

THE ADVENTURES OF
TEAM CHLORINE



TEAM CHLORINE



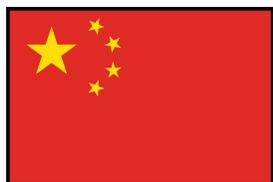
Belgium



Brazil



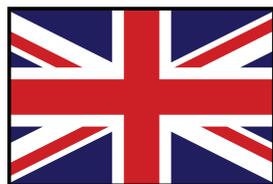
Canada



China



Germany



United Kingdom



European Union



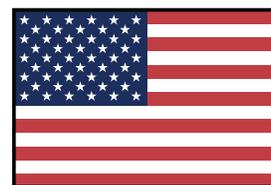
Haiti



Honduras



India



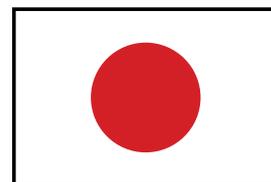
United States



Sierra Leone



Russia



Japan



Clara
10 years old



Clark
12 years old



Clarence
11 years old

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.

CHLORINE 101

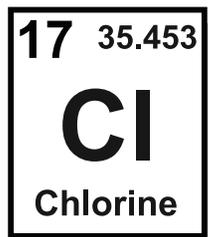


In 1774, in his small experimental laboratory, Swedish pharmacist Carl Wilhelm Scheele released a few drops of hydrochloric acid onto a piece of manganese dioxide metal. Within seconds, a greenish-yellow gas appeared.

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."

Represented 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.

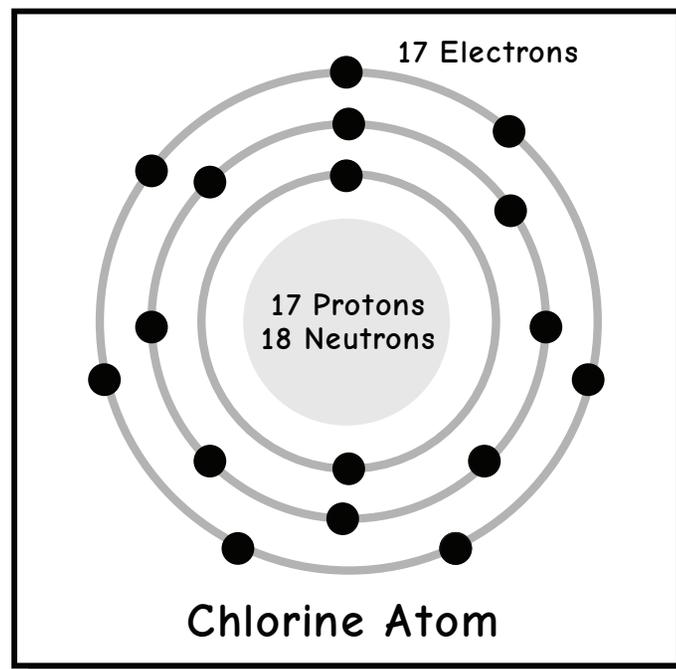


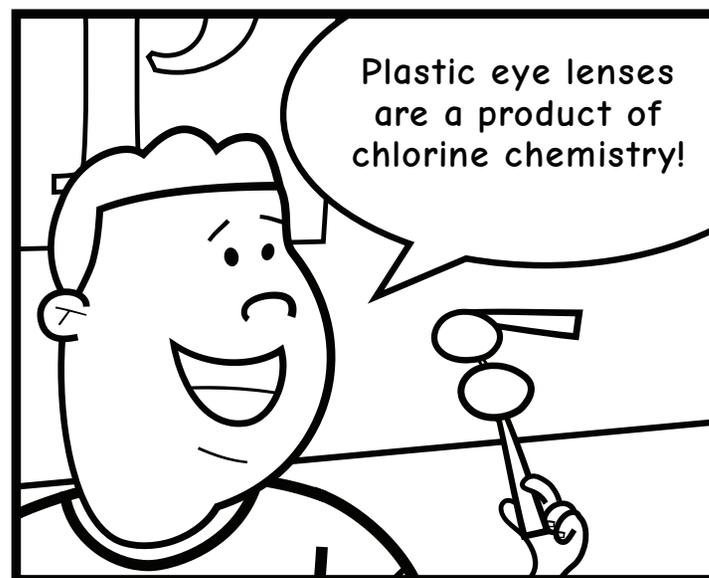
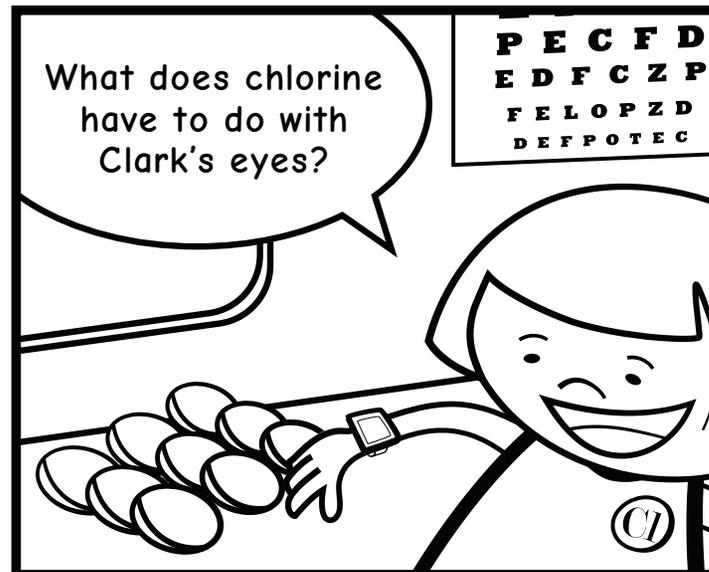
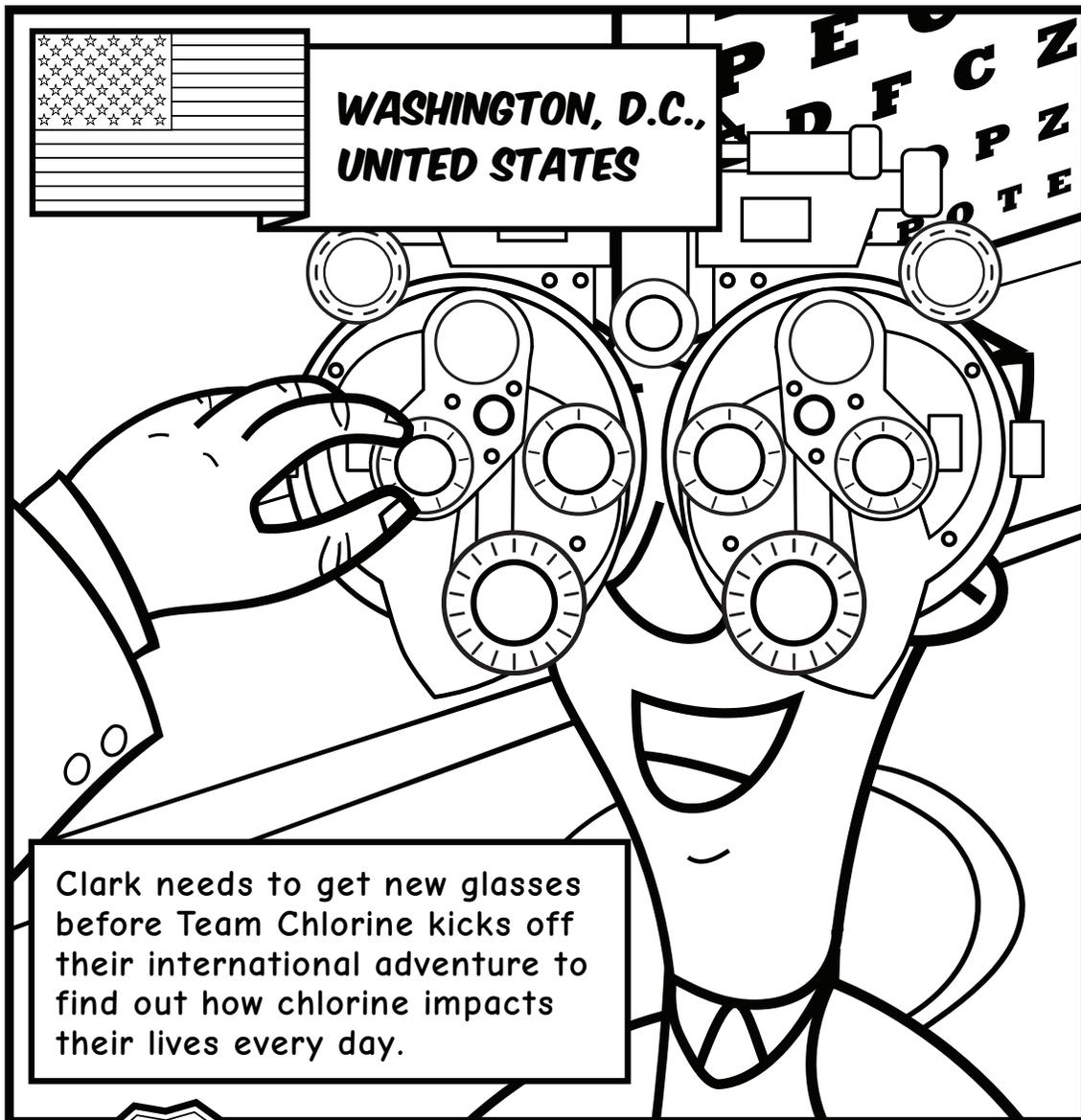
Chlorine is also one of the most useful chemical elements. Chlorine is known as a very reactive element—so reactive, in fact, that it is usually found combined with other elements in the form of compounds. More than 3,500 naturally occurring chlorinated organic (associated with living organisms) compounds 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. Chlorine was first used for drinking water treatment in the U.S. in Jersey City, New Jersey in 1908.

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."





**BROUGHT TO
YOU BY
CHLORINE
CHEMISTRY**

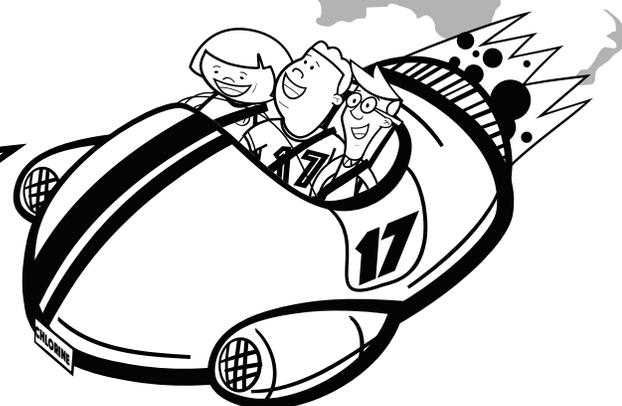
Polycarbonate – Clark's lenses are made of polycarbonate, a transparent plastic that blocks 100% of UV rays and is 10 times stronger than alternative eyewear.

GEOGRAPHY CONTEST



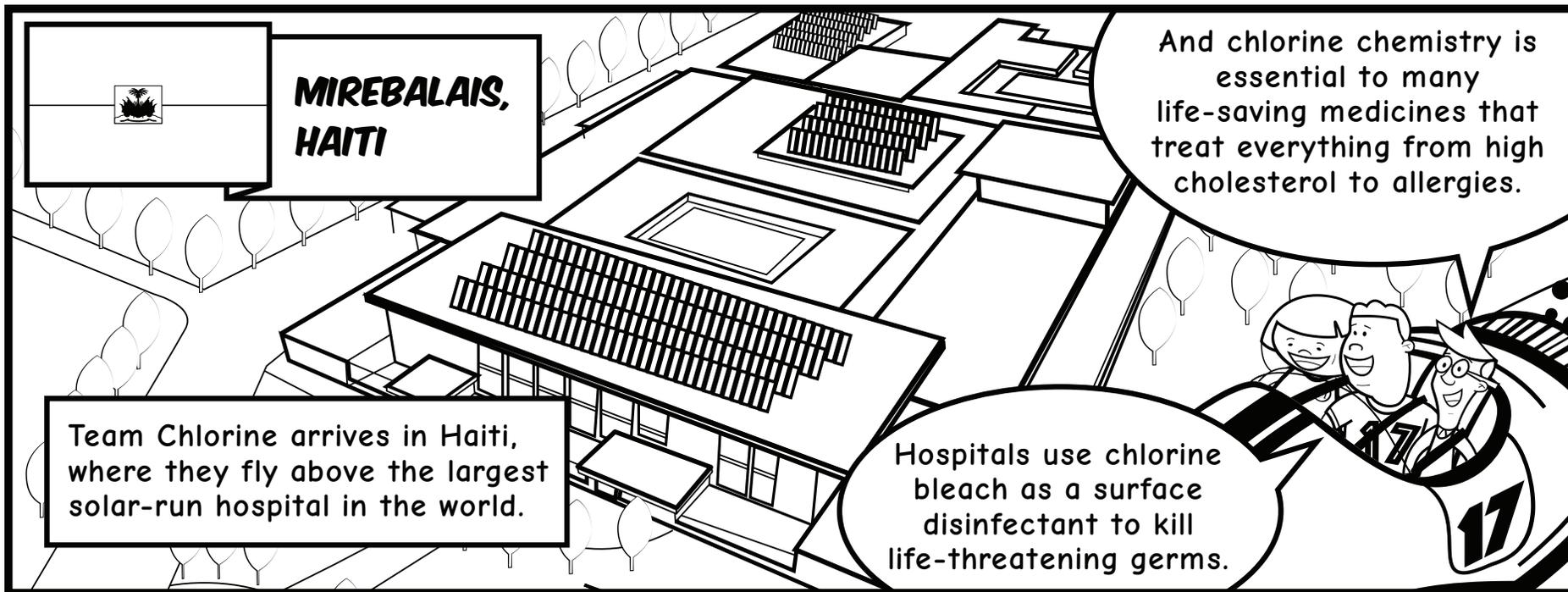
- ___ Beijing, China
- ___ Toronto, Canada
- ___ London, United Kingdom
- ___ St. Petersburg, Russia
- ___ Tokyo, Japan
- ___ Freetown, Sierra Leone
- ___ Rio de Janeiro, Brazil
- ___ Tegucigalpa, Honduras
- ___ Brussels, Belgium
- ___ New Delhi, India
- ___ Washington D.C., United States
- ___ Mirebalais, Haiti
- ___ Berlin, Germany

Can you match up the cities we're going to visit with their location on the map?



BROUGHT TO YOU BY CHLORINE CHEMISTRY

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.

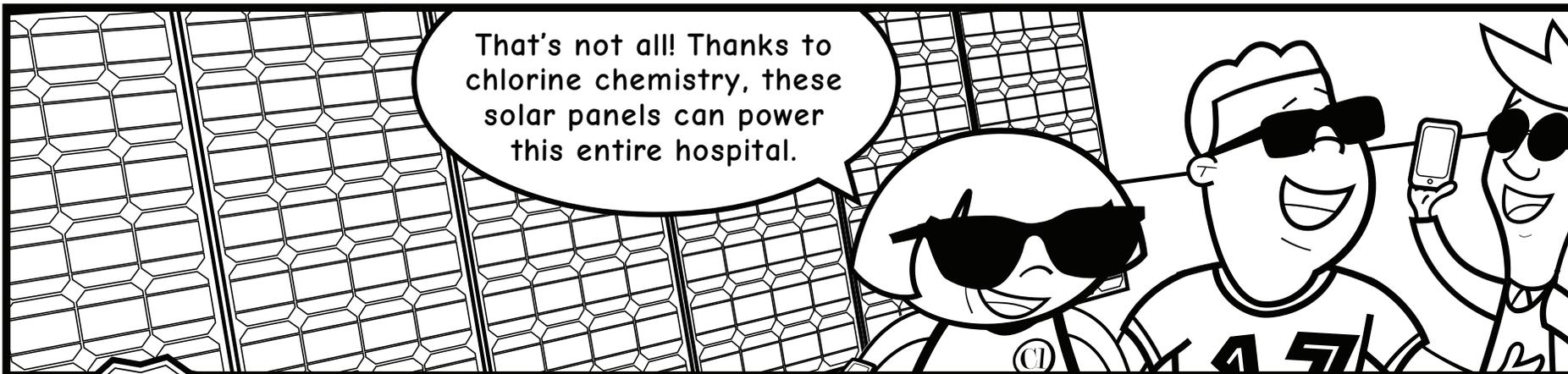
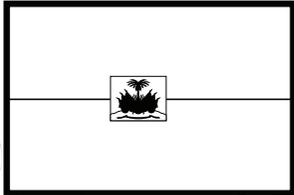


And chlorine chemistry is essential to many life-saving medicines that treat everything from high cholesterol to allergies.

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.

**MIREBALAIS,
HAITI**



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

**BROUGHT TO
YOU BY
CHLORINE
CHEMISTRY**

Polysilicon – A high-purity form of silicon (Si), which is the second most abundant element on Earth. Silicon is mined from sand.

WORD SEARCH

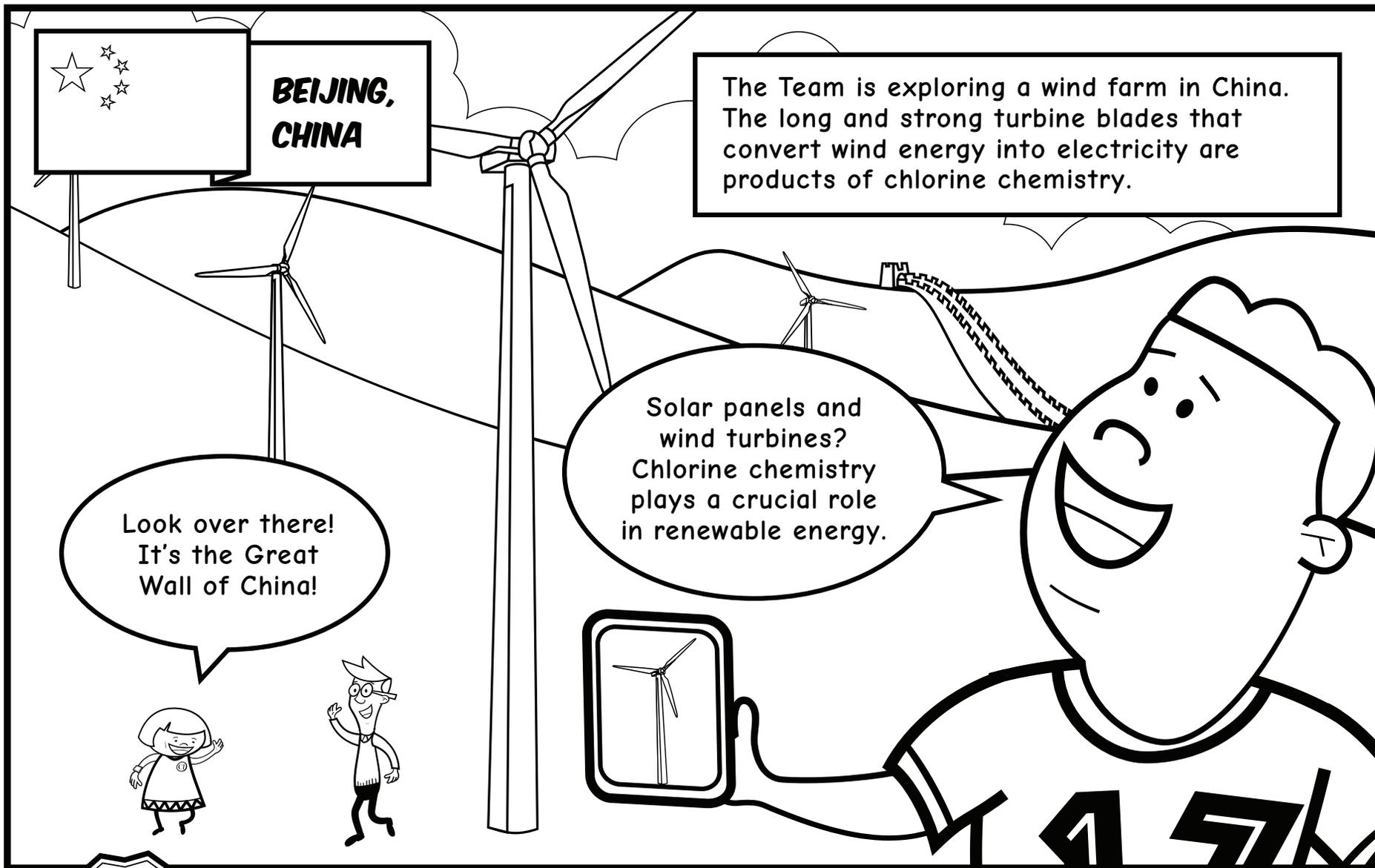


WORD LIST

Engineer
Chemist
Microbiologist
Scientist
Technician
Researcher
Health Officer
Environmentalist
Safety Specialist

See if you can find
all of these
chlorine-industry
jobs!

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	P	G	F	T



**BROUGHT TO
YOU BY
CHLORINE
CHEMISTRY**

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.

**ST. PETERSBURG,
RUSSIA**



Skating around an ice rink, Clark tells the team that the safety helmets on their heads are products of chlorine chemistry.

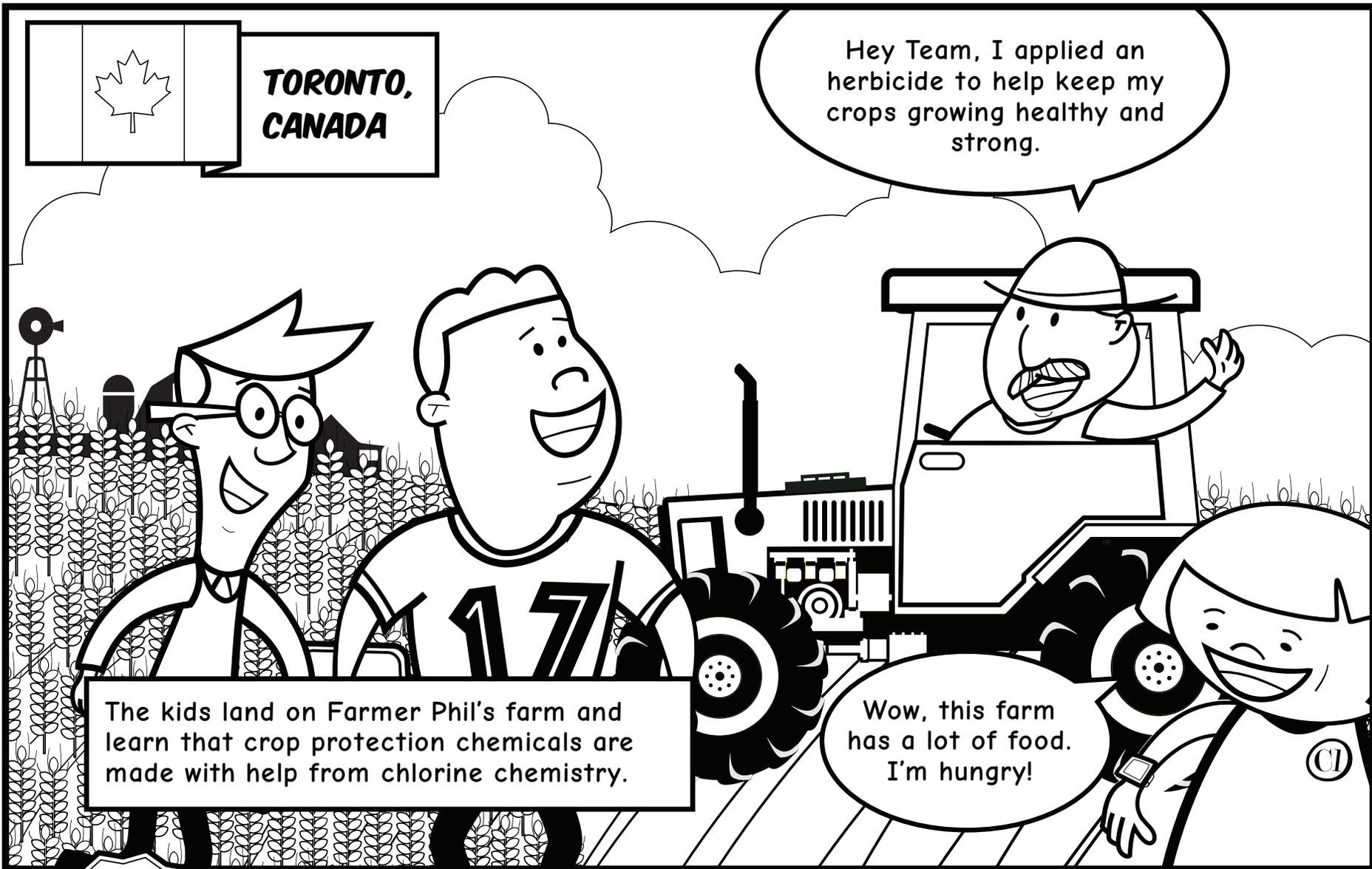
**BROUGHT TO
YOU BY
CHLORINE
CHEMISTRY**

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.

Who knew learning about chlorine could be so much fun?



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

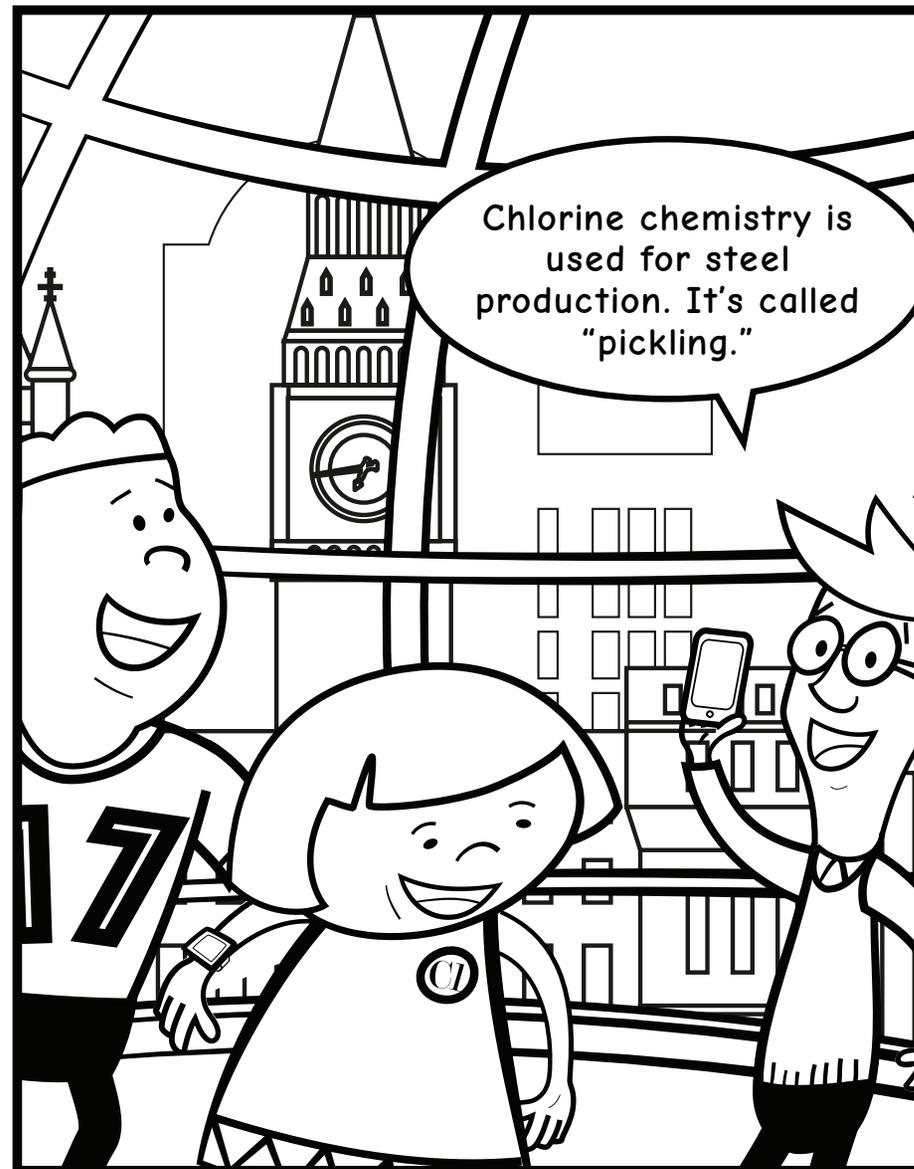


**BROUGHT TO
YOU BY
CHLORINE
CHEMISTRY**

The kids land on Farmer Phil's farm and learn that crop protection chemicals are made with help from chlorine chemistry.

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

Some crop protection chemicals contain chlorine and some are manufactured with chlorine-containing "intermediate" compounds but lack chlorine in the final product.



**BROUGHT TO
YOU BY
CHLORINE
CHEMISTRY**

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!

**BERLIN,
GERMANY**

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.

Did you know that the medicine in Clark's inhaler is a product of chlorine chemistry?

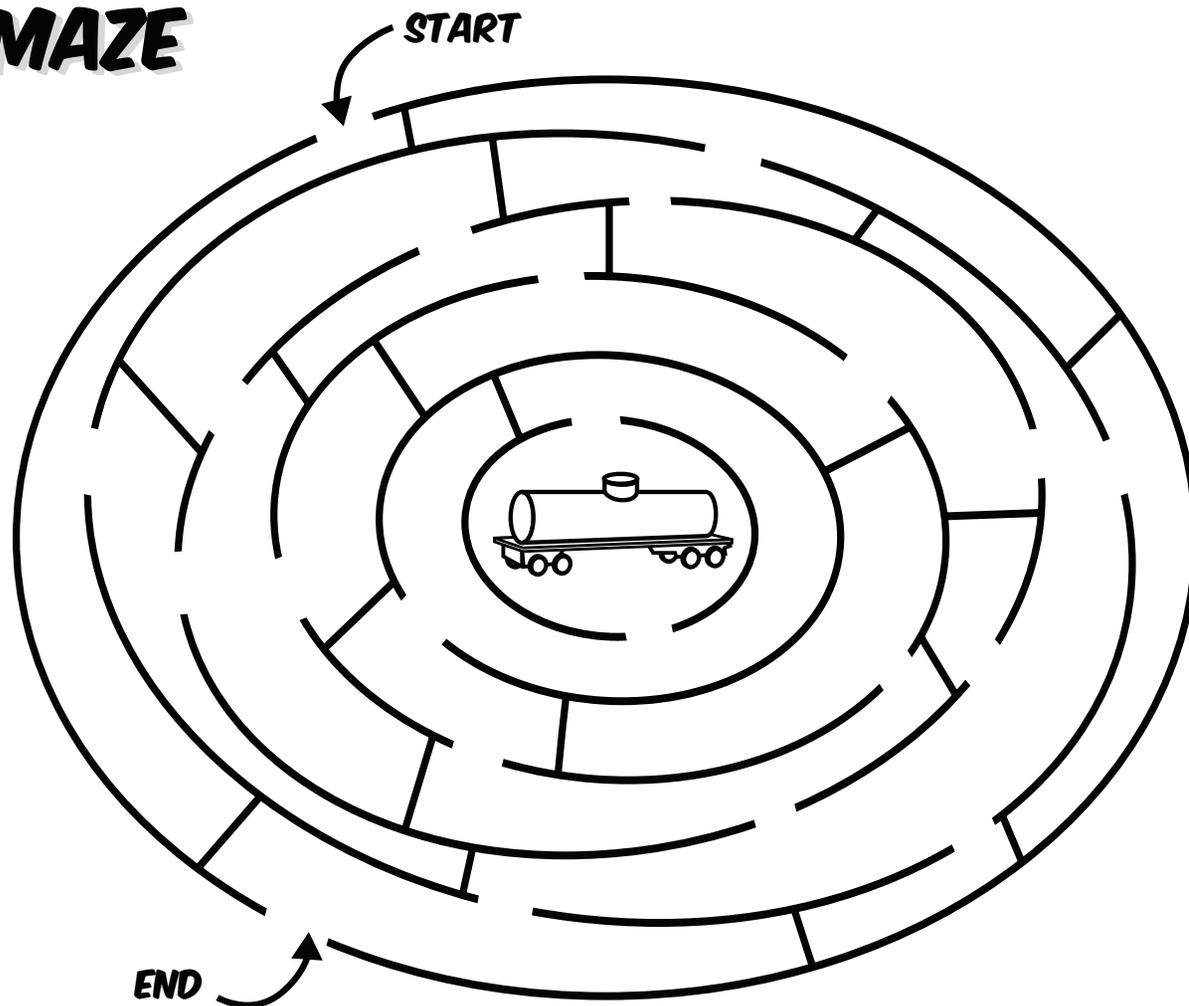
Wow! Chlorine chemistry is a part of my everyday life, from my glasses to my inhaler.

**BROUGHT TO
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CHLORINE
CHEMISTRY**

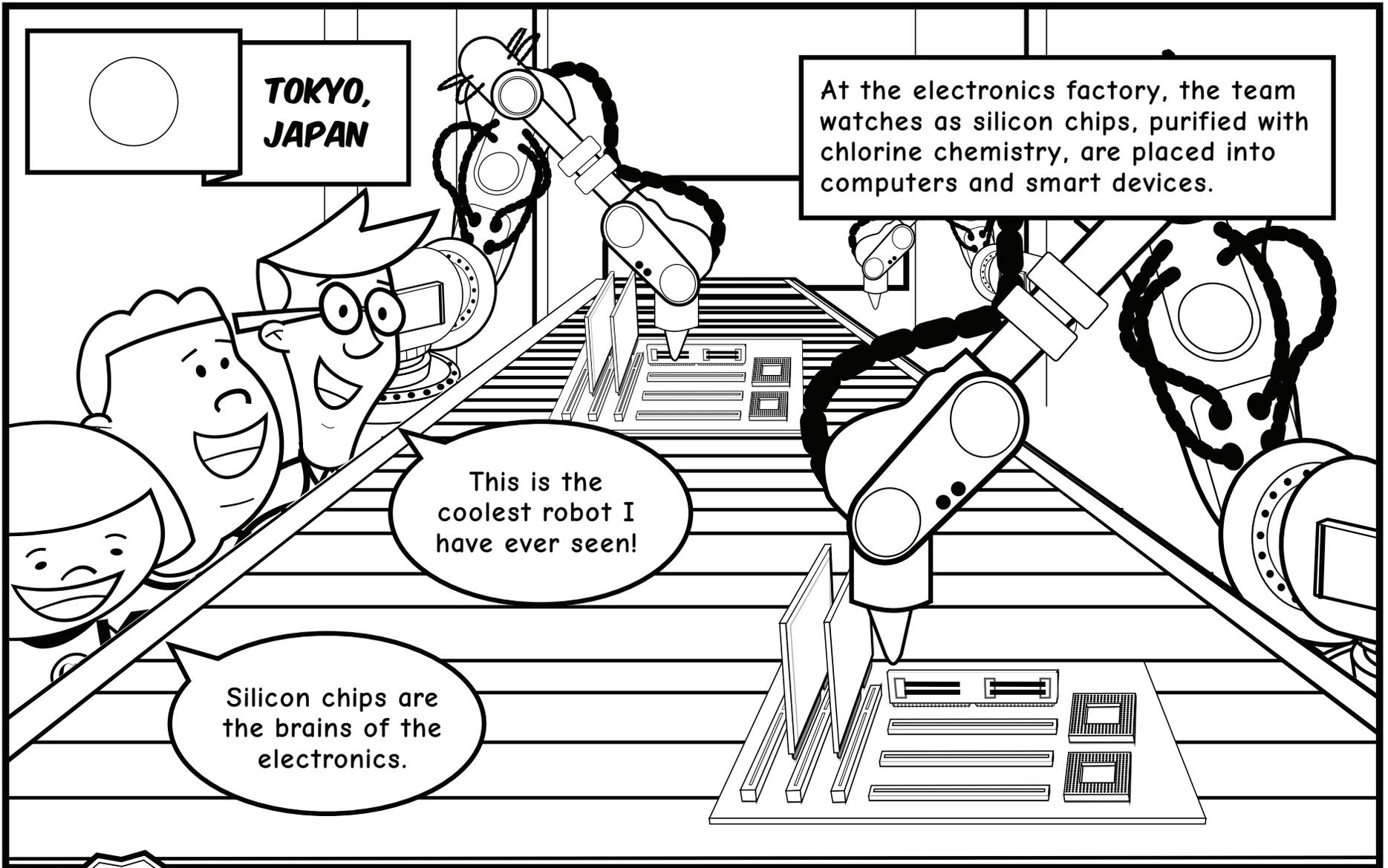
Hydrofluorocarbons (HFCs) – These compounds are commonly used in metered-dose inhalers to help propel medicine into lungs.

NAVIGATE THE MAZE

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!

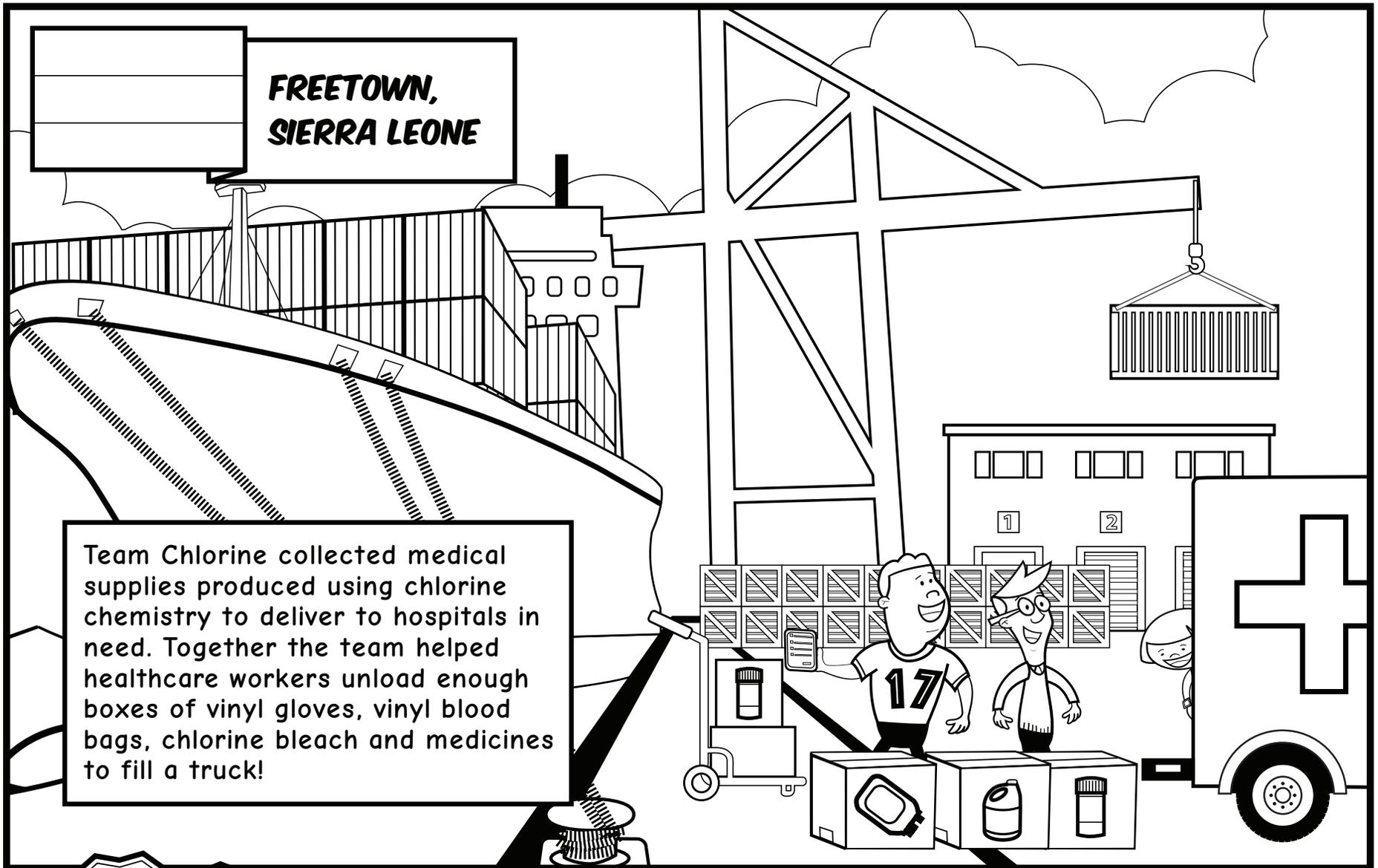


Chlorine Bleach – This chlorine-based liquid disinfectant destroys a wide range of germs in water. Over 98% of water treatment facilities in the United States disinfect their water supply with chlorine-based disinfectants.

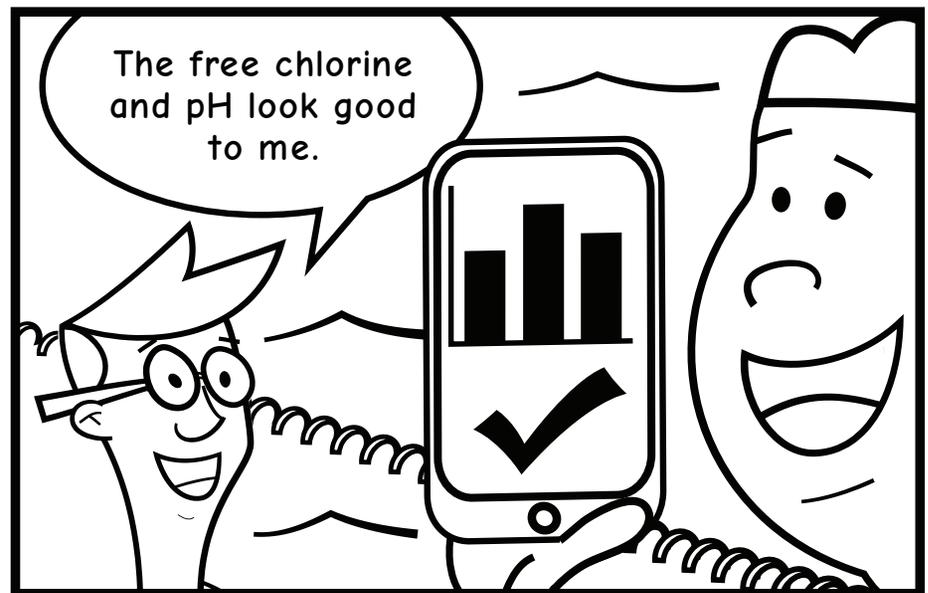
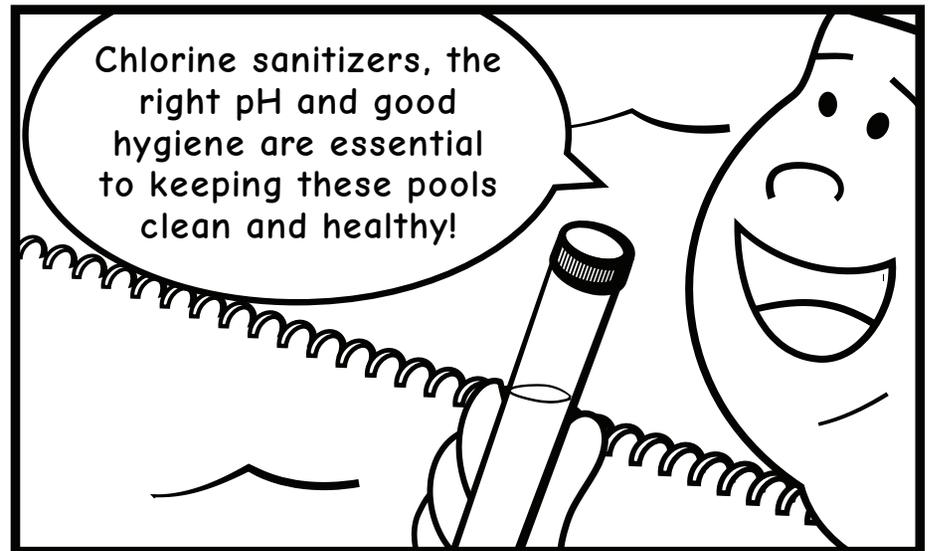


**BROUGHT TO
YOU BY
CHLORINE
CHEMISTRY**

Silicon (Si) – This element's atomic structure makes it ideal to serve as a semiconductor in electronics.



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.



BROUGHT TO YOU BY CHLORINE CHEMISTRY

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.

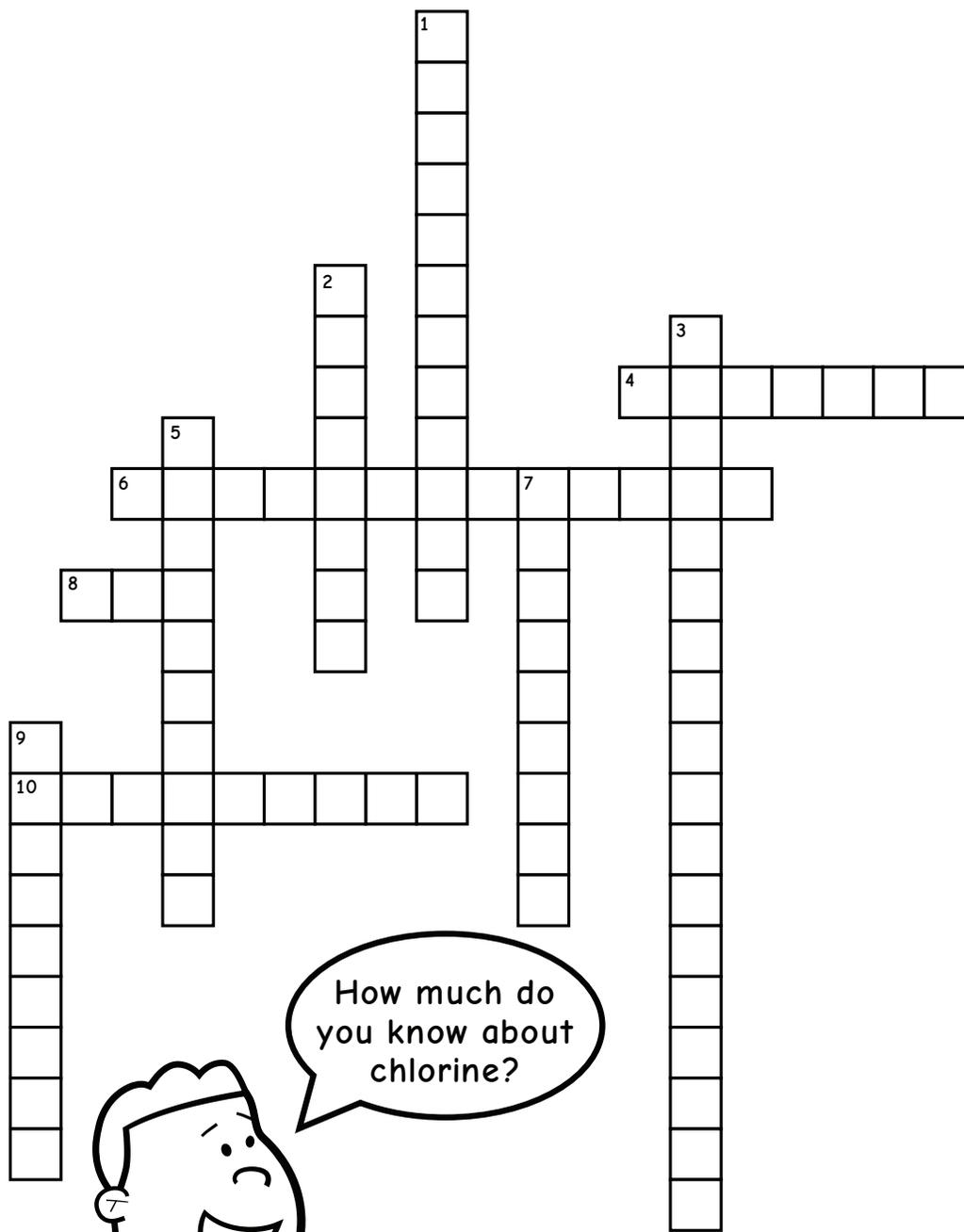
CROSSWORD

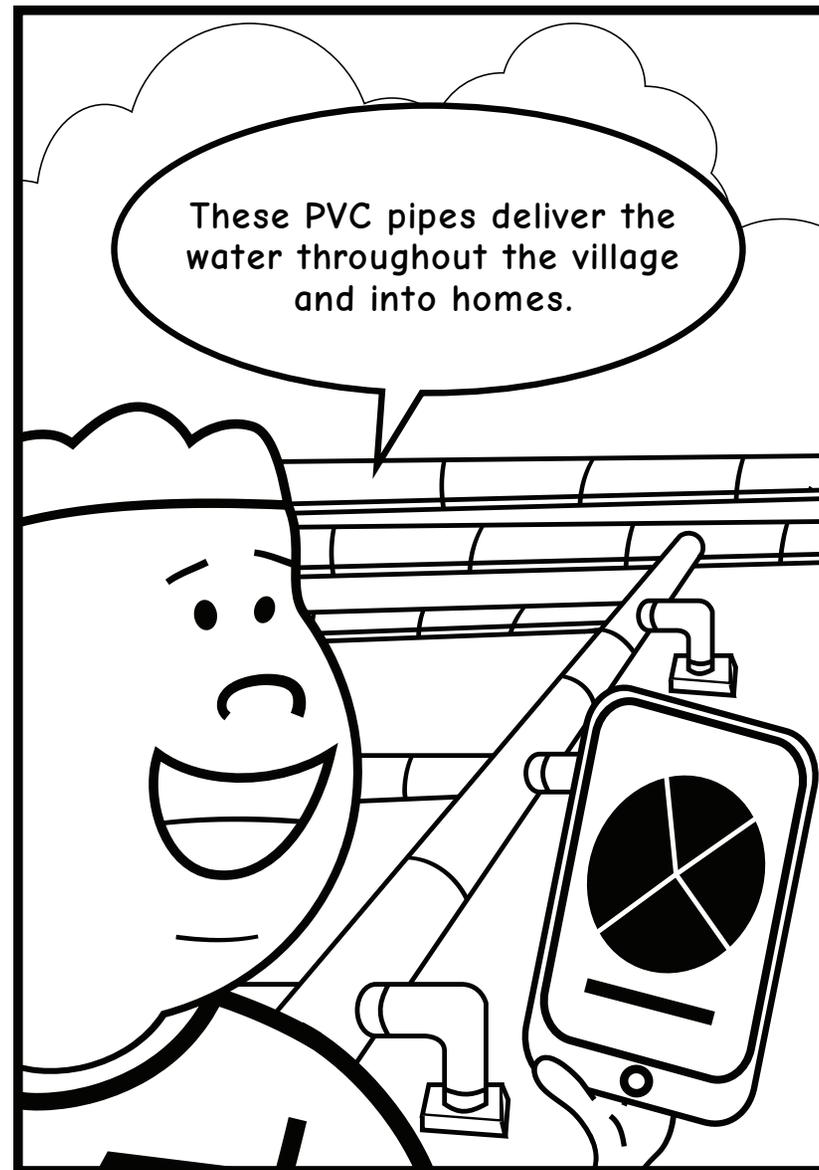
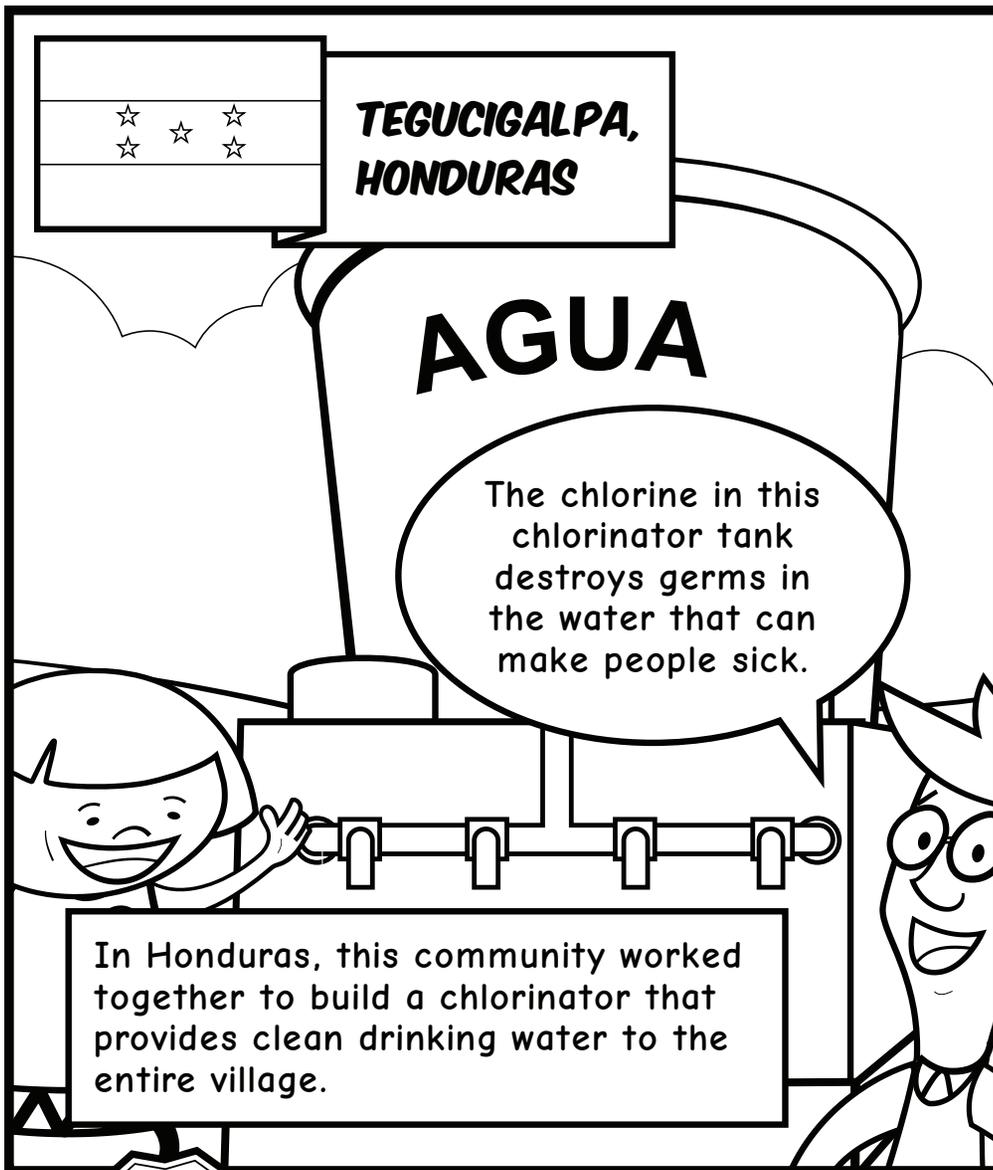
ACROSS

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

DOWN

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





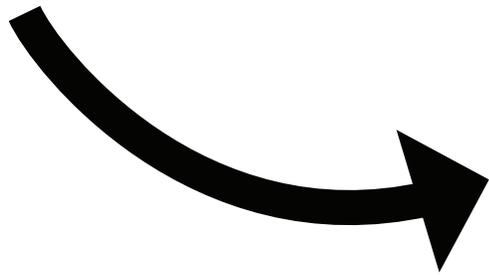
**BROUGHT TO
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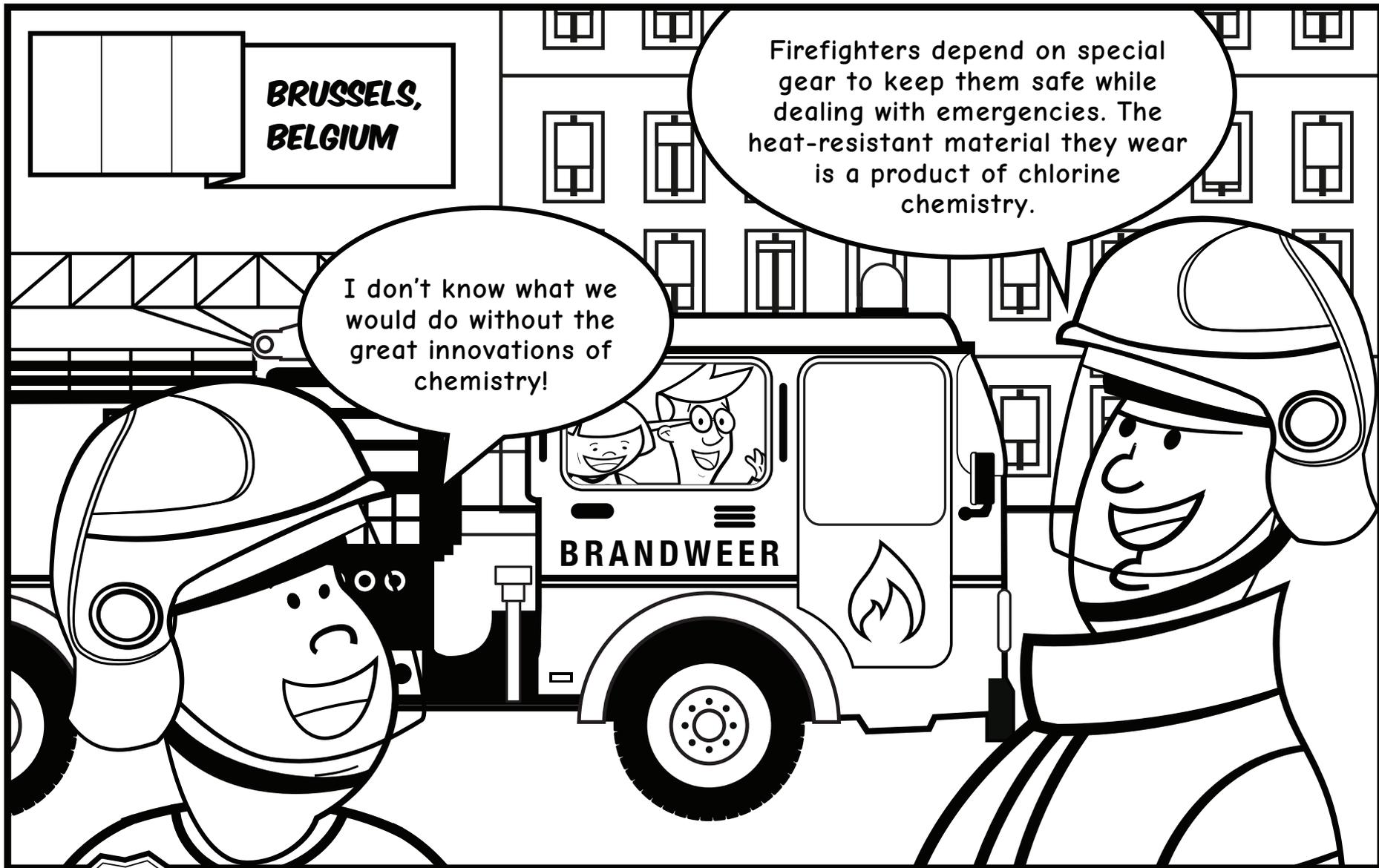
Calcium Hypochlorite ($\text{Ca}(\text{ClO})_2$) – This compound is commonly used to disinfect water in small water systems, and can be stored for long periods of time.

WHAT'S DIFFERENT?



The Team is in the lab working on their science homework. Can you spot all 13 differences?





**BRUSSELS,
BELGIUM**

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

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.

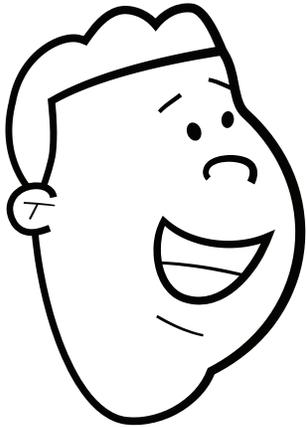
BRANDWEER

**BROUGHT TO
YOU BY
CHLORINE
CHEMISTRY**

Aramid Fibers – These heat-resistant, light-weight and extremely strong synthetic fibers are used in military, aerospace and first-responder equipment.

WORD SCRAMBLE

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

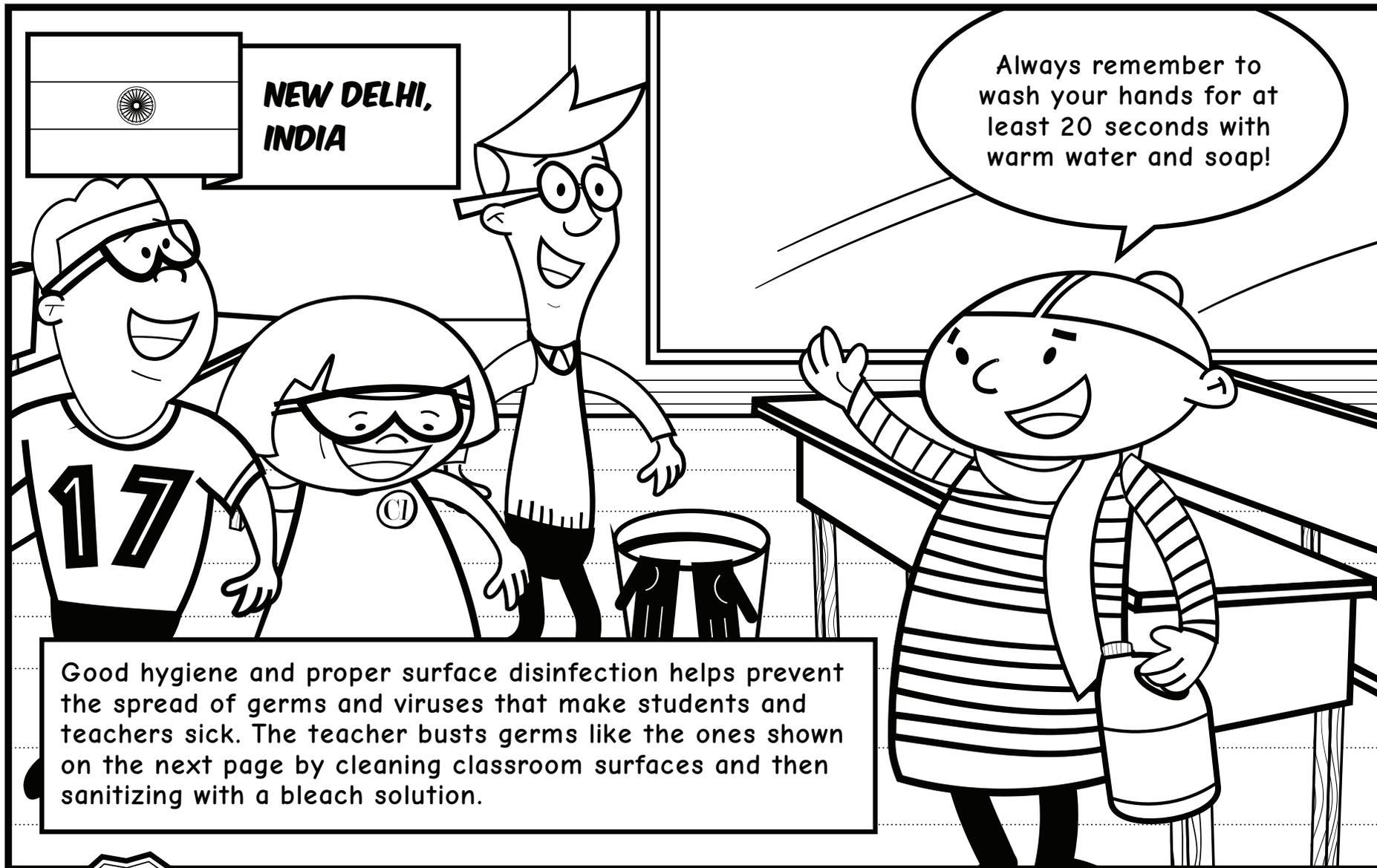
This process removes most organisms present on surfaces that cause infection and disease.

ENEMSTEL

The basic building blocks of matter.

HBLEAC

Chlorine _____ is a water solution of sodium hypochlorite.

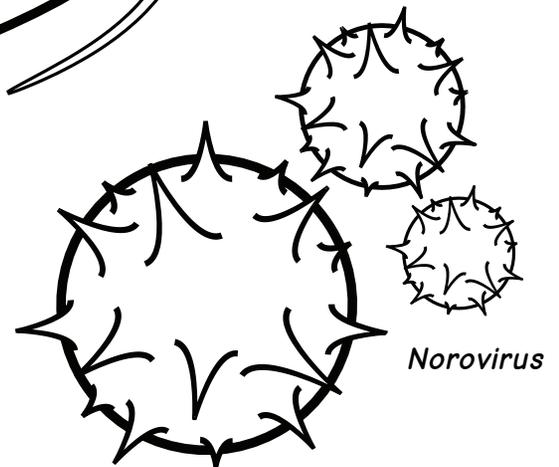
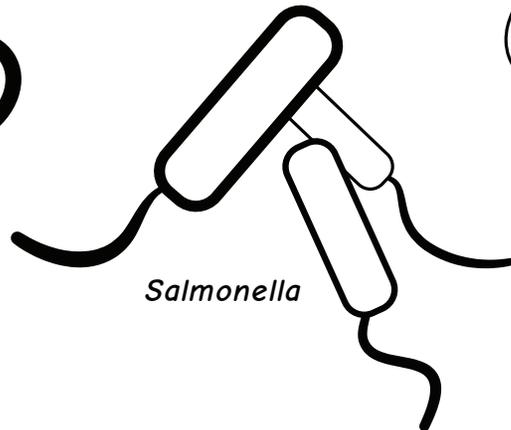
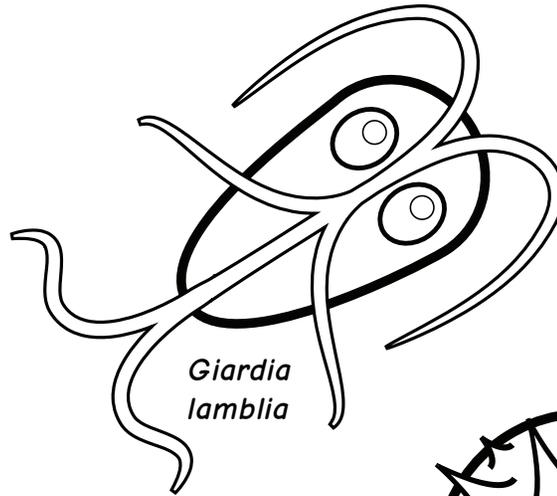
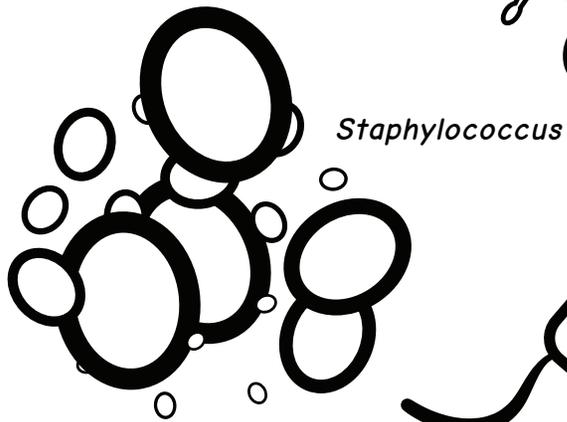
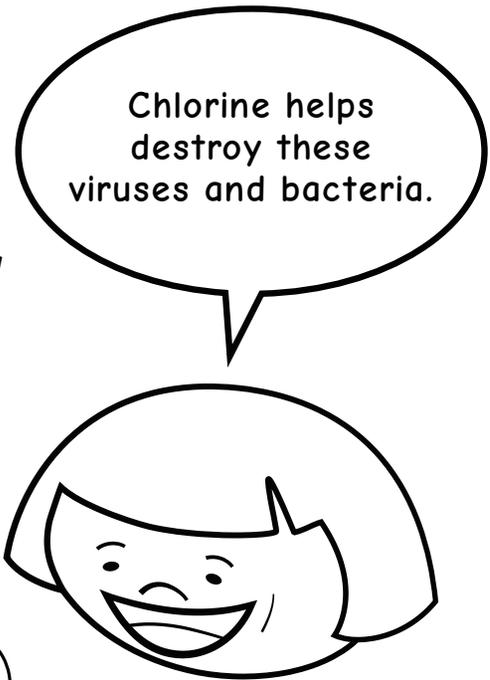
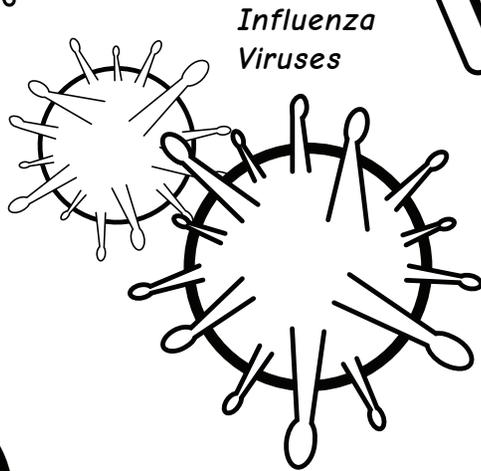
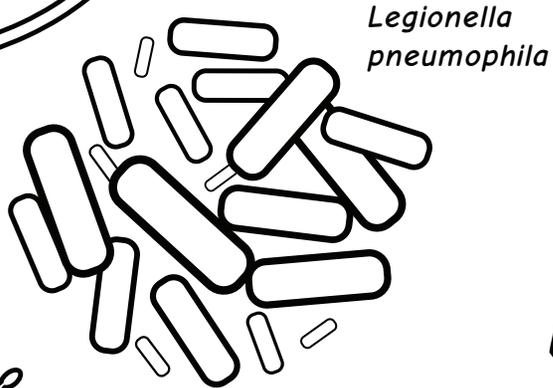
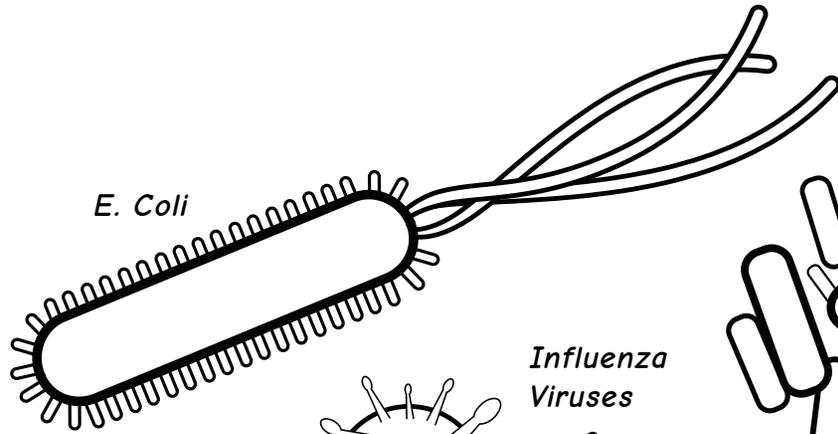


Good hygiene and proper surface disinfection helps prevent the spread of germs and viruses that make students and teachers sick. The teacher busts germs like the ones shown on the next page by cleaning classroom surfaces and then sanitizing with a bleach solution.

**BROUGHT TO
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CHEMISTRY**

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

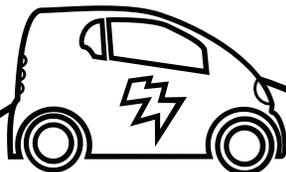
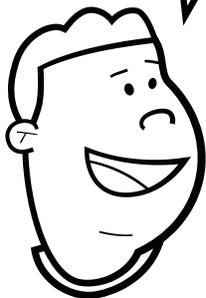
CHLORINE TO THE RESCUE!



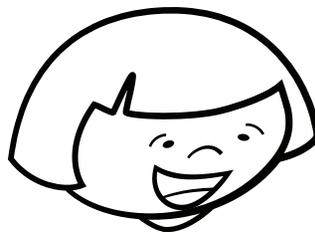
After a trip around the world, the team returns home and finds out that chlorine helps them in their everyday lives, too...



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!



**BROUGHT TO
YOU BY
CHLORINE
CHEMISTRY**

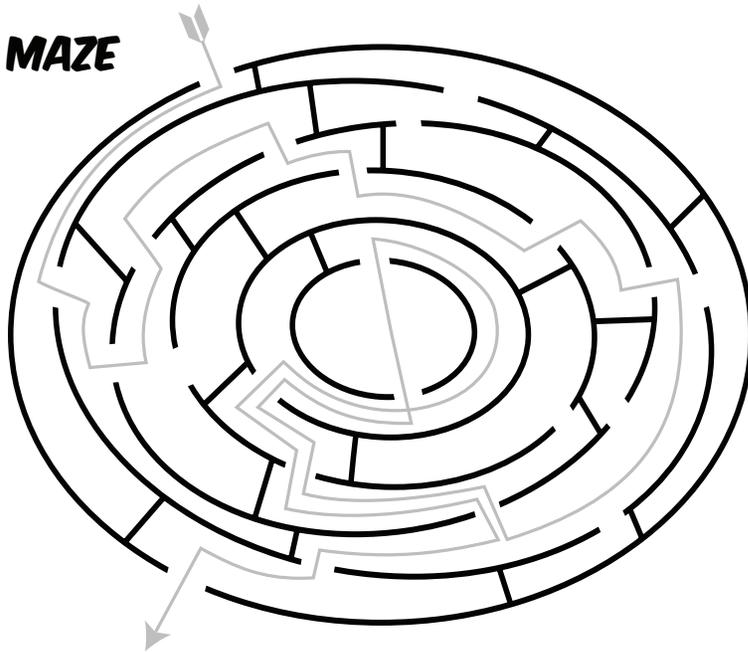
Titanium Dioxide – A common white pigment that is used in many different products including cosmetics and fabrics. It can even be found on some powdered donuts!

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

MAZE

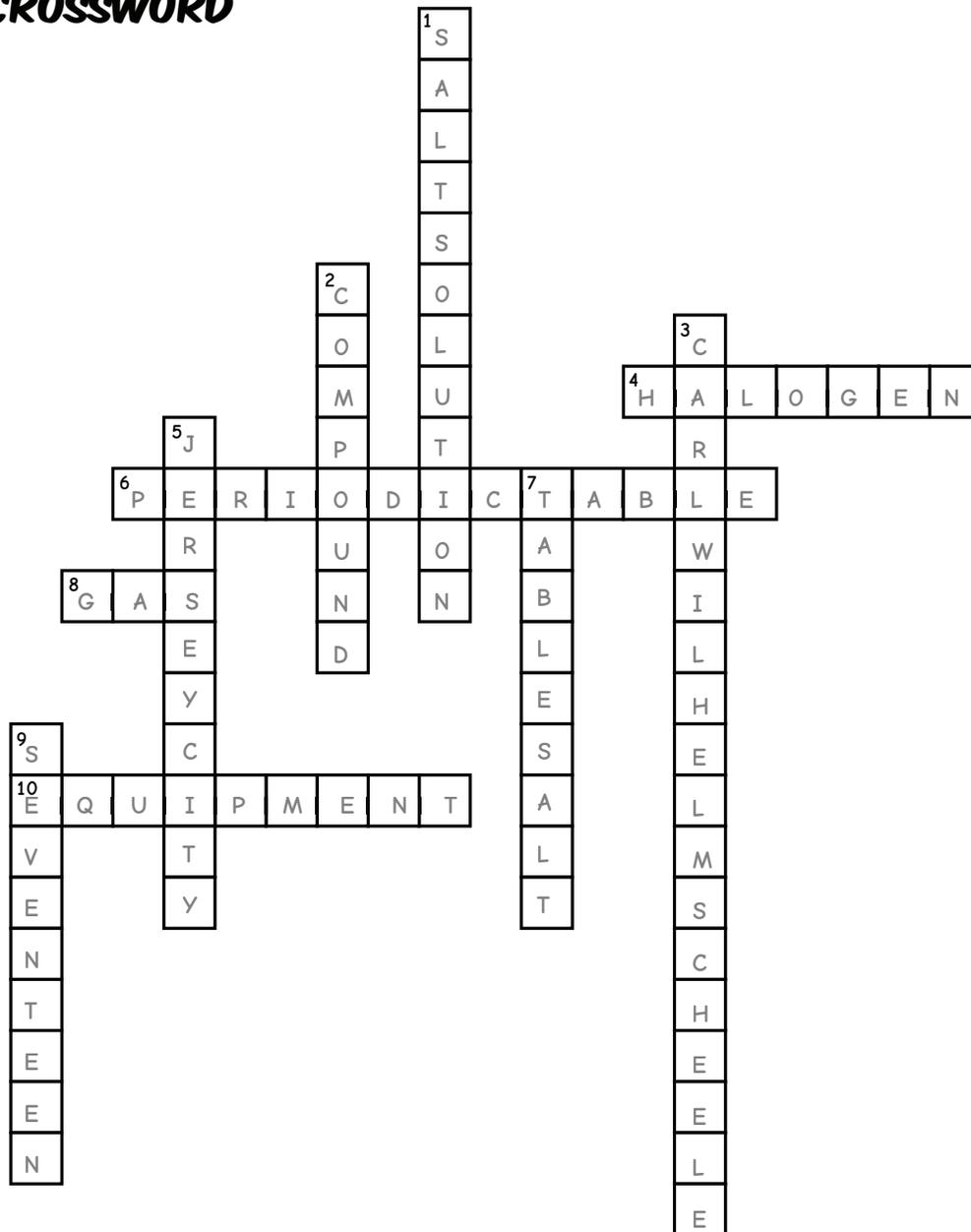


WORD SEARCH



ANSWER KEY

CROSSWORD

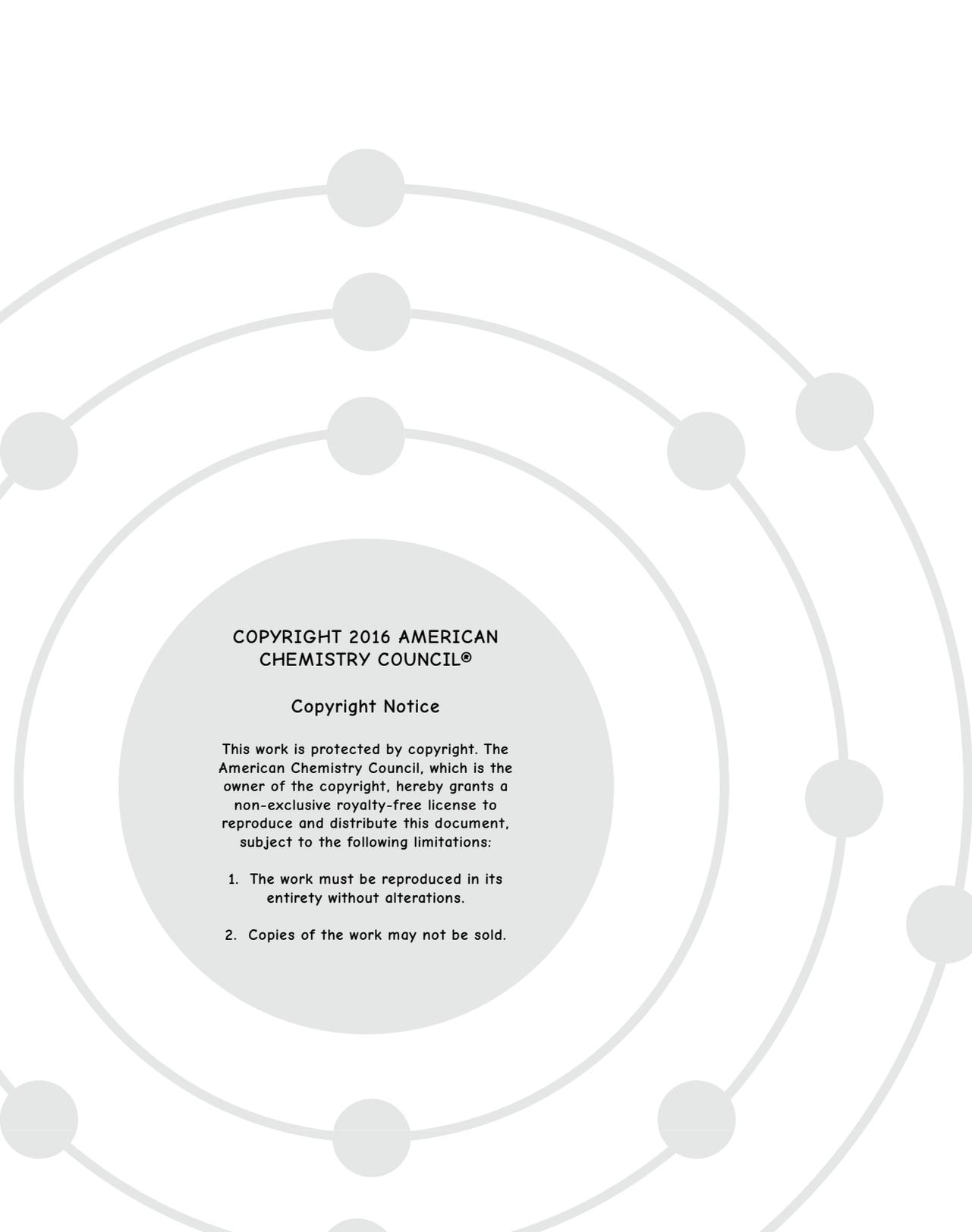


WHAT'S DIFFERENT?

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 | |

A decorative background graphic consisting of several concentric light gray circles with small gray circles at their intersections, resembling an atomic model.

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PERIODIC TABLE OF ELEMENTS

1 1.008 H Hydrogen																	2 4.003 He Helium		
3 6.94 Li Lithium	4 9.012 Be Beryllium																	10 20.180 Ne Neon	
11 22.990 Na Sodium	12 24.305 Mg Magnesium																	17 35.453 Cl Chlorine	18 39.948 Ar Argon
19 39.098 K Potassium	20 40.078 Ca Calcium	21 44.956 Sc Scandium	22 47.867 Ti Titanium	23 50.942 V Vanadium	24 51.996 Cr Chromium	25 54.938 Mn Manganese	26 4.000 Fe Iron	27 58.933 Co Cobalt	28 58.693 Ni Nickel	29 63.546 Cu Copper	30 65.38 Zn Zinc	31 69.723 Ga Gallium	32 72.63 Ge Germanium	33 74.922 As Arsenic	34 78.96 Se Selenium	35 79.904 Br Bromine	36 83.798 Kr Krypton		
37 85.468 Rb Rubidium	38 87.62 Sr Strontium	39 88.906 Y Yttrium	40 91.224 Zr Zirconium	41 92.906 Nb Niobium	42 95.96 Mo Molybdenum	43 (98) Tc Technetium	44 101.07 Ru Ruthenium	45 102.91 Rh Rhodium	46 106.42 Pd Palladium	47 107.87 Ag Silver	48 112.41 Cd Cadmium	49 114.82 In Indium	50 118.71 Sn Tin	51 121.76 Sb Antimony	52 127.60 Te Tellurium	53 126.90 I Iodine	54 131.29 Xe Xenon		
55 132.91 Cs Caesium	56 137.33 Ba Barium	57-71 Lanthanides	72 178.49 Hf Hafnium	73 180.95 Ta Tantalum	74 183.84 W Tungsten	75 186.21 Re Rhenium	76 190.23 Os Osmium	77 192.22 Ir Iridium	78 195.08 Pt Platinum	79 196.97 Au Gold	80 200.59 Hg Mercury	81 204.38 Tl Thallium	82 207.2 Pb Lead	83 208.98 Bi Bismuth	84 (209) Po Polonium	85 (210) At Astatine	86 (222) Rn Radon		
87 (223) Fr Francium	88 (226) Ra Radium	89-103 Actinides	104 (267) Rf Rutherfordium	105 (268) Db Dubnium	106 (269) Sg Seaborgium	107 (270) Bh Bohrium	108 (277) Hs Hassium	109 (278) Mt Meitnerium	110 (281) Ds Darmstadtium	111 (282) Rg Roentgenium	112 (285) Cn Copernicium	113 (286) Nh Nihonium	114 (289) Fl Flerovium	115 (289) Mc Moscovium	116 (293) Lv Livermorium	117 (294) Ts Tennessine	118 (294) Og Oganesson		

Metals

- Alkali Metals
- Alkali Earth Metals
- Transition Metals
- Other Metals
- Lanthanides
- Actinides

Nonmetals

- Metalloids
- Other Non Metals
- Halogens
- Noble Gases
- Unconfirmed

Atomic Number **17** Atomic Weight **35.453**

Black = Solid
Red = Liquid
Blue = Gas
Grey = Unknown
At 0°C 1 bar

Cl
Chlorine

Chemical Symbol
Name

57 138.91 La Lanthanum	58 140.12 Ce Cerium	59 140.91 Pr Praseodymium	60 144.24 Nd Neodymium	61 (145) Pm Promethium	62 150.36 Sm Samarium	63 151.96 Eu Europium	64 157.25 Gd Gadolinium	65 158.93 Tb Terbium	66 162.50 Dy Dysprosium	67 164.93 Ho Holmium	68 167.26 Er Erbium	69 168.93 Tm Thulium	70 173.05 Yb Ytterbium	71 174.97 Lu Lutetium
89 (227) Ac Actinium	90 232.04 Th Thorium	91 231.04 Pa Protactinium	92 238.03 U Uranium	93 (237) Np Neptunium	94 (244) Pu Plutonium	95 (243) Am Americium	96 (247) Cm Curium	97 (247) Bk Berkelium	98 (251) Cf Californium	99 (252) Es Einsteinium	100 (257) Fm Fermium	101 (258) Md Mendelevium	102 (259) No Nobelium	103 (262) Lr Lawrencium