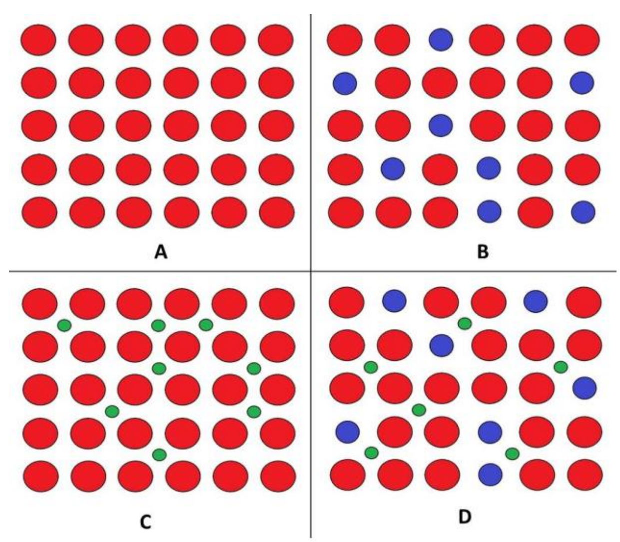
Transition Metals Lab; SC4 ab; SC5 bc 

The d-block transition metals have great importance in our lives. The d-block simply means that the elements' d-orbitals are the last to get occupied according to the Aufbau principle. The transition metals give off electrons from their outer s orbital, but most can lose a multiple number of d orbital electrons. Because of this many of the d-block metals have multiple oxidation numbers. A good example is copper which has two common oxidation states +1 and +2. In essence, the physical properties of these metals depend on the number of unpaired electrons in the d-block. Transition metals, for the most part, are good conductors. They are also malleable, ductile, lustrous, and sliver-white in color. Metals have another great characteristic, they easily mix. This is because all the d-block metals have about the same atomic size. This allows them to replace one another easily in a crystal lattice. When two or more metals mix, or replace one another, we call the new metal an alloy. Brass is a good example of an alloy, which comes from copper and zinc combined. Another notable characteristic of these metals is that they can act as catalysts and this activity is ascribed to their ability to adopt multiple oxidation states and to form complexes. Recall that we added manganese II oxide to the exploding pumpkin demonstration to speed up the evolution of pure oxygen gas. Lastly, these metals also exhibit varying degrees of magnetism, and again, this amazing property is predicated on the number of unpaired electrons. The purpose of this lab is to explore the various chemical and physical properties of the transition metals. During this lab we will explore the concept of metal alloys and also the ability of these metals to respond to a magnetic field. Remember to always read before you proceed.

Part 1: Penny Alloy- Read through entire procedure before starting the this section and create a data table suitable for the qualitative data that you will assimilate during this section of the lab.

Procedures: Obtain a penny that is dated on or before 1981. Place the penny in a beaker at your station containing 3M HCl for approximately five minutes. This will remove the outer oxidation layer. Record your observations. Remove the penny from the HCl using forceps and place it in a clean, dry 150 mL beaker. Add 40 mL of 6M NaOH and 1 small scoop of powdered zinc to the beaker and stir. Place the beaker on a hotplate and heat to a near boil. DO NOT BOIL. Continue heating until you have "plated" the penny with zinc. Remove the penny with forceps and transfer it to a beaker with cold tap water. This will cool and rinse the penny of excess zinc. Record your observations. Obtain some crucible tongs and ignite a Bunsen burner. Use the tongs to heat the penny (both sides) above the flame for no more than 20 seconds, or until you notice the color change. Immediately remove the penny once the color has changed and place it back into a beaker with cold tap water. Closely examine the penny and record your observations. Clean up according to Flinn safety protocol #27B and dispose chemicals with copious amounts of water. Flip the penny to see who gets to keep it.

Part 1: Post Lab Questions: (this section should come directly after the qualitative data)



1. Compare the color of the penny after each step. What common metals do these colors resemble?

2. What are the distinguishing characteristics of a metal alloy? Differentiate between interstitial and substitutional alloys and create an analogy to describe each type? Which type of alloy do you think was created in this lab?

3. Examine the schematic diagram to the right. Based on your answers for #2, label letters A-D.

3. Is making an alloy a chemical or physical change? Justify your response.

4. Described how metallic bonds are formed and be sure to describe the movement of electrons.

5. Let's consider the chemical reaction and equation for this lab. Zincate $(ZnO_2)^{2-}$ is a polyatomic ion that was a constituent of a product in the chemical reaction that occurred today. Using your knowledge of chemical bonding and chemical reactions, write the balanced equation for this section of the lab. Recall that we added zinc to sodium hydroxide for the first part of this lab. What were the products?

Part 2: Magnetism- This portion of the lab is designed to introduce, or reinforce, the properties of electron configuration. The molecular property of magnetism can be observed when a substance is placed in a magnetic field. The magnetic property of a substance is the result of its electronic configuration. Moving electrons create a magnetic field. The substance will either be attracted to the magnetic field, which is known as paramagnetism, or repelled by the magnetic field, which is a property known as diamagnetism. Paramagnetism indicates the presence of unpaired electrons whereas diamagnetism indicates that all of the electrons are paired. However, this can only occur at the "valence electron shell" level. Transcribe the data table above before moving on.

COMPOUND	# OF UNPAIRED ELECTRONS	+/- BALANCE READING IN GRAMS	PARA- OR DIA-	ATTRACTED OR REPELLED
Cobalt (II) chloride		grams		
Copper (II) chloride		grams		
Iron (II) chloride		grams		
Manganese (II) chloride		grams		
Nickel (II) chloride		grams		
Zinc chloride		grams		

Procedures: This part of the lab will be completed as a demonstration under the document camera.We will be using an extremely accurate instrument called an analytical balance. This balance is accurate to the $1/10{,}000^{th}$ of a gram. Before the demonstration, you will need to fill in the "unpaired electrons" column and also make predictions for the specific type of magnetism (para- or dia-).

Part 2: Post Lab Questions:

1. Prepare a graph plotting the balance reading in grams vs. the number of unpaired electrons in it orbital notation. What conclusion can you draw from the graph?

2. The element chromium has three common oxidation states, Cr^0, Cr^{3+}, Cr^{6+} Write the short electron configuration with orbital diagrams for all three states of chromium. Recall the exception for Cr^0.

3. One of the scientific principles applied when writing orbital notations is Hund's rule. Hund's rule states that "the most stable arrangement of electrons is that with the maximum number of unpaired electrons, all with the same spin direction." Explain briefly how your experiment supports Hund's rule?

4. How would our experimental results be different if electrons did not fill sublevels according to Hund's rule? That is, if each orbital was filled with a pair of electrons in order rather than first filling the sublevel with single electrons as now required.

5. Another important rule applied when writing electron configurations is the Pauli Exclusion Principle, "no two electrons can have the same set of four quantum numbers." How would our results be different if all electrons had the same magnetic spin quantum number (m_s)?