# Physics course 1 for Kitsat

On the way to the newly found planet Hope. The Kitsat satellite had a malfunction in it's navigation system and it has fallen down on a wrong planet. Unlike the newly found planet Hope this planet is notorious for its intense climate and harsh changes in the planet's weather. The satellite has broken into several pieces in the planet's atmosphere.

Nearby Kitsat space station has deployed some new Kitsat androids to salvage the satellite and launch it back to orbit. Satellite has precious cargo and vital information for the research department so it is a priority to get it back.
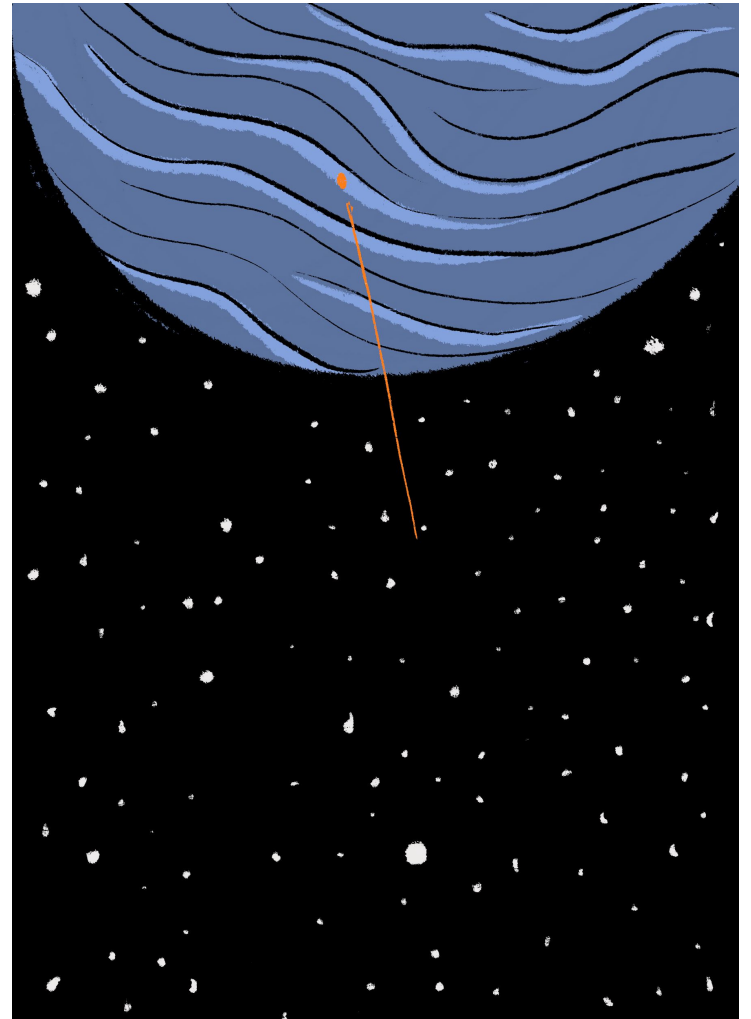
Kitsat androids are new top of the line human like robots. They can be controlled and given instructions. They can even communicate with you.

In the briefing of the salvage mission commander Niemi pointed out that they don't want the android to get into the wrong hand's so it's vital that the android survives this mission and returns to base.

Surveillance has spotted some activity near the planet and Niemi i sure that it must be the notorious Universe Order. They would love to get their hands on the satellite and the android.
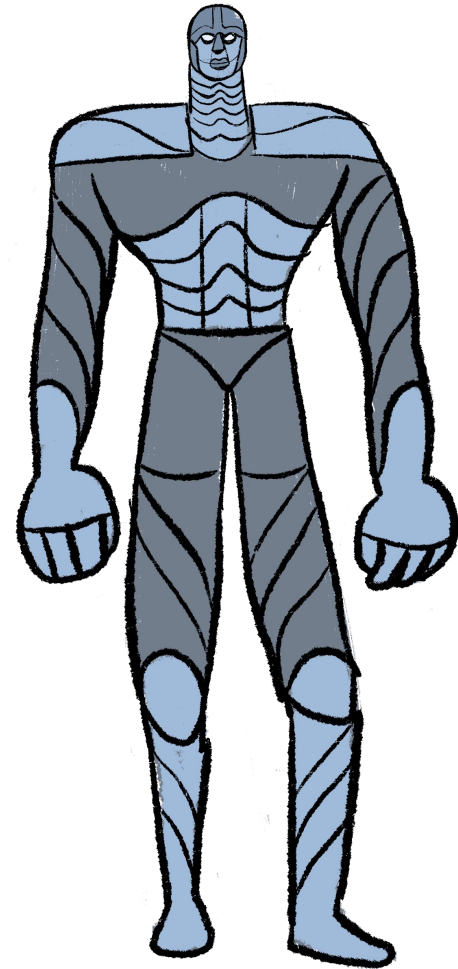
Kitsat androids can build anything. They are equipped with a multi material and extremely fast 3D printer. Kitsat androids are called the human swiss army knives because they are so well equipped with different tools and appliances. The Androids are also able to launch the fallen satellites back to orbit.

Every android can also be customized to fit different roles, tasks and tastes.
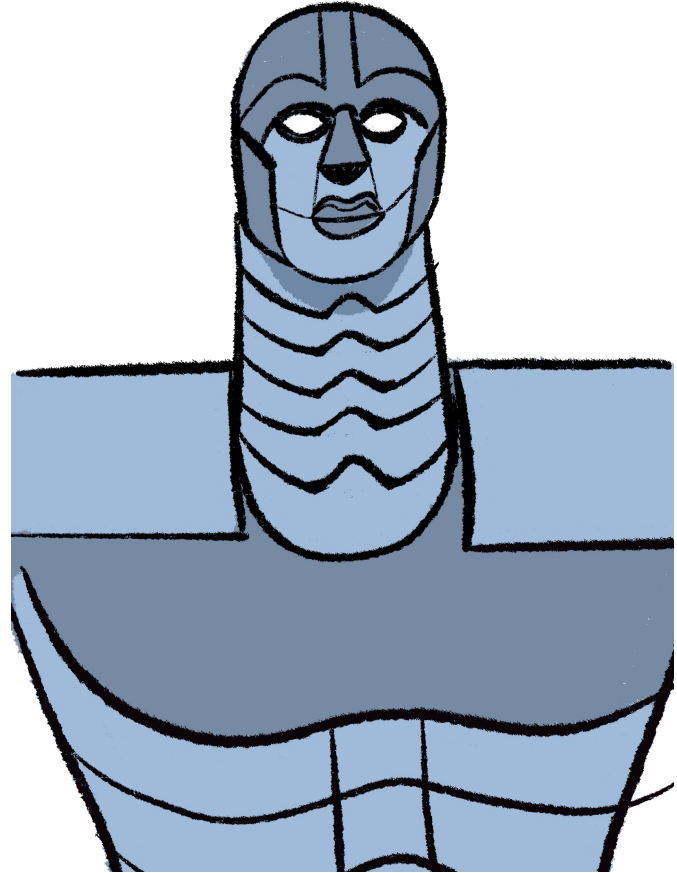
However the androids are not indestructible. But they are very adaptive and can learn new things. They can put themselves in harm's way if they are not controlled via Kitsat HQ.

Androids need fuel and they need to eat regularly. They also need to rest to reload their batteries. Protein bars are their favourite food.
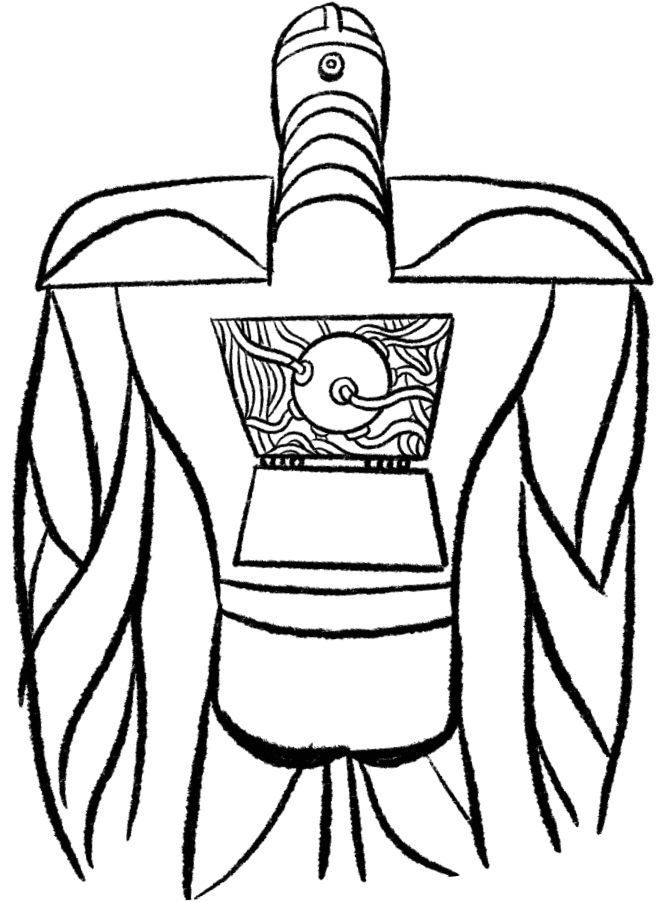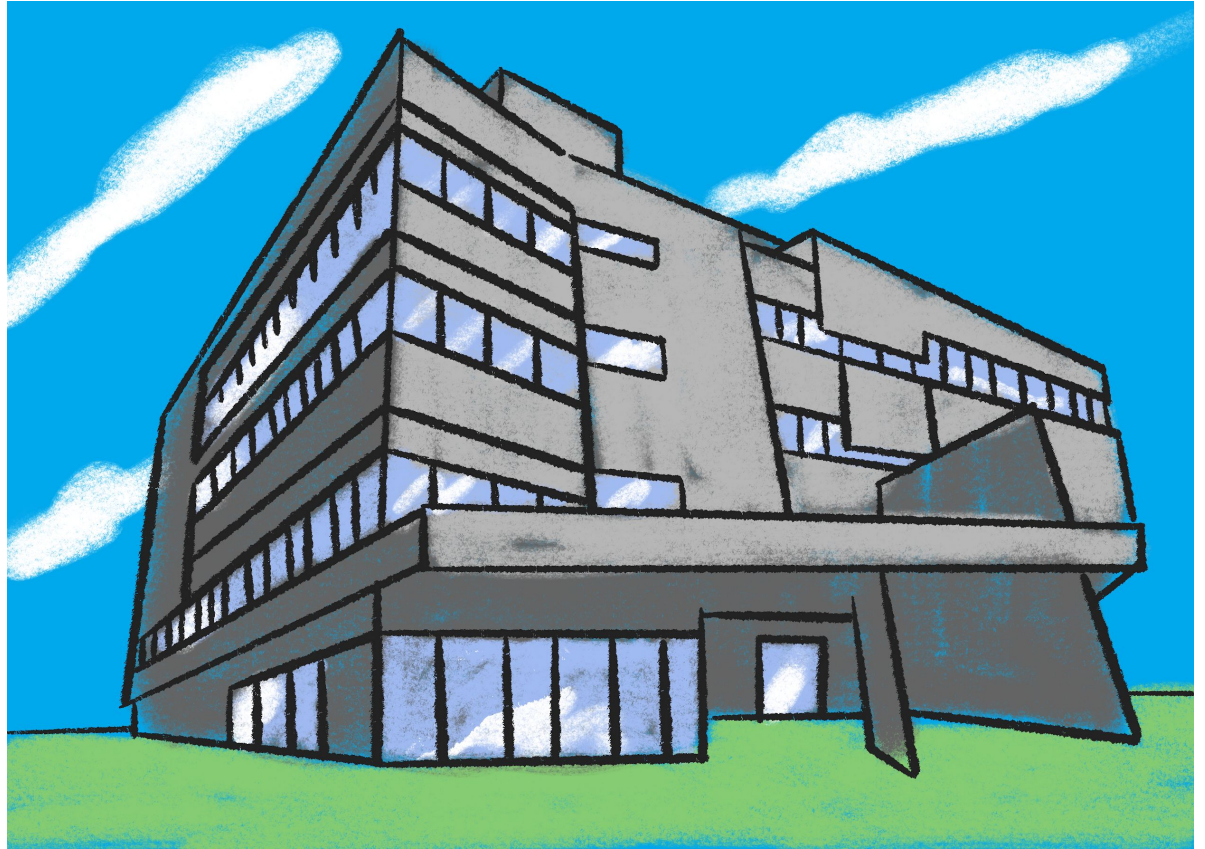
The satellite is broken into several different pieces and those pieces are scattered around the planet.

Fortunately all the satellite pieces have tracking beacons. The Kitsat space station launches a pod into the planet. Inside the small pod there is the new Kitsat android ready to find the missing pieces.
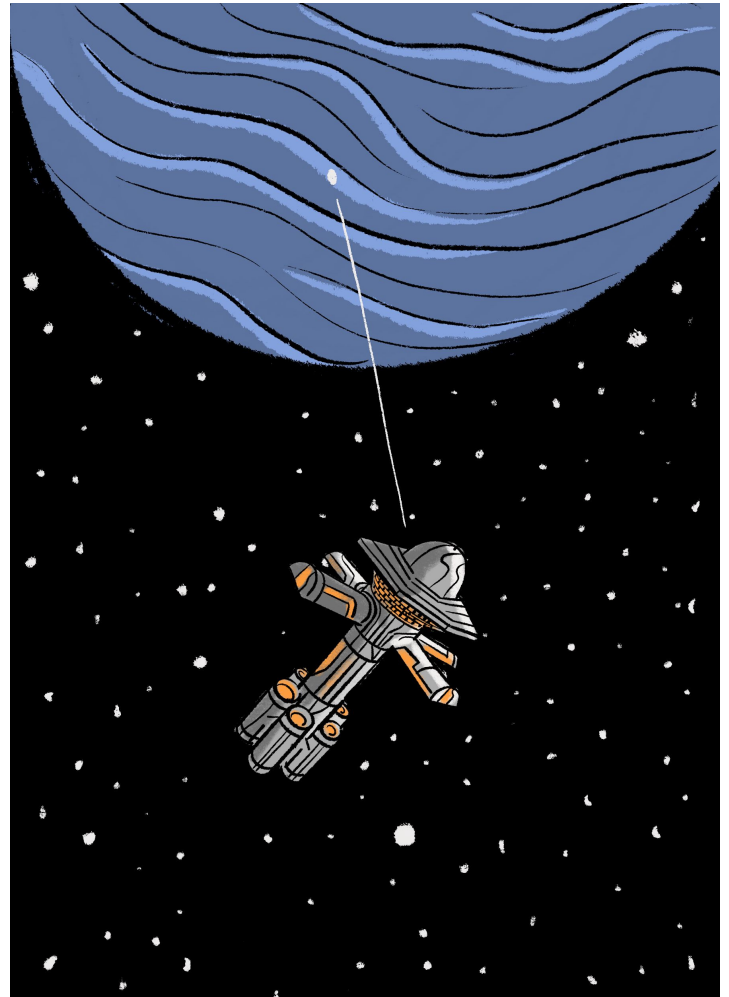
Back at the Kitsat HQ you
follow the android's
progress.

A lot of people have gathered in to a control room. Status updates and instructions fill the air. The screens in the room are showing different data and information. In one of the screens you are able to see a video stream. Your head is spinning.

–Enjoy the show! You don't really have to do that much because the android is programmed to survive. And of course GUIDE on your phone can help you out if we face some problems, Koivunen says cheerfully.
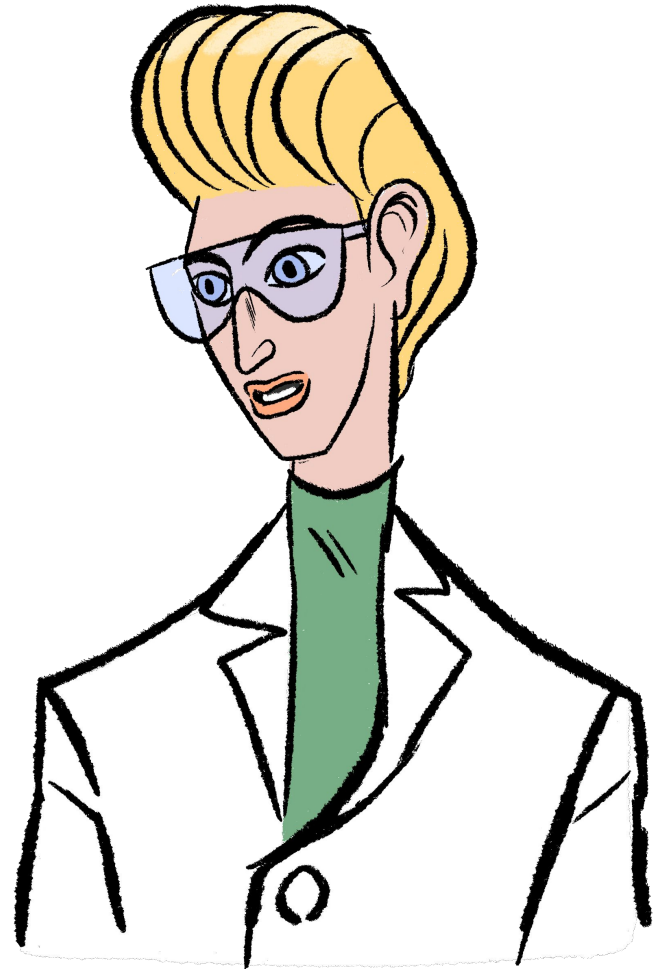
Alarming sounds and loud shouts are deafening. Panic spreads. People in the control room are shouting and running around. Something's not quite right

–Android's pod has crashed into the frozen ground! The pod's landing system was offline, someone shouts. The pod is ruined but the android seems to be ok.

You see something alarming in one of the control room's many screens. The android's head is dented. Something must have happened in the landing.

You scan the android with the drone circling it.
–Oh no, you say while looking at the monitor.
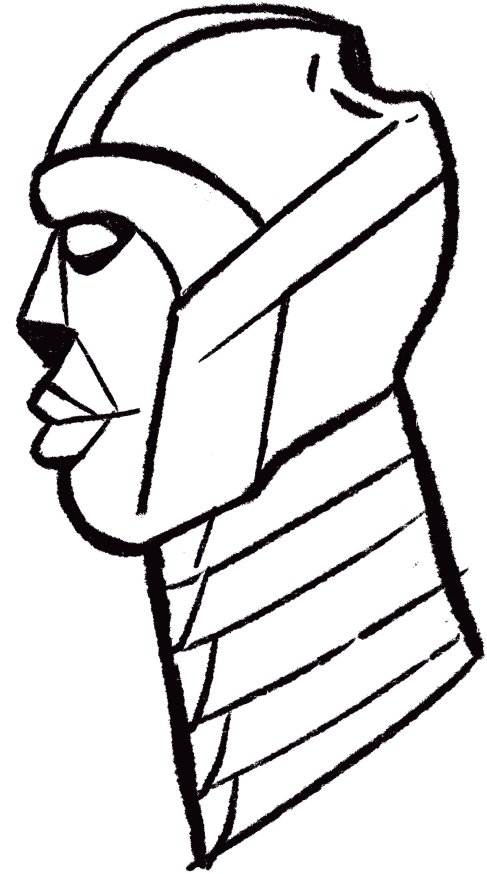
The pod should hold up to 300 million joules on the impact. But somehow the pod didn't hold up and the android is damaged. Something is not right here. Koivunen wants you to check the situation with a calculation. Remember to check out <mark>GUIDE</mark> for additional information.
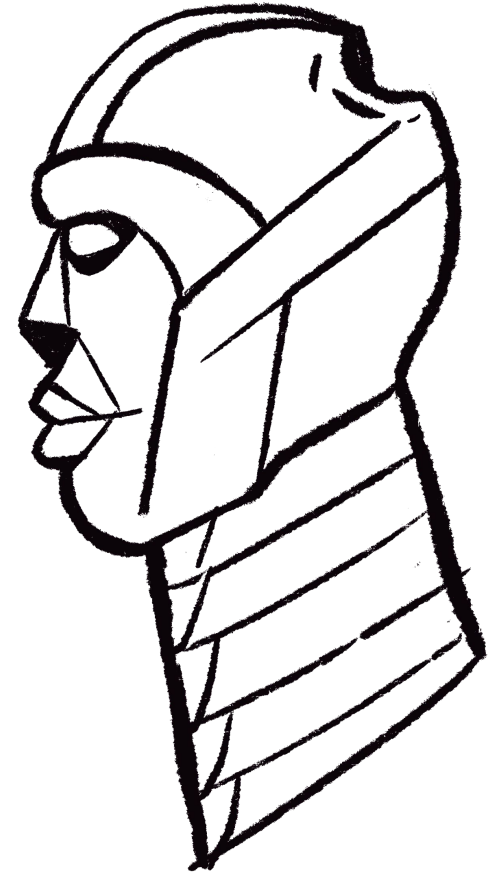
Assignment 1:

The pod weights 500 kg with the android. The speed of the pod was 12 kilometres per second, that is 1200 meters per second, as it entered the planet's atmosphere. Calculate how much kinetic energy the pod had when it crashed.

The calculation formula is the following:

$$E\square = \frac{1}{2} \cdot m \cdot v^2$$

You do the math and the numbers don't match. You start to investigate the pod with the drone. Suddenly you stop and stare. A shock runs through you. That logo on the pod. Universe Order. They are the manufacturers of this pod. Have they done this on purpose or was it just a coincidence?

But there is no time to think about this now. You feel someone grabbing your shoulder.

–The Androids central processing unit is located in the head and because of the dent it's broken. It seems that the android can't calculate anything with the broken CPU. It's more dependent on us than ever before. You have to do the math for it and instruct it during the mission, Koivunen says with a worrying tone in his voice.
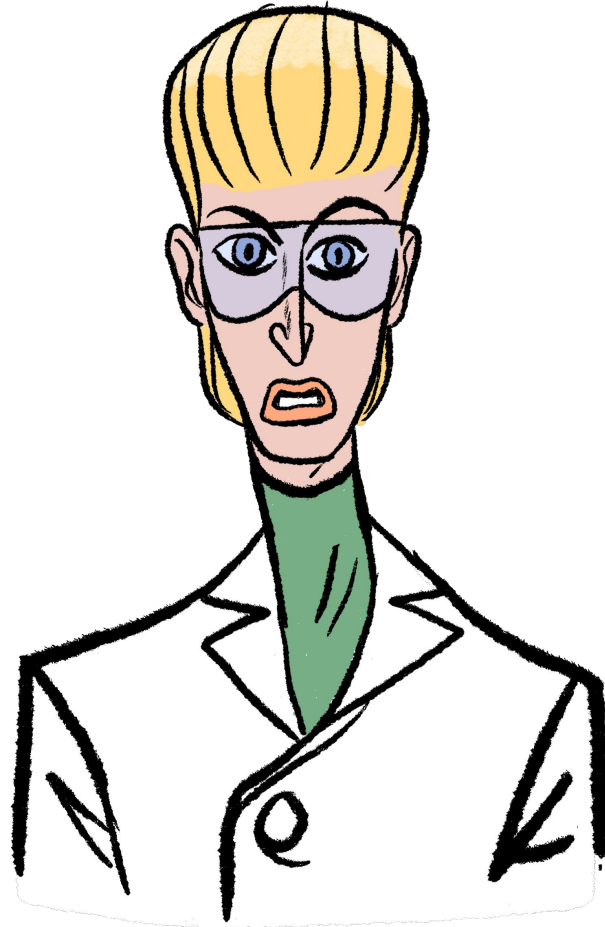
– We must be careful when giving command to the android. Remember that we don't want to destroy or damage it and thus compromise our main task. Luckily we have some Kitsat satellites on our disposal. It has some functions and equipments that can definitely help us on this mission. The satellite has a GPS, accelerometer, temperature sensor, pressure sensor and a camera, Koivunen says.
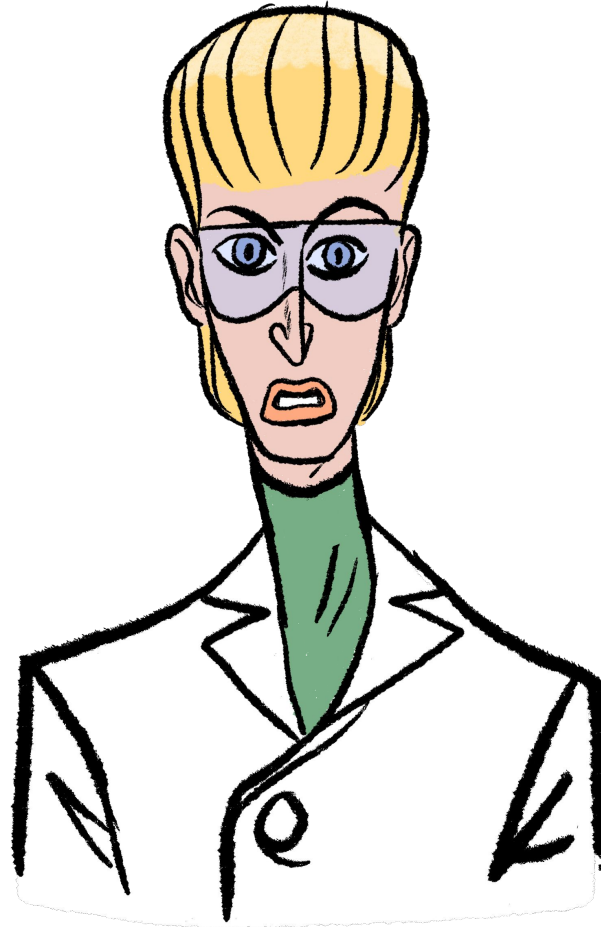
Assignment 2:

What functions and equipments of the Kitsat satellite would be beneficial on finding the missing satellite pieces and why?
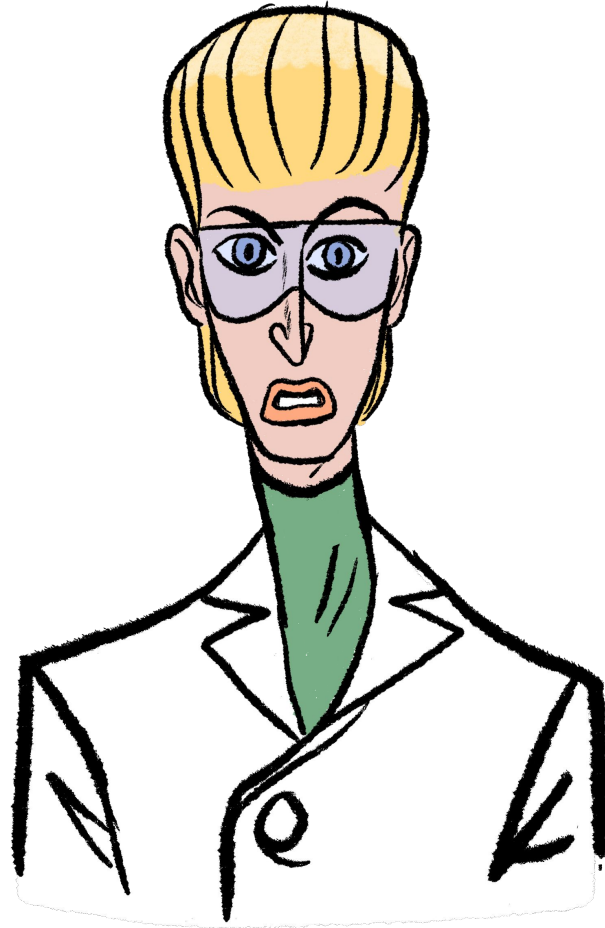
Despite the dent and the broken CPU the android picks up a signal. It's one of the satellite pieces. The android starts to trek in the snow.

It's very cold and the temperature is -20 celsius and heavy wind to accompany the harsh cold.
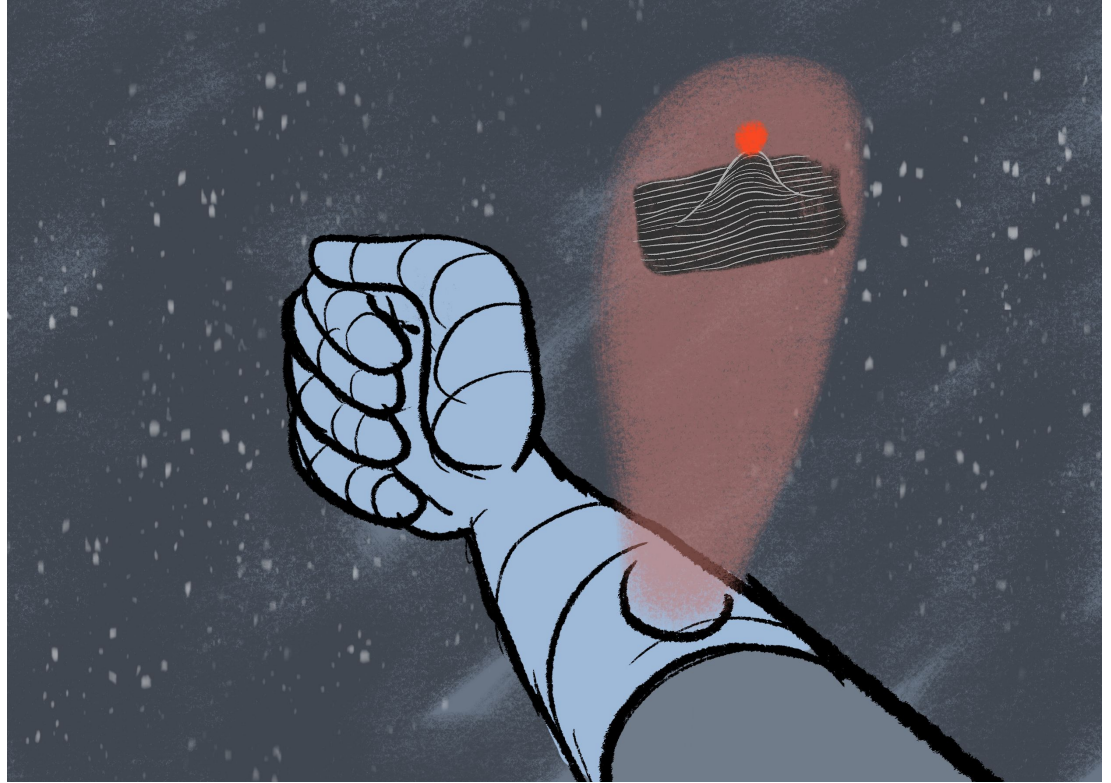
The Androids walking pace is slowing down. It has to be recharged and heated. All of it's joints are showing the signs of freezing. Different fluids inside the android are starting to freeze. It uses biomaterial for fuel and the engine liquids are freezing.

You start to research the satellite in the control room so you will be able to give the android the correct commands to endure the cold and avoid freezing. You can also check **GUIDE** for more information.

Assignment 3:
What is the coldest temperature in which the Kitsat satellite can function?
How the Kitsat satellite is being protected from cold temperatures?
What kind of materials are used to endure cold temperatures and insulate different materials?

–Thermos bottle! someone shouts in the control room.
It should build one, um, inside itself? It could isolate it's vital fluids from the cold and avoid freezing! The android can build anything so why not build something for itself.

The idea is crazy but worth a try. Otherwise the android will need to rest and that gives Univers Order more time to get to the satellite piece first.

It worked! The android isolated it's vital fluids with your instructions. It can continue the search.

The android comes across a huge hill. It prepares to climb the steep rise. The drone following the android informs that there is a path up the hill. Which way the android should take? Remember that it's important to save the androids energy because of the planet's harsh and unstable conditions.
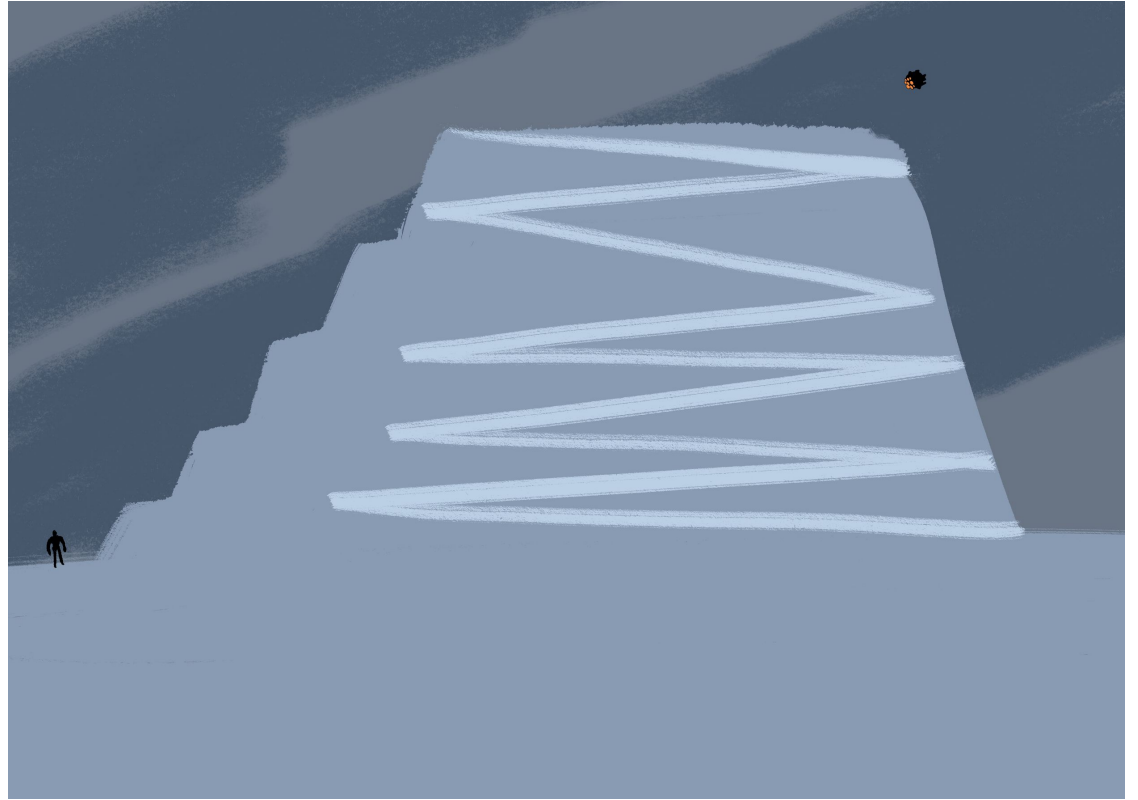
ASSIGNMENT 5: Should the android climb or walk up the hill? Which way saves more energy? Remember to explain your solution to the others in the control room.
What if the android would be in hurry? Which way it should choose?

Remember that **GUIDE** can give you some additional information.

The android walks the path up to the hill. After the long walk its energy levels are very low. relieved sighs echo around the control room. Good thing that you didn't command the android to climb. Otherwise it would have fallen down and... You don't want to continue that thought. It's time for the android to spend the night here and recharge its energy levels.

Three moons of the planet reflect beautifully from the nearby lake of the place where the android will stay for the night. With its last energy reserves the android managed to find a cave and light up a fire. The android has it's favourite food with it. Specially made marshmallows and sausages. Both made out of special ingredients to fit the android's energy needs. No human would eat these.

-Okay! These will be the final instructions for the day. Let's focus everyone. After this we can all rest as the night shift will take care of the night and monitor the situation, Koivunen says and chases away a yawn as he speaks.

Assignment 6: Android likes to eat it's food warm.
Give the android instructions on how to warm the food and keep it warm as long as possible.
Give the android instructions on how to stay warm for the cold night. What should it do and where should it be?

GUIDE may also have something useful to tell you.

You give the final instructions to the android for the night. You gather your stuff say goodbye to your colleagues and prepare to head home. Just as you are about to step out the control room door an alarm sets off. You are the only one in the control room.

You notice that the fire in the cave is dying and the android's hand are beginning to freeze. You check the energy levels and there should just enough energy to gather some more wood to burn for the rest of the night. But first you have to warm up the android's hand so it can go and gather some wood.
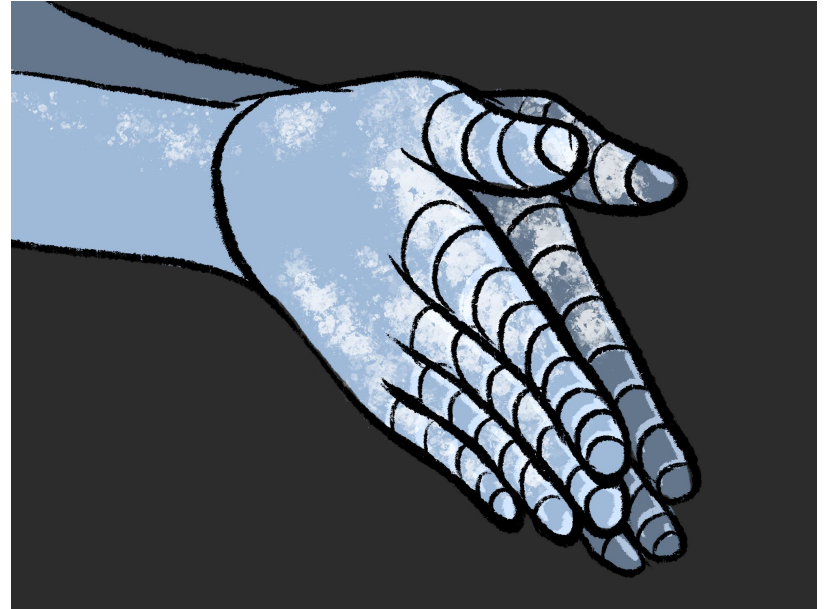
You think and think. What people do when their hands are getting cold? The temperature in the control room has dropped as everyone else has left. You start to rub your hands together by instinct. And then it hits you. It should rub its hands together. You give the instructions to the android and it starts to rub its hands together. A metallic clanging noise fills the control room. You check the temperature status of the android's hands but it doesn't rise. What now? How can I make this work, you ask yourself.
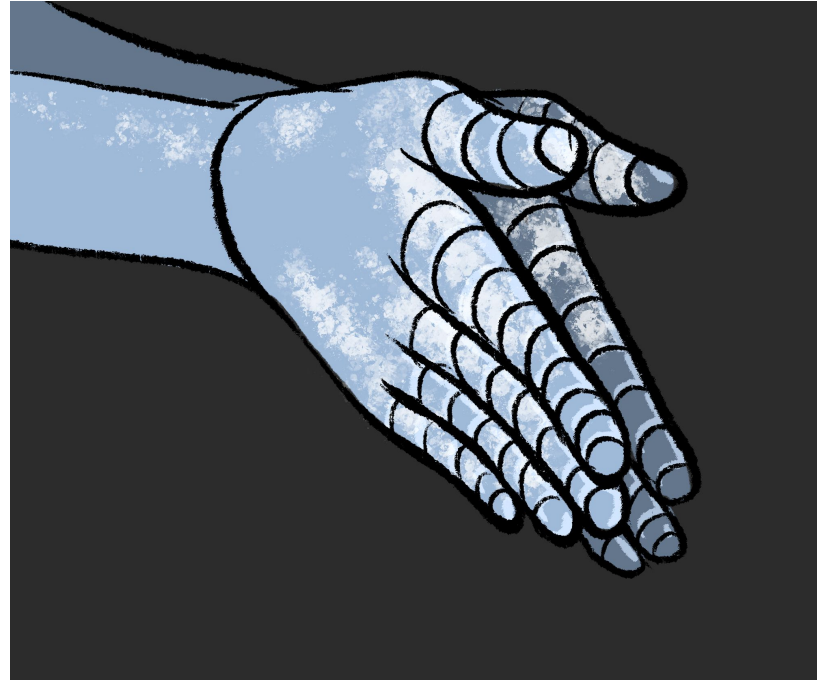
Assignment 7:

Try rubbing your hands together. What do you notice?

What explains this phenomenon?

Does it work if you rub your hands against your thighs?

Give the android instruction to change the material of its hands into something that could help the situation. What kind of material you chose and why?

Remember to check out **GUIDE** also!

Phew! It worked. The android's hand are getting warmer. You order it to gather enough wood to stay warm for the rest of the night. It's finally time to head home and get some rest.

In the morning one of the researchers from the night shift tells you that the rest of the night went well without problems.

There is a buzz in the control room as during the night the signal of a satellite piece has gotten stronger. The android climbs out of its cave and you notice that the cave was at the bottom of a steep walled gorge.
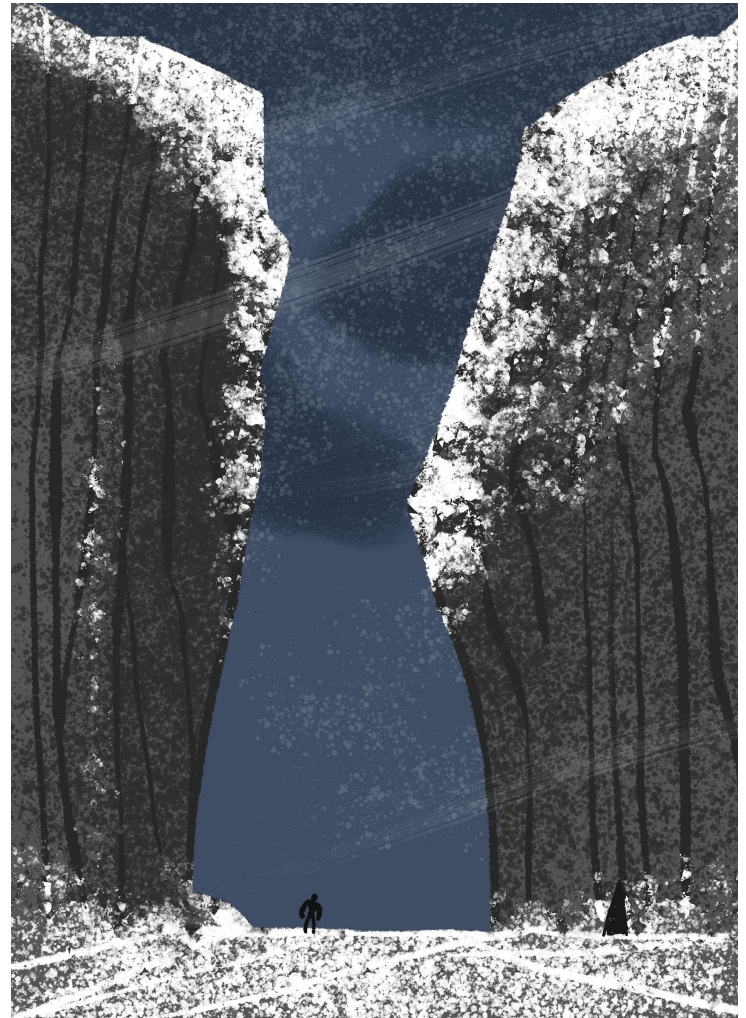
The android tells that the signal is coming from the top of the other steep wall of the gorge. You order the android to start the climb. As it begins the climb a deep rumbling sound starts and get louder and louder. You see a massive landslide approaching the android from the top of the steep wall.

The android is build to last some blows and hits but some the rocks in the landslide look massive. There is a wave of doubt that the android can handle the biggest rocks in the landslide.

You make a quick analysis using the data the android send you. The results are worrying. The android should be able to smash or withstand some of the rocks but not all of them. You have to give the android instruction to dodge some of the stones. But you have to be careful that while dodging the stones the android won't fall at the bottom of the gorge. The analysis points out that the landslide is divided into three different waves.
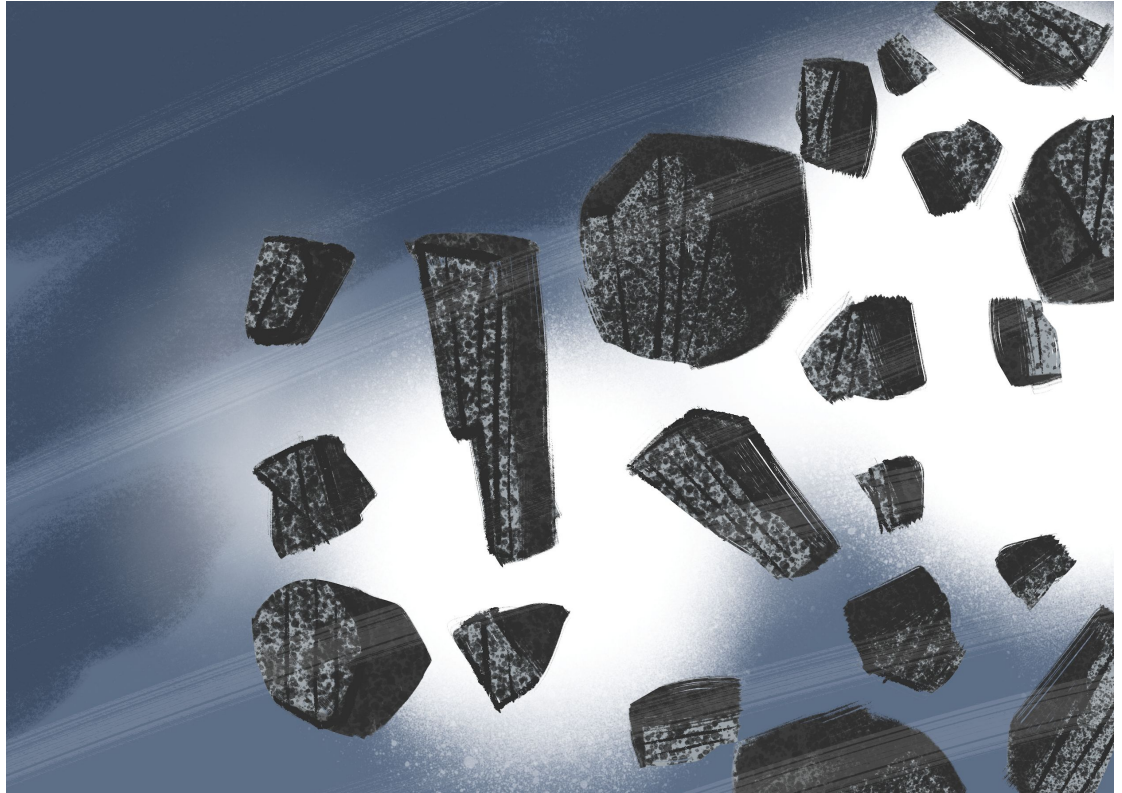
Assignment 8: The android can hold up blows that have no more than 500 joules of energy. Luckily the android doesn't feel any pain. These are the results of the quick analysis of the stones heading toward the android. Choose the correct stone types to dodge and correct stone types to let hit the android.

First wave of stones:

A) Small stones. One stone has mass of 80 g and speed of 5 m/s (18 km/h)

B) Medium sized stones. One stone has mass of 8 kg and speed of 5 m/s (18 km/h)

C) Large stones. One stone has mass of 80 kg and the speed of 5 m/s (18 km/h)

Use this formula to find out what stones the android can withstand or smash and what stones it should dodge.

The calculation formula is the following: **½ ▪ m▪v²**

You can also check out **GUIDE** for more information!

Assignment 8: The android can hold up blows that have no more than 500 joules of energy. Luckily the android doesn't feel any pain. These are the results of the quick analysis of the stones heading toward the android. Choose the correct stone types to dodge and correct stone types to let hit the android.

Second wave of stones
A) Slow stones. One stone has mass of 8 kg and speed of 5 m/s (18 km/h)
B) Faster stones. One stone has mass of 8 kg and speed of 10 m/s (36 km/h)
C) Fastest stones. One stone has mass of 8 kg and the speed of 20 m/s (72 km/h)

Use this formula to find out what stones the android can withstand or smash and what stones it should dodge.
The calculation formula is the following: **½ · m·v²**

You can also check out **GUIDE** for more information!

Assignment 8: The android can hold up blows that have no more than 500 joules of energy. Luckily the android doesn't feel any pain. These are the results of the quick analysis of the stones heading toward the android. Choose the correct stone types to dodge and correct stone types to let hit the android.

Third wave of stones
A) Small stones. One stone has mass of 80 g and speed of 50 m/s (180 km/h)
B) Medium sized stones. One stone has mass of 8 kg and speed of 25 m/s (90 km/h)
C) Biggest stones. One stone has mass of 80 kg and the speed of 5 m/s (18 km/h)

Use this formula to find out what stones the android can withstand or smash and what stones it should dodge.
The calculation formula is the following: **½ ▪ m▪v²**

You can also check out **GUIDE** for more information!

You give the android the instructions just in time before the landslide reaches it. It's hard to see anything but stones and snow. The silence in the control room is deafening as you all are waiting for the landslide to end. Next passing minutes feel like hours.

As the dust and snow settles you can see the android on the wall of the gorge. It's a bit scratched and dented but it's functioning perfectly. Everything seem to be in order and the android continues its climb.

The android reaches the top of the gorge and finds one of the satellite pieces under a small pile of rocks.

You order the android to tuck the piece away and look for the signals of the other satellite pieces. The android picks up one faint signal.

The android stops in front of a huge rock. The faint signal is coming under this huge rock. You instruct the android to lift the rock. Nothing happens. You turn up the power of the android to maximum and repeat the instruction. Nothing happens. You change the androids instructions to push the rock with maximum power but nothing happens.

The android is left staring at the rock as you and the others in the control room are scratching their heads and trying to figure out how to move the rock.
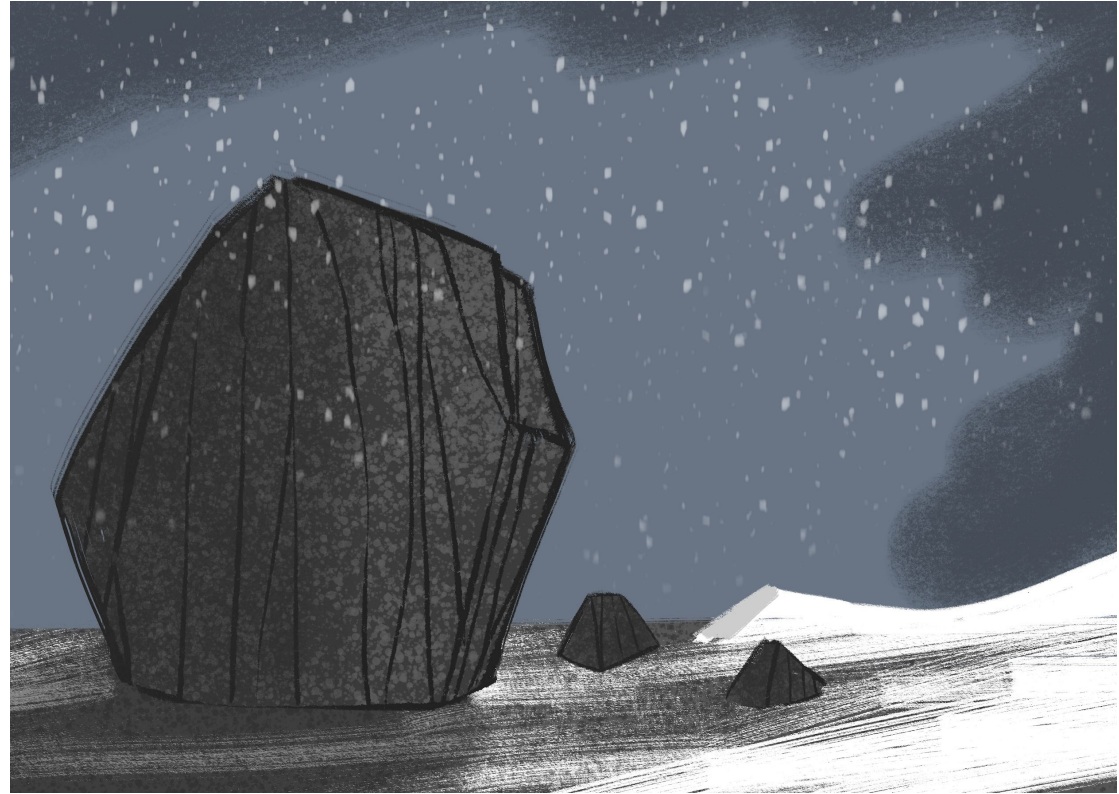
You instruct the android to do a scan of the surrounding area. Surprisingly you see something that might be of use in this situation. A sturdy looking long and broad metal bar. You instruct the android to pick it up and lodge the bar underneath the rock. Now you can use the bar as a lever. But with the android's CPU busted you need to do some calculations. But first you run an analysis of the situation.
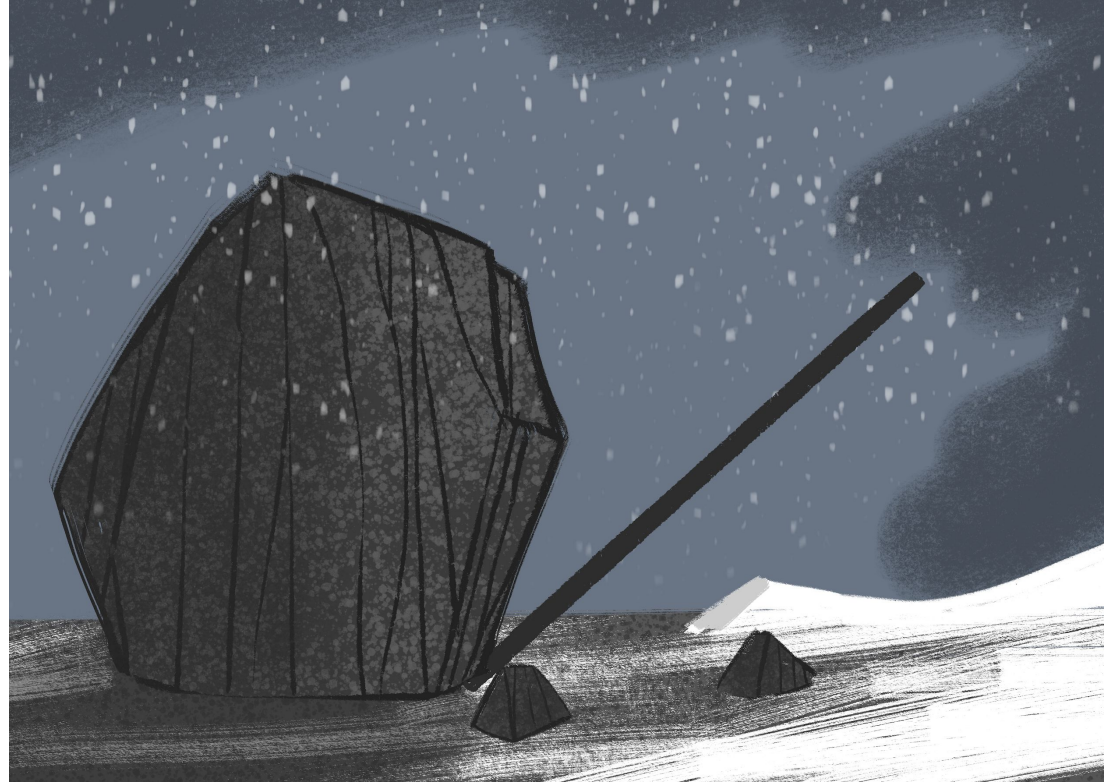
Assignment 9: The analysis tells you the following:

- The iron bar is 2,5 meters long
- The stone weights 2040 kg
- The iron bar's pivot point (a) is 0,5 m from the stone
- The distance (b) from the pivot point to the android is 2 m

1) Convert the weight of the stone into Newtons.

2) Calculate how much weight the android must add to the other end of the steel bar to lift the rock. Use the following formula. Remember to convert the Newtons you get as a result into kilograms so the android can pile up a correct amount of stones onto the other end of the iron bar.

You can also check out **GUIDE** for more information!

Formula for calculation 1:
$$kg \cdot 9,807 = N$$

Formula for calculation 2:
$$F(v) \cdot b = F(k) \cdot a$$

F(k)= Force of the stone
F(v) Force needed to lift the stone.

The android manages to lift the heavy rock with a help of the lever. Underneath the rock it finds one of the missing satellite pieces. You order the android to pick it up and tuck it away.

The weather and the scenery changes in the blink of an eye. Suddenly the temperature starts rising. Snow is melting away revealing parts of a barren desert underneath it. The android continues its journey.

The mood at the control room is relaxed and people are chatting with each other.

All of a sudden the android slips and starts sliding down a steep icy slope.
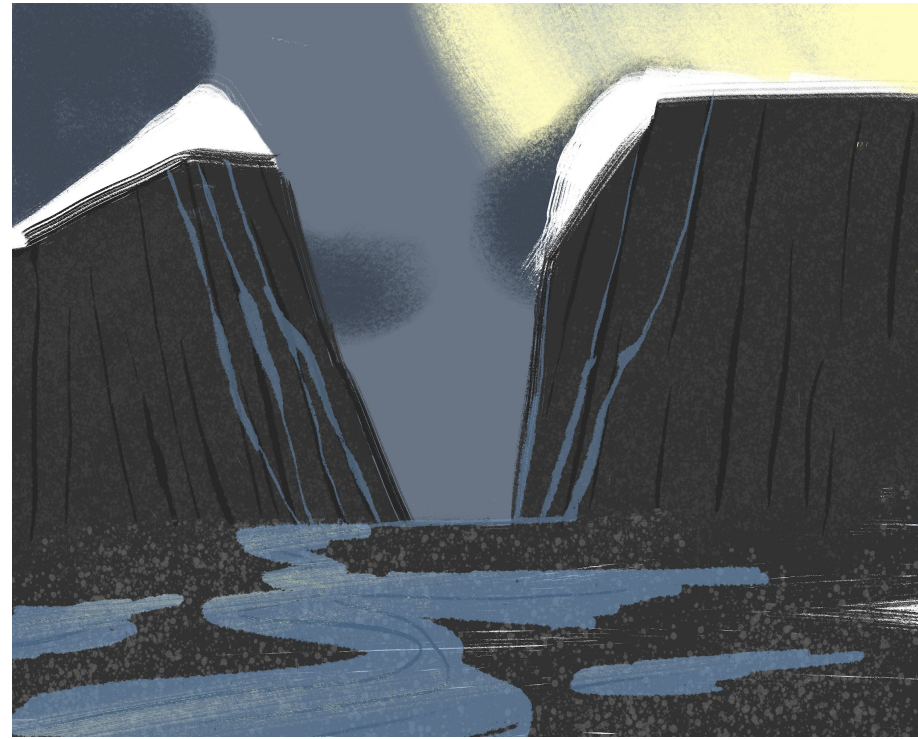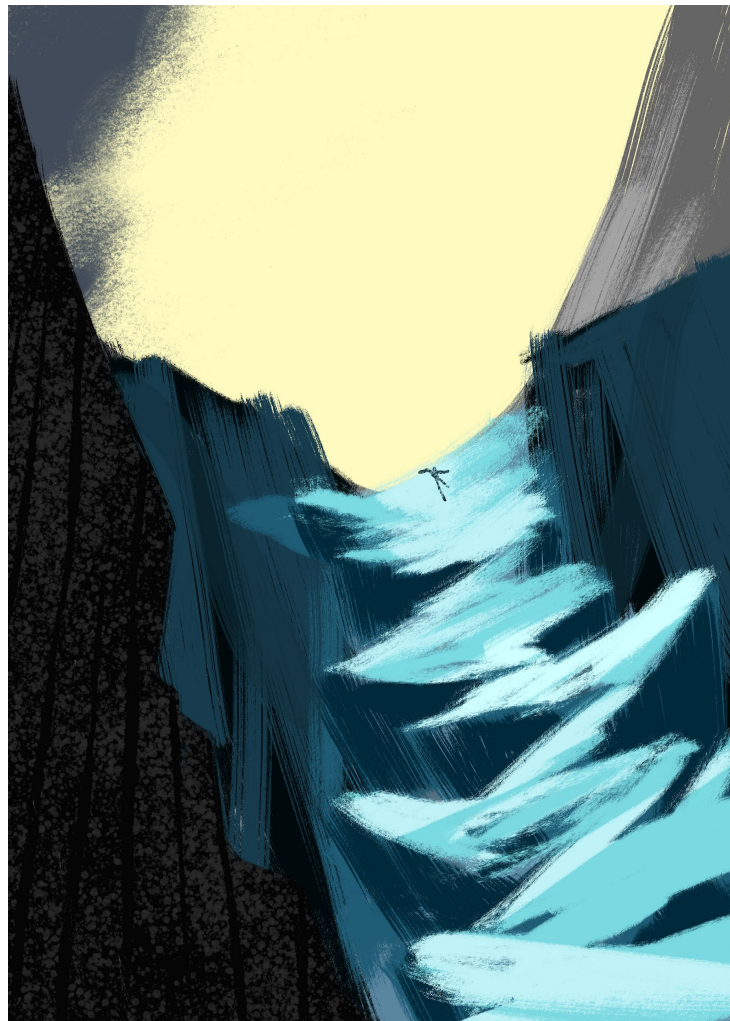
The control room wakes up as alarms start to sound. THe android need commands and fast. You fly a drone at the end of the slope and it doesn't look good. If you can't stop the androids slide it will fall into a what seems like endless hole at the end of the slope. And that would be the end of the mission.
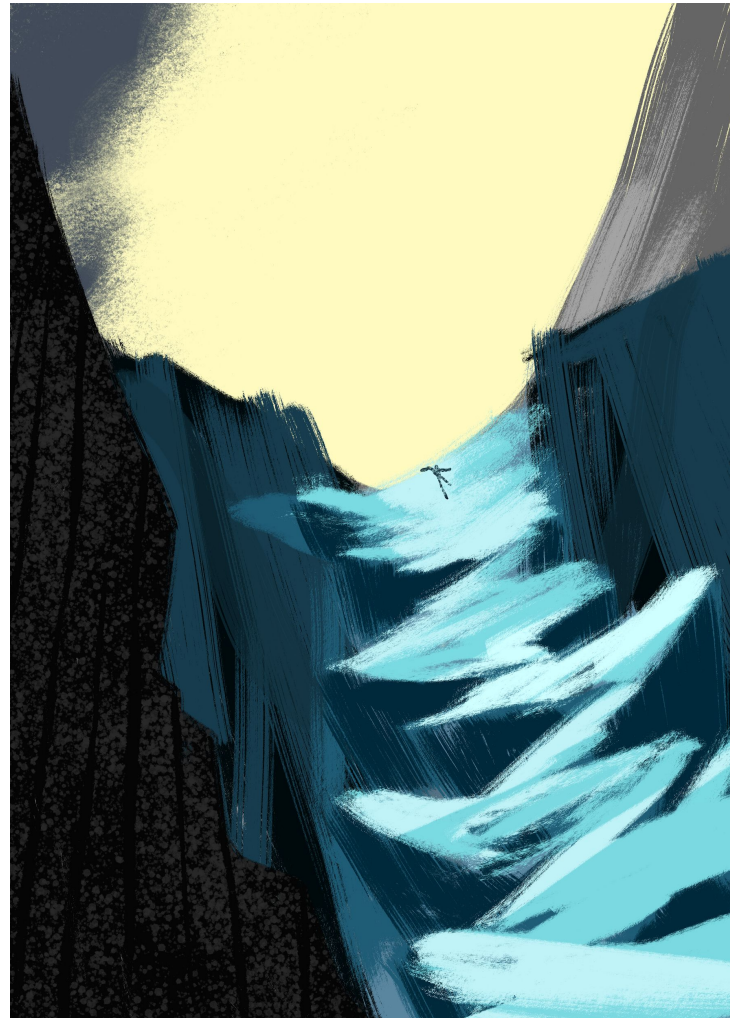
Assignment 10: Come up with at least **three** different ways how the android can slow down and stop its slide towards the endless hole.

A) What forces affect it when its sliding down the icy slope?
B) What forces affect it when its speed is slowing down?
C) What forces affect it when its stopped.
D) What forces affect the Kitsat satellite when:

    –It's launched to orbit?

    –When it's orbiting the Earth

    – When it's being taken back to Earth?

Remember to check out **GUIDE** if you are in need of additional information!

The android finally stops and there are sighs of relief in the control room. That was close. The android stands still on the steep slope. The ground beneath it starts to shake. You can see cracks appear underneath the androids feet. The part of the slope where the android is standing collapses. And all of a sudden the ground crumbles and the android is in free fall.

There is a panic in the control room. People are shouting and running around. You have a plan and you are sure it will work. You calm people in the control room down and present your idea.
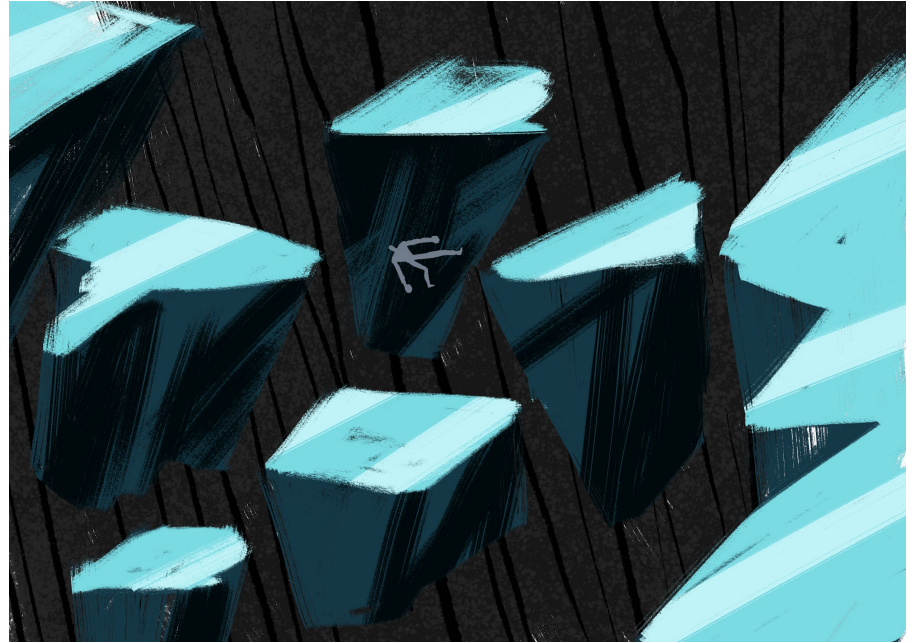
Assignment 11: How can the android slow down the fall and reduce the inevitable force of the impact that is going to happen. Remember that the android can manufacture different objects with it's built-in 3d printer.

How would you use the Kitsat satellite to demonstrate even movement (the android is walking at a steady speed)

How would you use the Kitsat satellite to demonstrate accelerated movement (the android is falling down)

How would you use the Kitsat satellite to demonstrate a situation where the movement is slowing down? (the android is slowing down the fall)

What kind of numeric results these demonstrations give to you? Try checking out **GUIDE** for more information!

You present the plan to the control room and people are nodding in agreement. You quickly give the android the instructions and the speed of the fall is slowing down. As the android is preparing for the inevitable (but not that hard) impact something quite unusual happens. What looked like solid ground underneath the android turns out to be water like fluid. The android splashes into it and sinks to the bottom.

The android manages the impact with this water like liquid without any problems. It doesn't need any oxygen to breathe and the electronic parts of it are well protected in case of underwater situation. The android sends an analysis about the liquid and surprisingly it just normal water.
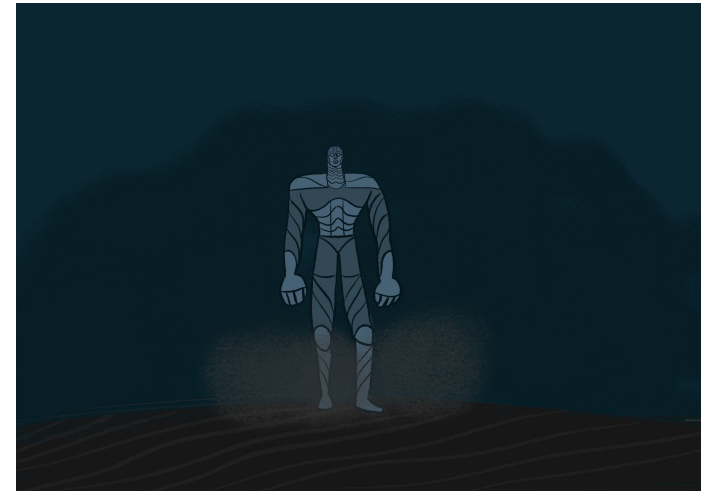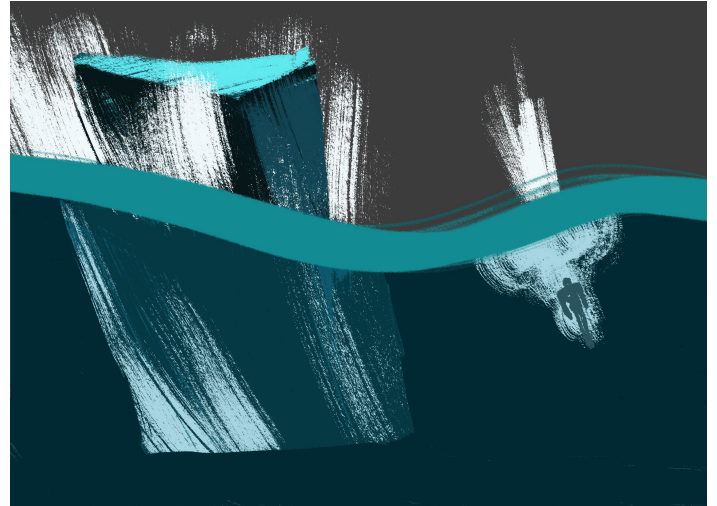
At the bottom android detects a signal nearby. It's a missing satellite piece. The android can see it. And you give the order for it to move towards the satellite piece.

You give android the order to move towards the satellite piece. The android moves slowly. The sight is like slow motion effect in the movies. At the same time the android spots a strange signal coming from nearby. The signal is quickly identified as Universe Order. A submarine perhaps or some other underwater vessel. It's time to hurry up.
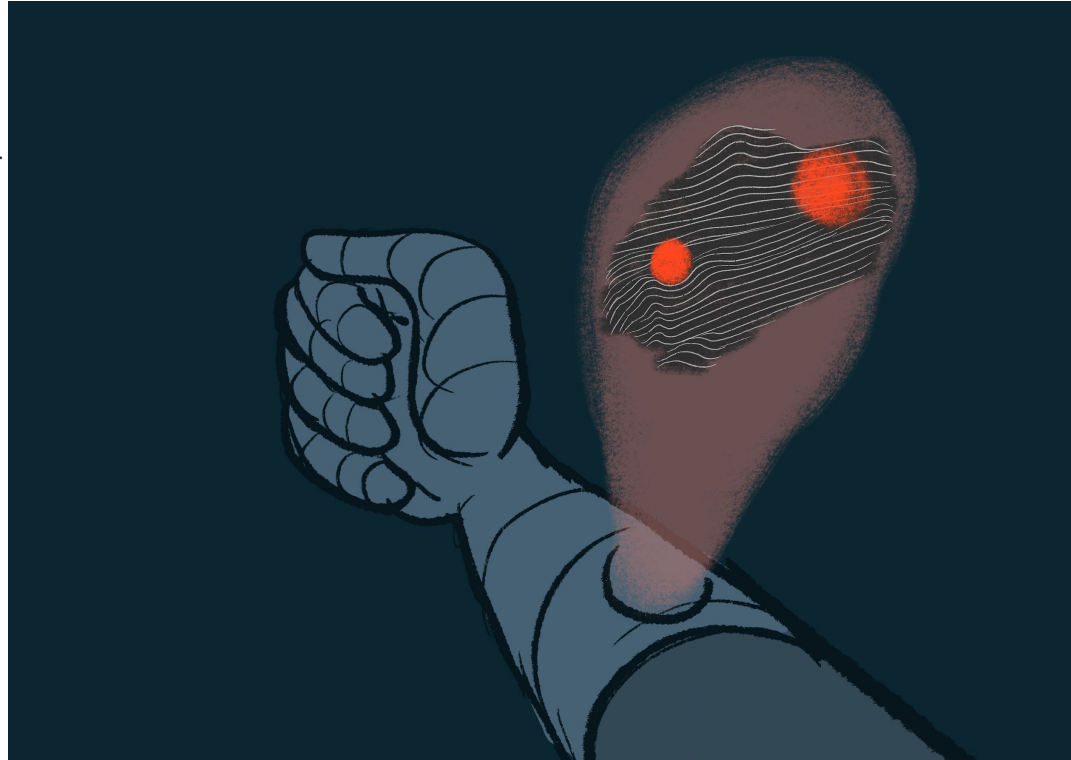
Assignment 12:

Find out why the android move slower underwater than on land.

What forces affect the android underwater?

Come up with different ways how the android could move faster underwater and explain why your solution makes the android move faster.

Make a plan how you could disturb, slow down or even capture the Universe Order underwater vessel. The vessel must not be destroyed as it may contain some vital information about the strategies and tactics the Universe Order may deploy in order to sabotage the salvage mission.

Can the Kitsat satellite work underwater? Why or why not?

Check out **GUIDE** for additional information!

The android rifles towards the satellite piece and captures it right in front of the Universe Order's vessel. It executes the plan to capture it and the plan works out perfectly. The android connects itself with the vessel and starts to transfer data to the control room.

You immediately find out that the Universe Order had sabotaged the landing pod of the android and caused the landslide at the gorge. Rest of the data is encrypted and it takes some time to open it.

The android pick up a new signal. A strong one but it's some way off it's current location. You give the android the instruction to move toward the signal.

The android comes to a sandy shore. It climbs on top of a small hill. The scenery is bare and the dessert goes on as long as the eye (or androids eye-like camera lenses) can see.

Adoring gasps can be heard around the control room. You instruct the android to continue towards the missing satellite piece.
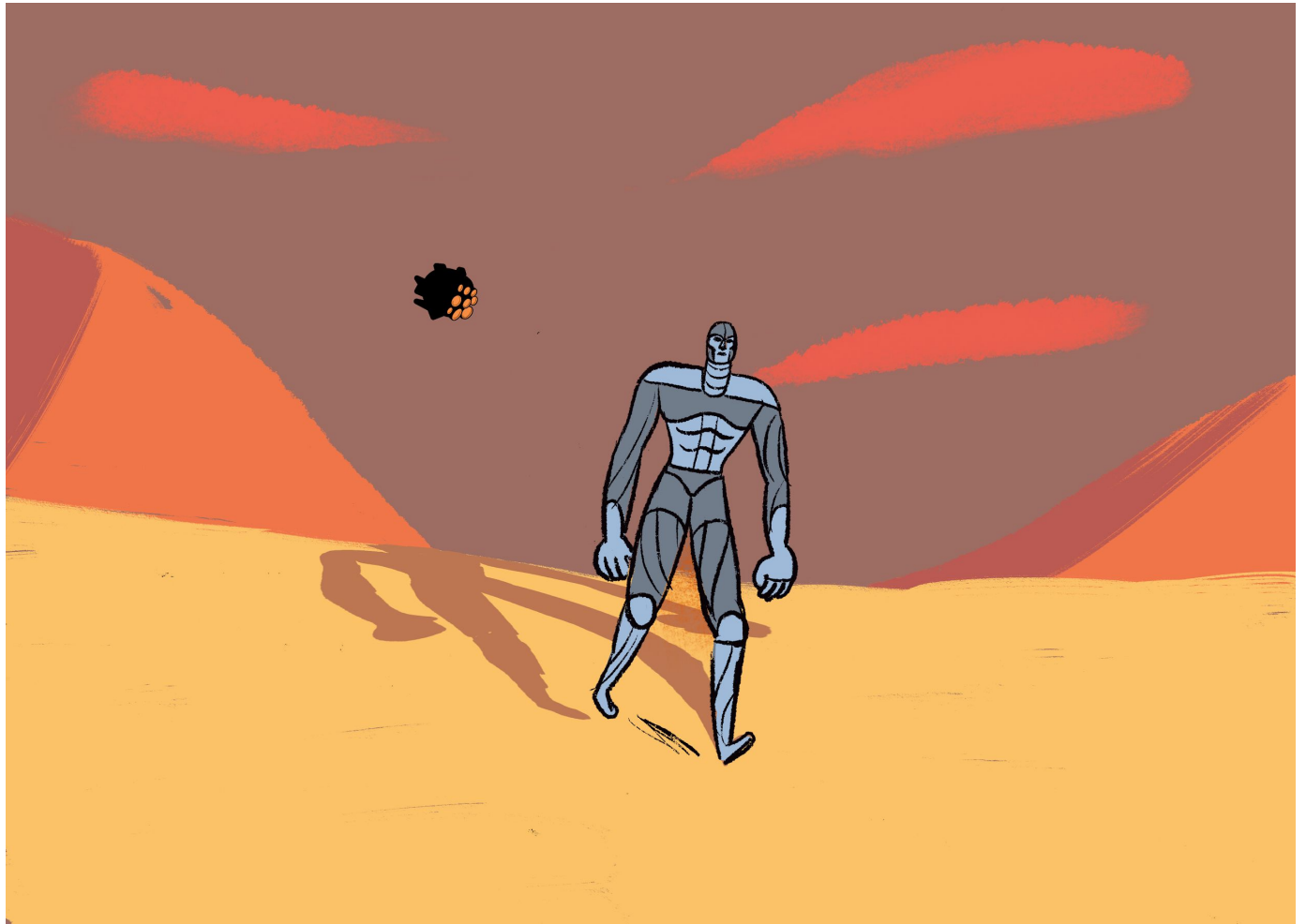
Temperature is rising rapidly and the water starts to evaporate from the android. Soon its outer shell is burning hot.

Alarm sets off at the control room and everyone is alert. The temperature of the android is rising rapidly and the fluids inside of it starts to evaporate. And some other materials are showing the signs of melting. This is not good as the android needs those fluids to function. The android needs to cool down in order to continue the search.
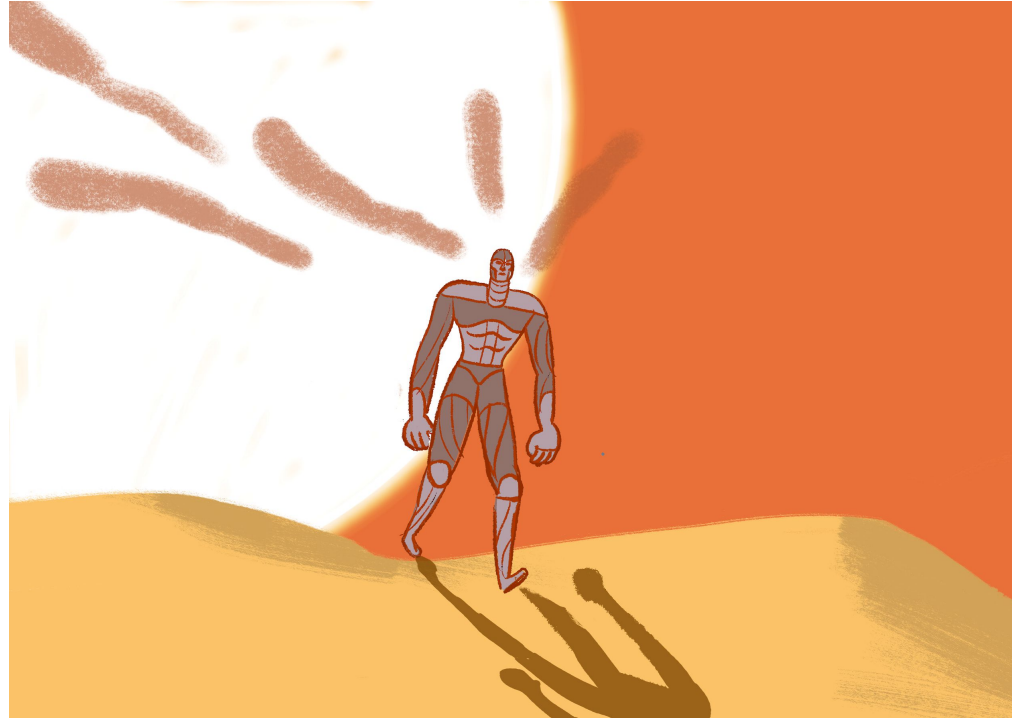
Assignment 13:

How can the android cool down itself? What it should do or where should it go? Come up with at least three ways how the android can cool itself down in the scorching heat.

Explain what is a boiling point?
Explain what is a melting point?

Choose three material that are being used in the Kitsat satellite and find out the material's melting and boiling points. Would the satellite do well in desert like high temperatures?

Check out **GUIDE** for more information!

It worked! The android is cooling down. But at the same time you notice that the androids power levels are very low. It need some energy before it can continue the search. But where to get some energy in these circumstances? All there is is scorching sun and desert as far as the eye can see. And all the food stored for this journey is already consumed.

Assignment 14:

How can the android get some energy to fill its power levels? Examine the Kitsat satellite. Where and how does the satellite get its power from? Come up with a solution to reload the androids power levels.

Remember that **GUIDE** is here to help you!

Nice! Cheers are echoing around the control room as the androids power levels are getting back to normal and the temperature of the android is dropping. You decide to wait until the sun sets and continue the search at night when its not that warm.

Darkness fall and the android continues the search. The signal is getting closer and the force of it is exceptionally strong.
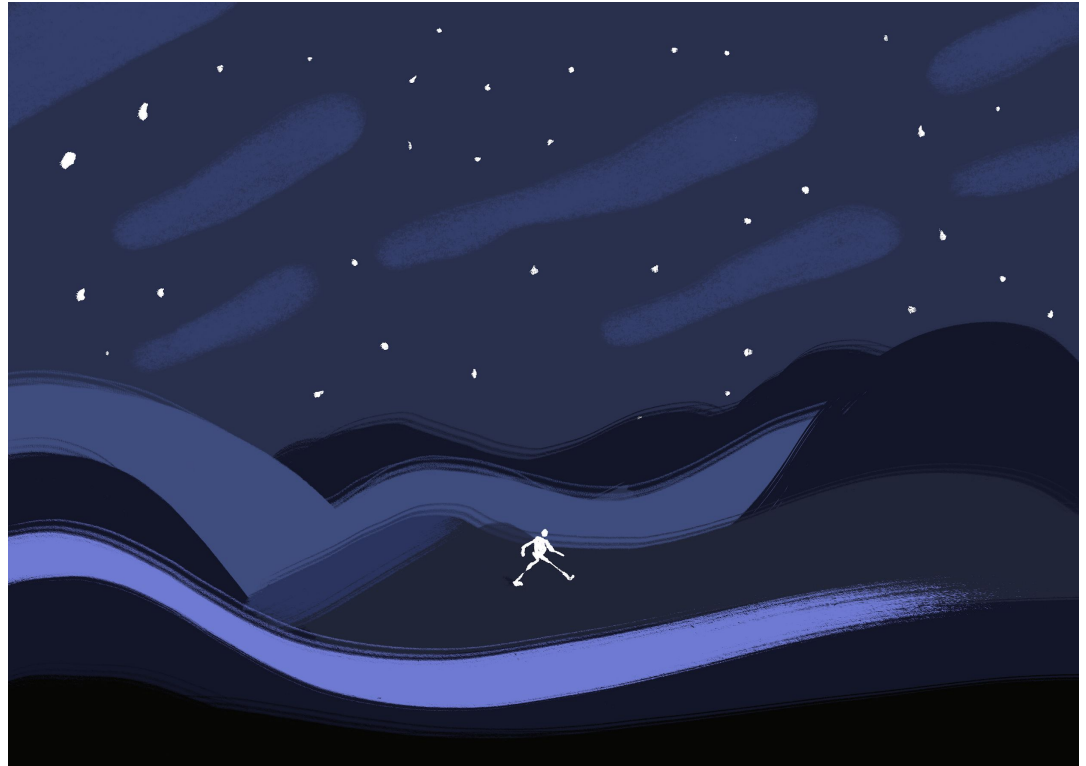
The android stops. The signal is coming underneath the android. You order the android to dig. It takes the android a while to reach the signal but when the android is done digging the sight is incredible. The rest of the missing satellite pieces are somehow attached to each others.

You order the android to pick up the rest of the pieces and assemble the satellite.

– Okay! Now it's time to get the satellite back to the space station and analyze the data it has gathered. Good thing that Universe Order didn't get their hands on the satellite, Koivunen says.
You instruct the android to do a basic scan and status update on the satellite and you notice something alarming. The thrusters of the satellite are damaged and you have to do some manual work in order to activate the thrusters and send the satellite on it's way.
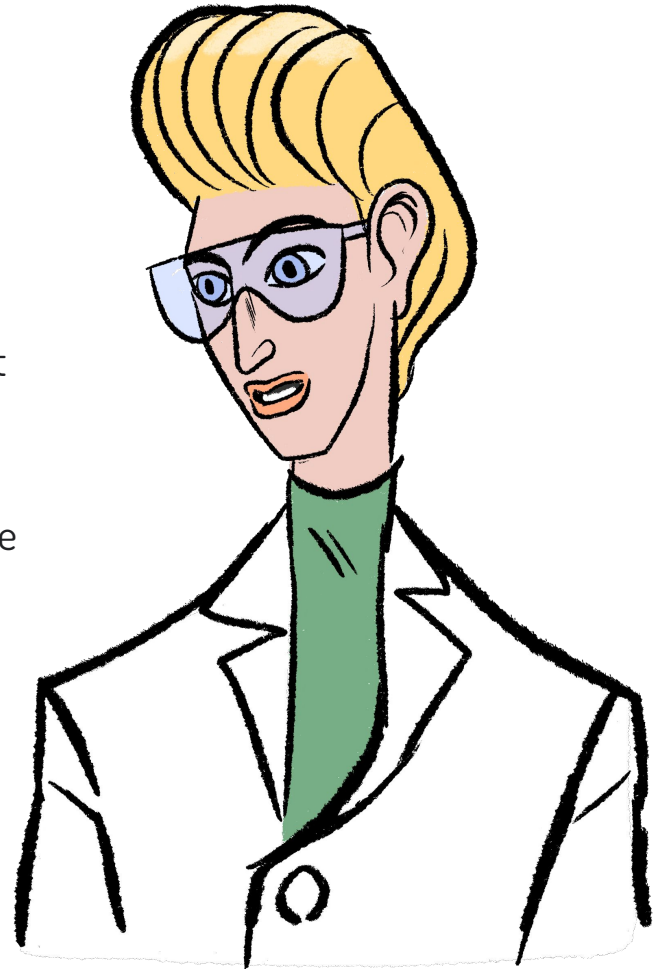
The satellite has to acquire enough kinetic energy so that its thrusters can activate and send the satellite back to the space station. Koivunen gives you some background information.

The satellite has to acquire some potential energy. This will be dealt by climbing up a wall. Because work done against the gravity of the planet will store up potential energy to the satellite. This potential energy will be transformed and released when the satellite is being dropped from a high point. And thus activating the thrusters of the satellite.
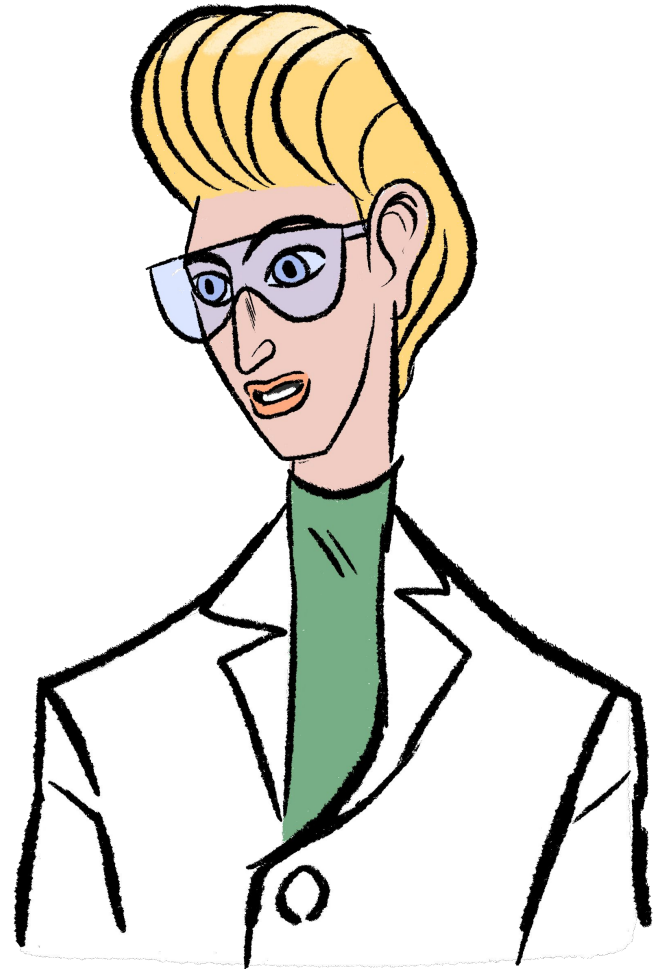
Assignment 15:

How high the android has to climb in order to store enough potential energy to the satellite? The satellites thrusters will activate when it reaches 5000 joules of kinetic energy.

The potential energy can be calculated using the following formula:

$$E_p = m \cdot g \cdot h$$

In which:

m= mass of the satellite

g= acceleration of gravity on the planet

h= distance from ground level

Mass of the satellite is: 5 kg
(Normal weight is 0,7 kg but the satellite has some important samples with it)

**Acceleration of gravity on the planet is: 10 m/s²**

The android climbs up and steps carefully on to the cliff's edge. It gently releases the satellite into free fall. The atmosphere in the control room is intense and silent as everyone were counting on you to do the calculations correctly.

The fall seem to last for eternity but finally just before the satellite hits the ground below its thrusters activate and it quickly starts to gain altitude. Soon the android is no longer able to see it as the satellite continues its journey towards the space station.

In the control room the encrypted data of the underwater vessel is finally being opened up. Koivunen read the data aloud to everyone in the control room and everyone is shocked. The collective shock is being interrupted by an alarm. With its final energy the android has picked up a strange signal that is approaching the satellite fast!
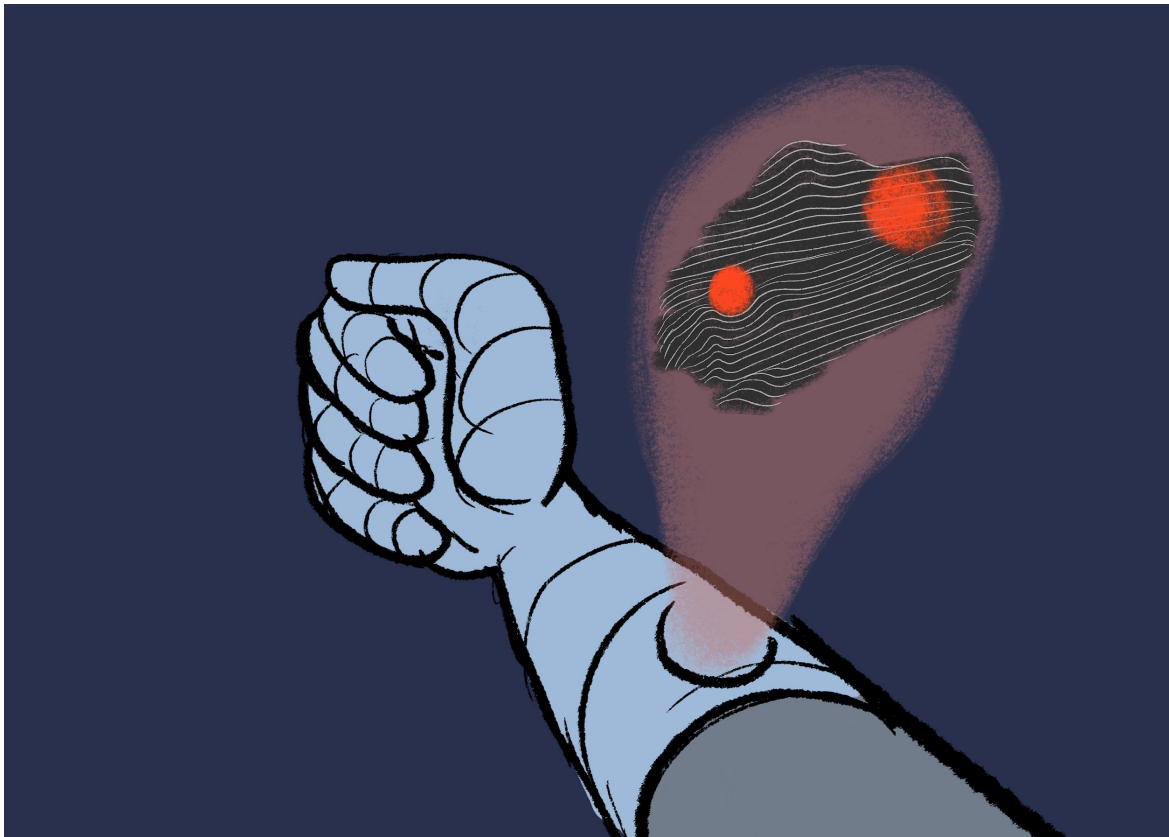
Bonus assignment:

Try to make a contact with the satellite using the Kitsat satellite Ground Station.

Try to warn the satellite about the coming threat!
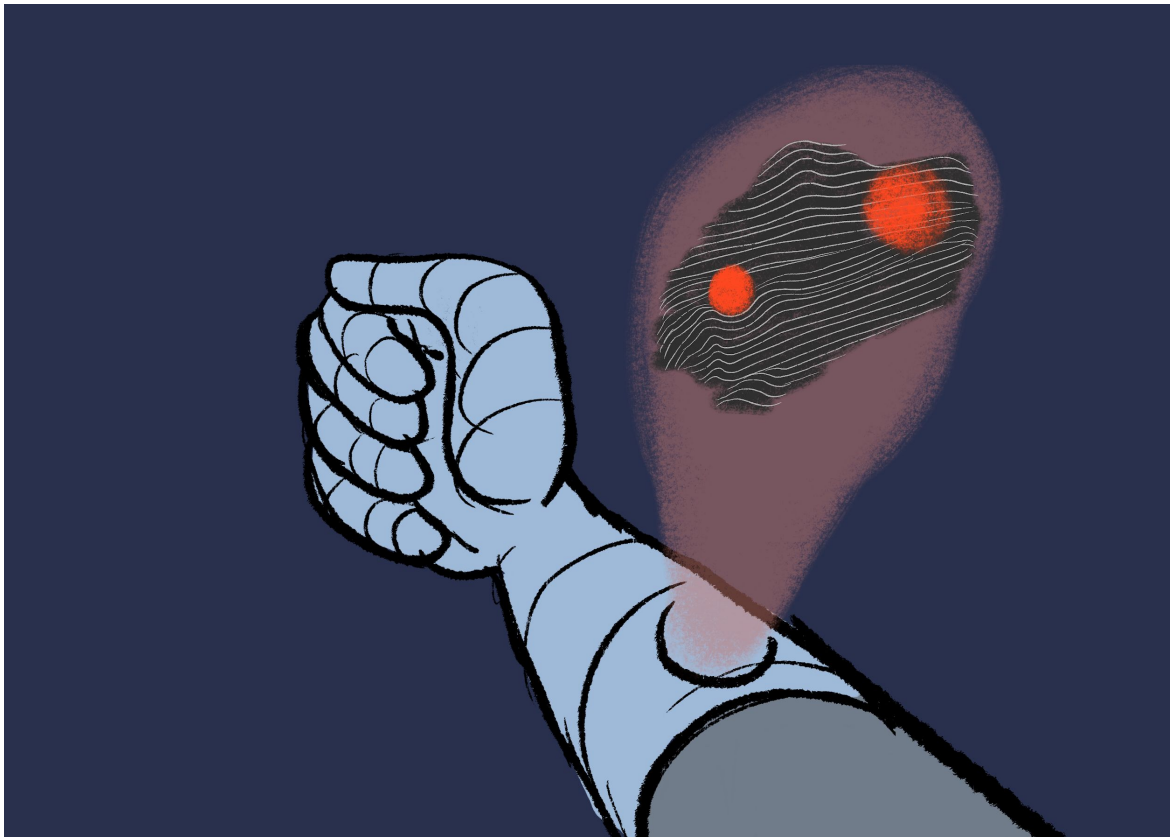
Assignment 16:

Make a plan how the android can get to space and save the satellite from the incoming threat. How the android can get away from the planet? What is the strange signal heading towards the satellite? How can the android make sure that the satellite gets safely to the space station?