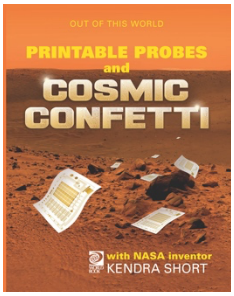
WOMEN AT NASA

Out of this World

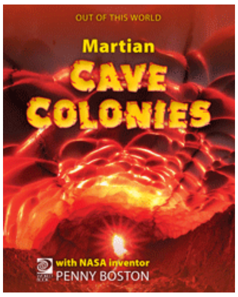
KENDRA SHORT



Printable Probes and Cosmic Confetti (with NASA inventor Kendra Short)

Learn how mechanical engineer Kendra Short plans to land her space probes with ease by creating an entirely new type of computer.

PENNY BOSTON



Martian Cave Colonies (with NASA inventor Penny Boston)

Penny Boston is developing the means for astronauts to live in caves on Mars.

STEPHANIE THOMAS

Fusion-Powered Spacecraft (with NASA inventor Stephanie Thomas)

Stephanie Thomas is developing a space probe powered by nuclear fusion that will speed the study of the outer planets.

DAVA NEWMAN

Second-Skin Space Suit (with NASA inventor Dava Newman)

Dava Newman is developing a space suit that will allow astronauts to explore Mars.

INVENTOR CHALLENGE – PENNY BOSTON

Inventor challenge:

Experimental cave

Penny Boston wants people to inhabit caves on Mars one day, but there's plenty more experimental work to be done first. Imagine NASA has just been granted permanent access to a large cave and funds to experiment … and you're in charge! What would you experiment with?

STEP 1 Think about the challenge

Go back through the book and make a list of things that need more research before they can be implemented in a Martian cave colony. Perhaps a couple could be studied together, in the way Boston supplied her mouse-tronauts breathing argon-buffered air with oxygen from a duckweed bioreactor. Think about things not mentioned here, too: how would humans react to living underground for months or years? Write down one or two things you'll be testing for. Those will be your variables.

STEP 2 Create your prototype

Design your experiment. Be sure to include one or more control groups in your design. In a scientific experiment, a control is a method of isolating the variable you are testing for. For example, a separate group of mouse-tronauts could live in the cave, but breathe a normal air mixture. This would help you determine whether changes in the mice inside the argon environment are due to the gas mixture or something else.

STEP 3 Share your design

Share your experiment design with friends, classmates, or teachers. See what they think could be improved. If possible, share your experiment with engineers and scientists and ask for their input.

STEP 4 Grow your idea

There's plenty to research. Design another experiment to go along with your first one. Perhaps you can collaborate with someone else. Maybe you can collect some duckweed and build your own bioreactor!

INVENTOR CHALLENGE – STEPHANIE THOMAS

Inventor challenge:

Power exploring

Stephanie Thomas and her team developed the Direct Fusion Drive to get large probes to the outer solar system quickly. DFD probes will also have huge amounts of power to use. Your task is to design a mission that will take advantage of the DFD's abilities to learn about the outer solar system. What kind of mission will you develop?

STEP 1 Think about the challenge

Make a list of potential targets in the outer solar system. The possibilities with a DFD-powered mission are virtually endless. Would you go straight to a single target? Would you split time between a planet and its moons? Would you go on a grand tour of the outer solar system like the Voyager probes, before settling into orbit around a distant target? Look up and record what is known about your target or targets and what scientists (and you) would like to find out.

STEP 2 Create your prototype

Now that you've picked a target or targets, it's time to create your probe. Look back on the mission design possibilities enabled by DFD in terms of size and power. After exploring the possibilities and figuring out what fits best for your targets, write out your mission. Model or draw the spacecraft and any other components.

STEP 3 Share your design

Share your design with friends, classmates, or teachers. See what they think could be improved. If possible, share your design with engineers and scientists and ask for their input.

STEP 4 Grow your idea

Remember how Thomas and Princeton Satellite Systems developed a detailed plan of successive prototypes to study the DFD concept in a cost-effective way. Create a similar road map to launch. What do you need to learn to further develop your design? How will you learn it?

INVENTOR CHALLENGE – DAVA NEWMAN

Inventor challenge:

Space suits for Europa

Imagine that life has been discovered beneath the frozen crust of Jupiter's moon Europa. Astronauts are needed to operate the equipment to dig through the ice and study this life. How would you develop a new space suit for working on the surface of Europa, just like Dava Newman did for Mars?

STEP 1 Think about the challenge

Compile the environmental conditions of Europa, Earth, Mars, the moon, and the vacuum of space. Look up things like gravitational pull; atmospheric pressure; radiation; and temperature highs, lows, and averages. Gather information from reliable sources, such as World Book or NASA's website. Think about the kinds of work astronauts would have to do on Europa.

STEP 2 Create your prototype

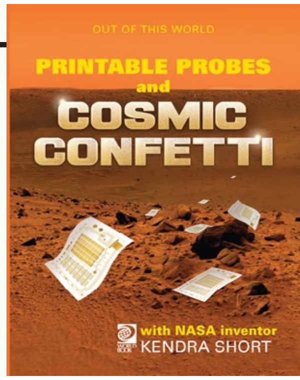
Compare the conditions of Europa with the other places you looked up and the space suits designed for these places. Will you be able to use existing designs as a starting-off point, or will you have to come up with something different? Remember that Newman first studied hard suits for Mars. Would that idea work for Europa?

STEP 3 Share your design

Share your design with friends, classmates, or teachers. Give a presentation showing how it would work, like Newman has done with the BioSuit. See what your audience thinks could be improved. If possible, share your design with engineers and scientists and ask for their input.

STEP 4 Grow your idea

Ask the people who gave you advice to help you revise your prototype. Maybe you can create a wearable prototype with their help, like Newman did. Repeat until your space suit is ready for launch. Now you just have to wait for scientists to find life on Europa!



OUT OF THIS WORLD

Printable Probes and Cosmic Confetti

What does it take to land a space probe safely on another planet? Would you need expensive parachutes or complicated rockets to keep the probe from simply crashing to the ground? Read *Printable Probes and Cosmic Confetti* to learn more!

What did you learn?

QUESTIONS

1. Kendra Short is a ...
   a. Mechanical engineer
   b. Astronaut
   c. Computer programmer
   d. Rocket designer

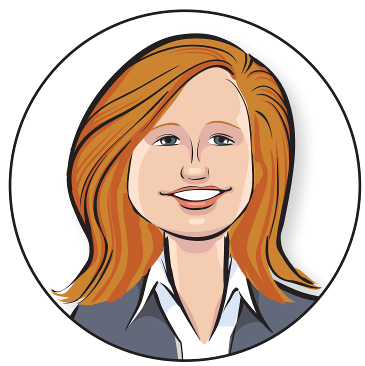
2. Temperatures on Mars average ...
   a. 32 °F (0 °C)
   b. 150 °F (66 °C)
   c. -175 °F (-115 °C)
   d. -80 °F (-60 °C)

3. The design to deliver landers more safely to the surface includes ...
   a. Seatbelts
   b. Magnetic forcefields
   c. Aeroshells
   d. Soft tyres

4. The Opportunity rover traveled ...
   a. Less than 1 mile
   b. Over 26 miles
   c. Over 76 miles
   d. Over 106 miles

5. What does NIAC stand for?

6. Who is this?



TRUE OR FALSE?

_____ 1. Mars is named after the Roman god of war.

_____ 2. The first spacecraft to complete a successful flyby of Mars was the Venus 7.

_____ 3. Landing on Mars is easy because of the atmosphere.

_____ 4. Conventional circuits can be stiff or rigid.

_____ 5. Flexible printed electronics don't perform as well as other circuits at certain tasks.

_____ 6. Women have always been encouraged to join the STEM field.

WORLD BOOK

ANSWERS

1. **a. Mechanical engineer.** According to section "Introduction" on page 6, we know that "I'm a mechanical engineer at NASA's Jet Propulsion Laboratory in Pasadena, California." So, the correct answer is A.

2. **d. Sunlight.** According to section "Destination: Mars" on page 10, we know that "Temperatures on the Martian surface average a frosty -80 °F (-60 °C)" So, the correct answer is D.

3. **c. Aeroshells.** According to section "A more flexible approach" on page 22, we know that "It was our job to design all the aeroshells [coverings that protect craft as they enter the atmosphere] and the parachutes and the airbags." So, the correct answer is C.

4. **b. 26 miles.** According to section "Exploring the Red Planet" on page 14, we know that "By 2016, Opportunity had traveled over 26 miles (43 kilometers) on its Martian marathon." So, the correct answer is B.

5. According to page 7, NIAC stands for NASA Innovative Advanced Concepts.

6. As can be seen on page 6, the illustration shows Kendra Short.

TRUE OR FALSE? ANSWERS

1. **True.** According to section "Destination: Mars" on page 8, we know that "Ancient people named Mars after the Roman god of war because of the planet's reddish color." So, the correct answer is True.

2. **False.** According to section "Exploring the Red Planet" on page 12, we know that "In 1964, the United States probe Mariner 4 became the first spacecraft to complete a successful flyby of the planet." So, the correct answer is False.

3. **False.** According to section "Failing (and succeeding) on Mars" on page 18, we know that "Landing on Mars is particularly difficult. The Martian atmosphere is too thin to land a craft using parachutes alone." So, the correct answer is False.

4. **True.** According to section "Big idea: Flexible electronics" on page 26, we know that "Both conventional circuits and integrated circuits tend to be rigid, or stiff." So, the correct answer is True.

5. **True.** According to section "Big idea: Flexible electronics" on page 28, we know that "Flexible printed electronics do not perform as well as integrated circuits at certain tasks." So, the correct answer is True.

6. **False.** According to section "Inventor feature: Women in engineering" on page 30, we know that "Women were once excluded or discouraged from entering many fields of study, including science, technology, engineering, and mathematics (together called STEM)." So, the correct answer is False.