THE ADVENTURES OF TEAM CHLORINE
Team Chlorine is a trio of students from an international cyber school focused on science and math. That simply means that they attend virtual classes. In fact, Clara, Clark and Clarence do not live in the same town or even on the same continent! Their cyber school allows them to connect and learn with students from all over the world.

For their Intro to Chemistry Class, the team is traveling the world to learn how the element chlorine is involved in their everyday life.

Why chlorine? It’s simple! Seventeen is their favorite number... so when their teacher told them to pick a number for their semester project, they all picked 17. Chlorine is number 17 on the Periodic Table of Elements (see back cover) because chlorine has an atomic number of 17.

So join the team as they travel around the world and learn about chlorine chemistry.
In 1774, in his small experimental laboratory, Swedish pharmacist Carl Wilhelm Scheele released a few drops of hydrochloric acid onto a piece of managnese dioxide metal. Within seconds, a greenish-yellow gas appeared.

Although he had no idea at the time, he had just discovered chlorine!

The fact that the greenish-yellow gas was actually an element was only recognized several decades later by English chemist Sir Humphrey Davy. Davy gave the element its name on the basis of the Greek word khloros, for greenish-yellow. In 1810 he suggested the name “chloric gas” or “chlorine.”

Representsed by the chemical symbol “Cl,” chlorine is number 17 on the Periodic Table of Elements, indicating each atom of chlorine contains both 17 protons, 17 electrons and 18 neutrons. Chlorine is one of the five nonmetallic elements that make up the halogen or “salt-producing” group.

Chlorine is also one of the most useful chemical elements. Chlorine is known as a very reactive element—so reactive, in fact, that it is usually found combined with other elements in the form of compounds. More than 3,500 naturally occurring chlorinated organic (associated with living organisms) compounds have been identified.

Chlorine is produced from one of nature’s most plentiful and inexhaustible minerals—common salt, sodium chloride (NaCl) —as well as potassium chloride. Chlorine is produced using the “chlor-alkali process.” In this process, electricity is applied to a salt and water solution. The electricity separates sodium from chloride and produces chlorine gas, hydrogen gas (H₂) and sodium hydroxide (caustic soda) solution.

Chlorine’s chemical properties have been harnessed innovatively for good use. For example, this element plays an essential role in public health. Chlorine-based disinfectants are capable of destroying a wide variety of disease-causing germs in drinking water and wastewater as well as from hospital and food production surfaces. LIFE magazine even called drinking water filtration plus the use of chlorine “probably the most significant public health advancement of the millennium.” Additionally, chlorine plays a critical role in the manufacturing of thousands of products we depend upon every day, from computer chips to crop-protection chemicals to cancer-fighting drugs. Some of these products contain chlorine, while others depend on chlorine chemistry for an intermediate step in their manufacturing. Chlorine is truly a “workhorse chemical.”
Plastic eye lenses are a product of chlorine chemistry!

What does chlorine have to do with Clark’s eyes?

Polycarbonate – Clark’s lenses are made of polycarbonate, a transparent plastic that blocks 100% of UV rays and is 10 times stronger than alternative eyewear.

Clark needs to get new glasses before Team Chlorine kicks off their international adventure to find out how chlorine impacts their lives every day.
Titanium (Ti) – Team Chlorine’s hovercraft is made from titanium metal because it is as strong as steel, but 45% lighter. Titanium is present in meteorites, moon rocks and even the sun.
And chlorine chemistry is essential to many life-saving medicines that treat everything from high cholesterol to allergies.

Hospitals use chlorine bleach as a surface disinfectant to kill life-threatening germs.

Team Chlorine arrives in Haiti, where they fly above the largest solar-run hospital in the world.

That’s not all! Thanks to chlorine chemistry, these solar panels can power this entire hospital.

Polysilicon – A high-purity form of silicon (Si), which is the second most abundant element on Earth. Silicon is mined from sand.
See if you can find all of these chlorine-industry jobs!

**WORD LIST**

Engineer  
Chemist  
Microbiologist  
Scientist  
Technician  
Researcher  
Health Officer  
Environmentalist  
Safety Specialist  

**WORD SEARCH**

T I R W X N K R S S V P E E P  
S X E K F T C G A T W Q G F M  
I G H G T M O O F G X X H F S  
L K C E N G I N E E R X C G P  
A B R S N W Q D T V J F R X M  
T F A K B C X Y Y B R V O I E  
N P E I N K S P S R S B C E O  
E L S B E A T J P Y N R W R T  
M H E B R E I H E W O I K S F  
N O R D C O F C C B E J I W M  
O A K G E H X F I X G T N V S  
R D I K H Q R O A N N G H S K  
I E J I F C L M L E H V T Y A  
V V I L Y O Z Q I Y W C I F I  
V M K V G G P C S S T T E U K  
E I F I Y L S U T J T D D T C  
I V S O N L S G P A X N T X I  
X T R E C I F F O H T L A E H  
T W U T S R S J D U L B K E Z  
R I K L F E W I W P P P G F T
Look over there! It's the Great Wall of China!

BEIJING, CHINA

The Team is exploring a wind farm in China. The long and strong turbine blades that convert wind energy into electricity are products of chlorine chemistry.

Solar panels and wind turbines? Chlorine chemistry plays a crucial role in renewable energy.

Epoxy Resin – A strong adhesive or glue, epoxy resins are used to help produce wind turbine blades. The high strength per weight of epoxies makes them ideal ingredients for these blades, which must be extremely strong and durable, but also lightweight.
Skating around an ice rink, Clark tells the team that the safety helmets on their heads are products of chlorine chemistry.

Who knew learning about chlorine could be so much fun?

You miss 100% of the chances you don’t take!

Polycarbonate – Not only is polycarbonate used for eye glass lenses, this plastic is utilized in a wide range of products including space exploration gear and construction materials because of its high impact resistance.
Hey Team, I applied an herbicide to help keep my crops growing healthy and strong.

Wow, this farm has a lot of food. I’m hungry!

The kids land on Farmer Phil’s farm and learn that crop protection chemicals are made with help from chlorine chemistry.
I can see the entire city!

The team arrives in London and explores the London Eye.

Chlorine chemistry is used for steel production. It’s called “pickling.”

Hydrochloric Acid (HCl) – This acid is used to remove rust and corrosion on steel. HCl is also found naturally in your stomach where it helps digest your food!
Did you know that the medicine in Clark’s inhaler is a product of chlorine chemistry?

Wow! Chlorine chemistry is a part of my everyday life, from my glasses to my inhaler.

Clark used the very last of his inhaler medicine and didn’t bring any extra. So the team made an emergency stop in Berlin to get Clark to the pharmacy.

Hydrofluorocarbons (HFCs) – These compounds are commonly used in metered-dose inhalers to help propel medicine into lungs.
One of the ways chlorine is transported is by railway. Help us get to the tank car and out of the maze to the water treatment plant!

Chlorine Bleach – This chlorine-based liquid disinfectant destroys a wide range of germs in water. Over 98% of water treatment facilities in the United States disinfect their water supply with chlorine-based disinfectants.
At the electronics factory, the team watches as silicon chips, purified with chlorine chemistry, are placed into computers and smart devices.

This is the coolest robot I have ever seen!

Silicon chips are the brains of the electronics.

Silicon (Si) – This element’s atomic structure makes it ideal to serve as a semiconductor in electronics.
Team Chlorine collected medical supplies produced using chlorine chemistry to deliver to hospitals in need. Together the team helped healthcare workers unload enough boxes of vinyl gloves, vinyl blood bags, chlorine bleach and medicines to fill a truck!

Polyvinyl Chloride (PVC) – A versatile and recyclable plastic that is the material of choice for thousands of medical products because it is durable, easily sterilized and non-breakable.
Chlorine sanitizers, the right pH and good hygiene are essential to keeping these pools clean and healthy!

Don't forget to shower before you jump in, Clarence!

The free chlorine and pH look good to me.

Chlorinated Isocyanurates – Dry concentrated chlorine-based disinfectants that form “free chlorine” in water. Chlorine-based disinfectants keep on destroying germs long after they are added to pools and spas.
**CROSSWORD**

**ACROSS**
4. Chlorine is one of five elements that make-up the ______ or ‘salt-producing’ group.
6. This table lists all of the chemical elements in order or it’s atomic number. (Hint: two words)
8. In its elemental form, chlorine ____ is greenish-yellow in color.
10. Always remember to read the directions before handling chemicals and always wear the proper safety ______.

**DOWN**
1. Chlorine is produced when a ______ is electrified which converts chloride ions to elemental chlorine. (Hint: two words)
2. A _____ is formed when two or more elements combine.
3. Chlorine was discovered in 1774 by a Swedish pharmacist named ______. (Hint: three words)
5. In 1908, Chlorine was first added to the drinking water in ______. New Jersey. (Hint: two words)
7. ______ is a common chlorine compound that can also be found on your dinner table. (Hint: Doctors warn against using too much)
9. Chlorine’s atomic number is ______. (Hint: spell out the number)

How much do you know about chlorine?
AGUA

The chlorine in this chlorinator tank destroys germs in the water that can make people sick.

In Honduras, this community worked together to build a chlorinator that provides clean drinking water to the entire village.

These PVC pipes deliver the water throughout the village and into homes.

Calcium Hypochlorite (Ca(ClO)₂) – This compound is commonly used to disinfect water in small water systems, and can be stored for long periods of time.
The Team is in the lab working on their science homework. Can you spot all 13 differences?
Firefighters depend on special gear to keep them safe while dealing with emergencies. The heat-resistant material they wear is a product of chlorine chemistry.

I don't know what we would do without the great innovations of chemistry!

Aramid Fibers – These heat-resistant, light-weight and extremely strong synthetic fibers are used in military, aerospace and first-responder equipment.
Can you unscramble these words? Use the clues to help you figure out what the word is.

**RONTH CERIAAM**
This continent has eight time zones.

**OTSHU ARIACME**
This continent is home to the largest rain forest in the world.

**AIAS**
This continent covers one-third of the earth's surface.

**IFAARC**
The world’s longest river and largest desert can be found on this continent.

**EOEPRU**
This continent is made up of 50 countries.

**HYEIMSCTR**
The branch of science that deals with the identification of the substances of which matter is composed.

**CTFIISEDNNOI**
This process removes most organisms present on surfaces that cause infection and disease.

**ENEMSTEL**
The basic building blocks of matter.

**HBLEAC**
Chlorine __________ is a water solution of sodium hypochlorite.
Always remember to wash your hands for at least 20 seconds with warm water and soap!

Good hygiene and proper surface disinfection helps prevent the spread of germs and viruses that make students and teachers sick. The teacher busts germs like the ones shown on the next page by cleaning classroom surfaces and then sanitizing with a bleach solution.

Chlorine Bleach – A water solution of sodium hypochlorite (NaOCl), chlorine bleach has been used as a disinfectant for more than 200 years.
Chlorine helps destroy these viruses and bacteria.

- E. Coli
- Legionella pneumophila
- Influenza Viruses
- Staphylococcus
- Giardia lamblia
- Salmonella
- Norovirus
From my home's insulated vinyl siding to the energy-efficient windows and door frames, chlorine chemistry helps protect me from the elements.

From seat cushions and seat covers, to the bumpers and air bags, chlorine chemistry helps keep my parents' car safe and comfortable.

Chlorine chemistry helps to provide the substance that's the alternative to lead in paints. Paints have never been brighter!

Titanium Dioxide – A common white pigment that is used in many different products including cosmetics and fabrics. It can even be found on some powdered donuts!

BROUGHT TO YOU BY CHLORINE CHEMISTRY
**ANSWER KEY**

**GEOGRAPHY QUIZ**

L. Beijing, China
A. Toronto, Canada
F. London, United Kingdom
I. St. Petersburg, Russia
M. Tokyo, Japan
J. Freetown, Sierra Leone
E. Rio de Janeiro, Brazil
D. Tegucigalpa, Honduras
G. Brussels, Belgium
K. New Delhi, India
B. Washington D.C., United States
C. Mirebalais, Haiti
H. Berlin, Germany

**WORD SEARCH**

T I R W X N K R S S V P E E P
S X E K F T C G A T W Q G F M
I G H G T M O O F G X X H F S
L K C E N G I N E E R X C G P
A B R S N W Q D T V J F R X M
T F A K B C X Y Y B R V O I E
N P E I N K S P S R S B C E O
E L S B E A T J P Y N R W R T
M H E B R E I H E W O I K S F
N O R D C O F C C B E J I W M
O A K G E H X F I X G T N V S
R D I K H Q E O A N N G H S K
I E J I F C L M L E H V T Y A
V V I L Y O Z Q I Y W C I F I
N M K V G G P C S S T T E U K
E I F I Y L S U T J T D D T C
I V S O N L S G P A X N T X I
X T R E C I F F O H T L A E H
T W U T S R S J D U L B K E Z
R I K L F E W I W P P G F T
WHAT'S DIFFERENT?
1. Clark's hair is different.
2. Clark's ear is different.
3. Clark's lab coat is missing a pocket.
4. Clark's legs are switched.
5. Clark is wearing safety goggles.
6. Clarence is not wearing a lab coat.
7. Clarence's dimple has moved.
8. One of Clarence's eyebrows is missing.
9. Clarence is holding the tablet in a different hand.
10. Clara's safety goggles are on the top of her head.
11. One of Clara's eyebrows is missing.
12. Clara's arm is lowered.
13. Clara's dress has changed.

WORD SCRAMBLE
NORTH AMERICA   CHEMISTRY
SOUTH AMERICA   DISINFECTION
ASIA   ELEMENTS
AFRICA   BLEACH
EUROPE
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1. Clark's hair is different.
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3. Clark's lab coat is missing a pocket.
4. Clark's legs are switched.
5. Clark is wearing safety goggles.
6. Clarence is not wearing a lab coat.
7. Clarence's dimple has moved.
8. One of Clarence's eyebrows is missing.
9. Clarence is holding the tablet in a different hand.
10. Clara's safety goggles are on the top of her head.
11. One of Clara's eyebrows is missing.
12. Clara's arm is lowered.
13. Clara's dress has changed.
On each adventure you will find a product that has been “brought to you by chlorine chemistry.” This means that chlorine serves as an essential building block in the manufacturing process.

Visit us on the web: www.teamchlorine.com