

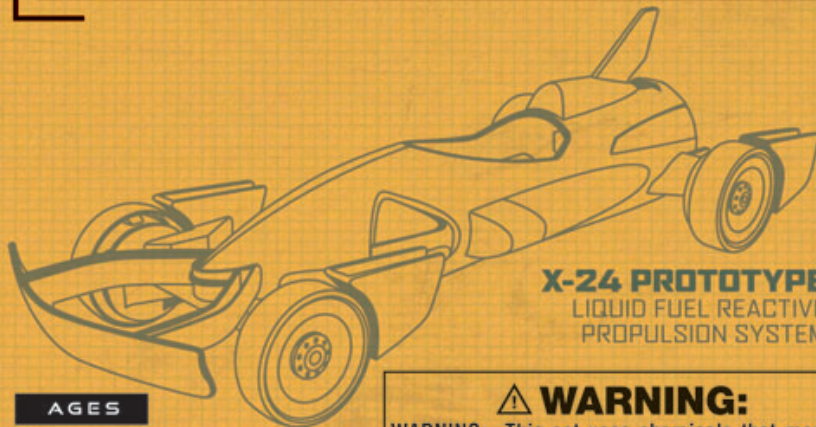


# HWTF™

HOT WHEELS TEST FACILITY™

**TOP SECRET**  
HOT WHEELS TEST FACILITY INTERNAL USE ONLY!

PROJECT:  
**ROCKET CAR**  
FIELD EXPERIMENTATION GUIDE BOOK



**X-24 PROTOTYPE**  
LIQUID FUEL REACTIVE  
PROPULSION SYSTEM

AGES  
**8+**

**WARNING:**  
WARNING: This set uses chemicals that may be harmful if misused. Not to be used by children except under adult supervision.



**HWTF™ CHEMICAL RESEARCH DIVISION**



ITEM NO.: X4003  
PART CODE: X4003-0900  
ITEM NAME: HW New Business Rocket Car  
TOY YEAR: 2011 Fall  
PKG. SIZE: 5.5" X 8"  
PKG. SPEC.: Booklet  
BLANK SIZE: 13" X 9"  
LANG.: DOM  
VER.: 1st Run

GRAPHIC DESIGNER: Ramen  
PI ENGINEER:  
PROJECT ENGINEER:  
CS VENDOR: IASIK  
SOFTWARE: Indesign C5  
COLOR PROFILE/LPI: Mag GCNB / 150lpi  
CS DATE: XX/XX/12

**PROOF APPROVAL**

SIGN OFF  
(GRAPHIC):

DATE:

**NOTES TO PRINTER:** Proofs accurate for process color only. All spot colors must follow PMS Color Formula Guide or color swatch specified.

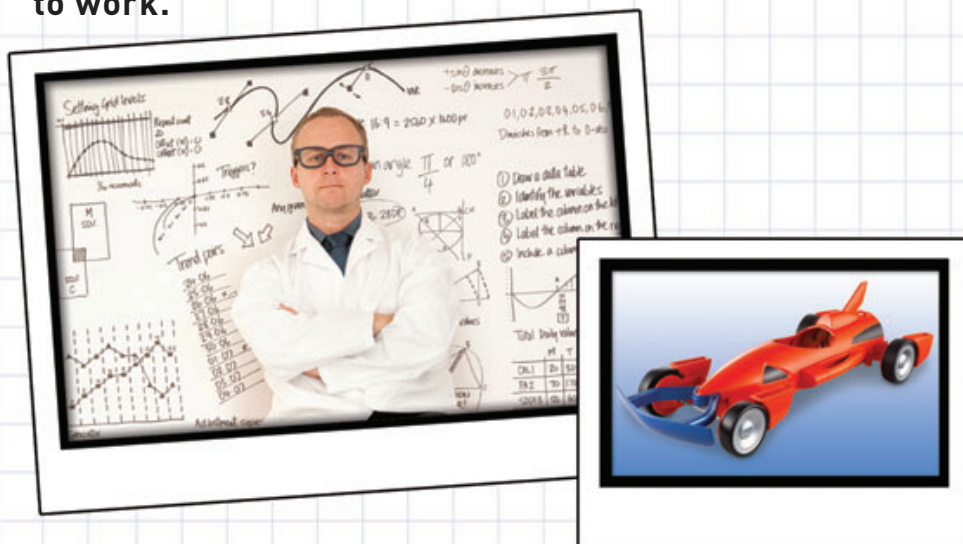


# THE SCIENCE OF SPEED

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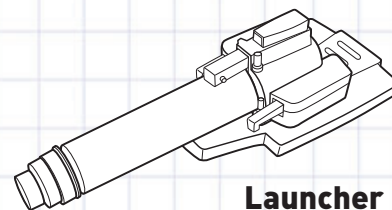
In this super science experiment, you will learn how to make a Rocket Car that travels furiously far! This set combines physics and fun as an experiment full of action. This sleek racer will amaze you as it blasts off at a frenzied pace.

Create a real rocket on wheels using chemistry and physics. Generate an amazing **CHEMICAL REACTION** that may propel your Rocket Car up to 120 feet. Experiment with different amounts to create your own special fuel mixture. Just like all science experiments, you must follow the steps exactly as listed for the experiment to work.

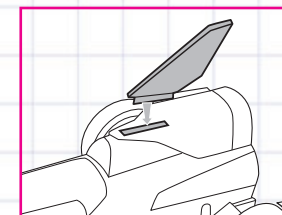


## PARTS LIST

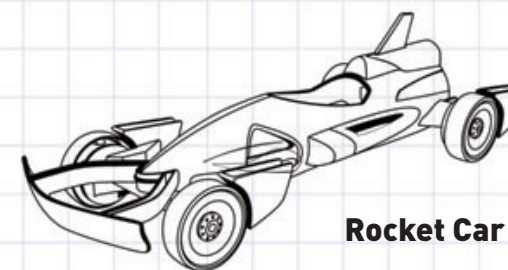
NOTE: SPOILER REQUIRES ONE-TIME ATTACHMENT TO ROCKET CAR.



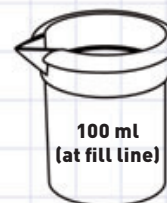
Launcher



Spoiler



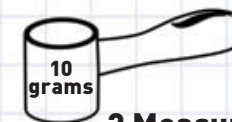
Rocket Car



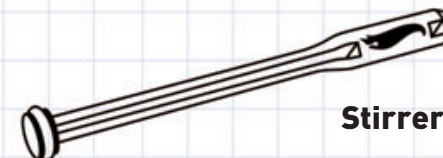
Beaker / Cup




Funnel



2 Measuring Cups



Stirrer / Plunger

**SCIENCE  
FACT** 

### CHEMICAL REACTIONS

#### DID YOU KNOW?

A chemical reaction is a process that leads to the transformation of one set of chemical substances to another.

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# HOW IT WORKS

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A rocket is simply a chamber filled with pressurized gas. A small opening called a **nozzle** allows the air to escape, causing **thrust** that propels the rocket. With this project you can make a Rocket Car that is powered by pressurized gas. The Rocket Car is one way to observe Newton's First and Third Laws of Motion. Because of individual variations in the Rocket Car, yours will travel different distances and often in unpredictable directions. Through modifications, you can correct for undesirable results and improve your car's efficiency.

## NEWTON'S LAWS OF MOTION:

### • Newton's First Law

"Objects at rest will stay at rest and objects in motion will stay in motion in a straight line unless acted upon by an unbalanced force." In other words, the forces propelling the rocket car forward must be stronger than those trying to stop it.

### • Newton's Third Law

"For every action there is always an opposite and equal reaction." When an action takes place, like gases escaping from a rocket, a reaction follows — in this case, the rocket car runs along the ground.

## ACIDS AND BASES ARE EVERYWHERE

Every liquid you see will probably have either acidic or basic traits. Scientists use something called the pH scale to measure how acidic or basic a liquid is.

### • What is an Acid?

An Acid is a solution that has an excess of Hydrogen ions. It comes from the Latin word "acidus" which means sharp or sour. Vinegar is one type of acid solution.

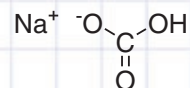
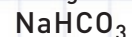
### • What is a Base?

A Base is a solution that has an excess of Hydroxide ions. Another word for base is alkali. One example of this is Sodium Bicarbonate, or Baking Soda.

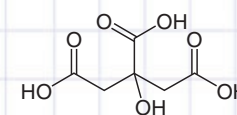
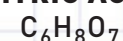
## SCIENTIFIC MAKE-UP OF VARIOUS CHEMICALS

### SODIUM BICARBONATE

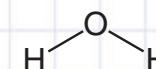
(Baking Soda)



### CITRIC ACID



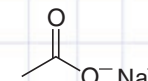
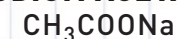
### WATER



### CARBON DIOXIDE



### SODIUM ACETATE



### CITRIC ACID + WATER = CITRIC ACID SOLUTION

NOTE: Citric Acid Solution has an equivalent pH value of Vinegar.

SCIENCE  
FACT

## SIR ISAAC NEWTON

### DID YOU KNOW?

Sir Isaac Newton is considered by many scholars to be one of the most influential people in human history!

# INSTRUCTIONS

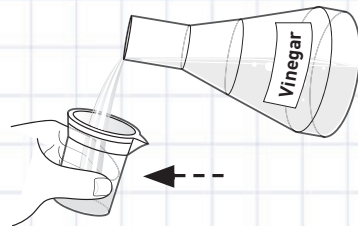
HWTF™ CHEMICAL RESEARCH DIVISION

## EXPERIMENT SAFELY:

- Find a flat smooth "track" with at least 200 feet of distance.
- Don't use the Rocket Car on a street or parking lot where vehicles are present.
- Always wear safety goggles (not included) when conducting experiments.
- Always conduct experiments under adult supervision.
- Never point the Rocket Car at anyone once the fuel is loaded.
- Use of the Rocket Car can get messy. Don't use around areas that could be damaged.
- Make certain nobody is in front of the Rocket Car during launch.

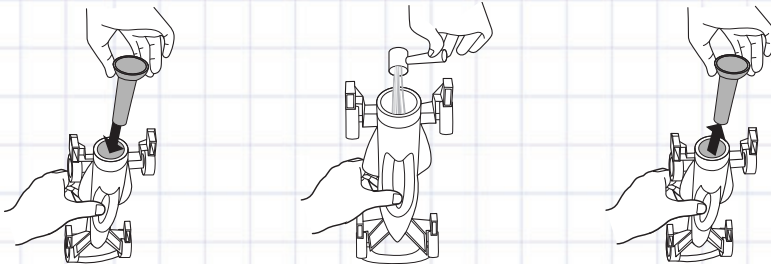
## STEP 1

Fill cup with Vinegar up to fill line.



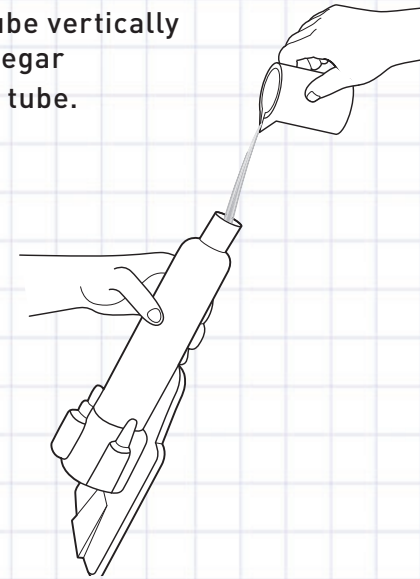
## STEP 2

Place funnel over center tube of Rocket Car and pour in 10 grams of Baking Soda then remove funnel.



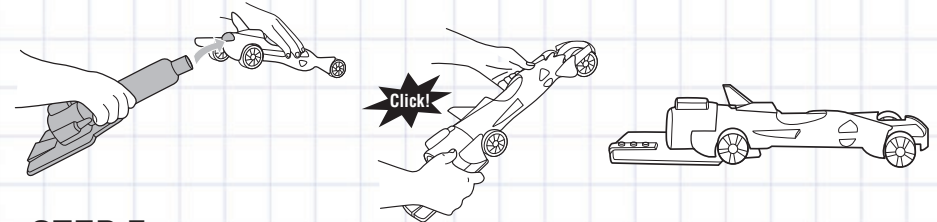
## STEP 3

Hold launcher tube vertically and pour the Vinegar solution into the tube.



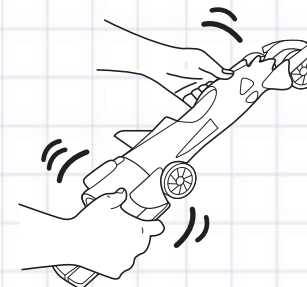
## STEP 4

Insert launcher tube into Rocket Car over central tube and push forward until all 3 latches click together.



## STEP 5

Shake the assembled Rocket Car vigorously to ensure mixture.



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# INSTRUCTIONS

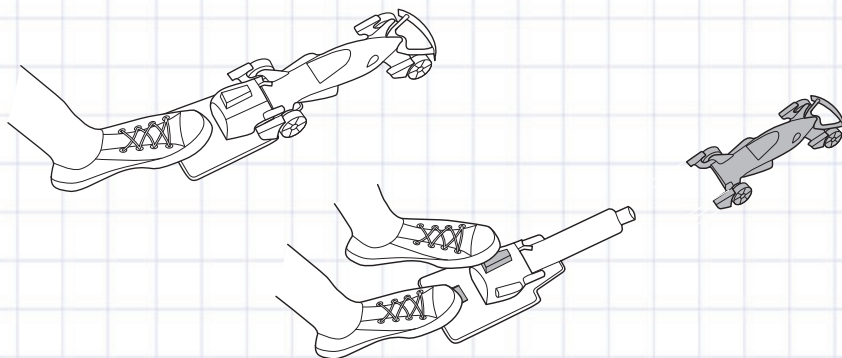
HWTF™ CHEMICAL RESEARCH DIVISION

## STEP 6

Place assembled Rocket Car on ground.

## STEP 7

Place foot on launcher base and wait 20 seconds. Then using other foot, step on launch button to release Rocket Car.



## IMPORTANT NOTE

If you wait longer or use a mixture of chemicals beyond recommended amounts, launch may be aborted by loss of pressure and you will need to restart process using correct amounts. We encourage you to experiment, but beware material may be lost if recommendations aren't followed.

## STEP 8

CLEAN YOUR ROCKET CAR AFTER EVERY LAUNCH.  
(INSTRUCTIONS ON PAGE 9)

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# RECORD YOUR RESULTS

TRACK THE DISTANCE YOUR ROCKET CAR TRAVELS  
HWTF™ CHEMICAL RESEARCH DIVISION

After launching your Rocket Car, answer the questions below.

1. Describe how your Rocket Car ran during the first trial run.

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2. Did it run on a straight or curved path?

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3. How far did it go?

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# MAINTENANCE

HOW TO CLEAN AND CARE  
FOR YOUR ROCKET CAR

HWTF™ CHEMICAL RESEARCH DIVISION

Great experiments require properly functioning equipment! Between each use and after you are done with the experiment, you must clean out the center cylinder.

## STEP 1

Add water.

## STEP 2

Shake and pour out to clean.

## STEP 3

Ensure the tube for the Sodium Bicarbonate is completely clean and unobstructed.

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# EXPERIMENT 1

EXPERIMENTING WITH FUEL RATIOS

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In this experiment, you will adjust the ratios of Vinegar (Acid) and Baking Soda (Base). Use your distance result from your first trial as your experiment's **CONTROL GROUP**.

Adjust the levels of Acid and Base in small increments and notice how your distance changes with each modification

**Did your distance improve or decrease with more Acid?**

**Did your distance improve or decrease with more Base?**

The speed and distance your Rocket Car travels is a direct result of the power of the reaction between your Acid and Base fuel mixtures, which is a measurement of the strength of the Acids and Bases you experiment with! **The stronger the Acids and Bases, the faster and farther your Rocket Car will go!**



Acids and Bases are measured by their “pH” level. The pH value indicates the strength of the Acid or Base on a scale of 0.0 - 14.0. Acids range from 0.0 - 6.9 and Bases range from 7.1 - 14.0.

**A liquid with a pH of 7.0 is neutral, like water, and is neither an Acid nor a Base.** When Acids and Bases mix together, they react and move towards the neutral 7.0 pH number. If the ratio of Acid-to-Base is exactly right, they will completely neutralize each other and the resulting mix will be a 7.0 on the pH scale.

The farther apart the pH level of the Acid and the Base, the more vigorous the reaction and more gas is generated in the Rocket Car fuel tank. This in turn creates more pressure in the closed system, which then propels the Rocket Car farther and faster when the gas is released through the nozzle! \*

## RECORD YOUR RESULTS

TRACK THE DISTANCE YOUR ROCKET CAR TRAVELS

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Use this booklet and test results to answer the following questions:

1. Which combination of Acid and Base caused the Rocket Car to travel the greatest distance?

\_\_\_\_\_


2. How many feet did your Rocket Car travel?

\_\_\_\_\_

3. What is the chemical reaction that takes place?

\_\_\_\_\_

\* A relief valve is installed which will limit the pressure allowed to build based on pre-determined safety limits.

**SCIENCE  
FACT** 

### CONTROL GROUPS

#### DID YOU KNOW?

Control Groups are a vital part of the Scientific Method, and are used in almost all experiments!

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# EXPERIMENT 2

EXPERIMENTING WITH NON-CARBONATED FUELS

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In this experiment, you will use other commonly found non-carbonated liquids instead of Vinegar.

## USE DIFFERENT ACIDS

Try orange juice, apple juice, lemon juice, iced tea.

Mix 100 ml of non-carbonated liquid in place of Acid with 10 grams of Base.

### Did your distance improve or decrease with different types of Acids?

You may notice that some types of juices work better than others as fuels in the Rocket Car. Once again, this is due to the pH levels being different for all types of juices, depending on the fruit from which they are made. Citric juices, like orange juice and especially lemon juice, have very low pH levels,



which means they are very acidic and have lower pH levels than other juices (like apple juice, which is not very acidic).

After experimenting with various types of juices, you will be able to determine which juices are the most acidic with the lowest pH values, and which ones aren't very acidic at all. As we discussed, the lower the pH level of the acidic part of the fuel mixture, the stronger the reaction will be with the baking soda (sodium bicarbonate), and the faster and farther the Rocket Car will go!

# RECORD YOUR RESULTS

TRACK THE DISTANCE YOUR ROCKET CAR TRAVELS

HWTF™ CHEMICAL RESEARCH DIVISION

Use this booklet and test results to answer the following questions:

1. How many feet did your Rocket Car travel?

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2. Which liquid produced the best results? Explain why you think this liquid worked best?

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3. Which liquid produced the worst results? Explain why you think this liquid was not as effective?

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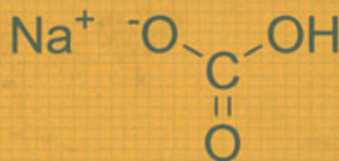
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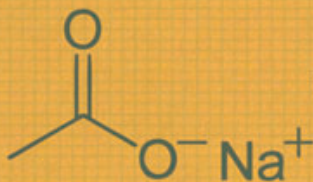
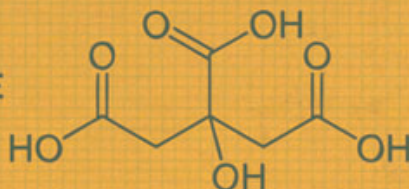
# HWTF™

## HOT WHEELS TEST FACILITY™



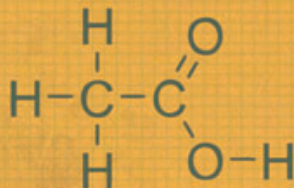
CITRIC ACID

SODIUM BICARBONATE



SODIUM ACETATE

ACETIC ACID



CARBON DIOXIDE



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