BAE Systems Partnered STEM Unit

TEAM ROCKET

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Industry Summary

“At BAE Systems, our advanced defence technology protects people and national security, and keeps critical information and infrastructure secure. We search for new ways to provide our customers with a competitive edge across the air, maritime, land and cyber domains (BAE Systems 2019a).”

Our industry visit to BAE Systems Australia national headquarters in Edinburgh help provide context and scale to who they are and what they do. One of Australia’s major defense primes BAE Systems Australia primarily focuses on project based development meaning that their role is always changing to the demands of their clients. The scale of these projects vary greatly from a security systems overhaul at Parliament House to a 30 billion dollar 30 year contract delivering Australia’s next fleet of Hunter Class Frigates. At its peak this project that will constitute approximately 50% of the companies workload will provide more than 6300 jobs and $1 billion to the national economy (BAE Systems 2018). As such a significant provider BAE Systems represents certain future career prospects to today’s students.

Although primarily focused on projects, one of the few products the Australian contingent exports is the Nulka Active Missile Decoy. The Nulka is a unique hovering rocket that seduces anti-ship missiles away from their intended targets. The rocket is Australia’s largest defence export providing significant research, education and career opportunities (BAE Systems 2019b). We found both the relevance of the Nulka as well as its potential to be engaging and ability to enable real educational links made it a great vessel to create a STEM unit around. Our industry contact couldn’t agree more.

Context

Our fictional classroom consists of 24 year 10 students at a North-Eastern 8-12 school. The 24 students feature 16 boys and 8 girls with a diverse range of cultural backgrounds including 6 with English being their second language at home. Being a high school the students in the class have a variety of previous technology experience. Although, all students do undertake a full year of rotational technology in years 8 and 9. This means that students are somewhat familiar with the CADD CAM programs used but haven’t done any 3D printing before. 2 students in the class are new to the school this year and have little experience with CADD CAM using Google Sketch-Up instead.

The school facility consists of a large open-plan technology space for technologies classrooms with dedicated CADD CAM rooms with 4 3D printers and 1 Trotec Laser Engraver. The school also has 2 Science Labs as well as other permanent and transportable classrooms.
### TEAM ROCKET | BAE SYSTEMS

**STEM: SCIENCE TECHNOLOGY ENGINEERING MATHS**  
**CLASS:** Yr 10, 24 Students  
**DURATION:** 10 Weeks (4x50/week)

#### UNIT FOCUS

This unit focuses on developing STEM skills and understanding through a project-based mindset of learning. Students will be exploring the vast and rich world of rockets and their relevance in South Australia. In particular the role of BAE Systems. Students will be taking on the role as young engineers tasked with learning the principles of rocket flight and how this learning can influence their production of a best possible design solution. By the end of this unit students will be more capable problem solvers developing their numeracy, ICT, critical thinking and personal & social capabilities.

#### ACHIEVEMENT STANDARDS

<table>
<thead>
<tr>
<th>Science</th>
<th>GENERAL CAPABILITIES</th>
</tr>
</thead>
</table>
| By the end of Year 10, students explain the concept of energy conservation and represent energy transfer and transformation within systems. They apply relationships between force, mass and acceleration to predict changes in the motion of objects. Students analyse how the models and theories they use have developed over time and discuss the factors that prompted their review. | **Numeracy**  
- Estimating and calculating with whole numbers element  
- Using fractions, decimals, percentages, ratios and rates element  
- Using spatial reasoning element  
- Interpreting statistical information element |
| Students develop questions and hypotheses and independently design and improve appropriate methods of investigation, including field work and laboratory experimentation. They explain how they have considered reliability, safety, fairness and ethical actions in their methods and identify where digital technologies can be used to enhance the quality of data. When analysing data, selecting evidence and developing and justifying conclusions, they identify alternative explanations for findings and explain any sources of uncertainty. | **ICT Capability**  
- Investigating with ICT element  
- Creating with ICT element |
| **Design and Technologies** By the end of Year 10, students explain how people working in design and technologies occupations consider factors that impact on design decisions and the technologies used to produce products, services and environments. They identify the changes necessary to designed solutions to realise preferred futures they have described. When producing designed solutions for identified needs or opportunities, students evaluate the features of technologies and their appropriateness for purpose for one or more of the technologies contexts. | **Critical and Creative Thinking**  
- Inquiring – identifying, exploring and organising information and ideas element  
- Generating ideas, possibilities and actions element  
- Reflecting on thinking and processes element  
- Analysing, synthesising and evaluating reasoning and procedures element |
| Students create designed solutions for one or more of the technologies contexts based on a critical evaluation of needs or opportunities. They establish detailed criteria for success, including sustainability considerations, and use these to evaluate their ideas and designed solutions and processes. They create and connect design ideas and | **Personal and Social Capability**  
- Self-management element |
processes of increasing complexity and justify decisions. Students communicate and document projects, including marketing for a range of audiences. They select and use appropriate technologies skilfully and safely to produce high-quality designed solutions suitable for the intended purpose.

**Mathematics**
By the end of Year 10, students make the connections between algebraic and graphical representations of relations. Students solve surface area and volume problems relating to composite solids. They compare data sets by referring to the shapes of the various data displays. They describe bivariate data where the independent variable is time. Students describe statistical relationships between two continuous variables. They evaluate statistical reports.

They find unknown values after substitution into formulas. They use triangle and angle properties to prove congruence and similarity. Students use trigonometry to calculate unknown angles in right-angled triangles.

*(Australian Curriculum and Reporting Authority (ACARA) 2018)*

<table>
<thead>
<tr>
<th>CONTENT DESCRIPTORS</th>
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</thead>
<tbody>
<tr>
<td><strong>SCIENCE</strong></td>
</tr>
<tr>
<td><strong>SCIENCE UNDERSTANDING</strong></td>
</tr>
<tr>
<td><strong>Physical Science</strong></td>
</tr>
<tr>
<td>Energy conservation in a system can be explained by describing energy transfers and transformations (ACSSU190)</td>
</tr>
<tr>
<td>The motion of objects can be described and predicted using the laws of physics (ACSSU229)</td>
</tr>
<tr>
<td><strong>SCIENCE AS A HUMAN ENDEAVOUR</strong></td>
</tr>
<tr>
<td><strong>Nature and Development of Science</strong></td>
</tr>
<tr>
<td>Scientific understanding, including models and theories, is contestable and is refined over time through a process of review by the scientific community (ACSHE191)</td>
</tr>
<tr>
<td><strong>Use and Influence of Science</strong></td>
</tr>
<tr>
<td>People use scientific knowledge to evaluate whether they accept claims, explanations or predictions, and advances in science can affect people’s lives, including generating new career opportunities (ACSHE194)</td>
</tr>
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<table>
<thead>
<tr>
<th>CROSS CURRICULUM PRIORITIES</th>
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<tbody>
<tr>
<td><strong>Asia and Australia’s Engagement with Asia</strong></td>
</tr>
<tr>
<td>The third concept addresses the nature of past and ongoing links between Australia and Asia, and develops the knowledge, understanding and skills that make it possible to engage actively and effectively with peoples of the Asia region.</td>
</tr>
<tr>
<td><strong>Sustainability</strong></td>
</tr>
<tr>
<td>The third concept is aimed at building capacities for thinking and acting in ways that are necessary to create a more sustainable future. The concept seeks to promote reflective thinking processes in young people and empower them to design action that will lead to more a more equitable and sustainable future.</td>
</tr>
</tbody>
</table>

*(ACARA 2018)*
SCIENCE INQUIRY SKILLS
Questioning and Predicting
Formulate questions or hypotheses that can be investigated scientifically (ACSIS198)

Planning and Conducting
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)

Processing and Analysing Data and Information
Analyse patterns and trends in data, including describing relationships between variables and identifying inconsistencies (ACSIS203)

Communicating
Communicate scientific ideas and information for a particular purpose, including constructing evidence-based arguments and using appropriate scientific language, conventions and representations (ACSIS208)

TECHNOLOGIES
DESIGN AND TECHNOLOGIES KNOWLEDGE AND UNDERSTANDING
Critically analyse factors, including social, ethical and sustainability considerations, that impact on designed solutions for global preferred futures and the complex design and production processes involved (ACTDEK040)
Investigate and make judgments on how the characteristics and properties of materials are combined with force, motion and energy to create engineered solutions (ACTDEK043)

DESIGN AND TECHNOLOGIES PROCESSES AND PRODUCTION SKILLS
Critique needs or opportunities to develop design briefs and investigate and select an increasingly sophisticated range of materials, systems, components, tools and equipment to develop design ideas (ACTDEP048)
Develop, modify and communicate design ideas by applying design thinking, creativity, innovation and enterprise skills of increasing sophistication (ACTDEP049)
Work flexibly to effectively and safely test, select, justify and use appropriate technologies and processes to make designed solutions (ACTDEP050)
Evaluate design ideas, processes and solutions against comprehensive criteria for success recognising the need for sustainability (ACTDEP051)

ENGINEERING
“Engineering is addressed across the curriculum through Science, Technologies and Mathematics and in a dedicated content description focusing on engineering principles and systems at each band in Design and Technologies, content relating to engineering is identified under the most appropriate Australian Curriculum learning area” (ACARA 2018).

MATHEMATICS
NUMBER AND ALGEBRA
Patterns and Algebra
Substitute values into formulas to determine an unknown (ACMNA234)
### MEASUREMENT AND GEOMETRY

**Geometric Reasoning**
Apply logical reasoning, including the use of congruence and similarity, to proofs and numerical exercises involving plane shapes (ACMMG244)

**Pythagoras and Trigonometry**
Solve right-angled triangle problems including those involving direction and angles of elevation and depression (ACMMG245)

### STATISTICS AND PROBABILITY

**Data Representation and Interpretation**
Investigate and describe bivariate numerical data where the independent variable is time (ACMSP252)

(ACARA 2018)

### TEACHING FOR EFFECTIVE LEARNING DOMAINS

<table>
<thead>
<tr>
<th>CREATE SAFE CONDITIONS FOR RIGOROUS LEARNING</th>
<th>DEVELOP EXPERT LEARNERS</th>
<th>PERSONALISE AND CONNECT LEARNING</th>
</tr>
</thead>
<tbody>
<tr>
<td>● Develop democratic relationships</td>
<td>● Teach students how to learn</td>
<td>● Build on learners’ understandings</td>
</tr>
<tr>
<td>● Build a community of learners</td>
<td>● Foster deep understanding and skilful action</td>
<td>● Connect learning to students’ lives and aspirations</td>
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<tr>
<td>● Negotiate learning</td>
<td>● Explore the construction of knowledge</td>
<td>● Apply and assess learning in authentic contexts</td>
</tr>
<tr>
<td>● Support and challenge students to achieve high standards</td>
<td>● Promote dialogue as a means of learning</td>
<td>● Communicate learning in multiple modes</td>
</tr>
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</table>

(Department of Education and Children’s Services (DECD) 2010, p 27-78)

### LESSON SEQUENCE

<table>
<thead>
<tr>
<th>WEEKS</th>
<th>LEARNING FOCUS</th>
<th>DESIGN PROCESS</th>
<th>ASSESSMENT</th>
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</thead>
<tbody>
<tr>
<td>W1</td>
<td>Introducing the students to BAE Systems, the Nulca and ESSM Introduction to rockets and assessment of prior knowledge - Testing different amounts of water ratios a recording results</td>
<td>Investigate</td>
<td>Formative Participation Record of data in science journal</td>
</tr>
<tr>
<td>W2-3</td>
<td>Physical Science - Physics - Introduction of the 3-laws</td>
<td>Investigate</td>
<td>Formative Science Journal Class discussion</td>
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<tr>
<td>Week</td>
<td>Activity</td>
<td>Description</td>
<td>Type</td>
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</table>
| W4   | Science Enquiry | - Examining how science skills are used at BAE Systems  
- Career opportunities at BAE Systems  
- Explaining the importance of the Nulca and ESSM | Enrichment | Science Enquiry Feedback Sheet and Marking Rubric |
| W5   | Students to Design their bottle rockets | - Investigating existing designs  
- Using what they've learnt about physics to critique existing designs for their purpose  
- Generating sketches of what they want their design to look like | Investigate/Generate | Development of critiqued design and generation of design solutions |
| W6   | 3D Modelling Crash Course | - Basic skills on CADD and 3D printing  
- Tutorials | Generate/Produce | Generation of 3D model files and printed artifact |
| W7-W8 | Modeling and printing their Rocket Designs | - Template for foundations of their design work  
- Visualising their design solution and generating and producing it though CAM technologies | Generate/Produce | Generation of 3D parts for their rocket  
Production of their 3D model and Bottle Rocket product |
| W8   | Materials Application | - Investigating additive manufacturing  
- Investigating sustainable materials  
- Investigating sustainable design solutions | Enrichment | Investigation into material applications |
| W9   | Final tests | - Testing rockets against criteria  
- Recording and analysing data  
- Presenting data | Evaluate | Recording of data and analysis of their testing results |
| W9&10 | Evaluation | - Critically evaluating the design process | Evaluate | Individual evaluation of the design process |
## Summative Assessment Tasks

<table>
<thead>
<tr>
<th></th>
<th>Resources</th>
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</thead>
</table>
| **Poster** | Bottle Rocket Design Brief  
Bottle Rocket Product and Folio Feedback Sheet and Marking Rubric  
Science Enquiry Brief  
Science Enquiry Feedback Sheet and Marking Rubric |
| 20% | Science Enquiry |
| **Product** | **Student Resources**  
Videos about rockets  
Design Investigation Exemplar  
Crash Course CADD Tutorial  
Bottle Rocket Foundations CADD Template  
Materials Investigation Guiding Questions  
Final Testing Worksheet  
Individual Evaluation Worksheet |
| 26% | Rocket Product |
| **Folio** | **Physical Resources**  
Example Rocket  
Example Launching Pad |
| 8% | Design Investigation  
Generation of Designs  
3D Files of their Rocket  
Detailing of Production  
Materials Application  
Pre and Post Testing Results  
Evaluation |
TEAM ROCKET
Careers In STEM | Research Assignment

**TASK**
Your task is to create a poster showing how science skills used at school relate to careers at BAE systems. Research two different careers at BAE systems that use either Science, Technology, Engineering or Maths and answer the following:

- What is the career?
- How does it involve STEM
- What are the educational requirements or skills or training required for this job?
- Research the NULCA and ESSM Rocket, explain what they are, outline the science involved in making them, what benefits do they have for society?
- Add any other interesting information you can find

**DELIVERABLES**
Your poster should be 700 words long no more than 900 and have references listed on the back.

**DUE DATE:** 11pm, Monday 01.01.20
# TEAM ROCKET
Marking Rubric & Feedback Sheet

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
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<th>D</th>
<th>E</th>
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<tbody>
<tr>
<td><strong>Science Understanding</strong></td>
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<tr>
<td></td>
<td>Sophisticated</td>
<td></td>
<td>Capable</td>
<td></td>
<td>Partial</td>
</tr>
<tr>
<td></td>
<td>Clear and Detailed description and comprehensive explanation of science knowledge</td>
<td>Clear description and detailed explanation of science knowledge</td>
<td>Adequate description, definition and identification of science knowledge</td>
<td>Simple description, definition and identification of science knowledge</td>
<td>Recognition and beginning understanding of science knowledge</td>
</tr>
<tr>
<td><strong>Science as a Human Endeavour</strong></td>
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<tr>
<td></td>
<td>Reasoned explanation of how evidence has led to the development of science knowledge and the application of science knowledge and skill to solve real world and contemporary problems.</td>
<td>Explanation of how evidence has led to the development of science knowledge and the application of science knowledge and skill to solve real world and contemporary problems.</td>
<td>Description about the role evidence has in the development of science knowledge and the application of science knowledge and skill to solve real world and contemporary problems.</td>
<td>Statements about the application of science knowledge and skills to solve real world and/or contemporary problems</td>
<td>Isolated statements about the use of science to solve real world problems</td>
</tr>
<tr>
<td><strong>Communication</strong></td>
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<tr>
<td></td>
<td>Clear and purposeful use of all appropriate scientific language, conventions, representations and text types to communicate findings with complete success.</td>
<td>Clear use of mostly appropriate scientific language, conventions, representations and text types to communicate findings and ideas with success.</td>
<td>Clear and purposeful use of all appropriate scientific language, conventions and text types to communicate findings with complete success.</td>
<td>Use of generally appropriate scientific language, conventions, representations and text types to communicate findings and ideas with general success.</td>
<td>Use of everyday language to communicate findings and ideas.</td>
</tr>
<tr>
<td><strong>Presentation/References</strong></td>
<td>The poster is exceptionally attractive in terms of design, layout, and neatness. There are no grammatical mistakes on the poster. Correct reference list provided with all information.</td>
<td>The poster is attractive in terms of design, layout, and neatness. There are 1-2 grammatical mistakes on the poster. List of references provided with some information.</td>
<td>The poster is satisfactory in terms of design, layout, and neatness. There are 3-4 grammatical mistakes on the poster. List of references.</td>
<td>The poster is acceptably attractive though it may be a bit messy. There are 4-5 grammatical mistakes on the poster. Some or no references.</td>
<td>The poster is distractingly messy or very poorly designed. It is not attractive. There are more than 5 grammatical mistakes on the poster. No references.</td>
</tr>
</tbody>
</table>

**GRADE**

Name:
### Achievement Standard

Students examine the different science knowledge used in occupations. They select appropriate representations and text types to communicate science ideas for specific purposes.

### Content Descriptors

<table>
<thead>
<tr>
<th>Science Understanding</th>
<th>General Capabilities</th>
<th>Cross Curriculum Priorities</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Physical Science</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy conservation in a system can be explained by describing energy transfers and transformations (ACSSU190)</td>
<td>Literacy</td>
<td>Asia and Australia’s Engagement with Asia</td>
</tr>
<tr>
<td>The motion of objects can be described and predicted using the laws of physics (ACSSU229)</td>
<td>ICT Capability</td>
<td></td>
</tr>
</tbody>
</table>

| **Science as a Human Endeavour** | | |
| Use and Influence of Science | Critical and Creative Thinking | |
| People use scientific knowledge to evaluate whether they accept claims, explanations or predictions, and advances in science can affect people’s lives, including generating new career opportunities (ACSHE194) | | |

| **Science Inquiry Skills** | | |
| Communicating | | |
| Communicate scientific ideas and information for a particular purpose, including constructing evidence-based arguments and using appropriate scientific language, conventions and representations (ACSIS208) | | |

(ACARA 2018)
TEAM ROCKET

Product & Folio Design Brief

CONTEXT
BAE Systems is one of Australia’s biggest employers and exporters and are based here in South Australia. Two of their front-line products are the Nulka Anti-Missile Defence System and Evolved Sea Sparrow Missile (ESSM). Although different in purpose both of these missiles have to be both reliably accurate and launched into the sky rapidly.

We will be starting where many of BAE Systems engineers did by exploring how we can shoot our very own water powered Bottle Rockets into the stratosphere. Just like the Nulka and ESSM our Bottle Rockets need to be reliable and aerodynamic so that they can be launched accurately into the sky. In groups you will be investigating rocket principles, designs and materials, generating design ideas, producing 3D parts and assembling, testing and evaluating the project collaboratively. All elements of the design process will be documented and managed in a design portfolio.

TASK
In groups of 3, to investigate, generate, produce and evaluate collaboratively a recycled and 3D printed bottle rocket that can be launched as high as possible and be launched as far as possible.

CONSTRAINTS
Students will:
- Have access to the CADD Pods and 3D printers with teacher permission.
- Need to use the Bottle Rocket design template, unless negotiated.
- Have access to the supplied materials only, unless negotiated with.
- Be allowed to use hand tools in the workshop with teacher permission.

CONSIDERATIONS
Students should consider:
- The aerodynamics of their Bottle Rocket.
- How you can sustainably use materials that will have a minimal or positive impact.

DELIVERABLES
- An A4 design portfolio displaying the stages of the design process (investigate, generate, produce and evaluate). [The portfolio is to be submitted online in word or PDF format]
- All final CADD files used for 3D printed rocket parts [Uploaded online]
- 1x Bottle Rocket product. [Labelled with all team member names]

WEIGHTING
- Design Portfolio 54%
- Product 26%

DUE DATE: 11pm, Monday 01.01.20
## TEAM ROCKET

### Marking Rubric & Feedback Sheet

<table>
<thead>
<tr>
<th>Design Investigation</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
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</thead>
<tbody>
<tr>
<td>Sophisticated</td>
<td>Capably critiqued the functionality and sustainability of many past and future designs against the brief.</td>
<td>Competently critiqued the functionality and sustainability of some past designs against the brief.</td>
<td>Partially critiqued the functionality and sustainability of a few past designs against the brief.</td>
<td>Attempted to critique the functionality and sustainability of past designs against the brief.</td>
<td></td>
</tr>
<tr>
<td>Capable</td>
<td>Competently critiqued the development of many possible design solutions.</td>
<td>Competently communicated and justified the development of some possible design solutions.</td>
<td>Partially communicated and justified the development of a few possible design solutions.</td>
<td>Attempted to communicate and justify the development of possible design solutions</td>
<td></td>
</tr>
<tr>
<td>Partially</td>
<td>Attempted to critique the functionality and sustainability of past designs against the brief.</td>
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<tr>
<td>Attempted</td>
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<table>
<thead>
<tr>
<th>Generation of Designs</th>
<th>A</th>
<th>B</th>
<th>C</th>
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<th>E</th>
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</thead>
<tbody>
<tr>
<td>Sophisticely communicated and justified the development of a vast array of possible design solutions.</td>
<td>Capably communicated and justified the development of many possible design solutions.</td>
<td>Competently communicated and justified the development of some possible design solutions.</td>
<td>Partially communicated and justified the development of a few possible design solutions.</td>
<td>Attempted to communicate and justify the development of possible design solutions</td>
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<tr>
<td>Capably</td>
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<tr>
<td>Competently</td>
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<td>Partially</td>
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<td>Attempted</td>
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<table>
<thead>
<tr>
<th>CADD Files</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
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</thead>
<tbody>
<tr>
<td>Sophistically generated a 3D model from the template. Efficient inclusion of further design elements through many modelling techniques.</td>
<td>Capably generated a 3D model from the template. Inclusion of further design elements through many modelling techniques.</td>
<td>Competently generated a 3D model from the template. Inclusion of further design elements through some modelling techniques.</td>
<td>Partially generated a 3D model from the template. Inclusion of further design elements through a few modelling techniques.</td>
<td>Attempted to generate a 3D model from the template. Absence of further design elements.</td>
<td></td>
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<tr>
<td>Capably</td>
<td></td>
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<tr>
<td>Competently</td>
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<td>Partially</td>
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<td>Attempted</td>
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<thead>
<tr>
<th>Production Walkthrough</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
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<tbody>
<tr>
<td>Sophisticately produced a design solution following all considerations and constraints. Expertly demonstrated safe working procedures.</td>
<td>Capably produced a design prototype following most considerations and constraints. Successfully demonstrated safe working procedures.</td>
<td>Competently produced a design prototype following many considerations and constraints. Generally demonstrated safe working procedures.</td>
<td>Partially produced a design prototype following few considerations and constraints. Occasionally demonstrated safe working procedures.</td>
<td>Attempted to produce a design prototype not following considerations and constraints. Did not demonstrate safe working procedures.</td>
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<tr>
<td>Capably</td>
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<td>Competently</td>
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<td>Partially</td>
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<table>
<thead>
<tr>
<th>Materials Application</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sophisticely analysed the impact of technological practices, products, or systems on individuals, society, and/or the environment.</td>
<td>Capably analysed the impact of technological practices, products, or systems on individuals, society, and/or the environment.</td>
<td>Competently analysed the impact of technological practices, products, or systems on individuals, society, and/or the environment.</td>
<td>Partially analysed the impact of technological practices, products, or systems on individuals, society, and/or the environment.</td>
<td>Attempted to analyse the impact of technological practices, products, or systems on individuals, society, and/or the environment.</td>
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<table>
<thead>
<tr>
<th>Testing</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sophistically communicated the analysis of data through testing of a design solution.</td>
<td>Capably communicated the analysis of data through testing of a design solution.</td>
<td>Competently communicated the analysis of data through testing of a design solution.</td>
<td>Partially communicated the analysis of data through testing of a design solution.</td>
<td>Attempted to communicate the analysis of data through testing of a design solution.</td>
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<td>Capably</td>
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<table>
<thead>
<tr>
<th>Evaluation</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sophistically critiqued and provided better design solutions to all stages of the design process.</td>
<td>Capably critiqued and provided better design solutions to most stages of the design process.</td>
<td>Competently critiqued and provided better design solutions to many stages of the design process.</td>
<td>Partially critiqued and provided few better design solutions to few stages of the design process.</td>
<td>Attempted to critique and provide better design solutions to stages of the design process.</td>
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</tr>
<tr>
<td>Capably</td>
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<td>Competently</td>
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<td>Attempted</td>
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</table>

## GRADE

Name: [Name]
By the end of Year 10, students explain how people working in design and technologies occupations consider factors that impact on design decisions and the technologies used to produce products, services and environments. They identify the changes necessary to designed solutions to realise preferred futures they have described. When producing designed solutions for identified needs or opportunities, students evaluate the features of technologies and their appropriateness for purpose for one or more of the technologies contexts.

Students create designed solutions for one or more of the technologies contexts based on a critical evaluation of needs or opportunities. They establish detailed criteria for success, including sustainability considerations, and use these to evaluate their ideas and designed solutions and processes. They create and connect design ideas and processes of increasing complexity and justify decisions. Students communicate and document projects, including marketing for a range of audiences. They select and use appropriate technologies skilfully and safely to produce high-quality designed solutions suitable for the intended purpose.

**CONTENT DESCRIPTORS**

**DESIGN AND TECHNOLOGIES KNOWLEDGE AND UNDERSTANDING**

Critically analyse factors, including social, ethical and sustainability considerations, that impact on designed solutions for global preferred futures and the complex design and production processes involved (ACTDEK040)

Investigate and make judgments on how the characteristics and properties of materials are combined with force, motion and energy to create engineered solutions (ACTDEK043)

**DESIGN AND TECHNOLOGIES PROCESSES AND PRODUCTION SKILLS**

Critique needs or opportunities to develop design briefs and investigate and select an increasingly sophisticated range of materials, systems, components, tools and equipment to develop design ideas (ACTDEP048)

Develop, modify and communicate design ideas by applying design thinking, creativity, innovation and enterprise skills of increasing sophistication (ACTDEP049)

Work flexibly to effectively and safely test, select, justify and use appropriate technologies and processes to make designed solutions (ACTDEP050)

Evaluate design ideas, processes and solutions against comprehensive criteria for success recognising the need for sustainability (ACTDEP051)

(ACARA 2018)
# TEAM ROCKET | BAE SYSTEMS

**LESSON NO:** 1  
**LOCATION:** Classroom  
**YR LEVEL:** 10  
**STUDENT NO:** 24  
**DURATION:** 50min

**LESSON FOCUS:** Introduction to STEM unit and BAE Systems

**UNIT FOCUS**

This unit focuses on developing STEM skills and understanding through a project-based mindset of learning. Students will be exploring the vast and rich world of rockets and their relevance in South Australia. In particular the role of BAE Systems. Students will be taking on the role as young engineers tasked with learning the principles of rocket flight and how this learning can influence their production of a best possible design solution. By the end of this unit students will be more capable problem solvers developing their numeracy, ICT, critical thinking and personal & social capabilities.

### CONTENT DESCRIPTORS

<table>
<thead>
<tr>
<th>SCIENCE UNDERSTANDING</th>
<th>ELABORATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Physical Science</strong></td>
<td></td>
</tr>
<tr>
<td>The motion of objects can be described and predicted using the laws of physics (ACSSU229)</td>
<td>(ACARA 2018)</td>
</tr>
</tbody>
</table>

### LEARNING OUTCOMES

Students will develop an understanding of the unit and BAE systems.

Teacher will outline the learning objectives and assessment requirements.

### RESOURCES

<table>
<thead>
<tr>
<th>Video</th>
</tr>
</thead>
<tbody>
<tr>
<td>White Board</td>
</tr>
<tr>
<td>PowerPoint</td>
</tr>
</tbody>
</table>

### SPECIAL CONSIDERATIONS
| LESSON STRUCTURE |
|------------------|------------------|------------------|
| **LEARNING ACTIVITIES** | **TEACHING POINTS/ASSESSMENT OF LEARNING/SAFETY** | **TIMINGS** |
| **INTRO** | Students to listen to teacher | Use PowerPoint to explain what the students are going to learn over the next 10 weeks | 15 |
| | Students to note any questions they have about the unit of work | Give explicit outline of the learning and assessments | |
| | | Introduce students to BAE Systems and what they make | |
| | | Link BAE to unit of work and show them the video of the NULCA | |
| **BODY** | In small groups students to make a concept map about what they know about motion | Students develop understanding of industry partnerships | 25 |
| | Groups to share maps with whole class | Assess prior knowledge of the laws of physics | |
| | Students to ask questions about unit and assessments | | |
| **CLOSURE** | Get the students to tell you one thing they learnt about BAE systems. | Check students understanding | 10 |
| | Students have opportunity to ask any more questions | | |

**EXTENSION**
LESSON NO: 2  LOCATION: Classroom  YR LEVEL: 10  STUDENT NO: 24  DURATION: 50min

LESSON FOCUS: Understand how bottle rockets work. Find the best amount of water to make the bottle rocket stay in the air longer.

UNIT FOCUS

This unit focuses on developing STEM skills and understanding through a project-based mindset of learning. Students will be exploring the vast and rich world of rockets and their relevance in South Australia. In particular the role of BAE Systems. Students will be taking on the role as young engineers tasked with learning the principles of rocket flight and how this learning can influence their production of a best possible design solution. By the end of this unit students will be more capable problem solvers developing their numeracy, ICT, critical thinking and personal & social capabilities.

CONTENT DESCRIPTORS

SCIENCE UNDERSTANDING

Physical Science
The motion of objects can be described and predicted using the laws of physics (ACSSU229)

(ACARA 2018)

ELABORATIONS

Gathering data to analyse everyday motions produced by forces, such as measurements of distance and time, speed, force, mass and acceleration.

(ACARA 2018)

LEARNING OUTCOMES

Students will Investigate the relationship between volume of water and the maximum time the rocket is air borne.

Teacher will develop students understanding of how a rocket works, ask questions that scaffolds students learning experiences.

RESOURCES

PowerPoint
White Board
Video
Bottle Rocket Kit

SPECIAL CONSIDERATIONS
**LESSON STRUCTURE**

<table>
<thead>
<tr>
<th><strong>LEARNING ACTIVITIES</strong></th>
<th><strong>TEACHING POINTS/ASSESSMENT OF LEARNING/SAFETY</strong></th>
<th><strong>TIMINGS</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>INTRO</strong></td>
<td>Students listen to instruction and ask any questions</td>
<td>Use PowerPoint to explain activity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Show students videos of bottle rockets and real rockets (BAE systems rockets)</td>
</tr>
<tr>
<td><strong>BODY</strong></td>
<td>Students to play with bottle rockets. Students test different amounts of water. Students to time how long the rockets are in the air. Students record all data in their journals. Students graph their results and interpret the data.</td>
<td>Ask students open-ended questions to assess knowledge. Class discussion about results and their findings Ensure students follow safe operating procedures when using rockets.</td>
</tr>
<tr>
<td><strong>CLOSURE</strong></td>
<td>Students stand in a circle and pass a ball around to one another.</td>
<td>Assess students current level of understanding of topic Play silent ball but when each student catches the ball they are to say one piece of information they have learnt from the lesson.</td>
</tr>
</tbody>
</table>

**EXTENSION**


**TEAM ROCKET I BAE SYSTEMS**

<table>
<thead>
<tr>
<th>LESSON NO: 4</th>
<th>LOCATION: Science Laboratory</th>
<th>YR LEVEL: 10</th>
<th>STUDENT NO: 24</th>
<th>DURATION: 50min</th>
</tr>
</thead>
</table>

**LESSON FOCUS:** Newton’s first law of motion.

**UNIT FOCUS**

This unit focuses on developing STEM skills and understanding through a project-based mindset of learning. Students will be exploring the vast and rich world of rockets and their relevance in South Australia. In particular the role of BAE Systems. Students will be taking on the role as young engineers tasked with learning the principles of rocket flight and how this learning can influence their production of a best possible design solution. By the end of this unit students will be more capable problem solvers developing their numeracy, ICT, critical thinking and personal & social capabilities.

**CONTENT DESCRIPTORS**

<table>
<thead>
<tr>
<th>SCIENCE UNDERSTANDING</th>
<th>ELABORATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical Science</td>
<td>Recognising that a stationary object, or a moving object with constant motion, has balanced forces acting on it.</td>
</tr>
<tr>
<td>The motion of objects can be described and predicted using the laws of physics (ACSSU229)</td>
<td><em>(ACARA 2018)</em></td>
</tr>
</tbody>
</table>

*(ACARA 2018)*

**LEARNING OUTCOMES**

- Students will explore Newton’s first law
- Students will explore motion and friction with a practical activity
- Students will record their observations

Teacher will facilitate student learning through a practical activity and ask questions to assess student understanding

**RESOURCES**

- PowerPoint
- Marbles
- Rulers
- Sticky tape

**SPECIAL CONSIDERATIONS**

- Scaffolding will be provided for all students to understand the topic.
<table>
<thead>
<tr>
<th>I N T R O</th>
<th>LEARNING ACTIVITIES</th>
<th>TEACHING POINTS/ASSESSMENT OF LEARNING/SAFETY</th>
<th>TIMINGS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students to listen to teacher</td>
<td>Use PowerPoint to explain Newton’s First law. Provide a video to give context.</td>
<td>10</td>
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</tbody>
</table>

| B O D Y | Students explore Newton’s first law through activity (Groups of two) Magic Marbles | Ask students: Walk around room and make sure students are on task. What happens to the marbles when you hit them? What happens when there is more marbles? Do all the marbles move? Does this show energy transfer? Why? Relate the science back to rockets and how they work using Newton’s first law. Define Rest, Motion, Balanced and unbalanced forces. | 30 |
| Students place two rulers on the table parallel to each other and tape them down. Place two marbles next to each other and then roll another marble in to them. Try with a different number of marbles. Students to complete Think pair Share activity with another group Then write notes in science journal Students Participate in class discussion. | |

| C L O S U R E | Students participate in class recap Students have to answer a question before they leave | Ask students a question before they get to leave the classroom. Refer back to lesson with the bottle rockets, students should be able to apply Newton’s first law to what they observed. | 10 |

EXTENSION
### UNIT FOCUS

This unit focuses on developing STEM skills and understanding through a project-based mindset of learning. Students will be exploring the vast and rich world of rockets and their relevance in South Australia. In particular the role of BAE Systems. Students will be taking on the role as young engineers tasked with learning the principles of rocket flight and how this learning can influence their production of a best possible design solution. By the end of this unit students will be more capable problem solvers developing their numeracy, ICT, critical thinking and personal & social capabilities.

### CONTENT DESCRIPTORS

**Physical Science**

The motion of objects can be described and predicted using the laws of physics (ACSSU229)

(ACARA 2018)

### LEARNING OUTCOMES

Students will test whether an object moves with greater acceleration when the size of a pulling force is increased

Teacher will ask students questions about key concepts

### RESOURCES

- Trolley
- Piece of wood
- G-clamp
- String or fishing line
- Electronic balance
- Pulley and clamp
- 50 g slotted masses
- Calculator
- Stopwatch and ruler

### SPECIAL CONSIDERATIONS

Scaffolding will be provided for all students to understand the topic and perform the practical.

Maintain Safety of all students during practical activity
## LESSON STRUCTURE

<table>
<thead>
<tr>
<th>LEARNING ACTIVITIES</th>
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<th>TIMINGS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>INTRO</strong></td>
<td></td>
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</tr>
<tr>
<td>Students to listen to teacher and take notes in their journal.</td>
<td>Use PowerPoint to explain Newton’s second law.</td>
<td>10</td>
</tr>
<tr>
<td><strong>BODY</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Students explore Newton’s second law through a practical activity. (In groups of 3)</td>
<td>Answer any questions students have</td>
<td>30</td>
</tr>
<tr>
<td>Students to Calculate the average time taken by the trolley for each hanging mass tested.</td>
<td>Provide explicit instructions on how to complete activity</td>
<td></td>
</tr>
<tr>
<td>As the trolley starts from a stationary position, its acceleration can be calculated: ( a = \frac{2d}{t^2} )</td>
<td>Get students to Describe the effect of increasing force on the acceleration of the trolley.</td>
<td></td>
</tr>
<tr>
<td>where ( d ) is distance travelled (m) and ( t ) is time taken (s).</td>
<td>Collect student’s journals to check understanding and work.</td>
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</tr>
<tr>
<td>Calculate acceleration, ( a = \frac{2d}{t} ), using the distance you measured (in metres) and the average time taken (in seconds)</td>
<td>Refer students back to the bottle rockets and how the mass of their rocket will affect acceleration and height achieved.</td>
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<tr>
<td>Using a set of axes, plot a graph of force applied (N) on the vertical axis against acceleration (m/s²) on the horizontal axis.</td>
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<tr>
<td>Draw a line through the points on your graph and calculate its gradient</td>
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<tr>
<td><strong>CLOSURE</strong></td>
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<tr>
<td>Students complete 321 exercise:</td>
<td>Assess students current level of understanding of topic</td>
<td>10</td>
</tr>
<tr>
<td>3: Name three things they learnt</td>
<td>Collect 321 exercise</td>
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<tr>
<td>2: List two things they want to know more about</td>
<td></td>
<td></td>
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<tr>
<td>1: Ask one question about the topic or lesson.</td>
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</tbody>
</table>

## EXTENSION
**UNIT FOCUS**

This unit focuses on developing STEM skills and understanding through a project-based mindset of learning. Students will be exploring the vast and rich world of rockets and their relevance in South Australia. In particular the role of BAE Systems. Students will be taking on the role as young engineers tasked with learning the principles of rocket flight and how this learning can influence their production of a best possible design solution. By the end of this unit students will be more capable problem solvers developing their numeracy, ICT, critical thinking and personal & social capabilities.

**CONTENT DESCRIPTORS**

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<tr>
<th>SCIENCE UNDERSTANDING</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Physical Science</td>
<td>Recognising and applying Newton’s Third Law to describe the effect of interactions between two objects</td>
</tr>
<tr>
<td>The motion of objects can be described and predicted using the laws of physics (ACSSU229)</td>
<td>(ACARA 2018)</td>
</tr>
</tbody>
</table>

**LEARNING OUTCOMES**

Students will explore Newton’s third law in relation to interactions between objects and within bottle rockets.

Teacher will explain Newton’s Third Law and ask questions to assess student knowledge. Teacher will be organised with work examples and resources.

**RESOURCES**

String or fishing line
Straw
Balloon
Masking tape
Piece of dowel
Pivot pin
Worksheet

**SPECIAL CONSIDERATIONS**

Scaffolding will be provided for all students to understand the Content and different questions will be asked to help students to understand. A worksheet will be provided to inform students what is expected of them.
<table>
<thead>
<tr>
<th>LESSON STRUCTURE</th>
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</thead>
<tbody>
<tr>
<td><strong>LEARNING ACTIVITIES</strong></td>
</tr>
<tr>
<td><strong>INTRO</strong></td>
</tr>
</tbody>
</table>
| **BODY** | **Balloon Challenge** Students to complete practical activity on Newton’s third law.  
*Experiment:*  
- Design a way of using a balloon releasing air to investigate Newton’s third law.  
- Investigate how the reaction force is affected by more air being released by the balloon.  
- Balloons could move horizontally along a string or piece of fishing wire, or spin on an axis  
*Results:*  
- Describe your practical design, including a diagram in your response.  
- Describe what happened.  
- Explain your results in terms of Newton’s third law.  
- Propose how you could make improvements to your practical activity | Ask questions while students are planning and performing the activity  
Collect experiment Worksheet  
Ask students about the relationship between the amount of air in the balloon and the reaction.  
Extension activity: Students design a balloon powered rocket or vehicle to increase understanding of how Newton’s Three laws relate to rockets. | 60 |
| **CLOSURE** | Students ask and answer questions | Recap the learning over the last few weeks about Newton’s Laws and how they relate to Bottle rockets  
What do the students need to consider when making their rocket?  
How can they make their bottle rocket more efficient? | 20 |

**EXTENSION**
**LESSON NO:** 9  
**LOCATION:** Computer Lab  
**YR LEVEL:** 10  
**STUDENT NO:** 24  
**DURATION:** 50min

**LESSON FOCUS:** Introduce the inquiry assignment about STEM careers and BAE systems. The task is to create a poster showing how science skills used at school relate to careers at BAE systems.

**UNIT FOCUS**

This unit focuses on developing STEM skills and understanding through a project-based mindset of learning. Students will be exploring the vast and rich world of rockets and their relevance in South Australia. In particular the role of BAE Systems. Students will be taking on the role as young engineers tasked with learning the principles of rocket flight and how this learning can influence their production of a best possible design solution. By the end of this unit students will be more capable problem solvers developing their numeracy, ICT, critical thinking and personal & social capabilities.

**CONTENT DESCRIPTORS**

**SCIENCE AS A HUMAN ENDEAVOUR**  
**Uses and Influence of Science**  
People use scientific knowledge to evaluate whether they accept claims, explanations or predictions, and advances in science can affect people’s lives, including generating new career opportunities (ACSHE194)

**SCIENCE INQUIRY SKILLS**  
**Communication**  
Communicate scientific ideas and information for a particular purpose, including constructing evidence-based arguments and using appropriate scientific language, conventions and representations (ACSI208)

*(ACARA 2018)*

**ELABORATIONS**

People use science understanding and skills in their occupations  
Presenting results and ideas using formal experimental reports, oral presentations, slide shows, poster presentations and contributing to group discussions

**LEARNING OUTCOMES**

Students will examine the different science knowledge used in occupations. They select appropriate representations and text types to communicate science ideas for specific purposes.

Teacher will assist students in their research of BAE and careers in STEM. The teacher will give explicit instructions on how to complete the assignment.
## RESOURCES
- Assignment cover sheet and Rubric
- Computers

## SPECIAL CONSIDERATIONS
- Students on NEPs will have modified assessment

## LESSON STRUCTURE

<table>
<thead>
<tr>
<th>TIMINGS</th>
<th>LEARNING ACTIVITIES</th>
<th>TEACHING POINTS/ASSESSMENT OF LEARNING/SAFETY</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td><strong>INTRO</strong></td>
<td>Class discussion about the assignment</td>
</tr>
<tr>
<td></td>
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<td>Answer any questions students have</td>
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<td></td>
<td></td>
<td>Use PowerPoint to explain what is expected</td>
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<td></td>
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<td>of the students and how they can achieve</td>
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<td></td>
<td></td>
<td>the learning objectives.</td>
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<td>Provide students with assignment task sheet</td>
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<td></td>
<td></td>
<td>and marking rubric.</td>
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<tr>
<td>30</td>
<td><strong>BODY</strong></td>
<td>Students begin research for their poster</td>
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<tr>
<td></td>
<td></td>
<td>Assist students with research</td>
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<tr>
<td></td>
<td></td>
<td>Answer any questions they may have about</td>
</tr>
<tr>
<td></td>
<td></td>
<td>the assignment</td>
</tr>
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<td></td>
<td></td>
<td>Make sure students use ICT appropriately</td>
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<tr>
<td>10</td>
<td><strong>CLOSURE</strong></td>
<td>Students to show three pieces of research</td>
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<tr>
<td></td>
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<td>or information they have collected.</td>
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<td></td>
<td></td>
<td>Check that each student has completed some</td>
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<tr>
<td></td>
<td></td>
<td>research.</td>
</tr>
</tbody>
</table>

## EXTENSION
## Lesson Focus
Introduction of Assessment & Investigation of Design Solutions

### Unit Focus
This unit focuses on developing STEM skills and understanding through a project-based mindset of learning. Students will be exploring the vast and rich world of rockets and their relevance in South Australia. In particular the role of BAE Systems. Students will be taking on the role as young engineers tasked with learning the principles of rocket flight and how this learning can influence their production of a best possible design solution. By the end of this unit students will be more capable problem solvers developing their numeracy, ICT, critical thinking and personal & social capabilities.

### Content Descriptors

#### Design and Technologies Knowledge and Understanding
Investigate and make judgments on how the characteristics and properties of materials are combined with force, motion and energy to create engineered solutions (ACTDEK043)

#### Design and Technologies Processes and Production Skills
Critique needs or opportunities to develop design briefs and investigate and select an increasingly sophisticated range of materials, systems, components, tools and equipment to develop design ideas (ACTDEP048)

(ACARA 2018)

### Elaborations

- Examining and explaining the interaction between material properties and function of a common system, such as car brakes
- Critiquing the effectiveness of the combinations of materials, forces, energy and motion in an engineered system such as a 3D printer
- Critiquing the design of new products to identify how well design ideas respond to sustainability issues.
- Examining relationships of properties for complementary materials for products, for example examining compressive and tensile strengths of materials.
- Identifying appropriate tools, equipment, techniques and safety procedures for each process and evaluating production processes for accuracy, quality, safety and efficiency.

(ACARA 2018)

### Learning Outcomes

Students will be able to detail key elements of the design brief by highlighting or answering prompted questions.

Students will demonstrate an understanding investigation skills and knowledge by critiquing appropriate existing and future design solutions online.

Teacher will clearly lay out the details of the design brief by using questioning and student-led reading when examining the brief as a class.

### Resources

- 25x Bottle Rocket Design Brief/Feedback Sheet and Marking Rubric
- [Online] Design Investigation Exemplar Folio Examples

### Special Considerations

Alternate assessment for NEP students
## LESSON STRUCTURE

<table>
<thead>
<tr>
<th>LEARNING ACTIVITIES</th>
<th>TEACHING POINTS/ASSESSMENT OF LEARNING/SAFETY</th>
<th>TIMINGS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>INTRO</strong></td>
<td></td>
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</tr>
</tbody>
</table>
| Set Learning Intentions and Outcomes | - Use the projector to guide students through the documents  
- Encourage students to read through parts explaining what they think it’d look like  
- Have examples for students to glance over as well | 15      |
| Introduction of Design Brief & Assessment | - Hand out briefs and rubrics  
- Make sure students put names on them  
- Read through and unpack the brief with the students  
- Answer questions as they arise  
- Encourage students to highlight and write on the sheet |         |
| **BODY**            |                                             |         |
| Investigation of Design Solutions | - Encourage collaboration  
- Walk the room guiding students with help  
- Be stern about monitoring off task work | 30      |
| - Direct students to Investigation Exemplars  
- Introduce the idea of the investigation  
- Refer to the Assessment Rubric strand |         |
| **CLOSURE**         |                                             |         |
| Recap Learning      | - Have students feedback the information. Questions! | 5       |
| - Highlight work expected to be completed by the end of the week  
- Highlight the design phase is to follow |         |

### EXTENSION

- Investigate and detail the systems of parachute deploying designs
**LESSON NO:** 21  
**LOCATION:** Computer lab  
**YR LEVEL:** 10  
**STUDENT NO:** 24  
**DURATION:** 50min

**LESSON FOCUS:** Introducing the use of 3D modelling software such as SolidWorks

**UNIT FOCUS**
This unit focuses on developing STEM skills and understanding through a project-based mindset of learning. Students will be exploring the vast and rich world of rockets and their relevance in South Australia. In particular the role of BAE Systems. Students will be taking on the role as young engineers tasked with learning the principles of rocket flight and how this learning can influence their production of a best possible design solution. By the end of this unit students will be more capable problem solvers developing their numeracy, ICT, critical thinking and personal & social capabilities.

**CONTENT DESCRIPTORS**  
**DESIGN AND TECHNOLOGIES KNOWLEDGE AND UNDERSTANDING**
Investigate and make judgments on how the characteristics and properties of materials are combined with force, motion and energy to create engineered solutions (ACTDEK043)  
(ACARA 2018)

**ELABORATIONS**
Recognising the impact of past designed solutions and possible decisions when creating preferred futures, for example the design of public transport systems that use renewable energy and the design of rural communities to reduce fire risk. Considering the factors that influence design and professional designers and technologists, including time, access to skills, knowledge, finance, expertise, for example Australian designers working with rapid prototyping manufacturers in China. Predicting the impact of emerging technologies for preferred futures.  
(ACARA 2018)

**LEARNING OUTCOMES**
Students will develop basic skills in the use of SolidWorks e.g. how to create and define shapes, extrude, cut and shell modelled shapes.

Teacher will facilitate lesson and assist students in learning SolidWorks basics

**RESOURCES**
Computer lab with access to SolidWorks

**SPECIAL CONSIDERATIONS**


<table>
<thead>
<tr>
<th>LESSON STRUCTURE</th>
</tr>
</thead>
</table>

**LEARNING ACTIVITIES** | **TEACHING POINTS/ASSESSMENT OF LEARNING/SAFETY** | **TIMINGS** |
<table>
<thead>
<tr>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>INTRO</strong></td>
<td>Introduction to SolidWorks, how to access and run</td>
<td>Use projector to demonstrate how to load up and access tutorials</td>
</tr>
</tbody>
</table>
| **BODY**               | Use tutorials to learn basic functions of SolidWorks | Encourage collaboration  
Assist students with questions  
Highlight on projector common questions to ensure whole class understanding | 30 |
| **CLOSURE**            | Recap learning  
Run through basic functions and terminology and ensure understanding of programme | Question students for understanding | 5 |

**EXTENSION**

If successful students can move onto more advanced tutorials and experiment making shapes utilising skill learnt to solidify knowledge
## UNIT FOCUS

This unit focuses on developing STEM skills and understanding through a project-based mindset of learning. Students will be exploring the vast and rich world of rockets and their relevance in South Australia. In particular the role of BAE Systems. Students will be taking on the role as young engineers tasked with learning the principles of rocket flight and how this learning can influence their production of a best possible design solution. By the end of this unit students will be more capable problem solvers developing their numeracy, ICT, critical thinking and personal & social capabilities.

## CONTENT DESCRIPTORS

### DESIGN AND TECHNOLOGIES KNOWLEDGE AND UNDERSTANDING

Investigate and make judgments on how the characteristics and properties of materials are combined with force, motion and energy to create engineered solutions (ACTDEK043)

**Elaborations**

Recognising the impact of past designed solutions and possible decisions when creating preferred futures, for example the design of public transport systems that use renewable energy and the design of rural communities to reduce fire risk. Considering the factors that influence design and professional designers and technologists, including time, access to skills, knowledge, finance, expertise, for example Australian designers working with rapid prototyping manufacturers in China. Predicting the impact of emerging technologies for preferred futures. (ACARA 2018)

## LEARNING OUTCOMES

Students will further develop their skills in SolidWorks by creating a custom nose cone and tailpiece to be 3D printed.

Teacher will facilitate lesson and assist students in following nose cone and tailpiece construction guide provided by teacher.

## RESOURCES

- Computer lab with access to SolidWorks
- 3D Printer
- Nose Cone & Tailpiece SolidWorks Tutorial

## SPECIAL CONSIDERATIONS
## LESSON STRUCTURE

<table>
<thead>
<tr>
<th>LEARNING ACTIVITIES</th>
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<th>TIMINGS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>INTRO</strong></td>
<td>Introduction to SolidWorks, how to access and run</td>
<td>Use projector to demonstrate how to load up and nose cone and tailpiece guide</td>
</tr>
<tr>
<td><strong>BODY</strong></td>
<td>Use guide to create personalised nose cone and tailpiece using SolidWorks Students when completed designs will create g-code file for printing and send to teacher.</td>
<td>Encourage collaboration Assist students with questions Highlight on projector common questions to ensure whole class understanding</td>
</tr>
<tr>
<td><strong>CLOSURE</strong></td>
<td>Recap learning Run through basic functions and terminology and ensure understanding of programme</td>
<td>Question students for understanding</td>
</tr>
</tbody>
</table>

### EXTENSION

Teacher will 3D print files when completed for students
### UNIT FOCUS

This unit focuses on developing STEM skills and understanding through a project-based mindset of learning. Students will be exploring the vast and rich world of rockets and their relevance in South Australia. In particular the role of BAE Systems. Students will be taking on the role as young engineers tasked with learning the principles of rocket flight and how this learning can influence their production of a best possible design solution. By the end of this unit students will be more capable problem solvers developing their numeracy, ICT, critical thinking and personal & social capabilities.

### CONTENT DESCRIPTORS

**DESIGN AND TECHNOLOGIES KNOWLEDGE AND UNDERSTANDING**

Critically analyse factors, including social, ethical and sustainability considerations, that impact on designed solutions for global preferred futures and the complex design and production processes involved (ACTDEK040).

Explain how products, services and environments evolve with consideration of preferred futures and the impact of emerging technologies on design decisions (ACTDEK041)

(ACARA 2018)

**ELABORATIONS**

Recognising the impact of past designed solutions and possible decisions when creating preferred futures, for example the design of public transport systems that use renewable energy and the design of rural communities to reduce fire risk.

Considering the factors that influence design and professional designers and technologists, including time, access to skills, knowledge, finance, expertise, for example Australian designers working with rapid prototyping manufacturers in China.

Predicting the impact of emerging technologies for preferred futures.

(ACARA 2018)

### LEARNING OUTCOMES

Students will analyse the impact of sustainable practices and the importance in the investigation of design solutions through the task online.

Teacher will engage students in the task by relating to real-world problems that children are leading the way with through timely resources.

### RESOURCES

<table>
<thead>
<tr>
<th>LESSON STRUCTURE</th>
<th>LEARNING ACTIVITIES</th>
<th>TEACHING POINTS/ASSESSMENT OF LEARNING/SAFETY</th>
<th>TIMINGS</th>
</tr>
</thead>
</table>
| **INTRO**        | Set Learning Intentions and Outcomes | - Encourage critical thinking.  
                                      - Be concise with the questions but if you feel it relates well then expand concisely | 5       |
|                  | Introduce the Materials Application Task  
                                      - Direct students to the guidesheet  
                                      - Detail the structure of the task  
                                      - Clear emphasis on the questions | - Student-led learning  
                                      - Help students as questions arise  
                                      - Asses collaboration and how students are delegating assessment roles |         |
| **BODY**         | Investigating Materials App.  
                                      - Encourage use of heading  
                                      - (kickstarter, freelancer) | - Recap of portfolio due date and lessons left | 40      |
|                  | Asses where students are sitting with their folios | |         |
|                  | Recap the learning intentions | |         |
| **CLOSURE**      |                      | | 10      |

**EXTENSION**

- Develop a sales pitch for an item and how it could be used to fix a current un-sustainable process or product.
## TEAM ROCKET | BAE SYSTEMS

**LESSON NO:** 35  
**LOCATION:** Classroom/ Oval/ Park  
**YR LEVEL:** 10  
**STUDENT NO:** 24  
**DURATION:** 2-3 Lessons

**LESSON FOCUS:** Mathematical applications for rocket testing

**UNIT FOCUS**

This unit focuses on developing STEM skills and understanding through a project-based mindset of learning. Students will be exploring the vast and rich world of rockets and their relevance in South Australia. In particular the role of BAE Systems. Students will be taking on the role as young engineers tasked with learning the principles of rocket flight and how this learning can influence their production of a best possible design solution. By the end of this unit students will be more capable problem solvers developing their numeracy, ICT, critical thinking and personal & social capabilities.

<table>
<thead>
<tr>
<th>CONTENT DESCRIPTORS</th>
<th>ELABORATIONS</th>
</tr>
</thead>
</table>
| **NUMBER AND ALGEBRA**  
Patterns and Algebra  
Substitute values into formulas to determine an unknown (ACMNA234)  
**MEASUREMENT AND GEOMETRY**  
Units of Measurement  
Solve problems involving surface area and volume for a range of prisms, cylinders and composite solids (ACMMG242)  
Geometric Reasoning  
Apply logical reasoning, including the use of congruence and similarity, to proofs and numerical exercises involving plane shapes (ACMMG244)  
Patterns and Algebra  
Solve right-angled triangle problems including those involving direction and angles of elevation and depression (ACMMG245)  
(ACARA 2018) |

**LEARNING OUTCOMES**

- Students will apply mathematics to analyse the results of rocket testing.
- Teacher will outline the learning objectives and assessment requirements.
RESOURCES
Bottle Rockets
Tape measure
Angle finding tool
Stopwatch
Safety glasses

SPECIAL CONSIDERATIONS
Safety for launching rockets is to be reinforced.

LESSON STRUCTURE

<table>
<thead>
<tr>
<th>LEARNING ACTIVITIES</th>
<th>TEACHING POINTS/ASSESSMENT OF LEARNING/SAFETY</th>
<th>TIMINGS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>INTRO</strong></td>
<td>Students to listen to teacher explain the SAFETY rules for launching the rockets. Note: SAFETY GLASSES ARE TO BE WORN AT ALL TIMES. How to launch the rockets and the testing procedures will be explained by the teacher.</td>
<td>Observational- ensure students understand the task and that they are adhering to safety rules.</td>
</tr>
<tr>
<td><strong>BODY</strong></td>
<td>Students undertake all testing and record results. Results are to be analysed and all questions answered on the attached worksheets.</td>
<td>Assess prior knowledge of the laws of physics. Assess current knowledge of the application of mathematics to analyse results.</td>
</tr>
<tr>
<td><strong>CLOSURE</strong></td>
<td>Run through the worksheet as a class to reconfirm student understanding. Students have opportunity to ask any more questions</td>
<td>Check students understanding with relation to mathematical procedures.</td>
</tr>
</tbody>
</table>

EXTENSION
### TEAM ROCKET

**Design Investigation Exemplar**

**Task:**
As part of your design folio you’ll need to detail an investigation and critique of possible design ideas. This will help inform your generation of designs by furthering your understanding on the vast array of design possibilities. Using the 'Investigative Questions Examples' as a guide you’ll need to critique at least 6 possible design ideas considering form, sustainability and importantly functionality.

**Investigative Question Examples**

- Is it aerodynamic?
- Would it perform well? (Refer to scientific principles)
- How can I create it?
- What materials would it use?
- Do I have the necessary tools & equipment?
- Can I learn the necessary skills & processes?
- What does and doesn’t look good?
- Does it meet the Task Constraints & Considerations?
- What ideas could I take influence from in my design?
- Is it sustainable?

**Example**

<table>
<thead>
<tr>
<th>Example</th>
<th>Investigative Questions</th>
</tr>
</thead>
</table>
| ![Rocket Image](Image) | - The nose cone looks aerodynamic and light  
- The fins are uneven and would throw the centre of mass out  
- It uses good sustainable materials that can easily be modified for new design changes  
- It looks like a prototype only |

*(de Vries 2016)*
## TEAM ROCKET
**Nose Cone & Tailpiece SolidWorks Tutorial**

### NOSE CONE TUTORIAL

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Open a new part file</td>
</tr>
<tr>
<td>2.</td>
<td>Select extrude Boss/Base function</td>
</tr>
<tr>
<td>3.</td>
<td>Select FRONT plane</td>
</tr>
<tr>
<td>4.</td>
<td>Select Front view functions</td>
</tr>
</tbody>
</table>

#### Step 2.1
- Select the circle function
- Left click on the origin to start the centre of the circle
- Drag it out and left click at a random size

#### Step 2.2
- Select the smart dimension tool and select the circle
- Give your circle a dimension 4 mm larger than the outside diameter of your bottle rocket e.g. 94mm
- Select the Exit Sketch function
- You will then be asked to Boss-Extrude your circle
- Give it a depth dimension in the left property manager bar e.g. 40mm
- Select the OK function (green tick)

- Select reference geometry function and select Plane
- Left click on the top surface of the cylinder (it will turn pink and project a second plane)
- Enter in the left property manager toolbar the dimension you desire for the height of the nose cone.
- Click the Ok function (green tick)

- Go to sketch toolbar and select the circle function
- Draw a circle in the new plane created keeping the centre of the circle at the origin mark
- Give it a dimension (this will determine the diameter of the end of the nose cone
- Select Exit sketch function
- In the features toolbar select lofted Boss/Base function
- Left click the top of the cylinder and left click the circle created in the new plane.
- Select Ok function (green tick)

- In the features toolbar select Fillet function
- Select the circle created in the second plane
- In the property manager toolbar on left side under fillet parameter attribute a dimension to the fillet
- Select Ok function (green tick)

- Repeat above steps but this time fillet the edge of the cylinder and cone meet
- Rotate your view to see the bottom of the nose cone
- In the Features toolbar select the Shell function
  - Select the bottom surface of the nose cone
  - In the property manager toolbar on the left side attribute a dimension to the shell (suggested 2mm)
  - Select the Ok function (green tick)
- Save the completed file
<table>
<thead>
<tr>
<th>TAILPIECE TUTORIAL</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Image 1" /></td>
</tr>
<tr>
<td>- Open a new part file</td>
</tr>
<tr>
<td>- In the Sketch toolbar menu select sketch</td>
</tr>
<tr>
<td>- Select top plane</td>
</tr>
<tr>
<td><img src="image2.png" alt="Image 2" /></td>
</tr>
<tr>
<td>- Draw a circle (make sure the centre of the circle is attached to the origin)</td>
</tr>
<tr>
<td>- Give it a dimension using the smart dimension tool. E.g. 48mm</td>
</tr>
<tr>
<td>- Select exit sketch</td>
</tr>
<tr>
<td><img src="image3.png" alt="Image 3" /></td>
</tr>
<tr>
<td>- On the left side in Feature manager design tree select top plane</td>
</tr>
<tr>
<td>- In the features toolbar select Reference Geometry</td>
</tr>
<tr>
<td>- Then select plane</td>
</tr>
<tr>
<td>- Give a dimension to the plane e.g. 115mm (height of the tailpiece)</td>
</tr>
<tr>
<td>- Select the Ok function (green tick)</td>
</tr>
</tbody>
</table>
- Select extrude Boss/Base
- In the new plane draw a circle keeping the centre locked onto the origin
- Give it a dimension (94mm)
- Select Exit sketch

- Select direction 1 in property manager toolbar
- Give it a dimension of 30mm
- Select Ok function (green tick)

- In features toolbar select Lofted Boss/Base
- Rotate view to as on screen shot
- Select bottom of cylinder and circle
- Select Ok function (green tick)
- Select Front plane

- Draw a vertical line running through the origin longer than tailpiece
- Turn it into a construction line using property manager toolbar

- Draw a rectangle locking onto the top and bottom of the tailpiece
- Using Smart Dimension tool give it a width of 4mm and centre it on the construction line

- Exit sketch
- Use extrude Boss/Base function extrude tail fin out to desired width
- Add a second direction and extrude out in opposite direction
- Change view to Right plane and repeat above 4 steps to create the 3rd and 4th tail fin

- Select Shell function
- Select top surface as seen in picture
- Rotate view to underneath
- Select bottom surface
- Give it a dimension of 2 mm in property manager section
- Select Ok function (green tick)

- Save completed file
TEAM ROCKET

Materials Application Guidesheet

Task
As part of your design folio you’ll need to complete a Materials Application task. This task is aimed toward making you further consider the materials and processes you will anticipate using in your final design solution and how you can ensure they’re sustainable outcomes.

Structure
The structure of your Materials Application task should be as follows:

- Title
- Introduction
- What are the benefits of additive manufacturing in 3D printing compared to more traditional production processes in relation to sustainability?
- What is the environmental impact of plastic containers and what are some alternative solutions?
- Investigate and detail one new or future product designed or produced in Asia for the Australian market that overcomes traditional non-sustainable manufacturing.
- Conclusion
- Referencing

Heading and any subheadings are encouraged.

Word Count
450-550 Words (Not including references)
TEAM ROCKET
Final Testing Worksheet
Maximum Height Test

Aim: To find the maximum height reached by the rocket. If time permits, average velocity and average acceleration are to be calculated, along with average flow rate.

Materials: Tape measure, angle finding tool, stopwatch.

Procedure:
1. Measure the distance from the rocket base with the tape measure and place the angle tool between 6 to 12 metres away from the base.
2. Have 1 person launching the rocket and the rest of the group at the angle finding tool.
3. Pump up and launch the rocket directly upwards. The launcher is to observe the release pressure. Another group member is to follow the rocket with the angle finding tool, measuring the angle the rocket reached at maximum height. Another member records the time the rocket takes after launch to reach the maximum height and the time it takes to come from maximum height to the ground.
4. Record the results in the table.

<table>
<thead>
<tr>
<th>Launch number</th>
<th>Pressure</th>
<th>Distance to angle finder</th>
<th>Maximum height angle</th>
<th>Time from launch to maximum height</th>
<th>Time from maximum height to the ground</th>
<th>Air to water volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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<td>Average</td>
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</tbody>
</table>

Analysis/ Investigation:
1. Calculate the maximum height of the rocket using trigonometry. Use the diagram for assistance. Using your knowledge of right-angled triangles and the tangent rule, determine the heights of all 3 flight tests and work out the average height from these calculations. Create a table to display the results.
2. Calculate the average speed of the rocket using Speed = distance/time.
3. Calculating the acceleration of the rocket from launch to maximum height.
4. Why can't the acceleration be estimated by F=ma?
5. Use the formula 'acceleration = Δ velocity/ Δ time' to calculate the average acceleration of the rocket.
Answer the following questions, explaining your answers:
1. At what point in time did the rocket have the greatest amount of thrust?
2. At what point in time did the rocket have its fastest/maximum velocity when travelling upward?
3. At what point did the rocket have its maximum velocity when travelling back to the ground?
4. At what point did the rocket have 0 velocity?
5. Was the distance the rocket travelled up the same as it travelled down?

Maximum Distance Test

Aim: To determine the best angle for maximum rocket displacement.

Materials: Tape measure, launch angle measurer, stopwatch.

Procedure:
1. Set the rocket to various angles around 45 degrees when launching.
2. Record the launch angle, launch pressure and distance that the rocket travels. One person must record the flight time of the rocket.
<table>
<thead>
<tr>
<th>Launch number</th>
<th>Pressure</th>
<th>Launch Angle</th>
<th>Rocket Displacement</th>
<th>Flight Time</th>
<th>Air to water volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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<td>4</td>
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<td>Average</td>
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</table>

**Analysis/Investigation:**
1. Draw what you believe the flight path of each rocket to have been on the graph below using the data from the above table.

![Graph](image)

**Answer the following questions, explaining your answers:**
1. Which angle had the best outcome for distance?
2. Which angle had the greatest flight time?
3. Which angle had the smallest flight time?
4. Why would the flight path of a shell fired from a cannon be different from that of a rocket?
TEAM ROCKET
Student Evaluation Worksheet

Tasks
As part of your design folio you’ll need to complete a individual evaluation. During this task think critically about your answers. Not just what happened, but why did it happen?

Guiding Questions

- As a whole, did you enjoy this unit of work? Explain your answer.
- What did you find most enjoyable during the project?
- What did you find least enjoyable during the project?
- Did your bottle rocket work as you expected/ intended? Why?
- What were new concepts to you? E.g. rocket thrust
- Would you have changed your original CAD design knowing the results from the testing? If so, how could your design be improved?
- How could you have made the project more environmentally friendly?
- Do you think you had a good water to air ratio? Why?
- Explain how your original understandings of the concepts of ‘how rockets work’ has changed from the beginning of this project to now? If you believe that they haven’t changed, explain why?
- Explain, to your ability, the process of bottle rocket operation using the correct technical terms.
- Was the mathematics and science challenging for you?
- What other areas of mathematics and/or science interest you?
- Do you see the benefits of understanding the world through the eyes of science and mathematics?
- Could you see yourself interested in a scientific or mathematical field of work? Why/ why not?
References


