**General Integrated Science**

**UNIT 2**

**Task 12 – Extended Response**

**Weighting 7.5 % (Part 1 and 2)**

**Conditions**

Time for the task:

**Part 1:** 1 week

**Part 2:** 50 min

Notes are not allowed and **MUST** be handed in prior to commencing Part 2.

## **Model Rockets – Research Assignment**

**Part 1:** Take home researchcomponent **(20% weighting)**

**Part 2:** In-class Validation **(80% weighting)**

**Part 1**

Your task is to research information on how model rockets work that will enable you to design and build your own. The information you research will be used to answer questions in an in-class validation test and then build your own model rocket design to test!

Research questions:

1. Rockets have a specific shape to enable them to be launched at great speeds into space. Describe the different shapes that the nose cone and the body could be to enable the **model rocket** to launch successfully. Which shape would launch it the furthest and why?

(6 marks)

1. Rockets have a set of fins at the base of the structure. Explain what shape the fins could be and how different designs affect the flight of the **model rocket**. (3 marks)
2. Aeroplanes and rockets need to overcome forces in order to launch and remain in constant motion while travelling through the air.
   1. What is “lift” and how does it keep objects in the air? (2 marks)
   2. What design features are needed to achieve maximum “lift” and ensure that the **model rocket** remains stable during take-off and in flight? (2 marks)
3. When launching a **model rocket** into the air the angle of release can dramatically affect the flight path of the rocket and also the distance it travels. How is the angle of release calculated? (1 mark)

What other design features need to be considered when calculating the angle? (2 marks)

1. To launch a **model rocket** successfully, designers need to consider Newton’s Laws of Motion when building the rocket and choosing the appropriate fuel.
   1. How could Newton’s Laws be applied when designing a model rocket? (3 marks)
   2. Discuss the different fuels used in **model rockets** and explain how designers select the most appropriate fuel for their design. (3 marks)
2. **Water rocket models** are often used to test theories before use with much bigger rockets. Considering Newton’s Third Law, research some different methods of how water rockets are propelled into the air and how maximum propulsion can be achieved. (4 marks)

**References to Include:**

<https://www.apogeerockets.com/education/downloads/Newsletter346.pdf>

<http://www.aerospaceweb.org/question/aerodynamics/q0151.shtml>

<http://ffden-2.phys.uaf.edu/102spring2004_web_projects/andrew_allen/Rocket_Engine.html>

<https://www.apogeerockets.com/education/downloads/Newsletter442.pdf>

<http://www.npl.co.uk/upload/pdf/wr_booklet_print.pdf>

<http://www.aircommandrockets.com/flying_higher.htm>

<http://www.waterrocketmanual.com/how_they_work.htm>

<https://www.meprogram.com.au/wp-content/uploads/2016/02/Rocket-Design-Info.doc>

<https://www.scarsdaleschools.k12.ny.us/cms/lib5/NY01001205/Centricity/Domain/330/water_rocket_physics_and_principles_18621.pdf>

**\*\*\*Marks will be deducted for not citing references\*\*\***

**\*\*\*Notes are to be summarised, in your own words\*\*\***

**\*\*\*Late submissions will be penalised\*\*\***

**Part 1: Marking Key**

1. Rockets have a specific shape to enable them to be launched at great speeds into space. Describe the different shapes that the nose cone and the body could be to enable the **model rocket** to launch successfully. Which shape would launch it the furthest and why?

Two cone shapes (parabolic, ogive, elliptical, cone, solid cylinder, vented cylinder) (2 marks)

Two body (cylinder and any other shape) (2 marks)

Which (cone with pointed top, and cylinder body (1 mark)

Why (more aerodynamic. Reduce resistance forces (e.g, drag) (1 mark)

1. Rockets have a set of fins at the base of the structure. Explain what shape the fins could be and how different designs affect the flight of the **model rocket**.

Two designs (e.g, semi-circle, triangle, elliptical, trapezoidal, square, clipped delta) (1 mark)

How affect flight (fins produce lift which enables the planes to fly. The also produce drag, which counteracts the lift.) (2 marks)

1. Aeroplanes and rockets need to overcome forces in order to launch and remain in constant motion while travelling through the air.
   1. What is “lift” and how does it keep objects in the air?

Lift is a force that draws things upwards (1 mark)

It keeps objects in the air because there’s lower air pressure above the object than there is below (1 mark)

* 1. What design features are needed to achieve maximum “lift” and ensure that the **model rocket** remains stable during take-off and in flight?

Nose cone, fins, a rocket engine, a system to change the direction of the fins, (2 marks)

1. When launching a **model rocket** into the air the angle of release can dramatically affect the flight path of the rocket and also the distance it travels. How is the angle of release calculated?

By measuring the angle of the launcher in relation to the ground (1 mark)

(1 mark instead if they managed to find the actual equation, but not needed)

What other design features need to be considered when calculating the angle?

(2 marks)

Any 4 of: The centre of mass of the rocket,the centre of pressure, launch ramps, launch tubes, where the fins have been placed, the weight of the rocket, the pressure in the launcher and the size/height of the rocket

1. To launch a **model rocket** successfully, designers need to consider Newton’s Laws of Motion when building the rocket and choosing the appropriate fuel.
   1. How could Newton’s Laws be applied when designing a model rocket?

Newtons First Law – some kind of force needs to be applied to the rocket so that it goes from rest to motion (1 mark)

Newtons Second Law – mass of the rocket needs to be reduced so that acceleration can be optimised without excessive fuel use (1 mark)

Newtons Third Law- Enough fuel needs to be burned/expelled/thrust produced so that it can push off of the ground with the same force that is needed to push the rocket up into the air. (1 mark)

* 1. Discuss the different fuels used in **model rockets** and explain how designers select the most appropriate fuel for their design.

Fuel 1 – solid fuel (1 mark)

Fuel 2 – liquid fuel (1 mark)

Choose based on whether they have access to enough of it, and also what kind of rocket they’re making. Solid is more dangerous but require minimum maintenance and are ready to use. Good for missiles. Liquid is less dangerous, but requires more complicated engines to control. Better for space rockets.

1. **Water rocket models** are often used to test theories before use with much bigger rockets. Considering Newton’s Third Law, research some different methods of how water rockets are propelled into the air and how maximum propulsion can be achieved.

Propulsion methods (2 marks)

* Bike pump to increase air pressure
* Add alka-selzter/ something that will produce a gas to increase pressure instead

Maximum achieved. Any two of: (2 marks)

* Minimum weight
* Mazimum volume
* Use higher pressures.
* Keep weight to a minimum
* Increase rocket volume.
* Streamline the body of the rocket to reduce drag.
* Use a launch tube on the launcher.
* Use the right amount of water.
* Use an optimum sized nozzle
* Use multiple stages.
* Optimize stage release timing
* Use a boat-tail on the rocket. .
* Allow the air to cool inside the pressure chamber
* Streamline the leading and trailing edges of your fins
* Use 3 fins instead of 4 or more
* Use optimally shaped fins.
* Use optimally sized fins.
* Ensure smooth internal water flow through the nozzle
* Fly on a windless day.
* Use a rounded nosecone.
* Use a less dense liquid.
* Use a heavier gas
* Align the fins properly.
* Make the rocket stable
* Remove internal obstructions.
* Fly from higher elevation launch sites.
* Launch rockets into thermals.
* Point the launcher as vertically as possible.
* Optimize direction of second stage after staging.
* Launch rockets on a humid day.
* Launch rockets on a hot day.
* Grease the launch tube for less friction.

**General Integrated Science**

**UNIT 2**

**Task 12 – Extended Response**

**Weighting: 7.5 % Part 1 : \_\_\_ / 26**

**Part 2 : \_\_\_ / 30**

**Total : \_\_\_\_\_ %**

**Conditions:**

Notes are not allowed and **MUST** be handed in prior to commencing.

Time for the task: **Part 2:** 50 min

## **Model Rockets – Research Validation**

**Part 2:** In-class Validation **(80% weighting)**

1. Rockets are a great example of how forces interact with each other to produce a net result, including adding together (sum of forces) and cancelling out opposing forces.
   1. What types of forces do you need to consider when designing a rocket to fly as far as possible? (2 marks)

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* 1. How do they work together to make the rocket fly? (2 marks)

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1. Newton’s Second Law states the equation:
   1. Using this equation, explain how mass affects the amount of force produced. (2 marks)

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* 1. What factors affect the acceleration of the rocket? (3 marks)

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* 1. How could you produce the maximum acceleration of the rocket? (3 marks)

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1. A rocket starts off stationary at a launching pad.
   1. Describe the rocket taking off in terms of Newton’s First Law. (2 marks)

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* 1. Explain how taking-off is a good example of Newton’s Third Law. (2 marks)

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1. The shape of the rocket is a key component that affects the flight path and distance travelled. It can greatly improve the rocket’s efficiency, or drastically affect its performance.
   1. Which design of rocket shape would you use? Explain your choice. (3 marks)

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* 1. Using appropriate force terminology, explain the importance of designing an optimum nose cone shape for your rocket? (3 marks)

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1. For your rocket to achieve maximum distance in the right direction, the forces acting on the rocket must work consistently in the same direction.
   1. Theoretically, which launch angle would result in the rocket travelling the furthest horizontal distance? (1 mark)

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* 1. Explain your answer in terms of the direction of force. (2 marks)

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* 1. Using knowledge from your research and other experiments, list three ways to that you could control the direction of the force. (3 marks)

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* 1. Explain one other design feature that could help the rocket go further. (2 marks)

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**Part 2: Marking Key**

1. Rockets are a great example of how forces interact with each other to produce a net result, including adding together (sum of forces) and cancelling out opposing forces.
   1. What types of forces do you need to consider when designing a rocket to fly as far as possible? (2 marks)

* Lift, Drag/Air Resistance, Thrust, Weight/Gravity (1/2 each)
  1. How do they work together to make the rocket fly? (2 marks)
* Sum together to produce net result upward (must specify certain direction)
* Thrust & lift need to overcome gravity & drag

1. Newton’s Second Law states the equation:
   1. Using this equation, explain how mass affects the amount of force produced. (2 marks)

* Increase mass, increase force (1) for same/constant acceleration (1)
  1. What factors affect the acceleration of the rocket? (3 marks)
* Mass
* Amount of force/thrust produced
* Description of aerodynamics (overcome forces / reduce gravity and drag)
  1. How could you produce the maximum acceleration for any rocket? (3 marks)
* Optimum/minimum mass (reduce gravity force)
* Stability of rocket in the air (Force produced in the one direction)
* Decrease drag/aerodynamic design
* Balance of weight force (right amount of fuel)

1. A rocket starts off stationary at a launching pad.
   1. Describe the rocket taking off in terms of Newton’s First Law. (2 marks)

* An object stays at rest until acted upon by another force (max 1)
* The rocket stays at rest until the force of thrust acts upon it (1)
  1. Explain how taking-off is a good example of Newton’s Third Law. (2 marks)
* Every action has an equal and opposite reaction (max 1)
* Propulsion force acts downwards to produce thrust in opposite direction (1)

1. The shape of the rocket is a key component that affects the flight path and distance travelled. It can greatly improve the rocket’s efficiency, or drastically affect its performance.
   1. Which design of rocket shape would you use? Explain your choice. (3 marks)

* Nose cone used
* Body shape used
* Fins for stability (max 2 marks)
* Explanation in terms or aerodynamics/drag force (1 mark)
  1. Using appropriate force terminology, explain the importance of designing an optimum nose cone shape for your rocket. (2 marks)
* Improve aerodynamics to reduce drag force
* Reduce drag force to improve thrust/net force

1. For your rocket to achieve maximum distance in the required direction, the forces propelling the rocket must work consistently in the same direction.
   1. Theoretically, which launch angle would result in the rocket travelling the furthest horizontal distance? (1 marks)

* 45° - 60°
  1. Explain your answer in terms of direction of force. (2 marks)
* 45° / halfway between 0° and 90°
* Need to have enough angle height to travel the distance
* Thrust force wasted if angle too shallow
  1. Using knowledge from your research and other experiments, list three ways that you could control the direction of the force. (3 marks)
* Fins for stability
* Direct force in the same direction
* Launch pad perpendicular
  1. Explain one other design feature that could help the rocket travel further. (3 marks)
* Length of body
* Volume of water / air mixture
* Increased pressure