Name _____ **Date** _____ **Period** _____

Partners_____ _____ _____

Blueprint Lab

Background: The blueprint process was developed by a British astronomer and photographer in 1842. The photosensitive compound, a solution of ammonium ferric citrate and potassium ferricyanide, is coated onto paper. Areas of the compound exposed to ultraviolet light are converted to insoluble blue ferrocyanide. The soluble chemicals are washed off with water leaving a light-stable print. These prints are also called Cyanotypes.

Pre Lab Questions

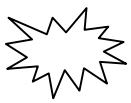
1. The compounds used in this lab contain many polyatomic ions. Find the oxidation number of each element in each of the following polyatomic ions.

Name	Formula	Oxidation number	Oxidation number	Oxidation number
Citrate ion	$C_6H_5O_7^{-3}$	C	H	0
Cyanide ion	CN^{-1}	C	N	
Ammonium ion	NH_4^{+1}	N	H	
Ferric cyanide ion	$[Fe(CN)_6]^{-3}$	Fe	C	N
Ferro cyanide ion	$[Fe(CN)_6]^{-4}$	Fe	C	N

2. The Alkali metal potassium is present in one of the reactants and one of the products in this lab What is the oxidation number of potassium in an ionic compound? _____ Why? _____
3. The chemical formula for Potassium Ferric Cyanide is $K_3Fe(CN)_6$ Using the values for the oxidation number of K^+ and $[Fe(CN)_6]^{-3}$ ions, find the oxidation number for Fe in this compound. _____
4. The chemical formula for Ammonium Ferric Citrate is $Fe(NH_4)_3(C_6H_5O_7)_2$. Knowing that you have 3 NH_4+1 and 2 $C_6H_5O_7^{-3}$ ions, what must the oxidation number of Fe be in this compound? _____
5. One of products of the reaction in this lab is Potassium Ferric Ferro cyanide, $KFe[Fe(CN)_6]$ The two irons in the compound each have a different oxidation number. Use the oxidation number of the Fe in the **Ferro** cyanide ion $[Fe(CN)_6]^{-4}$ that you found in question #1. Determine the oxidation number of the other Iron by making sure the sum of all the oxidation numbers in the compound is equal to zero. Write the values in the table below.
6. The other two products are Carbonic Acid and Ammonia. Find the oxidation number of all elements in these compounds. Write the value of the oxidation numbers in the table below.

Name	Formula	Oxidation number	Oxidation number	Oxidation number	Oxidation number	Oxidation number
Potassium Ferric Ferro cyanide	$KFe[Fe(CN)_6]$	K	Fe	Fe	C	N
Carbonic Acid	H_2CO_3	H	C	0		
Ammonia	NH_3	N	H			

7. The overall unbalanced equation for the reaction used in this lab is:



$$\mathbf{K_3[Fe(CN)_6] + Fe(NH_4)_3(C_6H_5O_7)_2 \rightarrow KFe[Fe(CN)_6] + H_2CO_3 + NH_3}$$

Write in the oxidation number for all elements in the equation. Underline the elements with oxidation numbers that change.

Procedure

Day 1

1. Make sure classroom lights are off and blinds are closed.
2. Prepare each solutions in separate beakers
   1. Solution A 10% potassium ferric cyanide (1.0 g in 10.0 ml distilled H_2O)
   2. Solution B 10% Ammonium Ferric citrate (1.0 g in 10.0 ml distilled H_2O)
3. Write your name and period on the back of a sheet of white paper & on the outside of a folder.
4. Mix the 10 ml of each solution in one of the two beakers.
5. Using a paintbrush, carefully coat one side of the white paper with the solution mixture.
6. Store the treated paper in a folder in a dark place to dry.
7. Prepare a stencil or a leaf that will fit on your coated paper.

Day 2

1. Retrieve your folder with your blue print paper and be careful to avoid exposing it to light.
2. Quickly place your stencil and a piece of plastic over the treated paper. Recover the treated paper with your folder.
3. Walk downstairs, keeping the treated paper covered.
4. Expose the blueprint paper with stencil and plastic sheet to the sunlight for 10 minutes.
5. Cover the treated paper with the folder again to stop exposure and return to the classroom.
6. Quickly and thoroughly rinse the solutions off of the treated paper.
7. Allow paper to dry in the open air.
8. Staple your dried blueprint to your completed lab questions.

Post Lab Questions

1. Iron ions can have a charge of either +2 or +3.
   What is the name for the Fe^{+2} ion? _____ What is the name for the Fe^{+3} ion? _____
2. What is the oxidation number for the Fe in the **Ferric** cyanide ion? _____
3. What is the oxidation number for the Fe in the **Ferro** cyanide ion? _____
4. Oxidation is an _____ in oxidation number and a _____ of electrons
5. Reduction is a _____ in oxidation number and a _____ of electrons.
6. Identify this half reaction as either oxidation or reduction and provide and explanation.

   Ferric cyanide ion → Ferro cyanide ion

   $[Fe(CN)_6]^{-3} + e^- \rightarrow [Fe(CN)_6]^{-4}$

   $Fe^{+3} + e^- \rightarrow Fe^{+2}$
7. Identify this half reaction as either oxidation or reduction and provide and explanation.

   Citrate ion → Carbonic Acid

   $C_6H_5O_7^{-3} \rightarrow H_2CO_3 + 3e^-$

   $C^{+1} \rightarrow C^{+4} + 3e^-$
8. What reactant is oxidized? _____What reactant is reduced? _____
9. What is the oxidizing agent? _____What is the reducing agent? _____
10. In the overall equation for the reaction (see pre-lab question #6), the oxidation number of the potassium ion and the oxidation numbers of the elements in the cyanide ion do not change. What do we call ions that do not participate in the reaction? _____
11. The blueprint should develop as well on a cloudy day as on a clear day. Explain.

12. Insufficient washing of exposed blueprints or of developed photographic film results in a slow deterioration of their images. Explain.

13. Why do you think blueprints were originally called cyanotypes?