

# **2012 NJAAPT PHYSICS OLYMPICS**

## **Events, Rules, and Scoring**

**Saturday, January 14<sup>th</sup>, 2012  
8:00am – 2:30pm**

**Monmouth Regional  
High School  
Tinton Falls, New Jersey**

### **Awards**

A maximum of 100 points will be given for each of the six events; therefore, the maximum number of total points is 600 points. The team with the highest number of total points will be the winner, followed by a second place team, and a third place team. The NJ Physics Olympics Silver Serial Bowl will be awarded for one year of custody to the overall first team. The top three teams will be awarded trophies as well as the winning team in each event.

### **General Rules**

- For each event the judge(s) will inspect all devices. It must be clear to the judge(s) that no part of a device is unsafe. For example, no rat or larger animal traps may be used as these traps have the potential to cause injury (mouse traps may be used), no elastic material wound so tightly that injury could result if it should snap free, no large fast spinning gyroscopes that could spin out of control, no large compressed gas cylinders or dangerous chemical reactions. If an entry is disqualified, the team will be given 30 minutes to modify their apparatus.
- The judges' decision(s) is /are final in all aspects of the event.
- All teams are encouraged to use creativity while keeping in the spirit of the competition.
- A team shall consist of not more than six members. Each team member must be from the high school of the team. No substitutions may be made for any member of a team during the course of the day's events (i.e., only the original team members and no others are eligible to compete in any of the events). Not all team members must participate in each event. A team may not use another team's entries for their own, even if they are from the same school.
- Updates to the rules will be posted on the NJAAPT web site at [www.NJAAPT.org](http://www.NJAAPT.org). Frequently asked questions with answers will be available by e-mailing

**[John\\_Valente@mast.mcvsd.org](mailto:John_Valente@mast.mcvsd.org)**

- It is your team's responsibility to keep the team updated about changes and clarifications to the rules.

## WELCOME!

We look forward to your school's participation at the NJAAPT sponsored "NJ Physics Olympics" to be held on Saturday, January 14<sup>h</sup>, 2012 at Monmouth Regional High School. The competition is a lot of fun and your students will meet, share experiences, and compete with other students from various parts of New Jersey.

In order to participate you must complete the attached **registration form** and send your check within the deadline prescribed. Rules & directions can be obtained by visiting the NJAAPT web site @ [www.njaapt.org](http://www.njaapt.org). You can also request that your team be mailed the complete rules for the competition and directions to the event. The **fee of \$35.00 per team** helps defray the cost of postage, supplies, trophies and donuts. IOU's will be accepted in the case where school checks cannot be sent in time. No purchase orders can be accepted. The fee will be reduced to **\$25.00 per team** if the team registers by **December 15, 2011**. Each team may have up to six members.

Each high school must have **at least one faculty member** accompanying the team who will be asked to help judge one of the events. More than one faculty member will be welcomed. **We could really use the help.**

On the day of the Olympics, plan on arriving for the final registration between 8:00 am and 9:00 am. **The first event begins at 9:00am.** The day's activities should **conclude around 2:30pm.**

You may bring your own **box lunches**. The cafeteria will not be open. Morning refreshments will be served.

Since there are a maximum number of teams that we will be able to handle, we may have to ask for a multiple team school to only send one team. Should this happen we will notify you by January 7, 2012. Fees for eliminated teams will be refunded.

## EVENT GOALS

**PLEASE NOTE: *The following are only brief descriptions of each event.***

***Full rules, competition scoring procedures, and the scoring formula can be obtained at [www.NJAAPT.org](http://www.NJAAPT.org).***

- **FERMI QUESTION**- To estimate the order of magnitude of a quantity that is difficult or impossible to measure.
- **SLOW BICYCLE RACE**- To ride a two wheeled bicycle in the longest interval of time.
- **THE HOOKED CARTESIAN DIVER**-To build a Cartesian diver that will retrieve sinkers in the least time.
- **BARGE BUILDING**- To build a barge that will support the greatest mass.
- **ZERO IMPACT VEHICLE**- To design a vehicle that will move as close as possible to a wall without touching it.
- **STRAW LEVER ARM**- To build a lever arm of minimal mass that will support a 1kg mass.

Updates to the rules as well as questions and answers concerning the rules will be posted on the NJAAPT web site at

[www.njaapt.org](http://www.njaapt.org).

It is your responsibility to check the web site so that your team is updated about changes and clarifications to the rules!

## Awards

### **Six First Place Trophies**

One for the highest score in each of the six events.

### **One Third Place Overall Trophy**

To the team with the third highest overall score in all six events.

### **One Second Place Overall Trophy**

To the team with the second highest overall score in all six events.

### **One First Place Overall Trophy**

To the team with the highest overall score in all six events.

## **The NJ PHYSICS OLYMPICS SILVER SERIAL BOWL**

**The first place trophy team will also receive the NJ Physics Olympics Serial Bowl. The name of the winning team's school will be engraved on the bowl and that school will proudly display it in their school's trophy case until the 2013 Physics Olympics.**

## REGISTRATION FORM

To register, complete and return this form with a \$35.00 check (if registering before December 15, 2011 the fee is \$25) for each team entered (6 members per team). Rules & directions can be obtained by visiting the NJAAPT web site at [www.njaapt.org](http://www.njaapt.org). You can also request that your team be mailed the rules for the competition and directions to the event.

School Name: \_\_\_\_\_

School Address: \_\_\_\_\_

Teacher's Name(s): \_\_\_\_\_

School Phone: \_\_\_\_\_

Home Phone: \_\_\_\_\_

FAX: \_\_\_\_\_

EMAIL: \_\_\_\_\_

Number of Teams: \_\_\_\_\_

Total Value of check: \_\_\_\_\_

Do you want a copy of the rules & directions mailed to you (you may obtain them by visiting the NJAAPT web site at [www.njaapt.org](http://www.njaapt.org))?

YES      NO

Make checks payable to the "NJAAPT" and include \$35.00 for each team entered. Send registration form and check by **January 1, 2012** to:

**John Valente**  
**M.A.S.T.**  
**BLDG. 305**  
**Sandy Hook, NJ 07732**

## FOR FURTHER INFO

If you need further information on the NJ Physics Olympics, please contact John Valente in one of the following ways:

**MAIL:** M.A.S.T.  
BLDG. 305  
Sandy Hook, NJ 07732

**PHONE:** (732) 291- 0995

**EMAIL:**  
[John\\_Valente@mast.mcvsd.org](mailto:John_Valente@mast.mcvsd.org)

## COMMITTEE

Dave Bandel  
Jessie Blair  
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John Valente

**The  
New Jersey Section  
of the**

**AMERICAN  
ASSOCIATION  
OF  
PHYSICS TEACHERS**

Invites you and your school to the

**2012 NEW JERSEY  
PHYSICS OLYMPICS**

on

**Saturday  
January 14<sup>th</sup>, 2012**

at

**Monmouth Regional  
High School  
Tinton Falls  
New Jersey**

Outline of this year's events with registration form and deadlines are inside.

## **EVENT 1: FERMI QUESTIONS**

(As of 9/30/11)

**OBJECTIVE:** To estimate the order of magnitude of a quantity that is difficult or impossible to measure.

### **RULES:**

- a. Each team will be provided with a list of ten Fermi Questions.
- b. Each team will have 30 minutes in which to answer these questions.
- c. Each team will submit a single set of answers.
- d. All answers must be recorded in order of magnitude format (i.e.,  $10^4$  not  $3 \times 10^4$ ,  $10^6$  not  $7 \times 10^5$ ).
- e. No electronic devices (cell phones, iPods/iPads, calculators, netbooks, computers, etc.) or preprinted references material shall be permitted to be used during the event.

### **COMPETITION AND SCORING:**

Ten points will be awarded for each correct answer (correct order of magnitude). There will be 1 point off for each order of magnitude difference from the accepted order of magnitude. No answer will score less than zero.

### **Sample Fermi Questions:**

1. How much land area (in square meters) is found on earth? (Answer is  $10^{14}$ )
2. How many revolutions will a 14-inch tire make during a crossing of the continental United States? (Answer is  $10^6$ )
3. How many liters of air does an adult inhale in a 24-hour day? (Answer is  $10^4$ )
4. How many square meters of turf (real or artificial) are there in a National Football League Stadium? (Answer is  $10^4$ )
5. An automobile travels 100,000 km before the tire tread wears out. What thickness of rubber wears off the tire each revolution of the wheel? Please express your answer in centimeters. (Answer is  $10^{-8}$ )

Updates to the rules will be posted on the NJAAPT web site at [www.njaapt.org](http://www.njaapt.org). Additionally, frequently asked questions with answer will be available by e-mailing [John\\_Valente@mast.mcvsd.org](mailto:John_Valente@mast.mcvsd.org). It is your team's responsibility to keep the team updated about changes and clarifications to the rules.

## **EVENT 2: SLOW BICYCLE RACE**

(As of 10/26/11)

**OBJECTIVE:** To ride a two wheeled bicycle over a fixed course in the longest interval of time.

### **RULES:**

1. The course will be 15 meters long and 0.75 meters wide on a flat (as close as possible) sidewalk or indoors in a non-carpeted typical school building hallway. A practice area will be provided.
2. Each team must provide its own bicycle. The same bicycle must be used for all trials by a single team. This bicycle can be modified in any manner as long as these modifications do not conflict with the following:
  - a. Each bicycle must have only two rubber tired pneumatic wheels in ground contact, which are coplanar in the plane of the bicycle frame when traveling forward in a normal fashion.
  - b. The bicycle must have steering capacity.
  - c. Tire prints of the bicycle must not exceed a width of 8 cm and a length of 15 cm when the student is on the bicycle. The minimum wheel radius is 10 cm.
  - d. No part of the bicycle except the tires may touch the course.
3. Only the muscles of the rider shall provide forward motion.
4. No part of the competitor's body may touch the ground during the event.
5. The bicycle must remain within the boundaries of the course and maintain **FORWARD** motion at all times.
6. Each team will be allowed two attempts to make a complete trip. A complete trip will consist of one run up the course and one run down the course.
7. The clock will be stopped while the bicycle is turned for the return trip.

### **COMPETITION AND SCORING:**

1. The course will be marked out indicating start and finish lines. As soon as the front wheel crosses the start line the judge will start the stopwatch.
2. Time will stop and be recorded when:
  - a. The front wheel crosses the finish line.
  - b. The rider's foot touches the ground.
  - c. The bicycle comes to a stop or rolls backwards.
  - d. The contact points of the wheel touch the boundary.

Note: In case of inclement weather, the event will take place indoors in a non-carpeted building hallway.

$$SCORE = \frac{(Your\ time)}{(Greatest\ total\ time)} \times 100\ points$$

### **EVENT 3: The Hooked Cartesian Diver**

(As of 10/26/11)

**OBJECTIVE:** To design and build hooked Cartesian divers that will retrieve different types of hooked sinkers in the least amount of time.

#### **RULES:**

1. The Cartesian divers must be designed and constructed by the team and brought to the competition fully or partially constructed.
2. The Cartesian divers may be constructed from any of the following materials: plastic transfer pipettes, tape, fasteners, wire, and glue.
3. The Cartesian divers must have an attached hook so that it is able to retrieve hooked sinkers.
4. The Cartesian divers, including the hooks, may not be over 8 centimeters long and must be able to fit through the opening of a one liter plastic soda bottle, diameter about 2.3 cm.
5. The team may design different types of Cartesian divers to anticipate different types of hooked sinkers (e.g., different weight sinkers, sinkers of different sizes or sinkers with the hook located in different positions).
6. A hooked sinker will be placed inside a one-liter plastic soda bottle filled to the brim with water.
7. The team will lower or raise the diver to hook the sinker by applying pressure from their hands to the sides of the plastic soda bottle. No other way to change the position of the diver will be allowed.

#### **COMPETITION AND SCORING:**

1. The team will have 10 minutes to complete this event.
2. Three (3) one-liter plastic soda bottles filled with water and containing a hooked sinker will be placed on a table.
3. The team will place their diver into one of the plastic soda bottles, refill the bottle to the brim with water, retrieve and remove the hooked sinker and Cartesian diver from the bottle and then repeat for the remaining bottles.
4. A small beaker and plastic transfer pipette will be provided for the team to refill the bottles to the brim with water.
5. When placing or retrieving the diver into or from the plastic soda bottles, tweezers or similar devices, provided by the team, may be used.
6. The bottle must remain in contact with the surface of the table.
7. The bottle may not be tilted more than 45 degrees from the vertical (visually judged) while retrieving the sinker.
8. The team may use different divers for each bottle but the team cannot load the next bottle until the first diver is retrieved and placed on the table.
9. Each retrieved sinker will receive a score of 100 points.
10. The team with the most points wins.

$$SCORE = \frac{(Your\ team's\ points)}{(Winning\ team's\ points)} \times 100\ points$$

**DISQUALIFICATION SCORE** = 50 points awarded for a qualifying Cartesian diver that is capable of sinking and rising as described in rule 7.

## **EVENT 4: BARGE BUILDING**

(As of 10/26/11)

**OBJECTIVE:** To design and construct a barge that will support the greatest mass.

### **RULES:**

- a. The team will construct the barge at the time of the competition.
- b. The barge is to be constructed from one sheet of heavy duty Reynolds, or similar brand, aluminum foil with dimension of approximately 15 cm x 15 cm.
- c. The team is not required to use the entire sheet of foil to construct their barge.
- d. No other materials may be used to construct the barge.
- e. The team will provide the foil to construct the barge.
- f. The team will be provided with recent US pennies.
- g. The teams will be allowed 8 minutes and 15 seconds for the entire event, 3 minutes to assemble their barge, 4 minutes and 15 seconds to test the barge and 1 minute to count the number of pennies supported by the barge.

### **COMPETITION AND SCORING:**

- a. Each team will be allowed 3 minutes to assemble their barge. After 3 minutes the judge will signal the teams to place their barge in the water. The barge must float for 15 seconds.
- b. After 15 seconds, the team will have 4 minutes to add as many pennies, slowly one at a time, to their barge without the barge sinking.
- c. If the barge does not float, then the score will be zero.
- d. If the barge floats but does not hold pennies, the team will earn the disqualification score.
- e. After 4 minutes, the judge(s) will signal the team to stop adding pennies to the barge, instruct the team to remove their barge from the water and start counting the number of pennies added.
- f. If the bridge sinks while pennies are being added, the team will subtract one penny from the total number of pennies supported by the barge.
- g. The winner of the event will be the barge that supports the greatest mass of pennies.

$$SCORE = \frac{(Your\ mass)}{(Winning\ mass)} \times 100\ points$$

**DISQUALIFICATION SCORE** = 10 points less than the lowest score for a qualifying barge but not less than zero.

## **EVENT 5: ZERO IMPACT VEHICLE**

(As of 10/26/11)

**OBJECTIVE:** To design a vehicle which when released eight meters from a wall will move as close as possible to a wall without touching it.

### **RULES:**

- a. The starting line will be 8 meters from the wall and parallel to it.
- b. The vehicle is to be designed and built by the team from household materials and/or materials available from hardware stores and/or from art/hobby supply stores. No commercial kits will be permitted.
- c. The design of the vehicle must meet the following specifications:
  - (1) The total mass of the vehicle system may not exceed 2 kg.
  - (2) No dimension of the vehicle may exceed one meter. (i.e. The vehicle must be able to fit within the volume of a 1m x 1m x 1m cube)
  - (3) The motion of the vehicle must be supplied by mechanical means such as rubber bands, springs weights, pulleys, and mechanical launchers.
  - (4) NO electrical components of any kind may be used, no remote controlled devices of any kind, and no chemical or nuclear reactions.
  - (5) No part of the vehicle or its operating system may be attached to the floor, wall, ceiling, or operator.

### **COMPETITION AND SCORING:**

- a. The vehicle will be started at or behind a starting line of masking tape attached to the floor 8 meters from a wall. It will proceed toward the wall and stop as close to the wall as possible without any part of the vehicle touching the wall. It may not bounce off the wall.
- b. No practice runs will be allowed at the competition site.
- c. Each team will be allowed two trials and the better one of the two will be used for the team's score.
- d. The vehicle can be modified between trials.
- e. The distance from the wall to the nearest part of the vehicle toward the wall will be measured for the purpose of calculating the score.
- f. If both trials result in touching the wall, the vehicle will be disqualified.

$$\text{SCORE} = \frac{(\text{Distance to the wall of the winning vehicle in cm})}{(\text{Distance to wall of your vehicle in cm})} \times 100$$

**DISQUALIFICATION SCORE** = 30 points for a qualifying and working vehicle.

## **EVENT 6: STRAW LEVER ARM**

(As of 10/26/11)

**OBJECTIVE:** To build a lever arm, of minimal mass, constructed solely of plastic drinking straws and straight pins, that will support a 1 kg mass.

### **RULES:**

- a. The lever arm must be brought to the competition constructed.
- b. The team will attach the lever arm to a support rod (diameter 1.8 cm) with not more than 15 cm of duct tape (width 2.5 cm). Tape may not touch the lever arm farther than 2cm from the contact point of the lever arm and support rod.
- c. The support rod will be attached to a lab table perpendicular to the table. The lever arm may be attached to the support rod orientated either parallel or perpendicular to the surface of the lab table.
- d. The lever arm is to be constructed of plastic drinking straws with a diameter of 0.635 cm (0.25 in).
- e. Straws may be cut or bent.
- f. Not more than three straws may be placed inside each other.
- g. Not more than three straws may touch one another at a time in a parallel arrangement (i.e. four or more straws may not be pinned together side by side).
- h. Pins used are to be straight pins. Pins may be cut or bent.

### **COMPETITION AND SCORING:**

- a. The judge will mass the lever arm prior to adding the 1 kg mass.
- b. The lever arm must be designed so that a 1 kg mass can be hung from the bottom outermost part of the arm, a minimum of 25 cm away from the support rod. Additionally, the mass must be free to swing (unobstructed) in all directions.
- c. The mass used will be a 1 kg hooked weight similar to that found in the 2000 Sargent-Welch Catalog (item number WLS-43322-11, page 939).
- d. The lever arm must support the 1 kg mass for 10 seconds.
- e. Once the weight is added, the lever arm may not deflect more than 10 degrees below its starting position.

$$\mathbf{SCORE} = \frac{(\text{Lowest mass of successful lever})}{(\text{Mass of your lever})} \times 100 \text{ points}$$