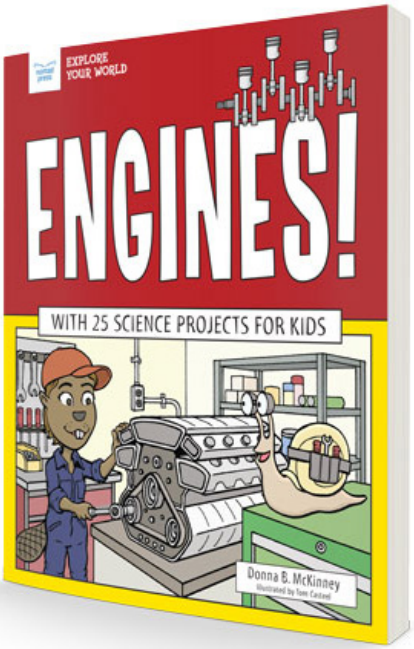
Nomad Press
CLASSROOM GUIDE



How does a car move from one place to another?
How do cranes lift such heavy objects?

From ancient times to now, engines have powered people's lives. ***Engines! With 25 Science Projects for Kids*** invites readers ages 7 to 10 to explore engines and deepen their understanding of the history of engines, what makes them hum, and all the special jobs they do for humans. Engines! also examines some of the ways mechanical innovation has backfired, such as how the cotton gin extended the history of slavery in eighteenth-century America.

Explore the world of engines through 25 hands-on, science-minded projects. Fascinating facts, essential questions, links to online resources, and even jokes help support deeper learning!

Learn more at nomadpress.net/nomadpress-books/engines

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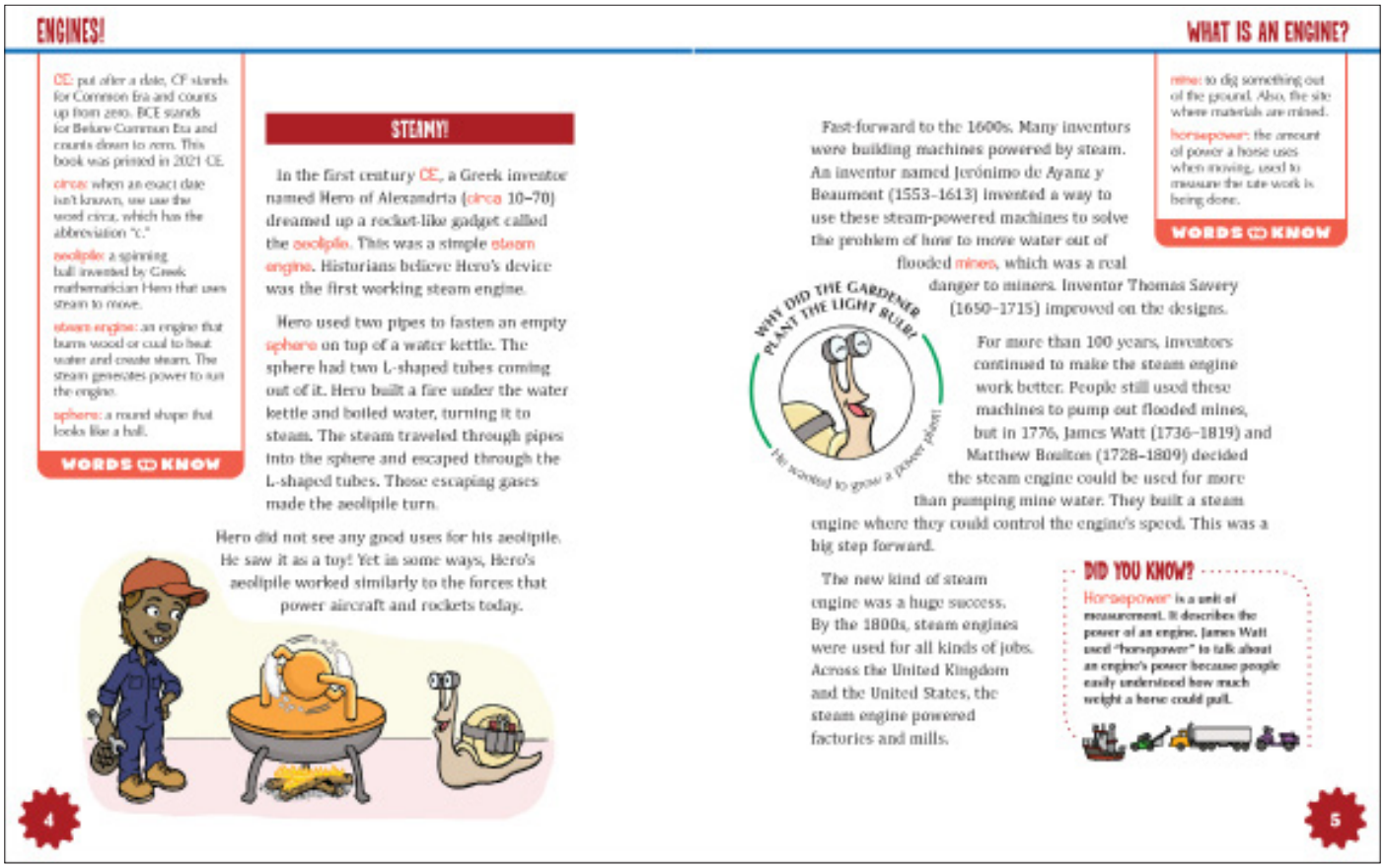
Interest Level: Grades 2–5
Focus: Engineering & Technology
GRL: U

LOOK Inside



ENGINES!

CE: put after a date, CE stands for Common Era and counts up from zero. BCE stands for Before Common Era and counts down to zero. This book was printed in 2021 CE.

circa: when an exact date isn't known, we use the word circa, which has the abbreviation "c."

aeolipile: a spinning ball invented by Greek mathematician Hero that uses steam to move.

steam engine: an engine that burns wood or coal to heat water and create steam. The steam generates power to run the engine.

sphere: a round shape that looks like a ball.

WORDS TO KNOW

STEAMY!

In the first century CE, a Greek inventor named Hero of Alexandria (circa 10–70) dreamed up a rocket-like gadget called the aeolipile. This was a simple steam engine. Historians believe Hero's device was the first working steam engine.

Hero used two pipes to fasten an empty sphere on top of a water kettle. The sphere had two L-shaped tubes coming out of it. Hero built a fire under the water kettle and boiled water, turning it to steam. The steam traveled through pipes into the sphere and escaped through the L-shaped tubes. These escaping gases made the aeolipile turn.

Hero did not see any good uses for his aeolipile. He saw it as a toy! Yet in some ways, Hero's aeolipile worked similarly to the forces that power aircraft and rockets today.

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WHAT IS AN ENGINE?

mine: to dig something out of the ground. Also, the site where materials are mined.

horsepower: the amount of power a horse uses when moving, used to measure the rate work is being done.

WORDS TO KNOW

Fast-forward to the 1600s. Many inventors were building machines powered by steam. An inventor named Jerónimo de Ayanz y Beaumont (1553–1613) invented a way to use these steam-powered machines to solve the problem of how to move water out of flooded mines, which was a real danger to miners. Inventor Thomas Savery (1650–1715) improved on the designs.

WHY DID THE GARDENER PLANT THE LIGHT BULB? He wanted to grow a flower plant!

For more than 100 years, inventors continued to make the steam engine work better. People still used these machines to pump out flooded mines, but in 1776, James Watt (1736–1819) and Matthew Boulton (1728–1809) decided the steam engine could be used for more than pumping mine water. They built a steam engine where they could control the engine's speed. This was a big step forward.

The new kind of steam engine was a huge success. By the 1800s, steam engines were used for all kinds of jobs. Across the United Kingdom and the United States, the steam engine powered factories and mills.

DID YOU KNOW?

Horsepower is a unit of measurement. It describes the power of an engine. James Watt used "horsepower" to talk about an engine's power because people easily understood how much weight a horse could pull.

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SAMPLE GLOSSARY

aeolipile: a spinning ball invented by Greek mathematician Hero that uses steam to move.

air compressor: a machine that creates high-pressured air to power tools and equipment.

astronomical: having to do with astronomy, or the study of space.

automaton: a mechanical device that looks and moves like a human or animal. Plural is automata.

battery: a device that produces electricity using chemicals.

bellows: a device that can be squeezed to blow air, often used to fan a fire.

biofuel: fuel made from living matter, such as plants.

blacksmith: a person who uses their hands to make objects out of iron or steel.

cargo: a load carried on a ship or aircraft.

catapult: a large war machine used to hurl objects at an enemy.

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cephalopod: a group of highly intelligent, ocean-dwelling creatures, which includes the octopus.

chemical energy: the energy stored in chemicals and released when some sort of reaction happens.

chemical reaction: the combination of two or more substances that results in a completely new chemical substance.

circa: when an exact date isn't known, we use the word circa, which has the abbreviation "c."

coal: a dark brown or black rock formed from decayed plants. Coal is a fossil fuel.

combustion: burning fuel to produce energy.

compress: to press or squeeze something so that it fits into a smaller space.

contract: to shrink and take up less space.

cotton gin: a machine that quickly and easily separates cotton fibers from their seeds.

crank: a handle that turns a wheel's axle.

current: the flow of electricity.

cylinder: a hollow tube shape.

dense: tightly packed together.

dung: solid animal waste.

eclipse: the total or partial hiding of a planet or other body in space by another body in space.

efficient: wasting as little energy as possible.

electrical energy: energy related to electricity.

electricity: a form of energy caused by the movement of tiny particles called electrons. It provides power for lights, appliances, video games, and many other electric devices.

electromagnet: a magnet that uses wire wrapped around a material such as steel, which becomes a magnet when electricity is applied to the coiled wire.

energy: the ability to do work.

engine: a machine that changes heat energy into mechanical force and motion.

engineering: the use of science, math, and creativity in the design and construction of things.

estimate: a best guess using facts you know.

evaporate: to change from a liquid to a gas, or vapor.

excavator: a large machine that uses a powerful shovel for digging the ground.

expand: to increase in size or to take up more space.

external combustion engine: a heat engine where the fuel burns outside the engine.

fiber: a long, thin thread that makes up cloth materials, such as cotton, wool, or linen.

fluid: a substance such as a liquid or gas that has no fixed shape and flows easily.

force: a push or pull applied to an object that changes an object's motion.

fossil: the remains of any living thing, including animals and plants, that have been preserved in rock.

fossil fuel: a fuel made from the remains of plants and animals that lived millions of years ago. Coal, oil, and natural gas are fossil fuels.

friction: the rubbing of one object against another.

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ESSENTIAL QUESTIONS

BEFORE READING:

Establish Background Knowledge

- What engines do you use in your everyday life?
- What do you already know about how engines work?
- What are some things about engines that you're curious about?

Skill Introduction

- What do you do when you come to a word or phrase you do not know?
- How do photographs, videos, and maps help someone learn about a topic?

CCSS.ELA-Literacy.L.5.4 Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grade 5 reading and content, choosing flexibly from a range of strategies.

CCSS.ELA-Literacy.L.5.4c Consult reference materials (e.g., dictionaries, glossaries, thesauruses), both print and digital, to find the pronunciation and determine or clarify the precise meaning of key words and phrases.

CCSS.ELA-Literacy.RF.5.4c Use context to confirm or self-correct word recognition and understanding, rereading as necessary.

DURING READING:

Check for Understanding

- What are some differences between engines and motors? How are the two related?
- How can you use the information you learn about engines to make your own life better or more efficient?
- Are you surprised at some of the history of engines? How did ancient people think about engines in ways similar to how we think about them now?

CCSS.ELA-Literacy.RI.5.3 Explain the relationships or interactions between two or more individuals, events, ideas, or concepts in a historical, scientific, or technical text based on specific information in the text.

CCSS.ELA-Literacy.SL.5.4 Report on a topic or text or present an opinion, sequencing ideas logically and using appropriate facts and relevant, descriptive details to support main ideas or themes; speak clearly at an understandable pace.

AFTER READING:

Summary and Expansion

- What kind of engine do you think is most useful in your life?
- Why is it important to consider climate change when learning about engines? What is the relationship between some engines and global warming?
- What can we do to engines to make them healthier for the planet?
- What are some of the different kinds of energy? How do they work together in an engine?
- How do potential energy and kinetic energy work together in a clockwork motor?
- How are magnets used to create electricity?
- How can air and liquid be used to transfer force in engines? Have you ever seen pneumatic or hydraulic motors at work?
- How are engines today different from engines in ancient times?
- How do hands-on activities help you learn about science and technology? How is learning from a video different from learning by reading?

CCSS.ELA-Literacy.RI.5.10 By the end of the year, read and comprehend informational texts, including history/social studies, science, and technical texts, at the high end of the grades 4–5 text complexity band independently and proficiently.

CCSS.ELA-Literacy.RI.5.7 Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently.

CCSS.ELA-Literacy.SL.5.1a Come to discussions prepared, having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion.

CCSS.ELA-Literacy.W.5.6 With some guidance and support from adults, use technology, icluding the Internet, to produce and publish writing as well as to interact and collaborate with others; demonstrate sufficient command of keyboarding skills to type a minimum of two pages in a single sitting.

CCSS.ELA-Literacy.W.5.10 Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of disciplinespecific tasks, purposes, and audiences.

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PROJECT!

BUILD A PAPER-ROLL CATAPULT

In ancient times, armies used siege engines such as the catapult to fight battles. These simple weapons gave armies a powerful advantage. In this activity, you will build a simple catapult.

SUPPLIES

- paper towel roll or toilet paper roll
- tape
- spoon
- cotton balls, marshmallows, or small candy pieces
- science notebook

1 Tape the spoon to the paper roll and place a cotton ball (or marshmallow or candy piece) in the spoon.

2 Using your finger, press down on the handle end of the spoon so that you hurl the cotton ball out of the spoon. This small, simple catapult demonstrates the way ancient armies hurled heavy objects over castle walls at their enemy using siege engines.

3 Place a "target," such as a small basket or even a sheet of paper, a short distance away from the catapult. Try to aim the catapult so that the cotton ball hits the target. How much pressure do you think you need to apply to hit the target? What happens if you apply too much pressure? Not enough pressure? Record your results in your notebook.

THINK ABOUT IT: Think about the playground seesaw where one person drops to the ground and the other person rises in the air. With the catapult, energy is being transferred from one object to another. The weight (your finger) drops on the end of the spoon and lifts the cotton ball into the air.

PROJECT!

AIR-PRESSURE MAGIC

This demonstration of air pressure doubles as a fun magic trick you can show your friends.

SUPPLIES

- small drinking glass
- water
- index card or thick sheet of paper (large enough to cover the mouth of the glass)
- science notebook

1 Working over the sink, fill the glass about one-third full of water.

2 Still over the sink, hold the glass in one hand. Place the index card over the mouth of the glass and hold it in place with your other hand.

3 While you hold the card tightly in place, flip the glass upside down. Keep your hand firmly in place as you flip it, or the water will spill out. When the glass is upside down, remove the hand that is holding the card. What happens? Record what you see in your science notebook.

THINK ABOUT IT: We cannot feel the air around us pushing on our bodies. Our bodies are used to this air pressure. In this project, the air pushing up on the index card is more powerful than the weight of the water in the glass that pushes down. Amaze your friends with this magic trick. Then, explain the science behind the magic.

AUTHOR INTERVIEW

HOW DID YOU GET STARTED WRITING FOR KIDS?

For many years, I worked at the U.S. Naval Research Laboratory in Washington, DC, writing about the amazing research the scientists and engineers do there. With an up-close seat, I got to talk to these scientists and tell the stories of their important research in areas like chemistry, physics, space, and robotics. I retired from that job a few years ago, and decided to focus my attention on writing for kids. I've always thought that kids ask the best questions. Writing for kids was a natural way to try to answer some of those questions.

WHY WILL KIDS FIND ENGINES FASCINATING?

I love figuring out what makes things work, and I think kids do too. This book helps kids see that engines truly are all around us. There are even engines inside the human body! This books describes these different kinds of engines and how they work.

DO YOU HAVE A FAVORITE ACTIVITY FROM THE BOOK?

I do have a favorite, and it's one of the simpler projects, as far as the supplies you need. The "Energy Transfer—Bouncing Balls" can be done with just two or three balls that are different sizes. But the results are somewhat "explosive." Be sure you do this project outside. Things can get a little wild when those balls collide.

DO ANY OF YOUR PROJECTS EVER TURN OUT TO BE FLOPS?

Actually yes, some of my projects failed. But with a few old towels and a mop, the kitchen was quickly cleaned up. The great thing about science projects, is that it's okay to try and mess up and then try again. Sometimes all you need is a little tweak and the project works on the second try.

DO YOU DO AUTHOR VISITS?

I do school visits whenever I can. Writing can be kind of lonely sometimes. But going out and talking to kids about the things I'm learning in my research and writing is great fun. Plus we can have fun doing some of the projects!

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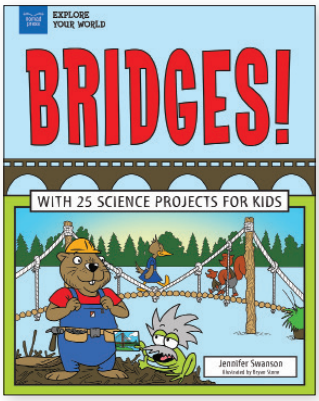

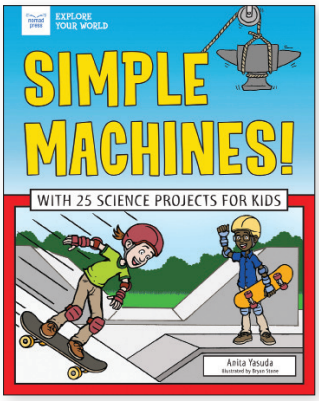

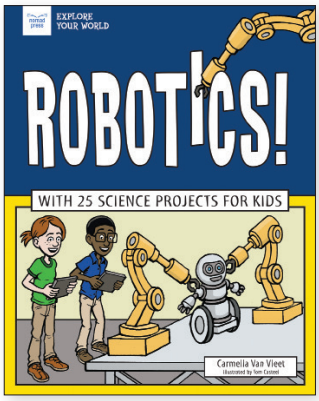

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