Teacher Guide: STEM Rocket Unit

STEM Project Year 10

ABSTRACT

A unit plan built with Boeing Defense in Adelaide with a focus on Rockets which explores the launching and landing.

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EDUC 5195 / EDUC 3070

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About Boeing Defence

Boeing is the world's largest aerospace company that was founded in 1916. They are a leading manufacturer of:

- Commercial jetliners
- Defense
- Space and security systems
- Service provider of aftermarket support.

Boeing employs over 140,000 people across the united states and in more than 65 countries. This represents one of the most diverse, talented and innovative work forces anywhere in the world.

In Australia Boeing defense have broad expertise in things like fighter jets, rotorcrafts, cybersecurity, surveillance suites, advanced weapons, missile defense and commercial aircraft derivatives. They aid in the maintenance and modifications of border security to protect Australia. They help to train people to maintain and fly jets and security systems. Boeing have a large role in Australian defense and security and together we worked on a space rocket unit that combines STEM topics.

Boeing's large focus on diversity, inclusion and sustainability has developed their interest in working with schools and younger people to increase engagement and aspiration to enter defense and security careers. They aim to increase the inclusion of females and people from diverse backgrounds and by working with school they hope to achieve that goal. Their goals towards sustainability aim for designs that are outmatch previous designs in terms of environmental impact.

Brainstorming

Together with a Boeing representative we explored a range of ideas for a STEM unit including fuel, tracking and location, technology on planes, plane efficiency or material selection. We selected to work on a highly engaging topic which we could integrate a range of topics - Rockets.

Boeing had its own resource ideas for primary school called 'Mission to Mars' and 'Soft Landing' which we have based our ideas off to develop a unit for a year 10 high-school class. So, for our unit we wanted two key experiments; (1) a launching experiment where students design a model rocket that can launch to a specific height; and (2) a landing where the model lands without damaging the egg inside. The experiments require students to develop an understanding of physics concepts like gravity, force and motion; design a model rocket; select specific materials that work towards long term sustainable goals; use scientific literacy and mathematics to collect and analyse data; and technology of the design processes.

Teaching Philosophy

Public Pedagogies

For this unit of work students will have the opportunity to have an excursion to the Adelaide Planetarium as a part of the science curriculum and the exploration of the solar system. This excursion will enable students to see stars, sun, moon and the planets at any time of the day and year.

Intellectual Quality

A big idea behind this unit, is enabling students to use higher order thinking skills. Students will be challenged to create a rocket and a safety landing capsule. Students will therefore need to be able to understand concepts surrounding Physics and Mathematics, and how to correctly apply to the creation of their products.

Through conversations and the overall, students will be doing their own inquiry-based learning, meaning that they control how the lessons are formed. This will enable students to explore different possibilities within a safe and controlled environment.

Relevance

The reason why this unit of work is good to use is the idea that this unit of work focuses on STEM and the integration of science, technology, engineering and mathematics. Within the unit, it enables students to see the real-life connection between what they are learning in the classroom and what work anyone does around e.g. aerospace.

Supportive Classroom Environment

With this unit of work, students are encouraged to be proactive in the completion of their own group projects. For students to be able to successfully complete these tasks, they will need to work together being socially and academically supportive whilst keeping each other safe and motivated.

Recognition of Difference

Diverse cultural is something that within a classroom can be very evident for students, however, when it comes to acknowledging what is learnt within the classroom and applying it to the 'outside world', it can be difficult. This unit will allow students to research into the jobs and people within the field.

This unit has aspects that can be changed to suit the students within the class, whether it is getting the students to design and build their own rocket/landing device and creating all the parts on the 3D printer to building the rocket/landing device from instructions/images.

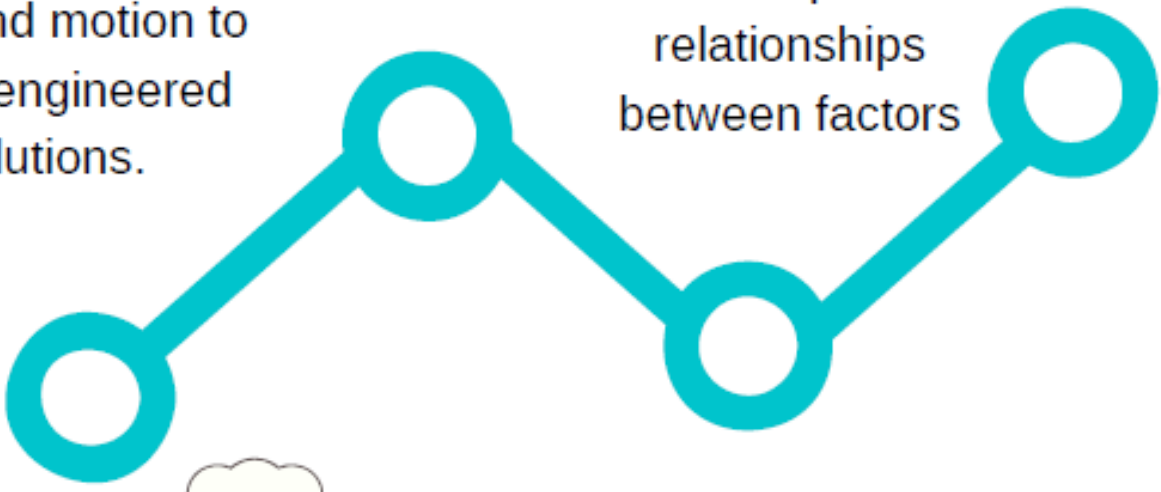
STEM

Technology

Investigate properties of materials that are combined with force and motion to create engineered solutions.

Mathematics

Use mathematical knowledge to design blueprints and explore relationships between factors



Science

Use knowledge of force and motion to predict and design a rocket launch and landing

Engineering

Understand the basic's of rocket ships and use blueprints to desgin a model that can launch and land safely

Introduction to the unit

This is a 10-week STEM project that explores the basic physics, engineering, technology and mathematics around Rocket Ships. The unit plan was built with Boeing who are a leading manufacturer in aircrafts and work on rockets. Students work collaboratively to learn, design and build their own model rocket ships. The **Aim** of this project is to create a holistic, engaging project that develops students integrated knowledge and skills of multiple subjects and increase aspiration in STEM fields.

The project is completed in three stages:

1. Design Process
2. Launching
3. Landing

The **design process** focuses the structure, materials and methods used to build their very own model rocket ship. Their rocket ship designs need to incorporate how it can take off, space for a 'passenger' and consider its weight for landing. Students will produce blueprints using measurement and what materials they wish to use and a rationale for their reasonings. Once the blueprints are cleared the students will present their ideas to the class, allowing for students to refine and improve their designs. At the end of the process students are given time to build their rocket ships ready for the experiments.

The first experiment is the **Launch** where students need to use their model rocket ships and use a science experiment to launch their model into the sky. Students will use ICT to take videos; use stopwatches to calculate velocity and compare rockets with their peers. Students will refine their model and continue to test it until it reaches a specific height and speed. At the end of this section, students need to present how they refined and improve their rocket with reasoning and show successful launch.

The second experiment is the **Landing** where students will drop their model rockets from a balcony and need to develop a mechanism to make it land softly. The final test for the landing is to whether an egg when placed within the rocket can be kept safe not crack. Students will use ICT and stopwatches like in the first experiment so they can continue to refine their model until the practical when they are given eggs to drop in the rockets.

At the end of the project students will **complete a final multimodal assessment** where they demonstrate their learning of their rocket design, their success in the experiments, their research on rockets and space and their mathematical calculations.

ACARA - Year 10

Grade: 10	Topic: Integrated STEM Project on Rockets
Science	• K-The universe contains features including galaxies, stars and solar systems, and the Big Bang theory can be used to explain the origin of the universe (ACSSU188) • K- Energy conservation in a system can be explained by describing energy transfers and transformations(ACSSU190) • K-The motion of objects can be described and predicted using the laws of physics (ACSSU229) • SHE- Advances in scientific understanding often rely on technological advances and are often linked to scientific discoveries(ACSHE192) • Formulate questions or hypotheses that can be investigated scientifically (ACSIS198) • Plan, select and use appropriate investigation types, including field work and laboratory experimentation, to collect reliable data; assess risk and address ethical issues associated with these methods (ACSIS199) • I - Select and use appropriate equipment, including digital technologies, to collect and record data systematically and accurately (ACSIS200)
Mathematics	• Solve problems involving surface area and volume for a range of prisms, cylinders and composite solids(ACMMG242) • Solve linear simultaneous equations, using algebraic and graphical techniques, including using digital technology(ACMNA237
Design & Technology	• Investigate and make judgments on how the characteristics and properties of materials are combined with force, motion and energy to create engineered solutions (ACTDEK043) • Investigate and make judgments on how the characteristics and properties of materials, systems, components, tools and equipment can be combined to create designed solutions (ACTDEK046)

This unit is a follow on from a unit on the Big Bang Theory and space, students will incorporate that knowledge into this unit to give more depth. This unit is taken by students taking a core science class.

Key Learning Outcomes

- Be able to construct blueprint using basic measurement and reasoning for the design
- Be able to describe the reason to how gravity works and why the rocket will return to Earth
- Gather data from experiments to analyse everyday motions using distance, time, speed, force, mass and acceleration
- Be able to recognise that when the rocket is launched, the chemical reaction is transformed into kinetic energy and heat
- Be able to select and justify reasoning on the chosen materials and how it will affect the rockets motion

Summative Assessments

Assessment Name	Products	Percentage of Grade
Research	Cornell Notes	**10%**
Blueprint	Drawing of model that includes; materials, measurements and special features Why did you choose this design (200 words)	**10%**
Launch Experiment	Video / pictures of experiment Data collected, calculations and changes made Summary of success (200 words)	**25%**
Landing Experiment		**25%**
Final Assessment	A multimodal assessment (PPT, Prezi, Video, Poster) of the success of your model with NASA as your audience. Your final Model Rocket	**30%**

Unit structure overview

Weeks	Project Process	Knowledge (research / mini-lessons)
1	Research	• Rocket structure and purpose • What is gravity • Types of materials review
2-3	Blueprints and Presentation of Rockets	• What are blueprints and check knowledge on measurement • Newton's three laws
4-5	Building the Rockets and Excursion	
6-7	Launching experiment	• Laws of motion • Petrol efficiency
8-9	Landing Experiment	• Forces that affect landing
10	Final Assessment and Rocket Model	

Week 1 - Student Research

Students will have three lessons that allow them to research and learn about rockets, forces and the materials they may wish to use for the project. Students will only receive the initial research worksheets at this stage and all work will be collected into personal folios.

<table>
<tr>
<td rowspan="2">Project Outcomes:

● Introduce the topic and hand out research sheet

● Design Questions about rockets

● Research their questions on rockets

● Begin to consider materials they may want to use</td>
<td>Knowledge Outcomes:

1. Rockets are specifically designed to launch at fast speeds to reach space
2. Specific materials are chosen because they are better for the environment
3. Gravity is a type of force that pulls everything towards the centre of the world</td>
<td>Assessments:

Diagnostic: Mind Maps

Formative: Class participation on theory

Summative: Cornell Notes</td>
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<tr>
<td>ENABLE:
● Questions: Give a question guide that helps them to construct the questions
● Practice summarizing together
● Words they should type into the google search system
● Should be able to research the basic 4 questions given</td>
<td>EXTEND:
● Type up their research and discuss their findings
● Have them create more challenging questions or give a more challenging question to research</td>
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Lesson 1	Lesson 2	Lesson 3
Rockets: 1. Video to engage the class (history, TED-ED or discussion on the future) 2. Mind-map and discussion to cover prior knowledge 3. Video on rocket scientists https://www.youtube.com/watch?v=wH8WFpcQ8_c ● Students independently work on their questions with teacher support when needed ● When students have had their questions checked they can begin researching	**Mini-Lesson: Material Selection** ● Teacher-led introduction of why choosing specific material is important using a video to engage LINK: https://www.smh.com.au/business/companies/as-fuel-bills-bite-airlines-are-going-through-a-weight-loss-challenge-20181123-p50hyy.html ● Practical setting where students write observation notes about selected materials given in class ● Independent Research Time (they should be halfway by the end of the lesson)	**Mini-Lesson: Gravity** ● Teacher-led discussion on gravity as a force and what it means for the rocket Independent Research Time (Students should be up to the summarizing section by the end of this)

Week 2 & 3 - Design Process

Students will learn about blueprints and design their model rocket using that process, they will need to consider the forces effect on their models shape and material. Students will receive mini-lessons on Newton's three laws of motion and design and technology relevant theory on material that can be used in the laser cutter and 3D printer.

Project Outcomes: ● Students are given the assessment worksheet ● Introduce blueprints and have students use them to design rockets ● Rationale worksheet that scaffolds how forces may affect their design ● Refine their model by comparing to peers' models	**Knowledge Outcomes:** 4. Blueprints and Measuring 5. Thrust of the Rocket & Choosing your 'fuel' 6. D&T - laser cutting and 3D	**Assessments:** Diagnostic: Class discussions Formative: Class participation on theory Summative (CONT): Blueprint and rationale worksheet
	ENABLE:	EXTEND: Make it as light as possible- to make it cheaper, faster, Environmental awareness (is it recycled)

Lesson 4	Lesson 5	Lesson 6
Introduce the Project Assessment Sheet **Blueprints Lesson:** ● Explanation of blueprints ● Expectations of their blueprints	**Thrust of Model Rocket:** ● Theory around rocket thrust to exit the Earth's Gravitational pull ● Students looks at different options of launching	**Laser Cutting and 3D Printing Lesson:** Use these techniques to improve the model Look at disadvantages of using the material

Lesson 7	Lesson 8	Lesson 9
Independent Time on Blueprint	Independent Time on Blueprint	model comparison and improvement

Week 4 & 5 - Building Section

Students will have the next two weeks to build and refine their model rockets. Theory covered this week will go into more depth on Newton's three laws by giving them context and using calculations. During these weeks are a good time to go on an excursion to the Planetarium.

Project Outcomes:	**Knowledge Outcomes:**	**Assessments:**
● Build a model rocket and be able to refine it within reason	7. Application of Newton's three laws 8. D &T - design process teaching- showing pictures at each step and folio write up 9. Calculating dist., time, speed, force, mass, acceleration	Diagnostic: Equipment check and procedures Formative: Class participation on theory and model building Summative (CONT): Final model rocket (check point)

Lesson 10-12	Lesson 13	Lesson 14-15
Student Group Work: Students are given three full lessons to work on their rockets Students are given online work on forces and motions to complete while waiting for things to dry for example glue.	**Theory: Newton's Laws and Mathematics** Mini-lesson where the teacher explanations the calculations for distance, time, speed, force, mass and acceleration **Rocket Checkpoint:** Students are given a checklist that allows them to critically analyse their current design so that they can improve.	**Student Group Work:** The remaining lessons of the week are for students to finish working on their model rockets ready for their first test. Students are given online work on forces and motions to complete while waiting for things to dry for example glue.

Week 6 & 7 - Launch Experiment

This week students will be completing their launch experiments on Launch days groups will take in turns to launch their model. When launched they begin to reflect and analyse on how it could improve. Students are given a chance to share their models and their launch experiment and how they plan to improve. This is to give other students ideas on how they could also improve. The theory content is more heavily focused on Astronomy, Space Exploration and sustainability.

Project Outcomes:	**Knowledge Outcomes:**	**Assessments:**
● Have successful launches of rockets to a specific height ● Rockets which do not meet the criteria are adjusted accordingly	10. Astronomy Mini-Lesson 11. Mission to Mars Exploration Mini-Lesson 12. Saving Fuel on the Launch Problem Solving Lesson	Formative: Data from experiments and their written plan to improve their model day 1 Summative: The data, reflections and improvements of their model rocket

Lesson 16	Lesson 17	Lesson 18
Launch Safety explanation for safety. Students complete day 1 launch - they take videos of their launch - Annotate observations - Reflect on the test and how they could improve	**Improvements:** Student make improvements to their models and share their ideas with the class.	**Astronomy Mini-Lesson** - teacher-led inquiry lesson on astronomy

Lesson 19	Lesson 20	Lesson 21
Launch Day 2: Student spend the lesson launching their rockets and their success and how they could continue to improve Students are given a homework task that involves researching Mars Exploration.	**Mini-Lesson on Saving Fuel** - Students use higher order thinking to come up with ideas on how rockets and aircrafts can save money on fuel and how it directly relates to their model rocket **Improvements:** Groups work to improve their model rocket or being to prepare for the landing section	**Launch Day 3:** - This is the student's final day to launch their rockets - Students analyse the patterns of their results - Students can then begin their presentations slides when completed.

Week 8 & 9 - Landing Experiment

Students have completed the launching experiments and are now going to prepare for landing. The first week students will be given flexible time to prepare their model rockets for the Egg-Landing test. Theory will cover the structure, parts, and purpose of rockets.

Project Outcomes:	**Knowledge Outcomes:**	**Assessments:**
● Introduce the topic and hand out research sheet ● Research rockets, materials and theory	13. Rocket History 14. Mission to Mars review	Formative: Data from experiments and their written plan to improve their model Summative: The data, reflections and improvements of their model rocket

Lesson 22	Lesson 23	Lesson 24
Review homework research task - As a class discuss findings on the mission to mars research task **Explicit Landing Experiment Instructions** - Explain expectations and how the next two weeks will work. Include how it is recommended they test from a short height and continue to make it bigger as to not ruin their models. **Flexible Group Time:** - Students are given time to prepare for Egg-Landing Test	**Mini-Lesson on Rocket History:** - The lesson explores how rockets have developed over time and that has led up to current explorations **Flexible Group Time:** - Students are given time to prepare for Egg-Landing Test	**Flexible Group Time:** - Students are given time to prepare for Egg-Landing Test

Lesson 25	Lesson 26	Lesson 27
Egg-Landing Test #1 - Teacher instruction on how the test will work and students will receive a maximum of 3 eggs and will need to record their data	**Make improvements** - Make the necessary improvements based of the previous lessons results and analyse **Egg-Landing Test #2** - This will run the same as the previous day with 3 eggs	**Presentation Explicit Instruction:** - write down expectations for what should be included in the presentations **Flexible Group Time:** - Students are given time to work on their presentations

Week 10- Presentations

This week students will have time to work on their presentations that will be presented in lesson 30 in their groups. It will include their blueprints, all experiment data and video's, their model reflections and their final summary.

Rocket and Forces Research Task sheet

NAME: _____ Term 2 2019 STEM

Context

Due: Monday Week 2

You are an engineer and you need to learn about rockets to help NASA prepare for their latest space exploration - to Mars. They have asked you to research and use your science knowledge to come up with a rocket design that can allow for a successful launch and landing for the astronauts.

As an engineer who thinks of the future, you will need to select appropriate materials for your rocket that are better for the environment and future generations. Good Luck!

Task

You need to research the following points using Cornell Notes:

- What shapes are rockets and why
- How to launch a model rocket
- How do rockets land safely?
- What is gravity

You then need to come up with at least 5 questions about rockets to research and summarize. This will help you in the project when you need to make a model Rocketship.

Checklist

STAGE	TASK	HAND-UP
Question	Write a minimum of 5 questions that can help you build a model rocket or learn more about rockets	Your five questions
Research	Write the answers you find online into your Cornell Note Taking Sheets	
Summarize	Using the box at the bottom of your Cornell notes, **summarize** your research	Cornell Notes
EXTEND: Type Up	Type up your research into a word document	300-word type-up

MISSION TO MARS

NASA has recently found what could be some sort of life form on the planet Mars. NASA has asked (School name) to design a rocket that will launch to Mars and a capsule that will land the astronauts safely on this planet.

TASK

For this assignment, you will be in teams of 3-4. The assignment involves three individual projects. Learning about STEM, the solar system, excursions, environmental factors and gaining information from the presentation from Boeing Defence Australia will help you guide your team with what you need to successfully complete the three projects.

PROJECT 1 - ROCKET LAUNCH

You are required to create a rocket that must meet the four requirements listed below:

1. Launch as straight as it possibly can.
2. Must launch above 5 metres high
3. Does not fall apart.
4. Can use any method to launch

PROJECT 2 - SOFT LANDING CAPSULE

In the same teams, you are required to create a soft-landing capsule that must meet the requirements below:

1. Must fit an egg in the inside of the capsule.
2. egg must not break when landing.
3. This Capsule will be dropped from around 5 metres high.
4. Can use any design for this capsule but needs to be approved by the teacher.
5. Must be as light as possible (Environmental factors)

PROJECT 3 - STUDENT PRESENTATION

Students in their teams must give a 5-10 minutes presentation about their rocket and soft-landing capsule.
Areas that students need to include in this presentation are:

1. Blue Prints
2. Where they discovered their ideas.
3. Challenges
4. Video of rocket launching and their capsule landing (Failed and accomplished attempts)
5. STEM

Constraints

- Must only use the materials that are supplied (See Teacher to show you material)
- Each team will be given 3 eggs to test their rockets and soft-landing designs.
- Each design must be different to every other team in the class.

Considerations

- Solar System
- Area - surface of rocket and how it affects flight
- Volume - weight
- Energy transfusion/conversion
- Motion - flight (maybe making paper planes etc.)
- Environmental Factors
- Laser cutting (To improve your rocket)
- 3D Printing (to help with your protection of the egg)
- Blueprints of designs
- Trial and Error

DUE DATE: 2nd of May 2019

Mission to Mars Marking Criteria

	Score = 4	Score = 3	Score = 2	Score = 1
Designing/ Investigation	Shows in depth knowledge and detail that clearly outlines students design process and investigation of the 3 projects.	Shows knowledge and detail that outlines students design process and investigation of the 3 projects	Shows some knowledge and detail that somewhat outlines students design process and investigation of the 3 projects	Shows minimal knowledge and no detail that somewhat outlines students design process and investigation of the 3 projects.
Project 1 Rocket Launch	Students successfully launch their rocket, meeting all the requirements needed.	Students successfully launch their rocket, meeting most of the requirements needed.	Students successfully launch their rocket, meeting some of the requirements needed.	Students didn't successfully launch their rocket or didn't meet any of the requirements needed.
Project 2 Soft landing capsule	Students successfully land their egg, meeting all the requirements needed.	Students successfully land their egg, meeting most of the requirements needed.	Students successfully land their egg, meeting some of the requirements needed.	Students didn't successfully land their egg or didn't meet any of the requirements needed.
Project 3 Presentation	Students present their 2 projects in depth, meeting all the presentation requirements and present all their information.	Students present their 2 projects in some depth, meeting most of the presentation requirements and present most of their information.	Students present their 2 projects in little depth, meeting some the presentation requirements and present some of their information.	Students present their 2 projects in minimal depth, meeting the minimum presentation requirements and present little of their information
Individual grade	Contributed to the group really well and was heavily involved in all 3 projects.	Contributed to the group well and was evenly involved in all 3 projects.	Contributed little to the group and was somewhat involved in all 3 projects.	Did not contributed to the group and was not involved in all 3 projects.
Comment				**Grade**

Potential hazards

Rocket launch

- Need to make sure that the air in which the launch is taking place, that it is all clear with no building or people (besides the class/es participating in the activity) around in close proximity.
- Ensure that students are standing a minimum of 2 metres away. To ensure this have cones placed around the launching area
- When the rocket is up in the air, be sure to make sure that no students are directly underneath it in case it comes down quicker than expected.

Egg drop

- Have cones placed around dropping area to ensure safety for students. Minimum of 2 Metres away from area of drop.

Websites

Boeing

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- Boeing, 2018, A Boeing and Teaching Channel Partnership, Teaching Channel, https://www.teachingchannel.org/boeing-engineering-curriculum
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Some bottle rocket examples

- Reviewoutdoorgear, 16 June 2012, Bottle Rocket design and launch, video, YouTube, https://www.youtube.com/watch?v=xav_7AkUgGw
- The Sci Guys, 17 October 2013, The Sci Guys: Science at home...bottle rocket, video, YouTube, https://www.youtube.com/watch?v=ii6D1R6lXVA
- iCreatabled, 21 October 2014, How to build the simplest water bottle rocket launcher, video, YouTube, https://www.youtube.com/watch?v=gyOzvqmUs4c

Some egg drop videos

- retrocoaster, 26 September 2010, Egg drop project, video, YouTube, https://www.youtube.com/watch?v=cSOjdbRFm4k
- Mark Rober, 27 May 2015, 1st place egg drop project ideas, video, YouTube, https://www.youtube.com/watch?v=nsnyl8llfH4
- fixitsamo, 11 July 2018, How to make a parachute, video, YouTube, https://www.youtube.com/watch?v=fnA2X6xLi3o

Lesson Plan Contents

Unit: Model Rocket Ship Unit	**Strand:** STEM Project - Physical Science - Design & Technology	**Lesson Topic:** Gravity and Rockets
Year Level: 10	**Length:** 40 mins	**Lesson number: 3**
ACARA: • The motion of objects can be described and predicted using the law of physics	**Key Learning Outcome:** • Be able to define gravity • Be able to apply their knowledge of gravity to understand Rockets	**Assessment:** • Practice Questions • Their written answer to how gravity affects rockets

Students will...	**Resources:**
Be introduced to concepts on gravity and different scenarios Students will then apply their knowledge in the context of rockets for their project	• Technology to allow for a timer • Objects of very different weights to drop • Screen to show a YouTube video

Sequence	**Teacher Outcomes**	**Evidence of Learning**
Assessing Prior Knowledge (5 mins) • Drop something onto the floor (like a pencil) and ask 'why did my pencil fall' [if students respond with let it go then ask if I let it go on the moon what will happen and return to your initial question]	Students of this age should already know what gravity is (and may have covered it in Yr7) so the goal is to facilitate that discussion.	**Possible Misconceptions:** • Gravity is related to movement, proximity to earth or magnetic fields • The moon has no gravity • Gravity is stronger between the most distant objects
Visible/Explicit Learning (5 mins) • Make it clear to students that the aim of the lesson is for them to understanding gravity well enough to be able to help them with their rocket project • Give definition of Gravity - '*Gravity is the force that exists between any two objects that have mass. Weight is a measure of the force of gravity pulling an object*	Visible Learning to ensure students are clear on outcomes and key learning points Write the definition on the board for students.	
Explain (8 mins) • Underline 'two objects that have mass' - ask students why they think this is important *It is important for students to recognise not just the Earth has a gravitational pull- because the pull is just so strong due to its large mass. Gravity is also what holds the planets in orbit (so yes, the Sun has a gravitational pull). The moon has 16% of the pull that Earth has, while Jupiter has 2.5 times more pull than Earth.*	This is to correct any misconceptions and reinforce any specific concepts. A thing is to ensure that all things with mass have a gravitational	They can participate in the discussion of the underlined definition Students will ask questions of concepts.

• Explain any concepts of how gravity works that students have misconceptions or reinforcement **Explore (10 mins)** • This time have two students with a timer (could just be a phone or computer app) and drop two things of significant different weights. Have students measure how long it takes them to fall. Ask why. *Note that mass is the amount of matter in an object, while weight is the force acting on that matter* • Give students one or two questions to check understanding **Connect to Rocket Project (10 mins)** • Start with "Rockets need to escape Earth's gravity and therefore needs a lot of force to push it upwards • Show video: https://www.youtube.com/watch?v=b9Dj-5LUYlo • Facilitate group discussion 'what does this mean for your rocket' *Students should discuss things like the weight of the material they choose, what they use to thrust the rocket, be able to explain that once the rocket reaches a specific speed the Earth's gravitational pull will bring it back down.* **Summary (2 mins)** • Review key concepts of physics and what the key points of the group's discussion were **Students can now return back to their projects for the remainder of the lesson.**	pull but it's just not noticeable. This is to help students connect their learning to world around them. Connectedness of the mini-lesson so students can see how it is useful for their projects on rockets. Aid in group discussions when necessary to ensure all students have the necessary tools to consider gravitational pull on their model rocket. Summarize to convey important ideas and concepts of the lesson.	Students come to the conclusion that gravity affects things of different MASS (the pull is stronger or weaker). The complete questions are correct demonstrates understanding of concepts. Evidence of learning is when students can apply their knowledge of gravity to discuss how it will impact their rocket.

Name		**Lesson**	4	**Date**	Week 2
Class	STEM	**Topic**	Newton's Three Laws	**Year level**	10
Total students	25	**Length (Mins)**	90 min		

Plan for lesson:	An introduction to Newton's Three Laws of Motion, students will learn about the three laws, watch videos on the topic and work on an activity book where they answer questions and participate in a short activity about inertia.
Key ideas:	• Newton's Three Laws of Motion • Inertia • F=ma • For every action, there is an equal and opposite reaction
Student learning outcomes:	Students will learn about the three laws of motion, how to rearrange the second law, and to conceptually think about the third and first law.
Evidence of learning	Students will produce answers in their workbook. Students will successfully carry out the activity.
Students will...	Demonstrate an understanding of the three laws by answering questions related to them, participating in a discussion related to the video and participate in the inertia activity.

Teacher Outcomes	**Class Plan**
Before class • To have teaching materials prepared, including videos and activity sheets. **During class** • To explain in detail what the students need to answer on Newton's Three Laws in their workbooks. • To demonstrate a short activity on inertia that the students can participate in. • To watch a video of an inertia demonstration on the Moon (https://www.youtube.com/watch?v=5C5_dOEyAfk) **Closure** • Make sure students have packed up their work area, assign homework and dismiss class. **After class** • Ensure that the class is packed up. • To look over any activities that were completed in class and to mark it in time for the next lesson.	**Introduction** • Introduce the three laws of motion • Play a video demonstrating inertia on the Moon. • Facilitate a discussion on the three laws • Introduce the questions that the students need to work on. **Development** • To walk around the room and see if the students need any help on any of their questions. • To help students through a short activity on inertia. **Closure** • Recap the lesson. • Go over the homework students need to work on. • Introduce a bridging question which will lead into the next lesson.

Name		**Lesson**	7	**Date**	Week 3
Class	STEM	**Topic**	Solar System	**Year level**	10
Total students	25	**Length (Mins)**	90 min		

Plan for lesson:	An introduction into the arrangement of the solar system and the scale of the solar system will be outlined. Students will learn about Mars in more detail and on the evolution of the solar system.
Key ideas:	· The solar system is 4.5 billion years old · Mars is the second closest planet to Earth · Earth is one of four rocky planets · Mars gets as close as 55 million kilometers to the Earth.
Student learning outcomes:	· Students will learn about the solar system, its age, scale and more about the planet Mars.
Evidence of learning	· Students will be able to describe the evolution of the solar system. · Name in order the planets of the solar system · Understand the difficulties, travel time and costs for a journey to the planet Mars
Students will...	· Appreciate and the age and scale of the solar system · Learn about the scale of Earth in relation to other planets · Understand the vast time scales involved in cosmology · Be introduced to a more in depth look at Mars.

Teacher Outcomes	**Class Plan**
Before class • To have teaching materials prepared, including videos and activity sheets. **During class** • To make the students participate in discussion. • To play videos related to the topic. • To outline the activities that the students will be participating in for the lesson. **Closure** • Make sure students have packed up their work area, assign homework and dismiss class. **After class** • Ensure that the class is packed up. • To look over any activities that were completed in class and to mark it in time for the next lesson.	**Introduction** • Introduce the students to an outline of the makeup and age of the solar system • Play a video demonstrating the scale of the solar system (https://www.youtube.com/watch?v=RoarYtQt2Us) • Facilitate a discussion on the scale of the solar system • Introduce the questions that the students need to work on and to get them to work in groups on a mind map on the difficulties of travelling to Mars. **Development** • To gather all the student's group ideas from their mind maps to a collective class mind map • To walk around the class as the students work through questions related to the solar system

	• To get the students to demonstrate scale by having them hold two balls, one representing the Moon and one representing the Earth and stand the equivalent correctly scaled distance away. Then using this demonstration, to facilitate discussion on scale again and relating it back to the cost of a Mars trip. **Closure** • Recap the lesson. • Go over the homework students need to work on. • Introduce a bridging question which will lead into the next lesson.

Name		**Lesson**	8	**Date**	Week 3
Class	STEM	**Topic**	Excursion to the Planetarium	**Year level**	10
Total students	25	**Length (Mins)**	Day Trip		

Plan for lesson:	In this lesson, students will go on an excursion to a planetarium.
Key ideas:	• Constellations can be catalogued in the sky by location • Light pollution obscures many stars from the sky • We can see some of the planets with the naked eye, and others with a telescope • Some nebulae, galaxies and star clusters can be seen with a telescope
Student learning outcomes:	• Students will learn about several astronomical constellations. • Students will learn where several planets are in the sky. • Students will get to see videos and images of nebulas, planets and galaxies.
Evidence of learning	• Students will answer any questions directed towards them about aspects of the planetarium.
Students will...	• Interact with the planetarium's facilities • Observe constellations • See different astronomical instruments • Answer astronomical questions

Teacher Outcomes	**Class Plan**
Before class • Have all materials prepared for the excursion and to be at the meeting area well before the students. **During class** • To closely monitor the students during the excursion and ensure that they are all accounted for during departure. **Closure** • Ensure that all students are accounted for before dismissing the students at the school. **After class** • Writing a review of the lesson and what could be done better next time, so there is a development in how well handling students during excursions is done.	**Introduction** • Students will gather at the assigned area to be signed on for the day and will depart with teacher oversight for the planetarium **Development** • Students will go to a planetarium • Students will interact with the instruments there • Students will observe constellations • Students will answer questions on astronomical topics while at the planetarium **Closure** • Students will return to school and all sign off in the correct manner so that they are all accounted for

Name		**Lesson**	11	**Date**	Week 4
Class	STEM	**Topic**	Laser cutter	**Year level**	10
Total students	25	**Length (Mins)**	90 mins		

Plan for lesson:	Students individually will be introduced to the laser cutter and the programs needed to use the laser cutter.
Key ideas:	Students understand how the laser cutter works, how to use the program for the laser cutter and show how it can be used in their projects.
Student learning outcomes:	Students learn how to use the laser cutter, use the program and print something if they use their time efficiently.
Evidence of learning	Students understand how the laser cutter and programs are used. Students produce a small key ring.
Students will...	Be introduced to the laser cutter and how to use the program used for the laser cutter. They will learn how to use the laser cutter in their project and if they use their time efficiently, they will get to print of a key ring made in class.

Teacher Outcomes	**Class Plan**
Before class • Have laser cutter ready. • Have materials ready. • Any YouTube clips or resources ready. • Have program all loaded and ready to go from the start of the lesson. **During class** • Go around the class room and help each student with their key ring they are making. **Closure** • Remind students who printed off some key rings to collect them later in the day. • Give students resources to watch for homework about the laser cutter. • Answer any questions the students may have. **After class** • Pack up class. • Leave laser cutter running if students work isn't finished.	**Introduction** • Introduce the laser cutter and programs to students. • Teach students how to use the laser cutter and show them what it can engrave and cut. • Show resources to students. **Development** • Go around to each group and help them with their design of their key ring. • Help students with any problems they are facing with the program. • Answer any questions they may have. **Closure** • Remind students of what they have learnt about the laser cutter • Remind students to pick up their work later in the day if they have printed. • If students want to print their key ring, they can email the file to the teacher. • Give students resources to look at for homework about the laser cutter.

Name		Lesson	12	Date	Week 4
Class	STEM	Topic	3D PRINTER	Year level	10
Total students	25	Length (Mins)	90 mins		

Plan for lesson:	Students will be introduced to the 3D Printer and Fusion 360 which is the program needed to use the 3D printer. Some students may have prior knowledge of how to use the 3D printer and Fusion 360, so this lesson will remind them students of how to use it.
Key ideas:	Students understand how the 3D Printer works, how to use the program for the 3D Printer and show how it can be used in their projects.
Student learning outcomes:	Students learn how to use the 3D Printer, how to use Fusion 360 and design a team logo for their team which may be printed out.
Evidence of learning	Students understand how the 3D Printer and Fusion 360 are used. Students produce a small key ring.
Students will...	Be introduced or re-introduced to the 3D Printer and how to use Fusion 360 which is needed to use the 3D Printer. They will learn how to use the 3D Printer in their project and if they use their time efficiently, they will get to print a team logo.

Teacher Outcomes	Class Plan
Before class ● Have 3D Printer and materials ready. ● Any YouTube clips or resources ready. ● Have Fusion 360 all loaded and ready to go from the start of the lesson. **During class** ● Go around the class room and help each student with their team logo they are making. **Closure** ● Remind students about what is expected of them for the next couple of weeks as we will start producing the projects next week. ● Give students resources to watch for homework about the laser cutter. ● Answer any questions the students may have. **After class** ● Pack up class. ● Leave 3D Printer running if students are printing their logo.	**Introduction** ● Introduce the 3D Printer and Fusion 360 to students. ● Teach students how to use the 3D and show them what it can print out. ● Show resources to students. ● Show students how the 3D Printer can be used in their projects. **Development** ● Go around to each group and help them with their design of their team logo. ● Help students with any problems they are facing with Fusion 360. ● Answer any questions they may have. **Closure** ● Remind students of what they have learnt about the 3D Printer ● Remind students to pick up their work later in the day if they have printed. ● If students want to print their team logo once they have finished it, they can email the file to the teacher. ● Give students resources to look at for homework about the 3D Printer and Fusion 360.

Name		**Lesson**	13	**Date**	Week 5
Class	STEM	**Topic**	Introducing the assignment	**Year level**	10
Total students	25	**Length (Mins)**	1 hour		

Plan for lesson:	Students will get introduced to the *mission to mars* assignment, will form their teams and start researching about project 1.
Key ideas:	For students to be able to fully understand what is expected of them for the assignments
Student learning outcomes:	To be introduced to their assignment that involves 3 different projects. Students will form their teams and discuss with the teacher any questions they have before starting on the 1st project.
Evidence of learning	Students understand the assignment and are starting to research what they need for the 1st project
Students will...	Be introduced to the assignment, Form their team of 3-4 Start project 1 Ask teacher about any questions they may have on the assignment.

Teacher Outcomes	**Class Plan**
Before class • Print of student handout of assignment • Prepare presentation • Organise how many students will be in one group **During class** • Introduce assignment • Discuss all 3 projects • Let students pick their groups • Answer any questions students may have off this assignment **Closure** • Ask one member of each group to write down the group member in their team and give to the teacher. • Prepare them for the next class. **After class** • Go over groups.	**Introduction** • Give each student a handout of the assignment. • Introduce the assignment to the students. **Development** • Students are to research about the 1st project • Discuss with the teacher what they may have in mind for project 1 • Ask the teacher any questions they may have. **Closure** • Make sure each member of the class is in a group. • Make sure each group understands the assignment and the expectations.

Name		**Lesson**	14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26	**Date**	Week 5 – Week 9
Class	STEM	**Topic**	Producing & testing of the projects.	**Year level**	10
Total students	25	**Length (Mins)**	45 mins (single) or 90 mins (double)		

Plan for lesson:	Students continue working on their rocket and soft-landing projects in their teams or individually. Students continue to do tests on their rocket and soft-landing project to fix any faults and to improve their design.
Key ideas:	Refer to plan for learning
Student learning outcomes:	Refer to evidence of learning
Evidence of learning	Students are working together in their group or individually to improve their rockets and soft-landing capsules. This can be shown by the students researching or working on their computer on the project or testing their projects outside.
Students will...	Continue working on their projects and improve their projects.

Teacher Outcomes	**Class Plan**
Before class • Make sure to bring all students projects. • All equipment and materials are ready for the students to use. • Warm up laser cutter and 3d printer. **During class** • Go around to all groups and work with them for 5 minutes on their project. • Make sure all groups are on task and on track to completing their project. **Closure** • Close class with what is expected next week. **After class** • Clean up personal gear	**Introduction** • Get them working on their projects straight away. **Development** • Show students examples of work or discuss implications of their groups project. • Continue to work on projects **Closure** • Get students to clean up all messes • Close class with what is expected next week.

Name		**Lesson**	27	**Date**	Week 9
Class	STEM	**Topic**	Introducing presentation (project 3)	**Year level**	10
Total students	25	**Length (Mins)**	45 mins		

Plan for lesson:	To introduce students to the 3rd project of this assignment, the presentations.
Key ideas:	Discuss what is needed for the presentations, as well as requirements etc.
Student learning outcomes:	Students learn what is needed for the presentation and start working on it.
Evidence of learning	Students make a start on presentation with PowerPoint or by writing notes.
Students will...	Start making their presentation on PowerPoint and have what is needed for their presentation needed.

Teacher Outcomes	**Class Plan**
Before class • Have class set up • Have anything students may need for class ready. **During class** • Go around to each class and see how their power point presentations are going. **Closure** • Give students homework and answer any questions students may have about project 3. **After class** • Pack up class.	**Introduction** • Introduce project 3 to the students in depth and in as much detail as you can. • Answer questions students may have. **Development** • Go around to each group and help them with their design of their presentation or answer any questions they may have. **Closure** • Go over what is required for project 3. • Answer any questions students may have.

Name		**Lesson**	28 and 29	**Date**	Week 10
Class	STEM	**Topic**	Continue working on presentation (project 3)	**Year level**	10
Total students	25	**Length (Mins)**	90 mins		

Plan for lesson:	Students in their groups continue to work on their presentations as a group.
Key ideas:	Make sure all groups are on task to finishing their presentation lay out by the end of the lesson.
Student learning outcomes:	Refer to evidence of learning
Evidence of learning	Students continue to work on presentation with power point or by writing notes.
Students will...	Finish or be near to finishing their presentation by the end of this lesson.

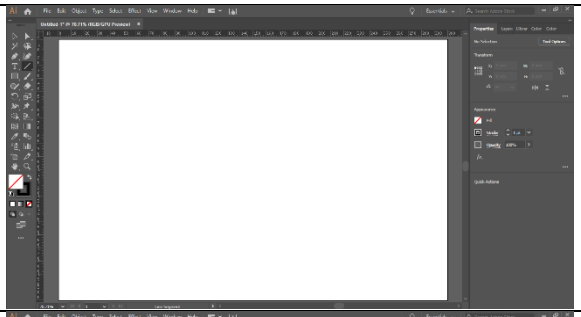
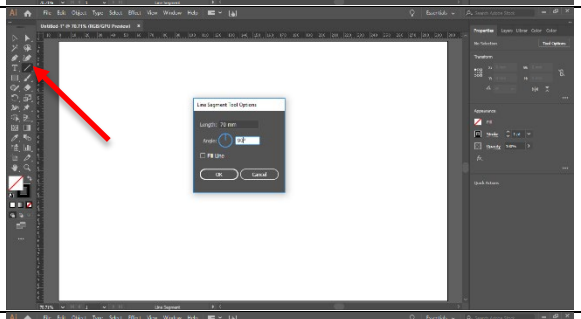
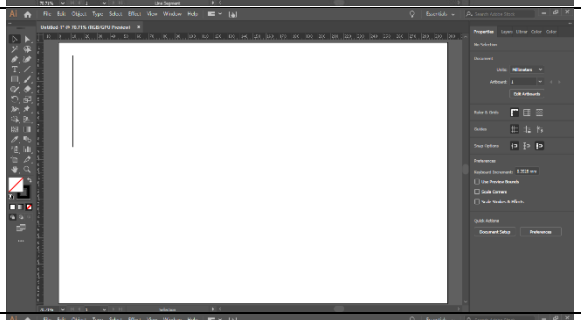
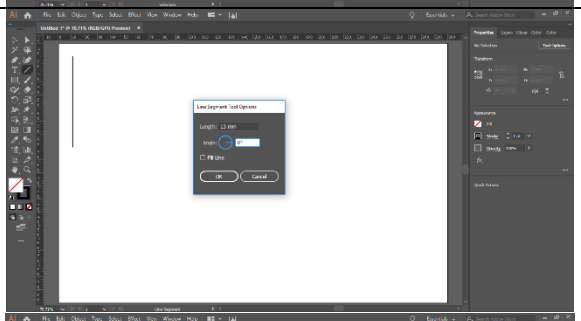
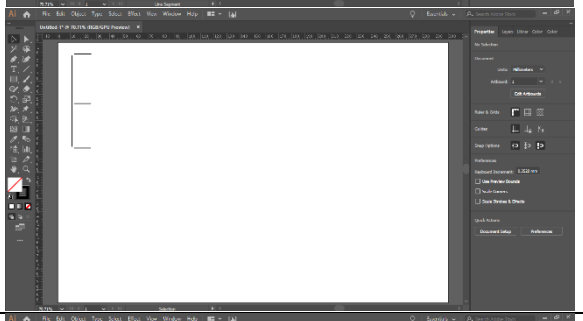
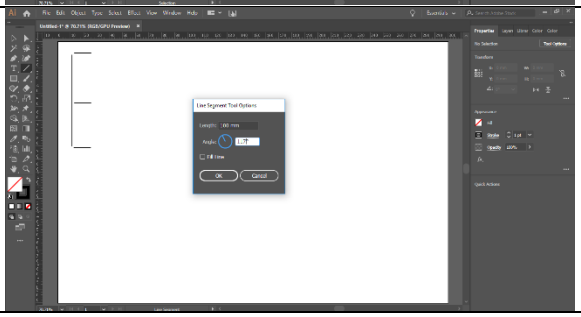
Teacher Outcomes	**Class Plan**
Before class • Have class set up • Have anything students may need for class ready. **During class** • Go around to each class and see how their power point presentations are going. **Closure** • Give students homework and answer any questions students may have about project 3. **After class** • Pack up class.	**Introduction** • Go over the requirements of the presentation so each group is reminded. • Answer questions students may have. **Development** • Go around to each group and help them with their design of their presentation or answer any questions they may have. **Closure** • Remind students to meet in the lecture room tomorrow. • Be ready to present their presentation • Remind students to bring model of rocket and soft-landing capsule.

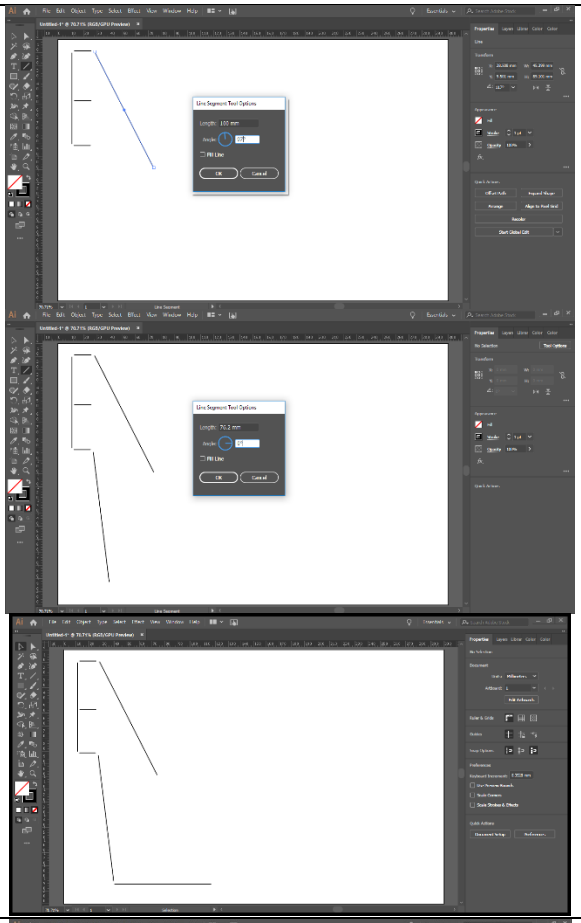
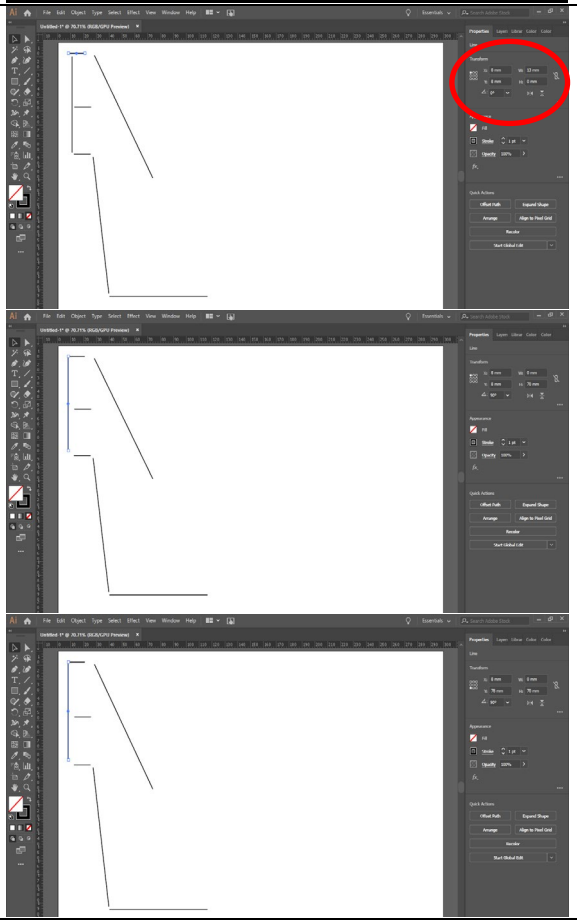
Name		**Lesson**	30	**Date**	Friday week 10
Class	STEM	**Topic**	Presentation of projects	**Year level**	10
Total students	25	**Length (Mins)**	1 hour		

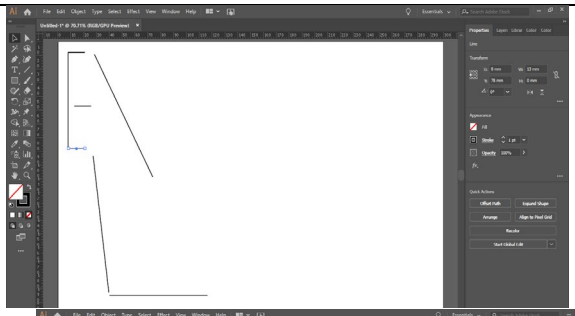
Plan for lesson:	The plan for this lesson is that each group in the class will perform a presentation about their projects to the class for around 5-10 mins.
Key ideas:	During the presentations, students should discuss their research on each project, challenges they faced and how they overcome this, what worked, a video of them testing their rockets and soft-landing capsules and anything extra the students want to include.
Student learning outcomes:	Speaking in front of people, confidence
Evidence of learning	Reflection in presentation
Students will...	Present their presentation in their teams about their rocket and soft-landing capsule to the class.

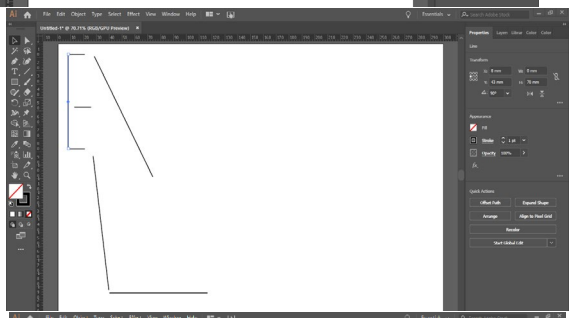
Teacher Outcomes	**Class Plan**
Before class ● Book Lecture room. ● Check that the projector is working ● Sound is working for videos **During class** ● Mark students' presentations ● Ask specific questions to groups when presenting ● Time each presentation **Closure** ● Congratulate the class. ● Overview of what the students accomplished **After class** ● Make sure lecture room is clean and tidy before leaving.	**Introduction** ● Introduce how the presentation will work. ● Number each group in order so they know when they are next to present. **Development** ● Students will during all presentations to gain knowledge and insights from other groups in the class. **Closure** ● Congratulate students on a successful mission to Mars.

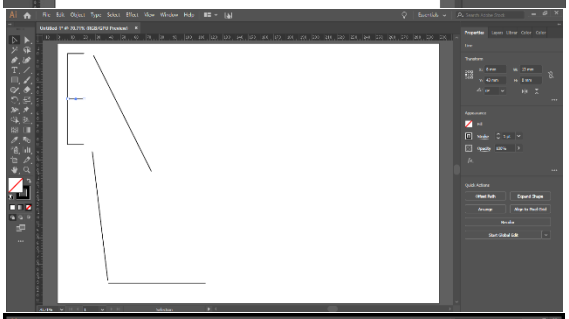
Designing the Rocket Fins in Adobe Illustrator

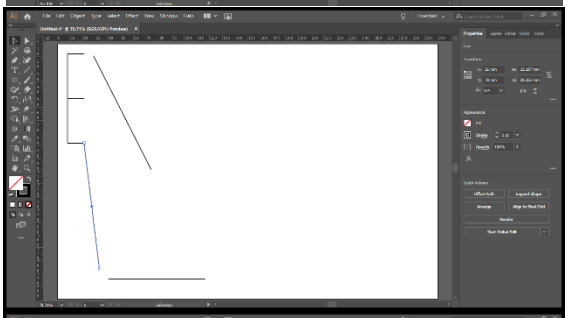
Create a new document in Adobe Illustrator	
Using the line tool draw a line that is 70mm long. Click on the line tool and then press anywhere on the document and enter in details and click ok.	
Move the line into position	
Create another line that is 13mm long. Copy and paste twice. use ctrl + c for copy and ctrl + v for paste.	 
Create another 3 lines	

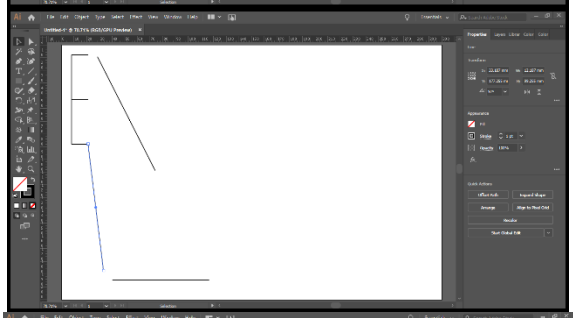
	
From here move all the line so that they all touch. With the lines on an angle you will need to adjust the lengths to the correct length. Use the grid references to correctly place the lines.	

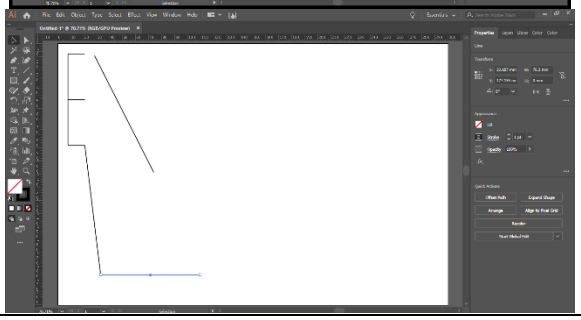


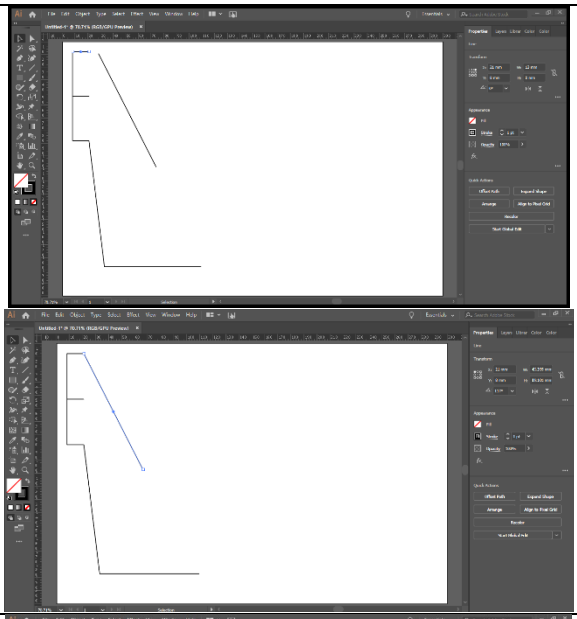
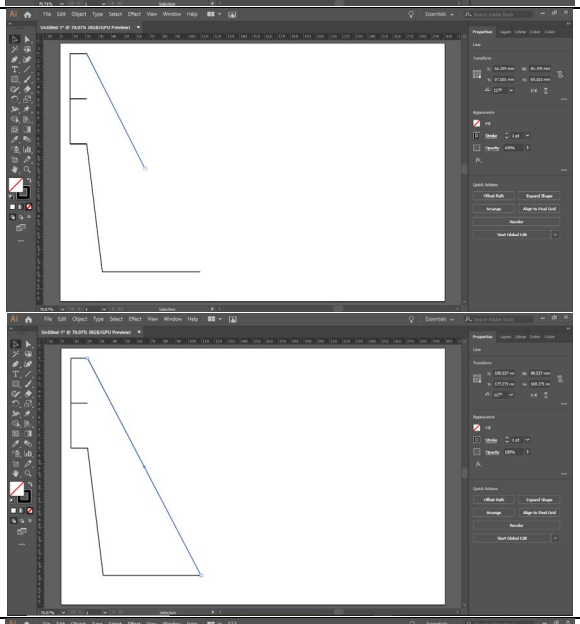
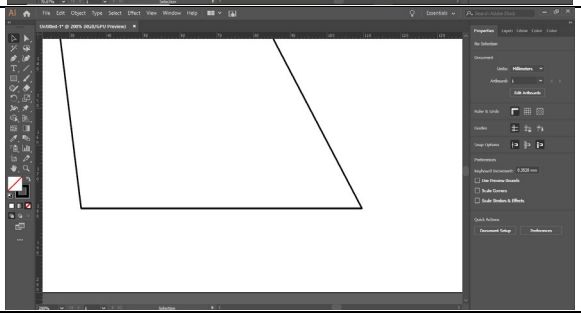
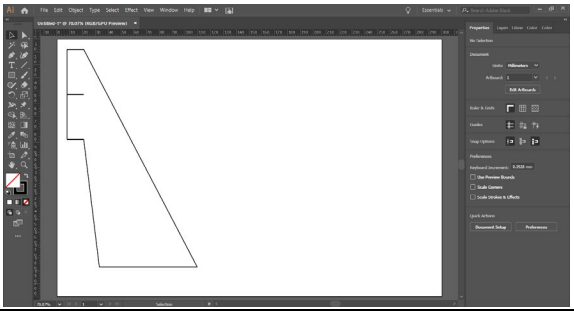


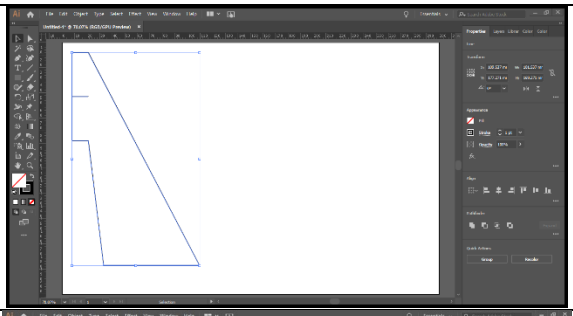
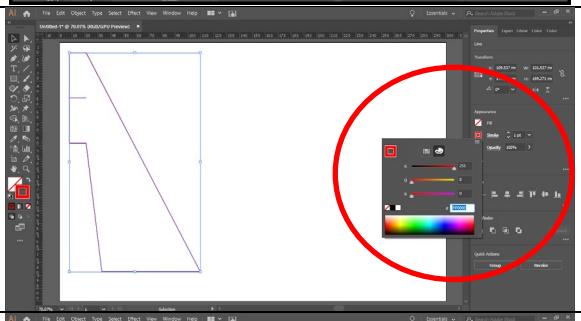
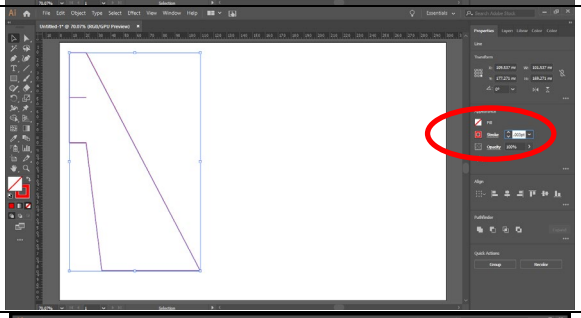
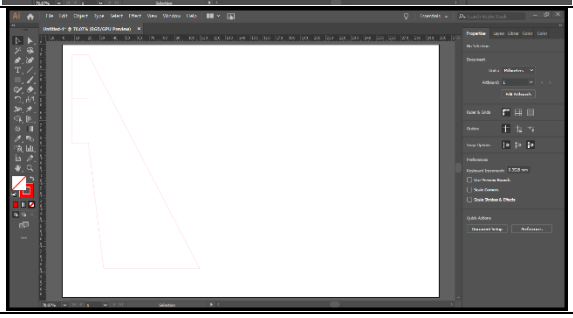
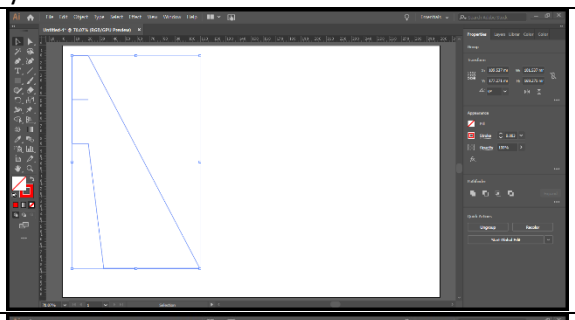
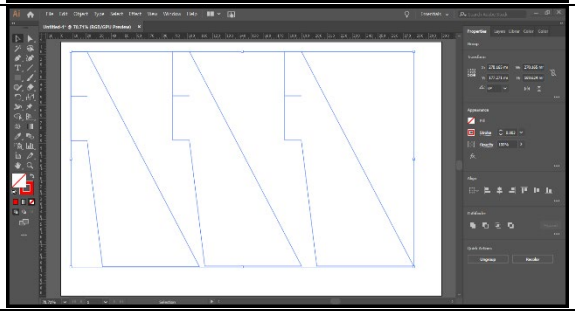


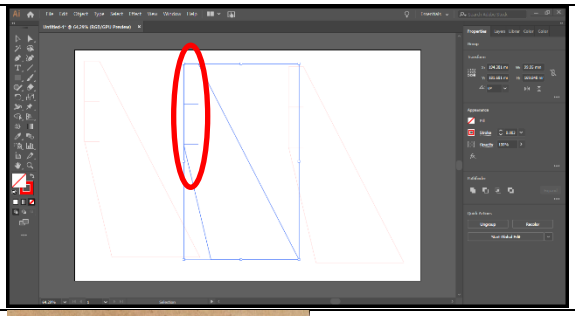




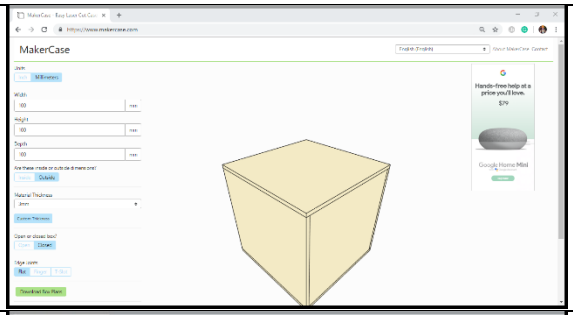
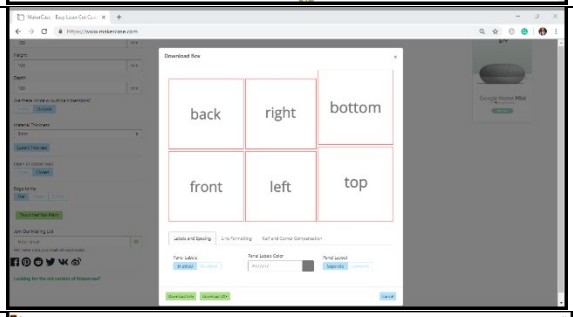
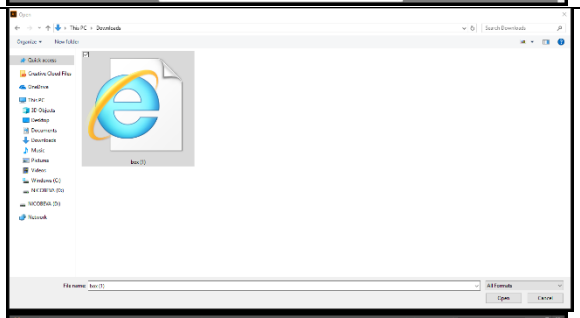
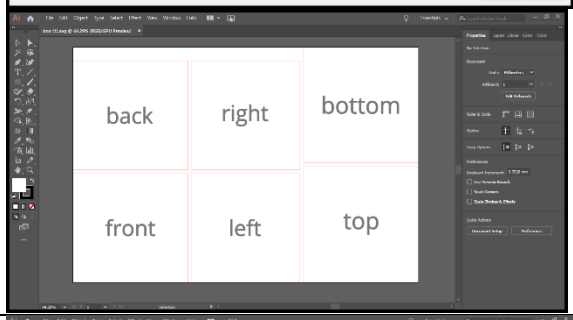
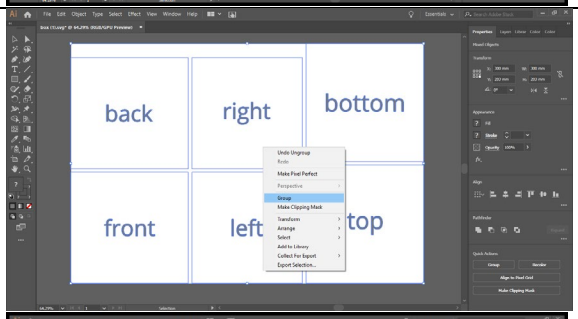
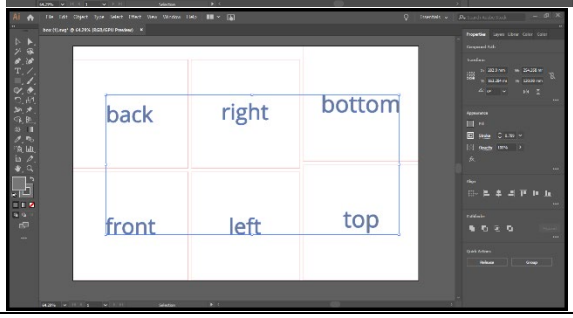


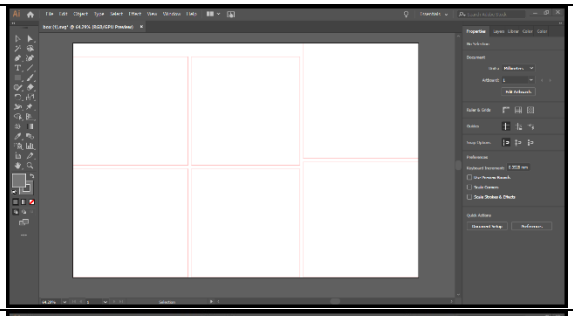
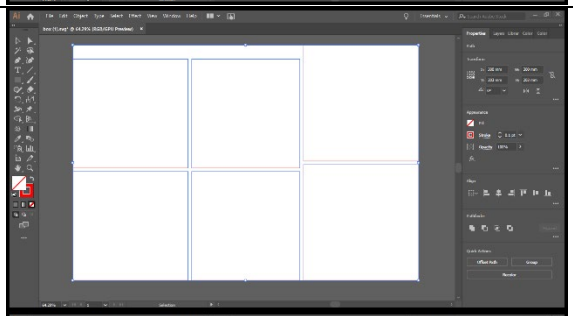
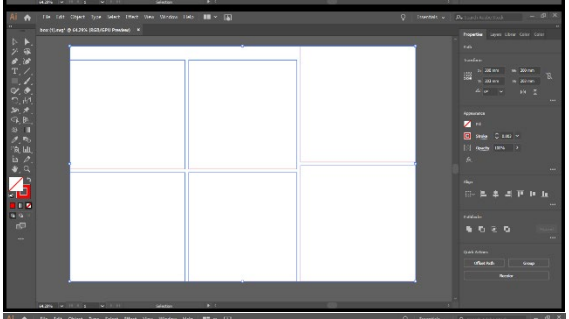
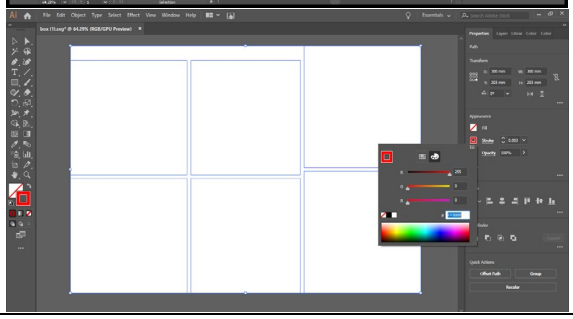
	
From here you will need to click and drag on the bottom white square of the line and drag it down till it meets the horizontal line at the bottom.	
Next, zoom in using ctrl & +, to see if the two lines meet	
Press ctrl & 0 to zoom to full screen	

Highlight all lines to change the thickness of lines	
Change the stroke colour to RGB red	
Change the line thickness to 0.003pt (or the correct thickness according to the laser cutter)	
Once you click somewhere on the document away from the wing, it will look like the wing has disappeared. It is there just faint due to line thickness	
From here using ctrl & + zoom in and check that all the line are touching where they are mean to. If not move them towards each others carefully. Ctrl & z for undo	
If lines are all touching, press ctrl & g to group all the lines together. This will allow the lines to be one and easier to move around and copy multiple times.	
From here copy and paste enough times to have desired number of wings. move them to desired location.	
Refer to your laser cutter for instructions on how to print with your laser cutter.	

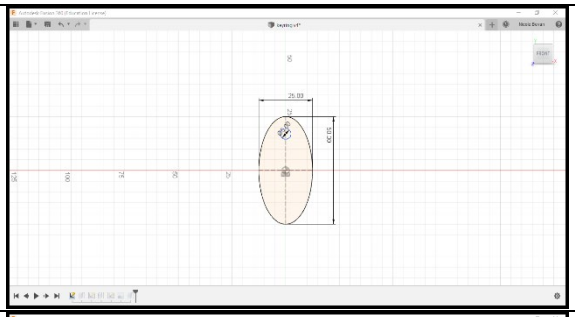
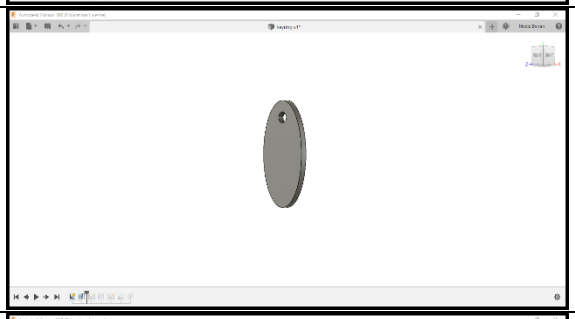
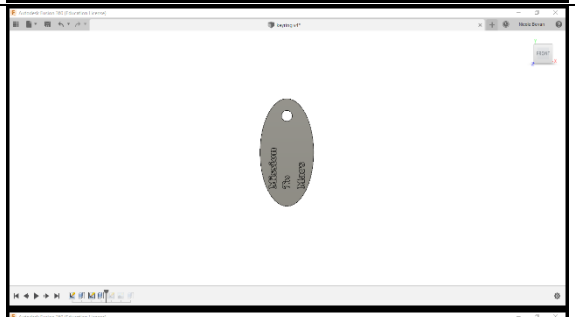
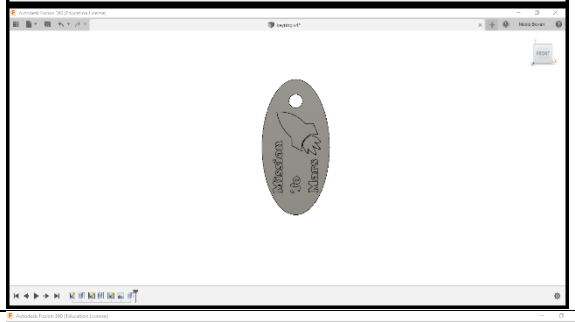
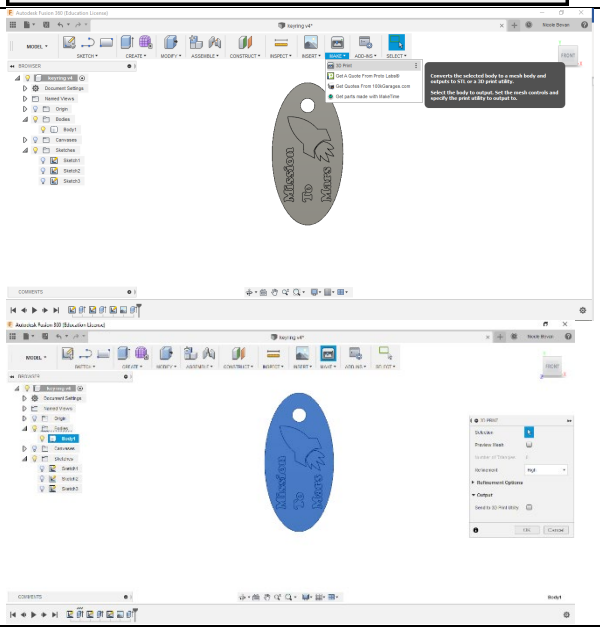
Once lasered, depending on the material used bend one of the tabs to the left and the other to the right. This will allow the wings to stick on easier to the bottle.	
Using super glue or any other possible method (not a hot glue gun as it will melt the bottle a little and it will lose its shape) glue on the wings where for example the coke labelling goes. Ensure that the bottom of the wings (opposite end to the tabs is near the bottle opening). Using scissors cut the labelling off the bottle. If you chose to decorate your rocket, ensure that you decorate the wings before you attach them to your rocket. You can add a nose cone if you like.	 

Designing the Egg Capsule in Adobe Illustrator

Using the following website enter in the correct measurements. https://www.makercase.com/	
Press “Download box plans”. Select “Download SVG”	
Open Adobe Illustrator and press open, this will then allow you to choose your file. press open.	 
Select all square and writing, right click on mouse and press ungroup. Select all the writing and delete all. hold shift down when selecting then delete.	 

<table>
<tr><td></td><td>  </td></tr>
<tr><td>From here, select all the boxes and change their colour to RGB red and line thickness to the correct one according to your laser cutter,</td><td> 
 
  </td></tr>
<tr><td colspan="2">Refer to your laser cutter for instructions on how to print with your laser cutter.</td></tr>
<tr><td colspan="2">Using any method to glue/stick box together. Ensure that a dry fit is completed first.</td></tr>
<tr><td colspan="2">Fill with desired materials e.g. cloths, bubble wrap and then place egg inside.</td></tr>
<tr><td colspan="2">  </td></tr>
</table>

Designing a Key Ring in Autodesk Fusion 360

Create a new fusion 360 file. Press sketch, then circle. Create an oval that is 50mm long by 25mm wide. Place a 5mm diameter 5mm away from the top of the oval.	
Extrude 5mm. Do this by pressing Create and then Extrude.	
From here you can add text and images.	 
Once you have your desired design press Make then 3D print. Then select Bodies – Bodies1 and then press ok. Select the desired file save locations and save. From here you will need to refer to your 3D printer instructions for what to do next.	

Basic Rocket Design

The following list of equipment, machines and other and images are of a possible Rocket launching system and bottle rocket. This system does work. (Missing from images is the bike pump)

<table>
<tr><th colspan="2">Equipment needed</th><th>Machines Needed</th></tr>
<tr><td>

15x Cable ties (8mm head)
19mm PVC piping
1x 8mm by 40mm bolt
1x coke bottle
1x PVC pipe L piece
2.5m of string
3x eye hook screws
2x 8mm hole metal washes
2x Minimum 20mm Hose clamp
2x wood screws – 10mm long 3mm
40mm PVC piping
4x metal tent pegs
4x 8mm hole nuts
4x 20mm PVC pipe end stoppers

</td><td>

4x 20mm PVC pipe T sections
8x 20mm Pipe saddle
8x wood screws – 25mm long 6mm think
Bike pump
External round chair leg tip Rubber stopper 19mm internal size circle
over 1m of 8mm hollow plastic tube
Solid board thickness minimum 25mm – MDF, Particle board, timber
Tube valve
Water

</td><td>

Corded Drill and/or Cordless drill
Drills bits – 1 @ 3mm and another @ depends on peg sizes
Hacksaw and/or Panel saw

Other

Pen/Pencil/Marker
Ruler
Screw driver
Vernia

</td></tr>
</table>