Machines B/C

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About Dali Sun

- Dr. Dali Sun
- Assistant Professor, Department of Physics, NC State
- Teaching: **Physics for Engineers and Scientists I: Mechanics and Thermodynamics**
- In 2017 and 2018, Coached ‘Blastoff 1,2,3’ and ‘Energy Matters’
- Assistant for “Mission Possible” in 2019 NCSO State Tournament

About Alex DeWalle

- Former competitor (2015-2018), team captain, 11-time state medalist
- Competed at National Tournament 2016, 2018
- Supervised Thermodynamics, Designer Genes in 2018
- Sophomore at UNC-CH

EVENT OVERVIEW

Event Overview

Written Test

Students will take a test on physics concepts related to simple machines (Divisions B and C) and complex machines (Division C only). Students will have a binder and any type of calculator to assist them.

Build the Machine – Measure the Masses

- Prior to the competition, students will construct a lever-based device and test/calibrate the device in preparation for the event.
- At the competition, students will use their device to estimate the mass ratio between 3 unknown masses labeled A, B & C.

Event overview: Principles

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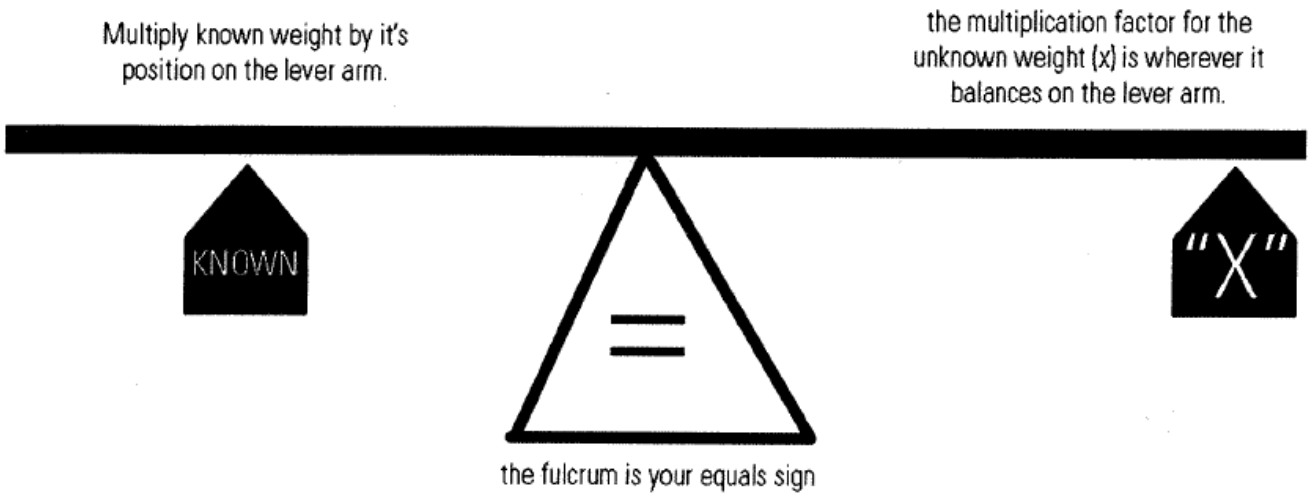
A Visual Representation of a Math Equation

In this instance, our first class lever is the formula. The fulcrum in the center is the equals sign. When you take a known weight on one side and place it on the lever arm, you can calculate the mass of an unknown object based on where it balances on the other side.



Event overview: Where to start

1. **Research:** Find past devices + common ideas, learn background info
2. **Experiment and Learn:** Build prototypes + take notes, study ALL topics + start binder
3. **Make Final Product:** Build final device*, assemble full binder
4. **Refine and Calibrate:** Test/calibrate device + make graphs, take practice tests + reorganize binder

*Make sure it follows the rules!

Event overview: Score Breakdown

High score wins; Final Score (FS) = ES + TS + R1 + R2 + CS - PE. A scoring spreadsheet is available at www.soinc.org.

- **Exam Score (ES): 45% (normalized to the highest score)**
- **Time Score (TS): 15% 15 * (240 - TIME) / 240**
- **Ratio Scores (R1 & R2): 30%** total (**15%** each, based on the accuracy of the students' ratio estimates)
- **Chart Score (CS): 10%** (based on the completeness of the charts and how well they meet scientific standards [units, axes, labeling, etc.])
- **Penalties:** Making a **construction violation** or missing impound results in a 30% penalty on TS, R1 and R2, and making a **competition violation** results in a 10% penalty on TS, R1, R2

Biggest Takeaway

Build and Test are EQUALLY important!

THE WRITTEN TEST

Written Test

- States will be harder than Regionals
- **Unless otherwise requested, answers must be in metric units with appropriate significant figures.**

Written Test - Topics

- **Topics**: Types of simple machines; calculations of MA, efficiency, load/effort.
  - **Division C only:** Compound machines; calculations of potential and kinetic energy, coefficients of friction
- **Simple Machines**: Lever, Inclined Plane, Wedge, Wheel+Axle, Pulleys, **Div. C**: Screw
- No “dynamic calculations”, no history questions

Making a binder

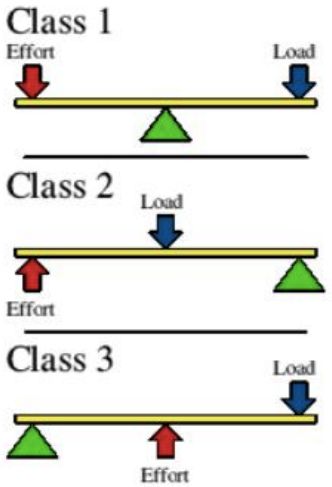
- Quality > Quantity
- Organization is key
- Students write binder info **themselves**

This is ***probably*** unnecessary

Building the Machine

The Device

- Div. B: One Class 1 lever
- Div. C: Compound lever made of one Class 1 lever and one Class 2/3 lever
- Great video about compound levers: https://www.youtube.com/watch?v=O36lNKCxvc8 (note that these are all Class 1 levers!)
- **Must determine ratios of masses!**
- Must accommodate masses



The Device: the building/testing process

- Research and plan before building
- Try several prototypes, **then stick with your best.** Note how different variables effect score
- Record data carefully, keep as much constant as possible – mimic the competition

Device testing on tournament day

1. Teams arrive, impound devices + graphs
2. Block starts, teams given 5 minutes to set up device
3. “Test timer” begins and teams start written test
4. During test teams are called up one by one to measure masses
5. Teams write down mass ratios, then return to written test
6. ”Test timer” ends and teams turn in tests

General Advice!

Read the rules!

- Lots of research and planning
- Try different ideas; build prototypes
- Study from the rules
- Visit scioly.org to learn more, get ideas, etc.
- Look out for clarifications

General Advice: Avoid Common Mistakes!

- **Ensure that your device meets all of the criteria in the rules!**

- **Impound:** Each team must impound their device, a device diagram, and copies of charts for scoring. **Missing impound results in a large penalty** (30% to TS, R1 & R2). Impound is on tournament day, prior to the competition block.
- All participants must bring **eye protection** that adheres to the rules.

General Advice: Avoid Common Mistakes!

- **Device Materials:** The device may be made out of any materials, however electric or electronic components, and springs, are prohibited.
- **Device Specs:** The entire device must fit inside a **100x100x50** cm box. For Division B, the device must have **one beam** and it must be **80 cm long or less**. For Division C, the device must have **two levers** connected in series, with **no beam longer than 40 cm**.
- Participants **must not bring masses** or include them in devices except when fixed in place prior to impound

General Advice: Avoid Common Mistakes!

- Make sure your charts are perfect! 2 pts each for:
  1. Data must span mass range
  2. 10 data points per series
  3. Proper labeling
  4. Diagram
  5. 4 graphs
     - Note: The Event Supervisor will pick only one graph to grade on points 1-3.
- Understand **significant figures**, as a small portion of the points on the test will rely on them.

General Advice: Avoid Common Mistakes!

- Build and Test are EQUAL
- To reiterate: Device specs will be enforced with **ZERO LENIENCY**. Your device **MUST** meet the requirements described or you will face large penalties

General Advice: Avoid Common Mistakes!

Calculator Guide:

- Both stand-alone, programmable, graphing calculators and stand-alone non-graphing, programmable calculators are allowed.

- Calculator applications on multipurpose devices (e.g., laptop, phone, tablet, watch) **are not allowed** unless expressly permitted in the event rule.

QUESTIONS?