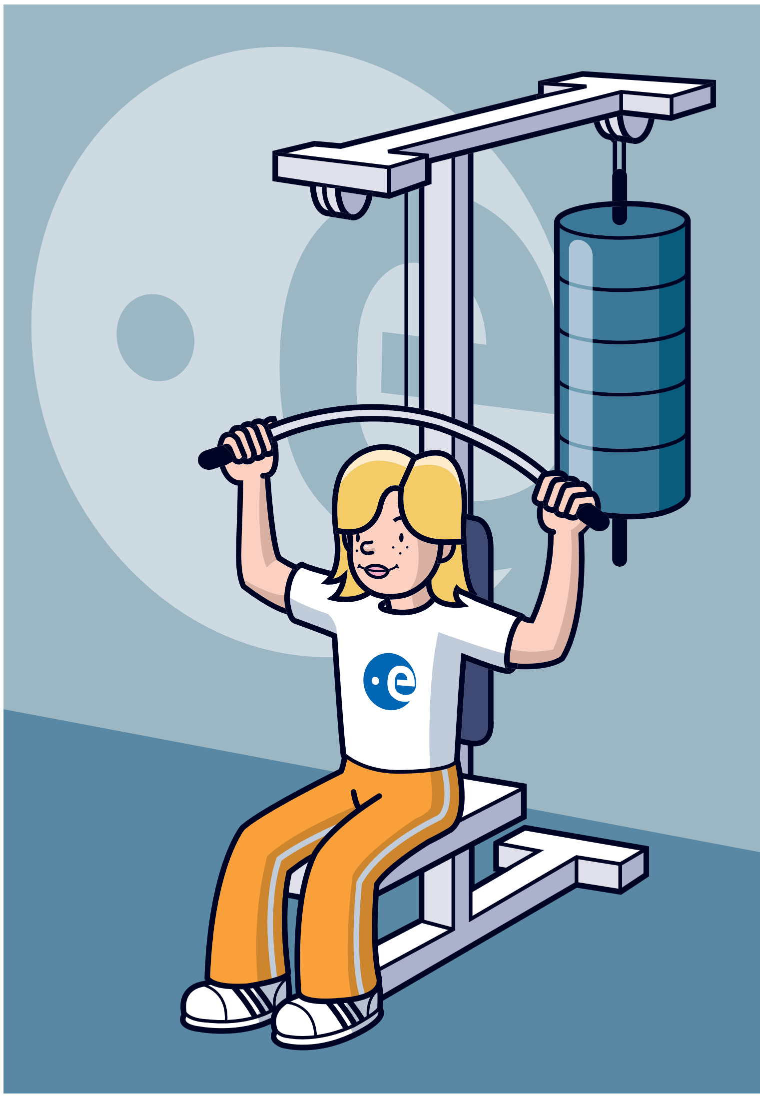


Astronauts train very hard. They can be pilots, engineers or scientists, and sometimes even more than one of these. And they must be very fit.

They often train for years before they are given their first space mission. And then they need more special training for that mission, on top of all the work they have already done.

Sometimes, they train underwater: floating inside a huge tank, they feel nearly weightless. Divers watch over the astronauts as they learn to use their tools while they float.

Underwater training.

Worksheet A: Apply to become an astronaut

●●○

If you would like to be an astronaut, you have to apply for the job. Write a letter and say why you would like to become an astronaut.

Anna Star
28, Sunny Road
Moonceister AB1 24Z
United Kingdom

European Space Agency
Head Quarters
Paris
France

Moonceister, 15 August 2005

APPLICATION TO BECOME AN ASTRONAUT

Hello,

My name is Anna Star, I am ….. ____________________

____

____

____

____

____

____

____

Faithfully,
Anna Star

Worksheet B: Astronaut training

●●○

For every task astronauts will do in space, they have to practise again and again on the ground, so that they can do their jobs in space with no problems.

Astronaut Frank De Winne during his survival training.

Specific training:
Work in pairs and groups and decide on a song or a play you would like to perform. Practise it and make sure you know it so well that you could almost do it in your sleep (make sure you can do it several times, without making mistakes)!

Choose a song or a play with one of the following themes: Stars, planets, astronauts, leaving home, dreams, practice.

Think about it!

- Why do you think it is so important that astronauts practise again and again on the ground before they do a specific task in space?
- What kind of tasks do you think it is most important not to get wrong?
- When is it a good idea that you do a lot of training or practise on a specific task before actually doing it?

Worksheet C: Learning a new alphabet

The Russian Alphabet

During the astronaut training, astronauts must learn to speak English and Russian, the two languages used on the Space Station. The Russian alphabet is different from the European alphabet. Learn the sounds of the Russian alphabet from the table on the next page. Use it to find out:

1. how to write your own name with Russian letters:

____

2. how to write the Russian word for “space”. It is pronounced “kosmos”.

____

The Russian word for astronaut is cosmonaut. It is pronounced “kosmonavt”. Write this in Russian letters:

____

Astronauts’ suvival training.

Worksheet C: Learning a new alphabet (2)

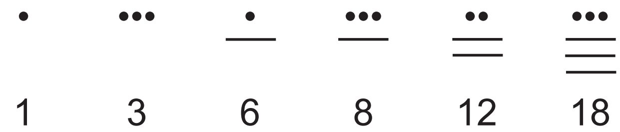
●●○

	Letter	Pronunciation
1	А	A (as in lAst)
2	Б	B (as in Bad)
3	В	V (as in Village)
4	Г	G (as in Goal)
5	Д	D (as in Delta)
6	Е	Je (as in YEs)
7	Ё	Jo (as in YOUR)
8	Ж	Zj (as in uSual)
9	З	Z (as in Zoo)
10	И	I (as in EAgle)
11	Й	J (as in York)
12	К	K (as in Kate)
13	Л	L (as in Lion)
14	М	M (as in Mother)
15	Н	N (as in Noon)
16	О	O (as in Ornament)
17	П	P (as in Papa)
18	Р	R (rolling R)

	Letter	Pronunciation
19	С	S (as in Snow)
20	Т	T (as in Table)
21	У	Oo (as in bOOk)
22	Ф	F (as in Friend)
23	Х	H (as in House)
24	Ц	Ts (as in German Z, Zug)
25	Ч	Ch (as in CHeese)
26	Ш	Sh (as in Shoes)
27	Щ	Sh (as in Shoes)
28	Ъ	to make other sounds harder
29	Ы	Y (a sound similar to the one you would make if you bite an apple and find a worm...)
30	Ь	to make other sounds softer
31	Э	È (as in bAd)
32	Ю	U (as in YOU)
33	Я	Ya (as in YArd)

Worksheet D: New symbols

1. These are Mayan numbers. By looking at the symbols below, find out how to write the Mayan numbers from 1 to 19.



1	2	3	4	5	6	7	8	9	10

11	12	13	14	15	16	17	18	19

2. Find out how to write numbers in a different way than you normally write them. Write the symbols for the numbers 1-19.

1	2	3	4	5	6	7	8	9	10

11	12	13	14	15	16	17	18	19

Think about it!

- What other languages do you know?
- What other alphabets are there?
- How many different ways of writing numbers do you know about?

Worksheet E: Floating and sinking

When astronauts are training in underwater tanks, the equipment they wear includes a weight-belt and a waistcoat they can fill with air. The weights make them sink, while the air in the waistcoat makes them float – in this way they can adjust the depth. When they have the right balance between sinking and floating, it feels almost like being weightless in space.


Underwater training

Find out:
Which materials float and which materials sink in water?

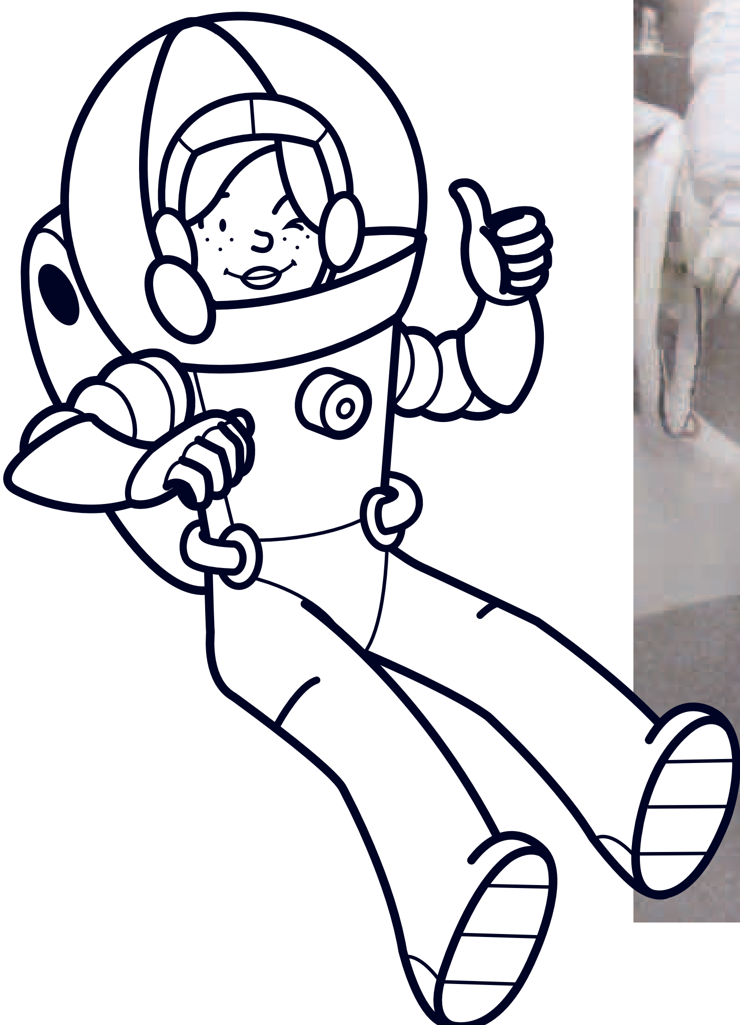
1. Decide which materials to test. Use for instance a piece of wood, a stone, a marble, a piece of cork or other things available. List them in the table.
2. Guess which materials will float or sink and note it in the table (mark it with a 'x').
3. Put the objects you have chosen, one at a time, in a bowl of water and find out whether they float or sink. Note your findings in the table (mark it with a 'x').
4. Discuss why you think some objects float and some objects sink.

Objects/materials used:	Predict what will happen:		Find out what actually happens:	
	Floats	Sinks	Floats	Sinks
Piece of wood				
Marble				

2.2 Space suits

Space is not a friendly place for humans. There is no air to breathe. On Earth, the atmosphere protects us from the rays that come from the Sun – and even here we sometimes get sunburnt! In space, the Sun's rays are very fierce. It can make things very hot. Yet where there is no direct sunlight, space is very cold.

Inside the Space Station, the astronauts are protected from these dangers. If they go outside, though, they have to wear space suits for protection.

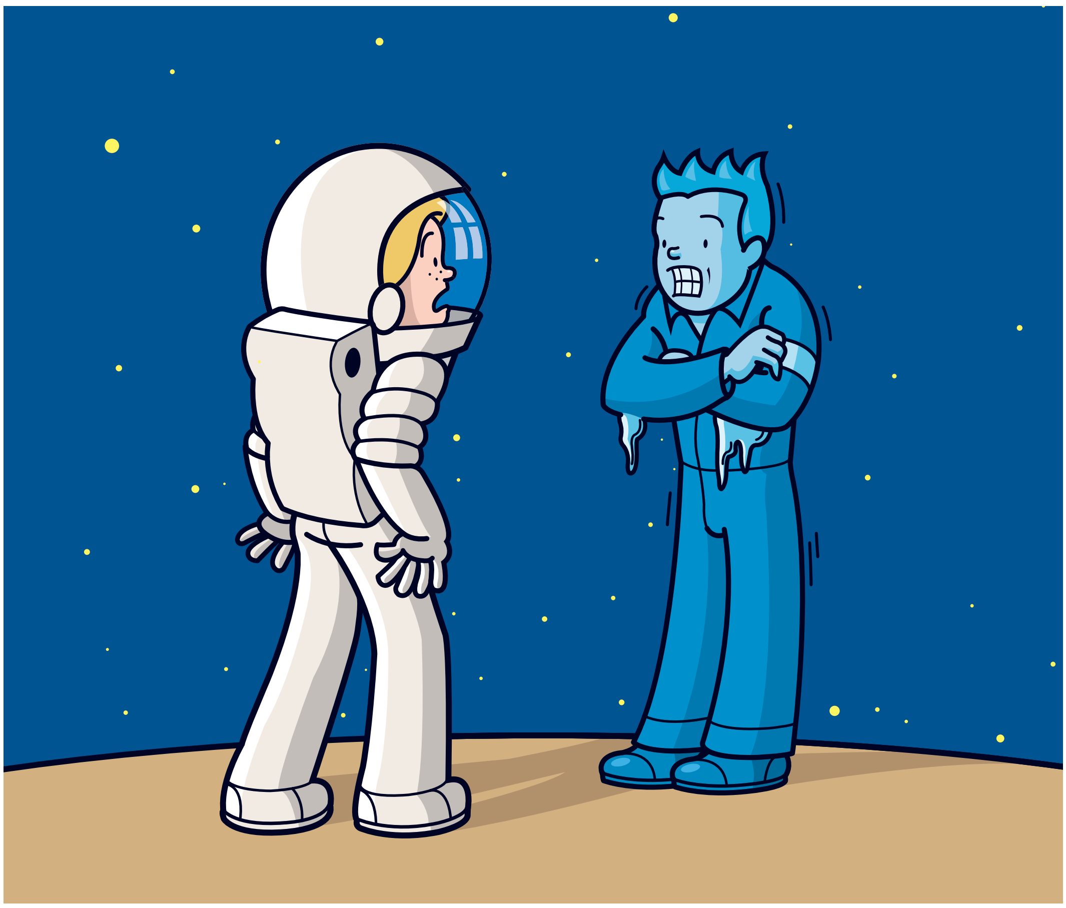


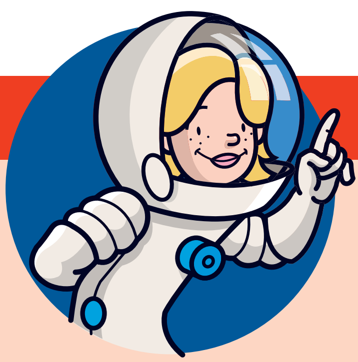
A real space suit.

2.2 Space suits

A space suit is almost like a small spacecraft and carries breathing air and water supply. It also has its own heaters, and its own cooler, to keep the astronaut comfortable.

Space suits are big and bulky. It takes a while to put one on, and astronauts usually help each other to dress. They check all the suit's tubes and connections very carefully, too!





Think about it!

The temperatures in space can be over 200 degrees Celsius in full sunlight, and minus 180 degrees Celsius in the shade.

- How hot is an oven?
- How cold is a fridge?
- How cold is a freezer?

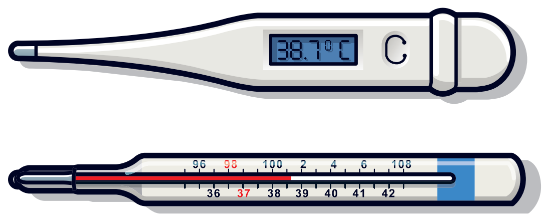
Worksheet A: Measure temperature – Indoor climate

●●○

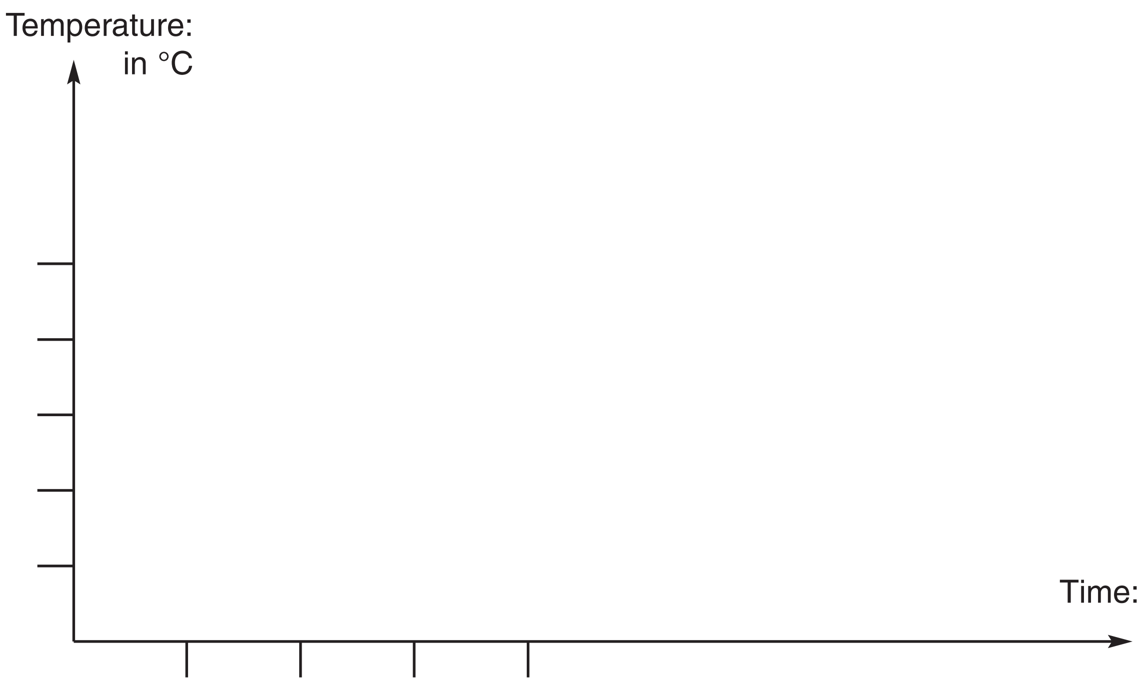
Inside the Space Station, the temperatures are about the same as normal indoor temperatures – the astronauts can wear t-shirts and shorts.

Find out what the temperature is in your classroom.

- Measure the temperature regularly (weekly, daily or several times during the day) – preferably in the middle of the classroom and away from direct sunlight – and note the findings in a table.
- Measure the temperature outside as well (in the shade).
- Make a diagram, illustrating the measurements you have made.



Time: / Temperature:					
Inside:					
Outside:					



Worksheet B: What would you wear?

Draw or make a list!

What would you wear when it is:

- Minus 180 degrees Celsius? ______________________________
- Minus 10 degrees Celsius? ______________________________
- 0 degrees Celsius? ______________________________
- Plus 15 degrees Celsius? ______________________________
- Plus 35 degrees Celsius? ______________________________
- Plus 200 degrees Celsius? ______________________________

Worksheet C: Design your own space suit

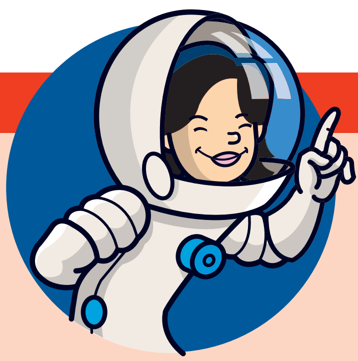
Astronauts wear space suits to protect themselves from the harsh **environment** of space. Design your own space suit. Draw and explain with words or make an astronaut costume.

André Kuipers in his space suit.

Safety

When constructing a space suit, you need to think about:

- How to protect against both the extreme heat and cold of space.
- How to supply the astronauts with air to breath in the vacuum of space.
- How to make sure the astronauts don't drift away.
- How to protect against dangerous rays or **meteoroids** that could hit the astronauts while doing a **spacewalk**?



Think about it!

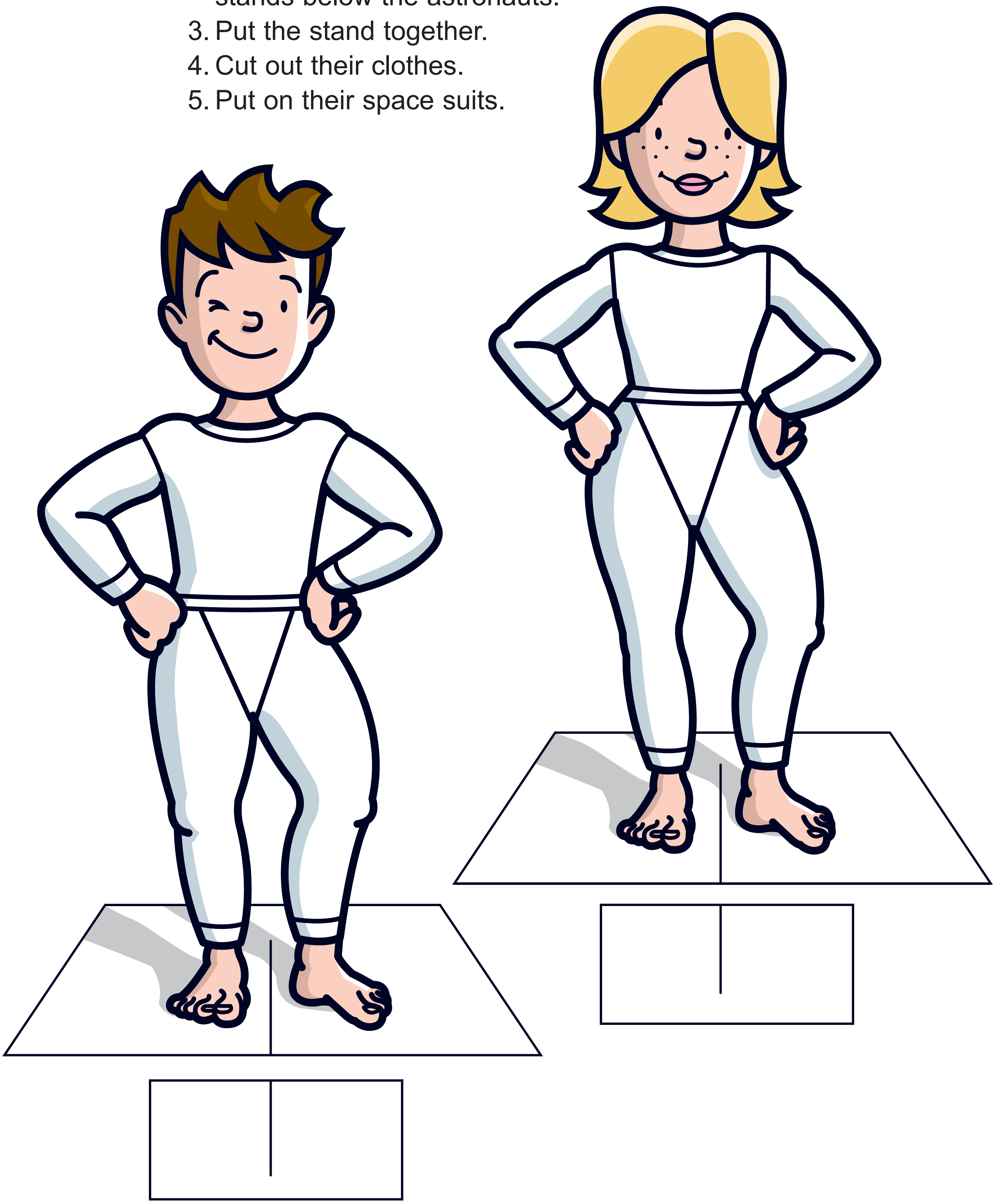
Some practicalities to think about:

- How to put on your space suit.
- How to eat or drink.
- How to urinate.
- How to communicate with others (for example other astronauts or the experts in the mission control centre on Earth).

Worksheet D: Put on the space suit (1)

●○○

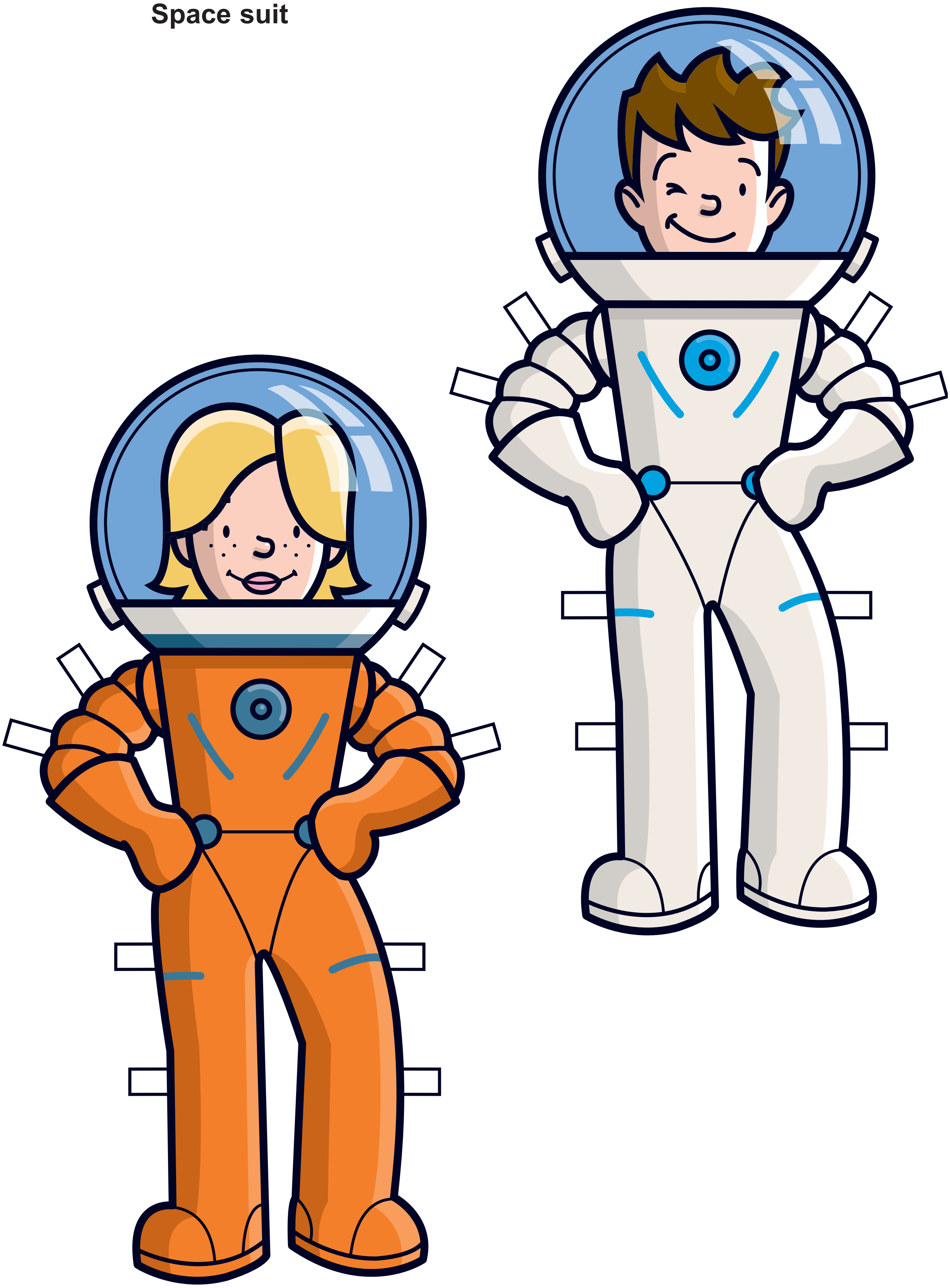
1. Colour the astronauts and stick them onto cardboard.
2. Cut out the astronauts. Make sure you also cut out the stands below the astronauts.
3. Put the stand together.
4. Cut out their clothes.
5. Put on their space suits.



Worksheet D: Put on the space suit (2)

●○○

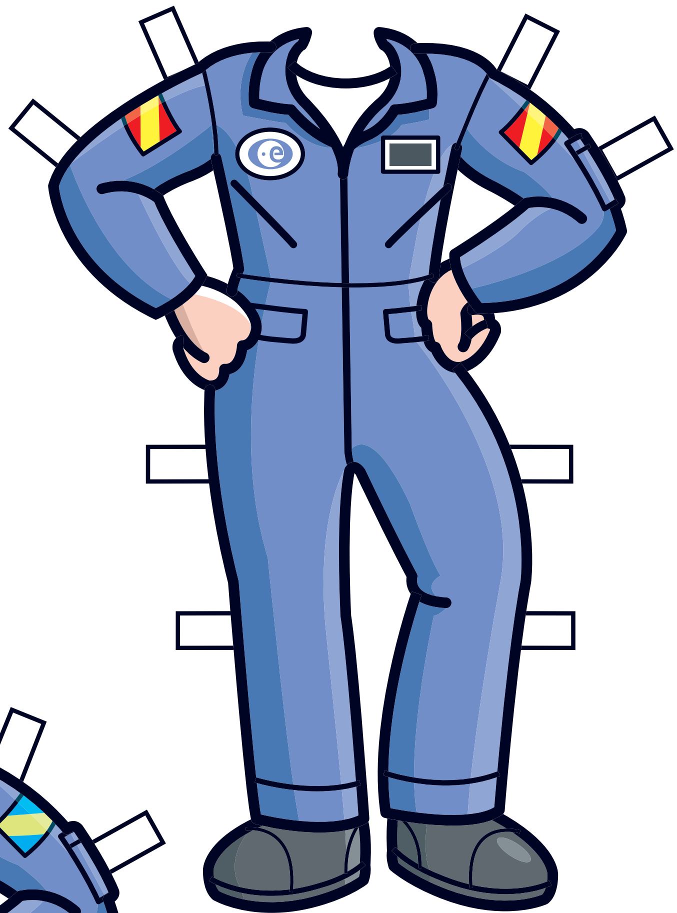
Space suit

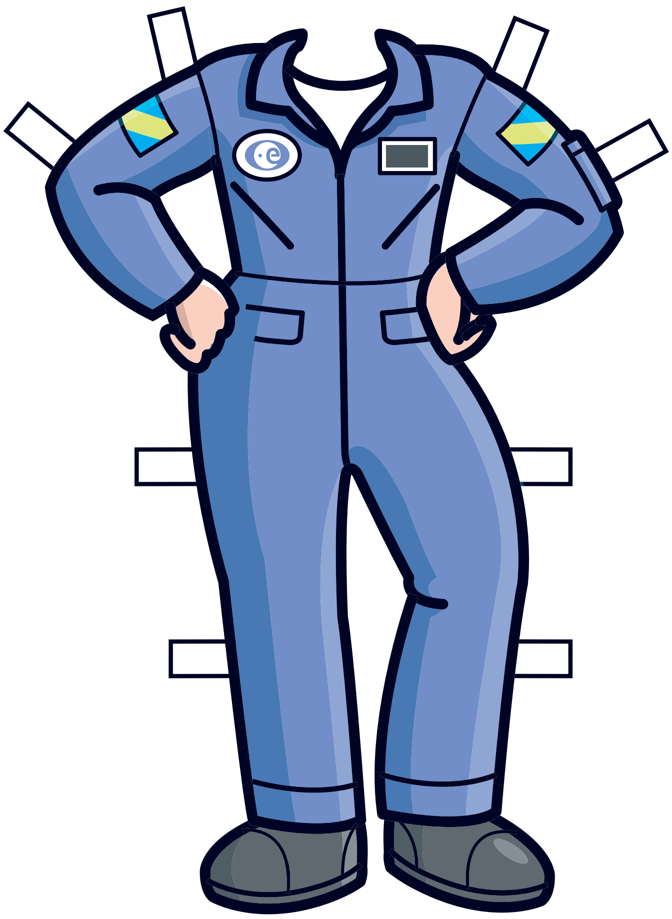


Worksheet D: Put on the space suit (3)

●○○

Indoor space overalls

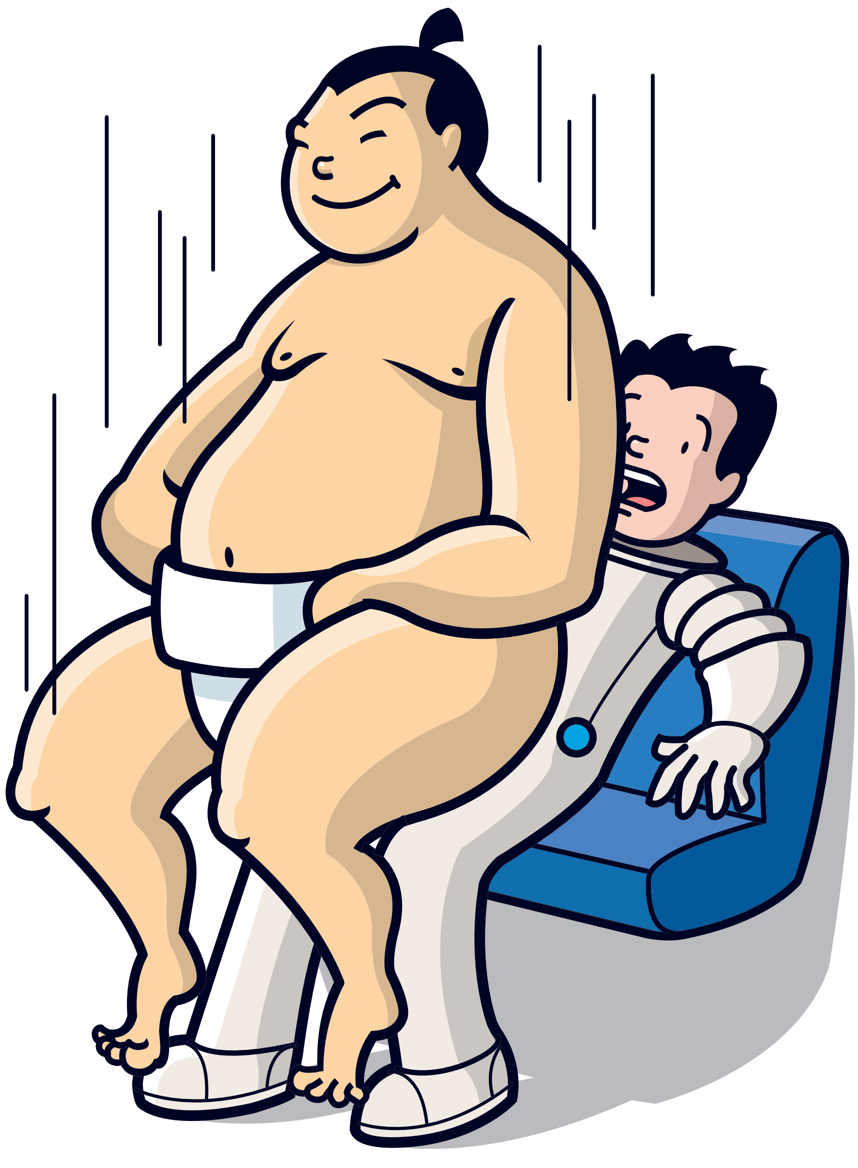




To reach the Space Station, astronauts must travel by rocket, either the American **Space Shuttle** or the Russian **Soyuz**.

Astronauts are strapped into their seat, and the rocket blasts off. It works just like rockets you have seen at fireworks displays, but it burns thousands of kilogrammes of propellants in just a few minutes.

When you are in a car, and the car **accelerates**, you are pushed back in your seat. Rockets accelerate much more fiercely than any car. Astronauts are pushed back so hard it feels like a heavy Sumo wrestler is sitting on top of them!



The spacecraft follows the International Space Station...

In a few minutes, though, the acceleration ends. The astronauts in their spacecraft are weightless. At this time, most of the rocket taking the spacecraft into the sky has been dropped back to Earth. And most of its propellants are burned away. Now they must use their last drops of propellant to nudge their spacecraft to meet up with the Space Station.

Although the spacecraft and the station are both whizzing around the Earth, they come together very slowly. The spacecraft is getting closer and closer, making sure it doesn't crash into the Station. At last, the spacecraft connects itself gently to a station docking port. The astronauts have arrived!

...and docks to it.

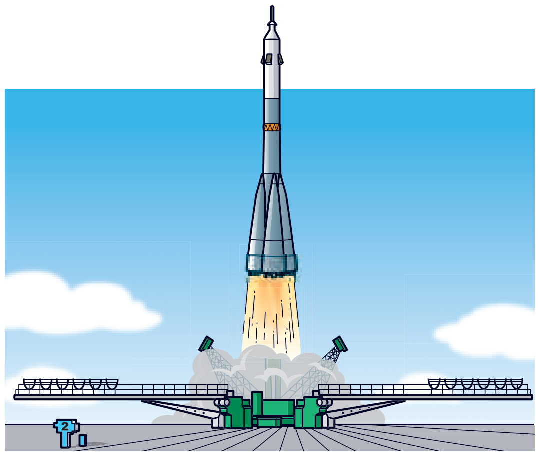
2.3 Travelling to space

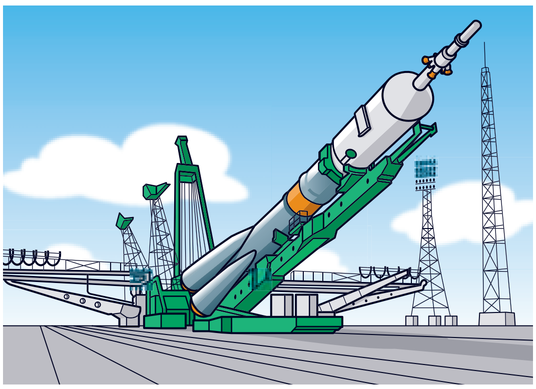
Worksheet A: Launching the spacecraft

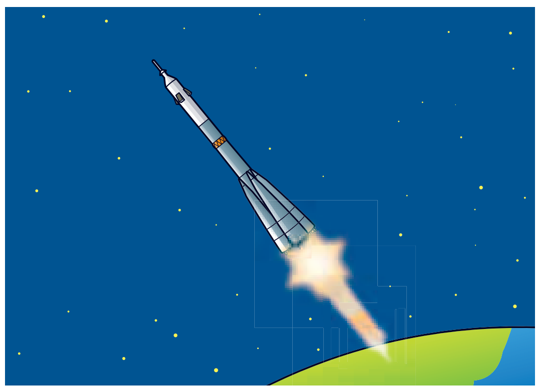
●○○

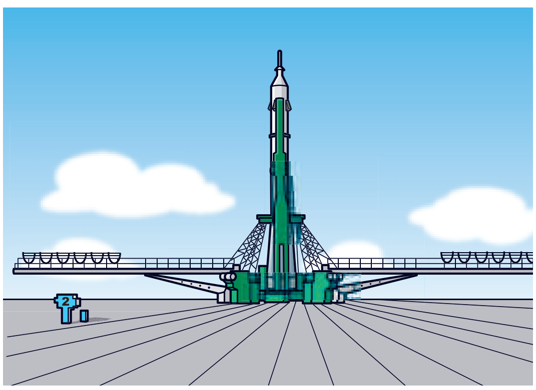
Cut out the pictures and glue them onto a sheet in the correct order, from the rocket being transported to it being launched.

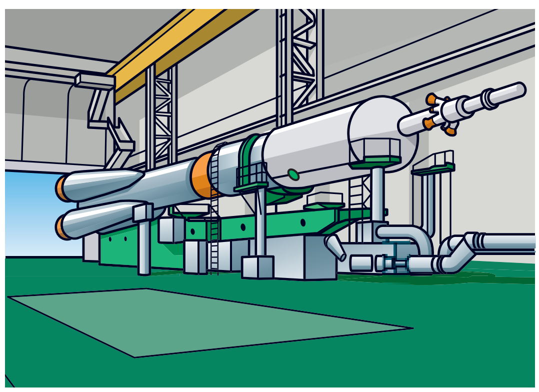
1. Rocket in the assembly building
2. Rocket during transport
3. Rocket being prepared
4. Rocket ready on platform
5. Rocket leaving platform
6. Spacecraft in space

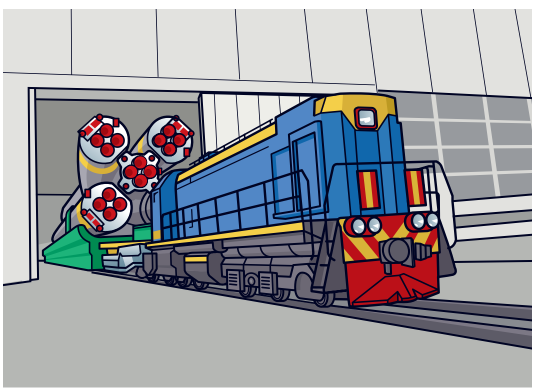












Worksheet B: Make a rocket film

Make a rocket film by following these steps:

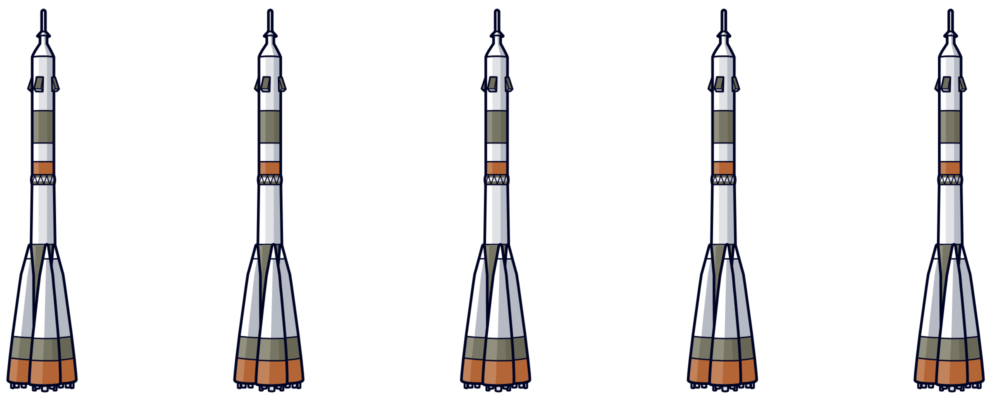
1. Decide what story you want to tell, for example “The launch of a rocket” or “A spacecraft landing on an unknown planet” .

2. Draw one picture for every movement or every step in the story. For instance:
- When the rocket is standing still on the launch pad.
- When there is the first burst of fire.
- When the rocket is leaving the launch pad.
- When the spacecraft is flying around the Earth.

3. Put all the pictures in the right order.

4. Staple them together on one side.

5. Now: Flip through the book and watch the film.



Think about it!

- The story should be simple and should include some motion.
- When the rocket is further away, it should look smaller than when it is closer.
- More pictures and more details mean it looks more like a real film.
- If you would like to let the rocket stand still for a while, you can put several pictures that look similar after each other.

Worksheet C: Make a rocket (1)

●●○

Work in teams and make a paper rocket.

You need:

- An A4 sheet
- A pair of scissors
- A pencil
- Tape
- A straw (preferably one with a wide diameter)

Paper rocket

1. Make the rocket's main stage:

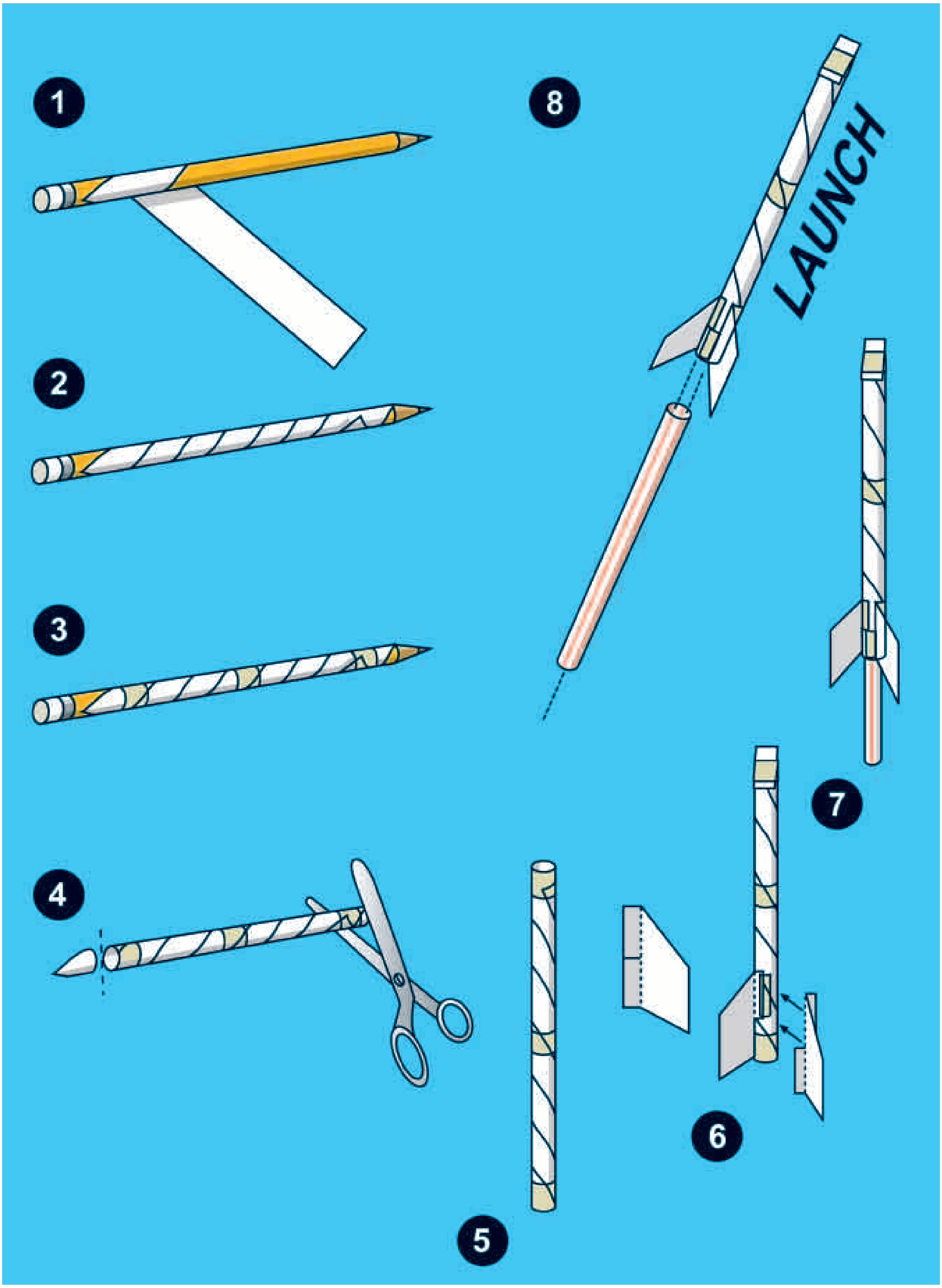
   - Cut a strip, 5 cm wide, from the long side of an A4 sheet.
   - Roll the paper strip around a pencil (about the same **diameter** as the straw you will use to launch your rocket). Start at one end of the straw, holding the paper inclined, and roll it up so that it becomes a tube (remember to keep it tight!).
   - Tape the tube at each end and at the middle of the rocket.
   - Remove the pencil.
   - Cut both ends.
   - Fold the upper end firmly and tape it.

2. Design the rocket's nose and fins.

3. Launch your rocket by inserting the straw in the open end and blow!

Worksheet C: Make a rocket (2)

●●○



Worksheet D: Rocket race (1)

●●○

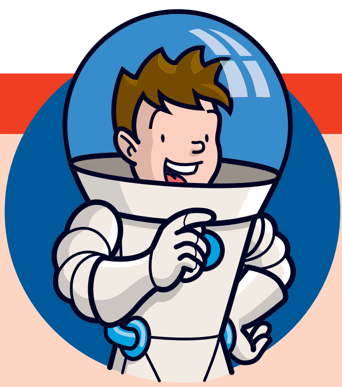
A Soyuz rocket just after launch.

First, create a race area in the classroom or in the hall. Mark the starting point. Decide how many rounds you will play per team member.

Per team:

1. Guess how far your rocket will go. Write down your guess.
2. Launch your rocket and measure how far it flies. Write it down and find out which team has the rocket that flies the furthest.
3. Calculate the difference between how far you guessed the rocket would fly and how far it actually flew. Find out who guessed correctly.

For further investigations:
Experiment with different sorts of fins and noses, the length of the rocket and find out how you can make the rocket fly even further.



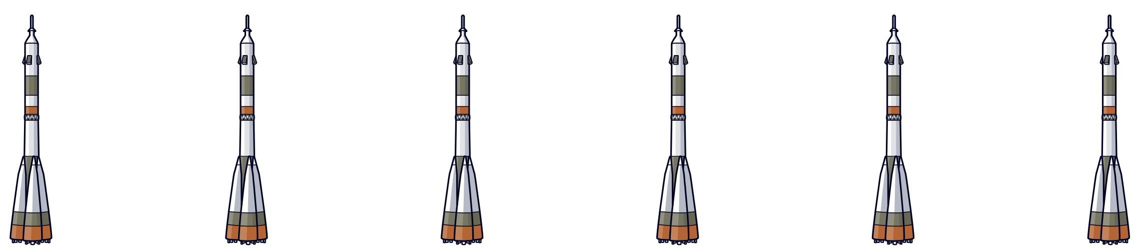
Think about it!

- How can you make a race fair for everybody?
- How can you make your measurements most precise?
- What other ways would you use to decide which team has won?
- What measurements would you suggest for other kinds of race; for instance, for sprint running and marathons?

Worksheet D: Rocket race – table (2)

●●○

		Launch 1	Launch 2	Launch 3	Launch 4
Team A	Guessed				
	Actual distance				
	Difference				
Team B	Guessed				
	Actual distance				
	Difference				
Team C	Guessed				
	Actual distance				
	Difference				
Team D	Guessed				
	Actual distance				
	Difference				
Team E	Guessed				
	Actual distance				
	Difference				
Team F	Guessed				
	Actual distance				
	Difference				
Team G	Guessed				
	Actual distance				
	Difference				



Worksheet E: Travelling by different means

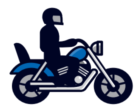
What speed do you travel at when cycling or driving a car – or going to space with a rocket?

Fill in the right number:

80 12 28000 50 800

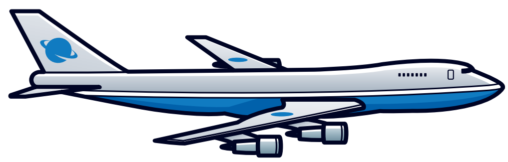
Cycling: . . . . .km/h

Riding a moped: . . . . .km/h

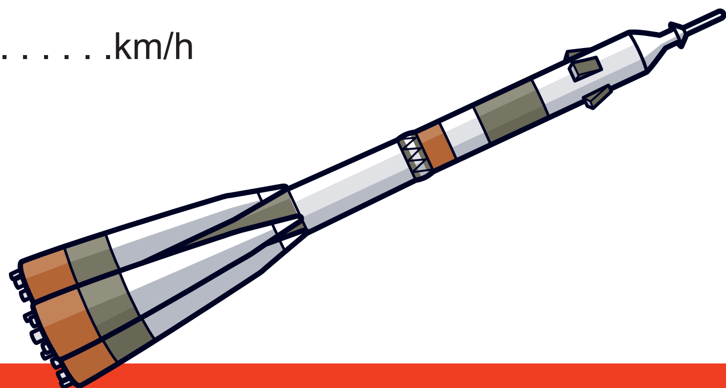


Driving a car: . . . . .km/h

Flying in an aircraft: . . . . . . .km/h



Flying on a rocket: . . . . .km/h



Think about it!

What means of transport would you use to go from home to:

- Your school?
- The nearest town?
- The nearest other country?
- A country on the other side of the Earth?
- The Moon?

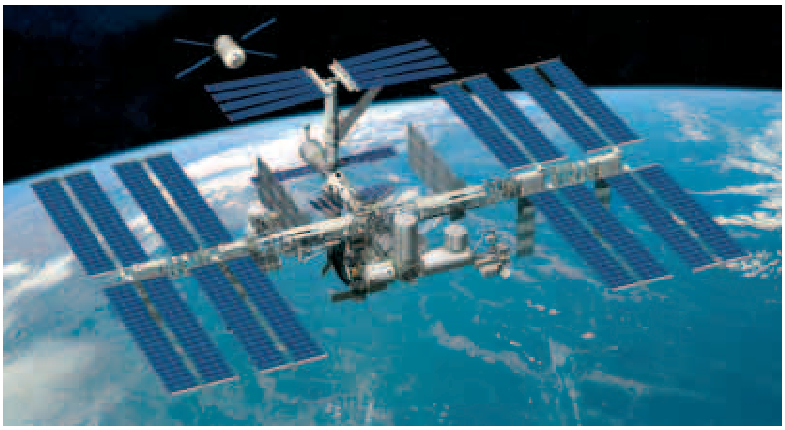
Why you would choose these means of transport?

Worksheet F: Speed in space

●●●

1. After the launch of a Soyuz rocket, it takes approximately 2 days and 2 hours before the astronauts reach the Space Station.
   How many hours does this trip take?
   a. 74 hours
   b. 50 hours
   c. 38 hours

View from the Station as Soyuz approaches.



The International Space Station.

2. It takes the Space Station 1.5 hours to travel around the Earth once. How many minutes does it take?
   a. 150 minutes
   b. 90 minutes
   c. 30 minutes

2. How many times during 24 hours will the Space Station travel around the Earth, when it takes 1.5 hours to travel once?
   a. 24 times
   b. 12 times
   c. 16 times

A Soyuz spacecraft approaching the Space Station.

2 Teacher's Background

2.1 The training of an astronaut

Lesson – core elements:

Pupil's text:	Astronauts' education and careers Astronauts need to be fit Training is hard, rigorous and repetitive Underwater training (simulation of weightlessness)
Worksheets:	Write a letter/an application about why you would like to become an astronaut Some tasks need a lot of practice before the actual performance Learning different alphabets and mathematical symbols, new languages Floating and sinking objects

Subjects represented:
Language
Science
Arts/Music/Drama
Mathematics

Background information:
It takes time to become a real astronaut. All of today's astronauts will have undergone a great deal of training before they even apply for the job: in science, in medicine, in piloting skills and often a combination. About half of the European Astronaut Corps began as pilots, often with a background in military aviation and test flying. The others are scientific specialists first and foremost. But there is no hard and fast division. The "pilot branch" are likely to have solid scientific or engineering qualifications, and the "science specialists" may well learn piloting skills.

The European Astronaut Corps.

After selection (and there are hundreds of applications for every vacancy) astronauts must undergo long and rigorous training for space. This will include learning to cope with weightlessness: astronauts spend a lot of time working underwater, where buoyancy imitates many of the effects.

André Kuipers training in the Soyuz.

Every part of a mission is rehearsed again and again, especially if it involves a "space walk". Space is a harsh and unforgiving environment, airless and chill: there is no room for error. So astronauts practise on ground-based mock-ups of the craft that they will fly in, and of the ISS itself. In fact, for every hour they will spend on a space mission, astronauts are likely to spend tens or even hundreds of hours practising on simulators.

Whatever their original speciality, astronauts must also learn to be general-purpose scientists: on the ISS, there are many experiments in progress at any one time, and an astronaut-physicist may well have to put in some time as a chemist or a biologist. An astronaut with a medical background may well also train as a flight engineer.

There are some less exotic but just as vital skills to be learned, too. Survival training helps astronauts cope in case of a forced landing in wilderness terrain, for instance. And they need to be fluent in the two most important languages in spaceflight: English and Russian.

Worksheet A: Apply to become an astronaut, page 38

Ideas and hints for the worksheet activities:

The last time there was an astronaut selection, there were about 22 000 applicants. The selection criteria are based on medical requirements, as well as scientific and technical competence. Also psychological suitability is of importance: astronauts need good concentration and memory, high motivation and should be emotionally stable. On the Space Station, astronauts work in teams and the crew have different nationalities and different cultural backgrounds.

Claudie Haigneré putting on her space suit.

Let the pupils use this worksheet or the "Mission diary – report" form to write a letter about why they would like to become an astronaut. Alternatively, let them write about their dreams for the future and what they would like to become when they grow up.

This worksheet can be used to teach different forms of letter writing: formal and informal letter, applications, diaries etc, as well as tips and practice using computers for writing formal letters.

Worksheet B: Astronaut training, page 39

The training an astronaut has to go through is divided into three phases. The **basic training** provides the astronauts with basic knowledge on space technology and skills training related to future operational tasks. This phase takes up to one year. The **advanced training** builds upon the basic training and lasts for about another year. It covers topics related to the operation of the Station's elements, payload, transport vehicles and related interaction with the ground. Only after having successfully completed this phase the astronauts can be assigned to a specific mission. The **increment specific training** starts and the astronauts train specifically those tasks they will perform during their mission. The duration of increment specific training is approximately one-and-a-half years.

The objective of this worksheet is to motivate pupils to practise tasks and show that it is important to be prepared in order to avoid mistakes. This can lead to discussions about and better understanding of why it is necessary to study and work hard, as well as to cooperate and have empathy for other humans.

Worksheet C: Learning a new alphabet, pages 40,41

Use the resources available in your class: if there are multilingual pupils in the class, they might have knowledge of other alphabets or ways of writing numbers. Even though they use the same alphabet or numbers as you use in your school, this can lead to a nice exercise about learning other languages – let the pupils teach the rest of the class how to count to ten, for instance.

In the first worksheet, you will find a table of the 33 letters of the Russian alphabet. How they are written is shown in the column "Letter" and an approximation of how they are pronounced according to English sounds/letters are shown in the column "Pronunciation". A sample word in English is given to help find the sound – the sound is highlighted by capital letters.

	Letter	Pronunciation
1	А	A (as in lAst)
2	Б	B (as in Bad)
3	В	V (as in Village)

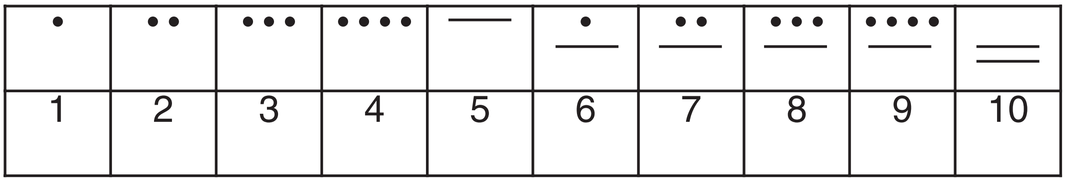
On the following pages you will find answers to the questions in the worksheets (including an example of a different way of writing numbers) and some background information about the Mayan numbers.

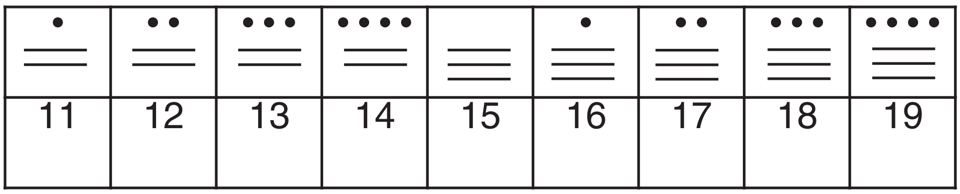
Worksheet C: Learning a new alphabet, page 40

Russian Alphabet :
Question 2. КОЗМОЗ
Question 3. КОЗМОИАЮТ

Worksheet D: New symbols, page 42

Mayan numbers:

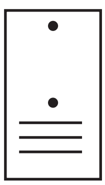




The Mayan culture has a history which dates back 3 000 years. Geographically, the Mayan people lived in the area which today is southern Mexico and northern Central America. The first findings related to Mayan numbers date from about 400 A.D. It is said that the Mayans were extremely advanced in mathematics (and also in astronomy, calendars, architecture etc.) – thousand years more advanced than European culture at that time.

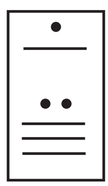
The Mayans used a number system based on twenty. As the number system used positional notation, the numbers above 20 were written as in the examples below:

Number 36:

20s:  (20) or: (1x20)

1s: (16) or: (3x5+1)

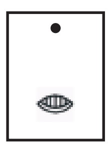
Number 137:

20s:  (120) or: (6x20)

1s: (17) or: (3x5+2)

Symbol for zero:

Number 20:

20s:  (1x20)

1s (0x1)

Example, Roman numbers:

I	II	III	IV	V	VI	VII	VIII	IX	X
1	2	3	4	5	6	7	8	9	10

XI	XII	XIII	XIV	XV	XVI	XVII	XVIII	XIX
11	12	13	14	15	16	17	18	19

Worksheet E: Floating and sinking, page 43

Part of every astronaut's basic training is scuba diving. In big pools the astronauts practise spacewalks (or Extra Vehicular Activity – EVA). This is the best place to simulate and experience weightless conditions on Earth.

Density: The Worksheet's topic is **density**, mass per unit of volume. The symbol for density is the Greek letter ρ (rho) and is, for example, given in kg/dm^3 (kg/litre) or g/cm^3. The formula for density is:

$$\rho = \frac{m}{V}$$ (m = mass and V = volume)

Further ideas and explorations:
Astronaut training
The astronaut training worksheet can be connected to the worksheet about robotics (specific training for operational tasks on the Space Station) and about space suits. Let the pupils bring a helmet, a big pair of ski gloves and a skateboard (or in-lines) and "perform" a spacewalk.

Description of the task: A part of the Space Station needs to be checked and you have to go out and tighten some of the bolts on the outside of the Space Station (let them tighten a few screws on a piece of wood placed almost out of reach).

Moving around in a space suit is difficult...

Learning a new alphabet

1. Different languages, same meaning: let the pupils make a list of words they would like to know in another language. Use dictionaries or other resources (other pupils in the class, neighbours etc).
2. Let the students find out how to add numbers using the Mayan numbers. Work in pairs or groups and let them play around with the dots and lines. It is actually quite easy to add up Mayan numbers: you just add up the dots and the lines. An example of addition:

3 + 11 = 14

3. Use these activities to learn more about other cultures. Also consider examples from literature, music, dance etc. in addition to language and mathematics.
4. Let the pupils find out when the alphabet and numbers used in your country/area today originated and whether there are examples of other written symbols used in earlier times in your country/area.

Floating and sinking

Experiment on density:

1. Fill three empty containers (for example 1-litre milk cartons) with different types of materials, e.g. water, sand, cotton wool. Seal the three containers.
2. Predict what will happen when the containers are put into a bucket or tray of water.
3. Carefully and one after the other place the three cartons in the water.
4. Describe what happens.
5. Analyse what happened (the size of the three containers is the same – why do some float and some sink?).
6. Weigh the three cartons.

Additional activity: Find the density of the three materials (take the mass in kg or g and divide it by the volume – e.g. 1 litre or 1 dm^3).

Related topics:

Chapter 2.2 “Space suits”

Chapter 3.2 “Building the International Space Station”, Worksheet C “Robotics”

Websites:

How to become an astronaut:

http://www.esa.int/esaHS/ESA1RMGBCLC_astronauts_0.html

Mayan numbers (and link to other numeral systems):

http://en.wikipedia.org/wiki/Maya_numerals

2.2 Space suits

Lesson – core elements:

Pupil's text:	• Harsh environment of space: vacuum, high-energy particles, cosmic rays, extreme temperatures • Space suits to protect the astronauts from these dangers • Space suits have water and air supply, heaters and coolers • Equipment is carefully checked
Worksheets:	• Indoor climate (health, measuring temperatures) • Temperatures (how do we protect ourselves against heat and cold and what temperatures can we handle?) • Design a space suit (draw/explain or make a costume) • Cut out the astronaut paper dolls and clothes and play

Subjects represented:
Arts
Science
Social Science
Maths
Language

Frank De Winne in the blue "flight suit".

Background information:
Most of the time, astronauts wear loose-fitting, comfortable "flight suits". But if they venture outside the station, they need much more protection – from heat, from cold and from radiation as well as the airlessness (vacuum) of space.

The space suit that provides this protection is a very complex piece of equipment: almost the equivalent of a one-person spacecraft. It contains its own air supply, which also pressurises the suit against the vacuum of space. The suit must deal with huge changes in temperature, from well over 200 degrees Celsius in full sunlight to –180 degrees Celsius in the shade. So the suit's backpack includes both a system for cooling and a system to keep warm. Beneath the outer suit, an entire inner garment helps insulate the astronaut: the whole process of "suiting up", including all the necessary checks, can take a considerable time.

The helmet has a gold-plated visor that shields astronauts from the bright sunlight of space, as well as lights to illuminate pools of shadow. The suit has a tough outer skin that gives some defence against micro-meteorites – tiny flakes of orbital dust – as well as radiation. But it is flexible, too: astronauts must be able to move freely while wearing it. The gloves are miracles of engineering in themselves, with their own heating element to protect against frostbite, yet thin enough to allow quite delicate work.

Since a "space walk" – EVA, or "Extra-Vehicular Activity" in astronaut jargon – may last for hours, the suit must also be reasonably comfortable. It even includes its own water supply – as well as a kind of diaper for urine.

A visor protects astronauts from the sunlight.

A real space suit.

Ideas and hints for the worksheet activities:

Worksheet A: Measure temperature – Indoor climate, page 46

This activity can lead to more extensive work related to temperature, environmental issues etc. Discuss in class:

- What's the temperature in the classroom – is the temperature the same all the time? If it changes – why do you think that is?
- What 's the temperature in the classroom compared with the outdoor temperature – is there any connection?
- How does temperature influence your health (think about very high and very low temperatures) and your ability to concentrate? (Recommended indoor temperatures are about 20-22 degrees)

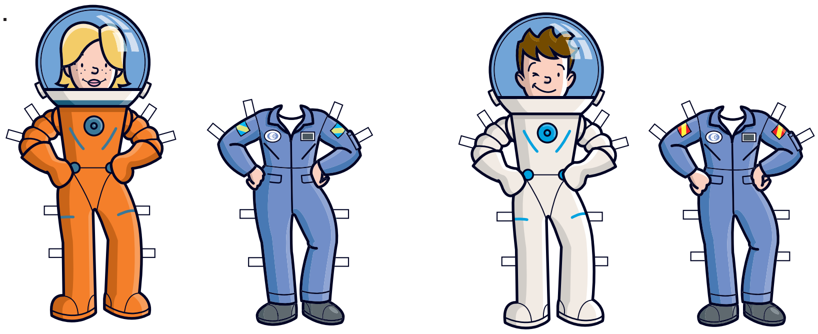
Worksheet B: What would you wear?, page 47

This worksheet can be used as a basis for discussion. If the concept of degrees is too difficult, talk about what they would wear when it snows, rains and when it's sunny, or you can connect it to the season and discuss what they wear in winter, spring, summer and autumn.

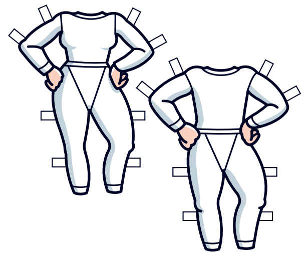
Survival training in the Russian winter.

Worksheets C and D: Design your own space suit/Put on the space suit, pages 48-51

Astronauts wear different types of space suits. They wear one type for travelling to and from the Space Station, one for "indoor" use (they also can wear trousers/shorts and t-shirts) and one for performing spacewalks (or EVAs).



The space suit used for spacewalks has several layers to protect the astronauts. First, they put on their underwear (including a disposable absorption garment – a sort of nappy), then their long underwear and on top of that, a special garment which regulates the temperatures with liquid cooling tubes and a gas ventilation system.



Claudie Haigneré is helped into her boot.

Finally the astronauts don the outer part of the EVA suit. This protects against them from dangerous rays and micro-meteoroids, regulates air pressure and provides the astronaut with air, water, electrical power and communication equipment (the helmet has a camera, radio and lights attached). The American suits and the Russian suits look a bit different. While the Russian suits are made as one piece (you have to climb into it from the back), the American suit has one upper part and one lower part (first you have to "climb" into the lower part, then you have to put on the upper part).

The astronauts change into their space suits in the hatch lock to equalise the air pressures and make sure the oxygen level in their blood is at the right level before they go out.

Roberto Vittori arrives in his flight suit.

Additional activities: Ask your pupils to draw a space suit and explain what the different parts are, or let them prepare an astronaut costume to wear for an event – for instance when watching the International Space Station pass


New space suits...

(see chapter 3.1 “What is a Space Station”). Pupils can work in pairs or groups to exchange ideas. Beforehand, discuss the issues listed in the worksheet and try to find answers:

- How can you have ONE suit for protection against extreme heat and extreme cold at the same time?
- What do you do if you have to go to the toilet during a spacewalk (and there is no time to go back inside…)? – What if you get thirsty?
- As you are weightless, you would float around freely, so the astronauts have to make sure they stay close and attached to the Space Station. Should a space suit have some specific equipment to help the astronauts to avoid disappearing into space? What can you think of?

Further ideas and explorations:

Measure temperature – Indoor climate

To extend the topics covered in the worksheet, discuss what other factors influence our health. Use the opportunity to introduce different types of diagrams, how to read them and how to create them. Another idea can be to look at the importance of the Earth’s atmosphere for life on Earth and how pollution has an influence on our living conditions on Earth.

What would you wear?

An extension of the worksheet: discuss what temperatures humans can handle without special protection and that astronauts need to wear space suits to protect themselves from the extreme temperatures of space. Discuss average temperatures in other parts of the world, the minimum and maximum temperatures measured at Earth, or what the average temperatures are on other planets.

Related topics:

Chapter 3.1 “What is a Space Station?”

Chapter 3.3 “Supplying the International Space Station”

2.3 Travelling to space

Lesson – core elements:

Pupil's text:	• Different types of rockets (Space Shuttle, Soyuz) • Rockets burn a lot of fuel • High acceleration at lift-off • Acceleration ends and the astronauts are weightless (when reaching orbit) • Docking to the International Space Station
Worksheets:	• Preparation of and launching the rocket (put pictures in correct order) • Make a rocket movie (paper version) • Make a paper rocket and organise a rocket race • Means of transport and speed

Subjects represented:
Science
Maths
Arts
Language

The launch of a Space Shuttle.

Background information:
At present, there are two ways to reach the ISS: the American Space Shuttle or the Russian Soyuz launcher. In each case, the experience is not for the faint-hearted! Essentially, astronauts sit on top of hundreds of tons of highly explosive rocket fuel, which hurls them upward with a staggering acceleration. Their spacecraft must reach orbital speed – about 8 km/s – as quickly as possible (the faster a rocket can burn its fuel, the more efficient it is). Aboard the Space Shuttle, that means an acceleration of 3G: that is, the astronauts' weight is tripled. On a Soyuz, acceleration reaches an even more uncomfortable 5G.

A Soyuz rocket on the launch pad.

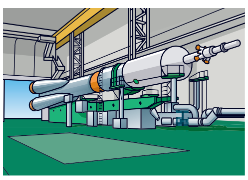
But the acceleration is soon over. Around eight minutes after lift-off, the rocket boosters fall away and the spacecraft is in orbit. Instead of weighing five times their normal weight, the astronauts now weigh nothing at all. But they do not have much time to relax and enjoy the experience: they must now get on with the job of matching orbits with the ISS.

It is a tricky business: spacecraft in orbit behave in ways that do not match human intuition. If you want to catch up with the ISS, for example, you must slow down a little. This will make your spacecraft drop Earthward – which increases its speed. It can take many hours before the Space Station is in sight (astronauts will spend the time checking out all systems and equipment on board, and making sure that communications links are working properly, and performing scheduled experiments). At last comes the most delicate manoeuvre of all: docking. Computers, radar and laser sighting equipment all help, but astronauts train to do the job manually if the automatics fail.

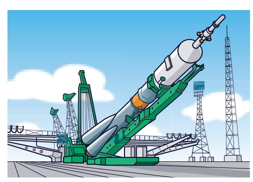
If all goes well, the incoming spacecraft will touch one of the station's docking ports so gently that the crew scarcely feel the bump. Then latches are fixed into place. The new arrivals may have to wait a while before they can open the hatch, though: it is important that the air pressure on each side is equal. Then, at last, they can leave their craft and join their colleagues on the station. Their mission has really begun.

Ideas and hints for the worksheet activities:
This chapter is mainly about launchers and speed. Use the worksheets to talk about rockets and the preparations needed before the rocket is ready for take-off (transport to the launch pad, set-up of the rocket at the launch pad, fuelling etc.), about what speed various means of transport can achieve, and how much time it takes to travel by different means.

Worksheet A: Launching the spacecraft, page 54
Answer:

①


②


③


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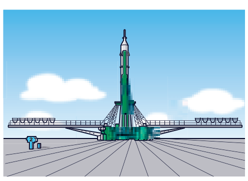

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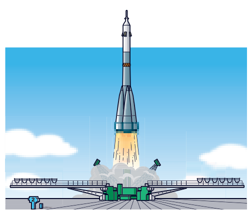

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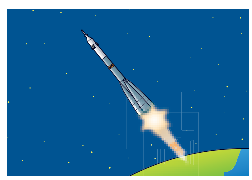
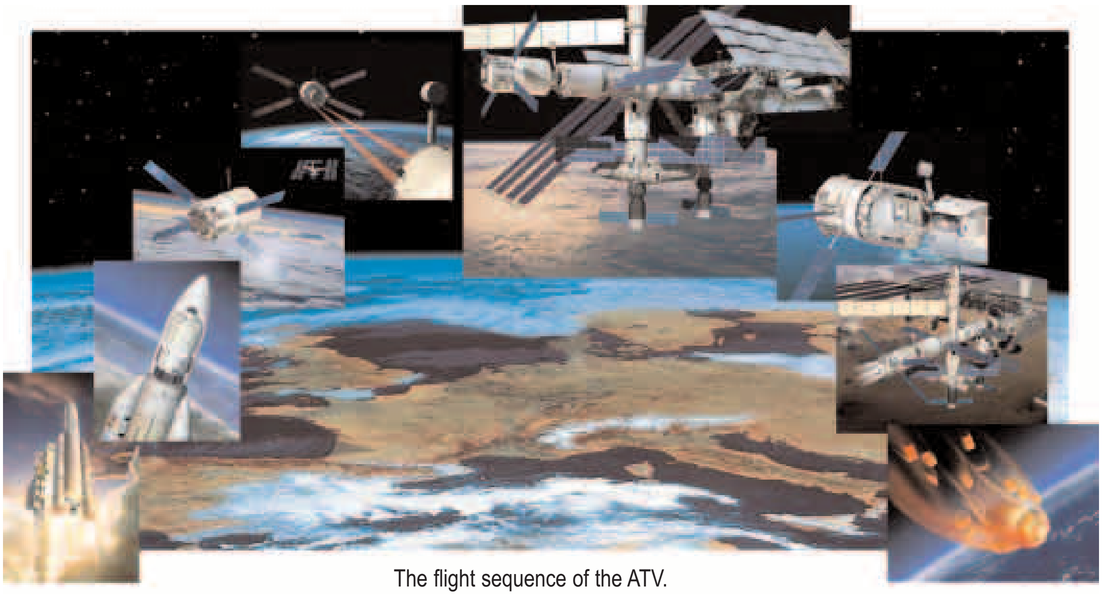


Worksheet B: Make a rocket film, page 55

The amount of fuel needed for a rocket to overcome Earth's gravity and reach the "escape velocity" (11.2 km/sec) depends on the rocket's weight. The heavier a rocket is, the more fuel is needed to ensure lift-off. And the more fuel, the bigger tanks and yet more weight. This is why most rockets today are so-called "three-stage rockets". This means that each time one part of the rocket has fulfilled its purpose, it drops off. The total weight is then reduced, which means that less fuel is needed for the rest of the flight. The materials used are light to reduce the total weight, but are also strong, to withstand the strong vibrations during lift-off.



The flight sequence of the ATV.

To create a "rocket film" may be difficult for the younger pupils to draw several similar pictures of a rocket. A good idea is to let the pupils use one sample rocket as a model and then copy the outline using tracing paper placed on top of it. To make the rocket move, they can use the same picture, but copy it at different angles on the paper.

NB! The size of the paper should not be too big, then it will be difficult to flip it.

Worksheets C and D: Make a rocket / Rocket race, pages 56-59

Let the pupils build a simple rocket and organise a rocket race. The rocket in the worksheet is made of a paper strip and tape. The only other things you need are a pair of scissors, a pencil and a straw. The pupils can find out more about aerodynamics by experimenting with different sorts of fins and noses, the length of the rocket etc.

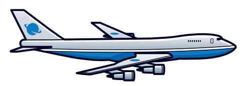
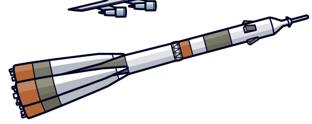
The data from the rocket race can be used in different ways. You can talk about predictions and estimations, find the average length of the flights and represent the data in tables and graphs. Another topic suggested in "Think

about it!" is what kind of measurements are used for different sorts of races. This can lead to a discussion about what kind of units are used for time, distance, volume etc and how precise they are – whether to use decimals (and how many) or for instance whether to use minutes, seconds or even smaller units as measurements.

Worksheet E: Travelling by different means, page 60

Introduce this with the means of a little experiment: let the pupils find out how far they can walk or cycle in a given period of time or how much time they need to walk or cycle a specific distance (depending on what is most convenient in your area). Talk about what speeds different means of transport can achieve and let the pupils find out of what kind of vehicles are best for different distances.

Answers to the worksheet:

Cycling:	12 km/h	
Riding a moped:	50 km/h	
Driving a car:	80 km/h	
Flying on an airplane:	800 km/h	
Flying on a rocket:	28 000 km/h	

Worksheet F: Speed in space, page 61

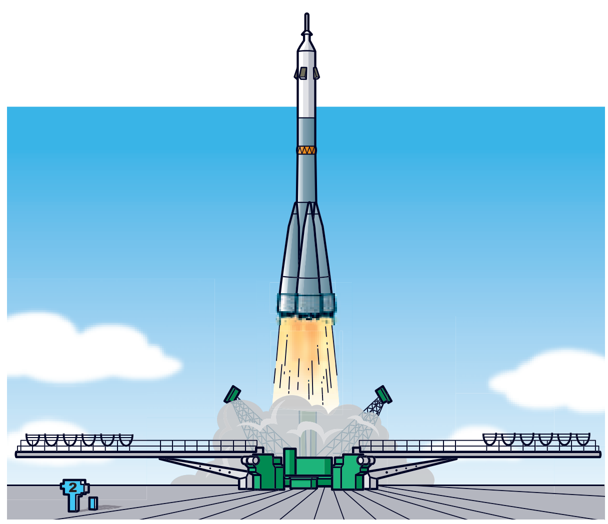
Depending on the pupils' level you can use this worksheet as it is, or you might need to adapt it as large numbers are involved. The worksheet can be used as a problem-solving task for students who need extra stimulus.

Answers to the worksheet:

1. 50 hours
2. 90 minutes
3. 16 times

Further ideas and explorations:
Launching a spacecraft

Let the pupils create their own cartoon, for example about a rocket launch or astronauts performing a spacewalk. Use this worksheet to introduce classifications of things around us: classify things according to time, size, weight, colour, age etc.



Make a rocket movie

You can also make an animation. You need a digital camera and models (based on cartoons, dolls, or for instance plasticine) and a stage set.

1. Hold a brainstorming session and choose characters for the movie, the models you need and the background for your screen.
2. Write a script and create a storyboard – a cartoon strip works very well as a storyboard.
3. Prepare the models/characters and the background.
4. Start shooting. Take one picture at a time. If you'd like the character to stand still for a while, take the same picture several times. If you'd like it to move, change its position picture per picture.
5. When you've taken all the pictures needed, or print them and make a flipbook or, if you have the software, export them to a computer. Use a software program to put them together.

Make a rocket

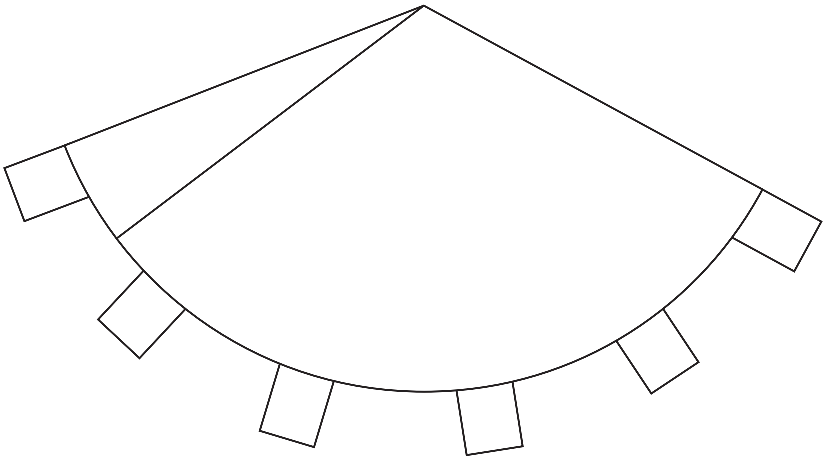
Experiment: fizzy tablet rocket

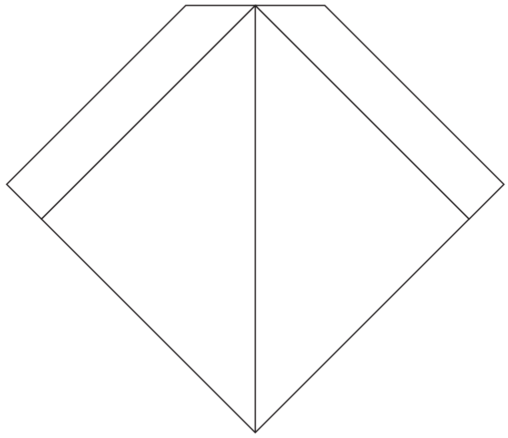
You need:

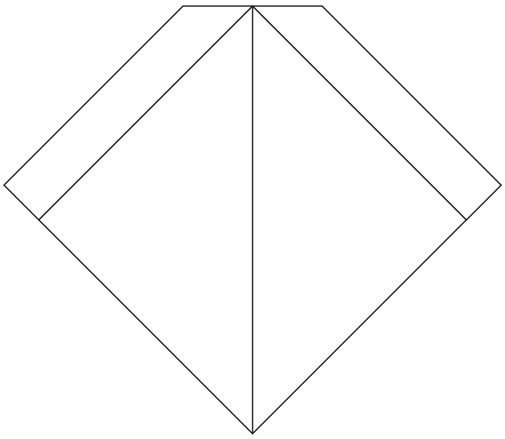
- Rocket cut-outs on thick paper
- Colouring pencils
- Scissors
- Glue or tape
- Tubes of film rolls
- Fizzy tablets
- Water

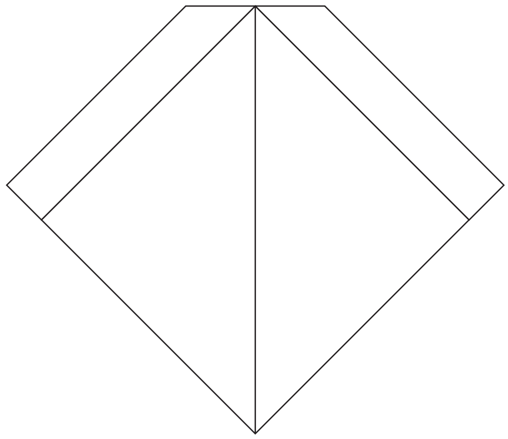
The fizzy tablets make the rocket take off.

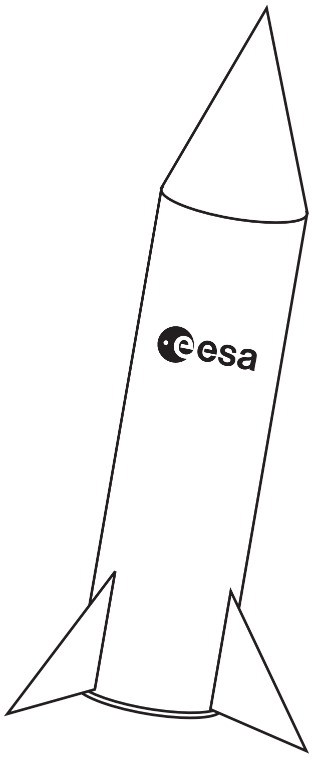

Use your imagination to colour in the rocket.











Let the children colour the rocket parts and cut them out. Glue the rocket cut-outs onto the film roll tube with the lid facing downwards. Place the tube on its lid on the table and glue the rocket fins onto the spaces indicated by dotted lines and finish with the rocket's nose.

Turn the rocket around, fill one-third of the tube with water, add half of a fizzy tablet, very quickly put the lid back on and put the rocket down for launch. As the water / fizzy-tablet mixture is expelled from the tube it might be advisable to launch the rocket outside and keep a safety distance.

10, 9, 8, 7, 6, 5, 4, 3 ,2,1 …..Lift OFF!

(Wait a little if the rocket does not take off right away – sometimes it takes a while.)

A train transports the rocket to the launch pad.

Worksheet F: Speed in space

Use this worksheet to talk about time and different measurements for time: Hours – minutes – seconds (e.g. 1 hour = 60 minutes, 1 minute = 60 seconds). It can also be used to work with time and distances. Below are some ideas for tasks for the pupils to work on.

1. The Space Station travels at a speed of 28 000 km/h. How many km would the Space Station travel in:
   a. 30 minutes? 14 000
   b. 15 minutes? 7 000
   c. 5 minutes? ≈ 2 300

2. How many hours would it take the Space Station to travel:
   a. 56 000 km? 2h
   b. 84 000 km? 3h
   c. 98 000 km? 3.5h

3. How much time would it take to go around the Earth once, if you went by:
   a. Car (e.g. 100 km/h)? 400h ≈17 days
   b. Bicycle (e.g. 10 km/h)? 4000h ≈167 days
   c. Walking (e.g. 5 km/h)? 8000h ≈333 days

Related topics:
Chapter 4.1 Living on board the International Space Station", worksheet D "Day and night " and worksheet E "The year through".

Websites:
With three stages to space:
Make simple animation (without camera) online:
http://apps.discovery.com/animaker/animaker.html

Ready for lift-off!