→ Challenge:

Design a space station

The ISS is a cooperative international, scientific and technological venture that is opening up a new era of human space exploration and research. The largest spacecraft in history, the space station will comprise six different laboratories allowing for groundbreaking advances in biological, medical, materials and industrial research. But the scientists need your help. They need new ideas for the ISS. It is your challenge to design a space station.

→ Contents

Powerhouse discovery challenges are inquiry-based units of work that:

- begin and end in your classroom
- involve a structured discovery process with links to the classroom curriculum
- provide a deeper understanding of the Museum's collection
- promote team problem-solving skills, and
- are fun!

→ Teacher information

Before your visit

- Read the challenge to your students.
- Divide your class into groups of four or five students. Each group is a team and should work together to complete the challenge.
- Do the pre-visit activity. This activity is directly related to your challenge and will help your students focus on the issues, preparing them for their museum experience.
- Prepare your group leaders (a teacher, accompanying parent or older student) for the visit to the Powerhouse Museum. Photocopy and give them the challenge trail (pages 7–10) ahead of time. Group leaders are essential to the success of the *Powerhouse discovery challenges*. The more they know, the harder they will work to make your students' museum experience a success.
- Assign a group leader to each team.

At the Powerhouse Museum

- The challenge will take approximately two hours from the time of arrival to the time of departure.
- The challenge trail should only be given to your group leaders. Students may bring along a pad and pencil to jot down their ideas to help complete the challenge.
- On arrival, an education staff member will meet and escort your group to a briefing area, introducing the areas of the Museum that are included in your challenge. They will also remind you of the safety rules and assist with any other details of your visit.
- Apart from this orientation and welcome, staff members will not be available to guide your group through the Museum.
- The exhibitions listed in the challenge can be visited in any order.

After your visit

- Do the post-visit activity. This activity will draw on students' knowledge gained during their exploration of the Museum to complete the challenge.
- Go over the assessment tool which you will use to grade their work.
- Choose an extension activity for your students.
- Return the feedback page to the Powerhouse Museum.

Photo by Sue Stafford, Powerhouse Museum

→ Challenge outcomes

Primary discovery challenges are structured for teachers to incorporate into their existing curriculum. A variety of learning processes are incorporated into the challenges as well as the 'values and attitude' outcomes as indicated in the K–6 Science and Technology syllabus. Outcomes for this challenge and examples of how they might be achieved are included here:

1. Students are able to design and construct a model.

   They show their ability by brainstorming, sketching, and discussing their plans and then constructing a space station with a given set of materials and guidelines.

2. Students are aware that there is more than one way to design something.

   They show their awareness by comparing their designs with other students.

3. Students will understand that a weightless environment challenges humans living in space. Humans must adjust their diets, sanitation, and sleep patterns, wear space suits and conduct specially designed experiments.

   Students show this by writing a story about life on a space station. They explore concepts about life in space by visiting exhibitions at the Powerhouse Museum. They will also consider these factors when designing their space station.

4. Students will understand some of the aspects of the science, technology and/or engineering involved in the construction of a space station.

   They show this by identifying and describing the components of a space station such as modules and solar panels and incorporating these features in their final design.

5. Students will understand that countries often collaborate in scientific developments.

   They show this by identifying the different countries involved in the construction of the International Space Station. They will also explore Australia's contribution to space exploration as displayed at the Powerhouse Museum.

6. Students will understand that the planet Earth is a finite resource and that we need to be aware of the importance of recycling and energy conservation.

   They show this by exploring the EcoLogic *exhibition at the Powerhouse Museum in general. They will include sustainable features in their space station design.*

An artist's rendering of the International Space Station (ISS) following the undocking of the Space Shuttle Atlantis in January 2001. Image courtesy of NASA

→ Pre-visit activity

Purpose: The purpose of these pre-visit activities is to prepare students for their Museum visit and provide an adequate background so they can design and make their own space station model. Adapt and modify the teaching strategy below to suit the needs of your students.

Teaching strategy

1. Familiarise yourself with the International Space Station (ISS). For up-to-date information, visit the ISS homepage at **http://spaceflight.nasa.gov/station/**. Images can be downloaded from this site.

2. Begin the lesson by asking students what they already know about the ISS. As they brainstorm facts, write them on the board. If students have other questions about the ISS, have them find answers in the library or on the internet and ask them to report back to class.

3. Sixteen countries are working together to build the ISS: the United States, Russia, Canada, Japan, Brazil, and the nations of the European Space Agency (Belgium, Britain, Denmark, France, Germany, Italy, the Netherlands, Norway, Spain, Sweden, and Switzerland). Have students locate the 16 nations on a world map. To extend this activity further you might like to explore Australia's involvement in space or allow students to investigate one of the 16 countries.

4. Using the diagram on page 6, discuss the different components of the ISS. Features to locate include modules, docking ports and solar panels. Have students label the different parts and ask them what they are used for.

5. Using the diagram on page 6 as inspiration, ask your students to write a short story or draw a picture about what it would be like to be chosen as the first student in space. Ask students to include information about the food they would eat, the clothes they would wear, how they would work, how they would sleep and what they would do for fun. You could even ask students to consider what would happen if they got into an argument with another astronaut.

6. Expanding on Activity 4, ask students to generate a list of critical equipment and supplies needed for humans to live comfortably in space. This activity will help students with the design of their space station in the post-visit activity. Begin with students considering what systems and supplies are needed in their own homes such as power supply, waste management and communication appliances. Discuss how they will provide these necessities.

7. Using the trail (pages 7–10) as a guide, prepare students for the visit to the Powerhouse Museum. At the Museum, students will explore exhibitions to help them construct a space station back in the classroom. Ask them about what they expect to see and what questions they might like to be answered by the visit.

ISS fun facts

Completed size: 111 metres across x 80 metres long (or the size of two football fields)

Weight: about 450 000 kilograms

Estimated cost: more than A$120 billion

Estimated date of completion: 2006

Number of pieces: over 70

Above Earth: 354 kilometres

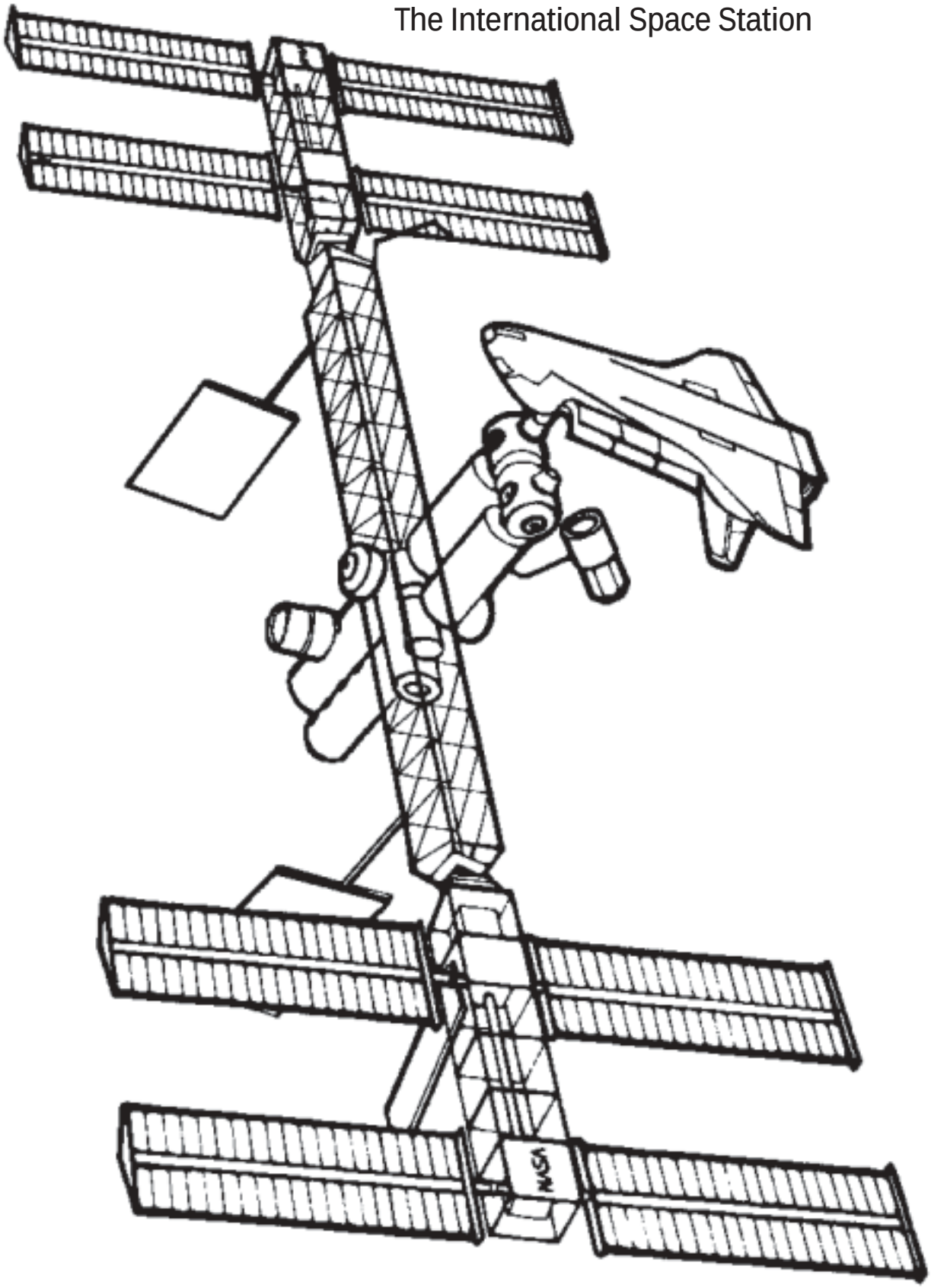
Time to orbit Earth: 90 minutes

Speed: 28 000 kilometres per hour

Power: The giant solar panels will generate enough electricity to power about 50 average Australian homes.

Diagram on page 6 courtesy of NASA

The International Space Station



FOR GROUP LEADERS

→ Challenge trail:

Design a Space Station

The ISS is a cooperative international, scientific and technological venture that is opening up a new era of human space exploration and research. The largest spacecraft in history, the space station will comprise six different laboratories allowing for groundbreaking advances in biological, medical, materials and industrial research. But the scientists need your help. They need new ideas for the ISS. It is your challenge to design a space station.

Tips for the group leader

(a teacher, accompanying parent or student)

1. Know your group. Help them get excited about their visit.
2. Study the map of the exhibitions you will visit.
3. **Where to go** gives you brief directions on the location of your next exhibition stop. If you get lost, please ask a gallery officer for directions.
4. **All about** is designed to familiarise the group leader with the exhibitions they are about to visit.
5. **To say or do** gives the group leader ways to introduce the topic to the group. Explain the focus, activity or discussion point at each stop. Remember *Powerhouse discovery challenge* trails are guides not rules. If the students are restless or no longer interested, move to another part of the exhibition.
6. At each stop give your group time to look around the exhibition, listen to the audiovisual(s) and/or play the interactive(s).
7. Gather your group to talk, reflect or do an activity according to the stop.
8. Rest, debrief and allow time for each student to go back to his or her own exhibition highlight.
9. Have fun! The Powerhouse is a place of discovery. Be an adventurer with your group.

→ Challenge guide

Stop 1

■ Where to go

Space: beyond this world exhibition, level 2. If you are in the *Transport* exhibition, enter behind the old timetable board. If you are in *Experimentations*, there is an entry though *Chemical attractions*.

■ All about

The *Space* exhibition looks at the history of our desire to travel beyond Earth's atmosphere. Your team will see early rocketry, follow the 'space race' between the USA and the former USSR, then glimpse the dream of future space travel.

■ To say or do

When students return to class they will be designing their own space station. When you walk into the exhibition for the first time ask students to point out the space station module. Floating outside the module is an astronaut in a space suit. Ask students why they need to wear a space suit. While inside the space station module, encourage students to explain to you the different things they can see (for example, ask how is it possible to sleep standing up!). Discuss what the astronauts might eat in space. Find the display of food to help your discussion (even cans of coke need to be modified for the space station!). Can students find the mice in the model of Cosmos–782? Discuss why animals were sent into space before humans.

Stop 2

■ Where to go

EcoLogic: creating a sustainable future exhibition, level 2. We recommend entering via the south end of the Turbine Hall and going around in an anticlockwise direction.

■ All about

EcoLogic looks at environmental problems facing Australia and the world. It also presents a positive picture of an ecologically sustainable future through case studies and real life stories of people and developments that are changing the way we live, manufacture, work and travel.

■ To say or do

Encourage your team to freely explore the different sections of this exhibition. When they design their space station back at school, they will need to consider how they are going to make it sustainable. Discuss how they are going to power the space station and what they are going to do with their waste. While looking at the 'Reduce, Reuse, Recycle' display in *EcoLogic* ask students why these terms are important in the design of their space station. One of the reasons why we need to do research about living on a space station is because we are using up all the resources on earth. Play the 'Big Foot' game and see how big students' ecological footprints are.

This handy little 'dog poo' bag, found in the *EcoLogic* exhibition, shows what individuals and 'best friends' can do for their environment on Earth. How would you clean up waste on a space station? Photo by Sue Stafford, Powerhouse Museum

Stop 3

■ Where to go

Experimentations, level 2. You can enter this exhibition via the northern end of the Turbine Hall. If you are in *Space*, find the entrance to *Experimentations* on the bottom level.

■ All about

Experimentations is all about the science behind familiar things. Students can make their own discoveries with over 30 hands-on exhibits that demonstrate a variety of scientific principles.

■ To say or do

Allow students to explore freely the hands-on exhibits. Scientists may carry out similar experiments on the space station. Encourage students to think how these experiments might work in a weightless environment. Will the results be different, or won't the experiments work at all?

Stop 4

■ Where to go

Go to the *'… never done'* exhibition on level 3.

■ All about

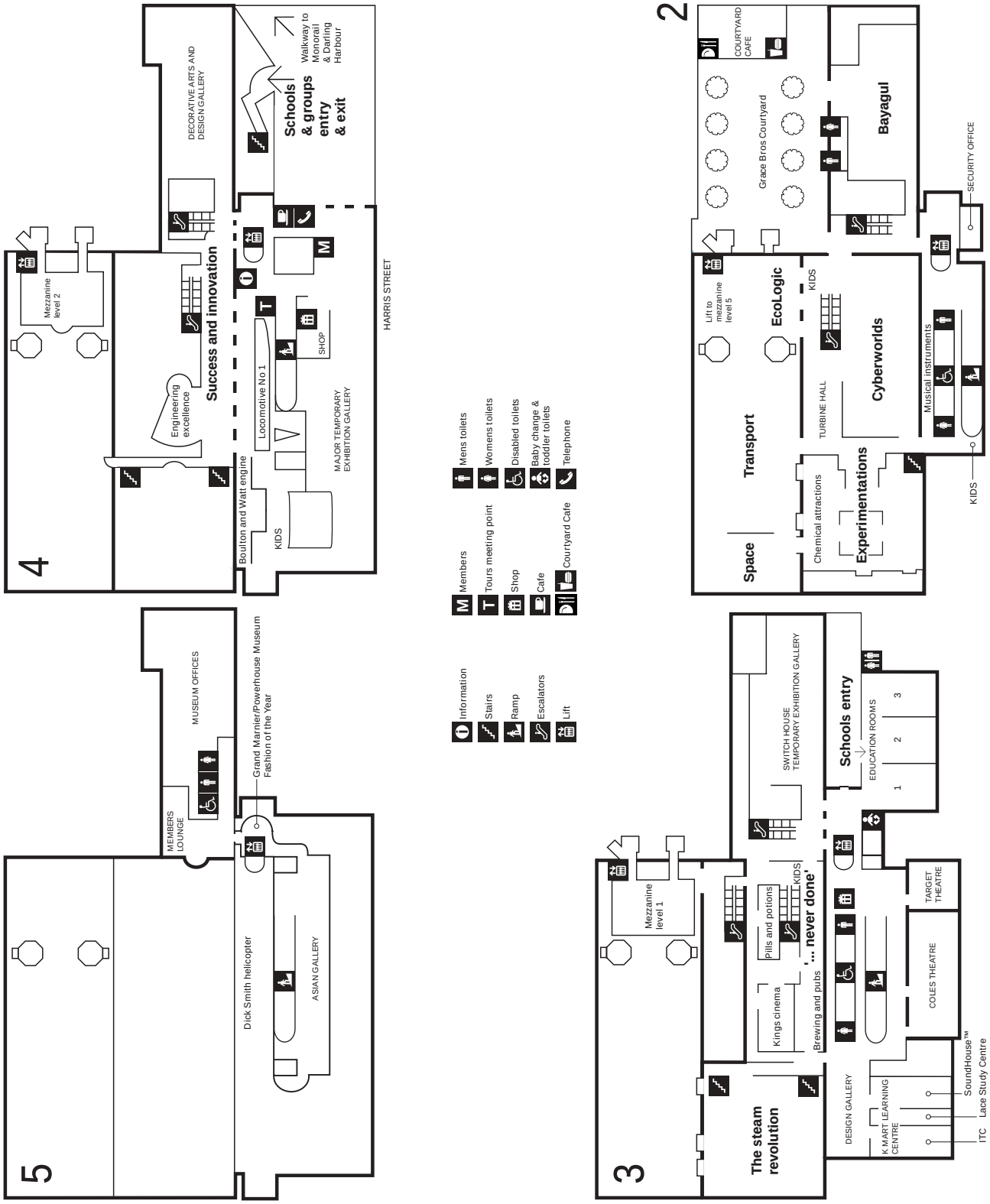
In this exhibition students will see what lives were like during the late 1800s and early 1900s by visiting the bush hut and the 1920s suburban kitchen sections. Lifestyles have changed since the 1920s with the development of new electrical appliances.

■ To say or do

Allow students to explore freely the different areas of this exhibition. Ask them to compare the displays with what is in their homes today. When looking at the bush hut and 1920s kitchens, students could consider how food was kept cold and how water was heated. As part of their final design, students have to incorporate living quarters. While looking at each of the displays, prompt discussion about how they would prepare and eat food in space. (Remember the weightless environment!) Remind students of the old saying 'Don't cry over spilt milk', but how would they clean it up in space when globs of milk float about.

The plasma ball in *Experimentations* obeys certain laws of physics here on Earth, but would it work in the same way if astronauts used it on a space station? Photo by Sue Stafford, Powerhouse Museum

Map


4
Mezzanine level 2
Engineering excellence
Success and innovation
DECORATIVE ARTS AND DESIGN GALLERY
Schools & groups entry & exit
Walkway to Monorail & Darling Harbour
Locomotive No 1
SHOP
MAJOR TEMPORARY EXHIBITION GALLERY
Boulton and Watt engine
KIDS
HARRIS STREET
5
MEMBERS LOUNGE
MUSEUM OFFICES
Grand Marnier/Powerhouse Museum Fashion of the Year
Dick Smith helicopter
ASIAN GALLERY
Information
Stairs
Ramp
Escalators
Lift
Members
Tours meeting point
Shop
Cafe
Courtyard Cafe
Mens toilets
Womens toilets
Disabled toilets
Baby change & toddler toilets
Telephone
2
COURTYARD CAFE
Grace Bros Courtyard
Bayagul
SECURITY OFFICE
Lift to mezzanine level 5
EcoLogic
KIDS
Cyberworlds
Musical instruments
Transport
TURBINE HALL
Space
Chemical attractions
Experimentations
KIDS
3
Mezzanine level 1
SWITCH HOUSE TEMPORARY EXHIBITION GALLERY
Schools entry
EDUCATION ROOMS
1
2
3
Pills and potions
KIDS
'... never done'
Kings cinema
Brewing and pubs
TARGET THEATRE
COLES THEATRE
The steam revolution
DESIGN GALLERY
K MART LEARNING CENTRE
SoundHouse™
Lace Study Centre
ITC

→ Post-visit activity

Purpose: Students will design and build their own space station.

Materials

- Soft drink cans, plastic soft drink bottles, tissue/ teabag and other small boxes — modules
- Cardboard tubes — docking ports
- Plastic kitchen wrap — solar panels
- Aluminium foil — thermal radiators
- Craft sticks — support structure for solar panels and thermal radiators
- Styrofoam food trays (cut into 4 cm wide strips) — truss segments
- Buttons/bottle tops — control jets
- Flexible straws — robotic arm
- Toothpicks — miscellaneous decorations, supports etc
- Paint, glue, scissors, masking tape

Teaching strategy

1. Collect the necessary materials or instruct students to bring them from home. Do this well ahead of time.

2. Since each team may have explored different exhibits at the Powerhouse Museum, we suggest the teams share their information and ideas for completing the challenge. Use the challenge trail to guide your discussion.

3. Re-read the challenge back to the students.

4. Ask students to equip their space station with a laboratory, an equipment and supply storage unit, living quarters, a docking port for transports travelling to and from earth and a solar panel to power the station. The design should contain information about temperature control and waste management. Also suggest adding a robot arm to service all parts of the station and a communication system for communicating with earth.

5. You might like older students to consider adding the following constraints to the design:

    - All modules must be connected to at least one other module.
    - The controlling jets must be positioned so that they will not fire on any component of the space station and can move it in any direction.
    - The docking port should be positioned so that there is a clear, straight path to it for the orbiter to dock.
    - The robotic arm should be placed to maximise the number of components that it can reach.
    - Be aware of the effect of heat when the space station is in the sunlight and in the shade.
    - Keep the weight of the space station as light as possible
    - Keep the cost as reasonable as possible.

6. Have students work in small groups to brainstorm ideas for the design of their space station. Encourage them to respect each person's opinion.

7. Once students have chosen an idea or combination of ideas to use for their design, they should make a sketch of their design. Their design should include labels that show any features and how any constraints will be met in their space station. Students should be encouraged to explain the reasoning behind their design including meeting the constraints. This explanation can be written on their design or presented verbally.

8. Once the design is complete, it should be presented to the supervisor/teacher.

9. The supervisor/teacher should review the design and suggest any changes that may be needed.

10. Once the design has been approved, students can begin constructing the space station, being sure to keep any constraints in mind.

11. When students finish constructing their space station, have them name it. If students have time, they can add decorations to their space station.

12. Once students have completed their space station, pair up groups of students. Have the groups switch their space stations and designs and evaluate each other's project.

13. In this evaluation process, the groups should focus on whether the space station is constructed as it was designed since this is what the supervisor approved. They should also check to make sure that each feature is included, and that the space station was built within the constraints specified.

14. Once groups have had time to evaluate the space stations, have the group pairs share their evaluations with each other.

15. Once the groups have shared their evaluations, discuss as a class what students learned from the evaluation. Lead a discussion using the following questions:

    - Did your space station meet the requirements?
    - What helpful comments did you get from the other group?
    - Do you see things that you could improve about your space station? Explain.
    - What changes would you make?

16. Have students work in their own groups to make any modifications/improvements needed after being evaluated by a group of peers. Note to teacher: Limit the time which students have to modify/improve their space station.

17. Have students explain their space station to the class. They should include the name of the space station, what features they included on their space station, why they included the features, what problems they had to solve during the design process, and how they solved the problems.

18. Have students explain the steps they went through to design their space station. Ask them if they think scientists follow similar steps.

19. After students have shared their ideas, explain that they followed a process very similar to what scientists do. Explain that the basic design process includes defining a problem, identifying features and constraints, generating ideas, selecting a solution, testing the solution(s), making the item, evaluating it, improving the design, and presenting the results.

20. Discuss the following questions. Be sure to have students explain the reasoning behind their answers:

    - What went well during the design of your space station?
    - What problems did you encounter during the design process?
    - How well did your space station meet the guidelines set up by the class and by the supervisor?
    - How did you make sure that you stayed within the constraints?
    - Were any of the space stations perfectly designed?
    - If not, how could yours be improved?
    - Was there more than one solution to the problem?
    - Do you think scientists design space stations that are perfect?

21. Explain to students that the space stations designed by scientists may appear to be perfect, but they can always be improved. Scientists who design space stations always model their design, test it (although not in space!), evaluate it, and then change the design to make it better. There is no perfect design for anything; all designs can be improved.

22. Ask students if they feel that they would be qualified to design a space station. Explain to them that they may not be quite ready for designing, but they are definitely on their way.

23. Display the models and design plans in the class.

→ Extension activities

1. Have students write instructions for building a space station.

2. Design a campaign for advertising the space station. Use video and/or print products.

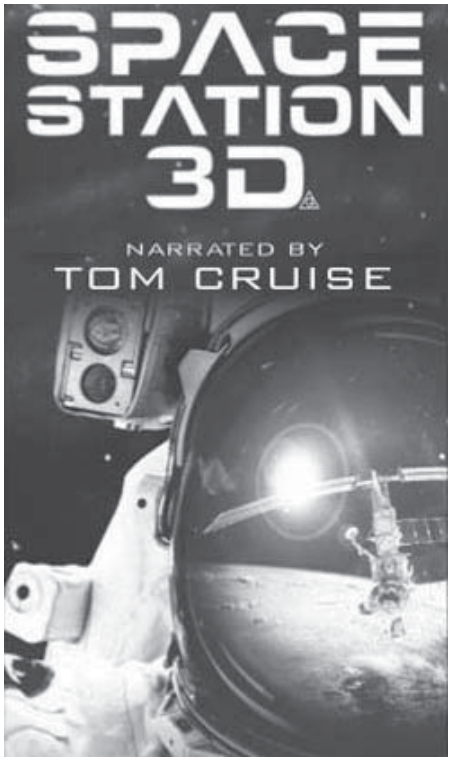
3. Invite parents, faculty and the local press to a Space Station Expo. The completed space stations can be displayed and group members can discuss their designs.

4. Create a glossary of words and terminology specific to the fields of space exploration and space stations.

5. Take a virtual tour of the international space station (**http://spaceflight.nasa.gov/gallery/vtour/**). After touring the space station, write a report describing your trip. Include descriptions of favourite parts of the tour, surprising discoveries, and new questions that come to mind as a result of the tour.

6. Students can catch a glimpse of the International Space Station when it passes over their homes or their school. To find out when the ISS can next be seen over Sydney please visit: **http://spaceflight.nasa.gov/realdata/sightings/SSapplications/Post/SightingData/Sydney.html**

7. Have students choose an environmental condition to research using images taken from the ISS. Topics could include evidence of deforestation, global warming, ozone depletion, water pollution/ oil spills, or weather phenomena such as hurricanes. Check the EarthKAM website at **http://earthkam.ucsd.edu**



We recommend that you combine the *Design a space station discovery challenge* with a screening of *SPACE STATION 3D* at the IMAX Theatre in Darling Harbour.

From the makers of *The dream is alive*, *Blue planet*, *Destiny in space* and *Mission to MIR* comes another strikingly beautiful and technically challenging film epic: the first-ever IMAX 3D film from space, *SPACE STATION 3D*. It is the story of the greatest engineering feat since landing a human on the Moon: the on-orbit assembly of the International Space Station, as it travels 354 kms above Earth at 28 000 km/h.

For more information about the film, contact the IMAX Theatre on (02) 9213 1600.

Save $1 per student at each venue by combining your Powerhouse Museum and IMAX Theatre visits.

→ Assessment tool

A Likert scale can be used by the teacher as an evaluation of the *Discovery challenges* program or by students as a self-assessment tool. Teams can use this to evaluate themselves or other teams. Below are some suggestions for creating your own Likert scale.

A sample Likert scale might look like this:

Name: Date:

Challenge name:

Who is assessing? (circle one) Student Team Teacher

1. Criterion: Quality and accuracy of information gathered at PHM

Quickly put together | Shows some thought | Accurate & detailed

2. Criterion: Completed challenge project

Incomplete | Meets criteria | Exceeds criteria

3. Criterion: Creativity

Lacks originality | Shows some thinking | Museum-worthy

Comments:

1. At the top of your scale include a place for name, date and challenge name.
2. Also include a 'Who is assessing?' line with choices to circle.
3. Establish criteria for assessment. The three criteria shown here are some examples. Objective statements may also be used for evaluation, such as, 'Students demonstrated the ability to…'
4. Decide on a scale. Scores are placed on the scale by marking an 'X' where the score falls. You can use a verbal scale like the ones shown left, or a variety of others. Some additional scales might be:

   1__2__3__4__5
   A__B__C__D__F
   Wow__Okay__Needs Work

5. Leave room for comments at the bottom of the page.

Grading Scale:

6. Include a scale if grades are used.

4.5 – 5 = A 3.8 – 4.4 = B 2.8 – 3.7 = C 2 – 2.7 = D below 2 = not yet

This is one scale that works with the 1————2————3————4————5 scale.

You would add the total points and divide by the number of criteria for final number grade.

→ Feedback form

Your feedback will help us modify and improve the *Discovery challenges* program. Please complete this evaluation with your students and return it to the address below or fax to (02) 9217 0441. When we receive your completed form we will send you a free family pass to the Museum.

School name:

Teacher in charge:

School phone:

School address:

Year level(s):

Total group size:

Day and date of visit:

Name of challenge:

Did you do the pre-visit activity?	Yes ☐	No ☐
Was the pre-visit activity useful?	Yes ☐	No ☐
Were the 'Where to go' directions helpful?	Yes ☐	No ☐
Was the 'All about' information helpful?	Yes ☐	No ☐
Were the 'To say or do' questions relevant?	Yes ☐	No ☐
Did your group do the post-visit activity?	Yes ☐	No ☐
Did the challenge trail assist in completing the post-visit activity?	Yes ☐	No ☐
Did you attempt an extension activity?	Yes ☐	No ☐
Would you like to do a challenge again in the future?	Yes ☐	No ☐

How did you incorporate the challenge into your curriculum?

Comments:

Thank you for taking the time to fill out this form!

Please return to: Powerhouse Discovery Challenge Program
Education & Visitor Services
Powerhouse Museum
PO Box K346
Haymarket NSW 1238

For other challenges visit:
http://www.phm.gov.au/education/challenges.html

For more information about *Powerhouse discovery challenges* or to make a booking, contact:
Education and Visitor Services, Powerhouse Museum
Telephone: (02) 9217 0222
Fax: (02) 9217 0441
Email: edserv@phm.gov.au
Post : PO Box K346, Haymarket, NSW 1238

500 Harris Street Ultimo
PO Box K346 Haymarket 1238
www.phm.gov.au