

AP Chemistry Exam 4 Chapters 7-9

Part I: 36 Questions, 36 minutes, Multiple Choice, No Calculator Allowed

Bubble the correct answer on the Green side of your scantron for each of the following.

Use the following answers for questions 1 - 5. Choose the molecular geometry for each of the following molecules. You may use an answer more than once.

(A) T-shaped (B) see-saw (C) square pyramidal (D) trigonal planar (E) trigonal bipyramidal

1. IF_5
2. SF_4
3. PF_5
4. ClF_3
5. NO_3^{1-}

Use the following answers for questions 6 - 10. Choose the molecular geometry for each of the following molecules. You may use an answer more than once.

(A) tetrahedral (B) bent (C) linear (D) octahedral (E) trigonal pyramidal

6. SF_6
7. XeO_3
8. CCl_2F_2
9. PF_3
10. PO_4^{3-}

Questions 11-14 refer to atoms of the following elements.

(A) potassium (B) bromine (C) selenium (D) gallium (E) calcium

11. Has the smallest atomic radius.
12. Has the largest value for the second ionization energy.
13. Has the largest electron affinity.
14. Is diamagnetic.
15. Which of the following compounds is LEAST likely to exist?
(A) PCl_5 (B) PBr_3 (C) NF_3 (D) NI_5 (E) SbF_5
16. Which of the following compounds contains both ionic and covalent bonds?
(A) SO_3 (B) $\text{C}_2\text{H}_5\text{OH}$ (C) MgF_2 (D) H_2S (E) NH_4Cl
17. Which of the following molecules is nonpolar but has polar covalent bonds?
(A) N_2 (B) H_2O_2 (C) H_2O (D) CCl_4 (E) CH_2Cl_2

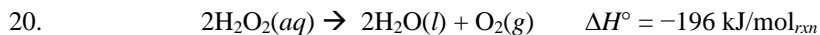
18. Which is NOT true about pi bonds?

- (A) They are formed by the sideways overlap of p orbitals. (B) They are present in double or triple bonds.
(C) Hybrid orbitals are used to form them. (D) They cause rotation about a double bond to be restricted.
(E) They place electron density above and below the line joining the nuclei of the bonded atoms.

19. The first five ionization energies of a second-period element are listed in the table to the right. Which of the following correctly identifies the element and best explains the data in the table?

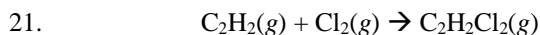
- (A) B, because it has five core electrons
 (B) B, because it has three valence electrons
 (C) C, because it has four valence electrons
 (D) N, because it has five valence electrons
 (E) N, because it has three electrons in the p sublevel

	Ionization Energy (kJ/mol)
First	801
Second	2,430
Third	3,660
Fourth	25,000
Fifth	32,820



Assume that the bond enthalpies of the oxygen-hydrogen bonds in H_2O are not significantly different from those in H_2O_2 . Based on the value of ΔH° of the reaction, which of the following could be the bond enthalpies (in kJ/mol) for the bonds broken and formed in the reaction?

	O-O in H_2O_2	O=O on O_2	O-H
(A)	500	300	500
(B)	300	500	500
(C)	150	500	500
(D)	500	300	150
(E)	250	300	150

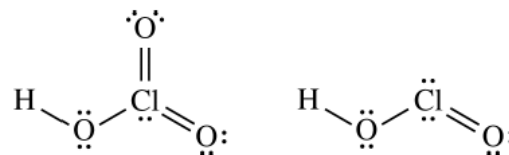


When the reaction above occurs, does the hybridization of the carbon atoms change?

- (A) Yes; it changes from sp to sp^2 (B) Yes; it changes from sp to sp^3 (C) Yes; it changes from sp^3 to sp^2
 (D) Yes; it changes from sp^2 to sp^3 (E) No; it does not change

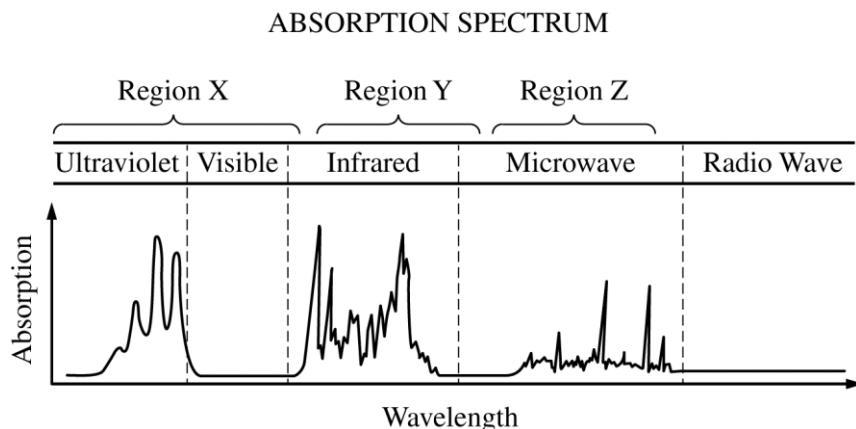
22. The Lewis electron-dot diagrams of the HClO_3 molecule and the HClO_2 molecule are shown at the left and right, respectively. Which of the following statements identifies the stronger acid and correctly identifies a factor that contributes to its being the stronger acid?

- (A) $\text{HClO}_3(aq)$ is the stronger acid because its molecules experience stronger hydrogen bonding.
 (B) $\text{HClO}_3(aq)$ is the stronger acid because its molecules experience stronger London dispersion forces.
 (C) $\text{HClO}_3(aq)$ is the stronger acid because the additional electronegative oxygen atom on the chlorine atom stabilizes the conjugate base.
 (D) $\text{HClO}_2(aq)$ is the stronger acid because its molecules experience weaker London dispersion forces.
 (E) $\text{HClO}_2(aq)$ is the stronger acid because the lone pairs of electrons on the chlorine atom stabilize the conjugate base.



23. The diagram to the right represents the absorption spectrum for a pure molecular substance. Which of the following correctly indicates the type of transition observed for the substance in each of the regions of the absorption spectrum?

	Region X	Region Y	Region Z
(A)	Molecular vibration	Molecular rotation	Electronic transition
(B)	Electronic transition	Molecular rotation	Molecular vibration
(C)	Molecular rotation	Molecular vibration	Electronic transition
(D)	Electronic transition	Molecular vibration	Molecular rotation
(E)	Molecular vibration	Electronic transition	Molecular rotation



24. Which of the following correctly identifies which has the higher first-ionization energy, Cl or Ar, and supplies the best justification?

- (A) Cl, because of its higher electronegativity (B) Cl, because of its higher electron affinity
 (C) Ar, because of its completely filled valence shell (D) Ar, because of its higher effective nuclear charge
 (E) Ar because it has a smaller atomic radius

25. The table to the right shows the first ionization energy and atomic radius of several elements. Which of the following best helps to explain the deviation of the first ionization energy of oxygen from the overall trend?

- (A) The atomic radius of oxygen is greater than the atomic radius of fluorine.
 (B) The atomic radius of oxygen is less than the atomic radius of nitrogen.
 (C) There is repulsion between paired electrons in oxygen's $2p$ orbitals.
 (D) There is attraction between paired electrons in oxygen's $2p$ orbitals.
 (E) Oxygen has more protons than nitrogen.

Element	First Ionization Energy (kJ/mol)	Atomic Radius (pm)
B	801	85
C	1086	77
N	1400	75
O	1314	73
F	1680	72
Ne	2080	70

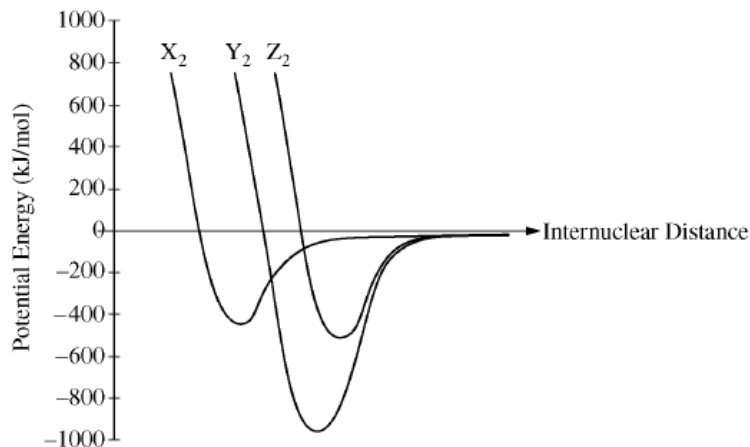
26. $\text{CO(g)} + 2 \text{H}_2\text{(g)} \rightleftharpoons \text{CH}_3\text{OH(g)}$ $\Delta H < 0$

Which of the following statements is true about bond energies in this reaction?

- (A) The energy absorbed as the bonds in the reactants are broken is greater than the energy released as the bonds in the product are formed.
 (B) The energy released as the bonds in the reactants are broken is greater than the energy absorbed as the bonds in the product are formed.
 (C) The energy absorbed as the bonds in the reactants are broken is less than the energy released as the bonds in the product are formed.
 (D) The energy released as the bonds in the reactants are broken is less than the energy absorbed as the bonds in the product are formed.
 (E) The energy released as the bonds in the reactants are broken is equal to the energy absorbed as the bonds are formed.

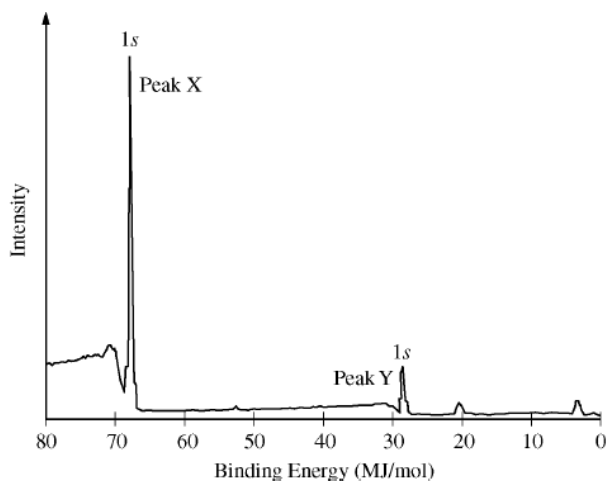
27. The potential energy as a function of internuclear distance for three diatomic molecules, X_2 , Y_2 and Z_2 , is shown in the graph above. Based on the data in the graph, which of the following correctly identifies the diatomic molecules, X_2 , Y_2 , and Z_2 ?

	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
(E)	N_2	H_2	O_2



28. A sample containing atoms of C and F was analyzed using x-ray photoelectron spectroscopy. The portion of the spectrum showing the $1s$ peaks for atoms of the two elements is shown to the right. Which of the following correctly identifies the $1s$ peak for the F atoms and provides an appropriate explanation?

- (A) Peak X, because F has a smaller first ionization energy than C has.
 (B) Peak X, because F has a greater nuclear charge than C has.
 (C) Peak Y, because F is more electronegative than C is.
 (D) Peak Y, because F has a larger ionization energy than C has.
 (E) Peak Y, because F has a smaller atomic radius than C has.



29. The BF_3 molecule is nonpolar, whereas the NF_3 molecule is polar. Which of the following statements accounts for the difference in polarity of the two molecules?

- (A) In NF_3 , each F is joined to N with multiple bonds, whereas in BF_3 , each F is joined to B with single bonds.
 (B) N – F bonds are polar, whereas B – F bonds are nonpolar.
 (C) NF_3 is an ionic compound, whereas BF_3 is a molecular compound.
 (D) Nitrogen has a higher electronegativity than boron.
 (E) Unlike BF_3 , NF_3 has a non-planar geometry due to an unshared pair of electrons on the N atom.

30. Which of the following arranges the molecules N_2 , O_2 , and F_2 in order of their bond enthalpies, from least to greatest?

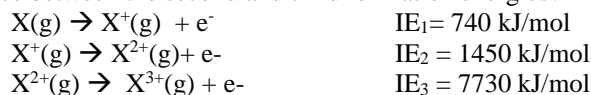
- (A) $\text{F}_2 < \text{O}_2 < \text{N}_2$ (B) $\text{O}_2 < \text{N}_2 < \text{F}_2$ (C) $\text{N}_2 < \text{O}_2 < \text{F}_2$ (D) $\text{N}_2 < \text{F}_2 < \text{O}_2$ (E) $\text{O}_2 < \text{F}_2 < \text{N}_2$

31. Based on Coulomb's law and the information in the table above, which of the following cations is most likely to have the weakest interaction with an adjacent water molecule in an aqueous solution?

- (A) Li^+ (B) Na^+ (C) Ca^{2+} (D) In^{3+}

Ion	Ionic Radius (pm)
Li^+	60
Na^+	95
Ca^{2+}	99
In^{3+}	81

32. 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?



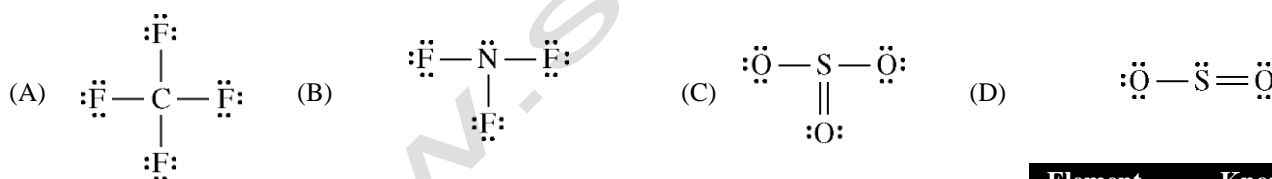
- (A) The effective nuclear charge decreases with successive ionizations.
 (B) The shielding of outer electrons increases with successive ionizations.
 (C) The electron removed during the third ionization is, on average, much closer to the nucleus than the first two electrons removed were.
 (D) The ionic radius increases with successive ionizations.

Element	Electronegativity
H	2.1
C	2.5
S	2.5
F	4.0
Cl	3.0
Si	1.8

33. On the basis of the information above, which of the following arranges the binary compounds in order of increasing bond polarity?

- (A) $\text{CH}_4 < \text{SiCl}_4 < \text{SF}_4$ (B) $\text{CH}_4 < \text{SF}_4 < \text{SiCl}_4$
 (C) $\text{SF}_4 < \text{CH}_4 < \text{SiCl}_4$ (D) $\text{SiCl}_4 < \text{SF}_4 < \text{CH}_4$

34. Which of the following Lewis electron-dot diagrams represents the molecule that contains the smallest bond angle?



35. Based on the information above and periodic trends, which of the following is the best hypothesis regarding the oxide(s) formed by Rb?

- (A) Rb will form only Rb_2O . (B) Rb will form only RbO_2 .
 (C) Rb will form only Rb_2O and Rb_2O_2 . (D) Rb will form Rb_2O , Rb_2O_2 , and RbO_2 .

Element	Known Oxides
H	H_2O , H_2O_2
Li	Li_2O , Li_2O_2
Na	Na_2O , Na_2O_2 , NaO_2
K	K_2O , K_2O_2 , KO_2

36. Based on the ionization energies of element X given in the table above, which of the following is most likely the empirical formula of an oxide of element X?

- (A) XO_2 (B) X_2O (C) X_2O_3 (D) X_2O_5

	Ionization Energy (kJ/mol)
First	577
Second	1,816
Third	2,745
Fourth	11,577
Fifth	14,482