Unit 1 - The Understanding of Rocket Design and Manufacture

Overview

The overall focus for learning in this unit is to explore the ways that rockets can be made to fly. It looks at some of the history of rockets and the changes of materials over time as well as the main forces that need to be understood and overcome for success. It allows learners to work with their own rockets of different types and explore materials and their overall effects. The unit also explores some of the impacts on society and the possible future use for their designs.

A work activity will typically be ‘straightforward or routine’ because:

The task or context will be familiar and involve few variable aspects. The techniques used will be familiar or commonly undertaken.

Example of context – making and flying a simple water powered rocket

Assessor's guide to interpreting the criteria

General Information

RQF general description for Level 1 qualifications

- Achievement at RQF level 1 (EQF Level 2) reflects the ability to use relevant knowledge, skills and procedures to complete routine tasks. It includes responsibility for completing tasks and procedures subject to direction or guidance.
- Use knowledge of facts, procedures and ideas to complete well-defined, routine tasks. Be aware of information relevant to the area of study or work
- Complete well-defined routine tasks. Use relevant skills and procedures. Select and use relevant information. Identify whether actions have been effective.
- Take responsibility for completing tasks and procedures subject to direction or guidance as needed

Requirements

- Standards must be confirmed by a trained Gold Level Assessor or higher.
- Assessors must at a minimum record assessment judgements as entries in the on-line mark book on the INGOTs.org certification site.
- The work in the unit is recommended in order for candidates to have covered enough depth and breadth in the topic to successfully carry out their controlled assessment and take the external exam.

- When the candidate has covered as much of ths material as necessary to complete the controlled assessment element, they may be introduced to the topic

- This unit should take an average level 1 learner 30 hours of work to complete.

Assessment Method

Understanding of these learning objectives will be demonstrated through answering questions related to key ideas and concepts in the terminal examination as well as practical application of their understanding through the controlled assessment.

Expansion of the assessment criteria

1.Understand the environment rockets work in and the materials used

1.1 I can list a number of materials used for rocket manufacture

Learners should be able to explore and comment on materials used for a range of rocket types

Additional information and guidance

Learners need to do some simple research to find out what materials are used in rocket manufacture. This can either be for their own build, or more generally. They can organise what they find as a presentation, table or short report. They need to list what the main materials are and perhaps some brief notes about what they are used for, for example, from the NASA site.

https://spaceflightsystems.grc.nasa.gov/education/rocket/rockpart.html [1]

This shows the relative strength to weight of materials.

1.2 I can explain some of the material properties

Learners should be able to go into a small amount of detail about the materials they have listed previously

Additional information and guidance

Learners can extend their presentation or table used above to make some more detailed notes about the materials they find. They can create a table for later reference.

Type	Properties	Useage
Titanium	Very strong and rigid	Used mainly for the fuselage frame
Carbon fibre	Strong and light	Used for body parts
Alloy	Mixture of aluminium, nickel and other metals	Coat the outer shell

The above table is just an example and can be varied depending on what type of rockets are explored.

There are numerous web pages that explain some details of materials used, such as this one on heat resistant tiles.

https://en.wikipedia.org/wiki/Space_Shuttle_thermal_protection_system [2]

1.3 I can list the environmental issues that inform rocket manufacture

Learners will show a basic understanding of the external forces and elements that act on rockets

Additional information and guidance

Learners do not need to understand too much detail, though they can obviously cover some of the physical forces in their science lessons. They just need to be informed enough about the forces to make their designs work. It could be something as simple as understanding that a very rough surface on their rocket will not make it travel easily through the air. Other issues will include basic environmental elements such as heat and humidity. Many of the world's existing rocket launch sites tend to be in places that are relatively warm and dry. Temperature and humidity have various effects on the rocket as it passes through the different layers of the atmosphere, as well as having effects on the propulsion methods.

1.4 I can explain how the environment affects design decisions

Learners should be able to explain a few aspects of the impact of environment on design

Additional information and guidance

The most severe environmental effects will occur once the rocket gets beyond the Earth's atmosphere. Designs and materials will need to reflect this environment. Learners can do some simple research to see some of these effects, such as temperature, humidity and air pressure. However, all of these will vary as the rocket travels upwards. These aspects all affect design considerations. The rocket needs to be able to withstand the forces and pressures for take-off and then all the way through the atmosphere to space itself and also, on re-entry when temperatures and pressures are also extreme.

1.5 I can explain my findings and thoughts to an audience for feedback

Learners should be able to summarise what they have found to their peers or another audience

Additional information and guidance

Many of these news technologies are still emerging and not fully understood by the people that need to pay for them, the investors. There is a need to "pitch" the value of these proposals and designs to people to try to get them to understand and invest. Without investment, it is very difficult to pay for some of these technologies like rockets or unmanned vehicles. Learner's here need to put together a simple pitch to explain why they think building a rocket is a good investment idea. This will give them a good overview of the process of trying to get a project completed from idea to final build. The delivery can be a presentation software, or a short report.

2. Testing and making a variety of rockets and exploring their construction

2.1 I can experiment with materials and make notes for manufacture

Learners should appreciate the effect different materials have on products

Additional information and guidance

It would be useful to introduce learners to as many materials as possible to allow them to analyse them and start thinking about their properties. They should also start to get into the habit of making some notes about their activities so that they make better informed decisions when it comes to the planning stages. Keeping detailed notes about their activities means they won't have to waste time at a later date when once again researching materials for a manufacturing project.

2.2 I can test the aspects of materials for rocket making

Learners should carry out some simple tests

Additional information and guidance

It would be useful to run some simple experiments on materials to show how suitable, or not, they are for different tasks. The end goal will be to understand what types of materials are best suited to rocket manufacture, so for example, building a water based rocket of out thin cardboard tubes may work, but they need the water at relatively high pressure for the thrust to release, so thicker card would be better. At what thickness does the card become too heavy to lift off successfully. These types of experiments will give hands on experience of the relationship between a material's properties and the requirements of the manufacturing end goal.

2.3 I can explain the properties of materials and relate these to the rocket's possible success

Learners will explain some of their results

Additional information and guidance

The tests they run and make notes on should give them some details which can be discussed in groups or as a class to determine what materials would be good going forward. They should give some indication that their understanding of materials and their use can be combined when looking at the outcomes. If they tested a number of different materials for some task, they should have some simple data to compare. For example, if they make the same simple glider out of different papers and thin card based materials, they can see which one flies the fastest, or farthest and relate these to properties.

2.4 I can test built rockets on simple flight tasks

Learners should test their simple rocket designs

Additional information and guidance

This will most likely be water based rockets as this will be the easiest to make and deploy, though some centres may be licensed to try with other rockets such as fuel based ones. The only real tests here are whether or not it flies straight or as high as expected and if there are other difficulties. If they can make rockets with different materials, this will also give a wider range of data to analyse and discuss.

2.5 I can summarise my findings in a clear way

Learners should make a brief summary of their results

Additional information and guidance

The learner should be able to demonstrate their findings in some way that is clear. This could be as a report in their coursework or as a presentation. A combination of both methods would be useful as it would give them a wider opportunity to demonstrate their skills and understanding of the subject.

3. Investigating uses for rockets and materials

3.1 I can list the different ways rockets are currently used

Learners should produce a list of rocket uses

Additional information and guidance

The most obvious example here will be to launch objects and people into space and there will be numerous examples, including the latest test launch of a Tesla car into space. However, there are other examples of rockets uses which are perhaps not quite so obvious, for example, small rockets are launched from one ship to another to carry a rope in order to assist stranded sailors on one of the vessels. There is also a lot of skill and science in rockets made for fireworks, particularly the large rockets used for public displays. The Bloodhound project is attempting to make the world's first 1,000mph car. Any other examples will allow learners to appreciate the different careers that might be available for them in following this manufacturing path.

3.2 I can comment on future uses for rocket technology

Learners should be confident in making some predictions based on their understanding

Additional information and guidance

Learners will understand some of the ways that rockets are made and used and this may give them some insight into other potential uses that have yet to be determined. There have been some discussions about using rockets to protect the planet. The asteroid that hit earth 65 million years ago and wiped out the dinosaurs was not a massive object, although was travelling very fast. If detected early enough, rockets could be used perhaps to destroy or deflect such objects. Rocket powered commercial flights could be achievable for flight between continents to cut down on travel time. Given the precision of the Tesla rockets to fly and land automatically, perhaps small rockets could be used for critical health deliveries across the world, such as heart transplants.

3.3 I can explain new manufacturing tools and techniques used for rocket production

Learners should explore and explain in simple terms any new advances in the field

Additional information and guidance

Many learners will probably have read about the way technology used for space development sometimes comes back to earth, for example the use of Teflon in cooking which was developed to protect the spacecraft shell from the heat of re-entry. What other materials are being talked about? What are their unique properties? How else might they be used?

One key area for investigation is in the increasing use of 3D printers to develop and manufacture items. Could these be used to create rocket based elements?

3.4 I can explain the most suitable approaches to manufacturing I have discovered

Learners can show their understanding of what they have discovered

Additional information and guidance

In recent years, there has been a great deal more collaborative work on rockets than in the past. In previous years, countries were secretive about their space technology and were involved in a "Space Race" to try to make themselves look better than others. Now, countries work together for a shared solution. The International Space Station is made, maintained and populated by numerous countries and all share in the research that is developed. The manufacturing techniques used to make items for the ISS are understood by all concerned and any feedback on the processes and output can be discussed and improved upon by all.

Learners can reflect on their own small scale manufacturing. Could they do it all on their own, or was it more successful when more people were involved? Were teams better at making working rockets than one person? Were there problems working with large teams when manufacturing devices?

3.5 I can predict some developments in rocket manufacturing in the coming years

Learners should be confident enough to share their ideas and predictions

Additional information and guidance

There is probably no wrong answers here. In the 1970s, science fiction shows amazed audiences by showing people carrying small hand held devices that allowed them to communicate over great distances. Now, almost every student in the UK probably has something more amazing in a smartphone. Many devices have come about from science fiction writers who tried to imagine future worlds and some of these ideas have come to be created.

Learners should think about what could be made and why and make some basic predictions and sketches about their ideas for the future of rockets. These can be shared and discussed with their peers.

Links
[1] https://spaceflightsystems.grc.nasa.gov/education/rocket/rockpart.html
[2] https://en.wikipedia.org/wiki/Space_Shuttle_thermal_protection_system