re(Solve) MATHS BY INQUIRY

# Mission Control to ISS

Y6

## Summary of learning goals

- Students manage scheduling problems and problems involving elapsed time. They construct a 24-hour program and a time line, when given a number of tasks and constraints.

### Australian Curriculum: Mathematics (Year 6)

**ACMMG139:** Interpret and use timetables.

## Summary of lessons

### Who is this sequence for?

- This is a sequence of lessons that require students to use logical thought to solve problems involving time lines and timetables. They need an appreciation of the relationship between hours and minutes. They also need to know how to record using 24-hour time. Both tasks require a high level of literacy skills.

### Lesson 1: An Astronaut's Day

Students construct a daily schedule for three astronauts on the International Space Station (ISS) when given a series of activities and duties they must undertake.

### Lesson 2: Monday Morning at Mission Control

Students are presented with a scenario and must carefully and logically order events and add and subtract times, with the use of a time line.

**reSolve: Mathematics by Inquiry** is funded by the Australian Government and is managed by the Australian Academy of Science.

# Reflection on this sequence

## Rationale

Time is a complex and complicated concept. The teaching of time should include a broad range of experiences to help students develop their understanding of time. Many classrooms focus instruction on reading clocks. Although telling time is a very important skill to be developed, it does not deal with time as a concept. For students to understand time effectively, they must appreciate four components: succession, duration, awareness of the language and patterns of time, and that time is a form of measurement (Thomas, Clarke, McDonough & Clarkson, 2017; see: https://www.researchgate.net/publication/318461259_Framing_Assessing_and_Developing_Children's_Understanding_of_Time).

### reSolve mathematics is purposeful

- This sequence draws on the four important components of time as students solve timetable and time line problems.

### reSolve tasks are inclusive and challenging

- Although the context for the lessons is fictitious, it is easily imaginable for students. It draws on real events and tasks that need to be performed on the ISS and by Mission Control.
- Students are challenged to construct time lines and timetables when given a number of tasks and constraints. Ideas to make the problems more concrete are provided.

### reSolve classrooms have a knowledge-building culture

- Students are encouraged to collaborate to construct solutions. Through their conversations and problem-solving, students' develop their understanding of the concepts of succession, duration, and their skills in measuring and recording time.
- Different solutions are compared so similarities and differences can be identified.

LESSON 1

# reSolve MATHS BY INQUIRY Mission Control to ISS

## An Astronaut's Day

Y6

## About this lesson

Students construct a daily schedule for three astronauts on the International Space Station (ISS) when given a list of activities and duties the astronauts must undertake.

## Australian Curriculum: Mathematics (Year 6)

**ACMMG139:** Interpret and use timetables.

## Mathematical purpose

- Students manage scheduling problems and construct a 24-hour program when given a number of tasks and constraints.

## Learning intention

- What does an astronaut's day look like?

### Time

A lesson of approximately 1 hour.

### Vocabulary

- 24-hour time
- International Space Station
- time line
- timetable

### Resources

- reSolve PowerPoint *1a ISS Schedule* (for display)
- Student Sheet 1 – Astronauts' Schedule

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# ISS Time Schedule

Introduce the context of astronauts living on the International Space Station (ISS).

**Resources:** Show students reSolve PowerPoint *1a ISS Schedule*.

**Teacher notes:**

- The NASA website (https://www.nasa.gov/) provides a breadth of information on all aspects of the work of NASA, including the ISS. Students may be interested in exploring the following and similar pages within the site to gain further understanding of the daily life of astronauts on board the ISS:
  - A Day in the Life Aboard the International Space Station (https://www.nasa.gov/audience/foreducators/stem-on-station/dayinthelife)
  - Let Me Check My Schedule (https://www.nasa.gov/missions/shuttle/f_schedule.html)
  - NASAfacts: Living and Working in Space (https://www.nasa.gov/centers/johnson/pdf/167746main_FS_LivingandWorkinginSpace508c.pdf)
- Show slide 6 of the PowerPoint: 'It is Day 172 of the current Expedition, with three astronauts in space: Tom Newton (USA), Yuri Ivanov (Russia), and Kylie Papadopoulos (Australia), the commander of this expedition.'

**Pose the problem:** *Program a 24-hour schedule for the three astronauts as they prepare for a spacewalk on Day 175, manage a range of experiments, talk with students on Earth and do ongoing maintenance to keep the ISS in perfect working order ahead of the arrival of the new crew next week.*

**Resources:** Provide students with Student Sheet 1 – Astronauts' Schedule, which outlines duties and conditions for the schedule.

Have students solve the problem in small groups.

One possible approach to solving the problem is for students to create strips of coloured paper, where:

- Lengths of paper represent time; for example, $\frac{1}{2}$ hour = 5 cm.
- Colours represent the different activities; for example, yellow represents sleep, blue represents work time, and green represents meal times.

Students create strips of paper for the different activities listed. These strips can then be manipulated to form a time line that works for all the astronauts.

**Enabling prompt:**

- Do not use the duties and conditions listed on page 2 of the Austronauts' Schedule. Have students just plan for the general duties.

There are a range of possible solutions. See Teacher Sheet – Schedule for an example.

# Reflection

Have some students share their solutions. Look at the similarities and differences between the different solutions.

# Astronauts' Schedule

Name: _____

**Program a 24-hour schedule for the three astronauts Kylie, Tom and Yuri as they prepare for a spacewalk on Day 175, manage a range of experiments, talk with students on Earth and do ongoing maintenance to keep the ISS in perfect working order ahead of the arrival of the new crew next week.**

## Important things that need to be included

Listed below are some important things that need to be included in each astronaut's schedule for the day.

- The crew is generally scheduled for sleep from 21:30 hours to 06:00 hours.
- The astronauts have three meals a day. They need 1 hour for each meal. They enjoy eating together but, if time does not permit, it is not necessary that they do.
- Each astronaut must do at least 2.5 hours of physical exercise, using three machines: a cycle ergometer, a treadmill and a Resistance Exercise Device. This must include at least 1 hour of cardio (treadmill or cycle ergometer) and 1 hour of resistance exercise. There is only one piece of each equipment. The astronauts like to break up the exercise into two sessions: one in the morning and another in the afternoon. They may not exercise 20 minutes before or after eating.
- Each day has a morning Daily Planning Conference (mDPC) and an evening Daily Planning Conference (eDPC) with Mission Control. Each meeting lasts for at least 30 minutes and all the astronauts must be present at these meetings.
- The astronauts each get some free time after dinner.

Astronauts also need some short break times during the day for a snack or a brief rest.

## Kylie

- Kylie is scheduled to do a 20 minute in-flight education downlink with an Australian primary school from the Northern Territory at 10:00 hours. She would like to have at least 20 minutes for preparation prior to the interview.
- Kylie has been taking part in an experiment about her emotional health and life in space. She needs to write in a journal for 20 minutes every day.
- Kylie is working on an experiment that is investigating how immune cells adapt to space flight. She must put immune cells in a centrifuge and then 90 minutes later put them in the ISS's freezer for analysis back on Earth.
- Every astronaut must do a 90 minute (individual) emergency drill per week. Today it is Kylie's turn.
- Kylie must spend at least 1 hour performing maintenance and cleaning tasks. Additionally, she must spend 30 minutes in the Advanced Plant Habitat and the Vegetable Production System, nicknamed 'Veggie', which is growing fresh produce. The astronauts are monitoring the growth of a range of lettuce and mustard plants.

## Tom

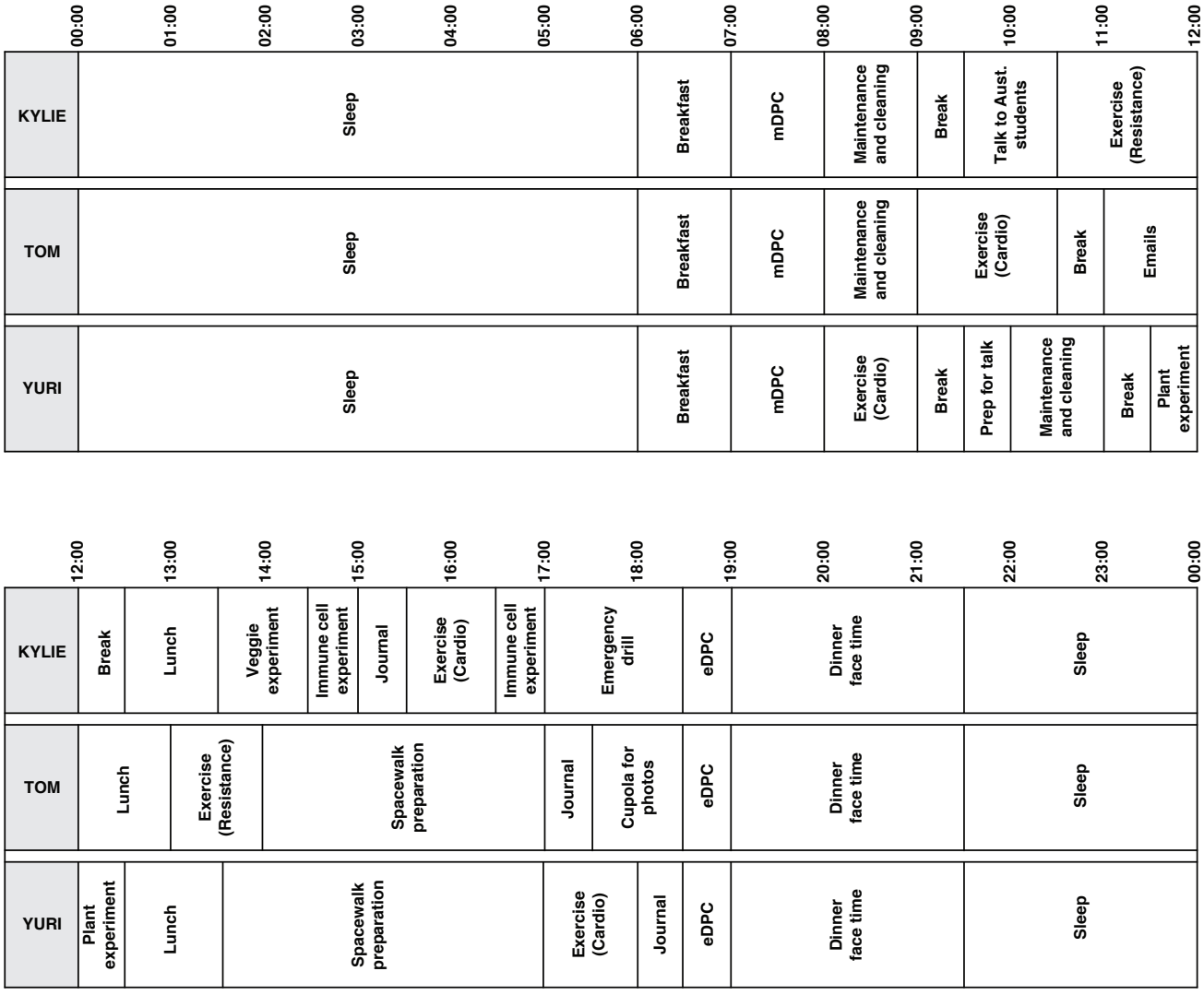
- Tom is also taking part in the experiment about his emotional health and life in space. He also needs to write in a journal for 20 minutes every day.
- Tom is beginning preparations for a spacewalk with Yuri in three days' time. He requires a 2–3 hour block of time for preparations.
- Tom needs about an hour to go up to the cupola to take some photographs of the active volcanoes in South-East Asia. These photographs will be loaded to the NASA website.
- In addition to 1 hour of general cleaning and maintenance, Tom manually updates his emails once a day. This takes him at least 1 hour.

## Yuri

- Yuri needs to work with Tom as they begin preparations for their spacewalk. He is responsible for the initial set-up and requires an additional 30 minutes of time before Tom joins him.
- Yuri is talking to a group of Russian university students tomorrow and he needs 20–30 minutes for preparation time.
- Yuri is conducting experiments on how a variety of plant seeds grow in micro-gravity. He is particularly interested in how vegetables grow in space. He requires 60 minutes to collect his data and another 30 minutes to update his daily blog on the experiment.

# Teacher Sheet – Schedule

This is one possible solution. There are many others.



LESSON 2

# reSolve MATHS BY INQUIRY Mission Control to ISS

## Monday Morning at Mission Control

Y6

## About this lesson

Students are presented with a scenario and must carefully and logically order events and add and subtract times, with the use of a time line.

## Australian Curriculum: Mathematics (Year 6)

**ACMMG139:** Interpret and use timetables.

## Mathematical purpose

- Students will manage problems involving elapsed time and construct a timetable, when given several constraints.

## Learning intention

- To sequence events based on a description of the day.

### Time

A lesson of approximately 1 hour.

### Vocabulary

- Mission Control
- time line
- timetable

### Resources

- reSolve PowerPoint *2a Mission Control* (for display)
- Student Sheet 1 – The Interview
- sticky notes or small pieces of paper of different colours
- masking tape

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## Mission Control

Introduce the context of NASA's Mission Control Centre.

**Resources:** Show students reSolve PowerPoint *2a Mission Control.*

Present the following scenario.

> *It is Monday midday, Day 173 of the current ISS Expedition 58. The Flight Director has just taken a break and gone up to the Viewing Gallery to meet with a visiting Australian film crew, who are preparing a documentary on the Mission Control Centre and its role with the International Space Station. This is the start of their interview…*

**Resources:** Provide students with Student Sheet 1 – The Interview.

To answer the five questions, students will need to construct a time line of events. Do not tell them that this is needed, rather let them see the need for a time line themselves.

*A possible approach to constructing the time line:* Provide small groups of students with a collection of different coloured sticky notes or small pieces of paper. Each event can be recorded on the sticky note/paper. A strip of masking tape on the floor or desk can be used as a time line. Students can decide on a scale for their time line and then manipulate the events as needed.

**Enabling prompt:**

- Start by constructing a time line of events. If Taj and the interns left at 09:15 hours, when did the other events occur?

See Teacher Sheet – Time line for a completed time line and answers to the five questions.

## Reflection

Have some students share their solutions. Look at the similarities and differences between the different solutions.

# The interview

Name: _____

**FC: How did your morning start today?**

**Thelma:** Things began well this morning. The morning shift of flight controllers arrived from 08:00 hours to do the handover from the overnight shift. Each shift lasts nine hours and there are three shifts a day. It's a lot of shifts, as we function 24 hours a day, 365 days a year.

Today, the handover was completed and the overnight shift were out the door, with 10 minutes to spare before the morning duties officially began with the shift check-in. This took only 10 minutes today. The 23 flight controllers who were rostered on today were all present, as well as a small group of interns who are training alongside them.

**FC: What are the interns doing at Mission Control?**

**Thelma:** The interns are shadowing the flight controllers to learn more about the specific jobs that they do. Currently, Taj is working with four of the six interns on some specialised training in preparation for the final spacewalk, which will happen before the crew leaves the ISS. Their training today took an hour and a half. They started just a few minutes after the shift check-in finished.

**FC: Do you get visitors to Mission Control?**

**Thelma:** At the moment we have eight Years 9 and 10 STEM students from Australia visiting. Two of the flight controllers, Tim and Kayla, left to take the students back to the viewing platform just as Taj and the interns returned from their training. It took 2 minutes for all the students to get through security and arrive on the floor of Mission Control. They had a special 30 minute session with the controllers as part of their participation in a 2-week NASA space camp. When the presentation was finished, it took Tim and Kayla another 2 minutes to escort them back up to the viewing platform.

**FC: Why is there a doctor on the Mission Control team?**

**Thelma:** The doctor, John, looks after the health of the astronauts. He is currently researching space headaches — this is an ongoing experiment that is looking at how high levels of carbon dioxide on the ISS may be triggering 'space headaches' in some crew members. Four minutes after Taj left with the interns, John left the room to speak with the astronauts on the ISS. He said he would need only 10 minutes but it took twice as long as expected. John logged out of the conversation and returned only a few minutes before the whole ISS crew and MCC team had a scheduled meeting about an interesting science experiment being conducted on plant growth in space.

**FC: Do the astronauts go for many spacewalks?**

**Thelma:** They do — in fact, there was a spacewalk today! Three of the flight controllers, Khalid, Zedan and Lily, left the meeting on plant growth to provide urgent assistance to the Expedition Commander, who was working outside on the space station. From an adjoining studio, Khalid, Zedan and Lily gave him instructions on how to move a robotic arm. This began halfway between the start of the meeting on plant growth and the time when Tim and Kayla left to get the Australian STEM students. The procedure took only 4 minutes and, when I glanced at the clock, I noticed that it showed 3 minutes past 10.

**FC: It sounds extraordinarily busy in Mission Control?**

**Thelma:** It certainly is! Despite the interruptions we were all able to continue with our scheduled meetings. I was fortunate this morning that I was able to take a few minutes to go up to the viewing platform to talk to the Australian students, too. Would you believe that all of the MCC team were back in the room and at their consoles for only 13 minutes before the scheduled 20 minute emergency drill began at 11:00 hours? And that was only the first part of the shift today!

**The film crew asked Thelma five more questions, which are given below.**
**What is the answer to each of these questions?**

1. For how many minutes were all the flight controllers and interns together this morning in the Mission Control Centre?

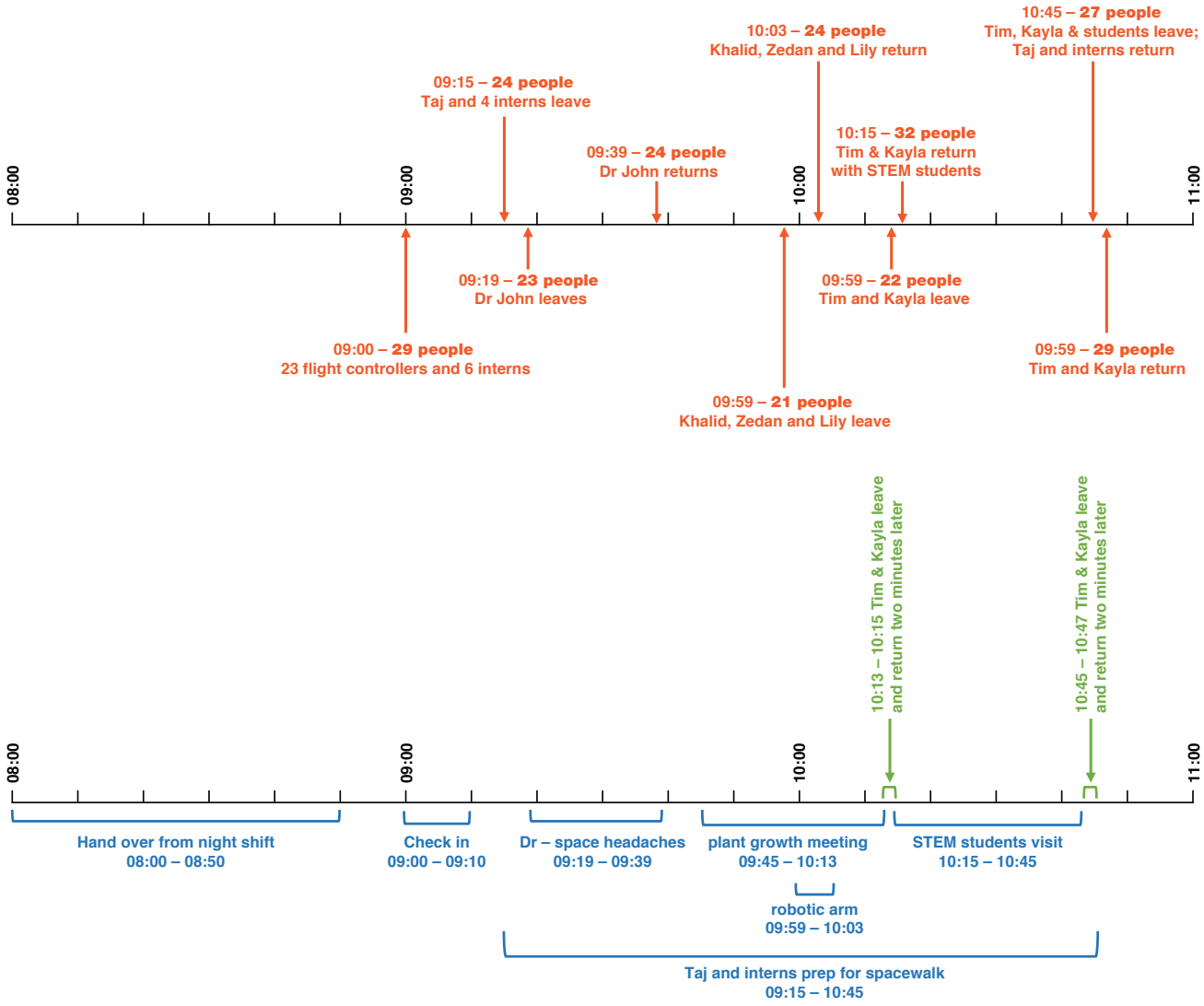
2. At what time did Taj and the interns get back from their training?

3. How long was spent on the meeting about growing plants in space?

4. During what times were there the least and the most people in the MCC this morning?

5. At what times of the day are there likely to be twice as many people as usual in the MCC? Why?

# Teacher Sheet – Time line




1. For how many minutes were all the flight controllers and interns together this morning in the Mission Control Centre?

   10 + 13 = 23 minutes

2. At what time did Taj and the interns get back from their training?

   10:45 hours

3. How long was spent on the meeting about growing plants in space?

   28 minutes

4. During what times were there the least and the most people in the MCC this morning?

   Least [22 people]: 9:59–10:03 am and 10:13–10:15 am.

   Most [32 people]: 10:15–10:45 am

5. At what times of the day are there likely to be twice as many people as usual in the MCC? Why?

   During the handovers between shifts: 8:00–9:00 am, 4:00–5:00 pm, midnight to 1:00 am.