Storm the Castle: The Energy Rule

Bruce Wiegand
September 2011

Rule 3.e ("The Energy rule") states:

> *The device, without the counterweight and projectile, must not contribute energy to the launch. Example violations, allowable types, and mechanisms for testing for added energy are available on soinc.org.*

This document serves the purpose of showing the examples mentioned. It is intended to help students, coaches and event supervisors understand and enforce this rule and thus reduce the number of clarification requests received.

- Event supervisors have an obligation to provide an even playing field for all students. By ensuring the energy rule is followed, the event will be won by the team that has designed and built the best device and has tested the device to be able to accurately predict its performance.

- Students should not try to build a device that adds energy to the launch; they should focus on efficiency and consistency. This is the spirit of the event and all events in Science Olympiad (Note the General Rules listed on the inside back cover of the Rules Manual and at http://soinc.org/ethics_rules).

- Coaches should check student built devices to ensure they don't add energy to the launch. Coaches would not want their students competing against a device that adds energy, so they should have enough understanding of their team's device to assure they do not have a device that adds energy.

Sections:

- Fixed Fulcrum Trebuchet
- Floating Arm Trebuchet
- Wheels
- Flexible Arms
- Other Devices

Fixed Fulcrum Trebuchet

The fixed fulcrum trebuchet is the easiest to check. A fixed point device without a sling (like a catapult) should be tested in the same manner as a fixed Fulcrum trebuchet.

1. The device should be set up as if the student is ready to launch the device without the counterweight and projectile (the sling should be attached to the arm).
2. The student should then release the triggering device and the arm should not move in the direction of launch.
3. The arm should be raised several inches and released, resulting in the arm either staying in place or returning to launch position. The device should be checked the same way in several positions up to the 90 degree position.
4. During both of these types of test, if the arm moves slowly in the launch direction and stops on its own, before the arm reaches 90 degrees in relation to the floor, the energy rule is not violated (provided there is nothing else in place to stop the arm from moving to the 90 degree position.)

Ready to launch position

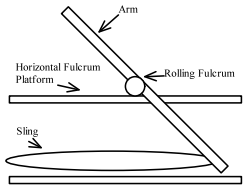
90 degree position

Balanced (not adding energy)

Floating Arm Trebuchet

The floating arm trebuchet is similar to a fixed fulcrum, with the exception that the fulcrum of the arm can move horizontally.

1. This type of device needs to be checked in the same manner as a fixed Fulcrum device
2. It should also be checked to ensure the arm does not roll downhill.
3. This can be checked by having the trigger released and the arm slightly raised. When released the fulcrum point should not move forward.

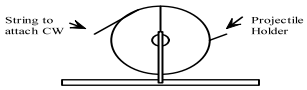


Floating Arm Trebuchet

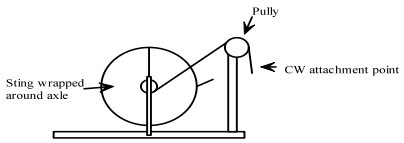
Wheels:

Wheels can be used to launch projectiles.

- One way of doing it is to have a string attach the counterweight to the outer surface of the wheel. When the weight drops it rotates the wheel forward and the projectile will ride in a holder and be released at the top of the wheel or be released when a stop is engaged.
- Another way is for the counterweight to be attached to the axle and have the projectile release on the second or third rotation.



Wheel device with CW attached to wheel



Wheel device that completes a rotation.

1. To test - first have student explain how the device works. What is the direction of rotation? Does the device release before one rotation or after the device completes one?
2. If the device does not complete a rotation you only have to test for energy to the release point.
    a. The device should be set up to launch without a counterweight and projectile.
    b. The trigger should then be released and the wheel should not move in launch direction.
    c. The wheel should then be rotated slowly in launch direction, then stopped, and released. At this time the wheel should not move in launch direction.
    d. This should be checked in several locations, until the projectile release point has been reached.
3. If the counter weight string attaches to the axle the device may make several rotations before release.
    a. Have the student set the device up for launch without counter weight and projectile.
    b. Release the trigger, and the device should not move in launch direction.
    c. Slowly pull the string to start rotation, stop the wheel and release it.
    d. The wheel should not move in launch direction.
    e. This must be checked for one complete revolution.

Flexible Arms

Many questions also come from flexible arms.

1. If an arm is bent before the counterweight is installed it is storing its own elastic energy.
2. This is generally tested by setting up the device for launch without the counterweight.
3. When the trigger is released the arm springs forward.
4. If the arm is only bent when the counterweight is hung, it is only storing some of the energy of the counterweight.

Other Devices

Many other devices can be built to launch projectiles. They all need to be checked to ensure they do not violate the energy rule. Other devices can be used but the same principles apply.

1. Ask the students to demonstrate how the device works.
2. Then put the device through a launch motion.
3. The device should not move in launch direction without the counterweight.