

Final Mission Briefing



Astronauts, you and I are about to take science to a new level.

Dr Natalie Meyer, Flight Commander

Today we will leave behind our Earth laboratory.

We will journey to a science lab, 200 miles above the planet.

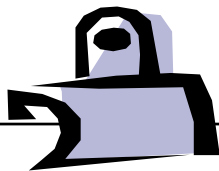
Our destination is the International Space Station (ISS). It's an amazing place — and it's so big that it had to be built in space.

Our mission: To learn how humans can live in zero gravity.

You will need all your years of scientific training for the experiments we will be doing.

When you're ready, climb aboard Space Shuttle Discovery. Strap yourself in and prepare for the launch sequence.

Good luck, astronauts!



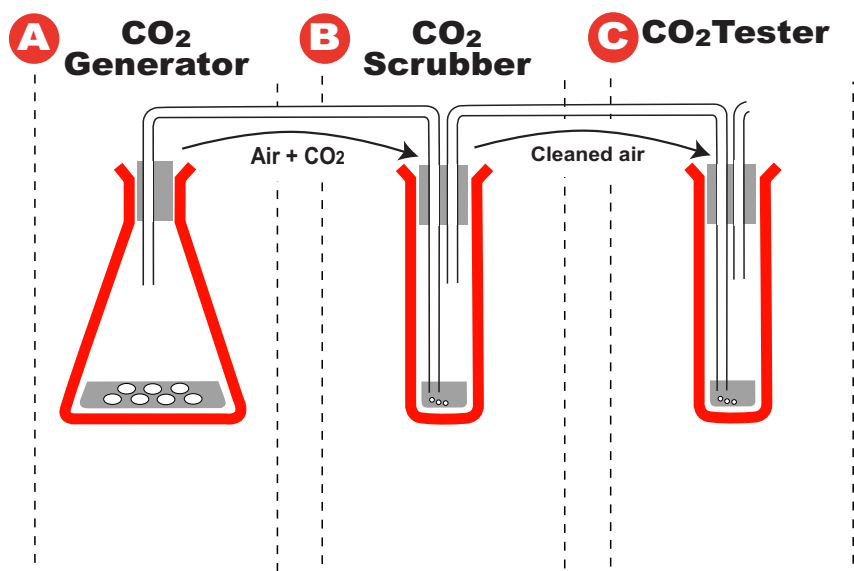
Mission message

To: Discovery crew
From: Mission Control, Houston
Priority: Urgent

CO₂ scrubber

The problem:

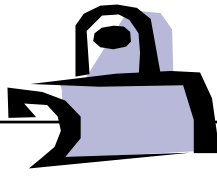
During the spaceflight, the crew release large amounts of carbon dioxide when they breathe out. The space station has a 'scrubber' to remove unwanted gases like CO₂ from the air, but it has malfunctioned. You are going to have to build yourselves a home-made scrubber. It will look like this:



You don't have very long before the CO₂ levels rise to dangerous levels. Work quickly.

Instructions

- 1
 - a) Find out what chemical(s) you can use that will:
 - i) react together to produce CO₂.
 - ii) detect when CO₂ is present.
 - b) Write your ideas on the planning sheet.
- 2 Choose chemicals from the Space Station lab to use for the scrubber.
 - a) CO₂ is an acid gas. An alkali could neutralise it and remove it from the air. Test the chemicals available with indicator.
 - b) Write down the chemicals you will test as scrubbers on the planning sheet. Remember, the more you test, the longer it will take.
- 3 Show your plan to the Flight Commander to make sure it is safe and sensible.
- 4 Set up your apparatus and experiment to find the best CO₂ scrubber.
 - a) First, leave tube B empty (no scrubbing chemical). Start the reaction in the CO₂ generator. Time how long it takes for your tester to show that lots of CO₂ is present.
 - b) Then, test each scrubber chemical in turn. Measure how long it takes until you can detect CO₂ in the tester. Make sure it is a fair test.
 - c) Write down your results on the sheet.
- 5
 - a) Analyse your results. Which chemical makes the best CO₂ scrubber?
 - b) Report your findings to the Flight Commander as soon as possible.



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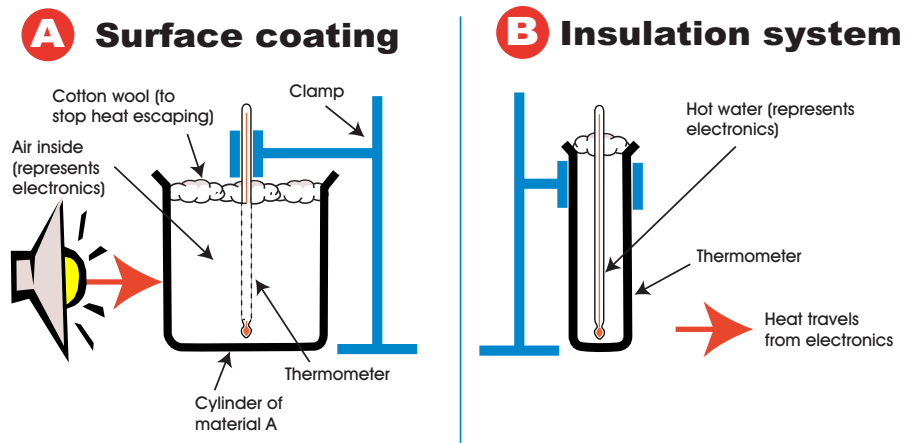
Cladding

The problem:

One of the solar panels broke off. It pulled away some of the covering to the spacecraft which is called 'cladding'. Sensitive electronics are now exposed to the extreme temperatures of space.

The equipment will malfunction if its temperature rises or falls. You will lose contact with the ground. You must design some new cladding to protect the electronics. The diagram shows the two parts to the cladding:

- A Surface coating – what you will put on the outside to stop the electronics absorbing the sun's rays.
- B Insulation system – what you put around the electronics to stop it cooling.

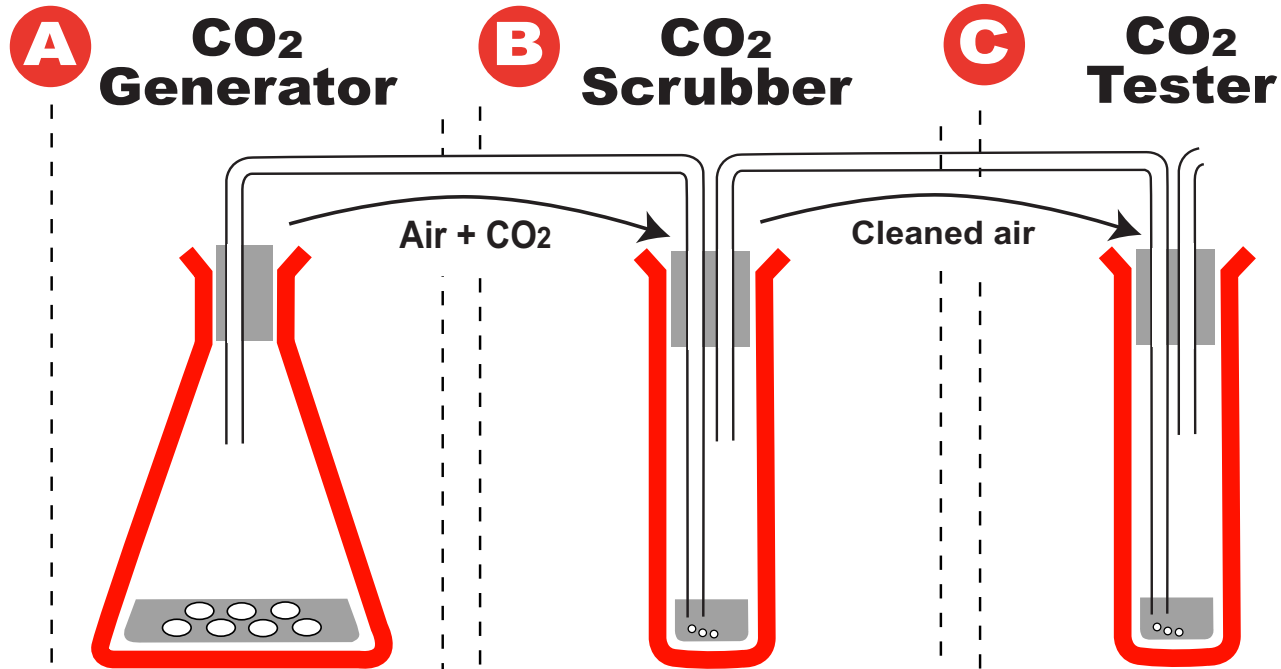


What to do

- 1 Find out what the three different ways heat travels are, and the differences between them.
- 2 Choose coating material A:
 - a) Think about how heat travels from the Sun to the outside of the spacecraft.
 - b) In the experiment you will use a lamp to represent the Sun. A thermometer will represent the electronics. Decide what coating material you could surround the electronics with, which will absorb the least heat.
 - c) Write your ideas on the planning sheet.
- 3 Test coating material A:
 - a) Set up your experiment. Fold material A into a cylinder and stick it together. Make sure it stays upright. Put the lamp 10cm away from the material.
 - b) Measure the initial temperature.
 - c) Turn on the lamp for 10 minutes. Then measure the final temperature.
 - d) Write your results on the planning sheet.
- 4 Design insulation system B:
 - a) Think about how heat travels from the hotter electronics to the cooler wall of the space station.
 - b) In the experiment you will use a boiling tube of water to represent the electronics. Decide how you can arrange and stick the insulating material to the outside of the tube, to reduce heat flow as much as possible.
 - c) Write your ideas on the planning sheet.
- 5 Test insulation system B:
 - a) Set up your experiment. Construct your insulating system and attach the material to the tube.
 - b) Fill the boiling tube with hot water up to a mark below the top of the tube.
 - c) Wait until the thermometer falls to the agreed starting temperature.
 - d) Start the stopwatch, or note the start time.
 - e) Measure the temperature after 10 minutes.
 - f) Write your results on the planning sheet.

Report your findings to the Flight Commander as soon as possible.

Problem one



SOLID = _____
SOLⁿ = _____
+

Substance 1 = _____
Substance 2 = _____
Substance 3 = _____
Substance 4 = _____

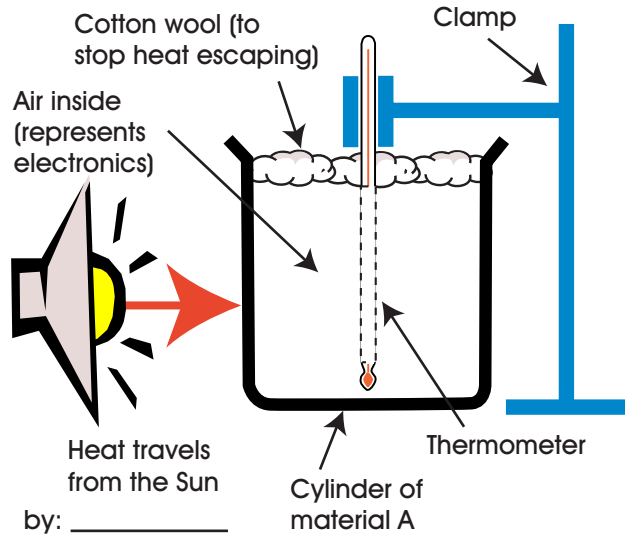
SOLⁿ = _____

RESULTS

Scrubber (in B)	Time until detect CO ₂
Substance 1	
Substance 2	
Substance 3	
Substance 4	

The best CO₂ scrubber is:

A Surface coating



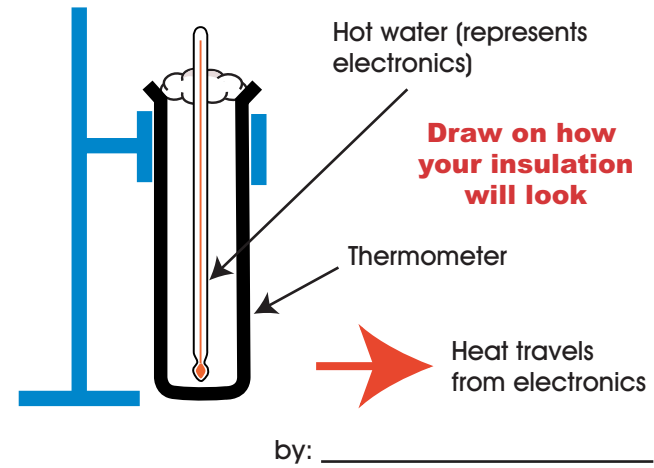
by: _____

Material chosen for A: _____

Material reduces heat flow because: _____

Results: Start temperature = °C
 End temperature = °C
 Temperature rise = °C

B Insulation system



by: _____

The insulation system reduces heat flow because: _____

Results: Start temperature = °C
 End temperature = °C
 Temperature fall = °C