Avogadro’s Number, \( N_A = 6.022 \times 10^{23} \)

1. [7 points] Given the following mathematical expression:

\[
(15.111 - 15.0)/(2.154 \times 10^3)
\]

How many significant figures should the answer contain?

(a) 1
(b) 2
(c) 3
(d) 4
(e) 5

2. [7 points] What is the empirical formula of lead (IV) sulfide?

(a) \( \text{Pb}_4\text{S} \)
(b) \( \text{LaS}_2 \)
(c) \( \text{PbS}_2 \)
(d) \( \text{Pb(SO}_4)_2 \)
(e) \( \text{PbS}_4 \)

3. [7 points] Which of the following pairs of atoms (ions) have the same number of electrons?

(a) \({}^{65}\text{Zn}^{2+}\) and \({}^{67}\text{Ge}\)
(b) \({}^{87}\text{Sr}^{2+}\) and \({}^{83}\text{Kr}\)
(c) \({}^{16}\text{O}^{2-}\) and \({}^{19}\text{F}\)
(d) \({}^{57}\text{Fe}^{3+}\) and \({}^{57}\text{Fe}^{2+}\)
(e) None of the above pairs have the same number of electrons

4. [7 points] What is the empirical formula of lithium carbonate?

(b) \( \text{LiCO}_2 \)
(c) \( \text{Li}_2\text{CO}_3 \)
(d) \( \text{Li(CO}_3)_2 \)
(e) \( \text{Li}_2\text{CO}_2 \)

5. [7 points] What is the mass of 0.200 gallons (a fifth) of pure ethanol (density = 0.789 \( g/cm^3 \))? [1 gallon = 3.785 Liters]

(a) 9.60 \( \times 10^2 \) g
(b) 651 g
(c) 96 g
(d) 0.597 g  
(e) 597 g

6. [7 points] Which of the following pure substances would you expect to be the best conductor of electricity?

(a) Silicon dioxide  
(b) Dihydrogen sulfide  
(c) Tungsten  
(d) Magnesium chloride  
(e) Silicon

7. [7 points] Which of the following statements is false?

(a) The elements in group 17 are collectively referred to as the halides  
(b) It's possible for two compounds with different empirical formulas to have the same molecular formula  
(c) Indium is a metal  
(d) $^{55}\text{Mn}$ has more neutrons than protons  
(e) If two atoms are isotopes of each other they must have the same number of protons

8. [7 points] What is the mass of 0.075 moles of silver nitrate?

(a) 2.3 kg  
(b) 13 g  
(c) 17 g  
(d) 21 g  
(e) none of the above

9. [7 points] Compositional analysis of an iron pyrite (fool's gold) sample reveals that this compound is 46.5% iron and 53.4% sulfur by mass. What is the empirical formula of iron pyrite?

(a) FeS  
(b) Fe$_2$S$_3$  
(c) FeS$_2$  
(d) Fe$_2$S  
(e) FeS$_3$

10. [7 points] A gaseous sample weighing 0.625 g and containing only carbon and hydrogen was subjected to combustion analysis. The analysis yielded 1.89 g of CO$_2$ and 0.969 g of H$_2$O. What is the empirical formula of this compound?

(a) C$_2$H  
(b) CH$_4$
11. [7 points] Which of the following is the balanced chemical equation that describes the reaction between iron (III) hydroxide and perchloric acid?

(a) \(2 \text{Fe(OH)}_3 (s) + 3 \text{H}_2\text{ClO}_4 (aq) \rightarrow \text{Fe}_2(\text{ClO}_4)_3 (aq) + 6 \text{H}_2\text{O} (l)\)
(b) \(\text{Fe}_3\text{OH} (s) + 3 \text{HClO}_3 (aq) \rightarrow \text{Fe}_3\text{ClO}_3 (aq) + \text{H}_2\text{O} (l)\)
(c) \(\text{Fe(OH)}_3 (s) + 3 \text{HClO}_3 (aq) \rightarrow \text{Fe(ClO}_3)_3 (aq) + 3 \text{H}_2\text{O} (l)\)
(d) \(\text{Fe(OH)}_3 (s) + \text{HClO}_4 (aq) \rightarrow \text{Fe(ClO}_4)_3 (aq) + \text{H}_2\text{O} (l)\)
(e) \(\text{Fe(OH)}_3 (s) + 3 \text{HClO}_4 (aq) \rightarrow \text{Fe(ClO}_4)_3 (aq) + 3 \text{H}_2\text{O} (l)\)

12. [7 points] Given the following balanced chemical equation:

\[4\text{NH}_3(g) + 5\text{O}_2(g) \rightarrow 4\text{NO}(g) + 6\text{H}_2\text{O}(g)\]

Consider the reaction between 16 ammonia (NH\(_3\)) molecules and 25 oxygen molecules. What molecules will remain after the reaction is complete, assuming the reaction goes to completion.

(a) 4 molecules \(\text{NH}_3\) + 20 molecules \(\text{NO}\) + 30 molecules \(\text{H}_2\text{O}\)
(b) 5 molecules \(\text{O}_2\) + 16 molecules \(\text{NO}\) + 24 molecules \(\text{H}_2\text{O}\)
(c) 20 molecules \(\text{O}_2\) + 16 molecules \(\text{NO}\) + 24 molecules \(\text{H}_2\text{O}\)
(d) 16 molecules \(\text{NO}\) + 24 molecules \(\text{H}_2\text{O}\)
(e) 20 molecules \(\text{NO}\) + 30 molecules \(\text{H}_2\text{O}\)

13. [7 points] A 1.32 g sample of calcium carbonate reacts with an excess of hydrochloric acid to form calcium chloride, carbon dioxide and water. The \(\text{CO}_2\) produced in this reaction is collected and its weight is found to be 0.534 g. What is the percent yield of carbon dioxide?

(a) 92.1%  
(b) 46.0%  
(c) 40.4%  
(d) 86.5%  
(e) 109%

14. [7 points] What is the molarity of the solution formed when 9.5 g of potassium chloride is dissolved in water to make 250 mL of solution?

(a) 0.13 M  
(b) 0.51 M  
(c) 0.031 M  
(d) 38 M  
(e) 0.57 M
15. [7 points] What is the concentration of the solution which results when 60.0 mL of 0.84 M KI solution is mixed with 30.0 mL of 1.44 M KI solution?

(a) 1.36 M  
(b) 0.844 M  
(c) 1.04 M  
(d) 1.24 M  
(e) 0.995 M

16. [7 points] What is the oxidation state (oxidation number) of chlorine in sodium hypochlorite?

(a) +3  
(b) -1  
(c) +7  
(d) +5  
(e) +1

17. [7 points] Which of the following substances is a weak electrolyte?

(a) CO₂  
(b) Zn(NO₃)₂  
(c) H₂SO₄  
(d) NH₃  
(e) None of the above substances are weak electrolytes.

18. [7 points] Which of the following metals will be oxidized by hydrochloric acid?

(a) zinc  
(b) nickel  
(c) silver  
(d) both (a) zinc and (b) nickel will be oxidized by hydrochloric acid  
(e) none of the above metals will be oxidized by hydrochloric acid

19. [7 points] What will be the outcome of the following two steps:

I. First 5.0 L of 1.0 M barium hydroxide solution and 8.0 L of 1.0 M hydrochloric acid solution are mixed in beaker A.
II. Next 12.0 L of 1.0 M zinc nitrate solution is added to beaker A.

(a) No precipitate will form, but the solution will be strongly acidic  
(b) No precipitate will form, but the solution will be strongly basic  
(c) A white precipitate will form, and the solution will be neutral  
(d) A white precipitate will form, and the solution will be strongly acidic  
(e) A white precipitate will form, and the solution will be strongly basic
For the next three problems consider the two solutions (A and B) below.

**Solution A**  
Solute = Silver Nitrate  
Volume = 50.0 mL  
Concentration = 1.50 M

**Solution B**  
Solute = Sodium Carbonate  
Volume = 85.0 mL  
Concentration = 1.00 M

20. [7 points] If solutions A and B are mixed together what is the identity of the precipitate that forms?

(a) AgNO₃  
(b) NaNO₃  
(c) Ag₂CO₃  
(d) AgCO₃  
(e) No precipitate is formed

21. [7 points] If you mix the two solutions together what is the theoretical yield of the precipitate?

(a) 10.3 g  
(b) 23.4 g  
(c) 20.6 g  
(d) 103 g  
(e) No precipitate is formed

22. [7 points] After mixing the two solutions together and removing the precipitate which ions are still present in solution?

(a) Ag⁺, Na⁺ and NO₃⁻  
(b) Na⁺ and NO₃⁻  
(c) CO₃²⁻, Na⁺ and NO₃⁻  
(d) Ag⁺, CO₃²⁻, Na⁺ and NO₃⁻  
(e) No ions remain in solution

23. [7 points] Which of the following equations is the correct balanced net ionic equation for the reaction between copper (II) bromide solution and potassium hydroxide solution.

(a) Cu₂Br (aq) + KOH (aq) → Cu₂OH (s) + KBr (aq)  
(b) CuBr (aq) + KOH (aq) → CuOH (s) + KBr (aq)
(c) $\text{CuBr}_2 (aq) + 2\text{KOH (aq)} \rightarrow \text{Cu(OH)}_2 (s) + 2\text{KBr (aq)}$
(d) $\text{Cu}^+ (aq) + \text{OH}^- (aq) \rightarrow \text{CuOH (s)}$
(e) $\text{Cu}^{2+} (aq) + 2\text{OH}^- (aq) \rightarrow \text{Cu(OH)}_2 (s)$

24. [7 points] Which of the following reactions is an example of an oxidation-reduction reaction?

(a) $\text{NaBr (aq)} + \text{AgNO}_3 (aq) \rightarrow \text{AgBr (s)} + \text{NaNO}_3 (aq)$
(b) $\text{Mg (s)} + \text{AgNO}_3 (aq) \rightarrow \text{Ag (s)} + \text{Mg(NO}_3)_2 (aq)$
(c) $\text{HClO (aq)} + \text{NaOH (aq)} \rightarrow \text{H}_2\text{O (l)} + \text{NaClO (aq)}$
(d) $\text{NH}_3 (aq) + \text{HCl (aq)} \rightarrow \text{NH}_4\text{Cl (aq)}$
(e) None of the above reactions are oxidation-reduction reactions

25. [7 points] How many protons are found in a $^{23}\text{Na}^+$ ion?

(a) 10
(b) 11
(c) 12
(d) 23
(e) none of the above