a wavelength of 580 nm have sufficient energy to break the Br–Br bond? Justify your answer with a calculation. Show your work below in order to receive full credit.
 - A different light source that emits infrared light is shined on a sample of Br_2 molecules.
 - The wavelength of infrared light is (shorter longer) than 580 nm.
 - The frequency of infrared light is (lower higher) than the frequency of yellow light.
 - Therefore, the energy associated with infrared light is (lower higher) than the value that was calculated in part (b) for yellow light.
 - It is likely that infrared radiation (would wouldn't) have sufficient energy to break the Br–Br bond.



3. The diagram shown above represents the photoelectron spectrum of a pure element.
- Write the chemical symbol for this element. _____
 - Label each peak in the diagram with the name of the orbital in which the electrons are located. Identify the orbital with its principal quantum number (n) and orbital type, such as 1s or 3p.
A _____ B _____ C _____ D _____ E _____
 - Explain why peak D is twice as high as peak E.
 - Explain why peak C has a higher binding energy than peak D.

Element	Atomic Radius (pm)	First Ionization Energy (kJ/mol)
Calcium	174	590
Potassium	?	?

- Based on periodic trends and the data in the table above, which of the following are the most probable values for atomic radius and first ionization energy for potassium?
 - 144 pm, 419 kJ/mol
 - 144 pm, 633 kJ/mol
 - 196 pm, 419 kJ/mol
 - 196 pm, 633 kJ/mol
- Which of the following properties tends to decrease as you move from top to bottom down Group 14?
 - atomic radius
 - ionization energy
 - metallic character
 - reactivity with oxygen

Successive Values of Ionization Energy (kJ/mol) for an Element in Period 3					
I_1	I_2	I_3	I_4	I_5	I_6
578	1817	2745	11577	14830	18376

- Based on the information in the table above, what is the most likely identity of this element?
 - Mg
 - Al
 - Si
 - P
- Which of the following series is listed in order of increasing radius?

	smallest radius	----->	largest radius
(A)	K^+	K	Rb
(B)	Ca^{2+}	Ca	Mg
(C)	O^{2-}	O	S
(D)	P^{3-}	P	N

Skip #5

- A certain substance is dissolved in water, forming a basic ($pH > 7$) solution. With respect to the possible identity of the substance and its reaction with water, which of the following choices is most likely to be correct?

	Possible Identity of the Substance	Chemical Reaction with Water
(A)	CO_2	$CO_2 + H_2O \rightarrow H_2CO_3$
(B)	SO_2	$SO_2 + H_2O \rightarrow HSO_2^+ + OH^-$
(C)	CaO	$CaO + H_2O \rightarrow Ca(OH)_2$
(D)	BaO	$BaO + H_2O \rightarrow Ba + H_2O_2$

7. A pure sample of XCl_3 exists as a colorless liquid and has a boiling point of 76°C . Which of the following choices represents a possible identity of element X and the type of bonding present in XCl_3 ?

	Possible Identity of Element X	Type of Bonding in XCl_3
(A)	phosphorus	ionic
(B)	phosphorus	covalent
(C)	nickel	ionic
(D)	nickel	covalent

8. Which of the following processes would release the largest quantity of energy?

- (A) $\text{KBr}(s) \rightarrow \text{K}^+(g) + \text{Br}^-(g)$
 (B) $\text{MgO}(s) \rightarrow \text{Mg}^{2+}(g) + \text{O}^{2-}(g)$
 (C) $\text{K}^+(g) + \text{Br}^-(g) \rightarrow \text{KBr}(s)$
 (D) $\text{Mg}^{2+}(g) + \text{O}^{2-}(g) \rightarrow \text{MgO}(s)$

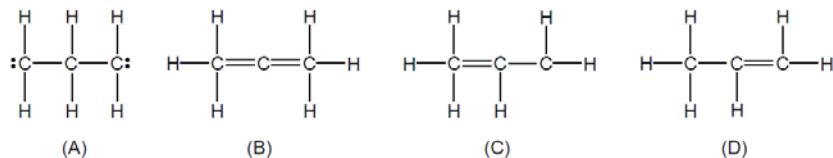
9. Which of the following bonds has the largest dipole moment?

- (A) C–N (B) P–S (C) As–F (D) Se–Br

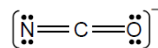
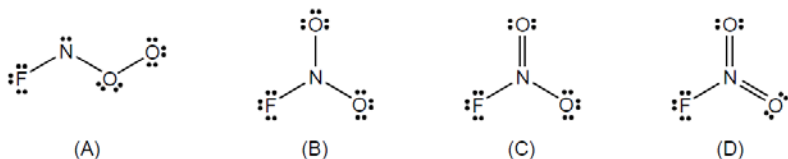
10. Which of the following molecules has a Lewis structure that is identical to nitrogen triiodide?

- (A) sulfur trioxide
 (B) boron trichloride
 (C) chlorine trifluoride
 (D) arsenic tribromide

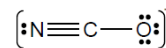
11. Which of the Lewis structures below best represents the molecule C_3H_6 ?



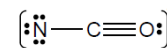
12. Which of the Lewis structures below best represents the molecule NO_2F ?



#1



#2



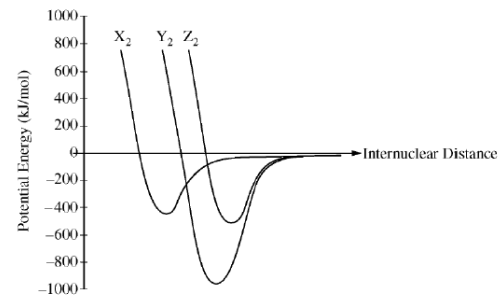
#3

13. Three different Lewis structures for the cyanate ion (NCO^-) are shown above. Which structure, if any, is the most favorable (or dominant)?

- (A) #1, because the C–N bond length is nearly equal to the C–O bond length.
 (B) #2, because the most electronegative atom carries the negative formal charge
 (C) #3, because the most electronegative atom is part of a strong triple bond
 (D) All three Lewis structures for the cyanate ion are equally favorable.

14. Which of the following series is listed in order of increasing O–O bond length (from shortest O–O bond to longest O–O bond)?

- (A) O_2 , O_3 , H_2O_2
 (B) O_2 , H_2O_2 , O_3
 (C) O_3 , O_2 , H_2O_2
 (D) O_3 , H_2O_2 , O_2



15. The potential energy as a function of internuclear distance for three diatomic molecules, X_2 , Y_2 , and Z_2 , is shown in the graph above. Based on the data in the graph, which of the following correctly identifies the diatomic molecules, X_2 , Y_2 , and Z_2 ?

	X_2	Y_2	Z_2
(A)	H_2	N_2	O_2
(B)	H_2	O_2	N_2
(C)	N_2	O_2	H_2
(D)	O_2	H_2	N_2



16. According to the data in the table below, what is the estimated value of ΔH° for the reaction shown above?

Bond	Average Bond Enthalpy (kJ/mol)
I-I	150
Cl-Cl	240
I-Cl	210

- (A) -390 kJ
 (B) -180 kJ
 (C) +180 kJ
 (D) +390 kJ

CHAPTER 4 - 5 PRACTICE QUIZ (Sections 4.5 - 4.6 & 5.1 - 5.4)

MULTIPLE CHOICE - NO CALCULATOR ALLOWED

 ←Linked at 11:56



12. Which of the following best describes and justifies the change in electrostatic potential energy that occurs when the two charged particles shown in the diagram above are brought closer together?

	Electrostatic Potential Energy	Justification
(A)	increases	the attraction between the particles increases
(B)	increases	the attraction between the particles decreases
(C)	decreases	the attraction between the particles increases
(D)	decreases	the attraction between the particles decreases

CHAPTER 7 - 8 PRACTICE QUIZ

FREE RESPONSE - CALCULATOR IS ALLOWED

 ←Linked at 23:05

Element	1 st ionization energy (kJ/mol)	2 nd ionization energy (kJ/mol)
Sodium	496	4562
Magnesium	738	1451
Potassium	419	3052

1. The following questions refer to the information in the table above.

- (a) Write the complete electron configuration for each of the following atoms or ions.

Na _____ Na⁺ _____

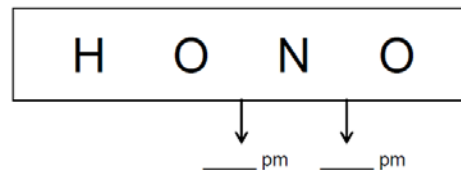
Mg _____ Mg⁺ _____

K _____ K⁺ _____

- (b) Explain why the 1st ionization energy of sodium is less than the 1st ionization energy of magnesium. Your answer should refer to the atomic structures of sodium and magnesium. Identify the specific orbital from which each electron is removed.
- (c) Explain why the 1st ionization energy of potassium is less than the 1st ionization energy of sodium. Your answer should refer to the atomic structures of potassium and sodium. Identify the specific orbital from which each electron is removed.
- (d) Explain why the 2nd ionization energy of sodium is higher than the 2nd ionization energy of magnesium. Your answer should refer to the electronic configurations of Na⁺ and Mg⁺. Identify the specific orbital from which each electron is removed.
- (e) Which metal (Na, Mg, or K) reacts most vigorously with water? Your answer should refer to specific information from the table above and how this property is related to the reactivity of metals.

2. Answer the following questions related to nitrous acid (HNO₂) and the nitrite ion (NO₂⁻).

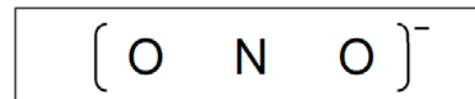
- (a) Complete the Lewis electron-dot diagram for HNO₂ by drawing the required number of electrons, including bonding pairs and nonbonding pairs. Each atom should have a full valence shell and a formal charge of zero.



- (b) When the HNO₂ molecule was analyzed, it was determined that one of the nitrogen-oxygen bonds has a length of 120 pm, and the other nitrogen-oxygen bond has a length of 146 pm.

Based on the Lewis electron dot structure that you drew in the box above, fill in the two blanks above with either a bond length of 120 pm or a bond length of 146 pm.

- (c) Complete the Lewis electron-dot diagram for the nitrite ion, NO₂⁻, by drawing the required number of electrons, including bonding pairs and nonbonding pairs.



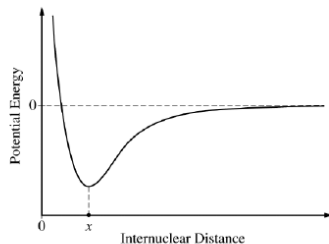
- (d) It was determined that the two nitrogen-oxygen bonds in the nitrite ion have the same length. Explain this result, using principles of chemical bonding.
- (e) Estimate the bond length of the nitrogen-oxygen bond in the nitrite ion: _____ pm

Average Bond Enthalpies (kJ/mol)	
H-H	436
N-H	391
N-N	163
N=N	418
N≡N	941

3. Use the bond enthalpy data in the table above to estimate the value of ΔH for the following reaction. Show your calculations below in order to receive full credit.



MULTIPLE CHOICE – NO CALCULATOR ALLOWED



1. The potential energy of a system of two atoms as a function of their internuclear distance is shown in the diagram above. Which of the following is true regarding the forces between the atoms when their internuclear distance is x ?
- (A) The attractive and repulsive forces are balanced, so the two atoms will maintain an average internuclear distance x .
- (B) There is a net repulsive force pushing the atoms farther apart, so the atoms will continue to move farther apart from each other.
- (C) There is a net attractive force pulling the atoms closer together, so the atoms will continue to move closer together.
- (D) The diagram only shows potential energy, so it cannot be determined if the forces between the two atoms are attractive or repulsive.
2. Which of the following choices most accurately describes both the molecular geometry and the polarity for both CO_2 and SO_2 ?

(A)	Substance	Molecular Geometry	Polarity
	CO_2	linear	polar
	SO_2	bent	nonpolar

(C)	Substance	Molecular Geometry	Polarity
	CO_2	linear	nonpolar
	SO_2	linear	nonpolar

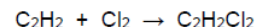
(B)	Substance	Molecular Geometry	Polarity
	CO_2	linear	nonpolar
	SO_2	linear	polar

(D)	Substance	Molecular Geometry	Polarity
	CO_2	linear	nonpolar
	SO_2	bent	polar

3. Which of the following statements most accurately describes boron trifluoride?
- (A) It is a nonpolar substance that contains nonpolar bonds.
- (B) It is a nonpolar substance that contains polar bonds.
- (C) It is a polar substance that contains nonpolar bonds.
- (D) It is a polar substance that contains polar bonds.
4. Which of the following choices represents the correct estimates of the bond angles in methane and water?

	H–C–H bond angle in CH_4	H–O–H bond angle in H_2O
(A)	90°	180°
(B)	109.5°	105°
(C)	109.5°	109.5°
(D)	109.5°	115°

5. Which of the following lists is arranged in order of increasing bond angle (i.e., from smallest bond angle to largest bond angle) ?
- (A) NF_3 , CF_4 , BF_3
- (B) NF_3 , BF_3 , CF_4
- (C) CF_4 , NF_3 , BF_3
- (D) CF_4 , BF_3 , NF_3



6. When the reaction shown above occurs, does the hybridization of the carbon atoms change?
- (A) No; the hybridization of the carbon atoms does not change.
- (B) Yes; the hybridization of the carbon atoms changes from sp to sp^2 .
- (C) Yes; the hybridization of the carbon atoms changes from sp to sp^3 .
- (D) Yes; the hybridization of the carbon atoms changes from sp^2 to sp^3 .
7. The hybridization of the carbon atoms in acetone, $(\text{CH}_3)_2\text{CO}$, is best described as
- (A) sp^2 for all three carbon atoms
- (B) sp^3 for all three carbon atoms
- (C) either sp or sp^2
- (D) either sp^2 or sp^3
8. Which of the following molecules contains exactly three sigma (σ) bonds and two pi (π) bonds?
- (A) HCN
- (B) HCO_2H
- (C) C_2H_2
- (D) C_2H_4

1. (a) Fill in the missing information in the table below.

Molecule	Molecular Geometry	Is this Molecule Polar or Nonpolar?
BeF ₂		
OF ₂		
XeF ₂		
CF ₄		
SF ₄		
XeF ₄		

- (b) Identify the bond angles for each of the following.

The F–Be–F angle in BeF₂ _____ The F–C–F angle in CF₄ _____

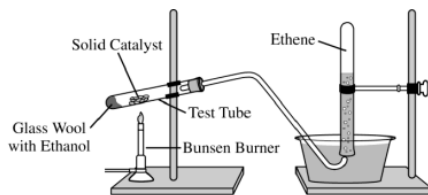
- (c) Identify the hybridization of the central atom (sp, sp
- ²
- , or sp
- ³
-) for each of the following.

BeF₂ _____ OF₂ _____ CF₄ _____

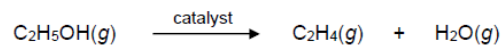
- (d) (i) Make a prediction regarding the F–O–F bond angle in OF
- ₂
- .

_____ The F–O–F bond angle in OF₂ is less than 109.5°._____ The F–O–F bond angle in OF₂ is equal to 109.5°._____ The F–O–F bond angle in OF₂ is greater than 109.5°.

- (ii) Justify your choice in part (d)(i) with a complete and thorough explanation.



2. Ethene, C
- ₂
- H
- ₄
- (g), may be prepared by the dehydration of ethanol, C
- ₂
- H
- ₅
- OH(l), using a solid catalyst. A setup for the lab synthesis is shown in the diagram above. The equation for the dehydration reaction is given below.



A student added a 0.200 g sample of C₂H₅OH(l) to a test tube using the setup shown above. The student heated the test tube gently with a Bunsen burner until all of the C₂H₅OH(l) evaporated and gas generation stopped. When the reaction stopped, the volume of collected gas was 85.4 mL at 625.0 torr and 32.0°C. (The vapor pressure of water at 32.0°C is 35.7 torr.)

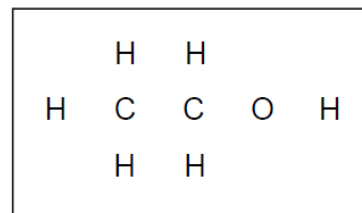
- (a) Calculate the number of moles of C
- ₂
- H
- ₄
- (g)

- (i) that are actually produced in the experiment and measured in the gas collection tube,
 (ii) and that would be produced if the dehydration reaction went to completion.

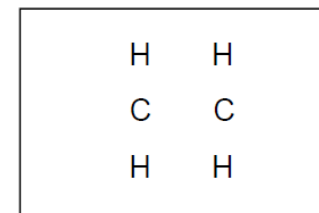
2.(continued)

- (b) Calculate the percent yield of ethene in the experiment.

- (c) In the boxes below, complete the Lewis electron-dot diagrams for ethene and ethanol by drawing in all of the electron pairs. Note that the diagrams below are not necessarily representative of the actual molecular geometry for either molecule.



ethanol



ethene

- (d) Identify the hybridization (sp, sp
- ²
- , or sp
- ³
-) of the carbon atoms

(i) in ethanol _____

(ii) in ethene _____

- (e) Identify the predicted value for the H–C–H bond angle

(i) in ethanol _____

(ii) in ethene _____