

INFORMATION, SCRAP AND COVER PAGE

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

SOLUBILITY TRENDS FOR IONIC COMPOUNDS

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

$$6.022 \times 10^{23}$$

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)

$$\text{NH}_3(g) \quad -45.9 \quad \text{NO}(g) \quad 90.3 \quad \text{H}_2\text{O}(l) \quad -285.8 \quad \text{H}_2\text{O}(g) \quad -241.8$$

Electromagnetic Radiation

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

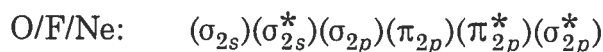
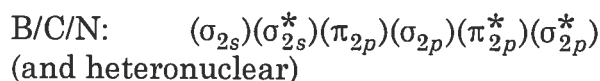
$$h = 6.626 \times 10^{-34} \text{ J} \cdot \text{s}$$

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

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. Which of the following is the most electronegative?

- (A) Pb (B) Ge (C) As (D) P (E) S

2. Consider the following molecules and ions.



How many of the above have one lone pair on the S atom?

- (A) none (B) one (C) two (D) three (E) four

3. FCN (C is central) has 3 nonequivalent resonance structures. What are the formal charges on F and N, respectively, in the preferred structure?

- (A) 0, 0 (B) +2, -2 (C) +1, -1 (D) 0, +1 (E) -1, -2

4. What is the oxidation number of the central atom in ClF_2^+ ?

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

5. What is the orientation of least repulsion (OLR) in the ion, IF_2^- ?

- (A) octahedral (B) trigonal bipyramidal (C) tetrahedral
(D) trigonal planar (E) bent

6. Which of the following has a square planar shape?

- (A) PCl_3 (B) BF_4^- (C) XeF_4 (D) BrF_5 (E) H_3O^+

7. What is the ideal bond angle in Cl_2O ?
- (A) 90° (B) 109.5° (C) 120° (D) 145° (E) 180°
8. Which of the following is nonpolar?
- (A) N_2O
(NNO) (B) NF_3 (C) H_2Se (D) TeO_3 (E) CH_3Cl
(C is central)
9. Consider the preferred (optimum) Lewis structure for SNO^- . Which of the following statements is FALSE?
- (A) The nitrogen has a lone pair in an sp^2 hybrid.
(B) The sulfur has two lone pairs in sp^2 hybrids.
(C) There is one π bond between S and N.
(D) The oxygen has two lone pairs in an sp^2 hybrid.
(E) The ion has a total of two σ bonds.

For Questions 10 - 12, consider the following five compounds. (Central atoms are underlined.)



10. How many of the compounds are nonpolar?
- (A) none (B) one (C) two (D) three (E) four
11. How many of the central atoms have sp^2 hybridization?
- (A) none (B) one (C) two (D) three (E) four
12. Which of the compounds has two σ and two π bonds?
- (A) CS_2 (B) AsH_3 (C) H_2Se (D) FCIO (E) GaF_3

13. Which of the following statements about the Molecular Orbital Approach is FALSE?
- (A) s AOs only form σ MOs.
(B) p AOs only form π MOs.
(C) Electrons added to bonding MOs increase the bond order in a molecule or ion.
(D) The combination of two AOs always produces two MOs.
(E) Some molecules with an even number of electrons are paramagnetic.
14. According to Molecular Orbital Approach, which species below would have the strongest bond?
- (A) C_2 (B) C_2^{2+} (C) N_2^{2+} (D) O_2 (E) O_2^{2+}
15. Which of the following species is NOT correctly matched with its bond order?
- | | species | bond order |
|-----|----------|------------|
| (A) | Li_2^+ | 0.5 |
| (B) | Li_2^- | 0.5 |
| (C) | B_2^+ | 1.0 |
| (D) | C_2 | 2.0 |
| (E) | C_2^- | 2.5 |

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

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Part 2. Older Material

26. Which is the correct name for Si_2F_6 ?
- (A) silicon(II) fluoride (B) silicon(VI) fluorine(II) (C) silicon trifluoride
(D) silicon(II) hexafluoride (E) disilicon hexafluoride

27. How many compounds below contain ions with -1 charge?

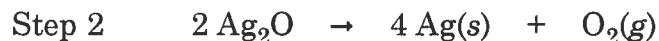
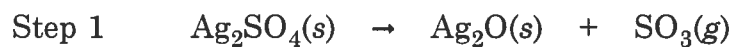


- (A) one (B) two (C) three (D) four (E) five

28. There are many binary compounds of silicon and hydrogen. One such compound contains 9.72% H by mass. Which of the following formulas is consistent with this percent composition?

- (A) SiH_2 (B) SiH_4 (C) Si_2H_3 (D) Si_2H_6 (E) Si_9H

29. At high temperature, silver sulfate reacts to form Ag metal, SO_3 and O_2 . This reaction occurs in two steps.



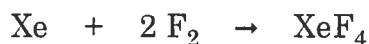
Which substance is an intermediate in the overall process?

- (A) $\text{Ag}_2\text{SO}_4(s)$ (B) $\text{Ag}_2\text{O}(s)$ (C) $\text{SO}_3(g)$ (D) $\text{Ag}(s)$ (E) $\text{O}_2(g)$

30. The reaction of aluminum chloride with water produces aluminum oxide and hydrogen chloride. For a reaction which produces 5.61 g aluminum oxide, how many grams of hydrogen chloride are also made?

- (A) 12.0 (B) 13.4 (C) 14.9 (D) 15.4 (E) 16.3

31. The following equation is balanced.



For a reaction which starts with 6.03 g Xe and 4.19 g F_2 , how many grams of XeF_4 can be made?

- (A) 7.82 (B) 8.16 (C) 9.52 (D) 10.8 (E) 11.7

32. The following undissociated equation is balanced.



For the net ionic equation, which of the following statements is FALSE?

- (A) There are two different reactants on the left side of the equation.
- (B) There is a total of four moles of ions on the left side of the equation.
- (C) There are three different products on the right side of the equation.
- (D) There is a total of four moles of ions on the right side of the equation.
- (E) The sum of charges on both sides of the equation is -4 .

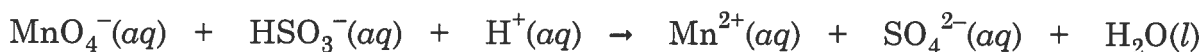
33. Which of the following statements is FALSE?

- (A) When solutions of sodium chlorate(*aq*) and magnesium acetate(*aq*) are combined, a precipitate is produced.
- (B) When solutions of ammonium chloride(*aq*) and silver nitrate(*aq*) are combined, a precipitate is produced.
- (C) The reaction of calcium hydroxide(*aq*) and acetic acid(*aq*) produces a soluble salt with the formula $\text{Ca}(\text{CH}_3\text{CO}_2)_2$.
- (D) The reaction of phosphoric acid(*aq*) with excess sodium hydroxide(*aq*) produces a soluble salt with the formula Na_3PO_4 .
- (E) The reaction of hydrochloric acid and iron(II) sulfide produces iron(II) chloride(*aq*) and hydrogen sulfide(*g*).

34. How many grams of salt can be obtained from the reaction of 25.0 mL of 0.213 M nitric acid(*aq*) with excess potassium hydroxide(*aq*)?

- (A) 0.158 (B) 0.236 (C) 0.316 (D) 0.472 (E) 0.538

35. Balance the following redox equation using the smallest integers possible, and select the correct coefficient for the hydrogen sulfite ion, HSO_3^- .

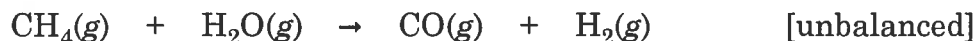


- (A) 1 (B) 2 (C) 3 (D) 5 (E) 10

36. For the reaction in Problem 35, identify the reducing agent (reductant).

- (A) MnO_4^- (B) HSO_3^- (C) H^+ (D) Mn^{2+} (E) SO_4^{2-}

37. Methane, $\text{CH}_4(g)$, reacts with steam to give *synthesis gas*, a mixture of carbon monoxide and hydrogen, which is used as starting material for the synthesis of a number of organic and inorganic compounds.



What mass (in g) of hydrogen is formed if 275 L (measured at STP) of methane is converted to synthesis gas?

- (A) 12.3 (B) 24.7 (C) 37.1 (D) 49.4 (E) 74.2

38. 9.33 g of an unknown gas occupies 3.16 L at 32.0 °C and 1.00 atm. What is the molar mass (in g/mol) of the gas?

- (A) 7.76 (B) 66.1 (C) 73.9 (D) 81.4 (E) 144

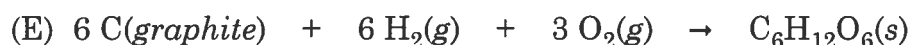
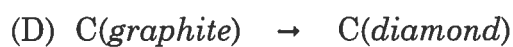
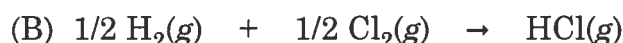
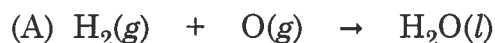
39. One of the steps in the synthesis of nitric acid is the conversion of ammonia to nitrogen oxide.



Calculate ΔH° (in kJ) for this reaction.

- (A) -906.0 (B) -197.4 (C) -105.6 (D) 197.4 (E) 906.0

40. Which of the following is NOT a correct equation for a thermodynamic formation reaction for the given product?



41. What is the energy (in J) of the transition $n = 2 \rightarrow n = 3$ for a hydrogen atom?
- (A) 1.40×10^{-19} (B) 2.15×10^{-19} (C) 3.03×10^{-19}
(D) 3.65×10^{-19} (E) 4.01×10^{-19}
42. What is the maximum number of electrons which can be placed in a g subshell?
- (A) 7 (B) 9 (C) 10 (D) 14 (E) 18
43. Which of the following are NOT correct ground state configurations for neutral atoms?
- I. $[\text{Ar}]4s^2$ II. $[\text{Ar}]3d^5$ III. $[\text{Ar}]4s^24p^2$ IV. $[\text{Kr}]5s^23d^3$
- (A) I only (B) I and IV (C) II and III (D) II, III and IV (E) all of them
44. Which one of the following does NOT have a full subshell configuration?
- (A) Zn (B) Ga^{3+} (C) Po^{2-} (D) Y^{3+} (E) Hf^{2+}
45. Which one of the following has the most unpaired electrons?
- (A) Os (B) Tc^{2+} (C) Ac^{2+} (D) Co (E) Zr^{2+}