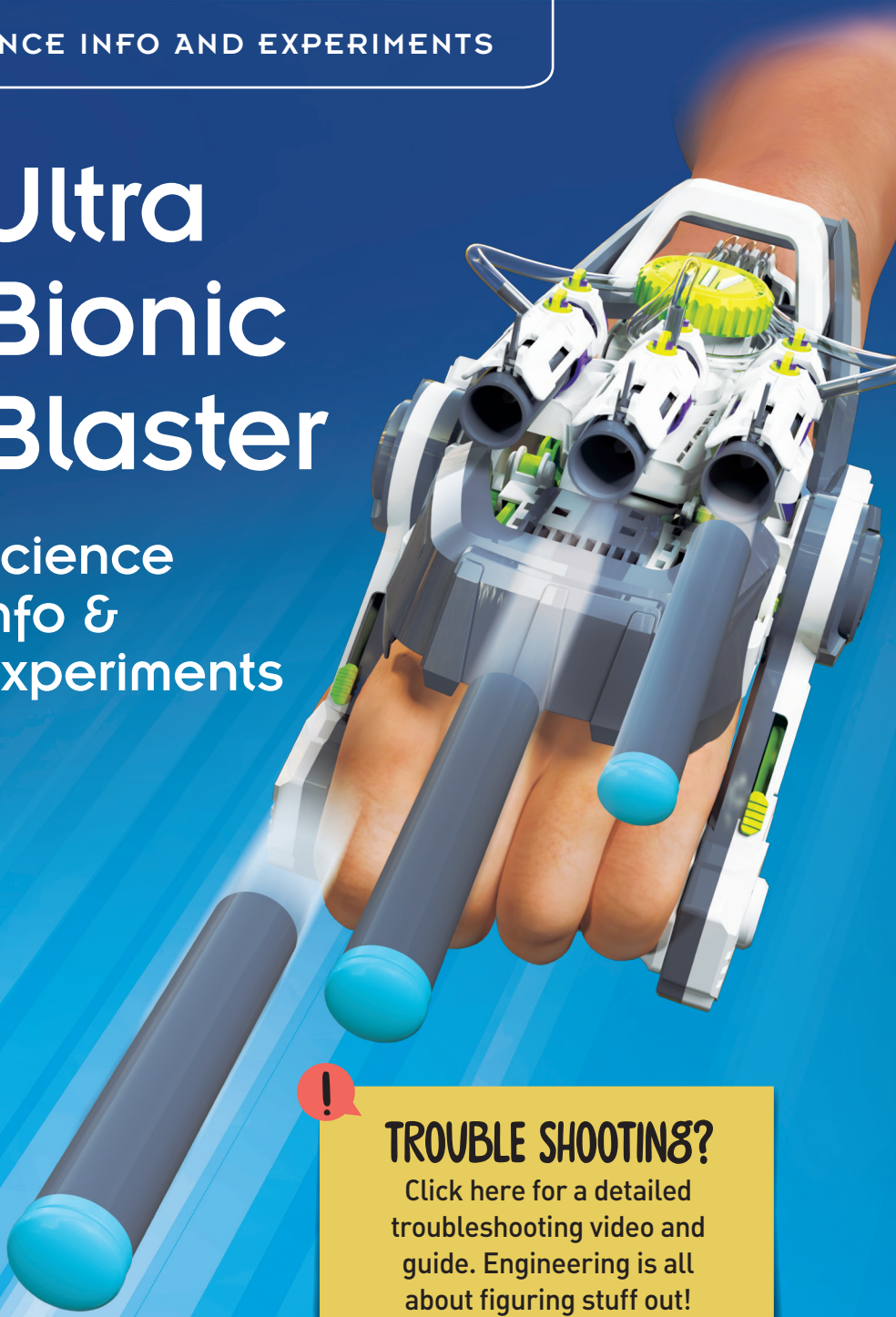
Ultra Bionic Blaster

Science Info & Experiments



TROUBLE SHOOTING?

Click here for a detailed troubleshooting video and guide. Engineering is all about figuring stuff out!

THAMES & KOSMOS

EXPERIMENT 1

Calculate dart speed

How fast is the dart going?

You will need

- *For all experiments, you will need the assembled blaster and foam darts*
- *Stopwatch*
- *Piece of tape or chalk*
- *Measuring stick or tape measure*

Here's how

1. Mark the floor with a piece of tape or chalk to create the starting line.
2. Make sure the dial is turned so that all of the darts are facing forward.
3. Have a friend get the stopwatch ready. They should start the timer when the dart leaves the blaster and stop the timer when the dart hits the ground.
4. Hold your arm straight out from your body, line up the darts with the starting line, and launch a dart. Have a friend make a mark on the floor where the dart landed.
5. Measure the distance from the starting line to the landing spot. Record the distance and the time the dart was in the air.
6. For best results, repeat several times and calculate the average distance, average time, and average speed.

To calculate the average, add up the values then divide the sum by the number of trials. (In this table, you would divide by 5.)

WHAT'S HAPPENING?

Speed is calculated by dividing the distance traveled by the time it takes to get there. Here's what that looks like as a formula:

$$\text{speed} = \frac{\text{distance}}{\text{time}}$$

This formula can be rearranged in two other ways. If you know two of the variables, you can calculate the third.

$$\text{distance} = \text{speed} * \text{time}$$

$$\text{time} = \frac{\text{distance}}{\text{speed}}$$

Data Table
Scientists run multiple trials to increase the reliability of their experiments.

Trial	Distance	Time	Speed (distance/ time)
1			
2			
3			
4			
5			
Average			

EXPERIMENT 2

Optimize launch angle

What angle should your arm be to launch a dart the furthest distance?

You will need

- *Measuring stick or tape measure*
- *Piece of tape or chalk*

Here's how

1. Make sure the dial is turned so that all of the darts are facing forward.
2. Hold your arm straight out from your body and fire a dart. Have a friend make a mark on the floor where the dart landed.
3. Point your arm slightly higher and fire a dart. Did it go further than the first dart?
4. Keep increasing the angle of your arm, little by little, until you find the optimal angle for dart range.

TIP

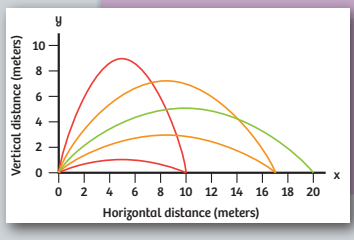
TRY THIS:

PUNCH YOUR HAND WEARING THE BLASTER THROUGH THE AIR AS YOU RELEASE THE DART. IF YOU GET THE TIMING RIGHT, YOU WILL BE INCREASING THE INITIAL SPEED OF THE DART, WHICH WILL RESULT IN A MUCH LONGER RANGE.

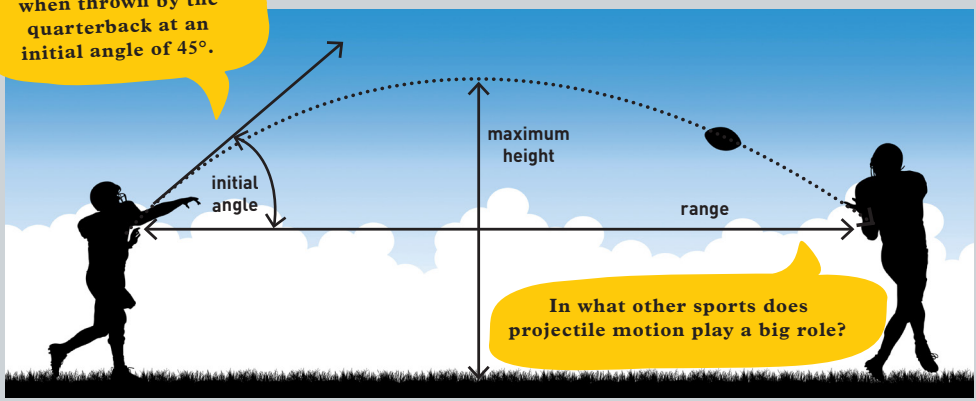
WHAT'S HAPPENING?

As soon as the dart leaves the blaster, it is undergoing **projectile motion**. The launch distance, or **range**, depends on two things: the initial angle and the initial speed. After launch, the only force acting on the dart is gravity, as long as you ignore air resistance.

Amazingly, if you launch one dart at a 20° angle, and another dart at a 70° angle, those darts will land in the same place. That's because those angles are **complimentary** — they add up to 90°.



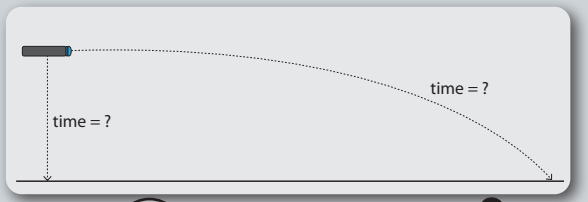
The maximum range is achieved when the initial angle of launch is equal to 45°.



EXPERIMENT 3

Dropping darts

Which will hit the ground first?

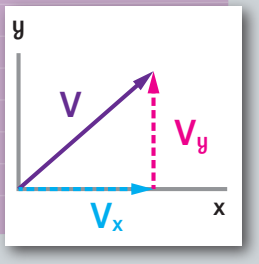


Here's how

1. Extend your arm with the blaster straight out in front of you.
2. Hold another dart in your other hand at the same height as the blaster. You will drop one dart at the same time that you launch the other one.
3. Which will land first? Make a hypothesis, or guess based on information you already know.
4. Try your best to drop the dart in your hand at the ***exact same time*** as you shoot a dart from the blaster.
5. Was your hypothesis correct?

WHAT'S HAPPENING?

Two darts that are released from the same height at the same moment will hit the ground at the same time! That's because, once they are in the air, the only force acting on the darts is **gravity**. And since the **horizontal** (V_x) and **vertical** (V_y) **components** of projectile motion are completely **independent** of one another, the initial horizontal speed of the dart does not affect the time it takes to reach the ground.



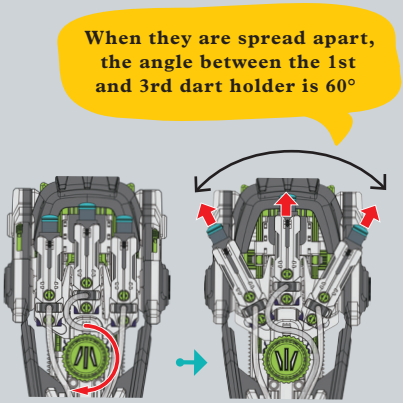
EXPERIMENT 4

Radial distance

You're at the center of the circle.

Here's how

1. Make sure you have a lot of space around you.
2. Rotate the green dial 180° clockwise to spread the angle of the dart holders. Then blast off three darts.
3. Now turn your body 180° without moving from your spot and blast off three more darts.
4. Now, walk over to the first dart you fired. Next, walk over to the next dart, and the next one. Finally return to the first dart. What shape was your path?



WHAT'S HAPPENING?

You can think of the blaster as the center point of a circle, and each dart trajectory as a radius of the circle. Can you calculate the circumference? ($C = 2\pi r$, where $\pi \approx 3.14$)

EXPERIMENT 5

Accuracy vs. Precision

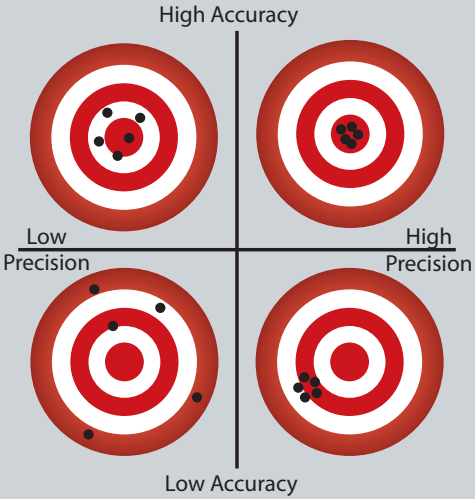
How often can you hit the target?

You will need

- *Metal pie pan or other durable dish*
- *Piece of tape or chalk*
- *Measuring stick or tape measure*

Here's how

1. Place a metal pie pan upside down on the floor. This is your bullseye,
2. Place a piece of tape 10 to 15 feet away from the pie pan. This is where you will stand when testing out your precision and accuracy.
3. Shoot three darts. How accurate were your shots? How precise were they?
4. How does changing your shooting technique affect precision and accuracy? Try closing one or both eyes. Use two hands or your non-dominant hand. What else can you try?



WHAT'S HAPPENING?

Accuracy is how close your results (or shots) are to your target value — in this case, the center of the target. Precision is how often you are able to get the same value, or have your projectile land in the same place. Look at the pictures above to see how accuracy and precision are related. Accuracy and precision are both critical concepts in the scientific world.

Keep a record of your results for the different experiments.

EXPERIMENT 6

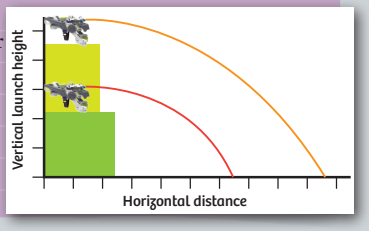
Changing heights

Here's how

1. Launch darts from different heights and record how far they travel. Try lying on your belly, standing up, or standing on a chair (with adult supervision). What do you notice?

WHAT'S HAPPENING?

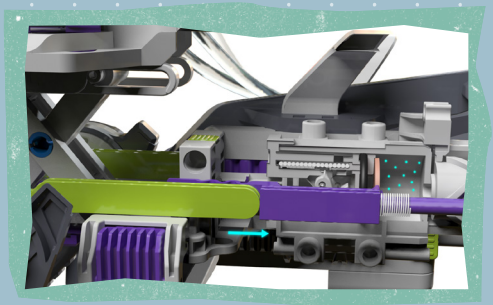
If everything else remains the same, when the height from which the projectile is shot increases, the time that the object is in the air will also increase. Maximizing the time that the object is in the air is important for a tennis lob, a football punt, and diving.

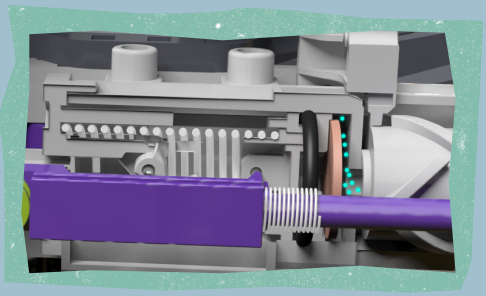


HOW DOES THE Ultra Bionic Blaster WORK?

This type of gear setup is called a rack and pinion. It transfers radial motion to linear motion, or vice verse. There are four rack-and-pinion setups on each side of the blaster!

The piston rod is locked in place by the E4 pin, but the rest of the cylinder moves backwards, drawing air into the chamber of the cylinder.



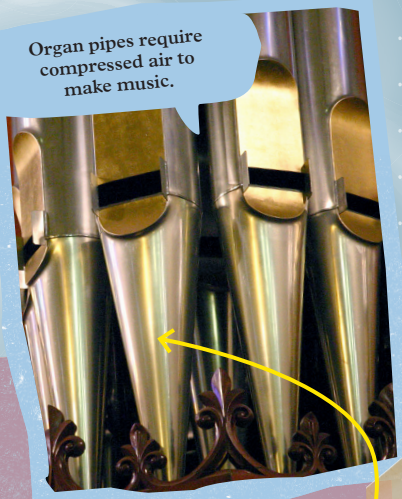


When you compress the trigger far enough, the latch that attaches the piston rod to the piston is released. The spring expands quickly, compressing the air in the chamber.

The compressed air travels up through the tube and pushes out a dart. The air wheel at the back of the machine rotates so the next nozzle will be ready to go.

CHECK IT OUT

The Ultra Bionic Blaster uses **compressed air** to send darts flying into the air. Compressed air has a lot of uses in wide range of devices, from musical instruments to construction equipment. The technical term is **pneumatic**, which comes from the Greek word for breath and wind.



Organ pipes require compressed air to make music.

In **pneumatic systems,** air is pressurized by a compressor. Electrically-controlled valves guide the compressed air in cylinders containing pistons, which perform desired movements. Compressed air cannot exert as great a force as compressed liquid. However, as you have learned, air has the property of being more compressible, so pneumatics have the advantage of being able to operate at high speeds. Also, systems like this are safer and easier to control than hydraulic systems, which use liquid.

You are probably familiar with the sight — and sound — of pneumatic jackhammers.

WHERE ARE Pneumatics USED?

There are many applications of pneumatic devices. Some of these may sound awful, such as **jackhammers**. Some, on the other hand, may sound very beautiful, such as **pipe organs**, which produce sound when compressed air is pushed through the pipes. Sometimes, compressed air helps to ensure a comfortable ride, such as in **car suspensions**. Pneumatic tube systems are still used in **hospitals** to deliver samples from patients' rooms to testing labs.