

NC Science Olympiad

Coach's Clinic

2007

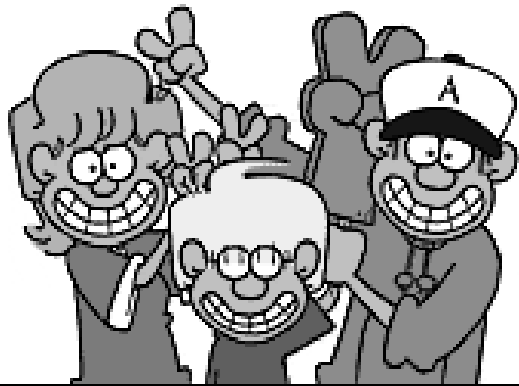
Every scientist starts out as a student.

Trajectory

By Katie Horne

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FoxTrot

by Bill Amend



Catapult Attack Plan

$I_{net} = I_{board} + I_m + I_M$
 $\tau_{net} = \tau_M - (\tau_m + \tau_{board})$
 $\alpha = \frac{\tau}{I}$ $\omega = \alpha t$ $\theta = \frac{1}{2} \alpha t^2$
 $v_{\omega} = \omega r$ $v_0 = \omega_f r$ $\omega_0^2 =$
 $\theta_0 = \frac{h}{r} \Rightarrow v_{\omega_0} = \frac{h}{r} r = h$ $v_0 = \frac{h}{\sqrt{2}}$ $v_{\omega_0} = \frac{h}{\sqrt{2}}$
 $h_0 = 2 r \sin \theta_0 = \sqrt{2} r$
 $\Delta y_0 = h - h_0$

FROM SUCH SMARTS,
SUCH STUPIDITY.

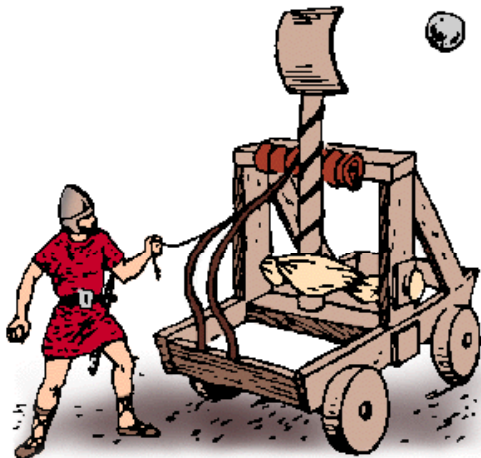
WAIT! WAIT!
DON'T LET GO!
PAIGE CLOSED
HER WINDOW!

AAAA!
IT'S
SLIPPING!

We all feel like this at this point in the year!



Construction: Types of devices



Historically, devices include the gastrophetes, ballista, onager, and the trebuchet. Most people associate the onager with the term catapult. The weapon itself goes back to 399 B.C. when Dionysius had teams research and develop such weapons to defend Syracuse, Sicily against Carthage.

Even after the invention of cannons and mortars in the thirteenth century, catapults were still active on the battlefield because they were easy to construct, more reliable, relatively noiseless, and had more flexibility to position.

Trebuchet

All About Catapults



The **Trebuchet** is probably the oldest type of catapult. It was invented either by the Chinese or in the middle east. If you look at an Egyptian shadouf, it looks very much like a trebuchet, and it's easy to imagine that the trebuchet was inspired by the shadouf. Shadoufs have been around since the beginning of recorded history.

Ballista

All About Catapults



The next oldest type of catapult is the **Ballista**. This machine was deliberately invented by the Greeks, around 800 B.C. Ballistae were even mounted on warships and used to hurl fire onto other ships.

Onager

All About Catapults



Onagers were used right up to the middle ages alongside the Trebuchet, when gunpowder and the Cannon were invented and eventually replaced the catapults.



Description

➡ Prior to competition, a team of 2 students will design, construct, and calibrate a device capable of launching a ball using energy provided by nonmetallic elastic solids into a target area of sand. Participants must wear goggles or safety glasses with side shields.

➡ Devices will be impounded, and it is a walk-in event. Teams have 10 minutes to launch.

Construction: Getting Started



Building a table-top catapult is a great way to start with the students. It also lets you get a good idea of who will be able to build the actual competition device. Click below to get the directions for this catapult.

<http://www.stormthecastle.com/catapult/popsiclestick-catapult.htm>

Another website that is fun for the students is Catapult 3-D Interactive

<http://www.forgefx.com/casestudies/prenticehall/ph/catapult/catapult.htm>

Hooke's Law

Once you have them “Hooked,” teach the physics behind it!

How is the force applied to the elastic material related to the amount of stretch?

- **AP Physics Lab—Hooke's Law**

http://www.batesville.k12.in.us/physics/APPhyNet/lab/experiments/measurement/hookes_law.htm

- **Hooke's Law: Online Lab**

<http://schools.matter.org.uk/Contest/HookesLaw/index.html>

- **Giant Hooke's Law Demonstration**

http://www.madphysics.com/exp/giant_hookes_law_demonstration.htm

Construction: Specifications

1. Entire device must fit in **80cm³ before and after a launch**. The launch area will be 1m X 1.5m square.
2. The device must be triggered from outside the Launch Area by pulling a string, firing pin, etc. Other than the triggering device, nothing else can extend outside of the LA before or after a launch. Battery-triggered devices are allowed.
3. Projectiles must be hollow balls 3-9cm in diameter, and **provided by the team**.
4. The only energy must be a nonmetallic elastic solid.
5. Event Sup. can disqualify if device is deemed unsafe.



Competition: General requirements

- 1.** Impound all materials (tools, notes, and graphs) with the device.
- 2.** Once teams enter the area to compete, they cannot receive any outside materials, assistance, or communication with anyone until they have finished competing.
- 3.** Students need goggles or safety glasses with side shields.

Competition: Target Area


1. Will be provided by event supervisor and will consist of sand or kitty litter.
2. Will be 1 m² or have a diameter of 1 m.
3. The center will be marked so that distance of initial contact can be measured from the center.
4. Two target areas will be placed in a straight line in front of the LA between 2-8 meters. Target areas must be at least 2m apart and will be two different levels. The first target will be the highest (up to 1m). The second will be on the floor.

Competition:

1. Teams have 10 minutes to make 4 launches, 2 for each target area. No practice launches, but adjustments can be made between launches.
2. Students must give ample warning that they are going to launch, if not, violation. They must also indicate which target they are aiming to hit.
3. If part of the device does not return to the LA, then the device can be returned/repared and following launches will be scored normally. A penalty would be assessed (100 points).
4. Participants/students may not enter the target area to measure or view results.

Nothin' but net!





Scoring: FINAL SCORE= graph + lowest CTA1 + lowest FTA2 + penalties

Lowest score wins!

- **Each launch will be measured in mm from the point of first impact to the center of the target area.**
- **The lowest for each target will be used in score calculations.**
- **If target is missed, then team will be ranked below those who do.**

Scoring: Graphs can reduce score by 400 points!

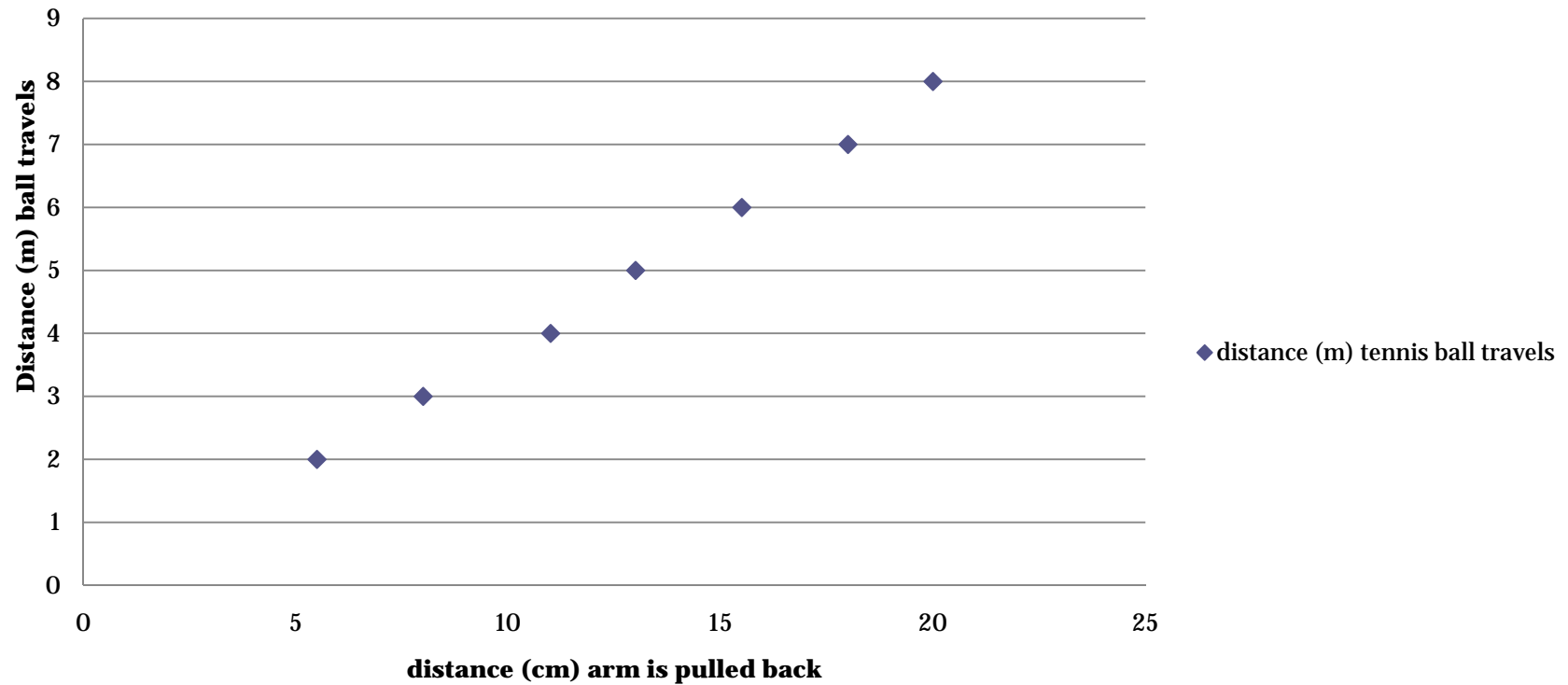
Lowest score wins!

↙ ↗ **Graphs:** Each team starts with 400 points which will be reduced by 100 points with each graph (up to four) turned in at impound or other date/time specified by event supervisor.

↙ ↗ 20 point reduction for graph, 20 point reduction for data table, 20 point reduction if **data on table and graph match**, 40 point reduction if graph is labeled properly.

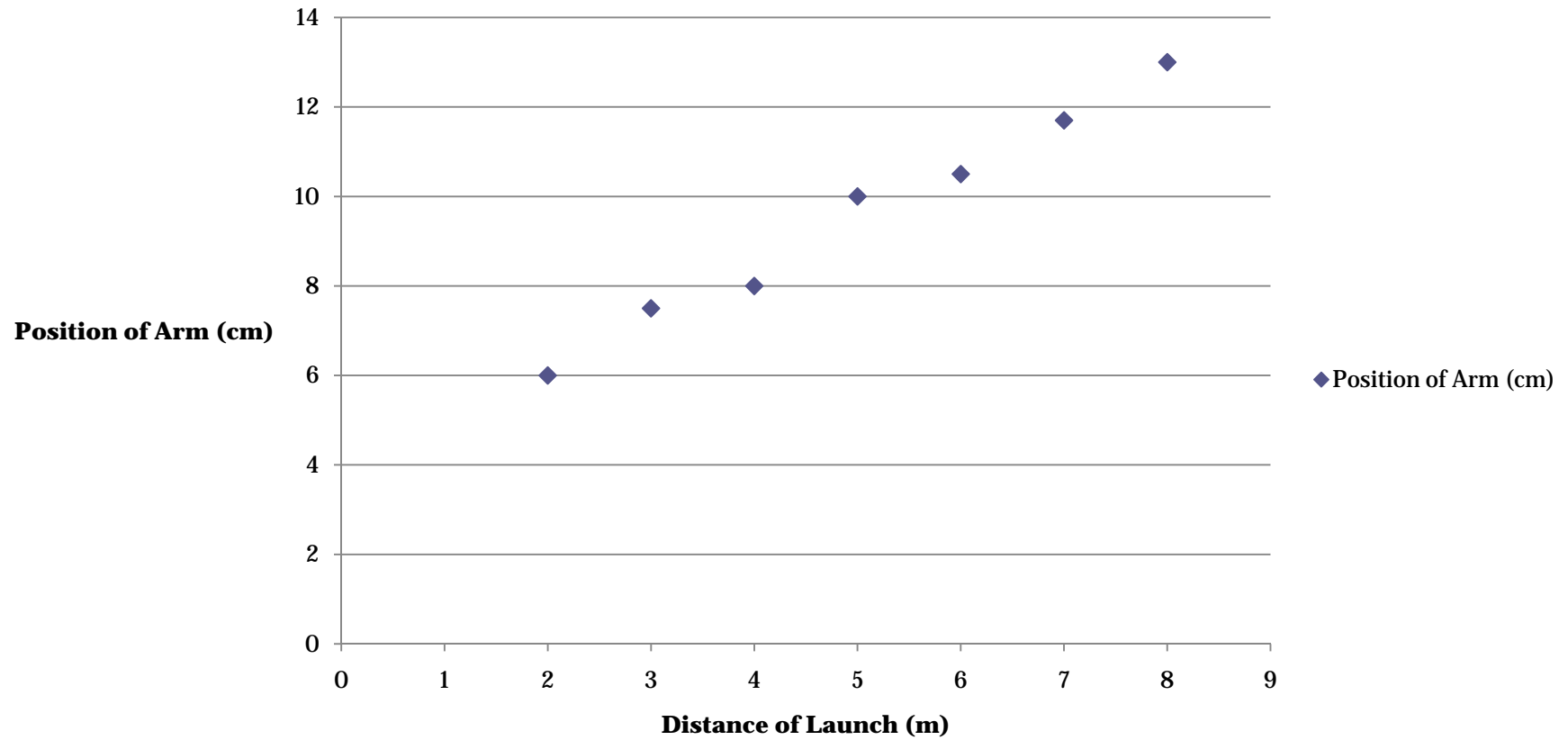
Graph Example

**Distance (m) tennis ball travels
South Brunswick Middle School—B52**



Graph: Example

SBMS B52 Projectile: Racquet ball



Scoring: Penalties

Penalties are 100 points each time assessed:

- Participant warned by judges for not correctly wearing safety goggles.
- Participant is in the launch or target areas when launch is triggered.
- The device goes through an unintentional launch motion.
- No warning is given before a launch.
- If part of the device leaves the 1 m X 1.5 m LA.
- Outside coaching: not specified in rules, but is against SO policy.

Scoring: Ranking of teams

- **First**—teams who meet specs/hit both target areas
- **Second**—teams who meet specs/hit one target area
- **Third**—teams who meet specs/hit no targets
- **Fourth**--those teams that did not meet specs, but they will still be allowed to launch. This includes not bringing a projectile!
- **Tie Breakers**—smallest distance between two scored launches

Resources/Websites

Kits are available to order, but the drawings of the catapults are very detailed.

http://www.redstoneprojects.com/trebuchetstore/build_a_catapult.html

Catapults.info: Ancient Engineering Series—kits available

<http://www.catapults.info/>

How to build a popsicle stick catapult (Catapult Crazy!)

<http://www.stormthecastle.com/catapult/popsiclestick-catapult.htm>

Catapult 3-D Interactive

<http://www.forgefx.com/casestudies/prenticehall/ph/catapult/catapult.htm>

Home of Team Tormentum: They build modern siege machines and compete in “Chunkin” contests

<http://www.siege-engine.com>

Pulis, Lee. 2000. Construct-a-Catapult. Arlington: NSTA Press.



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www.Bogworld.com

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