

INFORMATION PAGE

This page contains information which may or may not be needed.

SOLUBILITY TRENDS

For purposes of this course, we will use the following trends to predict whether a compound is soluble or insoluble. These guidelines are given in a priority sequence: use them in this order.

1. Group 1 compounds and ammonium compounds tend to be soluble.
2. Nitrates, acetates, chlorates, and perchlorates tend to be soluble.
3. Silver, lead, mercury(I) and copper(I) compounds tend to be INSOLUBLE.
4. Chlorides, bromides, and iodides tend to be soluble.
5. Sulfates tend to be soluble except calcium sulfate, strontium sulfate and barium sulfate.
6. Compounds with anions of 2- or 3- charge tend to be INSOLUBLE.
7. Hydroxides tend to be INSOLUBLE except calcium hydroxide, strontium hydroxide and barium hydroxide.

Avogadro's number 6.022×10^{23}

Temperature conversion $T(\text{K}) = T(^{\circ}\text{C}) + 273$

Gases

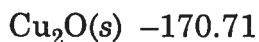
$$PV = nRT$$

$$R = 0.08206 \frac{\text{atm} \cdot \text{L}}{\text{mol} \cdot \text{K}} = 8.314 \frac{\text{J}}{\text{mol} \cdot \text{K}}$$

$$\text{atm} = 760 \text{ mmHg} = 760 \text{ Torr}$$

$$d = \frac{PM}{RT}$$

Standard Molar Enthalpies of Formation (in kJ/mol)



Electromagnetic Radiation $c = \lambda\nu = 3.00 \times 10^8 \text{ m/s}$

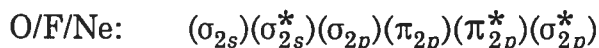
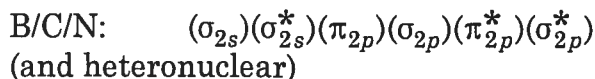
$$h = 6.626 \times 10^{-34} \text{ J} \cdot \text{s}$$

$$E = h\nu = hc/\lambda$$

Transition Energy

$$\Delta E = -2.18 \times 10^{-18} \text{ J} \left(\frac{1}{n_{\text{final}}^2} - \frac{1}{n_{\text{initial}}^2} \right)$$

Molecular Orbital Approach



KEEP YOUR WORK COVERED.

This includes your exam papers, your scrap work, and your Scantron card.

Part 1. Newer Material

1. How many of the ions below are paramagnetic?

O^{2-} Ti^{2+} Mn^{2+} Fe^{2+} Zn^{2+}
(A) none (B) one (C) two (D) three (E) four

2. Rank the following ionic compounds by increasing lattice energy.

NaCl NaI MgO MgS KI
(A) NaI < NaCl < MgO < MgS < KI
(B) KI < NaI < NaCl < MgS < MgO
(C) MgO < MgS < KI < NaI < NaCl
(D) MgO < MgS < NaI < NaCl < KI
(E) KI < MgS < NaI < NaCl < MgO

3. Which of the following elements is the most electronegative?

(A) Se (B) Bi (C) Ga (D) In (E) Pb

4. Which of the following statements is TRUE?

(A) Bond order is not related to the strength of the chemical bond.
(B) Both H_2S and CO_2 have one lone pair of electrons on the central atom.
(C) NF_2 has two double bonds.
(D) IF_4^- has three lone pairs on the central atom.
(E) The central atom in SF_4 has expanded valence.

5. Which one of the following has resonance?

(A) H_2O (B) SiF_4 (C) SO_2 (D) CS_2 (E) BCl_3

6. In the NO_4^{3-} ion, nitrogen has a formal charge of ___ and an oxidation number of ___.

- (A) 0, +3 (B) 0, +5 (C) +1, +3 (D) +1, +5 (E) +3, +3

7. How many of the following species have a tetrahedral shape?

- PO_4^{3-} SO_4^{2-} XeO_4 PCl_4^+ NF_3
 (A) one (B) two (C) three (D) four (E) five

8. Which one of the following molecules is nonpolar?

- (A) SO_2 (B) HCl (C) CS_2 (D) CO (E) OCl_2

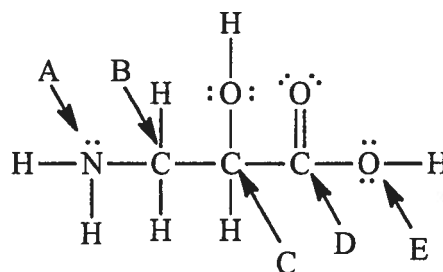
9. How many of the following molecules are polar?

- CH_4 CO CO_2 PH_3 SeCl_2
 (A) one (B) two (C) three (D) four (E) five

For Questions 10 and 11, consider the structure shown at right. Answer (A) - (E) according to the labels on the atoms which are shown.

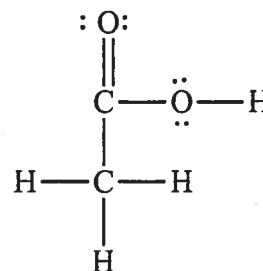
10. Which of the labeled atoms in the structure has a trigonal pyramidal shape?

11. Which of the labeled atoms has sp^2 hybridization?



12. How many sigma (σ) and pi (π) bonds are in the structure which is shown?

- | | σ | π |
|-----|----------|-------|
| (A) | 8 | 0 |
| (B) | 8 | 1 |
| (C) | 7 | 1 |
| (D) | 6 | 1 |
| (E) | 6 | 2 |



13. For the Molecular Orbital Approach for C_2 , which of the following statements is FALSE?

- (A) The bond order is two.
- (B) There are two electrons in σ_{2p}^* .
- (C) All electrons are spin paired.
- (D) The π_{2p} orbitals are full.
- (E) There are a total of two electrons in antibonding orbitals.

14. Consider the following.



How many have one unpaired electron in π_{2p}^* ?

- (A) one (B) two (C) three (D) four (E) five

15. Which one of the following is paramagnetic?

- (A) CN^- (B) O_2^{2-} (C) C_2^{2-} (D) OF^- (E) NO^-

**16-25: LEAVE THESE SPACES BLANK ON THE SCANTRON CARD.
GO TO NUMBER 26 ON THE BACKSIDE OF THE CARD.**

KEEP YOUR WORK COVERED.

This includes your exam papers, your scrap work, and your Scantron card.

Part 2. Older Material

26. What is the molar mass (in g) of iron(III) oxalate?

- (A) 59.14 (B) 88.02 (C) 122.25 (D) 291.73 (E) 375.76

27. Which of the following compounds contains ions with a -2 charge?

- (A) $CrPO_4$ (B) Ti_3N (C) PbS (D) SO_2 (E) NH_4NO_3

28. Ores of elements from different places in the world often contain different isotope ratios. This information can be used to show, for example, where prehistoric artifacts were moved along trade routes, or to detect where ancient meteorites struck the earth.

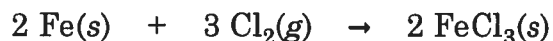
A certain sample of a lithium ore contains the two major isotopes of lithium, ${}^6\text{Li}$ and ${}^7\text{Li}$, in the following abundances. Calculate the atomic mass of lithium in this particular sample.

isotope	nuclear mass	abundance
${}^6\text{Li}$	6.015123	9.633%
${}^7\text{Li}$	7.016005	90.367%

- (A) 6.3402 (B) 6.5156 (C) 6.9196 (D) 6.941 (E) 7.016
29. Which of the following statements is FALSE?
- (A) Elements in the same period tend to have similar chemical properties.
(B) All of the nonmetals are Main Group elements.
(C) All of the transition elements are metals.
(D) Isotopes have the same number of protons, but different mass numbers.
(E) Hydrogen can form a +1 ion and a -1 ion.
30. Ammonia reacts with molecular fluorine to produce dinitrogen tetrafluoride and hydrogen fluoride. How many moles of ammonia are needed to react completely with 13.6 moles of molecular fluorine?

- (A) 2.27 (B) 5.44 (C) 6.80 (D) 27.2 (E) 34.0

31. The following equation is balanced.



If a reaction begins with 25.6 g each of iron and of chlorine, how much FeCl_3 can be formed (in g)?

- (A) 26.0 (B) 39.0 (C) 51.2 (D) 74.3 (E) 113

32. Aluminum metal reacts with sulfuric acid according to the equation below.



If 10.0 g of Al react with excess H_2SO_4 , and 54.2 g of $\text{Al}_2(\text{SO}_4)_3$ are obtained, then what is the percent yield for the reaction?

- (A) 47.1% (B) 63.4% (C) 73.5% (D) 85.5% (E) 97.0%

33. Consider the combustion reaction of propane. Which of the following statements is FALSE?

- (A) The balanced equation is: $\text{C}_3\text{H}_8 + 5 \text{O}_2 \rightarrow 3 \text{CO}_2 + 4 \text{H}_2\text{O}$
(B) If five molecules of propane react, then fifteen molecules of CO_2 are formed.
(C) If five molecules of propane react, then 25 molecules of O_2 must also react.
(D) If fifteen molecules of O_2 react, then nine molecules of H_2O are formed.
(E) If twelve molecules of CO_2 are formed, then four molecules of propane must have reacted.

34. Which of the following statements is TRUE?

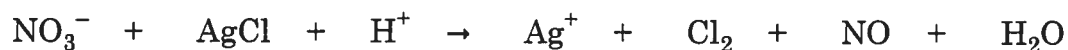
- (A) $\text{Mg}(\text{OH})_2$ is a strong base.
(B) CO_2 is an acid.
(C) The formula of chromic acid is HCrO_4 .
(D) Chlorous acid is a strong acid.
(E) Water is always one of the products of a neutralization reaction.

35. What are the oxidation numbers for each element in $\text{C}_2\text{H}_4\text{F}_2$?

- | | C | H | F |
|-----|----|----|----|
| (A) | +1 | -1 | +1 |
| (B) | +1 | -1 | -1 |
| (C) | +1 | +1 | -1 |
| (D) | -1 | +1 | +1 |
| (E) | -1 | +1 | -1 |

36. Which of the following compounds is insoluble in water?
(A) potassium oxalate (B) ammonium phosphate (C) silver acetate
(D) calcium hydroxide (E) copper(II) arsenate

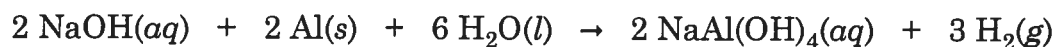
37. After balancing the following redox equation with the smallest whole-number coefficients,



what are the respective coefficients for NO_3^- and AgCl ?

- (A) 1 and 6 (B) 2 and 3 (C) 2 and 6 (D) 3 and 2 (E) 3 and 3
38. 4.50 L of gas at 28 °C has a pressure of 4.10 atm. How many moles of gas are present?
(A) 0.747 (B) 0.913 (C) 1.00 (D) 2.33 (E) 8.47

39. The following equation is balanced.



What is the volume (in L) of H_2 which can be formed at 24 °C and 1.00 atm if 4.15 g of Al are treated with excess NaOH?

- (A) 0.154 (B) 0.231 (C) 3.75 (D) 4.15 (E) 5.62
40. Which of the following gases has a density of 2.79 g/L at 25 °C and 2.00 atm?
(A) O_2 (B) CO_2 (C) SO_2 (D) H_2S (E) CH_3CH_3

41. The following equation is balanced.



For a reaction which uses up 1.50×10^4 kJ, how much Cu (in kg) is formed?

- (A) 3.86 (B) 6.59 (C) 9.85 (D) 11.2 (E) 13.3

42. What is the wavelength of the photon which has an energy of 1.29×10^{-24} J?
 (A) 157 nm (B) 458 nm (C) 252 μm (D) 658 μm (E) 154 mm
43. Which of the following statements is FALSE? (Assume ground state.)
 (A) Atoms of all elements in Group 14 have four unpaired electrons.
 (B) For every multi-electron atom, the $2p$ orbitals are higher energy than the $2s$ orbital.
 (C) In a sodium atom, the $3s$ electron is shielded by the electrons in the $1s$, $2s$ and $2p$ orbitals.
 (D) Every cation and anion with 18 total electrons has a noble gas configuration.
 (E) All electrons in atoms of all elements in Groups 2, 12 and 18 are spin paired.
44. Which of the following entries has the WRONG configuration for the indicated atom or ion?
 (A) Bi, $[\text{Xe}]6s^2 5d^{10} 6p^3$ (B) Ru^{3+} , $[\text{Kr}]4d^5$ (C) U^{2+} , $[\text{Rn}]5f^4$
 (D) As^{3-} , $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6$ (E) Ga^+ , $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10}$
45. Consider the following atoms.
- | | | | | |
|---|----|----|----|----|
| C | Si | Ga | Ge | As |
|---|----|----|----|----|
- For these atoms, which of the following statements is FALSE?
- (A) Three have four valence electrons.
 (B) Three have 18 core electrons.
 (C) One has its valence electrons in the $n = 3$ shell.
 (D) Ga has the largest size.
 (E) C has the strongest hold on its electrons.