DAQRI

ELEMENTS 4D™

CHEMISTRY LESSON PLAN

MIDDLE SCHOOL (Grades 6-8)

4D in the Classroom: A Whole New Way of Learning

WHAT IS 4D?

4D combines augmented reality and other technologies to create a new communication medium. 4D doesn't just superimpose a digital image: it intersperses your view of the real world with seamless, spatially in-context imagery and information in real-time, wherever you are. 4D creates an interactive and digitally manipulable world. 4D creates whatever you can imagine.

To discover more about the world of 4D, visit DAQRI.com.

4D Empowers Classroom Learning

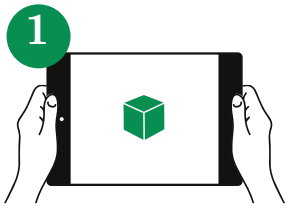
Educators have the opportunity to provide relevant, immersive learning experiences in 4D on just about every classroom topic and drive knowledge-transfer to their students. Thanks to its intuitive form and interactive functionality, 4D has massive potential to transform the way we learn, both inside and outside the classroom.

For example, Elements 4D is a 4D Experience™ supercharging the chemistry classroom. Elements 4D is a set of interactive blocks that help students learn the Periodic Table by showing how elements combine into new chemical substances, what the reactions look like, and the resulting chemical equation.

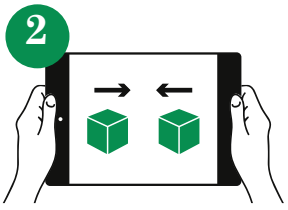
Similarly, students from grade school to grad school are able to explore the human body with Anatomy 4D, an app from DAQRI that enables interactive learning even beyond what's possible in a medical lab.

With 4D, students can interact with spatial, geometric models in math class, perform interactive dissections on a 3D model of a frog as though a real frog were sitting on the lab table in front of them and much more. Teachers and students can now create their own 4D Experience™, tailored to the classroom, with the help of DAQRI 4D Studio for Education.

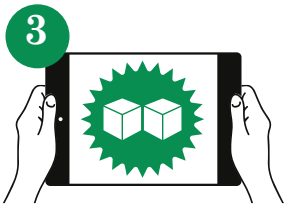
HOW ELEMENTS 4D WORKS



See the elements in 4D
Download and open the Elements 4D app and point your device at the block face illustrating the element you want to view.



Combine Two Elements
Next, introduce a second element. Move the two blocks together until they touch.



Marvel at the Reaction You've Created!
If nothing happens, those elements don't combine. Try another combination.

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ABOUT DAQRI

DAQRI is a global technology leader that is fundamentally transforming the way people deliver and interact with information through a powerful new medium, 4D. An innovator in computer vision, DAQRI's industry-leading software and hardware set the standard for the next generation in industrial, storytelling, and educational technologies.

DAQRI is headquartered in Los Angeles with an R&D center in Mountain View, California and sales offices in New York, Chicago, Boston, Detroit, Atlanta, San Antonio, and Minneapolis. For more information, visit DAQRI.com.

ACKNOWLEDGEMENTS

This lesson plan was made possible by the DAQRI Education team, as well as the thoughtful contributions of educators Ashlie Smith, Lori Green, and Jessica Lupone. We thank them for lending us their stellar expertise!

Lessons align to Common Core State Standards and Next Generation Science Standards.

Discover

What is augmented reality? How does it work? What do elements look like? How are they named?

LESSON 1

Discovering the Elements

50 MIN

Learning Objectives

STUDENTS WILL BE ABLE TO

Identify, spell, and list the properties of the thirty-six elements from the Periodic Table using the Elements 4D blocks.

MATERIALS

Six Elements 4D blocks, *Discovering the Elements* worksheet

VOCABULARY

atom, element, properties, states of matter, metal, non-metal, metalloid

STANDARDS

These lessons (1-3) align with the following Next Generation Science Standards.

PS1.B: Chemical Reactions (Middle School (6-8))
Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants. (MS-PS1-2), (MS-PS1-5) (Note: This Disciplinary Core Idea is also addressed by MS-PS1-3).

The total number of each type of atom is conserved, and thus the mass does not change. (MS-PS1-5)

Some chemical reactions release energy, others store energy. (MS-PS1-6)

Science Knowledge Is Based on Empirical Evidence (Middle School (6-8))

Science knowledge is based upon logical and conceptual connections between evidence and explanations. (MS-PS1-2)

Exercise 1

STEP 1 **INTRODUCTION (15 MIN)**

What does it mean to be a scientist? Discuss the nature of inquiry and discovery. Introduce the term atom, the building block of the universe, and how elements are specific atoms with unique properties. Define properties and how they help identify elements. The state of matter, color, luster and volume allow scientists to classify and group elements. Use this time to also discuss where metals, non-metals and metalloids are located on the Periodic Table.

STEP 2 **PRE-ACTIVITY (5 MIN)**

Augmented reality uses two-dimensional trigger images to activate video or coded moving images. Have students experiment with the Elements 4D blocks for a few minutes to understand how the Elements 4D app works and how to scan the blocks. Show students how you can hold the blocks in your hand or place on the desk. Only one block should be scanned at a time for this activity (See *Discovering the Elements* worksheet).

STEP 3 **ACTIVITY (25 MIN)**

Divide the students into pairs to investigate the thirty-six element block faces. Have students use the **Discovering the Elements worksheet** to list the name of the element, location on the Periodic Table, color of the sample and state of matter. The teacher should make note of the conversations students will be having with their partners.

STEP 4 **WRAP-UP (5 MIN)**

Create a class chart of student-pair findings. Ask students to obtain three highlighters to identify the metals from the non-metals and metalloids. Are there any similarities with the metals besides their location in the Periodic Table? What about the non-metals and metalloids?

Have students begin piecing together clues on which elements may want to bond together based upon their electron configuration and geographic location on the Periodic Table. Continue a discussion on valence electron patterns and chemical bonding before beginning Lesson 2.

EXTENSION ACTIVITY:

Students become an expert on a particular element by researching the history, characteristics and uses of that element in the real world. If time, consider viewing NOVA: Hunting the Elements with your students.

NAME: ______________________

DISCOVERING THE ELEMENTS WORKSHEET

DATE: ______________________

Name of Element	Location on the Periodic Table	Color	State of Matter	Additional Information

Discover

Why do elements react with other elements? What causes some elements to react violently, yet others to not react at all?

LESSON 2

Valence Electrons & Chemical Reactions

50 MIN

Learning Objectives

STUDENTS WILL BE ABLE TO

Identify how many valence electrons an atom has using the group number of the element and will determine that atoms that share valence electrons create new compounds in chemical reactions.

MATERIALS

Six Elements 4D blocks, Post-it notes, Periodic Tables, *Valence Electrons Patterns* worksheet

VOCABULARY

chemical reaction, valence electrons, electron, proton, atomic number

BACKGROUND INFO FOR TEACHERS

Atoms naturally want to be stable. In order to become stable, they have to either give away or take away electrons in their outermost layer in order to bond to other atoms. These electrons are called "valence electrons," and the process in which these electrons are shared is called a chemical reaction. Atoms that have only a few electrons in their valence shell tend to give away electrons, and elements that have a nearly full valence shell tend to take away electrons. Either way, when these electrons are shared, new compounds are formed with different chemical and physical properties.

Students need to know how to find the number of electrons an atom has using the Periodic Table. Elements listed on the Periodic Table are typical atoms of each element, and so, these atoms have the same number of electrons as protons—which is the same as the element's atomic number. However, it might be helpful to point out that atoms aren't always as found on the Periodic Table; atoms can form ions, meaning they can have extra or fewer negative charges (electrons). The number of protons (positive charges) never changes, only the number of negative charges to create either an overall positively-charged atom or an overall negatively-charged atom. For this activity, though, assume all atoms are neutral.

Exercise 2

STEP 1 **INTRODUCTION (10 MIN)**

Begin Lesson 2 by reviewing atomic structure, specifically electrons and valence electrons. Then, point out how the elements are arranged on the Periodic Table, using some of the patterns that students came up with in Lesson 1. Specifically, point out period numbers and group numbers (or introduce them if it wasn't a pattern that was noticed in Lesson 1). (Note: Students will connect valence electrons to group number in this lesson, so it is not necessary to teach them how to identify the number of valence electrons before this lesson; it is only necessary that they know where to find the group number.)

After reviewing structure and patterns, give students two Post-it notes. With one Post-it note, have students make a prediction about what they think valence electrons have to do with period and group numbers. Post predictions on their desk/table so they can refer to it during and after the activity. On the second Post-it note, have students draw a lightbulb. Instruct students that they will place this Post-it on their forehead when they have their "a-ha" moment about how valence electrons and group/period numbers are related.

STEP 2 **PRE-ACTIVITY (5 MIN)**

Students should know how to use the Elements 4D blocks after Lesson 1; however, they might not know that they can use two blocks at once and see the new compound formed. Show the class an example of what they will see when two blocks (that react) are put together. Point out how they can see the compound's name in the image.

STEP 3 **ACTIVITY (15-20 MIN)**

In partners, students will combine Elements 4D blocks to find ten compounds. Students must fill in the element name and group number for each of the reactant elements (not necessary to use the term reactant—they will learn it in Lesson 3) and the name of the compound formed.

Walk around the classroom as students are working and make sure that they are filling in the correct element name/group number and are filling in the correct compound name. Ask them how they think their prediction is holding up based on their observations so far (See *Valence Electrons Patterns* worksheet).

STEP 4 **WRAP-UP (10-15 MIN)**

Before beginning the wrap-up session, remind students of their lightbulb Post-it note if they have not yet placed it on their heads; let them know they can place it on their forehead at anytime in the wrap-up session. In bingo-style fashion, call out two or three element combinations and have students who have these combinations stand up. (Tip: you might want to pick very obvious combinations the students would come up with, such as Hydrogen and Oxygen OR make note of combinations students have come up with during the activity.) Ask these students why they think these particular combinations resulted in a chemical reaction/new compound being formed. Guide students to look at the group number and see if any notice a pattern.

(cont…)

Exercise 2

(...)

Debrief the class about how group number tells how many valence electrons an atom has. Make sure to explain the exceptions: groups three to twelve have only one or two valence electrons and for groups thirteen to eighteen, you have to subtract ten from the group number. Then, explain how atoms share electrons in order to be stable and that the valence shell has a max capacity for electrons. This capacity determines which other elements the atom will react and combine with. To finish, give out a few individual element examples, and ask the class to identify which groups of elements they would most likely react with based on how many valence electrons the element needs.

NAME: ______________________

VALENCE ELECTRONS PATTERNS WORKSHEET

DATE: ______________________

Element 1 Name	Element 1 Group #	Element 2 Name	Element 2 Group #	Compound Formed

Discover

Did you know that when atoms bond and form new compounds, there are formulas and an equation to demonstrate the reaction?

LESSON 3
Chemical Equations

Learning Objectives

STUDENTS WILL BE ABLE TO

Identify the type of reaction that is represented by a chemical equation. They will also be able to identify the reactants and products and calculate the number of atoms of each element on each side of the equation to balance.

VOCABULARY

chemical reaction, ionic bonds, covalent bonds, ions, valence, chemical equation, reactants, products, coefficients, subscripts, decomposition reactions, synthesis reactions, single replacement reactions, double replacement reactions, combustion

BACKGROUND INFORMATION FOR TEACHERS

Based on your knowledge from Lesson 2, an element's electron valence count will determine which new element it will bond with. Use a Periodic Table to have students review the patterns of valence electrons. Ionic bonds are formed when a positive metal ion is attracted to a negative nonmetal ion. Recall ions are charged atoms that form during chemical bonding when one or more electrons transfer from one atom to another. Atoms that lose electrons are positive ions. Atoms that gain electrons are negative ions. Make students aware that in order to recognize an ionic bond, look for a metal and a nonmetal. Covalent bonds are formed when electrons are shared by atoms. No ions are formed because no electrons are lost. Students should be aware that covalent bonds involve two or more nonmetals. Chemical formulas are created when two or more elements chemically combine. A chemical reaction involves one or more elements undergoing a change into one or more different kinds of elements.

For example, when you bake a cake, you start out with raw eggs, flour, sugar, etc. After exposure to heat, you have a completely new substance. Chemical formulas will be "arranged" and then "re-arranged" during chemical reactions

Chemists have developed a chemical language of "sentences" that can be understood by anyone who understands chemical formulas. A chemical equation is a short description of a chemical reaction using chemical symbols. There are two sides of the equation, reactants (on the left) and products (on the right). A "plus" sign separates formulas of two or more reactants or products from one another. The arrow represents yields or produces. It separates the reactants from the products.

Ask students to think about what the terms synthesize and decompose mean. Have you heard of these words in life science?

Exercise

Activity

STEP 1 Students revisit the **Valence Electrons Patterns worksheet** and the combinations they made.

STEP 2 Have them write down the chemical formulas for each reactant (element 1 and element 2) and the chemical formula for the product.

STEP 3 Make predictions about the number of atoms on each side.

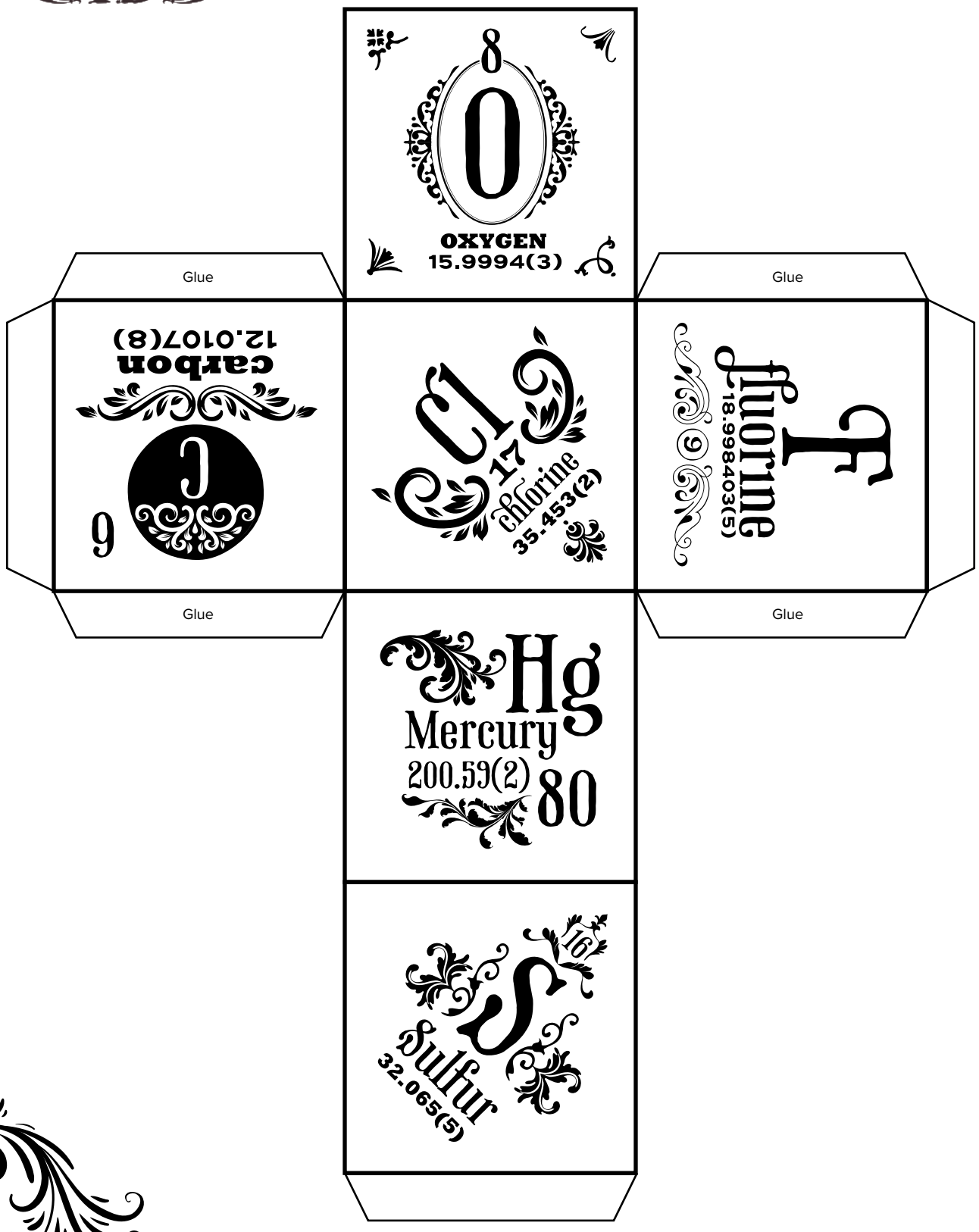
Wrap-Up

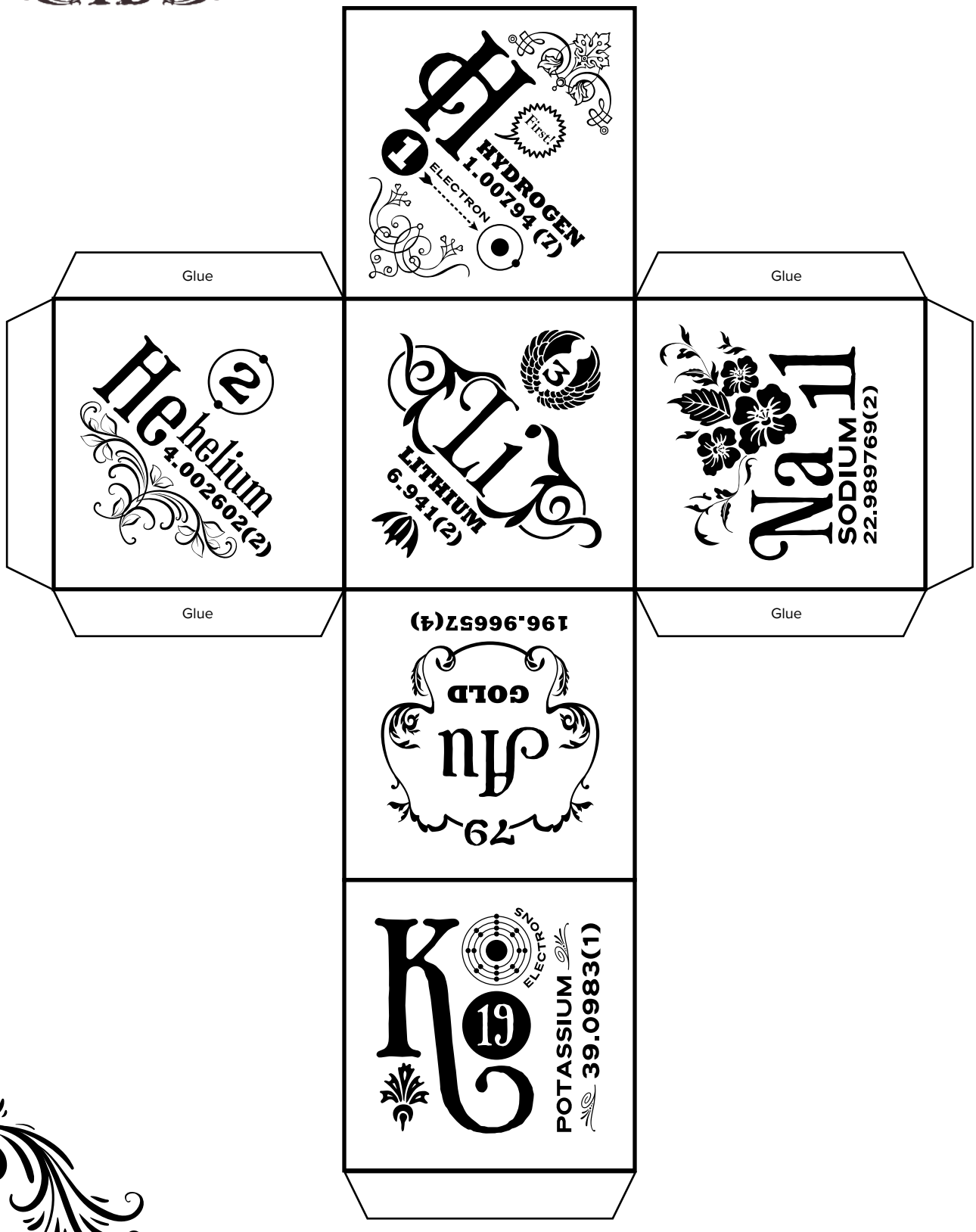
STEP 1 Revisit predictions students made about number of atoms on each side of the equation.

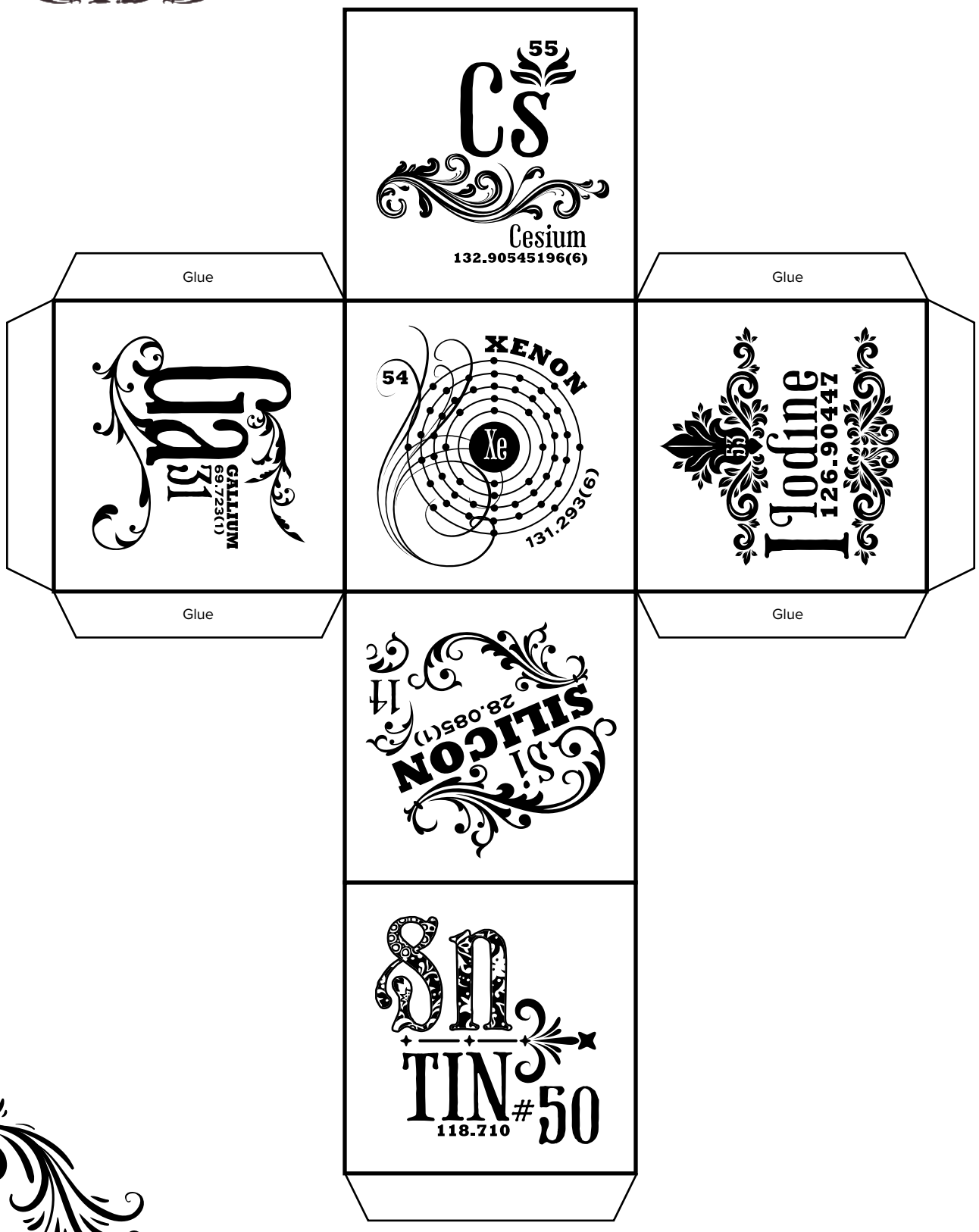
STEP 2 Recognize any patterns the students have come up with.

STEP 3 Explain the law of conservation of mass, how to identify number of atoms in the chemical formula, and check to see if it is balanced (optional depending on grade level and standards: how to balance an equation—not taught until HS chemistry/11th grade in Texas).

ELEMENTS 4D







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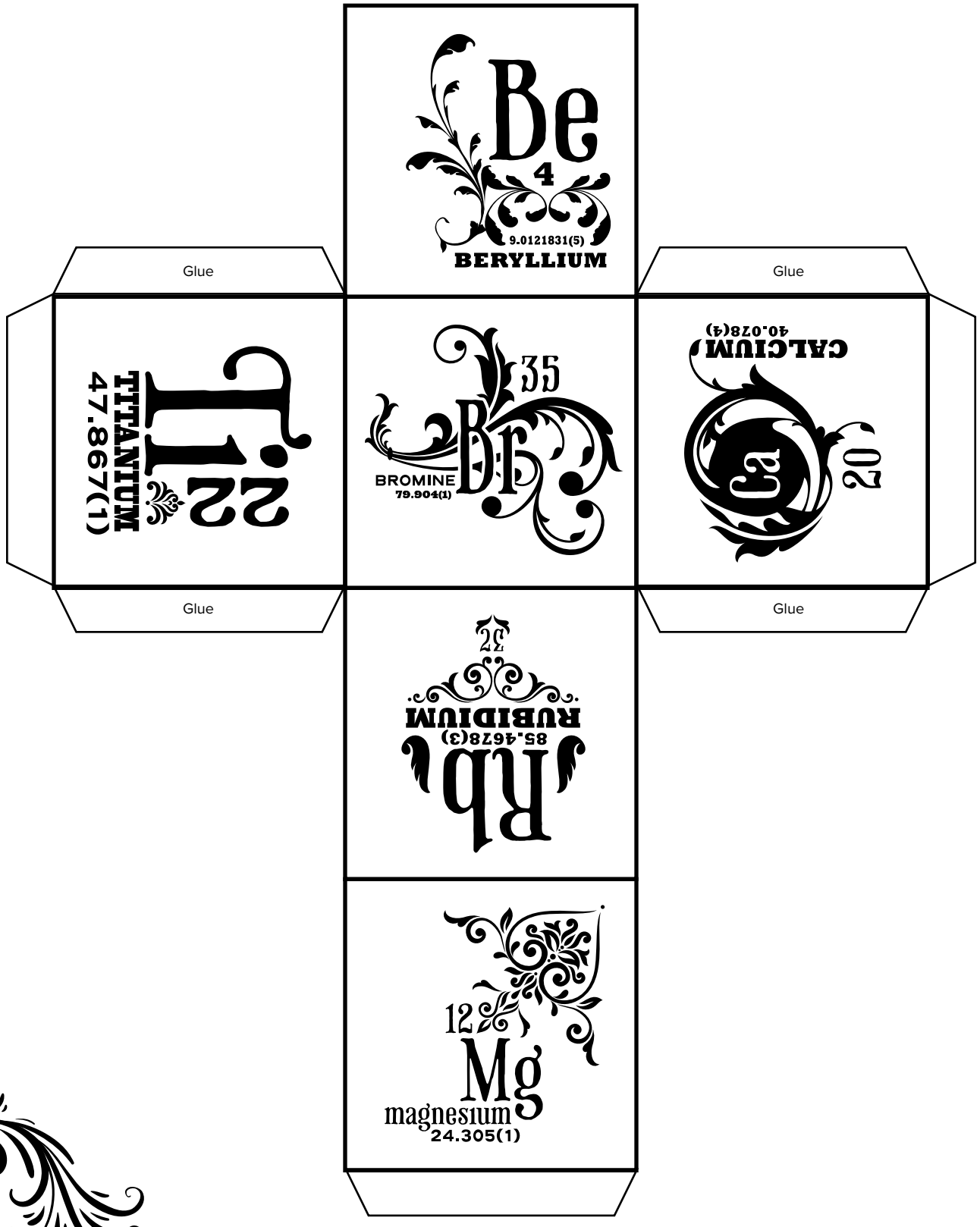

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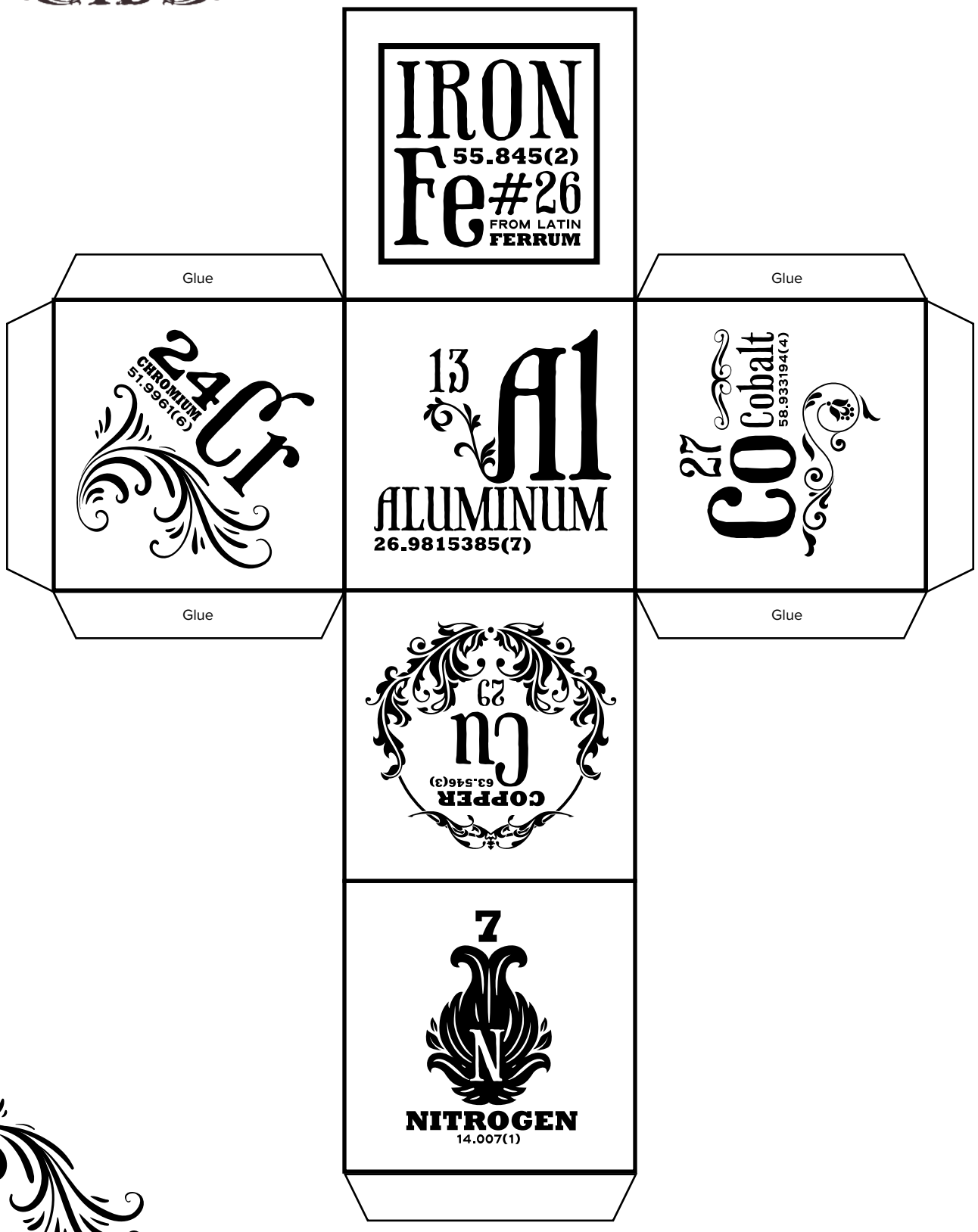

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