Supervised written assessment: Destination Mars

This sample has been compiled by the QSA to help teachers plan and develop assessment instruments for individual school settings. It demonstrates the following dimensions:

- Knowledge and conceptual understanding
- Investigative processes
- Issues and impacts

**Assessment instrument**

Aspects of at least two of the dimensions (Knowledge and conceptual understanding, Investigative processes or Issues and impacts) should be evident in a supervised written assessment.

**Scientific priorities**
- Environment
- Catalyst for Discovery

**Focus areas**
- Living systems
- Earth and space
- Energy
- Information and communication

**Key concepts**
- LS1 — The cell as the basis for life
- LS3 — Ecosystems
- ES2 — Global cycles and the atmosphere
- **ES3 — Solar systems and the universe**
- EN1 — Forms of energy
- **EN2 — Forces and motion**
- IC1 — Storage, transfer and interpretation

**Time allowed**
2 hours

**Conditions**
- Unseen questions
- Supervised test conditions
- No perusal time
- Calculators allowed
- Appendix of formulas and constants provided

Coverage of the key concepts identified in the school’s work program for each unit of work should be evident in the assessment instrument. Additional key concepts not included in the work program should not form the basis of the instrument.

This technique is used to assess student responses that are produced independently, under supervision and in a set timeframe. There is no question of student authorship in this technique.
Question 1

**Comparison and explain** the physical and atmospheric features of Mars and Earth and explain how these features affect the suitability of each planet for life.

Question 2

a. **Define and describe** what is meant by each of Newton’s three laws of motion. **Provide an example of a real-life situation** to illustrate each of these laws.

b. Of these three laws, one forms the basis of rocket propulsion. **Use this law to explain how** a rocket can function in the vacuum of space where there is nothing to push against.

Question 3

Kepler’s **Harmonic Law** is often described using the equation:

\[ p^2 \propto a^3 \]

**Explain** what this means in terms of planetary motion. **What conditions are assumed** when applying this law?

Question 4

A model rocket with a mass of 60 g, powered by a soda siphon bulb of 40 g, is launched horizontally. Students observing the rocket calculate the average acceleration to be 1.9 m/s².

a. **What is the thrust force** exerted by the gases exiting the bulb?

b. After all the gas is expelled the bulb weighs 34 g. **What was the acceleration** of the gas as it was expelled from the bulb? **Show all working.**

c. **Explain why this is different** from the observed acceleration of the rocket.

A student hypothesises that if 100 bulbs were strapped to the rocket and triggered all at once the rocket would be capable of vertical launch. Assuming that each bulb delivers a thrust equal to that demonstrated in Question 4a, is the hypothesis correct? Explain your answer.

Question 5

a. A Hohmann transfer orbit is often used to plan space missions to other planets. **Using a diagram, explain** what a Hohmann transfer orbit is and **explain** the major advantages and disadvantages of using this method **compared to** a straight launch pattern into space.

b. Jupiter’s orbit is approximately 5.2 AU (astronomical units) out from the Sun. If we were to plan a mission to Jupiter using a Hohmann transfer orbit, **how long would it take** to reach Jupiter?
Question 6

Many designs for space stations and spacecraft feature rotating sections which simulate gravity. One of these designs is shown below.

![Diagram of a space station with rotating sections]

Each section of the space station rotates at a different rate to suit the needs of the different species that lives within.

The average radius of the inner surface of the station is 840 m. The table below shows the speed of rotation for each of the sections:

<table>
<thead>
<tr>
<th>Sector</th>
<th>Speed of rotation (rpm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red</td>
<td>1.03</td>
</tr>
<tr>
<td>Green</td>
<td>1.27</td>
</tr>
<tr>
<td>Brown</td>
<td>0.51</td>
</tr>
</tbody>
</table>

What interpretation can you make about the home planets for the species that live in each sector? Show any calculations you may have made to reach your conclusions.

Questions 1–6 (short response prose and calculations) generally require a response of 50–250 words.
### Extended response

**Question 7**
A number of robotic rovers have been sent to Mars to take pictures and collect data about the surface and atmosphere. Considering the distances and conditions between these two planets, explain how the rovers can be controlled from the Earth, and data can be sent back from Mars.

Although there is only one question addressing IC1, this question allows students to write an extended response to demonstrate the breadth of their knowledge and understanding of this key concept.

**Question 8**
Current data from Mars suggests it would not be suitable for human life. However, plans have been proposed to terraform the planet for eventual human habitation. Explain what this process would involve and what issues each step would address. Evaluate the impacts of space travel on the human body and of living on Mars for extended periods of time.

Evidence of LS1, LS3 and ES2 can be produced in response to this question.

You can use diagrams in your response if needed.

**Question 9**
Space travel is very expensive and often involves great risk. Identify and analyse the range of knowledge that has been developed as a result of investigations into space travel and colonisation that would justify the costs and risks. What knowledge has been gained and what is the significance of this knowledge in our everyday lives?
## Instrument-specific criteria and standards

<table>
<thead>
<tr>
<th>Standard A</th>
<th>Standard B</th>
<th>Standard C</th>
<th>Standard D</th>
<th>Standard E</th>
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<tbody>
<tr>
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<tr>
<td>· description and explanation of complex scientific information about forces, planetary motion, communication, body systems, ecosystems and the atmosphere</td>
<td>· description and explanation of scientific information about forces, planetary motion, communication, body systems, ecosystems and the atmosphere</td>
<td>· description of scientific information about forces, planetary motion, communication, body systems, ecosystems and the atmosphere</td>
<td>· statements of scientific information about forces, planetary motion, communication, body systems, ecosystems or the atmosphere</td>
<td>· statements of isolated scientific facts about forces, planetary motion, communication, body systems, ecosystems or the atmosphere</td>
</tr>
<tr>
<td>· comparison and explanation of complex interrelationships, between scientific ideas, concepts, theories, processes and phenomena</td>
<td>· comparison and explanation of interrelationships between scientific ideas, concepts, theories, processes and phenomena</td>
<td>· description of interrelationships between scientific ideas, concepts, theories, processes and phenomena</td>
<td>· statements of simple interrelationships between scientific ideas and concepts</td>
<td>· statements of simple scientific ideas</td>
</tr>
<tr>
<td>· interpretation and application of scientific knowledge and information to generate reasoned explanations regarding space travel.</td>
<td>· application of scientific knowledge and information to generate informed explanations regarding space travel.</td>
<td>· generation of scientific explanations of regarding space travel.</td>
<td>· identification of scientific information regarding space travel.</td>
<td>· superficial statements regarding space travel.</td>
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**Complexity** refers to having a number of elements or components in the relationship or interaction.

**Reasoned** explanations are logical, sound and justified. **Informed** explanations contain relevant knowledge and demonstrate the student is conversant with this topic.

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<td>- systematic analysis and interpretation of data and information using appropriate quantitative techniques to identify relationships</td>
<td>- analysis and interpretation of data and information using appropriate quantitative techniques to identify trends and anomalies</td>
<td>- analysis of data and information using appropriate quantitative techniques</td>
<td>- partial analysis of data and information</td>
<td>- rudimentary analysis of data or information</td>
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<tr>
<td>A systematic approach involves methodical, logical and organised analysis and interpretation of data using appropriate quantitative techniques.</td>
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<td>- discriminating selection and presentation of scientific data/ideas, using scientific convention and terminology, to clearly convey meaning to a variety of intended audiences using appropriate formats.</td>
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<td>- selection and presentation of scientific data/ideas to make meaning accessible in a variety of formats.</td>
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<td>- presentation of information:</td>
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<td>- identification and explanation of issues and evaluation of scientific impacts relevant to an inquiry</td>
<td>- identification and explanation of issues and scientific impacts relevant to an inquiry</td>
<td>- identification and description of issues and scientific impacts related to an inquiry</td>
<td>- identification of issues and scientific impacts related to an inquiry</td>
<td>- statements about issues and scientific impacts</td>
</tr>
<tr>
<td>- analysis of a range of factors influencing the development of scientific knowledge.</td>
<td>- explanation of a range of factors influencing the development of scientific knowledge.</td>
<td>- description of factors influencing the development of scientific knowledge.</td>
<td>- identification of factors that directly led to developments of scientific knowledge.</td>
<td>- statements about developments in science.</td>
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Partial analysis represents an incomplete attempt with evidence provided, whereas rudimentary analysis is simple or basic — evidence is not required.

This Investigative processes general objective is demonstrated across the student response and does not refer to any one question.