**GENERAL INTEGRATED SCIENCE– UNIT 2**

**TASK 13 – Rocket Design Extended Response**

**MARKING KEY**

1. Rockets are a great example of how forces interact with each other to produce motion.
   1. **List** four forces that need to be considered when designing a rocket to fly as far as possible. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Mark** |
| Thrust/applied force | 1/2 |
| Lift | 1/2 |
| Drag/air resistance/friction | 1/2 |
| Weight/gravity | 1/2 |
| **TOTAL** | **2** |

* 1. **Describe** how these forces work together to make the rocket fly. (4 marks)

|  |  |
| --- | --- |
| **Description** | **Mark** |
| Thrust pushes plane forwards, drag pushes it backwards | 1 |
| Thrust must be greater than drag to move forwards | 1 |
| Lift makes plane go up, weight makes p[lane go down | 1 |
| Life must be greater than weight so plane goes up | 1 |
| **TOTAL** | **4** |

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

|  |  |
| --- | --- |
| **Description** | **Mark** |
| States Newtons’ Third Law | 1 |
| As engine pushes on ground, reaction is that rocket goes up in opposite direction | 1 |
| **TOTAL** | **2** |

* 1. If a rocket has a payload of 82 tonnes, use Newton’s First Law to **explain** why the total take-off weight of the rocket is 350 tonnes. (3 marks)

|  |  |
| --- | --- |
| **Description** | **Mark** |
| States Newton’s First Law | 1 |
| Need lots of force to overcome gravity/move from rest to upwards motion | 1 |
| Extra fuel needed to generate that force, which also weighs more. | 1 |
| **TOTAL** | **3** |

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. In the space below, draw a quick **sketch** of a rocket. On the sketch, **label** the main features of a rocket. (5 marks)

|  |  |
| --- | --- |
| **Description** | **Mark** |
| Labels nose cone | 1 |
| Labels fin | 1 |
| Labels payload | 1 |
| Labels propulsion | 1 |
| Label guidance system | 1 |
| **TOTAL** | **5** |

* 1. You have just drawn and labelled the different features of a rocket. In the space below, **describe** how the structural system of a rocket could be designed to maximise flight distance. (3 marks)

|  |  |
| --- | --- |
| **Description** | **Mark** |
| Fin – elliptical fin maximise lift | 1 |
| Nose cone – cone shape reduces drag | 1 |
| Body/frame – some mention of aerodynamic design | 1 |
| **TOTAL** | **3** |

* 1. **Explain** why titanium is used as a main component in the construction of rockets, but gold is not. (3 marks)

|  |  |
| --- | --- |
| **Description** | **Mark** |
| Any three of the following:   * Titanium cheaper than gold * Titanium lighter than gold * Titanium has higher melting point than gold * Titanium less malleable than gold * Any other valid reason | 1-3 |
| **TOTAL** | **3** |

1. In order to launch heavy rockets into space to deliver their payloads, a significant amount of force must be generated by the rocket’s engine(s).
   1. Most rockets use both a liquid fuel and a solid fuel. The liquid fuel is used to launch the rocket into space, and the solid fuel is then used to adjust movements in space. **List** one advantage and one disadvantage of solid fuels. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Mark** |
| Any one of the following advantages:   * Simple * Cheaper * Safer – does not explode | 1 |
| Any one of the following disadvantages:   * One ignited, cannot be turned off * Less control * Cannot be transported through pipelines | 1 |
| **TOTAL** | **2** |

* 1. There is a lot of research being conducted into the liquid fuel that rockets use, and new fuels are currently being developed and tested. In the space below, **describe** two reasons why new fuels are needed. (2 marks)

|  |  |
| --- | --- |
| **Description** | **Mark** |
| Any two of the following reasons:   * Reduction of pollution * More efficient weight-for-weight * New fuels can be made by recombining waste products/using substances from Mars * More stable/safer * To reduce toxicity * Any other valid reason | 1-2 |
| **TOTAL** | **2** |

* 1. Solid, metallic hydrogen was recently created in a lab. This revolutionary creation may change rocket fuel forever. Using your knowledge of hydrogen’s properties, **discuss** why metallic hydrogen is regarded as the future of rocket fuel. (3 marks)

|  |  |
| --- | --- |
| **Description** | **Mark** |
| Hydrogen is light-weight, so rocket weight decreased | 1 |
| Solids take up less space than gasses or liquids, so more room for payload | 1 |
| Hydrogen is highly reactive, so a small amount can generate a lot of force for take-off | 1 |
| **TOTAL** | **3** |

* 1. Many people believe that space travel is the future of our species. Companies like Space X are planning colonies on Mars, and China have discussed plans to mine helium from the moon. Many other people believe that it is unethical for humans to consider colonising another planet. In the space below, describe one argument for or one argument against colonising Mars. (1 mark)

|  |  |
| --- | --- |
| **Description** | **Mark** |
| Any reasonable argument for or against colonising Mars. For example:   * More room for agriculture * New materials to mine * Reduce population on Earth, so human impact smaller * Human curiosity * Current fuels not sustainable enough to start having hundreds of launches * Is it ethical to colonise a new planet when we are yet to perfect living on Earth? * How will we decide who gets to go to Mars? * Risk of starting a new human species of healthy and wealthy | 1 |
| **TOTAL** | **1** |