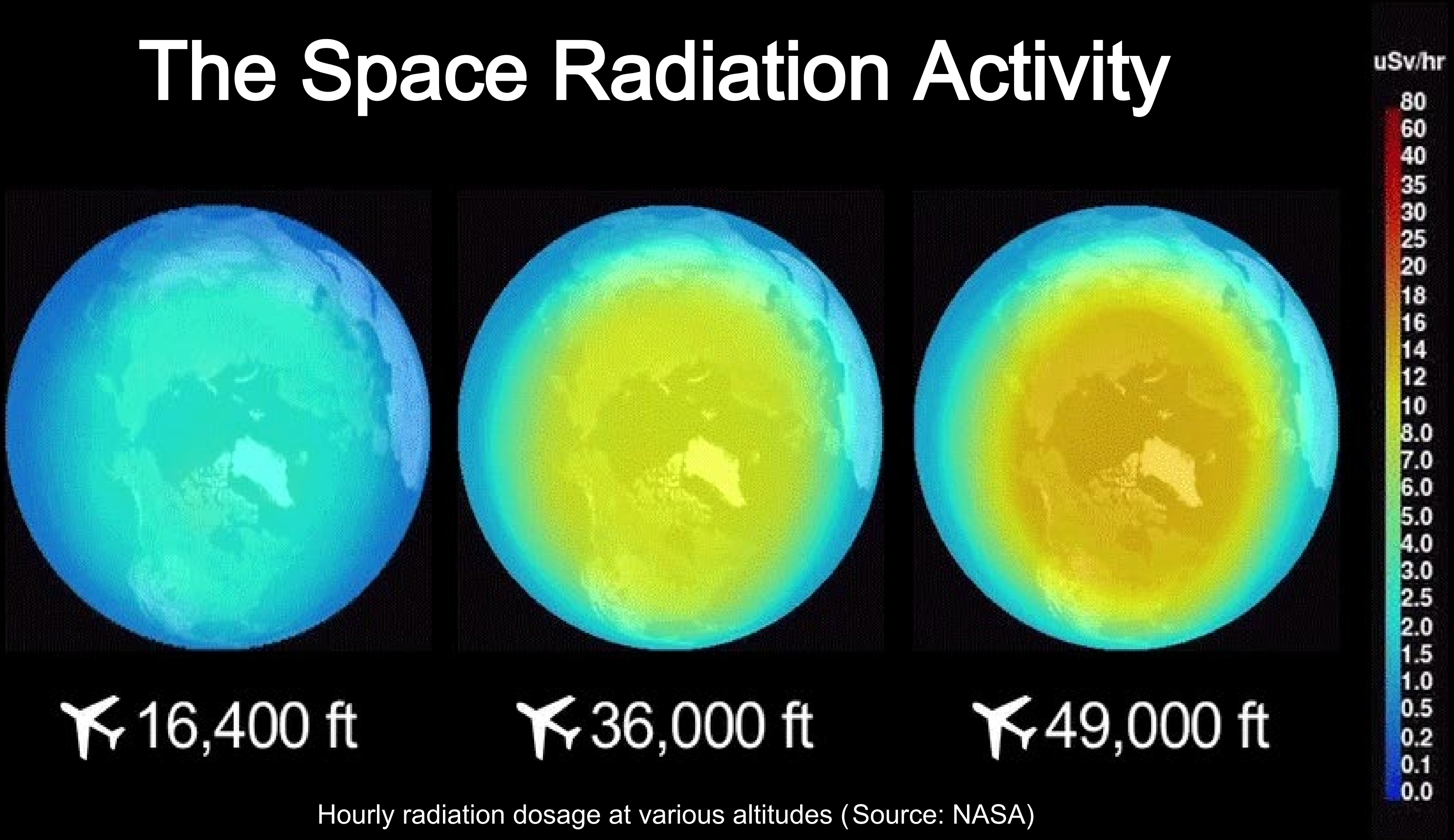
The Space Radiation Activity



Hourly radiation dosage at various altitudes (Source: NASA)

Why Would We Want to Pursue Space Travel?

- Satisfy our curiosity (exploring “The Great Unknown”)
- Discover new worlds (e.g., going to Mars)
- Scientific & technological advancement
- Economic growth opportunities
- National security a& foreign relations

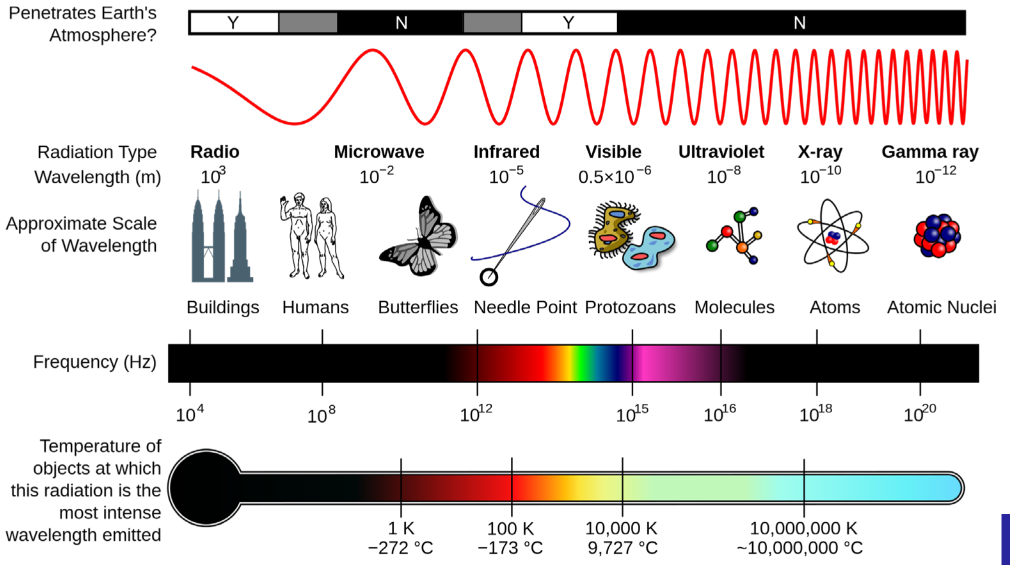
What Are the Biggest Obstacles to Space Travel?

- Cost
- Distance (we can’t travel very far with current technology)
- Inherent dangers and risks (rescue would be difficult/impossible)
- Keeping astronauts alive for long periods of time
- **Harmful radiation**

What are the Types of Radiation?

Electromagnetic (EM) Radiation

- Waves that carry energy across electric & magnetic fields
- Light, radio, UV, X-rays, etc.
- No mass, moves close to the speed of light
- Can be absorbed, reflected, refracted, & emitted
- UV, X-rays, & Gamma rays are ionizing radiation, can cause damage to human DNA

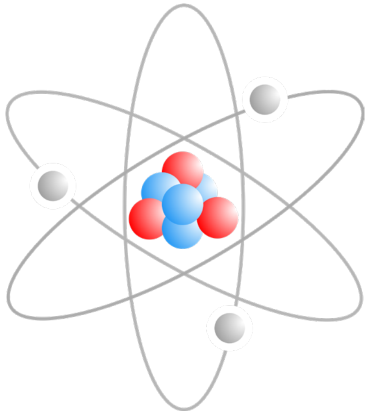


Source: Wikipedia

What are the Types of Radiation?

Particle Radiation

- High-energy, fast-moving subatomic particles that can ionize atoms & molecules
- They have mass, thus move slower than EM radiation
- **Alpha particles:** Helium nuclei emitted during radioactive decay
- **Beta particles:** Individual electrons emitted by radioactive materials or elements
- **Cosmic rays:** ~99% are bare nuclei of atoms, mostly hydrogen (single protons) and helium (Alpha particles), that emanate from distant stars. Less than 1% are electrons (Beta particles).



Source: Wikipedia

Harmful Ionizing Radiation

Alpha (α) Particles

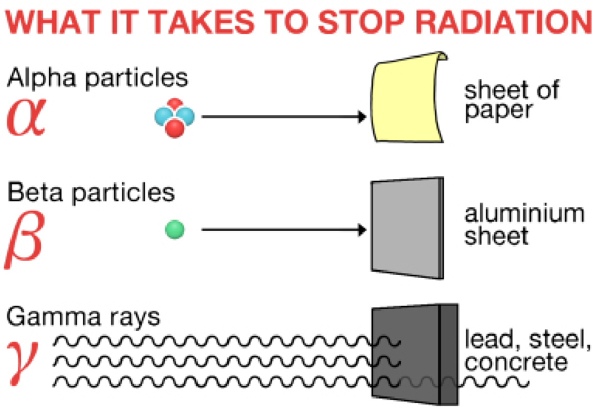
- High energy & strongly ionizing
- Relatively bulky, slow → Easy to stop

Beta (β) Particles

- Less energy & less ionizing than Alpha
- Smaller, lighter, faster than Alpha → Harder to stop
- Emits Gamma rays when interacting with matter

Gamma (γ) Rays

- Less energy & less ionizing than Beta
- No mass, very fast (speed of light) → Hardest to stop



Source: Wikipedia

https://youtu.be/GoEk7Uu8a2M

https://youtu.be/kxJd6RbcsgU

The Space Agency Scenario

- Two emerging nations have entered into an exciting **space race**!
- Each wants to build a **space-faring vessel** that will protect their astronauts from harmful radiation in space.
- Both nations have formed new **space agencies** and are hiring physicists, engineers, scientists, economists, & marketing specialists.
- **To win the space race, your agency must work together to develop an effective way to protect your astronauts from this dangerous radiation !**

What Are We Doing In This Activity?

We're going to send "astronauts" up to near space!

- Your agency will be building a payload capable of measuring ionizing radiation high up in the atmosphere.
- Using various materials, you'll need to create a **radiation shield** to protect the payload (i.e., your astronauts) from this radiation.
- Your job is to assemble the payloads & determine which materials to use for your shield.

Roles

International Advisor (teacher/instructor)

- Provides general assistance & guidance throughout the activity.
- Sells raw shielding materials to the agencies.
- Approves extra funding earned though social media.
- Examines & approves the payloads prior to launch.
- Determines the final scores and winning agency.

Director (1 student)

- Oversees & provides strategic direction for their agency.
- Makes final decisions for their agency.
- Ensures that everyone in their agency stays on task.
- Delivers two brief presentations to update the rest of the class on their agency's progress.

Engineer (1–2 students)

- Helps determine which shielding materials to purchase.
- Leads efforts to design & build the radiation shield.
- Assists with payload testing to ensure it functions properly.
- Ensures the payload is mounted securely for the launch.

Computer Scientist (1 –2 students)

- Assembles the Arduino electronics.
- Organizes & edits the code before uploading it to the Arduino.
- Leads Arduino testing prior to launch.
- Helps with graphing & data analysis after the launch.

Research Scientist (1–2 students)

- Provides research support for other members of their agency.
- Leads efforts to research the best available shielding materials.
- Helps the Engineer design how the shield should be built & mounted to the payload.
- Assists with graphing & data analysis after the launch.

Economist (1 student)

- Keeps track of their agency's budget & spending.
- Helps determine which shielding materials to purchase.
- Responsible for buying materials from the International Advisor.
- Provides the Director with budget updates & statistics.

Marketing Specialist (1 –2 students)

- Handles public relations & outreach for their agency.
- Designs their agency’s logo.
- Creates their agency’s social media page or website & updates it regularly with content.
- Helps the Director prepare their Director’s Presentations.

Main Components of the Payload

- Arduino Mega microcontroller
- Radiation Sensor
- GPS Breakout Board
- GPS antenna
- MicroSD card
- Jumper wires
- Battery pack
- Radiation shielding materials
- Payload box

Available Shielding Materials

- Aluminum ($)
- Balsa Wood ($)
- Bubble Wrap ($)
- Galvanized Steel ($)
- Lead ($)
- Mylar ($)
- Polyethylene/plastic ($)
- Steel ($)
- Duct Tape (FREE)
- Electrical Tape (FREE)
- Hot Glue (FREE)
- Zip Ties (FREE)

* ***Wear gloves when handling lead***

* ***Bare metal edges can be sharp***

* ***Be very careful using snips or cutting tools***

The Rules

1) The mass of each radiation shield by itself (i.e., not including radiation sensor) must be **at least 200 grams** but **cannot exceed 500 grams**

2) The radiation shield must completely enclose the radiation sensor on all sides. The sensor cannot be glued or permanently attached to any of the shielding material, must be easily removeable, and must face upward toward the sky during flight.

3) The radiation shield must fit within its payload box and be mounted securely to the box (preferably with zip ties) for the flight.

4) Shielding materials can be bent, folded, cut, molded, or otherwise altered, if done so in a safe manner that is approved by the International Advisor.

The Rules (continued)

5) Only the materials and tools provided by the International Advisor may be used in the construction of the radiation shield.

6) Final payload assemblies must be tested and receive final approval from the International Advisor prior to the balloon flight.

7) Each space agency begins with a budget of $300 million. Agencies can spend more than their budget, however doing so will incur a penalty.

8) (Optional) Agencies can earn up to an extra $75 million in funding for their budget by gaining followers on their social media. This extra funding can only be earned before the balloon launch and must be approved by the International Advisor.

Determining the Final Scores

(Up to 30 pts)	Design/performance of radiation shield
(Up to 20 pts)	Quality of Director Presentations
(Up to 20 pts)	Creativity/design of agency logo and name
(Up to 15 pts)	Quality of social media or website content (optional)
(Up to 15 pts)	Finished under budget

Get In Your Agencies

ROLE	AGENCY 1	AGENCY 2
Director		
Engineer(s)		
Computer Scientist(s)		
Research Scientist(s)		
Marketing Specialist(s)		
Economist		

Let The Space Race Begin!