

ACTIVITY: Launch simulator challenge

Activity idea

In this activity, students use a rocket launch simulation. They change variables such as thrust to make a rocket go as high as possible.

By the end of this activity, students should be able to:

- investigate how thrust, time of thrust and mass of a rocket can be changed to make a rocket go as high as possible
- explore how drag influences the height reached by a rocket
- explore how the speed and forces acting on a rocket change during a launch
- explore how the changing mass of a rocket (as propellant is used and ejected) affects the speed and height of a rocket.

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Student record sheet: [Analysing rocket launches](#)

Introduction/background

The interactive [Rocket launch simulation](#) provides students with five rockets to investigate, each of different mass. The challenge is to make a rocket go as high as possible.

Each rocket has been set to have the same diameter (8 cm) and the same external configuration. For each rocket:

- Students can vary the amount of thrust from 0–400 N. This simulation assumes that the thrust is constant for the time that it acts. The duration of thrust can be varied from 1–5 s.
- Drag can be set to off (ideal world without air resistance) or on (real world includes drag).
- Mass change can be set to off (ideal world where mass of rocket remains constant). In the real world, rockets lose mass as it is ejected from the engines.

You may pause the simulation at any time to check thrust, weight, drag and resultant force values, as well as speed and height. There is also the ability to skip straight to the results rather than waiting for the launch in real time.

What you need

- Access to the interactive [Rocket launch simulation](#)
- Copies of the student record sheet [Analysing rocket launches](#)

What to do

1. Introduce the challenge: to make a rocket go as high as possible using the interactive [Rocket launch simulation](#).
2. Discuss how each of the variables may affect the height reached by the rocket – mass, thrust, time, drag and mass change.
3. Discuss that this simulation allows students to investigate an ideal world without drag (by leaving the drag switch set to off). It is then useful to compare this with the real world where drag makes a great difference.
4. Hand out copies of the student record sheet [Analysing rocket launches](#) and ask students to work through it. (Questions 1–6 are recommended for all. There is more available if you want to go into greater depth.)

Analysing rocket launches

Activity 1 – use the rocket launch simulation to make a rocket go as high as possible

Leave drag and mass change set to off and change values for the first three columns to try to get each rocket flying as high as possible. Record at least two values for each size rocket.

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)
20	200	3	off	off		
20	300	3	off	off		
20	400	3	off	off		

Challenge: For a 20 kg rocket and a thrust time of 3 s, what thrust makes the rocket reach a height of 50 m? Answer: Thrust = _____ N

2. 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)
20	400	1	off	off		
20	400	3	off	off		
20	400	5	off	off		

Challenge: For a 20 kg rocket and a thrust of 400 N, what thrust time makes the rocket reach a height of 166 m? Answer: Thrust time = _____ s

3. 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)
20	200	3	off	off		
10	200	3	off	off		
5	200	3	off	off		

Challenge: For a 5 kg rocket and a thrust time of 3 s, what thrust makes the rocket reach a height of 871 m? Answer: Thrust = _____ N

4. 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)
20			off	off		
10			off	off		
5			off	off		
2			off	off		
1			off	off		

5. What was your highest distance? _____ metres

6. What did you do to make your rocket travel higher?

7. 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
8. What happens to the **speed** of the rocket while the engine is creating thrust?
- The **speed** of the rocket increases/decreases/stays the same
9. When is the speed of the rocket at its fastest?
10. 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
11. Why does a rocket keep moving upwards even after the thrust has finished?
12. What is the minimum thrust needed to launch each rocket?

Mass of rocket (kg)	20	10	5	2	1
Minimum thrust (N)					

13. 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

14. For each of the following, record results for a rocket if there was no drag acting (pretend 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)
10	400	5	off	off		
5	200	5	off	off		
2	80	5	off	off		
1	40	5	off	off		
10	400	5	on	off		
5	200	5	on	off		
2	80	5	on	off		
1	40	5	on	off		

15. 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)
10	400	5	off	off		
10	400	5	off	on		

16. How does motion change?

17. With drag and mass change both set to on what is the greatest height you can reach with any 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)
			on	on		

Activity 4 – how do the forces and speed of a rocket change during a launch?

For this activity, set your rocket as follows:

Launch settings				
Mass of rocket (kg)	Thrust (N)	Time of thrust (s)	Drag	Mass change
1	40	5	on	off

18. Once the rocket has launched, pause it during each second to record information about speed, height and forces:

- Note that time has been rounded to the nearest second, so values will vary slightly.
- For these results, a positive value shows the direction of that force is upwards; a negative value shows the direction is downwards. The resultant force is the sum of drag, weight and thrust.

Time (s)	Speed (m/s)	Height (m)	Drag (N)	Weight (N)	Thrust (N)	Resultant force (N)
0						
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						

19. When is drag at its greatest?

20. How does the change in speed relate to the resultant force?