2016 Physics Olympics
Detailed Rules

The UNT Society of Physics Students has hosted their annual Physics Olympics for many years now. Over the years, many teams have competed in a variety of events that have challenged their intelligence and ingenuity.

After such a successful competition in past years, we are eager to make this year even better. New ideas have been added and the classics have been perfected.

The events this year include:

- an Egg Drop
- a Bridge Build
- a Mousetrap Car Race
- a Circuit Build
- a Catapult Contest
- and a Physics Olympics Course

We welcome you to join us and encourage you to participate in all events. Be sure to read all of the rules for each event and remember to have fun!

Other than the eggs provided for the Egg Drop contest, and the material provided to construct the circuit board for the Circuit Build, please bring all apparatus completed before the start of the Olympics.

If there are any questions please contact the UNT Society of Physics Students by email at untatsps@gmail.com prior to the competition date.

Egg Drop

Objective:

To design a container that will protect a grade A medium egg from a fall of approximately 20 meters (5 stories) onto a concrete surface. Each team constructs one egg-drop container. The event staff will provide the eggs.

Apparatus:

1.) The container must be able to fit inside a box of dimensions 30cm x 30cm x 30cm.
2.) The container may be constructed of any kind of material, but keep safety in mind; padded wooden boxes and coffee cans can bounce dangerously after impact, and seldom protect their eggs.
3.) Accuracy is a factor- the container must land within the 1 square meter area above which it hangs. (the event's laser timing gate does not register beyond this region)
4.) A loop of string must be installed, such that the device is able to hang from a 1 inch diameter rod for purposes of deployment.
5.) The device **must not exceed 1kg**. This excludes the mass of the egg. Device mass is measured in grams and recorded as the value called mass in the formula below.

Event:

1.) the staff places the container's loop around a peg suspended directly above the target.
2.) The peg is withdrawn, allowing the container to drop. This starts the timer.
3.) The clock stops when the container hits the ground and trips the laser timing gate.
4.) The container does not have to survive the fall, but **the egg must**!
5.) Two drops are made with each team's device. Containers are not repaired between drops.
6.) The faster of the two times is recorded as the value time in the formula below.

Scores:

Each teams device is scored based on its average velocity (known as drop distance divided by time of flight), and it's mass as calculated.

<u>Raw Scores:</u>
Raw scores are directly proportional to velocity and inversely proportional to mass. Therefore, the best scoring teams are usually ones that build containers that have little mass but drop like bullets. The raw score is calculated as follows if the egg survives the fall.

$$Raw\,Score = \frac{d/t}{mass} = \frac{20m/time}{mass}$$

<u>Final Score:</u>
In order to create a fair and substantial delineation between each team's score, raw scores are scaled so that they span the range of 20 to 100 points as follows:

$$Final\,Score = 20 + 80\,(1 - \frac{RS_{max} - RS_{team}}{RS_{max} - RS_{min}})$$

Thus each team is awarded between 20 and 100 point and rankings are competitively based on device mass and average velocity. The team with the highest final score (100 points) wins.

Bridge Build

Objective:

To design and construct a bridge that will support the greatest weight possible per gram of material used in construction.

Apparatus:

1.) Each team brings one bridge composed only of popsicle sticks and regular school grade liquid glue (Elmers). The tensile testing apparatus will be supplied by the staff.
2.) The bridge must be free standing. (with and without load)
3.) The bridge must be made out of standard 11.5cm x 1.0cm popsicle sticks and standard grade school glue
4.) There must be a roadbed no higher than 3.0cm above the lowest point of the bridge and an 8.5cm x 3.0cm toy car must be able to travel across the roadbed.

Aspect	*Maximum*	*Minimum*
Height	.20m	.05m
Width	.10m	.03m
Length	.50m	.40m
Bridge Mass	.40kg	-
Mass Held	-	.01kg

Event:

1.) Event staff records the bridge mass and height.
2.) The bridge is placed on a testing stand consisting of two level surfaces of the same height separated by 20cm. (Two tables with a bit of space in between them)
3.) A bar is placed across the roadbed perpendicular to the length at the point appearing to be the weakest on the structure. A bridge is only strongest at its weakest point!
4.) Mass is added at a slow but steady rate until the bridge collapses or sags to 90% of its original height. At this point the total mass suspended by the bridge is recorded

Scores:

Raw score:

Raw scores are directly proportional to the mass held by the bridge and inversely proportional to the mass of the bridge. Therefore the best scoring bridges are usually light but strong.

$$Raw\ score = \frac{Mass\ held\ by\ bridge}{mass\ of\ bridge}$$

Final score:

In order to create a fair and substantial delineation between each teams score, the raw scores are scaled so that they span the range from 20 to 100 points.

$$Final\ score = 20 + 80\left(1 - \frac{RS_{max} - RS_{team}}{RS_{max} - RS_{min}}\right)$$

Thus each team is awarded between 20 and 100 points and rankings are competitively based on bridge mass and bridge strength. The team with the highest final score (100 points) wins.

Mousetrap Car Race

Objective:

Each team is to design and build a vehicle powered by one or more mousetraps. The vehicle should travel a distance of 7 meters in the shortest possible time.

Apparatus:

1.) A mousetrap spring (as part of a working mousetrap), or set thereof is to provide the sole source of power for the vehicle. No other stored energy supplies-including gravitational potential energy-may is released by the spring(s).
2.) Absolutely **no kits**. Mousetrap car kits will be disqualified regardless of modifications.
3.) All traps used to power the vehicle must be sold commercially as mousetraps. As such, each trap's spring should consist of a steel wire (approximately 1.3mm in diameter) wound to a coil (approximately 7mm in diameter) with approximately 20 turns. **Rat traps and any other traps with springs significantly different than just described will be disqualified**. Questions regarding this point may be submitted in writing to unt.sps@gmail.com prior to the competition.
4.) No mousetrap spring or portion of the trap board to which the spring is attached may be altered in any way. Trap restraining arms and other portions of the board may be modified. In no case should springs move through angles of more than 180 degrees.
5.) The mousetrap(s) must be contained in the vehicle and must propel the vehicle by means of a wheel in contact with the ground.
6.) The vehicle **must not exceed 1.5kg**.

Event:

1.) The vehicle must be started from a standstill by releasing the mousetrap spring in a manner that imparts no additional energy into the vehicle (no push starts, launchers, or other devices that propel the vehicle from the start).
2.) At least one wheel of the vehicle must remain in contact with the ground at all times.
3.) The race course consists of a hard, smooth, level surface (linoleum), seven meters long.
4.) The car's race time, t, is measured from the time the leading edge of the vehicle's front wheel trips the laser timing plane front gate to the time when the front wheel trips the laser timing plane end gate.
The car's race time, t, is measured from the time the leading edge of the vehicle's front wheel breaks the plane of the finish line.
   - In the event that a vehicle *does not* cross the finish line, no time is recorded for that vehicle, and the part of the Raw Score within curved braces {} does not apply to the team in question.
5.) The car's race distance, x, will be measured as the length of the segment normal (perpendicular) to both the plane of the starting line and the plane passing through the foremost front wheel at the ending location. No length will be recorded as longer than seven meters.

Scores:

Each car's distance and time are used in determining the team score as explained below.

<u>Raw Score:</u>
Each team receives points for the percentage of the course completed (up to 60 points). Ten additional points are awarded to every team crossing the finish line. The final 30 points are competitively distributed among the teams that complete the course.

$$Raw\,score = 60\left(\frac{distance\ traveled}{7\ meters}\right) + \left\{10 + 30\ \ 1 - \frac{t - \ - t_{fastest}}{t_{slowest} - t_{fastest}}\right\}$$

<u>Final Score</u>
In order to create a fair and substantial delineation between each team's score, raw scores are scaled so they span the range of 20 to 100 points as follows:

$$Final\,score = 20 + 80\left(1 - \frac{RS_{max} - RS_{team}}{RS_{max} - RS_{min}}\right)$$

Thus each team is awarded between 20 and 100 points. Rankings are competitively based on distance traveled and time

taken to complete the course. The team with the highest final score (100 points) wins.

Circuit Building

Objective:
Students will use their knowledge of circuits to complete a circuit as directed to achieve a desired result. Students should know how to read a circuit diagram and be able to place components such as resistors, capacitors, and/or inductors in the correct positions on a breadboard. Students will need to know how to place resistors in series and parallel to achieve desired total resistance. (Past events have been to make a LED blink or to combine resistors to achieve a desired resistance)

Apparatus:
All materials will be provided by the UNT Physics department.

Event:
The team members will work collectively to complete the circuit in the desired time. (15-30 minutes depending on how many teams enter the competition)

Scoring:
Scoring will be based on the shortest time taken to complete the circuit. The team with the highest score wins.

$$Final\,score = 20 + 80 \quad 1 - \frac{t_{team} - t_{fastest}}{t_{slowest} - t_{fastest}}$$

Catapult Contest

Objective:

Each team is to design and build an accurate catapult! Teams compete against one another in hitting a target 40 meters away with only a catapult and a softball.

Apparatus:

Design parameters are open ended, provided that the apparatus incorporates the basic aspects of a catapult:

- Long arm that swings through the vertical plane
- Spring or other tension devices providing torque to the motion arm
- Holder for the projectile
- Softball projectile (provided by event staff)
- Remote Launch Apparatus
  - Must be launched at least 5 ft away from catapult.

All entries must be catapults – no exceptions. Devices relying on spring potential energy are highly encouraged, but other tension devices will be allowed pending design approval. However, the use of slings, trebuchets, ballistae, man powered devices, compressed gases and electricity is prohibited for safety reasons. Questions concerning the definition of a "catapult" or your specific design may be submitted in writing to unt.sps@gmail.com prior to the competition date.

Event:

Catapults are arranged in an arc 40 meters from a bull's eye. Following each shot, the distance between the softball and the bull's eye is measured and recorded. The recorded distance will be from the launch to the first point of impact the softball makes with the ground. The competition proceeds with three practice shots (whose scores are not recorded) and then three actual shots with the average of the best two used as the value x in the formula below.

$$Raw\,score = 100\,(1 - \frac{x}{40\ meters})$$

$$Final\,score = 20 + 80\,(1 - \frac{RS_{max} - RS_{team}}{RS_{max} - RS_{min}})$$

Thus each team is awarded between 20 and 100 points, and rankings are competitively based on catapult accuracy. The team with the highest final score (100 points) wins.

Equipment Tests:

Catapult tests, aside from the three practice shots during the event, must be conducted PRIOR to arrival at the Olympics. The firing of test shots on university property before the designated time is grounds for disqualification.

Softballs must be launched towards the bull's eye. If more than one shot is deemed by the staff to be errant, the catapult will immediately be disqualified and its team's score will be determined by any scored shots (practice shots do not count) completed prior to disqualification. **PLEASE TEST THE SAFETY OF YOUR DEVICE BEFORE YOU ATTEND!**

Physics Olympics Course

Objective:

To demonstrate a general understanding of physics. This event will be conceptual and competitive, not a boring test! Physics questions will be incorporated into an obstacle course. (Categories from last year were trigonometry, centripetal motion, projectile motion, optical spectrums, and important people in physics)

Apparatus:

The entire team.

Procedure:

The team will work through an obstacle course consisting of physics questions and their applications, wrong answers will result in time penalties.

Scoring:

The score range will be from 20 to 100 based on the slowest and fastest team times.

$$Final\,score = 20 + 80 \quad 1 - \frac{RS_{fastest} - RS_{team}}{RS_{fastest} - RS_{slowest}}$$

Overall Winner

Scoring:

Each of the six events is worth a maximum of 100 points. The sum of these event scores will yield each team's overall score out of 600. The team with the most points wins the contest.

Note:

All participants need to be aware of the guidelines and rules for each event! Questions regarding any of the events, devices, or rules may be submitted in writing to unt.sps@gmail.com prior to the competition date. Failure to comply with the rules for each event may result in disqualification from that event.

Good luck!

UNIVERSITY OF NORTH TEXAS
PHYSICS OLYMPICS REGISTRATION

Entry fee is $100 per team. Please send a check to the address below.
Maximum of 5 students per team.

Please fill out one form per team and return by March 18, 2016.
All fields are required

School: _____

School contact number: _____

School address: _____

Team member names and T-shirt sizes:

1.) _____

2.)_____

3.) _____

4.) _____

5.) _____

Sponsor's name and T-shirt size: _____

Sponsor's contact number: _____

E-Mail:_____

Food allergies/ dietary restrictions:_____

Would you like to receive updates and degree information from UNT throughout the academic year?
❑ Yes ❑ No

RETURN TO: Physics Department
c/o Society of Physics Students
1155 Union Circle
#311427
Denton, TX 76203

Thank you for registering – we look forward to seeing you!
Good luck!

If you have any questions, please contact Holly Decker at
Email: Holly.Decker@unt.edu Phone: 940.565.3256