# For students – Analysing rocket launches

***Activity 1: Use the rocket launch simulation to make a rocket go as high as possible***

Leave drag and mass change switched off and change values for the first three columns to try to get each rocket flying as high as possible.

1. Changing thrust.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Launch settings** | | | | | **Launch results** | |
| **Mass of rocket (kg)** | **Thrust**  **(N)** | **Time of thrust (s)** | **Drag** | **Mass change** | **Height reached (m)** | **Maximum speed (m/s)** |
| 8,000 | 100,000 | 100 | OFF | OFF |  |  |
| 8,000 | 130,000 | 100 | OFF | OFF |  |  |
| 8,000 | 160,000 | 100 | OFF | OFF |  |  |

Challenge: For a 8,000 kg rocket and a thrust time of 100 s, what thrust makes the rocket reach a height of 69 km? Answer: Thrust = \_\_\_\_\_\_\_\_\_\_\_\_\_ N

1. Changing time of thrust.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Launch settings** | | | | | **Launch results** | |
| **Mass of rocket (kg)** | **Thrust**  **(N)** | **Time of thrust (s)** | **Drag** | **Mass change** | **Height reached (m)** | **Maximum speed (m/s)** |
| 8,000 | 130,000 | 60 | OFF | OFF |  |  |
| 8,000 | 130,000 | 100 | OFF | OFF |  |  |
| 8,000 | 130,000 | 140 | OFF | OFF |  |  |

Challenge: For a 8,000 kg rocket and a thrust of 130,000 N, what thrust time makes the rocket reach a height of 34 km? Answer: Thrust time = \_\_\_\_\_\_\_\_ s

1. Changing mass.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Launch settings** | | | | | **Launch results** | |
| **Mass of rocket (kg)** | **Thrust**  **(N)** | **Time of thrust (s)** | **Drag** | **Mass change** | **Height reached (m)** | **Maximum speed (m/s)** |
| 6,000 | 130,000 | 100 | OFF | OFF |  |  |
| 8,000 | 130,000 | 100 | OFF | OFF |  |  |
| 10,000 | 130,000 | 100 | OFF | OFF |  |  |

Challenge: For a thrust of 130,000 N and a thrust time of 100 s, what rocket mass makes the rocket reach a height of 220 km? Answer: mass = \_\_\_\_\_\_\_\_ kg

1. Find the maximum height you can reach for each rocket.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Launch settings** | | | | | **Launch results** | |
| **Mass of rocket (kg)** | **Thrust**  **(N)** | **Time of thrust (s)** | **Drag** | **Mass change** | **Height reached (m)** | **Maximum speed (m/s)** |
| 12,000 |  |  | OFF | OFF |  |  |
| 10,000 |  |  | OFF | OFF |  |  |
| 8,000 |  |  | OFF | OFF |  |  |
| 6,000 |  |  | OFF | OFF |  |  |
| 4,000 |  |  | OFF | OFF |  |  |

1. What was your highest distance? \_\_\_\_\_\_\_\_\_\_\_\_\_ km
2. What did you do to make your rocket travel higher?
3. Using your results above, what three things can be done to make a rocket go faster and higher?

* The **mass** of the rocket can be increased/decreased
* The **thrust** can be increased/decreased
* The **time of the thrust** can be increased/decreased

1. What happens to the **speed** of the rocket while the engine is creating thrust?

* The **speed** of the rocket increases/decreases/stays the same

1. When is the speed of the rocket at its fastest?
2. What happens to the speed of the rocket when the engine has finished producing thrust?

* The **speed** of the rocket increases/decreases/stays the same

1. Why does a rocket keep moving upwards even after the thrust has finished?
2. What is the minimum thrust needed to launch each of the following rocket masses?

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Mass of rocket (kg)** | 12,000 | 10,000 | 8,000 | 6,000 | 4,000 |
| **Minimum thrust (N)** |  |  |  |  |  |

1. Why does a rocket with more mass need more thrust to launch it?

***Activity 2: How does drag influence the height reached by a rocket?***

Drag is the air resistance that opposes the motion of a rocket. There is always drag as an object moves through the air

1. For each of the following, record results for a rocket if there was no drag acting (ideal world) and then compare the results when drag is switched on (real world).

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Launch settings** | | | | | **Launch results** | |
| **Mass of rocket (kg)** | **Thrust**  **(N)** | **Time of thrust (s)** | **Drag** | **Mass change** | **Height reached (m)** | **Maximum speed (m/s)** |
| 8,000 | 160,000 | 100 | OFF | OFF |  |  |
| 4,000 | 80,000 | 100 | OFF | OFF |  |  |
| 2,000 | 40,000 | 100 | OFF | OFF |  |  |
| 8,000 | 160,000 | 100 | ON | OFF |  |  |
| 4,000 | 80,000 | 100 | ON | OFF |  |  |
| 2,000 | 40,000 | 100 | ON | OFF |  |  |

1. Which rocket was affected the most by drag?

***Activity 3: How does the loss of mass from the rocket engine affect motion?***

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Launch settings** | | | | | **Launch results** | |
| **Mass of rocket (kg)** | **Thrust**  **(N)** | **Time of thrust (s)** | **Drag** | **Mass change** | **Height reached (m)** | **Maximum speed (m/s)** |
| 8,000 | 140,000 | 100 | OFF | OFF |  |  |
| 8,000 | 140,000 | 100 | OFF | ON |  |  |

1. How does the rocket’s motion change when mass change is switched on?
2. With drag and mass change both switched on what is the greatest height you can reach with any combination of launch settings? This is the simulation’s ultimate challenge.  
     
   Note that the simulation will not allow you to choose the smallest mass and the greatest thrust for the greatest time. As you increase the thrust, the minimum rocket mass also increases. Also, some setting combinations produce great stresses on the rocket during flight and it will explode. This is most embarrassing and very costly. Choose carefully.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Launch settings** | | | | | **Launch results** | |
| **Mass of rocket (kg)** | **Thrust**  **(N)** | **Time of thrust (s)** | **Drag** | **Mass change** | **Height reached (m)** | **Maximum speed (m/s)** |
|  |  |  | ON | ON |  |  |