First Flight
FIELD TRIP

LIGHT THE LAMP

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#15 RYAN GETZLAF

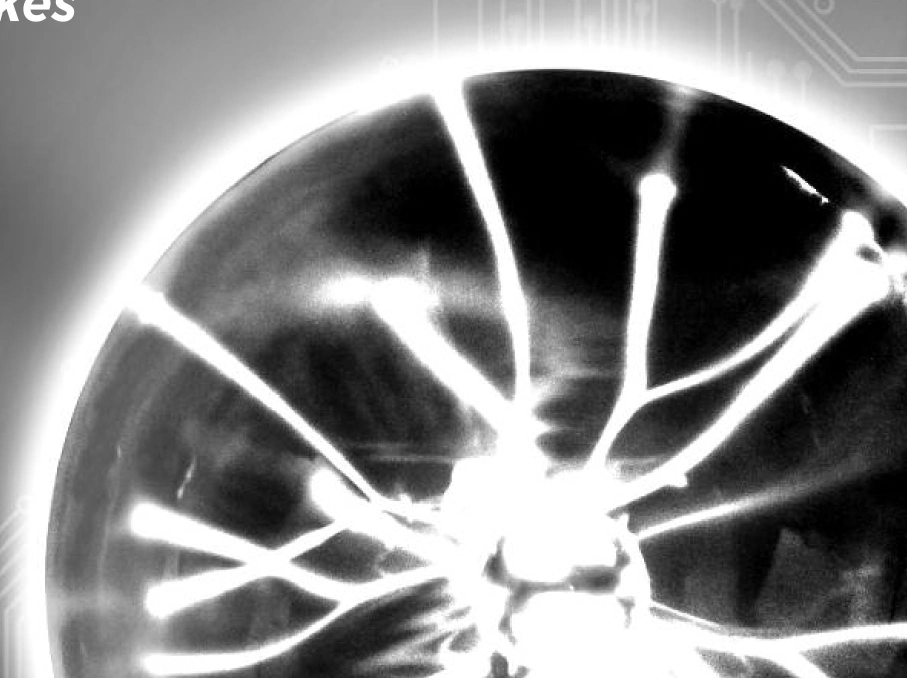
LIGHT THE LAMP

There's nothing more exciting than a goal scored by the home team. When the Ducks score you better be ready for something special to happen at Honda Center. A horn fills the arena with sound, a goal song blasts from speakers throughout the building, and intense red light flashes behind the goal. This electrifying event is known to Ducks players and fans as "Lighting the Lamp". While the puck entering the net sets off this chain of events, it's electricity, shooting through a vast series of circuits, that makes it all happen.

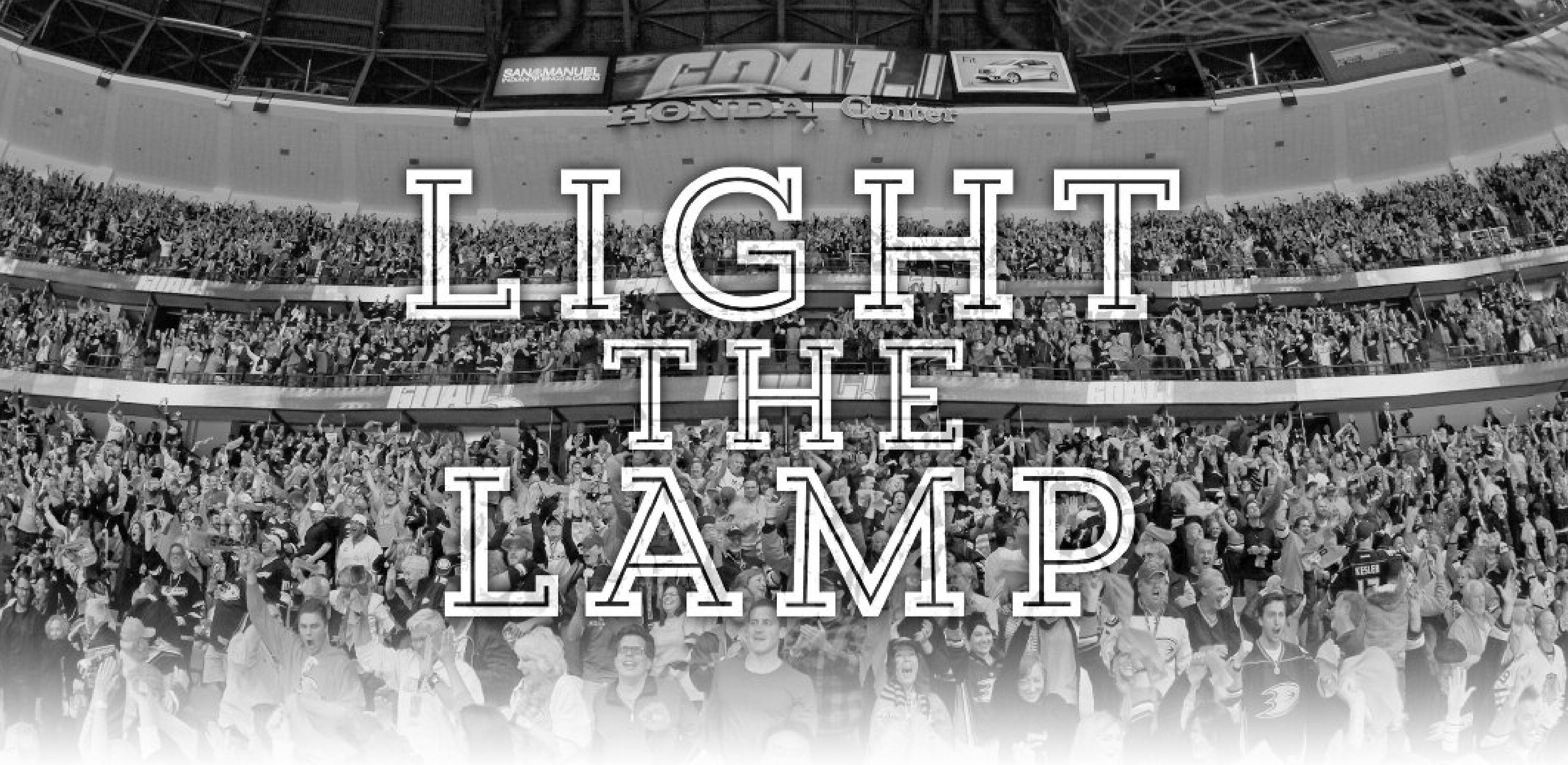
You probably already know this but, electricity makes a lot of the things we do each day possible. It powers the lights in our homes and the mobile devices we use to play the newest games or to say "Hey!" to a friend. Electricity can be found almost everywhere and Honda Center is no exception. We want you know how it works and to do so, you'll go on a journey to light your lamp. The information in this workbook will teach you to think like an electrical engineer. By the end of this book you'll design and build a circuit that powers a light and sets off sound just like an Anaheim Ducks goal.

It will take your best effort and some perseverance to work through this book, not to mention teamwork. But, once you do, you'll be ready to take on the challenges that await you during the First Flight Field Trip. When it comes to hockey, the best goals take teamwork, hard work, creativity, and skill.

Do you have what it takes to "Light the Lamp"? We know you do! We can't wait to see you March 9th. Let's get started!

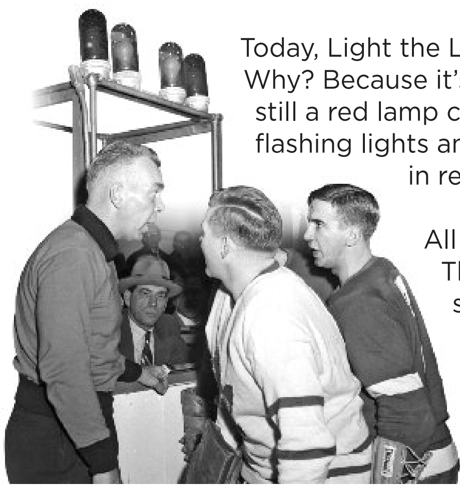


Dedicated to J.H.^{2}



LIGHT THE LAMP

The term Light the Lamp has been used in hockey ever since the early days of the game. When it became a spectator sport back in the early 1900's, Light the Lamp had a very different meaning because electricity wasn't available everywhere as it is now. NHL arenas didn't have access to lasers or smoke machines, nor did they have fog horns or goal songs blasting through the speakers. What they did have was a lamp installed behind the goaltender. This light was controlled by a goal judge who would turn it on only after the puck had gone past the goaltender, crossed the goal line, and entered the goal. A flashing red light would indicate to everyone in the arena that a goal had been scored!



Today, Light the Lamp is the event that fans look forward to when they attend a hockey game. Why? Because it's a celebration for a home team goal! At the heart of this celebration is still a red lamp controlled by a goal judge. But now, there's a whole lot more! A multitude of flashing lights and sounds are also used to give fans more reasons to scream, shout, and sing in response to their team's accomplishment on the ice.

All 31 teams across the league Light the Lamp in their own creative ways. The Calgary Flames fill the arena with red lights. The Columbus Blue Jackets shoot cannons. And, the Edmonton Oilers blow fire out of an oil rig up in the rafters. Just about every fog horn, every goal song, and every red lamp is unique. When the Anaheim Ducks score a goal, a loud siren, fog horn, and laser light show fill Honda Center. If you're a Ducks fan, this is the best thing in hockey!

LAMP HISTORY

Hockey often uses technology to improve the game for its fans. From hockey sticks to the ways people can interact with players using social media, lighting the lamp is no different. So, what will Light the Lamp look like in the future? The possibilities are limitless! Regardless, every light and every sound will still be powered by <u>electricity</u> and connected by <u>circuits</u>. It's time to learn about these things because **you are the engineer** we need to improve this important aspect of the game. How will you use your creativity to Light the Lamp?

THIS IS YOUR INVITATION TO INNOVATE!

THINK LIKE AN ENGINEER

Helmets are essential for the game of hockey. In order to think like an engineer you'll also need some equipment.

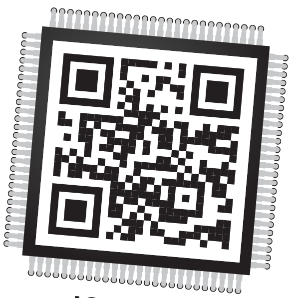
JOURNAL

Engineers use journals or notebooks to record their ideas, collected data and calculations to read them again later. Each time you see this icon, write down some notes or any observations about electricity in your journal. If you like to draw, sketching plans and diagrams is encouraged.

PENCIL & ERASER

Engineers and scientists like to take notes that are very neat. That's why they use pencils and erasers for the best results. It's important to keep your ideas or notes, no matter how wild and crazy they are. Erase mistakes, not ideas!

DON'T HAVE A JOURNAL?
Scan the QR CODE and find the PROJECTS link to learn how to make one.



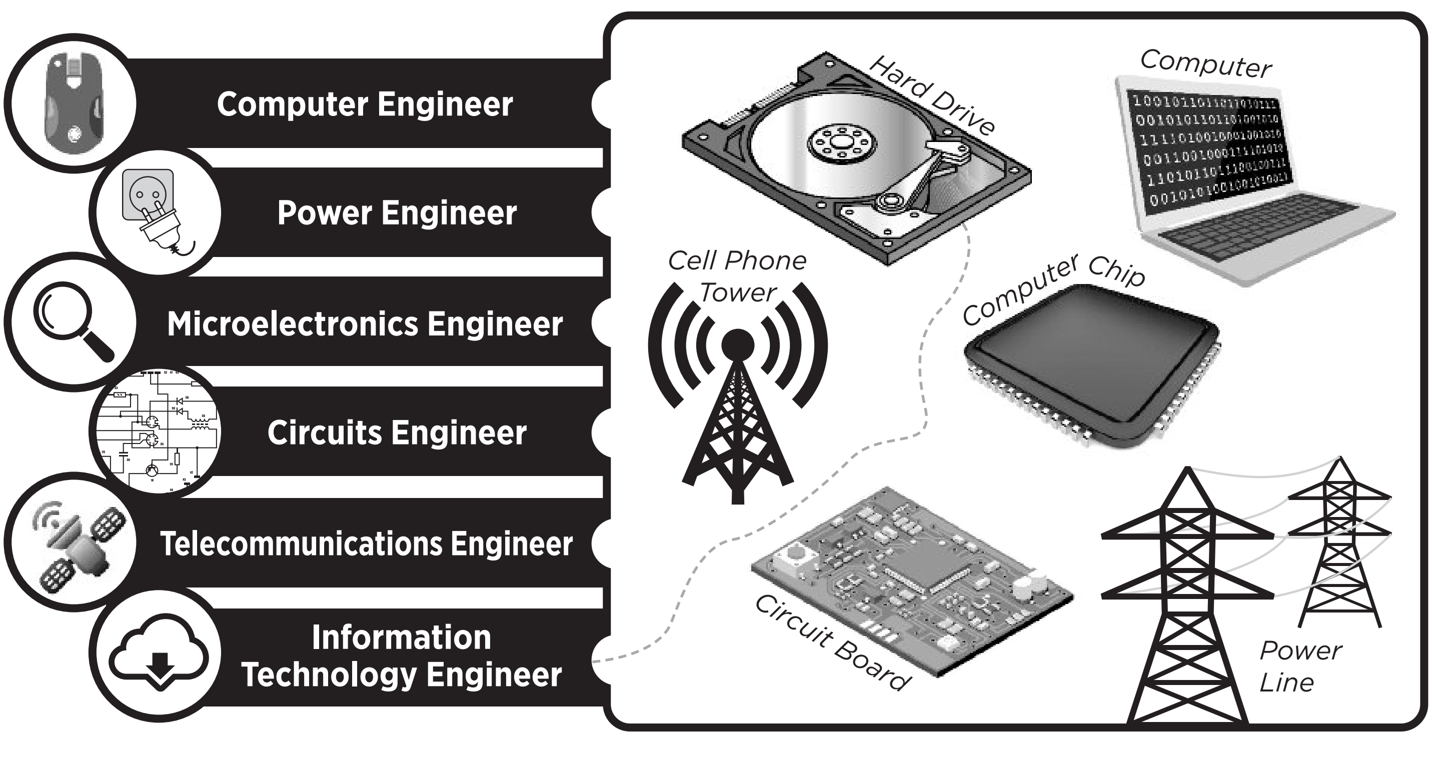
JOURNAL

AVENGER OR ENGINEER?

The heroes and villains from the movies that take place in a galaxy far, far, away seem to use electricity with such ease. They're able to stop lightning bolts out of midair or even shoot them out of their fingertips. Although this is make believe, there are in fact, real people who have the special ability to do amazing things with electricity. Who are they? They're electrical engineers! These men and women are behind countless everyday products and are able to make our lives better by harnessing the power of electricity. They can control it to turn motors, send digital messages through the air, and do thousands of other cool things. Most of all, we're fortunate that these engineers use their "powers" to turn on millions of light bulbs, keeping us out of the dark... side.

COACHES CHALLENGE

There are many types of electrical engineers, each specializing in using electricity for good. Match the objects in the box to the engineer who most likely built it. Use a dictionary or books on this topic to help you complete this activity! Then, in a journal, write down the type of electrical engineer that interests you the most.



IT'S ELECTRIC

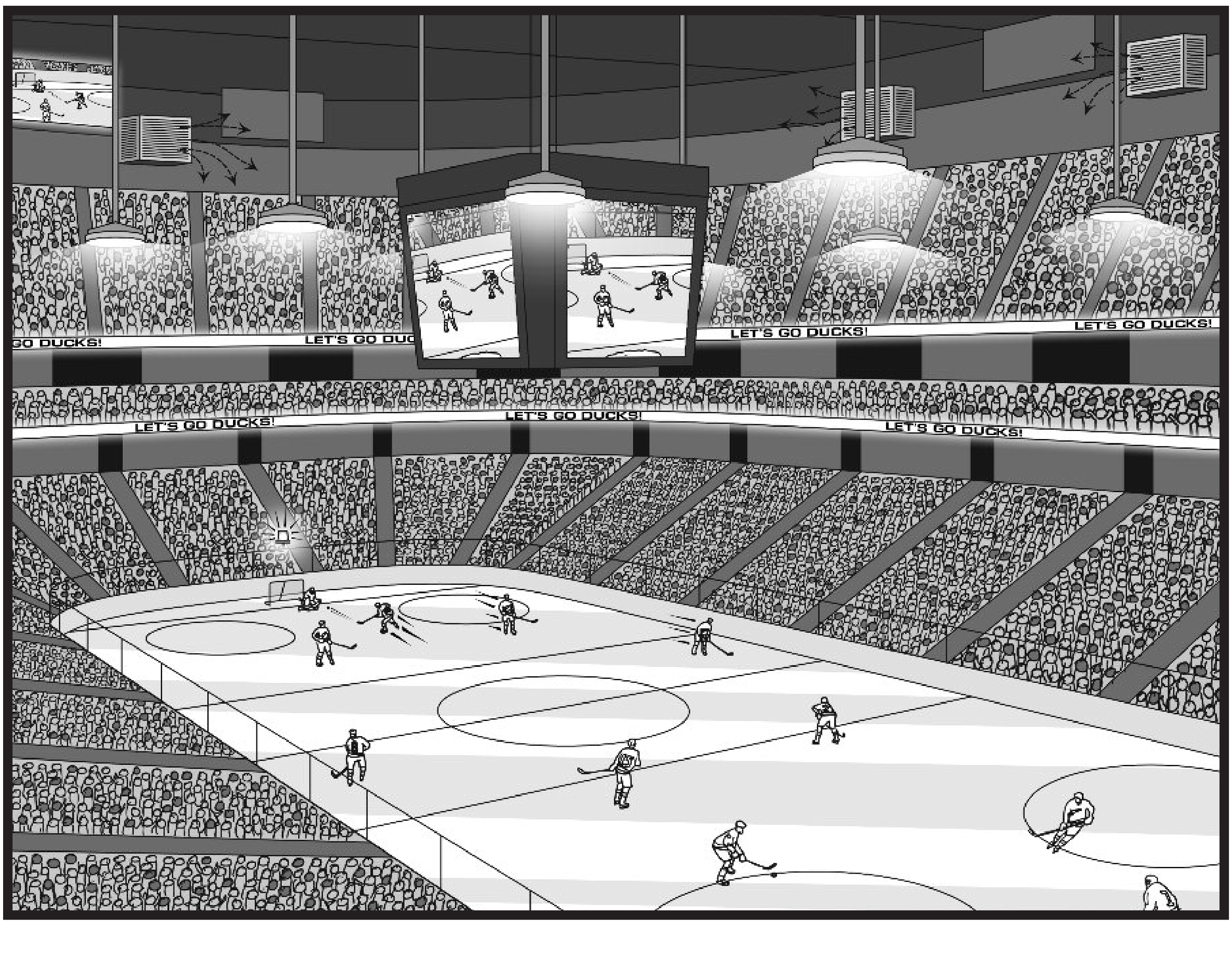
! READ THIS FIRST!

All the experiments in this workbook use safe, low-voltage batteries and should be done with adult supervision. **PLEASE DO NOT** use electricity from a wall outlet for any of these activities. This type of electricity is high voltage that could cause serious injury. Let's respect electricity so that we can have a fun and safe time Lighting the Lamp!

The atmosphere at a Ducks game is exciting. You can say that it's electric! Electricity is exciting too. That's because life as we know it would be very different without this important resource. It keeps our homes warm in the winter and cool in the summer. It allows us to do the many things that we love to do each day. Can you imagine a world where we wouldn't be able to turn on a light, car, or computer? We can't either. That's why electrical engineers have worked really hard to make electricity available to us no matter where we're at. Whether we're at home, school, or even at Honda Center, we are able to use electricity!

COACHES CHALLENGE

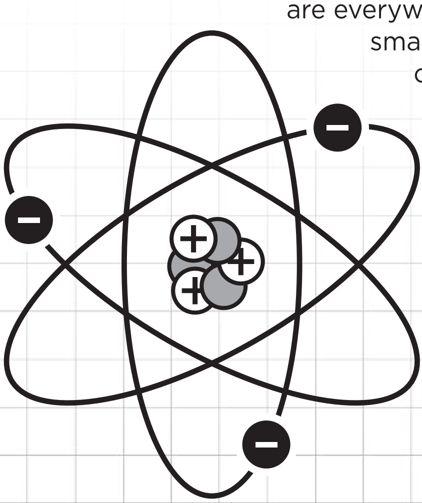
Take a look at Honda Center and circle as many things in the picture that use electricity. In your journal, write down how you think electricity makes these things work at this hockey game.



IT'S ELECTRIC

We hardly ever think about electricity beyond the outlets that we plug our devices into. So where does it come from? Sure, it comes from a network of power lines leading to water, coal, or solar power plants. But if we dig a little deeper, the truth is that electricity has always been around because it naturally exists in the world. Have you ever seen lightning during a thunderstorm? That's electricity! Electric eels have the natural ability to shock their predators. Inside each one of us, electricity is used to send and receive signals throughout our body's nervous system. When you stub your toe, electricity carries the message of pain all the way to your brain and then to your mouth to say "Ouch!"

It was just a little over 100 years ago that scientists figured out the nature of electricity. Most importantly, they learned how to control it. These really smart people found that the **atom** was behind this magic. Atoms are everywhere and in everything. They are the small building blocks of life that are too small to see with your eyes. With special equipment, you'll find that they're made of even tinier things called **protons**, **electrons**, and **neutrons**. These **teams of particles** have many different properties and their special relationship with each other is what we use to make electricity work for us!



Protons and electrons each carry their own type of electrical energy. This is called charge.

(+) Protons have a positive (+) charge

Electrons have a negative (-) charge (−)

Neutrons do not have a charge

Particles have a unique relationship with each other. There is an invisible (electric) field that wants to keep them together or apart!

Opposite charges are attracted to each other. This is where the phrase "opposites attract" comes from!

(−) → ← (+)

(−) ← → (−)

Like charges repel

(+) ← → (+)

IT'S ELECTRIC

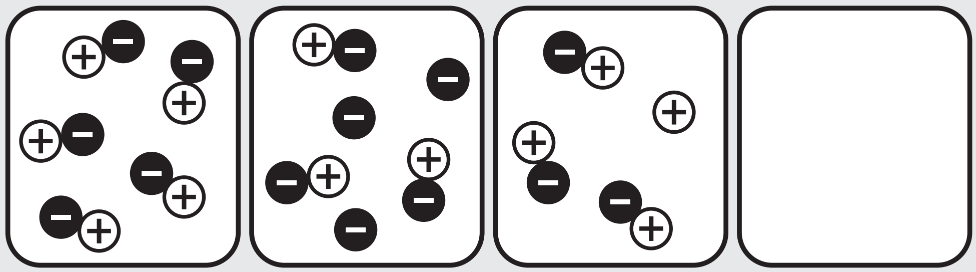
SPECIAL TEAMS

Objects around us are filled with millions, or even billions, of atomic particles. Most of the time, they are **neutral** and contain an even number of protons and electrons. Neutral objects don't have a charge because the pluses (+) from the protons and the minuses (-) from the electrons cancel each other out like a simple math problem. However, when particles become imbalanced, there's a name for these special objects. Objects with more electrons are **negatively charged** and those with more protons are **positively charged**.

COACHES CHALLENGE

Take a look at the pictures <u>to the right</u> and label each cell positively charged, negatively charged, or neutral. Then, draw your own picture using the information that's given to you.

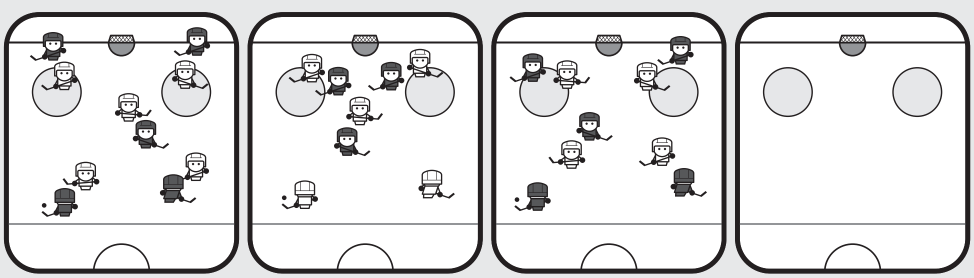
Protons = 5	**Protons** = 3	**Protons** = 4	**Protons** = 8
Electrons = 5	**Electrons** = 6	**Electrons** = 3	**Electrons** =



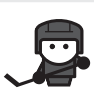
			Neutral

A hockey rink during an NHL game is filled with a lot of excitement as well as 40 players from a home team and away team. But, only five skaters and one goalie from each team are allowed to be on the ice while the others wait their turn on the bench. For most of the game, these teams play at **even-strength**. That's when the number of home team players on the ice are equal to the away team players. However, when penalties are called, players are sent to the box for two or five minutes. There's a name for these special teams. A team with more players is on a **power play** and a team with fewer players is on the **penalty kill**.

Ducks = 5	**Ducks** = 3	**Ducks** = 5	**Ducks** = 4
Sharks = 5	**Sharks** = 5	**Sharks** = 4	**Sharks** =



			Power Play

 **= Ducks (Home Team)**  **= Sharks (Away Team)**

COACHES CHALLENGE

Take a look at the pictures <u>to the left</u> and write down whether the <u>home team Ducks</u> are on the power play, penalty kill, or even strength. Then, draw your own picture using the information that's given to you.

POWER PLAY

IT'S ELECTRIC

In hockey, moving the puck using the skill of passing often leads to speedy rushes up the ice or incredible goals. This is the thing that Anaheim Ducks fans love to see. It's no different with electricity. Amazing things happen when electrons move. When they do, it generates two types of electricity - **static electricity** and **current electricity**.

STATIC ELECTRICITY

Static electricity is a build-up of electrons on the surface of an object. Although this happens all around us, we don't realize it exists until we touch something made of metal. The shock you feel, hear, or even see is the result of static electricity on your body. So how does this happen? The best way to explain this is through our most common run-in with static electricity.

A Static Electricity by Adhesion

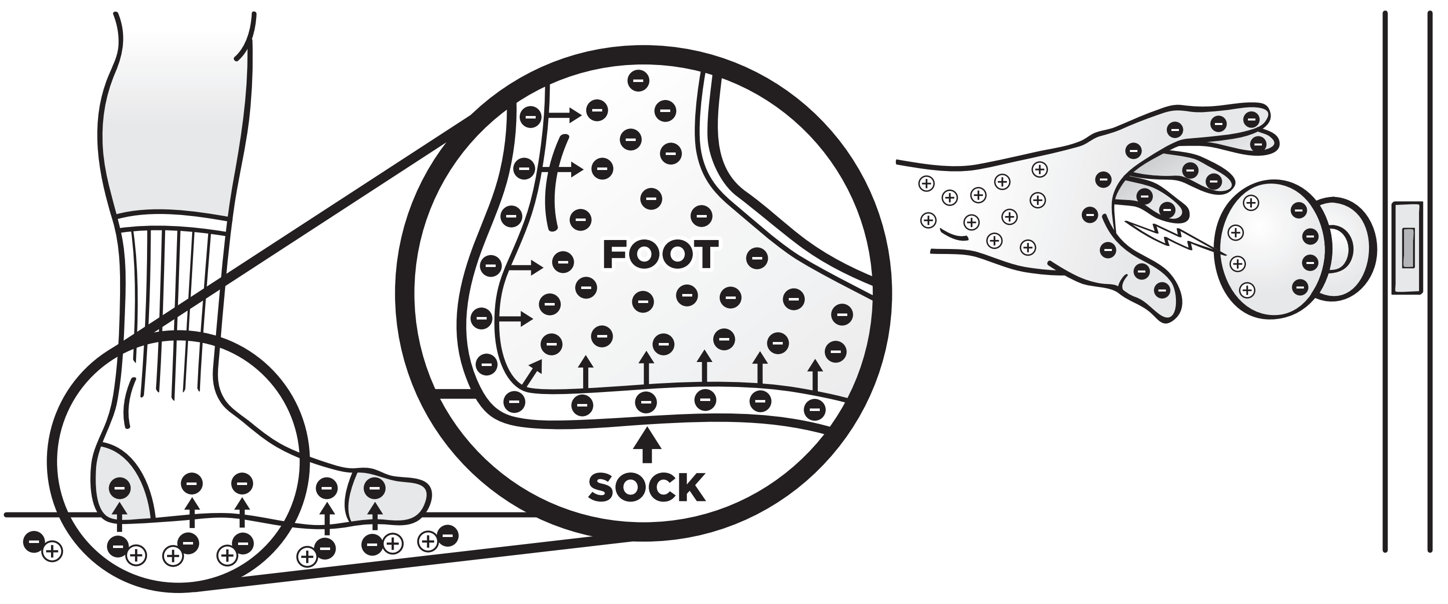
Electrons move by sticking onto another object. When two neutral objects are rubbed together, electrons can break free from one object and adhere, or stick, to the other.

B Static Electricity by Conduction

Electrons move through touching. The electrons from a negatively charged object will disperse all over a neutral object when they touch.

C Static Electricity by Induction

Induction is the movement of electrons by the repelling and attracting nature of atomic particles.



Walking over carpet is a perfect example of this. Electrons from the carpet stick to the sock each time you take a step. Now you've got a charged up sock!

Electrons move onto your skin when it touches the sock. Now, the entire surface of your skin is negatively charged... all the way out to your fingertips!

The electrons on your fingertips repel the electrons and attract the protons of the doorknob. Because opposites attract, the shock you feel when your hand gets near the doorknob are electrons jumping over to be with their proton friends.

What other places have you observed static electricity in your classroom or school?

IT'S ELECTRIC

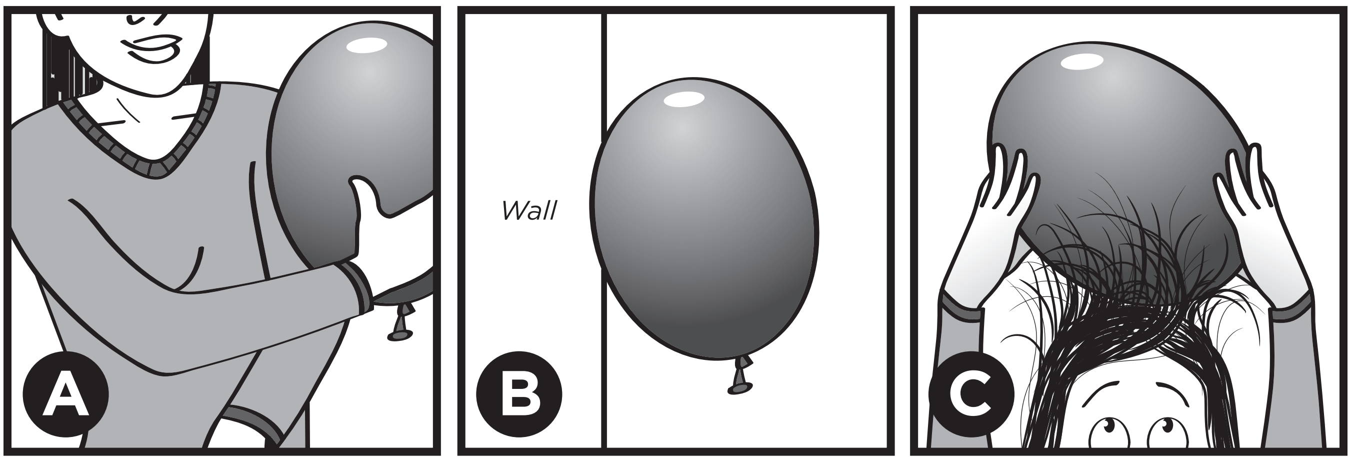
COACHES CHALLENGE

Complete the "hair raising" activities below to see, feel, and hear static electricity at work.

Step 1: **Gather** Materials
- Blown up balloon
- Bed head

Step 2: **Try** the activities found in pictures **A**, **B**, and **C**. Start with **A**. Then, for **B** and **C**, you'll need to charge up the balloon first before doing these activities.

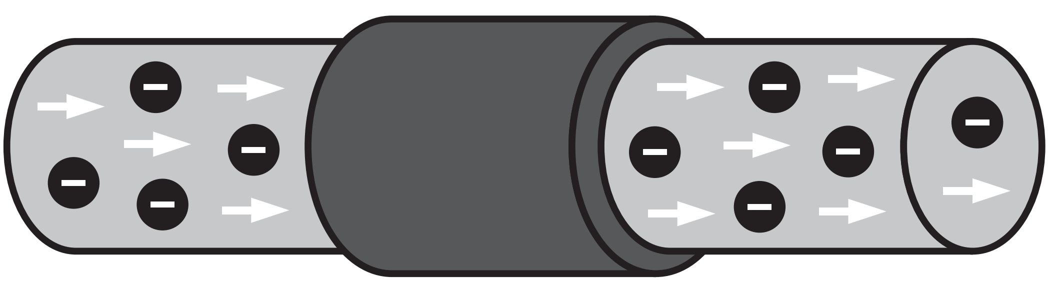
Step 3: **Write** your observations for each activity in the space provided or in your journal. How did you experience static electricity and where did you see static electricity by adhesion, conduction, and induction?



CURRENT ELECTRICITY

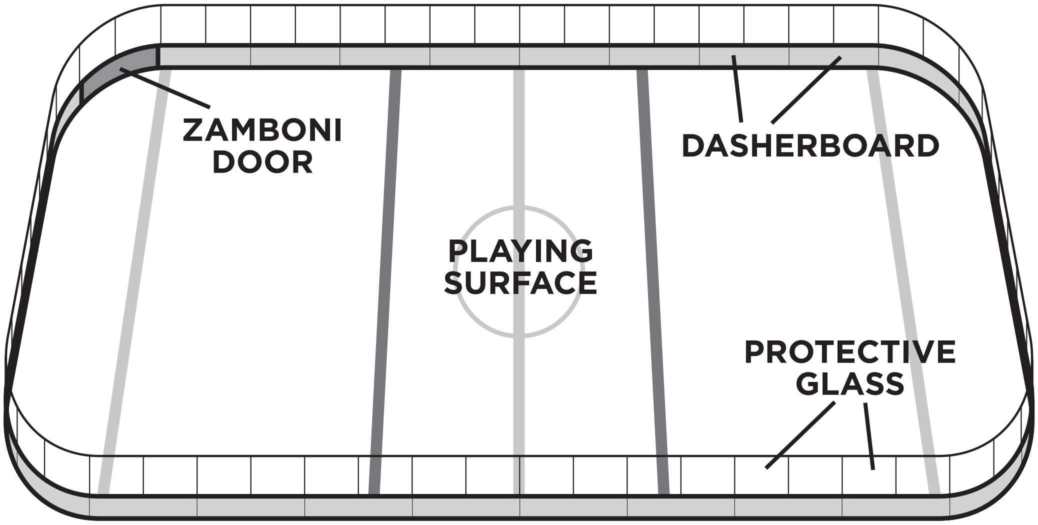
Static electricity goes away, or discharges, very quickly. While it can provide a large amount of electricity, we need something else that can power the lights and our devices for long periods of time. **Current electricity** is the answer! Current electricity is what you get when there's a continuous, or non-stop, flow of electrons through an object. Thanks to electrical engineers, we can create this flow of electrons using generators that push them safely to people's homes near and far. The best thing about current electricity is that we can control it using a circuit, the electric playground for electrons!

The rate, or speed, of electron flow is measured in **amperes (A)**.



THE ELECTRIC PLAYGROUND

THE ICE RINK



No other sport in the world has anything like the hockey rink. That's because no sport uses an object as dynamic as a hockey puck. From its shape to the materials it's made of, everything about the **ice rink** was made for hockey. It keeps the spectators safe, allows for physical play, and most of all, it's the place where the puck can move at a fast and exciting pace. ***Let's learn about the things that make up this frozen playground.***

DASHERBOARD
A series of about 70 rink segments called **dasherboards** are connected side-by-side in the shape of a hockey rink. Each one is 96 inches long and 40 inches tall.

PLAYING SURFACE
This is the one-inch thick ice sheet that makes up the foundation of the ice rink. The parallel lines that run across the width of an ice rink divides it into three zones - offensive, defensive, and neutral.

PROTECTIVE GLASS
A piece of half-inch thick acrylic glass sits on top of each dasherboard. They keep the puck in play and protect the fans from most slap shots and high speed collisions.

MATERIAL
Dasherboards are made of a durable but elastic material that helps the puck keep its speed each time it bounces off of the rink walls.

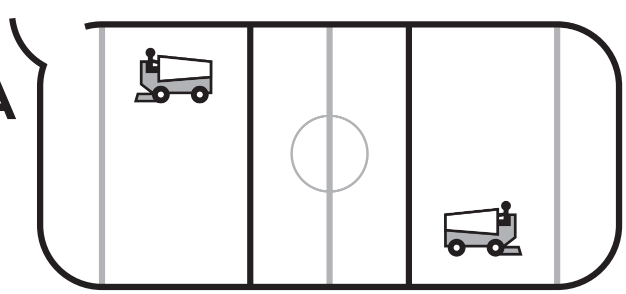
ZAMBONI DOOR
This segment can be opened or closed. When the **door is open**, the large gap it creates allows the Zamboni ice resurfacing machine to enter the rink. The game can only resume when the **door is closed**. This completes the rink's shape again.

SHAPE
The ice rink is formed in a complete loop and without any gaps. Its shape keeps the puck and players safely inside the rink.

COACHES CHALLENGE

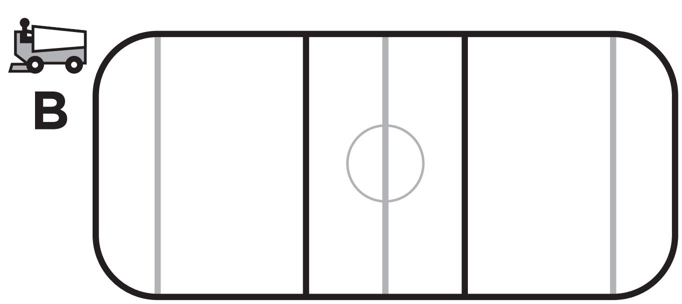
Identify the two types of ice rinks when the Zamboni door is at positions **A** and **B**. *Circle the correct answers below.*

A



OPEN RINK *or* **CLOSED RINK**

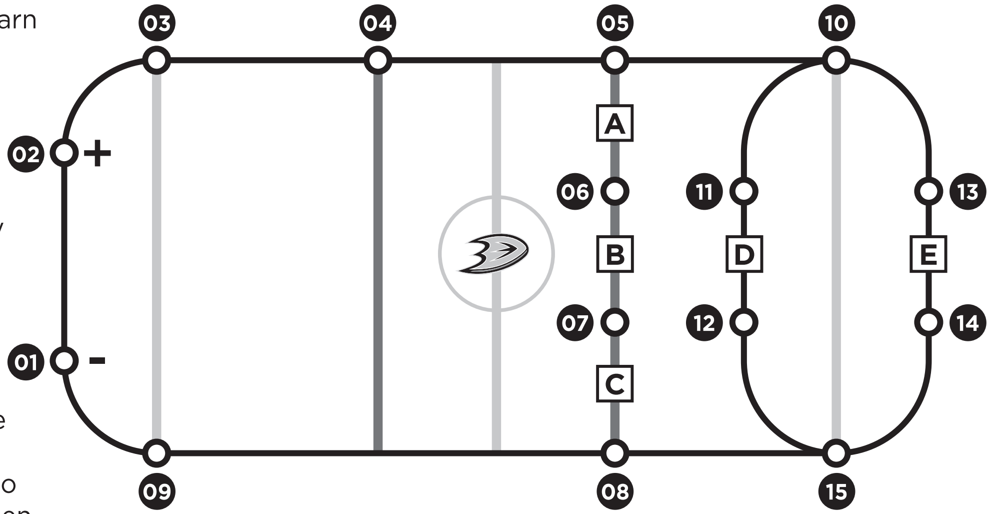
B



OPEN RINK *or* **CLOSED RINK**

THE ELECTRIC PLAYGROUND

The electron is an atom's most dynamic particle because it loves to move! But, it's not until they all flow in one direction in a circuit does it become electricity we can use. From its shape to the materials it's made of, everything about a circuit is amazing. It gives electrons a path to follow and it connects components together so that we can do fun and exciting things with them. Let's learn more about the things that make up this electric playground!



THE CIRCUIT BOARD

Circuits can be found inside any item that requires electricity. They can be found in simple items like flashlights or very complex ones like computers. No matter what they look like, all circuits share the same basic rules. That includes the circuit that Lights the Lamp at Honda Center! The best way to learn about these rules is to start with a working circuit and then learn about the parts that form it. This type of backwards engineering has a name. It's called **reverse engineering**. Let's engineer and reverse engineer your circuit!

CIRCUIT

COACHES CHALLENGE

Step 1: Gather Your Materials

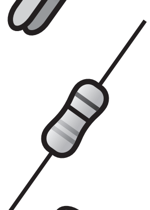
You'll need the following materials to engineer the Light the Lamp circuit. Before you get started, how do you think each item will be used?

Orange Wire ____________________

____

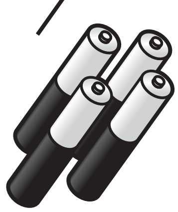
9 Brass Fasteners ____________________

____



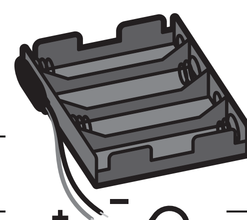
220Ω Resistor (red, red, black, black, brown) __________

____



Four (4) AAA Batteries ____________________

____



Battery Holder ____________________

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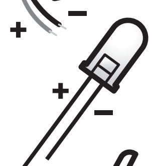
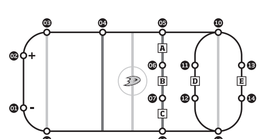


Red LED Bulb ____________________

____

Scissors ____________________

____



Light the Lamp Circuit Board ____________________

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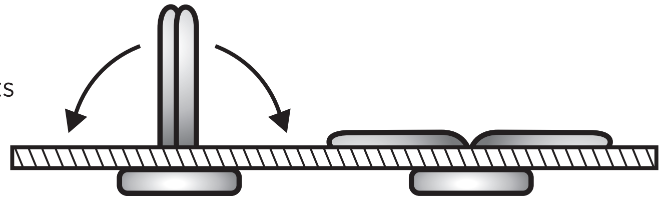
Step 2: Attach Your Materials to the Circuit Board

Follow the instructions below to attach the battery, wire, resistor, and red LED using the terminals (or holes) numbered 01 to 09.

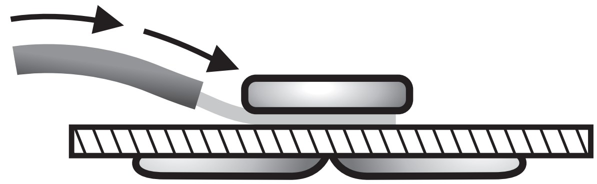
A. Terminals @ 01, 02, 03, 04, 05, 06, 07, 08, and 09

- A terminal is the place where wires and components connect. Push a brass fastener through the holes numbered 01 to 09 and bend the tails on the other side of the circuit board to secure them tightly.



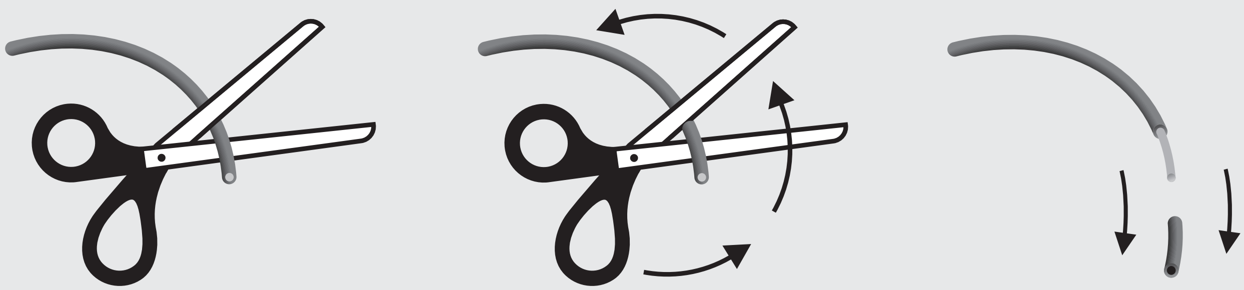
B. Wires @ segments [02-03], [04 -05], [05-06], [07-08], [08-09], and [01-09]

- Measure the distance between the terminals and then add an inch to it before cutting each wire segment.
- Use scissors to remove the outer jacket from both ends of the wire. Read the box below to learn how to do this!
- Insert, or hook, each metal end of the wire under the heads of the brass fastener. Push it from underneath the board to make space for the wire.



Stripping a Wire

There are fancy tools you can use to “strip” a wire but a pair of scissors will do the trick!



Step 1: Open your scissors and slide the wire about an inch through the place where the blades cross.

Step 2: Squeeze the scissors gently. Then, rotate it around the wire a few times or until you can see the metal center. Be careful not to cut the wire!

Step 3: Pull off the insulating jacket with your fingers. You’ve done it!

C. Battery Holder @ [01-02]

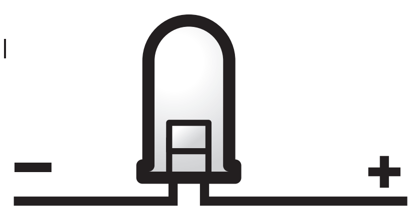
- Insert the black wire (-) at 01 and the red wire (+) at 02.
- Don’t insert the batteries yet!

D. Resistor @ [03-04]

- Insert the ends of the resistor at 03 and 04.

E. LED bulb @ B [06-07]

- Bend the leads gently until they run flat.
- Mark the longer lead with a black pen.
- Insert the longer lead (+) at 06 and the shorter lead (-) at 07.



Step 3: Power it UP!

- Insert four batteries into the battery holder and watch the LED light up!

Remove batteries from holder whenever you’re done engineering.

THE ELECTRIC PLAYGROUND

Congratulations! You just built your first **basic circuit**. In order to build bigger and more complex ones, you'll need to learn more about the following parts and the rules for forming a circuit. We're off to a great start!

A basic circuit consists of the following:

1. The right **shape** and **materials** for electrons to flow through.
2. A **power source** that provides the energy to create electron flow.
3. **Other components** that turn electron flow into light, heat, motion, and sound.

SHAPE

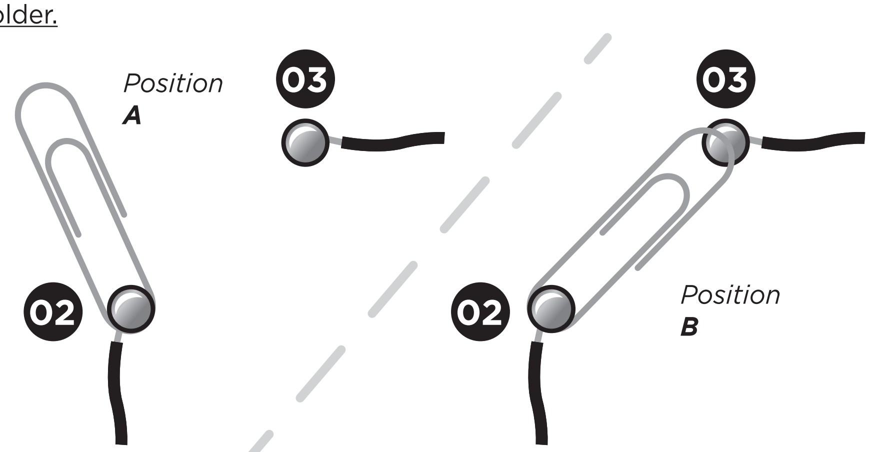
In order for electrons to flow, it needs a path to follow. That's why a basic circuit is formed like a hockey rink. It's a **closed loop** without any gaps or breaks. But when the segments that make up a circuit stop touching, electrons will stop flowing. This is called a <u>break</u> in the circuit. Not all breaks are bad though. Have you ever been told by an adult to turn off the lights? If so, you've broken a circuit using a light switch before.

Whether it's a push, pull, or flip, a switch works very much like a Zamboni door because it involves opening and closing a loop for a reason. An open switch usually turns a device off because it creates an **open circuit**. Closing a switch turns a device on. It forms a **closed circuit** so that electrons can flow again.

COACHES CHALLENGE

It's time to add a circuit's version of a Zamboni door to this electric playground. But first, make sure your basic circuit is assembled <u>***without*** any batteries in the battery holder.</u>

Step 1: Find a small paper clip.
Step 2: Remove the brass fastener completely at 02 and the wire at [02-03].
Step 3: Insert the brass fastener through one end of the paper clip and push it back into the circuit board at 02. Move the paper clip to position **A**.
Step 4: Insert four batteries into the battery holder.



Questions:

1. Which of the following circuits did you form with the paper clip at position **A**? *Circle the answer below.*

OPEN CIRCUIT *or* **CLOSED CIRCUIT**

2. What will happen to the LED when you move the paper clip to position **B**? *Explain.*

____

____

____

____

____

Remove batteries from holder whenever you're done engineering.

THE ELECTRIC PLAYGROUND

MATERIALS

Circuits must be made of the right materials to give electrons the best chance of flowing through it. That's why **conductors** are often used to form circuits. They're a highway for negative charge! **Insulators**, on the other hand, are often used as a barrier to prevent electrons from flowing to other conductors. Did you know that you can be a conductor if the electricity is strong enough? The rubber layer around an electrical cord is used to keep people, like you, safe from injury.

COACHES CHALLENGE

There are many objects around the house or classroom that are great conductors and insulators. Are you ready to identify them with your circuit? Complete the following sentence before starting this activity!

A circuit made of *conductors*
will (or) **will not** light the lamp.

A circuit made of *insulators*
will (or) **will not** light the lamp.

Step 1: With your circuit built and batteries installed, keep your switch in the OPEN position.
Step 2: **Gather** the objects from column A in the chart below.
Step 3: **Complete** columns B and C for your first object. Write down what it's made of and predict whether it is a conductor or insulator.
Step 4: **Place** the first object onto the brass fasteners at 02 and 03. Make sure they touch both terminals. Did the LED turn on? Update columns D and E.
Step 5: **Repeat** step 4 for the rest of the objects.

Object (A)	Material (B)	Prediction (C) *(circle one)*	LED (D) *(circle one)*	Results (E) *(circle one)*
Paper Clip		Conductor *or* Insulator	ON *or* OFF	Conductor *or* Insulator
Rubber Band		Conductor *or* Insulator	ON *or* OFF	Conductor *or* Insulator
Pencil		Conductor *or* Insulator	ON *or* OFF	Conductor *or* Insulator
Quarter		Conductor *or* Insulator	ON *or* OFF	Conductor *or* Insulator
Yarn or String		Conductor *or* Insulator	ON *or* OFF	Conductor *or* Insulator
Aluminum Foil		Conductor *or* Insulator	ON *or* OFF	Conductor *or* Insulator

Look around your classroom. List five (5) other objects you think conduct electricity.

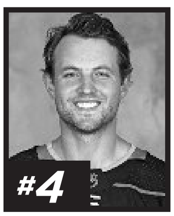
THE STARTING LINE UP

A hockey puck can't reach its potential without the passing, shooting, and stickhandling from Anaheim Ducks players. That's because players have their own abilities to turn the puck into an amazing play leading to a Ducks goal. When Coach Eakins looks at his roster of players each night, he has a very difficult decision to make with his **starting line-up**. He has to choose three **forwards**, two **defensemen**, and one **goaltender** to take the face-off at the start of each game. This decision is an important one because teams that start games well usually wins them.

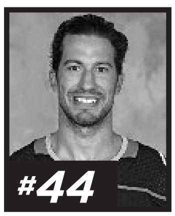
Are you ready to select your best starting line-up for the next Ducks game? Take a look at what these Anaheim Ducks components can do with the puck!

#15 Ryan Getzlaf "C"
Forward | CAN

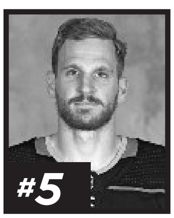
PLAYMAKER
Passes the puck to teammates at the right time and right place to score a goal.



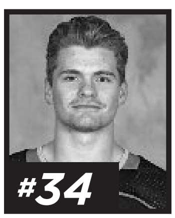
#4 Cam Fowler
Defenseman | USA



#44 Michael Del Zotto
Defenseman | CAN

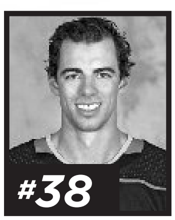


#5 Korbinian Holzer
Defenseman | DEU



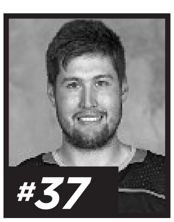
#34 Sam Steel
Forward | CAN

#25 Ondrej Kase
Forward | CZE

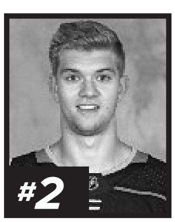


#38 Derek Grant
Forward | CAN

#67 Rickard Rakell
Forward | SWE

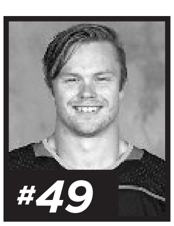


#37 Nick Ritchie
Forward | CAN

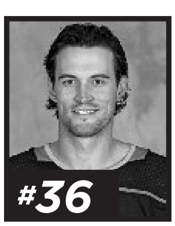


#2 Brendan Guhle
Defenseman | CAN

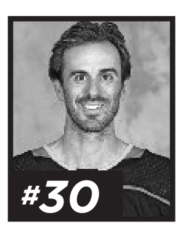
#29 Devin Shore
Forward | CAN



#49 Max Jones
Forward | CAN



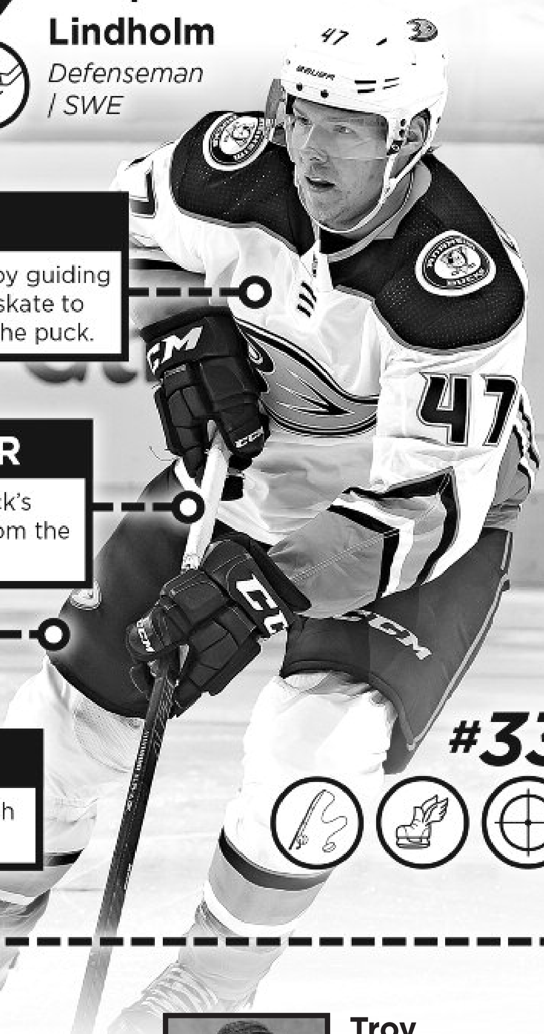
#36 John Gibson
Goalie | USA



#30 Ryan Miller
Goalie | USA

*Roster as of 1/20/20

THE STARTING LINE UP



#47 Hampus Lindholm
Defenseman | SWE

LEADER
Controls the game by guiding teammates where to skate to and what to do with the puck.

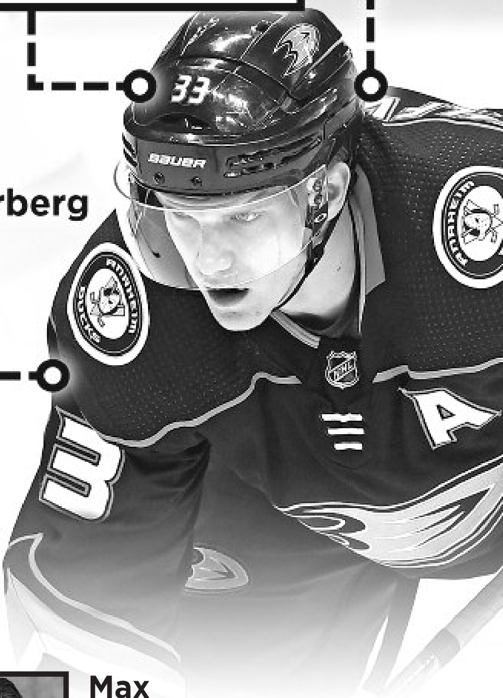
DEFENDER
Slows down the puck's movement coming from the opposing team.

SNIPER
Shoots the puck with accuracy and power.

GRINDER
Works hard with and without the puck even with a lot of resistance from opponents.

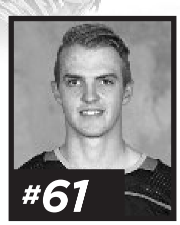
DANGLER
Holds the puck on a string using nifty stickhandling moves.

SPEEDSTER
Plays with the puck at a faster pace than others.



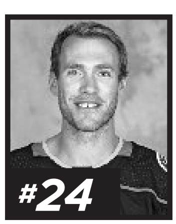
#33 Jakob Silfverberg "A"
Forward | SWE

Josh Manson
Defenseman | CAN



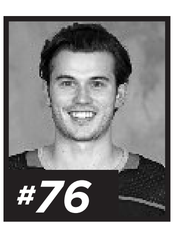
Troy Terry
Forward | USA

Jacob Larsson
Defenseman | SWE

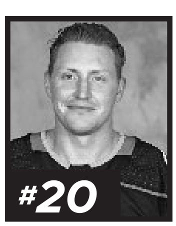


Carter Rowney
Forward | CAN

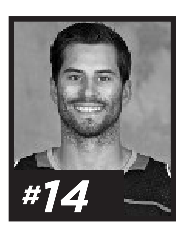
Max Comtois
Forward | CAN



Josh Mahura
Defenseman | CAN



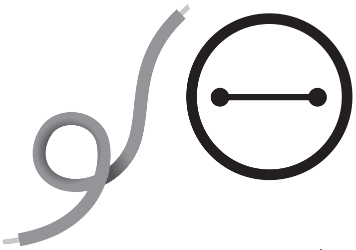
Nicolas Deslauriers
Forward | CAN



Adam Henrique
Forward | CAN

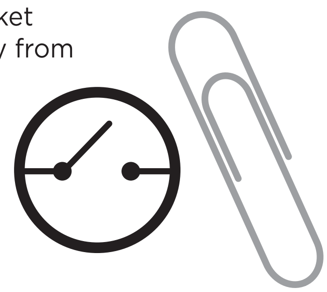
THE STARTING LINE UP

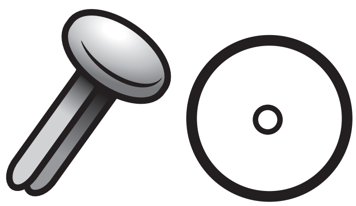
When it comes to circuits, electrons can't reach their full potential without some important players called **electronic components**. Similar to Ducks players, components come in many different forms, types, and sizes. They also have their own ability to turn electron flow into something useful. Some components can light up a dark room, others are microscopic, and then there are ones that can slow down electron flow with an opposing force called resistance. The best part about components is that you can use many of them in a circuit. You just need to connect them the right way. Once you do, you'll be able to Light the Lamp or accomplish any task with electricity. Let's learn more about the components for your circuit and the important role they play to Light the Lamp. This is your starting line-up!



Wires – *Orange Wire*
A wire uses a long piece of conductive material that allows electrons to flow between two points. The orange jacket around the wire is an insulator used to keep electricity from flowing through your hand.

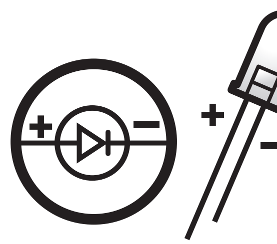
Switch – *Paper Clip*
There are many types of switches, but this door like switch uses a metal paper clip to open and close a gap in the circuit.

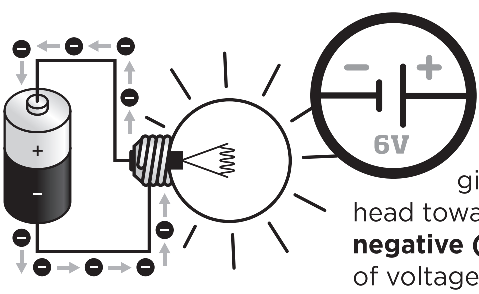




Terminal – *Brass Fasteners*
The brass fastener connects many wires and components at an intersection called a terminal. Most circuit boards use a material called solder in order to accomplish this same task.

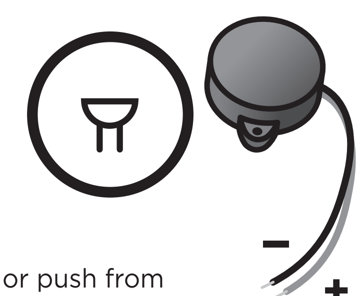
Light Source – *Low Voltage LED*
These low-voltage light emitting diodes (LED) turn electron flow into a red light. The long wire is the positive (+) pole and the shorter one is the negative (-) pole. A LED must be connected in the right direction or else it may break.

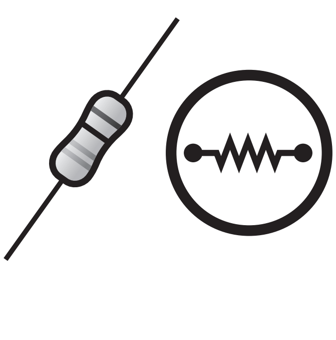




Power Source – *Four (4) AAA Batteries*
Electrons are present in everything but in order for them to start flowing they'll need a power source. A **power source** like a battery uses chemicals to generate the potential energy, or **voltage (v)**, needed to give electrons in a circuit a good push. Once they start flowing, they'll head towards the **positive (+) pole**, or side, of the battery and back out of the **negative (-) pole** so that it can go around the circuit again and again. The amount of voltage you need for a circuit depends on what you want to do.

Sound Source – *Buzzer*
This buzzer turns electron flow into sound. It uses a magnet and a coil of wire to vibrate a thin sheet of paper. The buzzer will only work if the red wire (+) and black wire (-) are hooked up correctly to the terminals.





Resistors – *220Ω, 5,000Ω, and 10,000Ω*
Components can break, or "blow", when the voltage or push from electron flow is too great. When this happens, it's important to add a defensive component called a resistor to the circuit. A resistor's defensive rating, or resistance, is measured in **ohms (Ω)**. Therefore, a 10,000Ω resistor has the ability to slow down electron flow better than a 220Ω resistor.

THE STARTING LINE UP

COACHES CHALLENGE

It's time to watch some great defense against electron flow. Follow the directions below to see the role that resistors play in a circuit.

Step 1: Assemble your simple circuit without a resistor.
- **Find** a clear plastic or glass cup.
- **Install** a battery holder with 4 AAA batteries at terminals 01(-) and 02(+).
- **Install** a switch at [02-03] and keep it in the OPEN position.
- **Insert** a LED at 06(+) and 07(-).
- **Insert** wires at all other segments [03-04], [04-05], [05-06], [07-08], [08-09], and [01-09] to complete the circuit.
- **Place** the cup over the LED. This is for safety!

Step 2: Turn on your circuit.
- **Swing** the paper clip to the CLOSE position so that it touches the brass fastener at 03. Keep your circuit on for at least 30 seconds.
- **Record** your findings in the chart below. Measure the brightness of the LED (0-no light; 10-very bright). Then, write down what you saw in the notes column.

Step 3: Let's ADD a defensive force!
- **Turn off** your circuit to the OPEN position (remove the cup over the LED if it's still there).
- **Replace** the wire at [03-04] with a 220Ω resistor.
- **Turn on** your circuit and record your findings in the chart below.

Step 4: Let's INCREASE the defensive force!
- **Repeat** step 3 with a 5,000Ω resistor (green, brown, black, brown, brown) and then a 10,000Ω resistor (brown, black, black, red, brown).

Resistor	LED Brightness	Notes
None	0 1 2 3 4 5 6 7 8 9 10	
220Ω	0 1 2 3 4 5 6 7 8 9 10	
5,000Ω	0 1 2 3 4 5 6 7 8 9 10	
10,000Ω	0 1 2 3 4 5 6 7 8 9 10	

QUESTIONS

1. Why do you think the LED stopped working when there were no resistors connected to the circuit? *Explain.*

____

____

____

2. According to your findings, how did replacing the resistors affect the LED? What do you think would happen to the LED (and circuit) if you continued to add more resistance? *Explain.*

____

____

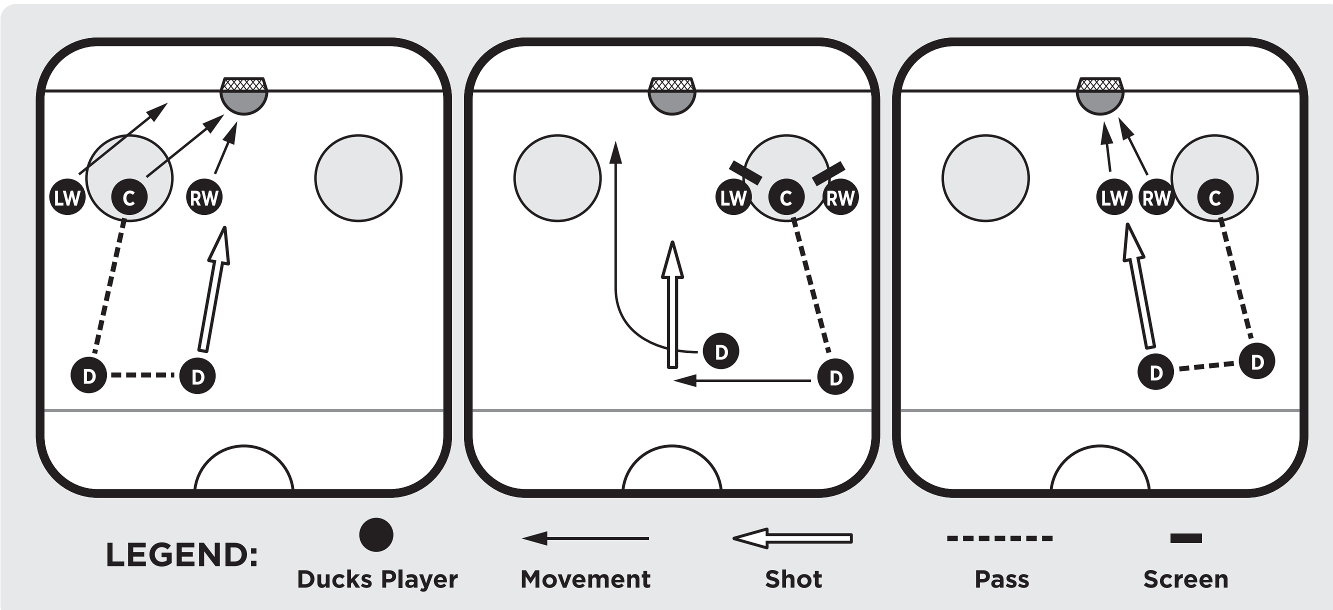
____

RESIST

Don't forget to remove the batteries when you're done!

DRAWING IT UP

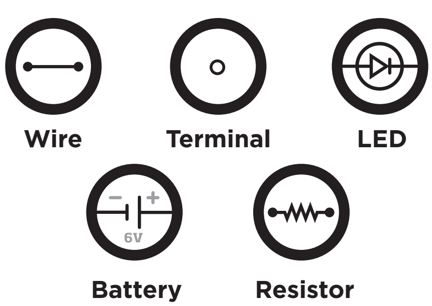
In hockey, a team is given only one timeout. It's a 30-second stop in the game coaches use to speak to players or give them a quick rest. That's why this important timeout is often saved for the final minutes when a game tying goal or a key defensive stop is needed. During a timeout, players huddle around their coach as he draws shapes, symbols, and lines on a white board. This is called **drawing up a play**. They are instructions showing players where to stand, who to pass to, and where to skate to once the puck is dropped. Check out some of the hockey plays Coach Eakins has drawn up in the past that have led to some exciting Light the Lamp moments.



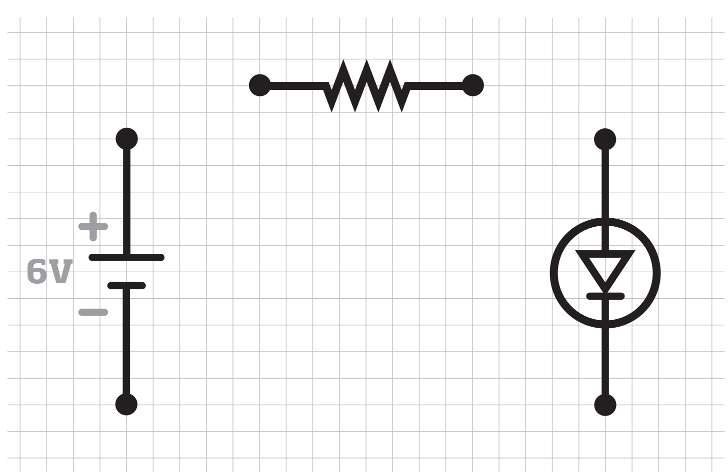
Drawing a **circuit diagram** is similar to drawing up a play in hockey. It uses a variety of shapes, symbols, and lines to represent a circuit that you want to build. These diagrams help engineers know which components to use, where to place them, and how to connect them to form the circuit. To learn how to draw one of these helpful pictures, take a look at the following steps that were taken to create a diagram for the circuit on page 10.

COACHES CHALLENGE

Step 1: Identify the components you want to build a circuit with. You'll need to know their symbol so that you can draw them. They can be found on page 16 of this workbook.

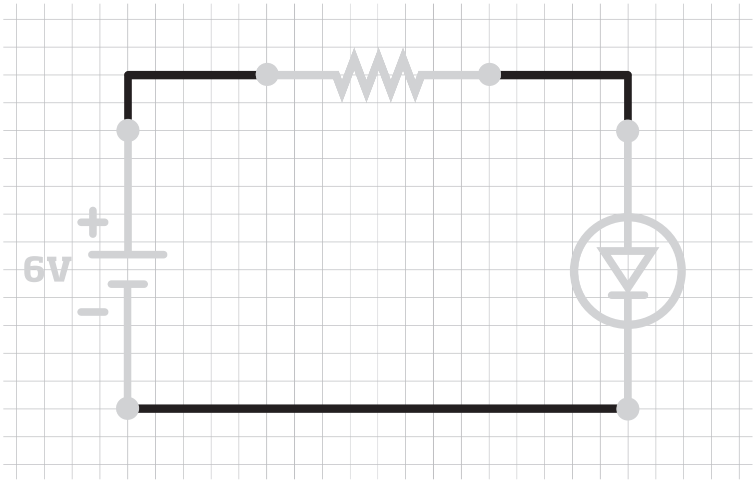


Step 2: Place your components by drawing them into position.



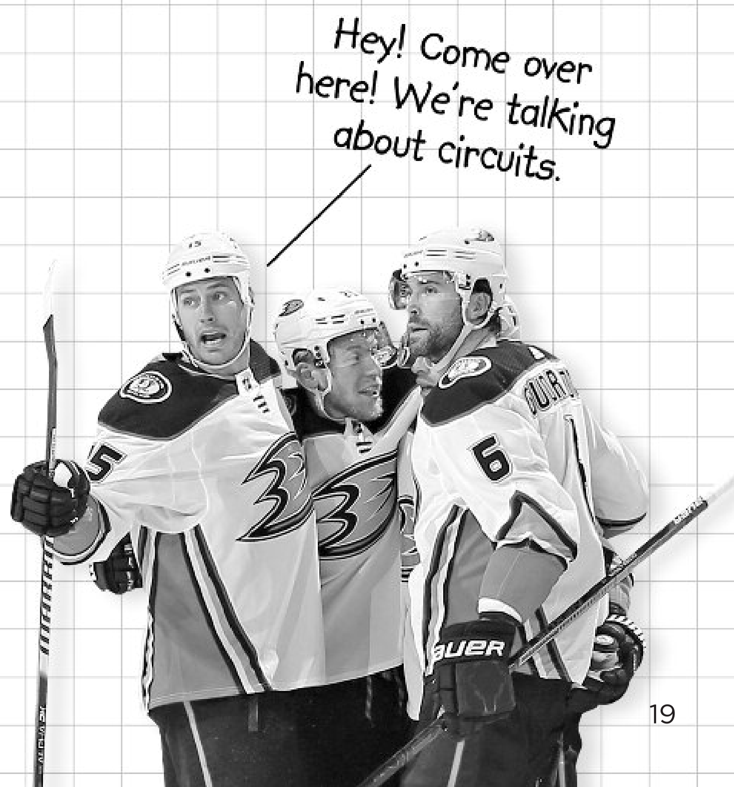
DRAWING IT UP

Step 3: Connect the components with lines to complete the circuit. You can draw them in any way you wish to. However, engineers draw straight lines for a cleaner look so that others seeing this picture can know exactly how to build the circuit.



COACHES CHALLENGE

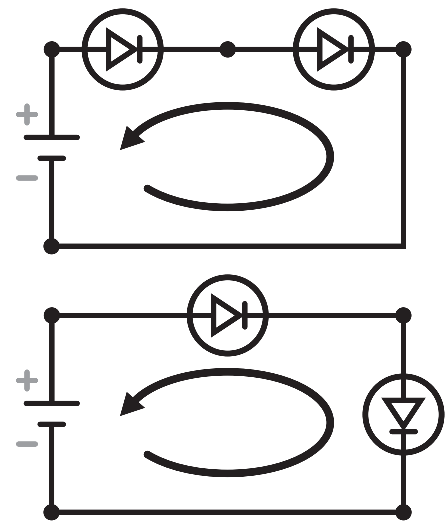
In the space below, use the three steps to draw a circuit diagram for the circuit on page 12.



DRAWING IT UP

Another reason engineers draw circuit diagrams is because circuits can get quite complicated once you start adding more "players". This tool comes in handy whether you want to add a few components or even thousands of them. And it's even more important to use when they're connected in series or parallel.

Series Circuit Examples



SERIES CIRCUIT

A **series circuit** connects every component in a single path. Electrons flow through one component, then the next, and continues to do this until it makes its way around to the battery. This type of connection is very simple to build but it has some drawbacks. For instance, connecting two LED bulbs in series will be half as bright than a circuit with only one LED bulb. The voltage drops off, or decreases, each time electrons flow through a component. Also, if a component breaks, the entire series circuit will turn off.

COACHES CHALLENGE

Build the following circuits to see how components, like red LED bulbs, work when they are connected in series. Use terminals 01 to 09 for this activity.

One LED Bulb Simple Circuit

Step 1: **Assemble** the circuit from page 12 with the switch in the OPEN position.
Step 2: **Turn on** the circuit.
Step 3: **Measure** the brightness of the bulb and record it in the chart (0-no light; 10-very bright).

Two LED Bulb Series Circuit

Step 1: **Turn off** the circuit to the OPEN position.
Step 2: **Remove** the components from **A** [05-06], **B** [06-07], and **C** [07-08].
Step 3: **Attach** the following components:
- Wire segment at **B** [06-07].
- LED bulbs at **A** [05-06] and **C** [07-08]. Make sure the longer leads (+) for each LED are connected to 05 and 07.

Step 4: **Turn on** the circuit.
Step 5: **Measure** the brightness of the bulbs at **A** and **C** and record them in the chart.

Questions:

1. Compare the LED bulbs between the simple and series circuits. What caused them to light up differently?

____

____

2. How would the LED bulbs in the series circuit change if a third LED was added? *Explain.* (***HINT:*** *Replace the wire at* ***B*** *[06-07] with an LED.)*

____

____

3. What would happen to the series circuit if one of the LED bulbs was removed? (***HINT:*** *Remove a LED bulb while the circuit is on.)*

____

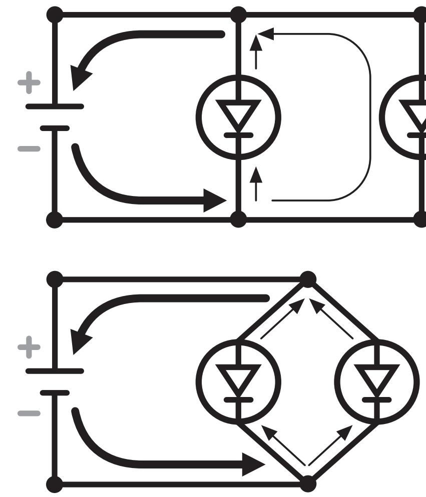
____

DRAWING IT UP

PARALLEL CIRCUIT

In a **parallel circuit**, electrons follow multiple paths. When a circuit splits, some electrons will follow one path while the rest will flow into the other ones. Although this happens, electrons will always meet back up and return to the battery together. Parallel circuits take more time to set up but they have an important feature that's advantageous to use. They can continue to work even if a component in one path breaks. That's why long strands of holiday lights are formed this way. It can continue to decorate your home even when a bulb goes out.

Parallel Circuit Examples



COACHES CHALLENGE

Build the following circuit to see how components, like red LED bulbs, work when they are connected in parallel. Follow the directions carefully because this circuit is unlike anything you've seen before!

Two LED Bulb Parallel Circuit

Step 1: Turn off the circuit to the OPEN position.
Step 2: Remove the components from **A** [05-06], **B** [06-07], and **C** [07-08].
Step 3: Attach the following components:
- Wire segments at [05-10], [10-11], [10-13], [12-15], [14-15], and [08-15].
- 220Ω resistor at [03-04].
- LED bulbs at **D** [11-12] and **E** [13-14]. Make sure their longer leads (+) are connected to 11 and 13.

Step 4: Turn on the circuit.
Step 5: Measure the brightness of the bulbs at **D** and **E** and record them in the chart.

Questions:

1. Compare the brightness of the LED bulbs formed in simple, series, and parallel circuits. What did you see?

____

____

2. What would happen to the circuit if one of the LED bulbs was removed? *Explain.* (***HINT:*** *Go ahead and pull out one LED bulb!)*

____

____

CHART

Formation	# of LED	Brightness											
Simple Circuit	1	**LED @ B:**	0	1	2	3	4	5	6	7	8	9	10
Series Circuit	2	**LED @ A:**	0	1	2	3	4	5	6	7	8	9	10
		LED @ C:	0	1	2	3	4	5	6	7	8	9	10
Parallel Circuit	2	**LED @ D:**	0	1	2	3	4	5	6	7	8	9	10
		LED @ E:	0	1	2	3	4	5	6	7	8	9	10

Don't forget to remove the batteries when you're done!

THE CHALLENGE

Congratulations. You did it! But even as a new engineer who has just harnessed the powers of electricity, your journey is not over. In fact, it gets better. The best part of being an engineer isn't learning about math formulas or electricity concepts. Instead, it's about using all of this information to think BIG! Every day, engineers answer the call to improve on past inventions, build the next cool gadget, or make things that help others in need. Are you ready to take on this challenge when it comes to hockey? Here are some easy steps called **The Engineering Design Process** that will help you Light the Lamp creatively. We can't wait to see you innovate!

Use your journal to take notes or write down ideas that will help improve your Light the Lamp circuit.

STEP 1: ASK A QUESTION

Thinking big always starts with a big question that deals with the problem to solve or an object to improve upon. **What can you do to make the Light the Lamp circuit bigger and better?**

STEP 2: BRAINSTORM

Work alone or with a large group to create a list of ideas and write them all down in a journal or on a whiteboard. Remember, all ideas are good ideas! **What ideas do you have in your head?**

STEP 3: DESIGN

Take your best ideas and decide on the best solution. Then, draw pictures and circuit diagrams to create the plans for how it will be built. **What are you going to design and how will it be made?**

STEP 4: BUILD, TEST, & REDESIGN

Assemble your circuit and watch it come to life. If it doesn't work, don't worry. Even the best electrical engineers have to go back to the drawing board. **How will you build, test, and improve your design?**

STEP 5: SHARE!

Don't keep your design a secret! Imagine a world where no one shared their ideas. There wouldn't be life-saving medical equipment or spacecraft to explore the Universe. Share your work in a report, through a presentation, or using technology like videos or apps. **How will you share your work with others?**

Share your Light the Lamp Challenge photos and videos on social media with #duckslightthelamp or upload them to bit.ly/2020FFFTprojects. We'll show them throughout the event on March 9!

"LIGHT THE LAMP" CHALLENGE?

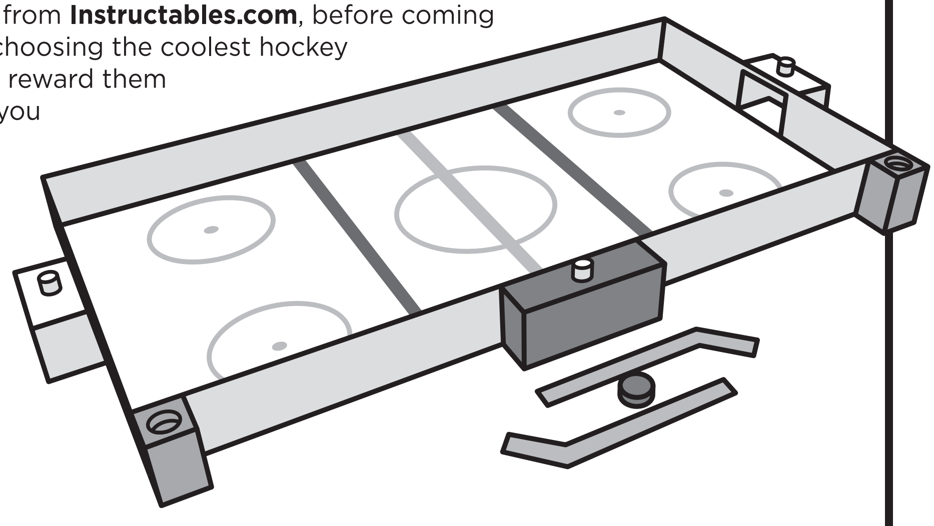
Presented by

EDISON INTERNATIONAL®

CHALLENGE

Pass, shoot, score, and celebrate with a real table top hockey rink designed by you!

Work together with your classmates and submit your best Light the Lamp Challenge projects, including this one from **Instructables.com**, before coming to the First Flight Field Trip. We'll be choosing the coolest hockey rinks created by students like you and reward them with some sweet prizes. So, what are you waiting for? Get started so that you can Light the Lamp today!



Check out these COOL prizes your classroom could win!

3D Printer

Autographed Items

And More!

Here's how to enter the "Light the Lamp Challenge"

1. Go to **bit.ly/2020FFFTprojects** and click on the "Light the Lamp Challenge" banner.

2. Click through the tutorial on **instructables.com**. You'll need help from your teacher on this one.

3. Follow the directions to learn how you can create a super cool project to Light the Lamp.

4. Get approval from your teacher. Your teacher won't know to give you the green light to start until you tell them the secret phrase - "I'm ready to Light the Lamp!"

5. Follow the directions at **instructables.com** to build your table top rink with your classmates. You'll be lighting the lamp in no time!

6. Share your photos or videos with **#duckslightthelamp** or upload them at **bit.ly/2020FFFTprojects**.

OFFICIAL SOUVENIR OF THE
FIRST FLIGHT FIELD TRIP

Every kit includes a free Knott's Berry Farm ticket good for the Wild Wingers Kids Club Party on February 29th, 2020. To reserve your spot, you must submit your order form with payment to your teacher by February 21st, 2020.

TAKE HOME THE EXCITING WILD WINGERS KIDS CLUB KIT FOR THE SPECIAL PRICE OF $20 (OVER $300 VALUE)

FOR MORE INFORMATION, PLEASE CONTACT KIDSCLUB@ANAHEIMDUCKS.COM

ORDER YOUR FIRST FLIGHT FIELD TRIP SOUVENIR BEFORE THEY RUN OUT!
FILL OUT THIS FORM AND GIVE IT TO YOUR TEACHER WITH PAYMENT

STUDENT NAME ______________________________

PARENT EMAILS ______________________________

PAYMENT

CASH ☐ ***CHECK*** ☐

MAKE ALL CHECKS PAYABLE TO
ANAHEIM DUCKS HOCKEY CLUB

THE ANAHEIM DUCKS WOULD LIKE TO THANK THE FOLLOWING FOR THEIR SUPPORT OF THE FIRST FLIGHT FIELD TRIP

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