1) Which of the following reactions is not classified correctly?

1. $\text{NaOH (aq)} + \text{HCl (aq)} \rightarrow \text{H}_2\text{O(l)} + \text{Cl}^-\text{(aq)}$ is both a Bronstead Lowry Acid Base and a precipitation (ppt) reaction.

2. $\text{CH}_3\text{OH(g)} + \text{O}_2\text{(g)} \rightarrow \text{CO}_2\text{(g)} + \text{H}_2\text{O(g)}$ is a combustion and a redox reaction.

3. $\text{NH}_4^+\text{(aq)} + \text{H}_2\text{O(l)} \rightarrow \text{NH}_3\text{(aq)} + \text{H}_3\text{O}^+\text{(aq)}$ is a Bronstead Lowry Acid Base Reaction.

4. $\text{Na(s)} + \text{Cl}_2\text{(g)} \rightarrow \text{NaCl(s)}$ is a redox and a ppt reaction.

5. All the reactions are classified correctly.

2) What is the net ionic equation for the two reactions respectively?

I. $2 \text{AgNO}_3\text{(aq)} + \text{BaCl}_2\text{(aq)} \rightarrow 2 \text{AgCl(s)} + \text{Ba(NO}_3\text{)}_2\text{(aq)}$

II. $2 \text{HNO}_3\text{(aq)} + \text{Ca(OH)}_2\text{(aq)} \rightarrow 2\text{H}_2\text{O(l)} + \text{Ca(NO}_3\text{)}_2\text{(aq)}$

1. $\text{Ba}^{2+}\text{(aq)} + 2 \text{NO}_3^-\text{(aq)} \rightarrow \text{Ba(NO}_3\text{)}_2\text{(aq)} : \text{H}^+\text{(aq)} + \text{OH}^-\text{(aq)} \rightarrow 2 \text{H}_2\text{O (l)}$

2. $2 \text{Ag}^+\text{(aq)} + 2\text{Cl}^-\text{(aq)} \rightarrow 2 \text{AgCl(s)} : \text{Ca}^{2+}\text{(aq)} + 2 \text{NO}_3^-\text{(aq)} \rightarrow \text{Ca(NO}_3\text{)}_2\text{(aq)}$

3. $\text{Ag}^+\text{(aq)} + \text{Cl}^-\text{(aq)} \rightarrow \text{AgCl(s)} : \text{H}^+\text{(aq)} + \text{OH}^-\text{(aq)} \rightarrow \text{H}_2\text{O (l)}$

4. $\text{Ba}^{2+}\text{(aq)} + 2 \text{NO}_3^-\text{(aq)} \rightarrow \text{Ba(NO}_3\text{)}_2\text{(aq)} : \text{Ca}^{2+}\text{(aq)} + 2 \text{NO}_3^-\text{(aq)} \rightarrow \text{Ca(NO}_3\text{)}_2\text{(aq)}$

5. None of the Above are correct.
3) An inorganic chemist is researching the crystal field theory and is using Copper (II) Sulfate in her research. She goes to the analytical balancer and measures out 29.34 grams of Copper (II) Sulfate. How many oxygen atoms are within the 29.34 g sample?

1) 6.022*10^{23}
2) 3.011*10^{23}
3) 4.3*10^{23}
4) 8.6*10^{23}
5) None of the Above

4) The compound (X) contains 49.48 % carbon, 5.191 % hydrogen, 28.87 % nitrogen, and 16.48% oxygen by mass. Additionally, X’s molecular weight lies between the domain of Compound Y’s MW and Compound Z’s MW. If MWY = 188 g/mol and MWZ = 200 g/mol. Determine the molecular formula of the compound.

1) C_4H_5N_2O  2) C_8H_10N_4O_2  3) C_8H_8N_3O_3  4) C_{10}H_7N_5O_2  5) C_8H_{10}N_2O
5) Which of the following reactions are redox reactions?

   I. \( \text{Ca(s)} + \text{CO(g)} \rightarrow \text{CaCO_3(s)} \)
   II. \( \text{Cl}_2(aq) + 2\text{KI(aq)} \rightarrow \text{I}_2(s) + 2\text{KCl(aq)} \)
   III. \( \text{CO}_2(g) + \text{O}_2(g) \rightarrow \text{CO}_2(g) + \text{H}_2\text{O(g)} \)

1) I only
2) II only
3) I, and II only
4) III only
5) All three are redox

6) Iron (III) Chloride is used in sewage to remove contaminants in water. Suppose an analytical chemist is trying to research the effects Iron (III) Chloride has on dirty water. First, he needs to make a sample of Iron (III) Chloride by reacting solid iron with chlorine gas. Suppose he has 6 grams of solid iron and 8 grams of chlorine gas. What is the excess reagent and how much will be left over?

1. Cl\(_2\); 2.13 g left over
2. Cl\(_2\); 4.23 g left over
3. Cl\(_2\); 0.0756 g left over
4. Fe; 4.73 g left over
5. Fe; 1.78 g left over
7) Suppose a small bottle of ethanol (CH₃CH₂OH) is combusted in a lab to form carbon dioxide and water vapor. The amount of ethanol found in the bottle was calculated to be 4.20g. However, after the reaction, only 70% of the ethanol reacted properly. How much CO₂ gas was produced?

1) 8.02g
2) 0.70g
3) 46.07 g
4) 44.01 g
5) 5.62 g

8) Which of the following acids and conjugate acids ARE CORRECTLY underlined?

1. HCl (aq) + NaOH (aq) \(\rightarrow\) H₂O(l) + Cl⁻ (aq)
2. HNO₃ (aq) + H₂O(l) \(\rightarrow\) H₃O⁺ (aq) + NO₃⁻ (aq)
3. H₃PO₄ (aq) + NH₃ (aq) \(\rightarrow\) NH₄⁺ (aq) + H₂PO₄⁻ (aq)
4. H₂CO₃ (aq) + Mg(OH)₂ (aq) \(\rightarrow\) HCO₃⁻ (aq) + H₂O(l)
5. None of the Above
9) Suppose in organic chemistry, an ethyl group (C₂H₅) is burned in a calorimeter. However, when the reaction was occurring, the oxygen gas in the fuel tank used had only a small amount (6 grams) of oxygen gas left. Additionally, suppose that a 3 gram ethyl sample was burned. How much energy could be produced from the reaction given that the balanced reaction is:

\[
2 \text{C}_2\text{H}_5 (g) + 5 \text{O}_2 (g) \rightarrow 4 \text{CO}_2 (g) + 2 \text{H}_2\text{O} (g) \quad \Delta H = -2510 \text{ kJ}
\]

1) 94.1 kJ
2) 129.56 kJ
3) 25.00 kJ
4) 2510 kJ
5) None of the above

10) Which of the following is NOT true

1. If a reaction requires energy, the reaction is endothermic
2. If a reaction produces energy, the reaction is exothermic
3. If a reaction is endothermic, the reaction must obtain energy from an external source
4. All combustion reactions are exothermic
5. All of the above are true
11) Suppose a 2 gram chunk of silver and a two gram chunk of gold are heated from 25°C to 100°C. Additionally, both chunks of metal are placed in two separate tanks of water. The water in both tanks have a temperature of 25°C. Once the metals are placed in their tanks, will the temperature of the water increase or decrease? Additionally, which metal will cause the greater temperature change?

1) Temperature of water will increase; Gold
2) Temperature of water will decrease; Gold
3) Temperature of water will decrease; Silver
4) Temperature of water will increase; Silver
5) The temperature will stay the same due to the water and the metal having the same initial temperature.

Questions 12 – 14 will be based on the paragraph and reaction below.

Blackpowder (black gunpowder) was first invented in China during 850 A.D. It was first weaponized by the Ottomans in 1350 through the use of cannons. It remained the only known chemical explosive up until 1884, when Paul Vieille invented the first successful form of smokeless powder. The ignition of gunpowder creates gases which propel the projectile forward. A simplified balanced equation for the ignition of gunpowder is seen below.

\[
6 \text{KNO}_3 + 7\text{H}_2\text{O}_4 + 2\text{S} \rightarrow \text{K}_2\text{CO}_3 + \text{K}_2\text{SO}_4 + \text{K}_2\text{S} + 4\text{CO}_2 + 2\text{CO} + 2\text{H}_2\text{O} + 3\text{N}_2
\]

Additionally, the mass proportions by weight of gunpowder are 75% potassium nitrate (known as saltpeter or saltpeter), 15% softwood charcoal (C\text{H}_4\text{O}), and 10% sulfur.
12) Now, suppose a soldier of the 69th New York Volunteer Infantry fires a cartridge from his issued US Model 1842 Musket during the battle of Gettysburg. Additionally, the average cartridge holds approximately 8.42 grams of black powder. Given this information, what is the maximum amount of Carbon Dioxide gas capable of being produced after ignition?

1. 3.47 g  
2. 1.65 g  
3. 2.14 g  
4. 1.52 g  
5. None of the Above

13) The main problem with black powder is that it is corrosive and firing blackpowder produces water which if left unattended will corrode the inside of the gun barrel. Suppose that a private of the 75th Ohio Mounted Infantry fires his Model 1861 Springfield during the Battle of Gainesville which occurred on August 17th 1864. After the battle the private forgets to clean his rifle. Suppose he fired a total of fifteen cartridges during the battle. Assuming that all the cartridges have excess saltpeter, and each cartridge holds approximately 1.263 g charcoal and 0.842 g sulfur, what is the maximum amount of water that could be in the barrel?

1. 6.56g  
2. 7.09 g  
3. 7.10g  
4. 8.33g  
5. None of the Above
14) Now, suppose that the soldier went to clean his rifle after the battle and that some of the water evaporated due to the heat in Florida. Suppose that only 5.23g of water was present in the barrel. With this information, what is the percent yield of the water from the ignition?

1. 80%
2. 74%
3. 66%
4. 63%
5. None of the Above

15) The Citric Acid Cycle is a fundamental biochemical reaction used by all aerobic organisms where stored energy is released through the oxidation of acetyl-coA. This cycle consists of ten different steps. The very first step of the citric acid cycle is called citrate synthase. Here, acetyl-coA undergoes a type of reaction called Claisen Condensation with oxaloacetate and water. The reaction produces a substance called citrate. The reaction for citrate synthase is shown below.

\[ \text{C}_2\text{H}_3\text{N}_7\text{O}_{17}\text{P}_3\text{S} + \text{C}_4\text{H}_4\text{O}_5 + \text{H}_2\text{O} = \text{C}_{21}\text{H}_{36}\text{N}_7\text{O}_{16}\text{P}_3\text{S} + \text{C}_6\text{H}_8\text{O}_7 + 32.2\text{kJ/mol} \]

Given the equation, what is true about this reaction?

1. The rxn is endothermic and delta H will be negative.
2. The rxn is endothermic and delta H will be positive.
3. The rxn is exothermic and delta H will be negative.
4. The rxn is exothermic and delta H will be positive.
5. The rxn is endothermic and delta H will be zero
16) How many electrons does the oxidizing agent get reduced by in the following reaction?

KClO₃ (aq) + HBr (aq) → Br₂ (g) + H₂O(l) + KCl (aq)

1) 1
2) 3
3) 5
4) 7
5) 10

17) Which of the following are true? Select the answer that has all the correct options

a. % yield = (\frac{\text{actual}}{\text{theoretical}}) * 100

b. The theoretical yield exists only on paper (i.e. it never truly exists)

c. If you have two different values of reactants, the limiting reactant’s product value is the actual value and the excess reactant’s product value is the theoretical

d. A 100% percent yield is possible to obtain

1. a, b, and d only
2. a, b, and c only
3. a and c only
4. all of the above
5. none of the above
18) What is the sum of the coefficients when the reaction is fully balanced?

\[ \text{C}_3\text{H}_8 (\text{g}) + \text{O}_2 (\text{g}) \rightarrow \text{CO}_2 (\text{g}) + \text{H}_2\text{O (g)} \]

1) ten  
2) eleven  
3) twelve  
4) thirteen  
5) None of the Above

19) Which of the following is true?

1) The balanced equation of Ag$_2$SO$_4$ (aq) + AlCl$_3$ (aq) \(\rightarrow\) AgCl (s) + Al$_2$(SO$_4$)$_3$ (aq) is

\[ \text{Ag}_6(\text{SO}_4)_3 + \text{Al}_2\text{Cl}_6 \rightarrow \text{Ag}_6\text{Cl}_6 + \text{Al}_2(\text{SO}_4)_3 \]

2) The subscripts in a balanced equation tells how many atoms of an element there are per molecule of compound, ions there are per unit of salt, and mols of element/ion per mol of compound.

3) There are three mols of nitrate and three moles of oxygen in Iron (III) Nitrate

4) There are \(6.022 \times 10^{23}\) mols per 1 atom of matter

5) In balancing an equation, you can add additional compounds to the reaction to balance the reaction out.
20) Which of the following compounds would form an insoluble compound when reacted with NaCl in aqueous solution?

1. Al₂(SO₄)₃
2. KBr
3. Fe(NO₃)₃
4. Pb(NO₃)₂
5. Cu(OAc)₂ (Copper (II) Acetate)

GOOD LUCK, SMILE ON THE EXAM, and remember to love your moles: all 6.022*10²³ of them!

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