

Report on 'Launch and land'



1. Overview

This report describes the winners of the 'Launch and land' challenge which we designed to be a 'run at home' version of the annual NPL Water rocket Challenge.

We identified 5 winners and were delighted with the effort participants had put in to launch and land an A4 sheet of paper exactly 3 metres distant, three times.

2. Who won?

In the spirit of our annual event, we gave awards for all manner of things. We look forward to seeing everyone in 2021 at our annual physical event (www.npl.co.uk/wrc).



Gordon (left) wins **most repeatable landing**, but it was close – most entrants shared videos of their attempts with several getting near to the target 3 times.

We had joint winners (right) of **best launcher technology**.

Kossay adapted a plastic bottle by cutting it in two to launch a rolled up sheet. It had the look of a 'message in a bottle'.



Jack the brilliant idea of using a dropping weight (water bottle) to provide a consistent force.

Team Jam propelled their A4 sheet (a cunningly using tissue paper to minimise mass, attached to a nerf gun pellet) though it was their enthusiastic 'banner' and dance that won them the coveted '**best banner and team dance**' award.



With '**most impressive rocket**', **The A team** shared a photo of some imposing 3D printed rockets.



3. What is the science?

NPL loves the Water Rocket Challenge and this derivative. Every day we all rely on engineering for equipment to perform reliably, and like good design, something that looks simple often hides many hours of thinking, design and experimentation. This challenge is about *forces* and motion, and here are a few things to consider.

Vertical motion is useful in avoiding obstacles. In this challenge, energy used to gain altitude also ‘buys’ flight time. Purely vertical or horizontal launches will not reach a distance of 3 metres and there is an optimal launch angle that keeps the projectile in the air long enough to travel the required distance. *Gravitational force* slows the rate of ascent and hastens descent. *Air resistance* always slows the projectile’s motion, which works against you on ascent (as it requires more energy to get higher) and helps you by slowing the descent.

Horizontal motion depends on the *horizontal component of force* used during launch, the mass of the projectile, *air resistance* changing speed and direction, and the time of flight (see ‘vertical motion’).

Your system’s reliability depends on keeping several factors constant for all launches. These include: mass of your projectile (bits shouldn’t fall off), projectile shape (affected by *air resistance* during flight and damage on landing), *launch force* (we saw some clever approaches to keep this constant, often involving a treasured single rubber band stretched to a marked position) and air motion (even light gusts of wind will cause problems).

Safety is always key. We were delighted to see how **Jack’s** deadweight launch system used a cushion to protect the floor (and people’s feet) from the falling weight, and that all participants’ landing areas were free of people and pets.

4. The funny thing about rules...

No matter how comprehensive rules are, individuals will always find an approach you didn’t consider. We were asked ‘Just checking... can I drop my paper out of a window 3 m above the ground – that way it will always reliably land 3 m from start.’ The response was ‘no’, and we made a note to include the word horizontal in the rules next time. The same person then asked if they could fire at a wall 3 m away, no again! Intriguingly, the individual did not enter our competition. After all, this is rocket science – one of the harder branches of engineering, so congratulations to those participants who did so well.

5. Do join in

Our **Measurement at Home** reports discuss submissions in the first week or so of issuing the challenge, though we welcome ongoing entries. In this case, we would ask you to have a go, and then consider entering the water rocket challenge – see www.npl.co.uk/wrc for details.

#MeasurementAtHome

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