PHYSICS OLYMPICS
Department of Physics & Astronomy
YOUNGSTOWN STATE UNIVERSITY

Saturday, February 22nd from 8:00 a.m. -3:00 p.m.
2025 Information and Rules

Contents

GENERAL INFORMATION

- The 2025 YSU Physics Olympics will be held **Saturday, February 22nd 2025** from 8:00 am -3:00 pm in the gymnasiums in Stambaugh Stadium (GPS address: 577 Fifth Ave., Youngstown, OH).
- Students in **grades 6-12** can participate in various categories.
- Participants will be able to drop their entries off starting at 7:00 am, using the north facing Ticket Window entrance across from McDonalds if needed.
- Parking is available for $5.00 in the M70 lot on Fifth Ave (Next to McDonalds).
- If you will be bringing a school bus, the bus may unload on Armed Forces Blvd, and then proceed to the M90 lot on Elm Street (across the Madison Expressway from the WATTS Center) for bus parking.
- For questions and information, contact the Physics Olympics coordinator, Sarah Bika via email at Sleisnaugle@ysu.edu, or the Department of Physics & Astronomy, Academic Operations Specialist, Jill Mogg at jmmogg@ysu.edu or by phone at 330-941-3616.
- Visit the Physics Olympics Facebook page or the YSU Physics Olympics page at http://www.ysu.edu/physics-olympics for updates and online registration forms
- There is a $20 registration fee per school. Checks/PO's may be made payable to "YSU Physics Olympics"

EVENT #1 – HOT WATER MAKING

TEAM: A team can have up to TWO (2) members

PURPOSE:

- To heat **300 grams of water** using **mechanical means only**.
- The goal is to achieve the **greatest temperature rise** in the **shortest time**.
- A minimum temperature rise of **5°C** is required for scoring.

APPARATUS RULES:

1. **Device Construction:**
    - Each team may bring **one device** to heat the water.
    - The device must use **mechanical means only** to generate heat.
        - **Prohibited methods**: Solar energy, flame, chemicals, electricity, or other direct heat sources.
        - Examples of acceptable methods: Producing heat through **friction** or similar mechanical processes.
2. **Energy Source:**
    - The **only energy source** allowed is the effort of the **two team members**.
3. **Safety Requirements:**
    - Devices must not cause any **damage to the surroundings**.
    - Judges will determine if the device qualifies, and their decision is **final**.

PROCEDURE:

1. **Check In:**
    - Upon arrival in the morning, all teams must submit their containers intended for heating water for inspection. These containers will be returned to them at the time of the competition.
2. **Starting the Event:**
    - Teams will receive **300 grams of water** at room temperature in a **12-oz Styrofoam cup**.
    - The water must be heated through **mechanical means only** and returned to the judges as **hot water**.
    - Teams may bring their own thermometers.
3. **Set-Up and Heating:**
    - Teams will have **3 minutes** to set up their apparatus.
    - The heating process will begin, with a maximum time of **15 minutes** allowed.
4. **Water Requirements:**
    - No **additives** (chemical or otherwise) are allowed in the water.
    - After heating, the water must be returned to the judges.

SCORING:

1. **Timing the Event:**
    - Two watches will be started when the water is poured into the heating device:
        - The first watch stops when the team returns the heated water to the cup and says "stop."
        - If a second heating attempt is needed, the **cumulative time** will be recorded using the second watch.
2. **Temperature Measurement:**
    - The water will be adjusted to **300 grams** with room-temperature water after heating.
    - The final temperature will be measured.
3. **Scoring Points:**
    - A minimum temperature rise of **5°C** is required to receive a score.
    - The event score is the temp rise / total time
    - The team with the **highest Event Score** will earn **15 points**.
    - Teams in **2nd – on** will earn points based on their relative Event Scores.

EVENT #2 – HOUSE OF CARDS

TEAM: A team consists of two (2) members.

OBJECTIVE:

- To build the **tallest free-standing structure** within **30 minutes**.

APPARATUS:

1. Each team will be provided with:
    - **100 (3 × 5)** lined file cards.
    - **1-meter length of transparent tape.**
2. At the construction site, teams will have access to:
    - Meter sticks, straight edges, and scissors.
    - **Tape dispensers are not allowed.**

COMPETITION RULES:

1. Each team may submit only **one structure** for measurement.
2. **File Cards:**
    - Can be **cut, folded, rolled, slit**, and reassembled as desired.
3. **Tape:**
    - Can only be used to **fasten parts of the structure**.
    - **Cannot** be used to attach the structure to the floor or any other object.
4. Teams have **30 minutes** to build their structure.
5. Height measurement:
    - The team may request a measurement once construction is complete.
    - Height is the **perpendicular distance** from the structure's highest point to the floor.
6. Free-standing requirement:
    - The structure must stand on its own for **at least 10 seconds** without changing height.
    - If any height change occurs, a second measurement will be taken, and the **shorter height** will be recorded.

SCORING:

1. The team with the **tallest free-standing structure** wins **first place**.
2. Other placements will be determined by relative heights.

EVENT #3 – SODA STRAW ARM

TEAM: A team consists of 2-3 members.

OBJECTIVE:

- Construct the **longest soda straw arm** that can support a **50-gram mass** for **10 seconds** without failure.

MATERIALS PROVIDED:

- Each team will be given the following at the competition site:
  - **15 jumbo plastic straws** (7¾" or 10" in length).
  - **10 straight pins.**
  - **1 #1 paper clip**, which must be bent into an "S" shape for attaching the weight.
  - **50-gram mass** attached to a string approximately **30 cm** long.

TOOLS AND SAFETY REQUIREMENTS:

1. **Teams must bring:**
   - **Scissors and pliers** (optional tools for construction).
   - **Chemical splash goggles and gloves** (required for cutting pins).
2. **Pin Cutting Safety Rules:**
   - Cutting pins must be done at the designated **Pin Cutting Station**.
   - Goggles and gloves **must** be worn during pin cutting. Failure to comply will result in disqualification.
   - Pins cut without goggles and gloves will result in disqualification.
   - Teams without goggles or gloves will not be allowed to cut pins.

DESIGN AND CONSTRUCTION RULES:

1. **Pre-Competition:**
   - Teams must present a **sketch of their design** to the judges before starting construction.
   - Physical models or pre-constructed arms are **not allowed**.
2. **Construction Time:**
   - Teams will have **20 minutes** to construct their straw arm on-site.
   - Teams may test their arm during construction.
3. **Restrictions:**
   - The **paper clip** may only be used for attaching the weight and cannot reinforce or strengthen the structure.
   - The arm apparatus must:
     - Be in contact with (but not secured to) the tabletop.
     - Remain free-standing during testing.
     - Support the 50-gram mass without "crimping" (fold lines in the straws are allowed during construction but not during testing).

POST-CONSTRUCTION:

- At the end of the 20 minutes, arms will be labeled and placed on the judge's table.
- No modifications to the arm are allowed after the construction time ends, including replacing bent or broken straws or pins.

COMPETITION RULES:

1. **Testing Procedure:**
   - One team member will hold the arm in the desired position on the tabletop with **both palms touching the table**.
   - No part of the team member's body may extend beyond the table's edge.
   - The arm is slid out from the table's edge to the desired position.
2. **Weight Attachment:**
   - The second team member will hook the **50-gram mass** onto the paper clip.
   - Once the mass is attached, the team member must **immediately remove their hand** from the string.
   - The 10-second timer starts once the weight is in place.
3. **Hold Period:**
   - During the 10-second hold, the arm must remain:
     - Self-supported.
     - Free from manipulation or support by the team members.
   - Any visible "crimping" of the straws during this period will disqualify the arm.
4. **Measurement:**
   - Judges will measure the arm's length along a **horizontal line perpendicular to the tabletop** from the table edge to the farthest point of the arm.
   - If the arm end is higher than the tabletop, the **string must extend below the tabletop** to allow accurate measurement.
5. **Second Trial:**
   - Teams whose arms successfully hold the weight for 10 seconds in the first trial will immediately be given a second trial.
   - Teams may reposition the arm on the table for the second trial but **may not modify the structure**.

SCORING:

1. The **distance recorded** after the 10-second hold period determines the score.
2. The team with the **longest recorded arm length** wins first place.
3. In the event of a tie:
   - The second trial distance will serve as the tiebreaker.
4. Teams unable to support the mass for the required 10 seconds will not receive a recorded distance.
5. Awards are given as follows:
   - **1st place:** Longest arm that successfully holds the weight.
   - **Subsequent placements:** Based on relative arm lengths.

EVENT #4 – PING-PONG BALL LAUNCH

TEAM: Each team will consist of one (1) official competitor.

OBJECTIVE:

- Use a self-made catapult to launch a ping-pong ball onto a **circular target** from **three different distances**.
- The goal is to achieve the **highest total score** across all distances.

APPARATUS RULES:

1. **Catapult Design:**
    - The catapult must have a base (e.g., wheels, rubber base, etc.) that will **not scuff the gym floor**.
    - There is **no weight limit** for the catapult.
    - For the **2-meter competition**, the catapult must fit entirely within a **30 cm × 30 cm × 30 cm** box when in the ready-to-launch position.
    - The catapult must be made of **non-metallic materials**, except for **metal fasteners** (e.g., hook eyes, rings, angle braces).
        - **Metal hinges or rods are NOT allowed.**
    - Materials may include cloth, wood, rubber, latex, canvas, tape, glue, etc.
2. **Launch Mechanism:**
    - The catapult must have a **self-sufficient trigger mechanism** that holds the launch mechanism in place until intentionally released.
    - The trigger must allow the user to **walk away safely** without releasing the launcher prematurely.
    - The eligibility of the apparatus will be determined solely by the judges.
3. **Ping-Pong Balls:**
    - **Good-quality ping-pong balls** will be provided by the judges.
    - Teams may bring their own ping-pong balls, provided they are of equal quality.
4. **Target:**
    - The target will consist of **concentric circles**, with scoring based on the initial point of contact.

COMPETITION RULES:

1. **Phases of Competition:**
    - Teams will launch **four ping-pong balls** at the target from **three different distances**:
        - **0.75 meters, 2 meters, and 7 meters.**
    - The target's center will be positioned on the floor, with distances measured from its center to the shooting box.
2. **Shooting Box:**
    - The shooting box will be a **0.5-meter square**.
    - The entire base of the catapult must fit inside this box during each phase.
3. **Adjustments:**
    - A **3-minute adjustment period** will be allowed between each set of distances.

    - No adjustments or recorded launches may occur during this period. **Practice launches** are allowed but will not count for scoring.
4. **Launch Timing:**
    - Teams will have **5 minutes** to complete all four launches for each distance.
    - Launches not completed within the time limit will be scored as **0 points**.
5. **Scoring Rules:**
    - Each launch will be scored based on where the ball **initially lands** on the target.
    - Balls must land **completely within a scoring area** to earn points. Balls partially in two areas will be scored as the **lower value**.
    - Balls that do not hit the target will still earn a minimum of **10 points**.

SCORING AND TIE BREAKERS:

Scoring:

1. For each distance, the **three highest-scoring launches** will count toward the final score.
2. The **4th ball** will only be used in the event of a tie.
3. The final score will be the sum of the scores from all three distances.

Tie Breakers:

In case of a tie, the following criteria will be applied in order:

1. **4th ball score at 7 meters.**
2. **4th ball score at 2 meters.**
3. **4th ball score at 0.75 meters.**
4. **Number of 50-point shots at 7 meters.**
5. **Number of 40-point shots at 2 meters.**
6. **Number of 40-point shots at 0.75 meters.**

WINNING CRITERIA:

- The team with the **highest total score** across all three distances will be declared the winner.
- Awards for **2nd on** will be determined based on the same scoring method.

EVENT #5 – PHYSICS PHLOATER

TEAM COMPOSITION:

- Each school may submit up to **two (2) entries**.
- A maximum of **two (2) students** per entry.
- **Phloaters** must be submitted at the time of registration and will be returned to competitors during the event.

OBJECTIVE:

- Build a **rubber-band-propelled Phloater** that travels the fastest along a water-filled PVC raceway.

APPARATUS RULES:

1. **Raceway:**
    - The raceway is a **4-inch PVC pipe**, cut in half lengthwise, and is approximately **10 feet long**.
    - It will be filled with water to a depth of **3.5 cm**.
2. **Phloater Specifications:**
    - The Phloater may be constructed from **any material**, provided it:
        - Fits within the PVC raceway.
        - **Floats freely** for the entire run.
    - Dimensions:
        - **Maximum length and width:** 30 cm.
        - **Minimum mass:** 75 grams.
    - The Phloater must include a **mast** made from a **1/8-inch dowel rod**:
        - The mast must extend at least **15 cm above the trough** and cannot exceed **48 cm** in height.
        - The mast must remain upright throughout the entire race for timing purposes.
3. **Propulsion:**
    - Propulsion must be provided solely by **rubber band(s)**, which must remain attached to the Phloater throughout the run.
    - **Water propellers are NOT allowed.**

COMPETITION RULES:

1. **Race Details:**
    - Each Phloater will race on a **1.5-meter course** within the PVC trough.
    - Timing will be measured using **photogates** and **laser pointers** placed **1.5 meters apart**.
        - The photogate and laser pointer will be positioned **5 cm to each side of the trough**.
2. **Starting Procedure:**
    - Contestants will place their Phloater at the starting line.
    - The **mast** must be positioned within **2 cm of the first photogate** and must remain **no higher than 48 cm** above the trough.
    - On the judge's signal ("GO"), the contestant must release the Phloater.

3. **Timing Rules:**
    - Timing begins when the **mast** breaks the first beam and stops when it breaks the second beam.
4. **Race Attempts:**
    - Each Phloater will be given **two runs**.
    - The **shortest valid time** of the two runs will be recorded for scoring.

SCORING:

1. **Time Measurement:**
    - The shortest **non-zero time** from the two runs will be the team's competition score.
    - If a team records a **tie**, the better time from the **second race trial** will break the tie.

EVENT #6 – PHYSICS HANG-UPS

TEAM COMPOSITION: Entrants (students) must be or have been enrolled in Physics. Entries will be limited to one (1) poster per student and up to two (2) posters per school.

If more than one poster is entered by a school, the one with the higher number of points will count toward the total team score. Students must be present at the time of the judging to answer questions.

OBJECT: To give students an opportunity to express their knowledge of physics in a creative, artistic, or humorous manner.

RULES:

1. The theme for the 2025 contest is: What Makes Things Move?
2. The poster MUST include the equation.
3. The poster board used must be 18" x 22" in size.
4. Any medium except chalk or pastel may be used.
5. No part of the poster may be thicker than 1 cm.

COMPETITION:

1. Posters will be judged on appearance, appropriateness, and execution. A good poster should present its topic in a simple, visual manner.
2. A panel of two judges will evaluate each poster. This part of the competition will be limited to two minutes. The poster must speak for itself.
3. Posters must be properly hung up no later than 10 a.m. Posters must have holes punched in the upper right- and left-hand corners so they can be displayed by suspending them with clips.
4. The posters will remain displayed until 1 p.m., after which they must be removed by the contestant or his/her designee.
5. Each poster must be labeled on the front with the name of the artist, the name of the school, and if it is the "A" (first) poster or "B" (second) poster from that school.

JUDGING: Judging will be based on the following point system:

1. Physics - 40 points
2. Creativity and originality - 30 points
3. Workmanship (construction) - 30 points

SCORING: The poster that receives the highest number of points will be declared the winner. Second through fifteenth places will be determined in a similar manner.

EVENT #7 – MAKING MUSIC (Original Musical Instruments)

TEAM COMPOSITION:
Each team must consist of no more than three (3) students.

INSTRUMENT REQUIREMENTS:

- Instruments must be entirely **handcrafted** using materials not originally intended for musical use (e.g., no commercially manufactured instrument parts such as guitar strings, drumheads, or mouthpieces).
- Instruments must be **complex or innovative** and demonstrate more than a basic understanding of sound production (e.g., no simple buckets, pans, or basic shakers).
- YSU will reference an **"Instrument Index"** (maintained by the competition committee) to ensure no previously constructed instrument designs are reused. Past designs will be disqualified if repeated.
- Instruments must produce distinct tones (e.g., different pitches or timbres) and be capable of performing the required melody.

SONG PERFORMANCE:

- Teams will perform **"Shake It Off" by Taylor Swift**. The performance must reflect the original melody, rhythm, and structure.
- All sound must be created using the team's constructed instruments. No external effects or pre-recorded sounds are permitted.

WRITTEN EXPLANATION:

- Teams must submit **three copies** of a one-page, double-spaced technical explanation (12-point font) at the registration table upon arrival. The explanation must:
  - Describe the physics principles behind their instrument (e.g., vibration, resonance, sound waves, pitch, and amplitude).
  - Include an additional page of diagrams or labeled drawings showing instrument construction.

ORAL EXPLANATION:

- Teams will give a brief oral explanation of their instrument design before performing. Judges may ask questions about sound production and construction.

DISQUALIFICATION RISKS:

- Using a design already indexed in the **Instrument Archive**.
- Presenting overly simplistic instruments (e.g., buckets or basic shakers).
- Using mechanical or commercially manufactured devices to aid sound production.

EXAMPLES OF CREATIVE INSTRUMENTS

1. **String Instruments**:
    - **Rubber Band Harp**: Rubber bands of various lengths and tensions stretched over a wooden frame to create different pitches.
    - **Box Zither**: Metal wires stretched over an empty box with bridges for tension adjustment.
2. **Wind Instruments**:
    - **PVC Pipe Flute**: A series of cut PVC pipes of varying lengths to produce different tones when blown.
    - **Straw Pan Flute**: Straws of different lengths taped together to produce a melody.
3. **Percussion Instruments**:
    - **Water Drum**: A plastic or glass container partially filled with water; tapping different levels of water changes the pitch.
    - **Spring Drum**: A metal spring attached to a hollow cylinder that resonates when tapped or stretched.
4. **Unique Instruments**:
    - **Bottle Xylophone**: Glass bottles filled with varying amounts of water to create a tuned percussion instrument.
    - **Balloon Kazoo**: A stretched balloon over a tube to produce a buzzing sound when air is blown through.
5. **Combination Instruments**:
    - **Multi-Purpose "Orchestra Box"**: A wooden box containing strings, pipes, and percussion elements that one or more students can play simultaneously.

EXAMPLES OF DESIGNS THAT CANNOT BE REUSED

- Simple bucket drums.
- Basic shakers using plastic bottles or containers.
- Single-pitched rubber band "guitars."
- Cardboard box "drums."

SCORING CRITERIA

Originality of Instruments (30%):

- Innovative use of materials.
- Complexity and uniqueness of the design.

Musicality (30%):

- Ability to replicate the melody, rhythm, and structure of "Shake It Off."
- Instrument tuning and sound quality.

Written Technical Explanation (20%):

- Clear understanding of the physics behind sound production.
- Well-drawn diagrams and detailed descriptions.

Oral Technical Explanation (20%):

- Clear and concise presentation of the instrument's design and sound production.
- Ability to answer judges' questions confidently and accurately.

ADJUDICATION: Adjudication will be based on the construction of the instrument(s), the musicality of the performance and the explanation of the physics involved in making the project. An oral explanation must be made. Adjudicators may ask questions regarding the project.

EVENT #8 – EGG DROP

TEAM COMPOSITION:

- Each school may submit **one entry**.
- A team may consist of **up to two (2) members**.

OBJECTIVE:

- Build a container of **original design** with **minimum mass** to protect a **medium raw egg** from breaking or cracking when dropped from a height of **14 meters**.

APPARATUS RULES:

1. **Materials Provided:**
    - Teams will receive **10 sheets of 8½" x 11" standard copy paper** and **1 meter of transparent tape** for constructing their container.
    - Teams must bring their own construction aids, such as:
        - Scissors, rulers, model eggs, or other tools.
2. **Design Requirements:**
    - The container can be of **any design** but must:
        - Fit through a standard door opening.
        - Be made only from the provided paper and tape.
    - The **egg must be loaded securely** into the container and remain intact during the drop.
3. **Construction:**
    - Teams will have **20 minutes** to construct their container on-site.
    - No eggs will be provided during the construction period.
4. **Judging Preparation:**
    - Once the container is built, it will be:
        - **Weighed** by a judge.
        - Inspected for identification and any specific **launching instructions**.
    - Raw eggs will be supplied **after the container is submitted** for weighing.
5. **Egg Loading:**
    - Teams will have **one minute** to load the egg into their container under judge supervision.

COMPETITION RULES:

1. **Drop Procedure:**
    - The container with the egg will be dropped by a judge from **14 meters** (3½ flights up the interior stairwell of Stambaugh Stadium).
    - The container will land in a designated **1-meter x 5-meter x 14-meter drop zone** in the basement level.
2. **Egg Protection:**
    - The egg must survive the fall **intact** (without cracks or breaks) to be eligible for scoring.
    - Judges will inspect the egg immediately after the drop. The judge's decision is **final**.

SCORING:

1. The team with the **lightest container** that successfully protects the egg will be declared the **winner**.
2. In the event of a tie, accuracy may be considered as a determining factor.
3. **Second through fifteenth place** will be determined based on container mass for entries that successfully protect the egg.

ADDITIONAL NOTES:

1. **Drop Height:**
    - The official drop height is approximately 7 meters, measured from the top balcony of the DeBartolo Stadium Club to the designated landing area.
2. **Landing Zone:**
    - A hard-surface landing zone will be established at the base of the balcony.
    - A target will be positioned in the landing zone to assess the accuracy of the apparatus during testing.

EVENT #9 – BARBIE BUNGEE

PURPOSE: To encourage students to explore concepts in physics, such as energy, motion, and elasticity, by designing a bungee cord system for a Barbie doll that achieves the longest possible "safe" fall.

TEAM COMPOSITION:

- Each team may consist of no more than three (3) students.
- All team members must actively participate in the design and testing.

OBJECTIVE:

- Teams must construct a bungee cord system that allows Barbie to fall from a given height of 4 meters as close as possible to the ground **without touching it**.

MATERIALS:

- Teams can use the following materials to construct their bungee system:
  - 25 new rubber bands. Universal 00132 32-Size Rubber Bands
  - 1 rolls of tape (standard masking tape).
  - 1 Barbie doll (standard size, provided by the competition).
  - A measuring tape or ruler (for pre-drop adjustments).
  - Scissors (for cutting materials).

DESIGN RESTRICTIONS:

- Barbie must be securely attached to the bungee cord system during each drop.
- The bungee cord must stretch, not break, during the fall. Breaking the cord will result in disqualification.
- Barbie must remain upright during the drop (e.g., no gliding or parachute-like motion is allowed).
- No additional materials may be brought or used.

TESTING AND MEASUREMENT:

- Teams will perform one official drop from the designated height.
- Distance will be measured from the lowest point Barbie reaches during the fall to the ground.
- If Barbie touches the ground, the team is disqualified for that attempt.
- The competition committee will determine the exact height of the drop on the day of the event (e.g., gym balcony or staircase).

DISQUALIFICATION RISKS:

- Using materials not provided by the competition.
- Barbie touching the ground during the official drop.
- Breaking the bungee cord during the drop.

SCORING CRITERIA

1. **Accuracy of the Drop (50%)**:
   - How close Barbie comes to the ground without touching it.
2. **Originality of the Design (20%)**:
   - Creative approaches to the bungee system while adhering to the rules.
3. **Execution of the Drop (30%)**:
   - Higher points for fewest number of bands used. Smoothness of the drop and whether the system performs as intended.