XPLORLABS® *LifeSmarts* Lesson Plan
XPLOR Portable Electrical Power

The LifeSmarts program is excited to offer middle school teams the opportunity to go on a quest — a safety quest! The JV XPLORLABS Quest is provided in partnership with UL and its safety engineering module on portable electrical power.

INTRODUCTION
Safety engineering protects consumers by developing solutions and reducing risk through scientific investigation. Explore the safety of lithium ion batteries which are widely used as a source of electrical power in common consumer products.

SNYOPSIS
From cell phones to laptops and electric cars to hoverboards, portable electrical power and lithium ion batteries are part of students' lives every day. They're also the result of scientific inquiry and engineering. Learn about safety engineering and lithium-ion batteries, and the phenomenon of thermal runaway; then transform that knowledge into a PSA to educate others about consumer safety.

QUESTION
What problems and/or challenges are posed by the wide use of lithium ion batteries?

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PORTABLE ELECTRICAL POWER XPLORLABS LESSON			
Materials: https://lifesmarts.org/xplorlabs/ 1. *Portable Electricity* Pretest/Posttest 2. *Portable Electricity* Vocabulary Worksheet 3. *Portable Electricity* Vocabulary Worksheet Key 4. *Portable Electricity* Discussion Questions 5. *Portable Electricity* Discussion Question Key 6. *Portable Electricity* PSA Rubric: https://lifesmarts.org/wp-content/uploads/2019/09/JV-XPLORLABS-PSA-Rubric.pdf 7. *Quizlet* Vocabulary Review: https://quizlet.com/367975842/portable-electrical-power-flash-cards/			
Before the presentation: Check equipment and streaming video segments.			
XPLORLABS RESOURCES			
VIDEO	TITLE	LOCATING URL	LENGTH
Overview	XPLOR LABS	https://watch.cloudflarestream.com/2d901122c148021a6515aaaf41544d90	0:55
Part 1	Intro to Portable Electrical Power	https://watch.cloudflarestream.com/ce62010d5b5dcb3c6b85ac139d0adbe8	2:48
Part 2	Intro to Thermal Runaway	https://watch.cloudflarestream.com/1158e3959bc1ab33eca4e9f95e5d80c0	1:05
Part 3	Understanding Safety Engineering	https://watch.cloudflarestream.com/f75217ba4208da019a04aa13de924584	0:35
Choose an Experiment	Crush Test	https://watch.cloudflarestream.com/338aab322e8bd38a667ffdbf7d758d57	0:55
	Blunted Nail Test	https://watch.cloudflarestream.com/65d7d334134919fc236ed99f32a1392e	0:52
	Projectile Test	https://watch.cloudflarestream.com/9894275304aafc12c98046faf990f4a4	1:08
	Abusive Overcharge Test	https://watch.cloudflarestream.com/ab917adf7d07b898ae1853b7f9e6c10b	1:03
Part 4	Safety Engineering and You	https://watch.cloudflarestream.com/b2febcff5621f021123c726d39cb5e03	0:43
PUBLIC SERVICE ANNOUNCEMENT TUTORIAL			
RESOURCE		URL	
PSA Source:*What is a PSA, Let me Learn site by the Joseph H Wade Junior High School*		https://sites.google.com/a/pacek-8.org/psa-step-by-step/home	

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LESSON PART ONE			
Duration	**Activity**	**Leader Detail**	**Lesson Questions/Prompts/Notes**
3 minutes 3/3	Overview Video	Play the XPLORLABS Introductory video. You may wish to play it a second time.	The video states that scientific exploration is an attitude. What do you think that means? Understanding science is a process. Being curious and understanding scientific principles is one way of looking at the world.
10 minutes 10/13	Pretest	Individual students complete the Pretest on the LifeSmarts Website.	Record the Pretest scores to compare with Posttest scores at the end of the lesson.
10 minutes 10/23	*Portable Electricity* Vocabulary Worksheet Discussion	Group participants into working teams of two or three. Distribute worksheet and ask teams to listen carefully for the definitions of the words listed. Most of the words will be defined in several short video clips	
3 minutes 3/26	Video Part 1 Intro to Portable Electric Power	Use the *Portable Electricity* Vocabulary Key check for vocabulary understanding after each video section.	
3 minutes 3/29	Video Part 2 Intro to Thermal Runaway		View this video two times to fully understand concepts presented.
2 minutes 3/32	Video Part 3		What is a safety engineer's job? Safety engineers test the use and misuse of products in a controlled environment. They test how products might react during use.
5 minutes 5/37	Crush Test Blunted Nail Test	Discuss results for both tests.	Why do scientists test batteries? So they understand how batteries will react to conditions in the real world. What happens when a battery has an internal short circuit and why is that dangerous? In the test the battery had thermal runaway. It is dangerous because not only can the battery-powered device catch on fire, but the extreme heat could ignite other items.

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Duration	**Activity**	**Leader Detail**	**Lesson Questions/Prompts/Notes**
5 minutes 5/42	Projectile Test Abusive Overcharge Test	Discuss results for both tests	What is the purpose of the self-pressure release mechanism? It reduces the chance of a battery exploding. What could happen if you mismatched a charge to charge a device? If the charger puts out more power than the battery can handle, the device could heat up quickly.
5/47	Part 4 Safety Engineering and You	Discuss the importance of safety engineering and the benefits to the consumer.	Look around you, how many battery-powered devices do you see? Suggestions: cell phones, tablets, laptops, remote controls, etc. How is safety engineered? Safety engineers test products to see how safe they are when used in normal and extreme conditions. They push batteries to the extreme. Products are designed in order to reduce safety hazards. Scientists test various risks and design safer products based on what the tests indicate.
5/50	Review Vocabulary	Project or discuss Vocabulary Key	
15/65	Discussion Questions	Distribute Discussion Questions to teams. Allow time for teams to discuss and write answers. Follow with group discussion.	See Discussion Question Prompts

LESSON PART TWO		
Duration	Activity	Leader Detail
15 minutes	Posttest	Ask participants to complete the Posttest on the LifeSmarts Website. Compare posttest with pretest scores.
60-90 minutes	How to create a PSA	Distribute PSA Rubric to large group and explain Review step-by-step instructions to create a PSA NOTE: If time does not allow you to review the steps to create a PSA, assign this step as homework Preview several PSAs from the Resource Website
60 minutes	Create PSA	Divide participants into groups of three or four. Groups will use the PSA learning site as a resource as they create their own 60-second PSAs Suggested Topic: *Safety & Portable Electrical Power* Post your final PSA at: https://lifesmarts.org/xplorlabs-video-form

ADDITIONAL ACTIVITIES	The Bologna Test—An Experiment See the energy in a battery expressed as heat and why button batteries are dangerous to small children. When swallowed, these button cell batteries can get stuck in the throat and cause severe burns. https://ulxplorlabs.org/experiments/the-bologna-test/
	Create Scientific Inquiry flash cards to help students remember and order the process. • Ask a question • Do the research • Make predictions • Do the test • Track/Analyze the Data • Form a Conclusion • Check your findings – was your hypothesis correct or incorrect? Distribute the cards to student volunteers and have the group place them in the correct order.
	Provide students with links to access the UL XPLORLABS web site for more videos, information, and modules.
	Showcase group PSAs with a “screening.” Make popcorn; invite parents or another class or group.
	Quizlet Study Tool: https://quizlet.com/367975842/portable-electrical-power-flash-cards/

XPLORLABS® *LifeSmarts* Discussion Questions
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Remote controls, greeting cards tablets, cell phones, and even electric vehicles, lithium ion batteries power the consumer products we use and rely upon. We check the power status and charge our devices without even considering the possible safety concerns these batteries may pose. Safety engineering and safety standards allow consumers to use numerous electronic devices worry free. However, thermal runaway, a battery hazard which happens infrequently, can have serious consequences.

Understanding how safety engineering and safety standards helps reduce the likelihood of thermal runaway is part of being a safety smart consumer.

List the devices powered by lithium ion batteries used by you and your family.
Share what you learned about the hazard of thermal runaway.
Why does being an informed consumer include understanding the way lithium ion batteries work?
List ways safety engineering and safety standards help make lithium ion batteries safer for the consumer.

XPLORLABS® *LifeSmarts* Discussion Question Key
XPLOR Portable Electrical Power

Remote controls, greeting cards, tablets, cell phones, and even electric vehicles, lithium ion batteries power the consumer products we use and rely upon. We check the power status and charge our devices without even considering the possible safety concerns these batteries may pose. Safety engineering and safety standards allow consumers to use numerous electronic devices worry free. However, thermal runaway, a battery hazard which happens infrequently, can have serious consequences.

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List the devices powered by lithium ion batteries used by you and your family. Answers will vary. Possible answers include: watches, remote controls, digital cameras, cell phones, remote car locks, electric cars, tablets, laptop computers, solar panels, MP3 players, calculators, electric wheelchairs, etc.
Share what you learned about the hazard of thermal runaway. When the separator in a lithium ion batters breaks down, the chemicals in the battery mix. This generates more and more heat, leading to popping, burning, and in some cases, explosions. Incidents of thermal runaway are frequently reported in the news. Examples of devices that have caught fire include computers, children's battery powered vehicles and cell phones.
Why does being an informed consumer include understanding the way lithium ion batteries work? It is important to understand safety measures one can take to keep and use devices safely. Knowing what could damage a battery and lead to thermal runaway is part of using battery-powered devices safely.
List ways safety engineering and safety standards help make lithium ion batteries safer for the consumer. Safety engineering identifies risks and hazards and then develops solutions to make products safer for consumers. Battery designs are tested for safety and risk. Safety standards are created by safety engineers. Battery design allows for normal use and failure.

XPLORLABS® *LifeSmarts* Vocabulary Key
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Vocabulary Term	Definition
anode	The negative electrode
battery	A device that converts chemical energy into electrical energy
button or coin cell battery	Lithium cells shaped like buttons or small coins that power small electronic devices such as remote controls or garage door openers.
cathode	The positive electrode
chargeable battery	A battery that can be discharged and then recharged, it is not discarded after a single use
coin cell battery	See button cell battery
electrode	One of the two points where electricity is flowing into or out of a battery
electrolyte	A liquid or gel that conducts electricity
EV	Electric vehicle
lithium-ion battery	A battery that works by lithium ions moving from the negative electrode (anode) to the positive electrode (cathode) during discharge
lithium-ion battery pack	An assembly of multiple batteries
portable electric power	Electrical power that can be brought with you
safety engineering	Identifying hazards and reducing risks by developing solutions informed by scientific investigation, study, experiments and tests
safety standards	Written documents that outline the process in which a product is tested to help mitigate risk, injury, or danger
scientific inquiry	Investigation to gather and analyze data, construct arguments from evidence, and communicate findings
separator	A thin porous membrane that divides the anode and cathode while enabling the exchange of electrically charged ions from one side to the other
thermal runaway	A rapid, uncontrolled increase in temperature causing additional increases in temperature, usually resulting in a hazardous situation

PLORLABS® *LifeSmarts* Vocabulary Worksheet
XPLOR Portable Electrical Power

Vocabulary Term	Definition
anode	
battery	
button cell battery	
cathode	
chargeable battery	
coin cell battery	
electrode	
electrolyte	
EV	

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lithium-ion battery	
lithium-ion battery pack	
portable electric power	
safety engineering	
safety standards	
scientific inquiry	
separator	
thermal runaway	