

**“Learning the PFAS LINGO”**  
**A Hands-on Activity for Learning about PFAS Molecules,**  
**(Also known as ‘Forever Chemicals’)**

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Vandiver thanks her colleague and friend, Ann Backus, M.S.,  
for inspiring me to create this hands-on PFAS activity

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**Teaching this PFAS Curriculum at Public Events**  
**With the MIT Edgerton Center Molecule Set**

**Description:**

This curriculum, called “Learning the PFAS Lingo,” is designed to help participants decode the names for 6 common PFAS molecules, and provides information about health effects attributed to PFAS exposures.

This activity was designed to be a leader-lead and hands-on lesson for participants working in teams. Six teams of 1-4 people/ team will work well. This activity can be taught in classrooms, workshops, or at STEM events. The following online guide includes the list of materials for creating the 6 stations, one for each kind of PFAS that the participants will be building. This guide was written for the activity leader, and the lesson plan was designed to provide an enjoyable PFAS learning experience. The lesson employs LEGO® Bricks to represent the atoms present in different PFAS molecules. Thus, learning PFAS naming conventions can become an enjoyable activity and a shared learning experience.

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## **LEARNING GOALS FOR ADULT PARTICIPANTS:**

- Be able to recall a couple of new facts about PFAS. Examples: 1) PFAS molecules are man-made molecules. 2) Brand names of products made of PFAS molecules.
- Be able to recall what makes PFAS molecules different from each other. (Example: the number of Carbon atoms in their structure.)
- Be able to describe the method by which scientists name the different kinds of PFAS molecules. (“PF” stands for “per-fluoro,” etc.)
- Be able to explain why PFAS molecules are referred to as “Forever Chemicals.” These molecules do not break down easily because the bond between Fluoride and Carbon Atoms is an unusually strong bond. That is why these molecules cannot be broken down easily and PFAS molecules can accumulate inside the human body and in the environment. (SEE handouts for more detailed information.)

**Leader’s Introductory Comments about PFAS:** Select some general information to share based on your audience’s age and/or background. (Text in blue font is a suggested script for the activity leader.)

**PFAS chemicals have been found in people’s drinking water. How does PFAS get into our public water supply?**

- **Here is a one common way: PFAS can be found in firefighting foam which fire fighters use.**
- **When firemen at military airbases practice use their firefighting foam to put out airplane fires on runways, these PFAS molecules get into the groundwater the next time it rains!**
- **This contaminated groundwater then serves as the source of drinking water for the public. (Here you might mention specific contaminated sites nearby/in your area.)**

Your high school and adult participants may recognize the brand names of some famous commercial products, but they may not know that these materials are made of PFAS! Here is one way to prompt your participants’ prior knowledge to make an association with PFAS products! Ask the following:

- 1) **“Do you know the name of a kind of coating found on frying pans? Its purpose is to prevent foods, such as eggs from sticking to the bottom of the pan.”**
  - **“Teflon” is the correct answer. A PFAS molecule gives that coating its excellent non-stick properties. (You can recommend that people should toss out their old Teflon coated pots and pans, because people ingest PFAS along with their perfectly fried egg!**
- 2) **What is the name of the chemical coating that has been applied to outdoor jackets to make them waterproof?**
  - **“GORE-TEX” is the correct answer. This PFAS molecule has been manufactured and applied to outdoor jackets and other clothing articles as a water repellent.**
- 3) **Babies’ pajamas and living room sofas were once advertised as having “life-saving fire retardants” added to their fabrics. Now most of these products are no longer allowed to be sold! They have been banned. Can you guess why? Explain.**
  - **The fire retardant in the baby’s pajamas and sofa cushions was PFAS!**
  - **Note: Babies and children are most vulnerable to hazardous chemicals because their bodies are growing rapidly.**

2 important Infographics at this URL! Leaders can print them as handouts:

<https://mytapscore.com/blogs/tips-for-taps/the-ultimate-guide-to-pfas>

- 1) Handout: Common PFAS molecules in the environment
- 2) Handout: Common health issues attributed to PFAS exposure

### Instruction on how to SET UP THE SPACE for teaching the PFAS Activity

***Instructors:*** First, create 6 different PFAS stations, one for each team of participants. This is like setting up a dinner table for 6 around one large table. You can also use a couple of tables or even 6 small tables. (School desktops, might work.) Participants may stand or sit for this activity. It's useful to know that every participant will have the opportunity to visit all 6 PFAS stations.

#### Set up each station with:

1. 1 numbered PFAS mats (1-6)
2. 1 **matching** numbered LEGO Kits (1-6)
3. 1 laminated White Card (SIDE 1 and SIDE 2)
4. 1 white-board marking pen with an eraser on one end

#### Here is a Summary of the PFAS Activity

(PLEASE PRACTICE building at least 1 of PFAS Molecules before leading this activity!) **BLUE TEXT in the guide indicates: Leader reads this aloud (instructions) (BLUE Italicized text = Leader's Actions or notes)**

We suggest that you Print and Read these Instructions to the participants, if this is your first time.

Each participant is a member of a team constructing one of six PFAS molecules using the LEGO bricks. The instructions for building are provided by the 6 "PFAS Layout Mats." You will lead participants through several steps, keeping the teams together. (The STEPS are outlined below in this LEADER Guide.)

- 1) The activity begins with a warmup with some simpler molecules to build with the bricks. (See the White Card SIDE1)
- 2) Next, each team moves ahead on its own, guided by their PFAS Layout Mat. There are 6 different PFAS molecules in this Set. After the team completes constructing their PFAS, they use their instructions (See White Card, SIDE 2) as their guide to correctly name their PFAS model.
- 3) Next, they use a marker to write the 4 or 5 letter abbreviation for their PFAS molecule on the white card. Observing the model's chemical structure helps the team learn the chemical name for their PFAS molecule.

### STEP 1. INTRODUCTION for the Group

***Introductory words (Leader briefly describes the learning objectives given below.)***

- PFAS molecules appear to have many unreadable letters in their shortened names!
- Today you will be participating in a LEGO® hands-on activity that will help you learn the naming rules for 6 common PFAS molecules. These 6 PFAS molecules are currently regulated in the public water supplies in the New England States. (*Instructors, mention your own local PFAS regulations here?*)
- We will provide handouts about these PFAS molecules and their health effects after this activity.

**Begin Instructions and starting with a quick Warm-up Activity :**

1) "Our activity is called 'Learning the PFAS Lingo!' It should be fun and playful because we will be using LEGO bricks as our atoms." (*Hold up one PFAS kit box with the LEGO.*)

2) Every group will have just one kind of PFAS molecule at their station. (*Hold up one of the PFAS mats from one station.*) We will be building PFAS molecules with LEGO so we can observe how each kind of PFAS molecule is different.

### The INTRODUCTORY ACTIVITY for “LEGO Bricks as Atoms”

We will begin by modeling some simpler molecules to become familiar with using LEGO Bricks as Atoms. (*Hold up the White CARD- SIDE 1 “Atoms and Molecules.”*)

(“Open your LEGO kit. Take Out the White Card from the Kit )

- “We will build some simple molecules using the LEGO bricks as atoms, first. Let’s try out the ‘Atom Key’ on SIDE 1 as shown inside the black lines on the right”. These colors shown here are the CPK Standard Chemistry colors that scientists use for these atoms! ... Carbon, Oxygen, Sulfur, and Fluorine, and Hydrogen!) “
- ‘Place one colored brick on top of its picture on your Atom Key.’
  - Note the Hydrogen atom is white and smaller than the others. Be able to recognize these atoms by their color and shape.
  - Also NOTICE the bonding is correct: H<sub>2</sub>O has each 2 Hs attached to 1 O.
  - You will use colors and molecular shapes to build the PFAS molecules. “
- “Notice that the ‘Space Filling Models’ are as spherical objects.
  - There are 3 molecules here with their atoms bonded together. (Scientists use space-filling model so the bonds aren’t needed.)
  - Now we can also build our molecules in the same way. We put them together like you do with LEGO.
- NEXT...Make sure your 3 LEGO Brick Models in the correct shapes! Molecules take exact shapes. Build LEGO molecules as shown.
  - Check your molecular shapes! Place your model molecules on top of their pictures. (Work together; take turns!) Your team should make and place them on their pictures on SIDE 1 of the white CARD:
  - 1 Water Molecule,
  - 1 Oxygen Molecule
  - 1 Carbon Dioxide Molecule
- “Which atom or color has not been used here yet?”
  - Answer: Fluoride is **LIME GREEN!** ...Fluoride is not a common atom.
  - But PFAS molecules have a LOT of Fluoride atoms in them!
  - Fluoride binds very, very strongly to Carbon

“Great! Now your team is prepared to build molecules with LEGO bricks.

Put back all the LEGO bricks. Stack them together again as pictured before the kit box.”

### STEP 2. EACH TEAM NOW BUILDS THEIR OWN PFAS MOLECULE

Now to building more complicated molecules like PFAS! Working as a team, your team will have the challenge of correctly constructing your own PFAS molecule!

- Build your own kind of PFAS molecule on top of its picture as shown on your PFAS Mat.
- (*Hold up a sample mat.*)
- *Circulate to help teams that need help with building!*

*Some individuals may be spatially challenged, and others may never have played with LEGO bricks before!*

What about Teams that finish early with building their PFAS Molecule?

- Help these teams individually get started with the NAMING ACTIVITY.

### STEP 3. NAMING YOUR TEAM'S PFAS MOLECULE

**“Our next objective will be to use the white instructional card with white board marker to write out the correct name for PFAS molecule just built.”**

- Point out the instructions on the White Card (SIDE 2)
- Teams should use the erasable marker to fill in the blanks to Name their PFAS molecule
- Write in only the 4 or 5 LETTERS for the abbreviation.
- It might be helpful to say...**“Remember this is ‘Not this is not a race!’** for people hurrying too much. And if someone trying to take notes (taking too long?)**“we have PFAS handouts for you.”**

“After you have written down the PFAS initials, you may check your answer.

The answer key is on the back of the mat. “

- **“To do this: First, carefully slide your LEGO PFAS molecule off the mat.**
- **Be sure to keep the structure together, because you will need to replace it again on its picture.**
- **Turn over the PFAS mat to discover the correct name!!**
- **Make corrections on your White Card if necessary. “**

Note Some teams may need more time, if so-- you may want to hand out the 2 Printouts to some teams early. They can read them and discuss these pages together.

**When every team has named their PFAS molecule, the teams will soon be invited to rotate to the next station.** Give Instructions, **“Teams, please move 1 station to your right, now.”**

No more building is necessary, because all 6 different molecules have already been built.

- Optional; suggest taking a photos of their LEGO PFAS with their names, if they like?
- Note: No more building is necessary, because all 6 different molecules have already been built.

“Your team will now practice recording the Name of this new PFAS molecule at this Station”.

- Tell them each time when to move on to the next station.
- After we have all made the 6 stations and named each one, we will be back to start and then we will all disassemble the PFAS molecule you first built and close the kit boxes. Be sure tell them **put the bricks away on top of their pictures inside the box. This shows us that everyone has put back all the LEGO.**

### Here is an Abstract/Description

Here is a short description of what we will be doing. today. PFAS molecules appear to have many unreadable letters in their names! Today you will be participating in a unique activity that will help you learn the naming rules for 6 common PFAS molecules. This activity is called “Learning the PFAS Lingo”

Each person will be part of a team that will construct one PFAS molecule using each LEGO brick as an atom. Next, each team follows some steps and together makes some key observations about the atoms present in their PFAS model. From this information, the team will be able to correctly name and write the abbreviation for the PFAS molecule they have been given.

The 4 or 5 letters in a PFAS molecules' name describe the molecule's full chemical structure. Each letter refers to the atoms that are present in the model that your team built.