

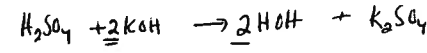
I. Select the answer that best completes each statement below.

1. Which oxides of manganese have a percent by mass of manganese that is greater than 50%?
- | | |
|-----|----|
| Mn | O |
| 55 | 16 |
| 55 | 32 |
| 110 | 48 |
- a) II only b) III only c) I and III only d) II and III only **e) I, II, and III**

2. Which describes the resulting system when 0.40 moles of Na₂CO₃(s) is added to 0.500 liters of 0.600 molar CuCl₂ solution?
- a) A blue precipitate forms; excess CO₃²⁻ is found in solution.**
 b) A blue precipitate forms; excess Cu²⁺ is found in solution.
 c) A blue precipitate forms; no excess reactants are found in solution.
 d) A colorless homogeneous system is formed; excess CO₃²⁻ is found in solution.
 e) A colorless homogeneous system is formed; excess Cu²⁺ is found in solution.
- Na₂CO₃(s) + CuCl₂(aq) → CuCO₃(s) + 2NaCl
- .40 mole .30 moles (L)

3. Consider the following reaction:
 2 C₂H₆(g) + 7 O₂(g) → 4 CO₂(g) + 6 H₂O(g)
- What quantity of reactant remains after ignition of a mixture that contains 0.40 moles of C₂H₆ mixed with 1.60 moles of O₂? (Assume maximum reaction according to the above equation.)
- a) 0.20 mol O₂**
 b) 0.80 mol O₂
 c) 1.20 mol O₂
 d) 0.20 mol C₂H₆
 e) 0.30 mol C₂H₆
- 1.60 mol O₂ | 2 mol C₂H₆ = .45 mol
 7 mol O₂
- 1.40 mol C₂H₆ | 7 mol O₂ = 1.40 mol
 2 mol C₂H₆
- Start Reactants: 1.60 - 1.40 = .20 mol O₂

4. Which compares elemental potassium metal with a potassium ion?
- I. The potassium ion is smaller than a neutral potassium atom.**
II. There are more protons in a potassium ion.
III. They both contain the same mass.
IV. They contain different number of neutrons.
- a) I only b) I and II only c) IV only d) II only **e) I and III only**



5. In a titration of 35.00 mL of 0.737 M H₂SO₄, _____ mL of a 0.827 M KOH solution is required for neutralization.
- a) 35.0 b) 1.12 c) 25.8 **d) 62.4** e) 39.3
- 0.3500 L × 0.737 mol/L = 0.258 mol H₂SO₄
 2 mol KOH / 1 mol H₂SO₄ = 0.516 mol KOH
 0.516 mol KOH × 1000 mL / 0.827 mol/L = 624 mL

6. What is the final concentration of Cl⁻ ion when 250 mL of 0.20 M CaCl₂ solution is mixed with 250 mL of 0.40 M KCl solution? (Assume additive volumes)
- a) 0.10 M b) 0.20 M c) 0.30 M **d) 0.40 M** e) 0.60 M
- [Cl⁻] = (250 mL × 0.40 M) + (250 mL × 0.80 M) / 500 mL = 0.50 M

7. The net ionic equation for formation of an aqueous solution of Al(NO₃)₃ by mixing solid Al(OH)₃ and aqueous nitric acid is _____
- a) Al(OH)₃(s) + 3 HNO₃(aq) → 3 H₂O(l) + Al(NO₃)₃(aq)
 b) Al(OH)₃(s) + 3 NO₃⁻(aq) → 3 OH⁻(aq) + Al(NO₃)₃(aq)
 c) Al(OH)₃(s) + 3 NO₃⁻(aq) → 3 OH⁻(aq) + Al(NO₃)₃(s)
d) Al(OH)₃(s) + 3 H⁺(aq) → 3 H₂O(l) + Al³⁺(aq)
 e) Al(OH)₃(s) + 3 HNO₃(aq) → 3 H₂O(l) + Al³⁺(aq) + NO₃⁻(aq)

8. Given the following set of two quantum numbers for a multi-electron atom:
 2, 0, 0, +1/2
- What are the next higher permitted n and l quantum numbers for this ground state atom?
- a) n = 3, l = 2
 b) n = 3, l = 1
 c) n = 3, l = 0
 d) n = 2, l = 1
e) n = 2, l = 1
- 2p n = 2 s p d f
 l = 1 0 1 2 3

9. The combustion of 3.42 g of a compound known to contain only nitrogen and hydrogen gave 9.82 g of NO₂ and 3.85 g of water. Determine the empirical formula of this compound.
- a) NH **b) NH₂** c) N₂H d) NH₃ e) N₂H₆
- 9.82 g NO₂ | 14g N | 14g N = .213
 46g NO₂ | 14g N
- 3.85 g H₂O | 2g H | 2g H = .213
 18g H₂O | 2g H

10. The percentage of aluminum in aluminum sulfate is _____ %
- a) 7.886 b) 21.93 **c) 15.77** d) 45.70 e) 18.36
- % Al = (mass Al / total mass) × 100 = (54g Al / 342g Total) × 100

11. Given the following reactions:
 N₂(g) + 2 O₂(g) → 2 NO₂(g) ΔH = +86.4 kJ
 2 NO(g) + O₂(g) → 2 NO₂(g) ΔH = -114.2 kJ
- Then the enthalpy of the reaction of the nitrogen to produce nitric oxide is _____
- N₂(g) + O₂(g) → 2 NO(g) ΔH = +180.6 kJ
- a) 180.6 kJ**
 b) -180.6 kJ
 c) 47.8 kJ
 d) 90.3 kJ
 e) -90.3 kJ

12. A 5.00 gram sample of liquid water at 25.0 °C is heated by the addition of 84.0 J of energy. What is the final temperature in °C of the water? (specific heat capacity = 4.184 J/g·K)
- a) 95.2 b) 25.2 c) -21.0 **d) 29.0** e) 4.02
- q = m C ΔT -84.0 J = -(5.00g)(4.184 J/g°C) ΔT
 ΔT = 4.01 °C

13. All of these molecular shapes can be explained by dsp² hybridization of electrons on the central atom EXCEPT _____
- a. linear b. t-shape c. seesaw **d. octahedral** e. trigonal bipyramidal
- sp³ d²

14. The central iodine atom in ICl₄⁻ ion has _____ nonbonded electron pairs and _____ bonded electron pairs in its valence shell.
- a. 2, 2 b. 3, 1 c. 1, 3 **d. 3, 2** e. 2, 4
- sp³ d² square planar
- ICl₄⁻ 5(7) + 1 = 36

15. In general, as you go across a period from left to right in the periodic table the atomic radius _____, the electronegativity _____, and the first ionization energy _____
- a. decreases, decreases, increases
b. decreases, increases, increases
 c. increases, increases, decreases
 d. increases, increases, increases

16. The elements, below, ranked in order of increasing first ionization energy.
- a. P, Cl, S, Al, Ar, Si b. Ar, Cl, S, P, Si, Al
 c. Al, Si, P, S, Cl, Ar **d. P > S**
- 1/2 Filled

17. Which three of the following pairs of particles is the first particle the largest?
- a. I, F** c. S, S²⁻
 b. Br, K d. Ca, K+
 e. Mg, Mg²⁺
18. Which set(s) of quantum numbers CANNOT be correct? (More than one may be incorrect.)
- a. n = 2, l = 0, m_l = 0 c. n = 3, l = 1, m_l = -1
 b. n = 2, l = 1, m_l = -1 **d. n = 1, l = 1, m_l = 0**
 e. n = 4, l = 2, m_l = 3

19. The n = 5 to n = 3 transition in the Bohr hydrogen atom corresponds to the _____ of a photon with a wavelength of _____ nm.
- a) absorption, 657 **b) emission, 1280**
 c) absorption, 1280 e) emission, 369
- E_n = -13.6 eV / n² E₅ = -0.54 eV E₃ = -1.51 eV ΔE = 0.97 eV λ = hc / ΔE = 1280 nm

20. An endothermic reaction is carried out in a coffee-cup calorimeter. Which one of the following is NOT true for this process?
- a. The temperature of the water decreases.** T
 b. Heat is absorbed by the water. F (absorbed by reactants)
 c. The products have higher enthalpy than the reactants. T
 d. The enthalpy change for the reaction is positive. T
- ΔH = + ΔT = - H_p > H_r

21. Which of the following aqueous solutions are strong electrolytes?
1. HCl(aq)
 2. HClO₂(aq)
 3. NH₃(g)
 4. KCl(aq)
- a) 1 & 4** b) 1, 3, & 4 c) 1, 2, 3, & 4 d) 1, 2, and 4 e) 2 & 4

22. The hybridization of the central carbon in Br₂CCCB₂ is _____
- a. sp** b. sp² c. sp³ d. sp³d e. sp³d²

23. Which compound below has the lowest melting point?
- a) Na₂O b) Na₂S **c) KCl** d) MgS e) CaBr₂

24. Which one of the following would be the most soluble in CCl₄?
- a) H₂O b) NH₃ **c) C₁₀H₂₂** d) CH₃CH₂OH

25. As the concentration of a solute in a solution increases, the freezing point of the solution decreases and the vapor pressure of the solution decreases.

- (D) a. increases, increases
b. increases, decreases
c. decreases, increases
d. decreases, decreases
e. decreases, is unaffected

26. An excess of Mg(s) is added to 100. mL of 0.400 M HCl. At 0°C and 1 atm pressure, what volume of H₂ gas can be obtained?

- a. 0.448 L b. 0.896 L c. 0.0200 L d. 22.4 L STP

$$\text{Mg} + 2\text{HCl} \rightarrow \text{H}_2 + \text{MgCl}_2$$

$$0.100 \text{ L} \times \frac{0.400 \text{ mol HCl}}{\text{L}} \times \frac{1 \text{ mol H}_2}{2 \text{ mol HCl}} \times \frac{22.4 \text{ L}}{\text{mol H}_2} = 0.448 \text{ L}$$

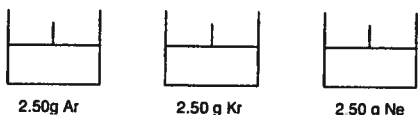
27. The gaseous product of a reaction is collected in a 25.0 L container 27°C. The pressure in the container is 3.0 atm and the gas has a mass of 96.0 g. What is the molar mass of the gas?

- a. 16 g/mole
b. 20.2 g/mole
c. 32 g/mole
d. 56 g/mole

$$MM = \frac{dRT}{P} = \frac{(96.0 \text{ g})}{(25.0 \text{ L})} \times \frac{(0.0821)}{(3.0 \text{ atm})} \times (300. \text{ K}) = 32 \text{ g/mole}$$

Questions 28, 29: Consider three pistons each containing 2.50 g of the gas specified in 2.24 liters measures at 273 K. The pressure is not specified. Assume ideal behavior.

Same temp
Same volume



smallest # of molecules

28. Which is a correct comparison of the contents of the pistons?

- I. The number of molecules in each piston is the same. F
II. The density of the contents of each piston is the same. T
III. The average velocity of all the gas molecules in the pistons are the same. F

- a. II only
b. III only
c. I and II only

Same average KE.

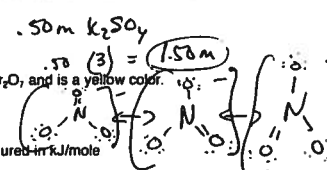
- d. II and III only
e. I, II, and III

Ne Faster!

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II. Identify whether the following statements are TRUE or FALSE

36. PbCl₂ and PbCl₄ follow the law of definite and multiple proportions. **True**
37. There are two sigma and two pi bonds in the molecule N₂H₂. **True**
38. If 10.0 moles of both helium and carbon dioxide is placed in a balloon that has a tiny pin hole in it then after one hour there would be more moles of helium left in the balloon than carbon dioxide. **True**
39. The addition of 31.2 cm plus 1.8 m will equal to 2.12 m. **False** (go to .1)
40. A 0.50 m solution of sodium nitrate will have a lower freezing point than a 0.50 molar solution of potassium sulfate. **True**
41. A solution of sodium dichromate has the formula Na₂Cr₂O₇ and is a yellow color. **True**
42. The nitrate ion has three resonance structures. **True**
43. The units for the standard heat of formation are measured in kJ/mole. **True**
44. Sodium oxide when added to water forms a basic solution whereas diphosphorus pentoxide when added to water will form an acidic solution. **True**



46. Of the following there are three strong electrolytes, two weak electrolytes and one nonelectrolyte.

- HF(aq) weak CuCl₂(s) weak HClO₃(aq) strong CH₃OH(l) nonelectrolyte LiOH(aq) weak CO₂(g) nonelectrolyte

47. Given the following information: C₂H₄(g) + 3 O₂(g) yields 2 CO₂(g) + 2 H₂O(g)
ΔH° C₂H₄(g) = 52.3 kJ/mol
ΔH° CO₂(g) = -393.5 kJ/mol
ΔH° H₂O(g) = -241.8 kJ/mol

a. What is the change in enthalpy for this reaction?

$$\Delta H = [2(-393.5) + 2(-241.8)] - 52.3 \text{ kJ} = -1322.9 \text{ kJ}$$

b. How much heat would be evolved when 220.56 g H₂O were produced?

$$220.56 \text{ g H}_2\text{O} \times \frac{1 \text{ mol H}_2\text{O}}{18 \text{ g H}_2\text{O}} \times \frac{1322.9 \text{ kJ}}{2 \text{ mol H}_2\text{O}} = 16209 \text{ kJ Released}$$

29. Which is a correct comparison of the contents of the pistons?

- (E) a. All have the same pressure because they have the same mass and volume.
b. All have the same pressure because they have the same average kinetic energy.
c. All have the same pressure because noble gases deviate little from ideal behavior.
d. The pressure of the krypton is the greatest because the molecular mass of krypton is the greatest.
e. The pressure of the neon is the greatest because the number of neon molecules is the greatest.

30. The vapor pressure of pure water at 25°C is 23.8 torr. Determine the vapor pressure (torr) of water at 25°C above a solution containing 35 g of urea (a nonvolatile, non-electrolyte, MW = 60.0 g/mol) dissolved in 75 g of water.

Correct →

$$P = \chi_{\text{solvent}} P^\circ$$

$$P = \left(\frac{4.7}{.583 + 4.7} \right) 23.8 \text{ torr} = 4.7 \text{ torr}$$

$$\frac{35 \text{ g urea}}{60 \text{ g urea}} \times \frac{1 \text{ mol urea}}{60 \text{ g urea}} = .583 \text{ moles}$$

$$\frac{75 \text{ g H}_2\text{O}}{18 \text{ g}} \times \frac{1 \text{ mol H}_2\text{O}}{18 \text{ g}} = 4.17 \text{ mol H}_2\text{O}$$

31. Which one of the following substances has dispersion forces as its only intermolecular force?

- a. CH₃OH b. NH₃ c. H₂S d. CH₄

32. A solution is prepared by dissolving 15.0 g of NH₃ in 250 g of water. The density of the resulting solution is 0.974 g/mL. Therefore the molarity of the solution is

- a. 0.0353 b. 0.882 c. 60.0 d. 3.24

$$15.0 \text{ g NH}_3 \times \frac{1 \text{ mol NH}_3}{17 \text{ g}} = 0.882 \text{ mol NH}_3$$

$$M = \frac{0.882 \text{ moles}}{0.272 \text{ L}} = 3.24 \text{ M}$$

$$\text{Total mass of solution} = 15.0 \text{ g} + 250 \text{ g} = 265 \text{ g solution}$$

$$\frac{265 \text{ g}}{0.974 \text{ g/mL}} \times \frac{1 \text{ L}}{10^3 \text{ mL}} = 0.272 \text{ L}$$

33. The substance with the largest enthalpy (heat) of vaporization is

- a. I₂ b. Br₂ c. Cl₂ d. F₂

34. A solution containing 10.0 g of an unknown liquid and 90.0 g water has a freezing point of -3.33°C. Given K_f = 1.86 °C/m of water, the molar mass of the unknown liquid is

- a. 84.2 b. 38.7 c. 62.1 d. 124

$$\Delta T_{\text{fpt}} = K_f m$$

$$3.33^\circ = (1.86 \frac{^\circ\text{C}}{\text{m}}) m; m = 1.79 \text{ m}$$

$$MM = \frac{10.0 \text{ g unknown}}{0.161 \text{ mol}} = 62.1 \text{ g/mole}$$

35.

$$MM = \frac{dRT}{P} = \frac{(96.0 \text{ g})}{(25.0 \text{ L})} \times \frac{(0.0821)}{(3.0 \text{ atm})} \times (300 \text{ K}) = 32 \text{ g/mole}$$

32 g/mole
(Do w/o calc)

45. Ammonia is polar whereas SF₆ is NP due to cancelled dipoles