1 - Before you read:

a) Discuss these questions with a partner:

1. What practical benefits of space research can you think of?
2. Space research is very expensive. Do you think the benefits of space research outweigh its cost? Why or why not?

b) Learn the meanings of the following words before you read the article:

- specialized – специализированный, специальный
- anticipate – ожидать, предвидеть
- spin-off – спин-офф (здесь: товар, появившийся в результате развития какой-либо технологии)
- device – устройство, прибор
- durable – долговечный, обладающий большим ресурсом
- monitor – управлять
- resistant – прочный
- optimum – наиболее подходящий

c) As you read, underline the main ideas and examples. This will help you complete the chart after the text:

Valuable By-Products of Space Research

1. Research that went into developing the highly specialized technology for space travel has resulted in many unexpected practical applications back on Earth. Out of the engineering that produced rocket motors, liquid propellants, spacesuits, and other necessities of space flight came by-products that no one had anticipated. Equipment and procedures designed for astronauts and space flights have been successfully adapted for use in medicine, industry and the home. These valuable by-products of space research, called spin-offs, have improved the quality of life on Earth in many ways.
2. Some of the best-known examples of spin-offs from space research are found in hospitals and doctors' offices. One such example is the sight switch, which was originally developed to allow astronauts to control their spacecraft without using their hands. The sight switch is now used by disabled people to operate devices using eye movements. Another spin-off is the voice command device, which was designed to enable astronauts to steer their spacecraft by voice command. This device is now being used to help deaf people learn to speak.
3. Doctors have also benefited from the technology required to make miniature electronic instruments small enough and durable enough for trips into space. From this technology have come hearing aids the size of a small pill and tiny television cameras small enough to be attached to surgeon's head to give medical students a close-up view of an operation. Dentists and their patients have benefited, too. Invisible braces for straightening teeth evolved from NASA (National Aeronautics and Space Administration) research for strong and durable materials for spacecraft.

4. Biotelemetry, which was developed to monitor the physical signs of astronauts by checking their temperature, brain-wave activity, breathing rate, and heartbeat, offers doctors a new means of monitoring hospital patients. Biosensors attached to the body send data by wire or radio. This information is displayed on computer screens for doctors to analyze.
5. Aerospace scientists in England developed a special bed for astronauts that is now used for burn patients. It enables *them* to float on a cushion of air. Burns can heal more quickly because they do not rub against the bed.
6. Another valuable spin-off came from a special stretcher developed to remove injured workers from the huge propellant tanks of the Saturn V rocket. The stretcher is now widely employed to remove injured workers from mines, oil-drilling rigs, and boats. The rigid aluminum device permits someone to be moved through an opening 18 inches in diameter. And much of the portable medical equipment carried on ambulances has its roots in NASA's need for small, portable equipment in space.
7. Many items developed in space research are now being used in homes, factories and offices. For example, smoke detectors used in homes evolved from technology originally developed for NASA's first space station, Skylab. Cordless tools were first used by Apollo astronauts to drill into the moon's surface and collect soil and rock samples to bring back to Earth. Today, cordless screwdrivers, drills, and vacuum cleaners are popular in many homes around the world. Fiberglass materials created for rocket-fuel tanks are used to make very strong and durable storage tanks, railway tank cars, and highway tankers. A magnetic hammer that originally served to eliminate small imperfections in the Saturn V rocket is being adapted for use in the automotive and shipbuilding industries.
8. The experience gained from developing NASA spacesuits has been applied to the process of designing clothing for other uses. Firefighters now wear lighter, less bulky clothing made of special "fireblocking" materials that are more resistant to cracking and burning. The spacers used for ventilation and cushioning in moon boots were adapted for use in athletic shoes that are designed to reduce fatigue and injury. Thermal gloves and boots that keep you warm in the winter were also adapted from space technology. These thermal gloves and boots have tiny heating elements that operate on rechargeable batteries.
9. They were used to keep astronauts warm on Apollo missions to the moon.
10. Even watches and clocks have improved because of technologies originally designed for use in spacecraft. The quartz timing crystals used in many watches and small clocks were first developed for NASA as a highly accurate, lightweight, and durable timing device for the Apollo spacecraft. The bar codes that are now used by stores and manufacturers to keep track of sales and stock were originally developed for NASA as a way to keep track of millions of spacecraft parts.
11. One of the most valuable contributions of aerospace technology to industry is a management technique called the systems approach. With the aid of computers, this technique brings together all the elements of a complex project, including people, money, and materials, to assure that everything is completed at the optimum time. It has been applied to a variety of situations unrelated to space exploration. Among them are cancer research, hospital design, city planning, crime detection, pollution control, building construction, and transportation.

12. These are but a few of the more than 30,000 practical applications of space technology that provide daily benefits here on Earth. These spin-offs can be found in hospitals, offices, schools, and homes around the world. So, the next time you look at your watch, put on your sneakers, or check your smoke detector, think about how much safer and more convenient your life is because of the technology that was designed for astronauts and space flights.

2 - Circle the correct answer:

1. The article mainly discusses _____.
    a. devices that enable astronauts to control their spacecraft
    b. the value of the systems approach
    c. practical applications of space research
    d. ways of monitoring patients
2. The authors mention applications in all of the following areas **except** _____.
    a. medicine
    b. industry
    c. the home
    d. the law
3. The authors use tiny hearing aids and television cameras as examples of _____.
    a. spin-offs in the fields of clothing design
    b. applications of space research in medicine
    c. inventions by aerospace scientists in England
    d. devices used to enhance the benefits of the systems approach
4. The word *them* in paragraph 5 refers to _____.
    a. aerospace scientists
    b. astronauts
    c. burn patients
    d. doctors
5. Which is an example of a practical application resulting from research that went into developing spacesuits?
    a. storage tanks
    b. firefighters' clothing
    c. cordless tools
    d. invisible braces
6. Where in the article do the authors mention ways to monitor a patient?
    a. Paragraph 2
    b. Paragraph 4
    c. Paragraph 6
    d. Paragraph 8
7. With what topic is paragraph 10 mainly concerned?
    a. The importance of importance of management techniques
    b. The complexity of hospital design
    c. Use of computers in industry
    d. Applications of the systems approach
8. Bar codes were first developed _____.
    a. as a way to record patients' temperatures
    b. to keep track of sales and stock
    c. to keep track of millions of spacecraft parts
    d. as timing devices for the Apollo spacecraft

3 - Choose five other spin-offs from the article that you think are valuable. List them in the first column of the chart and complete the other columns with information from the article. Use the information you underlined to help you. Then compare answers with a partner:

Device/Procedure	**Space Use/Description**	**Practical Application**
Sight switch	*lets astronauts control their spacecraft without using their hands*	*permits handicapped people to operate devices using only eye movements*

4 - Match each word with the correct definition:

1. spin-off	**a.** to imagine or expect that something will happen
2. specialized	**b.** not harmed or affected by something
3. device	**c.** an object that has been invented to fulfill a particular purpose
4. durable	**d.** a product that develops from another product
5. anticipate	**e.** able to last a long time without becoming damaged
6. monitor	**f.** the best out of a number of possible alternatives
7. resistant	**g.** to watch and check the progress of something
8. optimum	**h.** developed for a particular purpose or job

5 - Circle the correct answer:

1. If you <u>anticipate</u> that you are going to get a raise in your salary, you _____.
    a. expect to get a raise
    b. don't plan on getting a raise
2. If the <u>optimum</u> time travel to Spain is in the summer, you would probably _____.
    a. avoid Spain in the summer
    b. plan a trip to Spain in the summer
3. A material that is <u>resistant</u> to water _____.
    a. keeps water out
    b. lets water in
4. An example of a <u>spin-off</u> of space technology is a special bed for _____.
    a. astronauts
    b. burn patients
5. <u>Durable</u> tires for your car _____.
    a. need to be replaced very often

b. should last for a long time

6. Which is an example of a specialized device?
    a. an electronic microscope
    b. a book of poetry
7. Which would a nurse be more likely to monitor?
    a. a patient's heart rate
    b. a customer's purchases

6 - Learn synonyms and antonyms. For each pair of words circle "S" if they are synonyms or "A" if they are antonyms:

spin-offs	by-products	S	A
device	machine	S	A
durable	weak	S	A
optimum	worst	S	A
monitor	check	S	A
resistant	vulnerable	S	A
adapted	modified	S	A
anticipate	predict	S	A

7 - Discuss these questions:

1) Have you ever used any of the spin-offs mentioned in the article? If so, describe when and why.
2) Do you think any of the spin-off from space technology are more valuable that their originally intended purpose? Which one(s)?

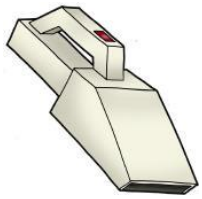
8- Scan the text below and choose the most interesting facts about spin-offs:

Many of the inventions and materials that we take for granted in our everyday lives came about through basic research originally done to fulfill the needs of the space program. Attempting to do things that have never been done before is the best incentive for innovation. And what human endeavor is more trailblazing than going into space, whether it is to send people to the moon or to place spacecraft in orbit to study our own planet. Some of the products are technologies that start out to serve a particular purpose in space or aeronautics. But then clever inventors, engineers, and entrepreneurs find new uses. For example, excimer laser technology developed at JPL to study Earth's ozone layer has been further developed and adapted for use in laser angioplasty and vision correction surgery. Digital cameras, electron microscopes, and all sorts of medical imaging technologies use digital

imaging and processing techniques whose development was greatly accelerated by NASA's need to record images in space and transmit them back to Earth

The computer game joystick (above), made by ThrustMaster, Inc., uses technology developed for a Space Shuttle hand controller. The design for these toy gliders (AeroNerf Gliders), made by Hasbro, Inc., benefited from NASA wind tunnel and aerodynamic research

PUT YOUR OWN SPIN ON TECHNOLOGY



If you have ever seen anyone use a cordless drill, cordless power screwdriver, or cordless Dustbuster® vacuum cleaner, you know how handy they are. You don't have to worry about finding some- place to plug them in, or find an extension cord because the cord is too short to reach to where you need to use them (like outside someplace).

Another neat invention is barcoding. When you go to the supermarket, the checker just passes the items in front of a laser, which reads the special striped pattern on the item and feeds the information to the computer. The computer converts the pattern to numbers and finds the item in its data- base. Thus, the computer instantly knows what the item is, how much it costs, how many are left on the shelf, and when to order more.

Did you know that both cordless appliances and barcoding were originally invented for the space program? The first cordless tools were used by the Apollo astronauts to drill into the moon's surface and collect soil and rock samples to bring back to Earth. Barcoding was invented initially to help NASA keep track of millions of spacecraft parts.

Here are some other space program spinoffs:

EAR THERMOMETER:

Takes an instantaneous reading of body temperature. No sticking a glass tube under your tongue for 2 or 3 minutes. (No more tricking your Mom into letting you stay home from school by drinking hot water first!) Great for checking on sick babies.

The ear thermometer uses special infrared sensor technology developed to detect the birth of stars. Hot objects put out more infrared energy than cool objects. We cannot see infrared, but we detect it as heat.

SMOKE DETECTORS: Now used in most homes and other buildings, they were first used in NASA's Skylab orbiting space station in 1973.

MEDICAL IMAGING: Magnetic Resonance Imaging (MRI) and Computer Aided Tomography (CAT) are imaging technologies that allow doctors to see what is wrong inside their patients' bodies without doing invasive and painful procedures to find out. These technologies use digital signal processing and digital imaging technologies that were initially developed to make and process images from space.

This amazing MRI image of the inside of a human head is from The Basics of MRI, J.P. Hornak and is used with permission from the author.

OLD WEATHER GLOVES AND THERMAL BOOTS: These gloves and boots have heating elements that operate on rechargeable batteries. They were adapted from a design originally used to keep astronauts warm or cool in the temperature extremes of the Apollo moon mission.

INVISIBLE ORTHODONTIC BRACES: These teeth straightening braces use a ceramic material called polycrystalline alumina that was originally developed by NASA. The ceramic is used to make an almost invisible, tooth-colored bracket that is cemented to each tooth, and then connected to the other teeth by a very thin metal wire.

INVENTORS AND DESIGNERS

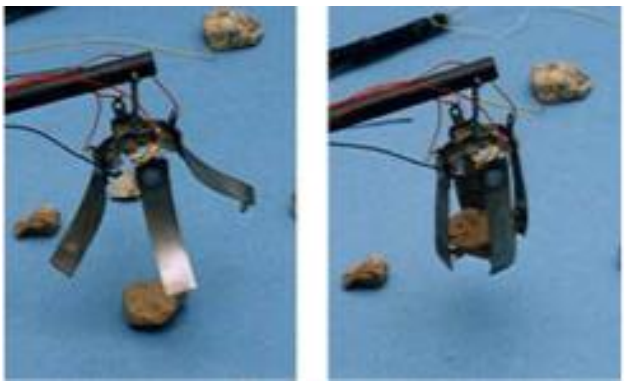
In many cases, inventors have used a technology developed for the space program to come up with something entirely new, like the ear thermometer. In other cases, designers have used these new technologies (for example, barcoding) in new situations. Or, they have used new materials (such as the ceramics used in braces) to improve the designs of existing inventions.

Anyone can come up with a space technology spinoff. The materials and technologies developed for the space program belong to everybody, not just the engineers, scientists, and astronauts working in the space program. NASA often works with inventors, designers, and new companies to help make sure the new technologies get the widest possible use and benefit the greatest possible number of people.

We would like to invite you to think of some new uses for some of NASA's space program developments. We will describe some new materials and technologies developed for the space program. Think of some other uses these new technologies might have in such areas as health and medicine, the home, the environment, public safety, recreation, transportation, computer technology, and industrial productivity. Your ideas can be as far out as you want. Don't worry about how practical or impractical it might be to actually make your invention.

Here are some new technologies. Now, look for the possibilities!

- Temper foam is a “memory foam,” so-called because it matches the contour of the body pressing against it and returns to its original shape once the pressure is removed. As a shock absorber, a three-inch-thick pad of temper foam has the ability to absorb the impact of a 10-foot fall by an adult.
- NASA research on airfoil design has greatly improved our understanding of how air and water flow over shapes. An airfoil is anything that is shaped so that air or water flowing over and under it causes it to lift like an airplane wing. Shapes like this are often used in things that need to flow smoothly through air or water, or things that need to go fast, or need to lift or get lighter in weight as they go faster.
- JARtool (JPL Adaptive Recognition Tool) is a computer program that can be trained to find a particular object in an image. The user trains the system by marking examples in a set of images using a mouse cursor on a computer screen. Then, the computer program is run on a new set of images and it picks out new in- stances of the object it has been trained to find.
- Electroactive Polymers are materials that bend or change stiffness properties when an electric current is applied to them. When the current stops, the material returns to its previous shape and characteristics. They are being developed and tested for use as artificial muscles



Electroactive polymers bend when a current is passed through them, so they can be used like artificial muscles (like a hand, in the picture on the left).

- SMART, Sound Modification and Regulated Temperature compound, is a liquid plastic mixture with exceptional energy and sound absorbing qualities. It is derived from a very elastic plastic which was used for noise reduction in the Apollo program.
- Hand held infrared camera is sensitive to heat, rather than light. This camera was developed to observe the plumes from the rockets that launch the Space Shuttle.
- Heat shield tiles for the Space Shuttle are made of a ceramic material that can with- stand the extremely high temperatures en- countered during re-entry into Earth’s atmosphere.
- A superabsorbent fabric can hold up to 400 times its own weight in water.
- NASA space suit technology includes techniques for circulating cold water in a garment to keep the wearer cool. It may allow a person to remain in a very hot environment 3 times longer than would normally be possible.

9 -

a) -Draw a picture of your invention, design, or new technology application. Then, write a description of your idea that you might use to help convince someone to invest money or time in helping you make the product. Answer as many of these important questions in your description as seem to apply to your idea:

- What is this item?
- What is its function?

- Is it a new invention, a new design of an existing product or process, or a new use of an existing technology?
- What problem does it solve?
- Who would use it and under what circumstances?
- How is it an improvement over existing designs or processes?
- Does the new design have more market appeal than existing designs?
- Does the new design make the product safer than existing designs?
- What is it made of?
- What are its physical dimensions and weight?
- How will this idea change the world?

b) - Take the next step:

Build a model or prototype of your idea. Inventors often use what are normally considered children's building materials, like clay or interlocking blocks, to make their early models. They also use computer aided design (CAD) tools to help.

10 -

a) Before you listen, could you guess what topic is going to be discussed? Is there a wide range of opinions about the true value of space flight? Suggest one of your own and after listening compare them to the narrator's view. Try to suggest the true reasons why we should explore the space:

Vocabulary:

- tangible – вещественный, материальный; ощутимый, заметный
- consciousness – осознание, понимание
- cost effective – экономически выгодный
- controversial – спорный, сомнительный
- to stir up somebody with – побуждать, возбуждать, всколыхнуть, взволновать, активизировать
- to embed – вкладывать, заключаться
- capabilities – возможности
- machinery – механизмы, машины, оборудование
- descendants – потомки

♫ b) Listen to the text in which Bob Parkinson, a rocket scientist, talks about the reasons for exploring space and the possibility of post-humans exploring Mars. Ask your teacher for the related script, if necessary.

11 - Ask your partner what reasons for space exploration he/she has found in the recording and compare them with the ones given below:

Reasons:

- Knowledge
- Expansion of our consciousness of the universe
- Cost effectiveness

- Mars colonization
- Mechanisms' improvements

Attention: Continue to list advantages (good things) about manned space exploration and possible disadvantages in the chart given after the text Space Exploration (Lesson 1), if any.

12 - Check the completed chart from the previous exercises. Split into two groups and discuss which point (advantages or disadvantages of space exploration) overweighs the other and why.

13 - Choose one of the suggested topics, search for the information needed and prepare your project. You may work in small groups of two or three.

1. How does the climate of Mars compare to that of Earth?
2. What technologies should be implemented to allow the growing crops on Mars?
3. Review several space-related films and identify "errors" in how life in space is depicted.
4. Is there microbial life in the surface layers of Mars?
5. The Moon will play an important role in the future space travel. Research to find out what the plans are for the future Moon expeditions.
6. How will travel to, and working on the Moon assist in the plans for space travel to Mars?
7. Is there any true Paleobiological evidence of life on Mars?
8. How can research related to farming on Mars be applied to practices here on Earth?
9. What is the relationship between science fiction and space travel reality?
10. Sputnik went up in 1957. Then, the United States became more active in the space program. What countries are now in the "space race" and what are their major areas of focus?
11. You have an idea for space exploration. Research how you could find out if it is practical.
12. Should human space travel be replaced with robots?
13. Compare the exploration of space to the exploration of a new area in the history of the Earth - the Americas, Africa, or the expedition to the top of Mount Everest.
14. Should the exploration of space be controlled/financed by countries or should the process be privatized?
15. Research Newton's laws of motion and design a demonstration of Newton's first or third law. The demonstration must be applicable to space travel. A possible extension might involve students' study of the relationships among force, mass and acceleration [Newton's 2nd law] and the design of an experiment to test the variables.
16. Although many young people would like to be astronauts, it is statistically more difficult than becoming a major league athlete. However, there are many alternative occupations related to the space program that will demand scientific and technological expertise. Research one area of interest related to space and/or space agriculture, and outline the educational path it would take to work in this area.
17. On Earth we may have to deal with sunburn as a consequence of working outdoors in summer. Research the effect of radiation on astronauts and, in particular, on astronauts who may be spacewalking during the construction of the International Space Station.
18. Research the effect of radiation on the development of plant life for space travel.
19. Research one of the following aspects of life support in space - food, water, waste disposal, atmosphere control, or fire protection.
20. Is it possible to use solar rays in space to make a space "sailing ship" move through space, thus creating an energy efficient space craft?
21. Research the earth's magnetosphere - how it works, its components, the benefits for us on earth, how it is detected from a spacecraft.

22. Research how food will be produced within closed life-support systems as a means of enhancing self-sufficiency and crew health during long space missions.
23. Research the topic of "space medicine".
24. Design a habitat for living on Mars for 6 astronauts for a period of six months; the habitat would include bedrooms, bathrooms, exercise area, kitchen, laboratory and medical station.
25. Design a kitchen appliance that could be used on the surface of Mars.
26. Research the nutrition issues facing astronauts when travelling to and from Mars.
27. Design a greenhouse for implementation on the surface of Mars. Consider Mars' weather conditions – temperature level and moisture availability, chemistry, radiation and gravity.
28. Research the time-line from now until a trip to Mars takes place. Identify one major obstacle to overcome in the time-line and suggest solutions to eliminate the obstacle.
29. Research areas of the Earth that might be used for simulations of the Mars environment. Prioritize your choices and provide a rationale for the ranking.
30. Identify an environmental problem on Earth that may be solved by the application of space-based research on Earth; correlate the potential findings from space to the Earth-based environmental problem.