



ACTIVITY MODULE

Name

Group

Editors:

Khalif Amir Zakry
Adrus Mohamad Tazuddin
Abg Ashmirul Abg Abu Nawas



UNIMAS Scienceploration 2026

EDITORS

Khalif Amir Zakry, Adrus Mohamad Tazuddin, Abg Ashmirul Abg Abu Nawas

Centre for Pre-University Studies,
Universiti Malaysia Sarawak
94300, Kota Samarahan, Sarawak
Malaysia

First Printing 2026

@ Khalif Amir Zakry, Adrus Mohamad Tazuddin, Abg Ashmirul Abg Abu Nawas, Mohd Syamim Safian, Rohaiza Daud, Mohamad Razif Othman, Mohamad Fhaizal Mohamad Bukhori, Mohd Ridwan Abd Rahman @ Tahir, Roberta Chaya Tawie Tingga, Norfarahin Norwen, Muhamad Ikhwan Idris, Mohd Aminudin Mustapha, Idza Riati Ibrahim, Faznny Mohd Fudzi, Nor Amalina Ahmad, Mohamad Amin Jumat, Noor Azie Azura Mohd Arif, Azizi Hussain, Nur Asriza Azmi, Wan Roslina Wan Yusof, Farah Afiqah Abdullah, Dhana Jay Raja Gopal, Iswan Nur Ariff Ismail, Sharifah Mona Abd Aziz Abdullah, Eswaran Madiahlagan, Melody Kimi, Mohd Alhafiizh Zailani, Noorazman Samsudin, Farah Hanim Jamali, Khairil Rizadh Razali, Ayu Ameliatul Shahilah Ahmad Jamri, Siti Aishah Azhar, Ahmad Deedat Ibrahim, Abang Mohammad Hudzaifah Abang Shakawi, Farah Liyana Azizan, Nurul Syuhada Ismail, Chew Khui Tat, Ibrahim Bohari, Fatin Hanani Kamaluddin, Nor Ika Shahirah Ramli, Michelle George, Tarmizi Mohammad Shukri, Abd Razak Hosen, Nursiah Haji Sabdin, Sylvester Guyang

UNIMAS Scienceploration 2026 logo and covers designed by Tarmizi Mohammad Shukri

Copyright © 2026 by Centre for Pre-University Studies

All rights reserved. This book or any portion thereof may not be reproduced or used in any manner whatsoever without the express written permission of the publisher.

Published in Malaysia by
Centre for Pre-University Studies,
Universiti Malaysia Sarawak
94300, Kota Samarahan, Sarawak

eISBN 978-629-97069-5-3

Contents

Contents	i
Acknowledgement	ii
Synopsis	iii
Note for Participants	iv
Activity 1: TerraScope-E1 - Decoding Earth's Living Systems	1
Activity 2: Mighty Little Push - Build Your Own Hydraulic Crane	8
Activity 3: Hydrogen-Fueled Mini Rocket	15
Activity 4: Is the Sun at the Centre? Let's Build the Orbit	21
Activity 5: Cosmic Odyssey - AeroLogic Expedition	27

Acknowledgement

The Scienceploration Camp 2026 organising committee would like to acknowledge and express our sincere appreciation to our sponsors who have made contributions towards the organisation of the camp.

- Jabatan Agama Islam Sarawak
- Musyati Sdn Bhd
- Scilla Sdn Bhd
- Modern Scientific Sdn Bhd
- Universal Reform Sdn Bhd
- IEM Safe

Synopsis

The Scienceploration Camp 2026 is an initiative organised by the Centre for Pre-University Studies, UNIMAS (PPPU), designed to foster interest in science, technology, engineering, and mathematics (STEM) among secondary school students.

The camp offers a structured programme incorporating inquiry-based learning, hands-on experiments, project-based assignments, and interactive activities in an immersive environment that promotes discovery, creativity, and the development of essential 21st-century skills.

This programme also demonstrates PPPU's commitment to supporting the Sustainable Development Goals (SDGs) by promoting quality education and lifelong learning opportunities for all. Furthermore, the camp aims to advance the Sarawak Post-COVID-19 Development Strategy (PCDS) 2030 by contributing to increased student enrolment in science, technology, engineering, and mathematics (STEM) fields.

Students are invited to participate in engaging hands-on activities specifically crafted to spark curiosity and interest, with curated step-by-step methods and objectives designed to lead students to ask questions, explore, and think critically about the world and environment around them. By navigating and undertaking the journey through the activities outlined within this book, participants will not only deepen their understanding of STEM disciplines but also cultivate the skills, perspectives, and experiences for becoming impactful future contributors to society and their communities.

Note for Participants

The activities outlined for this Camp will be carried out with close supervision from the experts within the allocated venues. Engage your interests, ask questions, and relate what you have learned to your experiences.

Let's together make learning fun and rewarding!

UNIMAS
Scienceploration Camp 2026

Activity 1: TerraScope-E1 - Decoding Earth's Living Systems

OBJECTIVES:

1. To identify different types of landscapes from Earth observation images, including forest, agricultural areas, settlements, water bodies, and deforested areas.
2. To explain how land-use changes, such as deforestation, urban development, and agricultural expansion, affect ecosystems and biodiversity.
3. To propose simple, practical actions to protect Earth's living systems and promote environmental sustainability.

INTRODUCTION:

Ecosystems are living systems composed of plants, animals, microorganisms, and their physical environment. Changes in land-use, such as deforestation, agricultural expansion, settlement development, and disturbance to water bodies, can affect habitat quality, biodiversity, and ecosystem balance. These environmental changes can be observed and monitored using Earth observation images.

In this activity, students take on the role of Associate Ecosystem Analysts at the TerraScope-E1 Ground Mission Control Station. After watching the TerraScope-E1 mission briefing, students analyze Earth observation images captured by satellite sensors from Mission Zones A–E. They identify different landscape types, detect potential environmental issues, and propose practical actions to protect Earth's living systems.

Through this investigation, students apply Biology concepts, including ecosystems, biodiversity, habitat fragmentation, and environmental sustainability, while exploring the role of Earth observation technology in environmental monitoring and conservation.

APPARATUS:

- Laptop
- Projector
- Speaker
- Smartphone or tablet for QR code scanning
- Pens or pencils

MATERIALS:

- TerraScope-E1 mission briefing video
- Mission Access Pass
- Sealed Mission Data Packet
- Earth observation images of Mission Zones A-E
- Landscape Classification Guide
- TerraScope-E1 Mission Logbook / activity handout
- Transparent coloured acrylic discs
- Official TerraScope-E1 Mission Badge

METHOD:

1. Students enter the TerraScope-E1 Ground Mission Control Station and receive their Mission Access Pass.
2. Facilitators introduce the mission and explain the students' role as Associate Ecosystem Analysts.
3. Students watch a short TerraScope-E1 mission briefing video featuring Earth as viewed from space and an environmental alert from the TerraScope-E1 Mission Crew.
4. Students are divided into four teams: Orion, Vega, Sirius, and Nova. Each team receives a sealed Mission Data Packet containing Earth observation images for Mission Zones A–E, a Landscape Classification Guide, and transparent coloured acrylic discs.
5. Students carefully examine the Earth observation images and identify different land-use types, including forest, agricultural or plantation areas, settlements, water bodies, and deforested or disturbed areas.
6. Students use the transparent colour-coded acrylic discs to mark the identified land-use types on the images.
7. Students complete the Results section of the Mission Logbook by ticking the appropriate land-use types, environmental issues, and suggested actions for each mission zone.
8. Each team discusses how the observed land-use changes may affect ecosystems, biodiversity, habitats, plants, animals, and human communities.
9. Students complete the Mission Decision section by selecting the mission zone that requires the most urgent intervention and choosing the most appropriate conservation action.
10. Students answer the quiz questions and complete the mission reflection in the Discussion section.
11. Upon successful completion of the mission, students receive the Official TerraScope-E1 Mission Badge, and the Mission Accomplished section is verified by Mission Control.

RESULTS:**A. Identify the Land-Use Types**

Tick (✓) the land-use type(s) identified in each mission zone. You may tick more than one option.

Mission Zone	Water Body	Forest	Settlement	Agriculture / Plantation	Deforested / Disturbed Area
Zone A	☐	☐	☐	☐	☐
Zone B	☐	☐	☐	☐	☐
Zone C	☐	☐	☐	☐	☐
Zone D	☐	☐	☐	☐	☐
Zone E	☐	☐	☐	☐	☐

B. Identify the Environmental Issues

Tick (✓) the possible environmental issue(s) observed in each mission zone. You may tick more than one option.

Mission Zone	Deforestation	Habitat Fragmentation	Settlement Expansion	Loss of Vegetation Cover	Water Disturbance
Zone A	☐	☐	☐	☐	☐
Zone B	☐	☐	☐	☐	☐
Zone C	☐	☐	☐	☐	☐
Zone D	☐	☐	☐	☐	☐
Zone E	☐	☐	☐	☐	☐

C. Select the Suggested Actions

Tick (✓) one or more recommended actions to address the environmental issues identified in each mission zone.

Mission Zone	Reforestation	Protect Forest Corridors	Sustainable Land-use Planning	Increase Green Spaces	Protect Rivers / Water Bodies
Zone A	☐	☐	☐	☐	☐
Zone B	☐	☐	☐	☐	☐
Zone C	☐	☐	☐	☐	☐
Zone D	☐	☐	☐	☐	☐
Zone E	☐	☐	☐	☐	☐

MISSION DECISION:

1. Based on your analysis, which mission zone requires the most urgent action?

- ☐ Zone A
- ☐ Zone B
- ☐ Zone C
- ☐ Zone D
- ☐ Zone E

2. Why did you choose this mission zone?

3. What is the most appropriate action for this mission zone?

- ☐ Reforestation
- ☐ Protect forest corridors
- ☐ Sustainable land-use planning
- ☐ Increase green spaces
- ☐ Protect rivers / water bodies

4. Based on your analysis, which mission zone requires the most urgent action?

- ☐ Zone A
- ☐ Zone B
- ☐ Zone C
- ☐ Zone D
- ☐ Zone E

5. Why did you choose this mission zone?

6. What is the most appropriate action for this mission zone?

- ☐ Reforestation
- ☐ Protect forest corridors
- ☐ Sustainable land-use planning
- ☐ Increase green spaces
- ☐ Protect rivers / water bodies

DISCUSSION:

A. Quick Quizzes

1. Why do scientists use satellite images to study ecosystems?
 - A. To observe landscape changes over a large area.
 - B. To replace all field observations.
 - C. To make images look colourful only.

2. Which landscape type is most likely to support high biodiversity?
 - A. Forest
 - B. Settlement
 - C. Bare land

B. Mission Reflection

1. One environmental issue that I observed from the images is:

2. One action humans can take to protect Earth's living systems is:

MISSION TAKE-HOME MESSAGE:

- Earth is a living system.
- Every landscape tells a story.
- When we observe carefully, we understand better.
- When we understand better, we can protect more wisely.

MISSION ACCOMPLISHED:

I have successfully completed the TerraScope-E1 mission and contributed as an Associate Ecosystem Analyst in decoding Earth's living systems.

Name: _____

Team: _____

Date: _____

Mission Status: ☐ Completed

Badge Status: ☐ TerraScope-E1 Mission Badge Awarded

Verified by: _____

Mission Control Officer

AUTHORS:

Rohaiza Daud, Mohamad Razif Othman, Mohamad Fhaizal Mohamad Bukhori, Mohd Ridwan Abd Rahman @ Tahir, Mohd Aminudin Mustapha, Muhamad Ikhwan Idris, Roberta Chaya Tawie Tingga, Norfarahin Norwen

REFERENCES:

1. Chuvieco, E. (2008). Earth observation of global change: The role of satellite remote sensing in monitoring the global environment. Springer.
2. Chuvieco, E. (2020). Fundamentals of satellite remote sensing: An environmental approach. CRC press.
3. Wu, J., & Hobbs, R. J. (Eds.). (2007). Key topics in landscape ecology. Cambridge University Press.
4. Saldias, D. S. M., Reinke, K., McLennan, B., & Wallace, L. (2021). The influence of satellite imagery on landscape perception. Landscape Research, 46(6), 749-765.

NOTES

Activity 2: Mighty Little Push - Build Your Own Hydraulic Crane

OBJECTIVES:

1. To explain the basic working principle of a hydraulic system.
2. To apply Pascal's Principle to operate and control a hydraulic crane.
3. To analyze the performance of the hydraulic crane for various loads based on systematic observations.

INTRODUCTION:

Have you ever seen a mechanic lift a car using a hydraulic jack? Have you watched an excavator move soil at a construction site? Or have you wondered how an aircraft lowers its wheels before landing?

All these systems use hydraulics.

Hydraulics is a technology that uses liquid in a closed system to transfer force and produce movement. In real life, hydraulic systems are used in many machines that need to lift, push, pull, press, or move heavy loads smoothly and powerfully. Examples include hydraulic cranes, car jacks, excavators, hydraulic lifts, forklifts, vehicle braking systems, and aircraft landing gear.

Hydraulics is also very important in aerospace technology. In aircraft, hydraulic systems are used to operate important parts such as flight control surfaces, landing gear, braking systems, cargo doors, wing flaps, and slats. These systems must work accurately and reliably, especially during take-off, landing, and braking.

The working principle behind hydraulics is Pascal's Principle. Pascal's Principle states that:

Pressure applied to an enclosed fluid is transmitted equally in all directions throughout the fluid.

The relationship between pressure, force, and area is given by:

$$P = \frac{F}{A}$$

where:

P : Pressure

F : Force applied

A : Area of the piston

As shown in **Figure 1**, pressure is transmitted equally throughout the enclosed fluid, so $P_1 = P_2$. When the output piston (slave piston) has a larger area than the input piston (master piston), a larger output force can be produced. This is why hydraulic systems can help lift heavy objects, such as cars, cranes, and aircraft components.

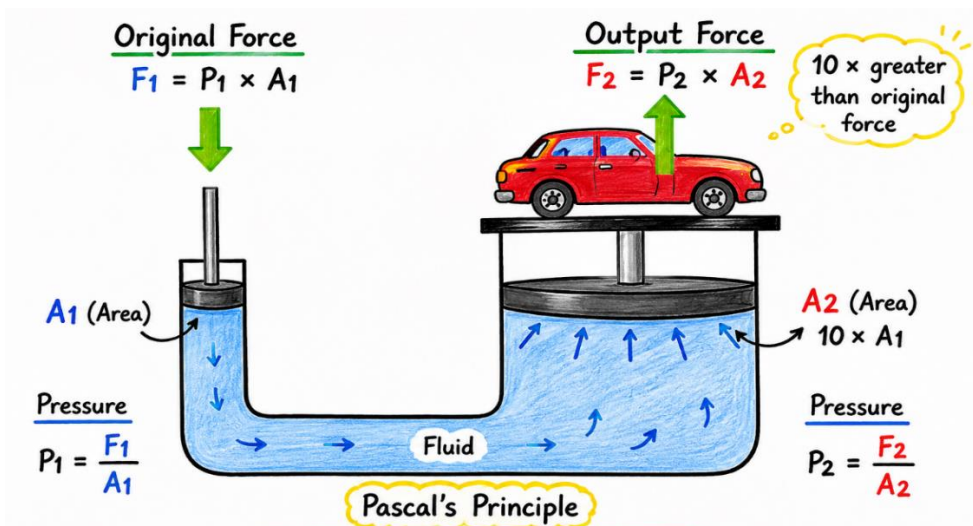


Figure 1

In this activity, students will assemble and test a simple hydraulic crane using syringes, plastic tubes, water, and pre-cut cardboard pieces. The control syringe acts as the master piston, while the syringe under the crane arm acts as the slave piston or output syringe. When the control syringe is pressed, water transfers pressure through the tube to the output syringe, causing the crane arm to move upward.

Through this activity, students will explore how a small push can create useful movement and understand how the same physics principle is applied in real hydraulic machines.

APPARATUS:

- Scissor
- Cutter
- Syringe
- Hot Glue Gun
- Ruler
- Small container

MATERIALS:

- Pre-cut cardboard
- Base board
- Water
- Food colouring
- Wooden skewers
- String
- Plastic tubing
- Loads

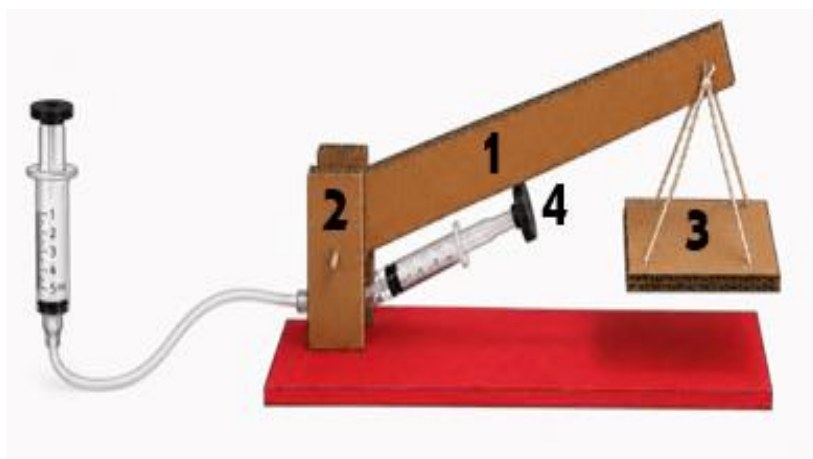
METHOD:**Safety Precautions**

1. Be careful when using scissors, wooden skewers, and a hot glue gun.
2. Do not point syringes or tubes at the face.
3. Wipe any spilled water immediately to avoid slipping.
4. Handle the crane gently to avoid breaking the joints or supports.

Construction Steps for Hydraulic Crane

1. Refer to **Figure 2** and the following parts table while making sure that all the required cardboard pieces are available in the correct quantity:

Part	Size	Quantity	Function
Cardboard 1	30 cm × 3.5 cm	2 pieces	Crane arm
Cardboard 2	3.5 cm × 9 cm	4 pieces	Vertical support
Cardboard 3	8 cm × 10 cm	1 piece	Load platform
Cardboard 4	3 cm × 1 cm, folded	1 piece	Syringe support / stopper

**Figure 2**

2. Glue the two crane arm pieces together to form a stronger crane arm. Ensure that both pieces are properly aligned.
3. Glue the two vertical support pieces together to form one thick support. Repeat this step with the remaining two pieces to obtain two thick vertical supports.
4. Make a small hole through both vertical supports and the crane arm.
5. Position the crane arm between the two vertical supports and insert a wooden skewer through the holes. Do not glue the crane arm, as it must be able to rotate freely.
6. Glue the two vertical supports upright near one end of the base board.
7. Use Cardboard 3 as the load platform.
8. Make small holes at the corners or sides of the platform.
9. Make a small hole at the front end of the crane arm and insert a wooden skewer.

10. Tie the strings from the load platform to the wooden skewer and secure them with glue if necessary. Ensure that the platform hangs evenly.
11. Fold Cardboard 4 and glue it beneath the crane arm to act as a support for the output syringe.
12. Place one syringe under the crane arm and glue it securely to the base board. This syringe acts as the output syringe (slave piston) that pushes the crane arm upward when the control syringe (master piston) is pressed.
13. Fill the control syringe with water. Remove air bubbles as much as possible.
14. Connect the two syringes using a plastic tube. Make sure the plastic tube connects both syringes properly. The tube should not be bent, blocked, or leaking.
15. Place the control syringe outside the cardboard structure. This syringe acts as the master piston and is used to push and pull the water to control the crane movement.
16. Slowly push the control syringe. Observe whether the syringe under the crane arm moves and lifts the crane arm.
17. Place a 20 g load on the load platform and press the control syringe slowly until the crane attempts to lift the load.
18. Observe the performance of the crane and then record your observations in the results table.
19. Repeat Steps 17 to 18 using loads of 40 g, 60 g, 80 g, and 100 g.

RESULTS:

Tick (✓) if the criterion was achieved and (X) if it was not achieved. (or "Mark ✓ if the criterion was met and X if it was not.")

No	Observation Criteria	Mass (g)				
		20	40	60	80	100
1	No water leakage was observed.					
2	The base remained firmly in position.					
3	The crane remained stable while lifting the load.					
4	The crane successfully lifted the load.					
5	The load remained balanced during lifting.					

1. Based on your observation above, what improvement(s) can be made to the crane?

DISCUSSION:

1. What physics principle is primarily applied in a hydraulic crane?
 - A. Newton's First Law
 - B. Pascal's Principle
 - C. Bernoulli's Principle
 - D. Archimedes' Principle
2. What is the function of the control syringe, also known as the master piston?
 - A. To hold the load platform.
 - B. To support the crane arm.
 - C. To act as the base of the crane.
 - D. To push and pull water to control the movement of the crane.
3. Why must air bubbles be removed from the tube?
 - A. Air bubbles make the water heavier.
 - B. Air bubbles make the syringe move faster.
 - C. Air bubbles increase the strength of the crane.
 - D. Air bubbles can be compressed and reduce the efficiency of the system.
4. Why might a heavier load be lifted to a lower height?
 - A. A heavier load needs less force.
 - B. A heavier load requires more force to lift.
 - C. A heavier load makes the syringe smaller.
 - D. A heavier load removes water from the tube.
5. Which action would **NOT** improve the performance of a hydraulic crane?
 - A. Making the crane arm heavier.
 - B. Balancing the load properly.
 - C. Reducing friction at the pivot.
 - D. Making the crane arm lighter but stronger.

AUTHORS:

Idza Riati Ibrahim, Faznny Mohd Fudzi, Nor Amalina Ahmad, Mohamad Amin Jumat, Noor Azie Azura Mohd Arif, Azizi Hussain, Nur Asriza Azmi

REFERENCES:

1. Wang, Y., Shen, T., Tan, C., Fu, J., & Guo, S. (2021). Research status, critical technologies, and development trends of hydraulic pressure pulsation attenuator. *Chinese Journal of Mechanical Engineering*, 34(1), 14.
2. Freedman, R. A., & Freedman, R. A. (2014). *University Physics with Modern Physics*. Pearson.

NOTES

Activity 3: Hydrogen-Fueled Mini Rocket

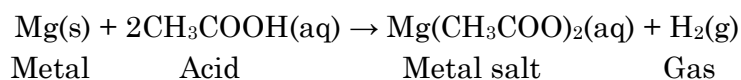
OBJECTIVES:

1. To produce hydrogen gas by reacting a metal with vinegar.
2. To collect the hydrogen gas using the water displacement method.
3. To demonstrate the conversion of chemical energy into kinetic energy through the launch of a mini rocket.

INTRODUCTION:

The Hydrogen-Fueled Mini Rocket demonstrates the application of a simple chemical reaction to produce hydrogen gas, which serves as the fuel for launching a mini rocket. This activity provides an opportunity to explore the relationship between chemical reactions, energy transformation, and motion through a hands-on investigation.

This investigation begins with the production of hydrogen gas (H_2) through the chemical reaction between a reactive metal strip (magnesium, Mg) and vinegar, which is a dilute solution of acetic acid (CH_3COOH). In the Reactivity Series, magnesium is more reactive than hydrogen. During the reaction, magnesium atoms readily lose electrons and are oxidised to magnesium ions (Mg^{2+}), while hydrogen ions (H^+) from the acid gain electrons and are reduced to form hydrogen gas (H_2) as shown in the chemical equation below:

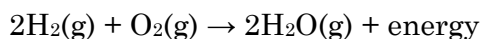


A plastic dropper, which serves as the mini rocket model, is then filled with the hydrogen gas. The hydrogen gas is collected using the water displacement method as shown in **Figure 3**. Once sufficient hydrogen gas has been collected, the mini rocket is ready to be launched using a piezo spark igniter.



Figure 3

Upon ignition, the hydrogen gas undergoes rapid combustion with oxygen from air, as represented by the chemical equation below:



This rapid combustion releases energy, creating pressure that propels the mini rocket. The distance travelled by the mini rocket increases with the amount of hydrogen gas until an optimum hydrogen and air mixture is reached. Beyond this point, adding more hydrogen may reduce the distance achieved because there is insufficient oxygen for complete combustion.

Through this exciting launch, the transformation of chemical energy into kinetic energy can be observed while exploring the scientific principles underlying rocket launching.

APPARATUS:

- Boiling tubes and rack
- Rubber stopper with delivery tube
- Plastic dropper
- Piezo spark igniter
- Bunsen burner
- Measuring tape

MATERIALS:

- Magnesium strip
- Vinegar
- Wooden splinter
- Distilled water

METHOD:**Production of Hydrogen Gas**

1. Transfer 15.00 mL of vinegar into a boiling tube.
2. Place a magnesium metal strip into the vinegar.
3. Immediately seal the boiling tube with a rubber stopper fitted with a delivery tube.
4. Test the gas produced using a burning wooden splinter.

Collection of Hydrogen Gas using Water Displacement Method

1. Fill the mini rocket model completely with distilled water.
2. Invert the water-filled mini rocket over the end of the delivery tube to collect the hydrogen gas produced. *Allow the gas to displace water until the water level reaches the white level line.*
3. Once the water level reaches the white line, carefully remove the mini rocket from the delivery tube and immediately cover its opening with a finger to prevent the hydrogen gas from escaping and the remaining water from spilling.

Launching the Hydrogen-Fueled Mini Rocket

1. Carefully insert the tip of the piezo spark igniter into the opening of the mini rocket.
2. Press the ignition button to generate a spark that ignites the hydrogen gas, causing the mini rocket to launch.
3. Observe and record the distance travelled by the mini rocket in the results table.
4. Repeat the **collection of hydrogen gas** from steps 1 to 3 until the water level reaches the yellow line and launch the mini rocket.

RESULTS:

Level of hydrogen gas in mini rocket (indicated by the coloured line)	Distance travelled by the mini rocket (cm)
White	
Yellow	

DISCUSSION:

1. What did you observe when magnesium was added to vinegar?
 - A. No visible change occurred.
 - B. A white solid formed instantly in the solution.
 - C. Gas bubbles formed around the magnesium strip.
2. State another metal that can produce hydrogen gas when it reacts with vinegar.
 - A. Zinc
 - B. Copper
 - C. Gold
3. How can you verify that hydrogen gas is produced in this chemical reaction?
 - A. Use a glowing wooden splinter.
 - B. Use a burning wooden splinter.
 - C. Use litmus paper.
4. Why was the mini rocket filled with water before collecting the hydrogen gas?
 - A. To cool the hydrogen gas during the reaction.
 - B. To increase the pressure inside the mini rocket before ignition.
 - C. To collect hydrogen gas by water displacement and control the volume of gas collected.
5. Will there be any combustion if the mini rocket only contains hydrogen gas?
 - A. No
 - B. Yes
6. Based on your observations, what is the relationship between the amount of hydrogen gas in the mini rocket and the distance travelled by the rocket?
 - A. The rocket travels the greatest distance when there is more hydrogen than oxygen.
 - B. The rocket travels the greatest distance when there is less hydrogen than oxygen.
 - C. The rocket travels the greatest distance when there is a suitable mixture of hydrogen and oxygen in the mini rocket.

AUTHORS:

Dr Wan Roslina Wan Yusof, Farah Afiqah Abdullah, Iswan Nur Ariff Ismail, Dhana Jay Raja Gopal, Dr Mohd Alhafiizh Zailani, Sharifah Mona Abd. Aziz Abdullah, ChM Dr Melody Kimi, ChM Eswaran Madiahlagan, ChM Muhamad Akif Aizuddin Jasni, Noorazman Samsudin, Khairil Rizadh Razali and Farah Hanim Jamali

REFERENCES:

1. Oak National Academy. (n.d.). Chemical reactions: Acid and metal. Retrieved from <https://www.thenational.academy/teachers/programmes/science-secondary-ks3/units/acids-and-bases/lessons/chemical-reactions-acid-and-meta>
2. NASA. (2025, July 10). *Rocket Laboratory: Laying the hydrogen foundation*. Retrieved from <https://www.nasa.gov/rocket-laboratory-laying-the-hydrogen-foundation/>
3. Yilmaz, N., Arowolo, M., & Atmanli, A. (2025). Performance characteristics of liquid hydrogen in rocket propulsion across various thermochemical conditions and oxidizers. *International Journal of Hydrogen Energy*, 167, 151019. <https://doi.org/10.1016/j.ijhydene.2025.151019>

NOTES

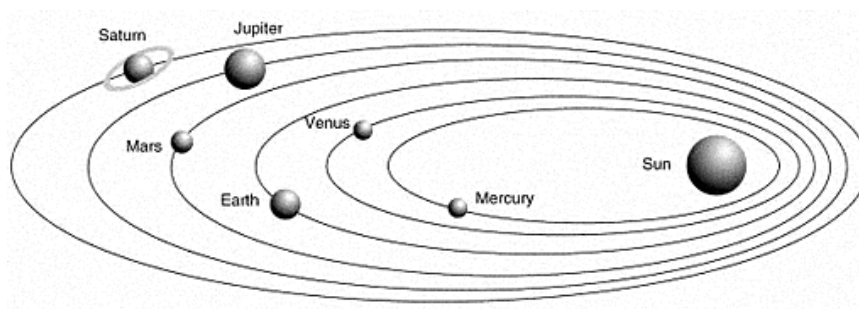
Activity 4: Is the Sun at the Centre? Let's Build the Orbit

OBJECTIVES:

1. To explain the concept of an ellipse and justify why the Sun is located at one focus rather than at the centre of a planetary orbit.
2. To construct an ellipse using the string-and-pins method based on the geometric definition of an ellipse.
3. To investigate how the positions of the foci and the length of the string affect the size and shape of an ellipse.

INTRODUCTION:

Ellipses are special shapes in mathematics that we also see in space. In astronomy, the orbit of each planet around the Sun is not a perfect circle but an ellipse, as explained by Kepler's First Law (see **Figure 4**). Each ellipse has two special points called foci, and the Sun is located at one of these foci, not at the centre.

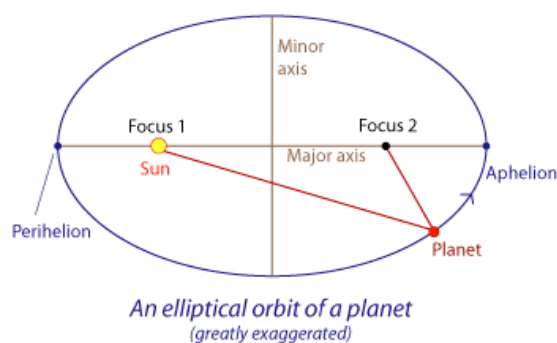


<https://www.universetoday.com/articles/keplers-law>

Figure 4

In this activity, you will construct an ellipse using simple tools: pegs, string, and a pen. By carefully following the steps, you will see how the foci control the shape of the ellipse. This hands-on approach allows you to visualize the mathematics behind the ellipses instead of just reading about it in a textbook.

Ellipses can look very different depending on how far apart the foci are. When the foci are close together, the ellipse resembles a circle more closely. When they are far apart, the ellipse becomes stretched and narrow. By experimenting with different distances between the foci, you will observe how the shape changes.



https://www.brainkart.com/article/Kepler---s-Laws-of-Planetary-Motion_36142/

Figure 5

This activity shows that mathematics is not just abstract numbers and formulas, but it can be something you build, see, and explore. Understanding ellipses also helps you make connections to other areas of math, such as coordinate geometry, curves, and distances.

By the end of the activity, you will understand why the positions of the foci are so important and how they define the ellipse. You will also gain a deeper appreciation for how geometry can describe shapes in both math and the real world.

This hands-on experience will strengthen your problem-solving and critical thinking skills while giving you a clear, visual understanding of one of the most fascinating shapes in mathematics.

APPARATUS:

- Drawing board or flat surface
- Pegs or push pins (2 per group)
- Ruler

MATERIALS:

- String
- Pencil or pen
- Tape
- Eraser

METHOD:

Activity Briefing

1. The facilitator introduces the activity.
“Is the Sun really at the centre of a planet’s orbit?”
2. Each group then appoints a team leader to coordinate communication and submission of answers.

Start of Activity

1. Set up the coordinate plane:
 - Fold the A4 paper in half vertically (left to right), then in half horizontally (top to bottom).
 - Unfold the paper and trace along the fold lines to form the x-axis and y-axis.

- Label the horizontal line as the x-axis and the vertical line as the y-axis.
 - Mark the intersection of the two axes as the centre.
 - On the positive x-axis, mark the points +5 cm and +8 cm from the centre.
2. Prepare the string:
 - Measure the provided strings and ensure that one is 11 cm long and the other is 14.5 cm long.
 3. Build the orbit (Ellipse A):
 - Leave the first push pin at the centre.
 - Insert the second push pin at the 5 cm mark on the positive x-axis.
 - Tie the 11 cm string into a closed loop and place it around both push pins.
 - Insert a pencil inside the loop and pull the string taut.
 - Keeping the string stretched, trace the ellipse.
 - Label the drawing Ellipse A.
 4. Build the orbit (Ellipse B):
 - Move the second push pin from 5 cm to the 8 cm mark on the positive x-axis.
 - Keep the first push pin at the centre.
 - Using the same string loop, trace a second ellipse.
 - Label the drawing Ellipse B.
 5. Build the orbit (Ellipse C):
 - Keep the push pins at the centre and 8 cm.
 - Replace the 11 cm string with the 14.5 cm string.
 - Place the new string loop around both push pins.
 - Pull the string taut and trace a third ellipse.
 - Label the drawing Ellipse C.
 6. Observe and compare:
 - Observe how changing the distance between the two push pins affects the shape of the ellipse.
 - Observe how changing the string length affects the size of the ellipse.
 - Complete the observation table and answer the discussion questions.

RESULTS:

Observations & Measurements	Ellipse A	Ellipse B	Ellipse C
Distance between the two push pins	_____ cm	_____ cm	_____ cm
String length	_____ cm	_____ cm	_____ cm
Shape observation (tick ✓)	☐ More circular ☐ More elongated ☐ Larger than ellipse C	☐ More circular ☐ More elongated ☐ Larger than ellipse A	☐ More circular ☐ More elongated ☐ Larger than ellipse B

DISCUSSION:

- After completing this activity, what can you conclude about a planetary orbit?
 - Planetary orbits are perfect circles with the Sun at the centre.
 - Planetary orbits are ellipses with the Sun at one focus.
 - Planetary orbits are straight lines around the Sun.
 - The Sun changes its position in the orbit.
- In the string-and-pins activity, the two push pins represent the:
 - Vertices
 - Axes
 - Foci
 - Centre points
- What is the effect of increasing the string length from 11 cm to 14.5 cm while keeping the two push pins at the same positions?
 - The ellipse becomes smaller
 - The ellipse becomes more circular.
 - The ellipse becomes larger.
 - The number of foci increases.

4. Why does the ellipse not become a circle when the foci are far apart?
- A. Because the sum of distances from any point on the ellipse to the two foci changes.
 - B. Because increasing the distance between the foci makes the ellipse more elongated.
 - C. Because the centre moves away from the ellipse.
 - D. Because the string is insufficient.

AUTHORS:

Mr. Ahmad Deedat bin Ibrahim, Mr. Chew Khui Tat, Mr. Ibrahim bin Bohari, Mr. Abang Mohammad Hudzaifah bin Abang Shakawi, Dr. Ayu Ameliatul Shahilah binti Ahmad Jamri, Dr. Nurul Syuhada binti Ismail, Dr. Farah Liyana binti Azizan, Ms. Siti Aishah binti Azhar

REFERENCES:

1. Caspar, Max (1993). Kepler. New York: Dover. ISBN 9780486676050.
2. Gingerich, Owen (2011). "The great Martian catastrophe and how Kepler fixed it". *Physics Today*. 64 (9): 50–54. <https://doi.org/10.1063/PT.3.1259>
3. Guillemin, Victor; Sternberg, Shlomo (2006). *Variations on a Theme by Kepler*. American Mathematical Soc. ISBN 978-0-8218-4184-6.
4. Murray, Carl D.; Dermott, S. F. (1999). *Solar System Dynamics*. Cambridge; New York: Cambridge University Press. ISBN 978-0-521-57295-8.
5. Stephenson, Bruce (1994). *Kepler's Physical Astronomy*. Princeton University Press. ISBN 978-0-691-03652-6.
6. Draw an Ellipse (Pin and String Method) (2021). Retrieved from <https://www.youtube.com/watch?v=663nnvjImh8>

NOTES

Activity 5: Cosmic Odyssey - AeroLogic Expedition

OBJECTIVES:

1. To understand the basic concept of computational thinking through a space-themed programming mission.
2. To apply logical thinking and simple programming commands to complete space-themed programming challenges.
3. To work collaboratively with team members to solve challenges and accomplish the mission objectives.

INTRODUCTION:

Space exploration is made possible through the power of programming and computational thinking. From guiding rockets to navigating spacecraft and avoiding obstacles in space, every successful mission relies on logical instructions that enable digital systems to make accurate decisions.

In Cosmic Odyssey - AeroLogic Expedition, you will take on the role of an AeroLogic Cadet. Your mission is to guide a rocket safely through a series of space-themed programming challenges. Using a visual programming interface, you and your teammates will select the correct programming commands to navigate through obstacles, complete mission objectives, and reach your destination successfully.

Throughout the expedition, you will develop computational thinking skills, apply logical reasoning, solve programming challenges, and collaborate effectively with your team, just like the programmers behind real-world aerospace technologies.

Successfully completing the missions will earn your team the title of Elite AeroLogic Explorers, proving that you have what it takes to think logically, solve problems, and navigate your way *From Code to Cosmos*.

Mission Control is counting on you. Are you ready, Cadets? Your cosmic adventure begins now!

APPARATUS:

- Desktop computers
- Projector
- Projection screen
- Whiteboard and markers
- Sticky notes

MATERIALS:

- Cosmic Odyssey visual programming interface
- Mission instruction sheets
- Mission worksheet

METHOD:

AeroLogic Bootcamp

1. Introduce the activity and brief participants on their role as AeroLogic Cadets.
2. Explain the basic concept of computational thinking and its application in space technologies.
3. Demonstrate the Input-Process-Output (IPO) model and basic programming commands using Kanban Planning Method.
4. Complete a sample mission to demonstrate how the rocket is navigated using simple programming commands.
5. Organise participants into groups of five and provide instructions for the mission challenge.

Cosmic Mission Challenge

1. Launch the space-themed programming mission using the visual programming interface.
2. Discuss and plan the sequence of commands with team members before executing the mission.
3. Select the appropriate programming commands to navigate the rocket through the mission.
4. Test and improve the solution until the rocket successfully reaches its destination.
5. Share the team's strategy and reflect on the challenges encountered during the mission.

RESULTS:**AeroLogic Mission Planner (inspired by the Kanban Planning Method)**

Mission Brief	Mission Planning	Mission Testing	Mission Success
<i>Write the assigned mission problem.</i>	<i>Arrange the command cards in the proposed sequence</i>	<i>Revise or rearrange the commands after testing and discussion.</i>	<i>Record the final command sequence that successfully completes the mission.</i>

DISCUSSION:

- Which of the following best describes computational thinking?
 - Decorate a rocket with different colours.
 - Memorize programming commands.
 - Solve problems by breaking them into logical steps.
 - Make the rocket move faster.

2. Before clicking a programming command, what should your team do first?
 - A. Click as quickly as possible.
 - B. Guess the next command.
 - C. Discuss and plan the sequence of commands together.
 - D. Wait for another team to finish.
3. What was the most challenging part of the mission? How did your team overcome it?

4. If you could replay the mission, what would your team do differently to complete it more efficiently?

5. If you could replay the mission, what would your team do differently to complete it more efficiently?

AUTHORS:

Fatin Hanani Kamaluddin, Nor Ika Shahirah Ramli, Michelle George, Khalif Amir Zakry, Tarmizi Mohammad Shukri, Abd Razak Hosen, Adrus Bin Mohamad Tazuddin, Nursiah Haji Sabdin, Sylvester Guyang

REFERENCES:

1. National Aeronautics and Space Administration. (2026). About STEM engagement at NASA. NASA. Retrieved from <https://www.nasa.gov/learning-resources/stem-engagement/>
2. International Society for Technology in Education. (2024). ISTE Standards: For students. ISTE. Retrieved from <https://iste.org/standards/students>
3. Wei, Y., Wang, L., Tang, Y., Su, J., Lei, Y. & Peng, W. (2024). Influence of programming education modalities on computational thinking in young children: A comprehensive review and meta-analysis. *Journal of Computer Assisted Learning*. <https://doi.org/10.1111/jcal.13038>

NOTES

NOTES



CENTRE FOR
PRE-UNIVERSITY STUDIES

Organized by:

Centre for Pre-University Studies
Universiti Malaysia Sarawak
94300 Kota Samarahan
Sarawak



Contact Information:

Tel: +6 082-582479 / 2480 / 2294

Fax: +6 082-582330

Email: asasi@unimas.my

Website: pppu.unimas.my

eISBN 978-629-97069-5-3



9 786299 706953