PLANET CHANGE

Space Hazards:
Space debris

Answer sheet

ECF level 3 and 4

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Planet change is the short name of an EU Erasmus+ project aimed at VET teachers and their students. With small activities, the idea is to create awareness about sustainability and acquire 21st century skills. All this is done in a technical context, mostly from space technology.

www.planetchange.eu

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1. Space pollution exploration

2. What colors do the objects have? Name the four colors in the table below.
3. What category does each color correspond to? Add the categories in the table below.

Color	***Category***
Red	*Satellite*
Blue	*Rocket body*
Grey	*Grey*
Yellow	*Unknown*

4. *Do you think the objects in the category 'rocket body' are also space debris? Why?*

Yes, these rocket bodies are discarded during space missions and either fall back to or stay in orbit around the Earth.

Hover over 'Groups' in the upper-left corner of the screen and click on 'GPS'.

5. What do the blue lines represent?

The blue lines represent the trajectory of the object.

Click on the black background to see all objects again. Zoom in on the country you live in.

6. Over the next 30 seconds, count the objects that fly through the airspace directly above the country. How many objects have been there?

Any number.

7. Click on one of the objects. Fill in the table below.

Example:

Name of object	*SL-8 DEB*
Type of object	*Debris*
Speed	*7.06 km/s*
Altitude	*1631.50 km*
Orbit	*LEO/MEO/GEO*

Right now, there are around 36,500 pieces of space debris larger than 10 cm in orbit around the Earth. This number will increase over the years.

8. Why will this number increase? Give two possible reasons.

- *Humanity will keep sending stuff into space;*
- *During space missions, parts of the systems may be lost intentionally or by accident;*
- *Object in space may collide with each other and shatter*

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2. Collisions in space

Investigate the 2009 collision between two satellites, Iridium 33 and Kosmos 2251.

You can search the internet to find answers to the questions below.

During this assignment, the students may find various answers. The answers below are an indication originating from a variety of sources.

1. How many pieces of debris were reported?

Ten days after the collision, NASA estimated the collision created 1000 pieces of debris larger than 10 cm. In reality this would be more, as pieces smaller than 10 cm were more difficult to detect.

In July 2010, the U.S. Space Surveillance Network (SNN) reported that almost 2000 pieces of debris larger than 10 cm were produced by the collision.

Over time some pieces fell back to Earth. However, at least 1000 pieces of debris remain in space as of 2023 according to the U.S. Space Surveillance Network (SNN).

2. What factors are involved in a collision between two satellites? Give three possible factors.

Answers could include:

- *orientation of the satellites;*
- *how the satellites are positioned relative to each other;*
- *how fast the satellites are moving relative to each other;*
- *how much energy is stored in the structure of the satellites;*
- *how many fragments the satellites will break into;*
- *how large the fragments will be after collision;*
- *how much energy will remain in the fragments.*

3. Mark the spot where a collision would cause the most damage to a satellite on the image below.

The satellite is marked righth in the middle. This point is the center of mass.

4. Why is this point of impact the place that results in the most damage?

This point of impact is closest to the center of mass of the satellite. As a result, a significant portion of the energy from this collision is efficiently transferred. Colliding at points other than the center of mass could introduce rotational motion, diverting energy away from effective fragmentation of the satellites

5. What do you think happens if one of the pieces of debris from this collision hits another satellite?
   Hint: Look at the speed of one of the pieces on https://sky.rogue.space

If one piece hits another piece of debris at the indicated speed, there would be a good chance of the objects shattering upon impact. This could result in more debris.

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3. Clean the orbits

Circle one of the five objectives to focus on:

- Prevent uncontrolled growth of abandoned spacecraft and spent launch vehicle orbital stages with particular regard to preserve the LEO and GEO Protected Regions.
- Prevent debris generation as a result of intentional release of mission-related objects or breakup of space systems.
- Prevent accidental break-ups as a result of explosions of components storing energy on-board space systems and collision with space debris and meteoroids.
- Prevent orbital collisions by performing collision avoidance maneuvers and disposal maneuvers to limit long-term presence of non-operational space systems in the Protected Regions.
- Limit casualty risk due to controlled or uncontrolled re-entry of space systems

Circle the problem you want to address

- debris release
- particle release in Earth's atmosphere
- internal or external break-up
- clearance in LEO or in GEO
- re-entry of debris

Circle the part of the satellite's life cycle you want to implement your solution in.

- Design
- Production
- Launch
- Mission
- End-of-life disposal

What is your solution?

This solution solves a part of the problem, focuses on one of the objectives and can be implemented in the chosen part of the satellites lifecycle.

What does your solution solve?