



Let Math Move You Around

Gillette Stadium



**“The Power To Hear”
Engineering Design Competition
Requirements and Scoring Rules
Spring 2011**

Activity Name: "The Power To Hear"
Activity Type: Classroom and Lab

Competition Groups:
Group I: 6, 7 and 8
Group II: 9, 10, 11 & 12

Subject Area: Sound Waves, Electronics,
Physics and Conic Sections

Location: Gillette Stadium
Dana Farber Field House

Study the basics of sound and the math of conic sections.

Calculate the focus of the parabola
so you know where to put the microphone.

Build and test your own parabolic microphone
just like they use during the game only a lot less costly !



Design Requirements

- REQ101 The parabolic microphone SHALL have no dimension exceeding 48 inches.
- REQ102 The total cost of all components and materials SHALL be less than \$50.01 US dollars
- REQ103 The parabolic microphone SHALL plug into the microphone jack on a laptop or PC. The microphone and the feed to the PC SHALL NOT contain any amplifiers or preamp circuits.
- REQ 104 Each entry **for Grades 9 – 12** SHALL be accompanied by a drawing of their test setup and a graph plotting distance on the x axis and your measured output for 6, 12, 24, and 48 yards on the y axis.
- REQ105 The team SHALL provide a design report and a complete parts list with costs. Documented cost estimates are required for all borrowed or scavenged items. *Provide receipts, pages from a catalog or price lists from online vendors.*
- REQ106 The team SHALL give a 10 to 12 minute¹ PowerPoint presentation explaining the design, costs and building process.
- REQ 107 Each entry SHALL provide a fixture that plugs into the headphone jack on a laptop or PC. The fixture SHALL have leads of at least 12 inches and SHALL have alligator clips attached to one end. This fixture SHALL be passive. ie. no active components like amplifiers.

Entries must meet all requirements to participate in the Measurement Playoff Round.

See Appendix 3 for scoring rubric

How Your Team's Total Score Will Be Computed

1. **The EDC Budget Report** $1000 - (20 * \text{cost})$
1000 points maximum

Receipts or cost estimates must be provided for each component
If cost exceeds 50 dollars the entry is not eligible to compete

2. **The "Power to Hear" Engineering Design Presentation**
1000 points maximum

Judged on completeness, delivery and staying within allowed time. The presentation should describe the design process as well as the thinking and learning which took place within the team. At a minimum it should cover each step of the design process provided in the team rules.

3. **The Measurement Playoff**

Points will be added to your score based on the measured millivolts from each round. The playoff rules and measurement technique will be discussed ahead. The algorithm is given below.

[X mV@12 yds + Y mV@24 yds + W mV@48 yds + Z mV@72 yds + Bonus Round]

Example: $300 \text{ mV} + 150 \text{ mV} + 75 \text{ mV} + 38 \text{ mV} = 563$ points added to the points earned based on the cost algorithm and the presentation round.

How Your Team's Total Score Will Be Computed

4. The Challenge Round for Bonus Points

Each team who is still in the competition at 72 yards will have the option of trying for bonus points by competing at 96 yards.

If your microphone produces results greater than 12 mV at 96 yards the total number of millivolts we measure at 96 yards will be added to your score.

If your microphone does not exceed 12 mV at 96 yards then **50 mV will be subtracted** from your score.

[**X mV@12 yds + Y mV@24 yds + W mV @48 yds + Z mV@72 yds + K mV@ 96 yards**]

Example 1: Team chooses to compete at 96 yds and measures 19 mv

$300 \text{ mV} + 150 \text{ mV} + 75 \text{ mV} + 38 \text{ mV} + \mathbf{19 \text{ mV}} = 582$ points added to the points earned based on the cost algorithm and the presentation round.

Example 2: Team chooses to compete at 96 yds and measures only 11 mv at 96 yds

$300 \text{ mV} + 150 \text{ mV} + 75 \text{ mV} + 38 \text{ mV} - \mathbf{50 \text{ mv}} = 513$ points added to the points earned based on the cost algorithm and the presentation round.

How Your Team's Total Score Will Be Computed

Example:

Budget Team A spent 30 dollars on their design and provided documentation for each part. They get 400 points in the cost part of the competition.

$$1000 - (20 * 30) = 1000 - 600 = 400.$$

Team A's design meets all of the requirements.

Presentation The panel of judges ranked the presentation according to a scoring checklist and gave the presentation a score of 800 points.

Team A's presentation took 13.25¹ minutes, which was longer than the allowed time so 150 points will be subtracted from the presentation score.

Team A's total score at this point is: $400 + 800 - 150 = 1050$ points.

Measurement In the measurement round at 12 yards Team A's microphone measured output was 400 millivolts max. This is added to their score: $1050 + 400 = 1450$ points.

At 24 yards Team A's microphone put out 200 millivolts max. Team A's score is now $1450 + 200 = 1650$ points.

At 48 yards Team A's microphone put out 60 millivolts max. Team A's score is now $1650 + 60 = 1710$ points.

At 72 yards Team A's microphone put out 20 millivolts. Team A's score is now $1710 + 20 = 1730$.

An entry is disqualified if their reading falls below 12 mV at any range because our test setup registers about 11 mV due to the ambient noise in the Dana Farber Field House.

¹ See Appendix 3 for scoring rubric

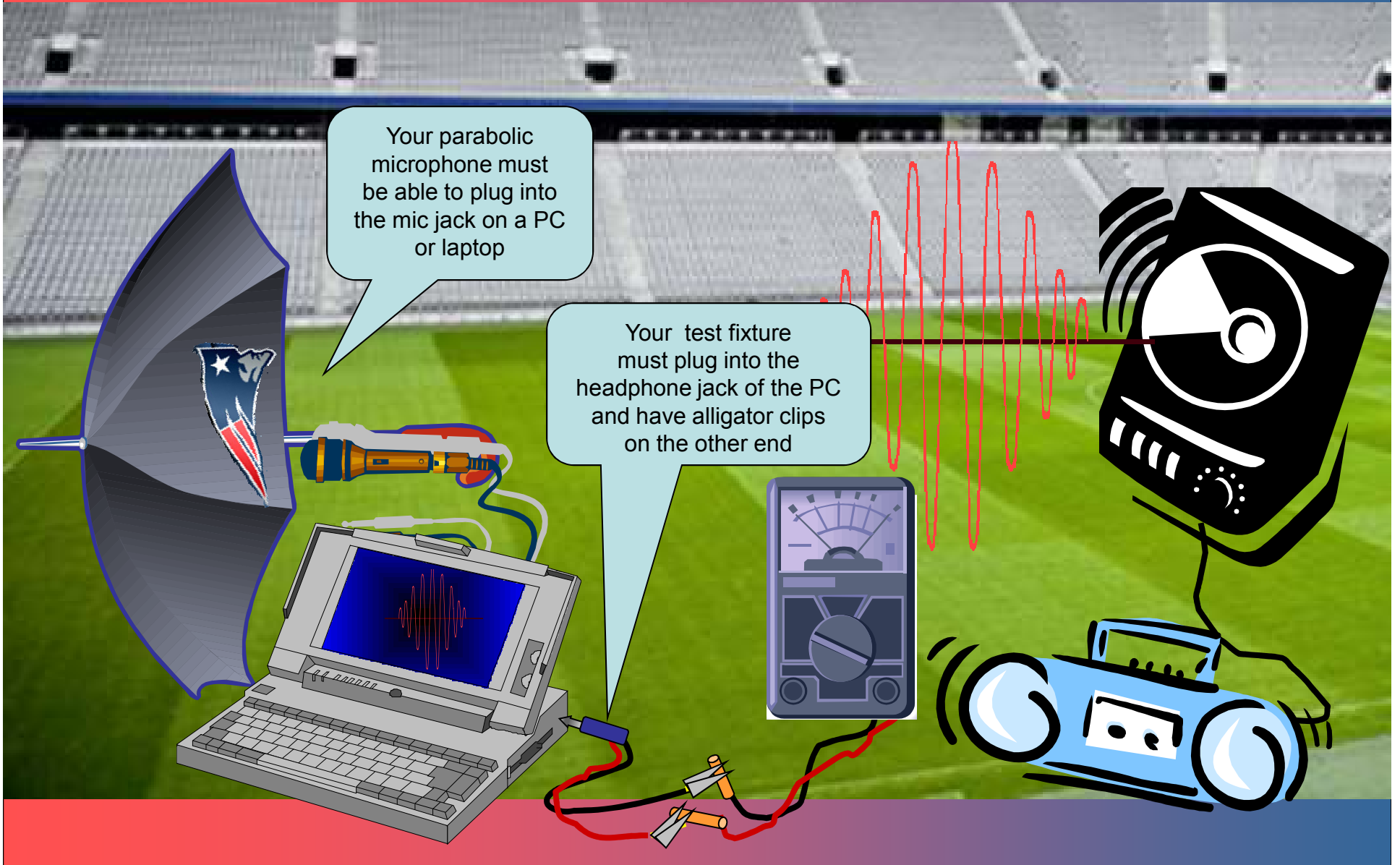
Testing Set Up for Measurement Playoff

Each team must provide a parabolic mic and a test fixture.

We will provide all of the remaining test equipment.

Your parabolic microphone must be able to plug into the mic jack on a PC or laptop

Your test fixture must plug into the headphone jack of the PC and have alligator clips on the other end



Testing Procedure for Measurement Playoff

A short pre-recorded sound source¹ will be provided for each round.

Your microphone will be plugged into the microphone jack on a laptop or PC.

The evaluation team will capture the output from your mic as the track plays. We will record with either the PC's Sound Recorder or Media Player application.

Your output fixture will be plugged into the headphone jack and must be clipped onto the metal leads of our voltmeter.

The recorded output from your mic will be played back and the output of the PC's headphone jack will be measured by our voltmeter.

Your score will be determined by the maximum reading in millivolts recorded by our voltmeter over the period of the recording.

¹ The sound source will be a prerecorded multi-tone source played from an amplifier. It may be a short track from a symphony or pop music selection or a set of tones.

Measurement Playoff Elimination: Top 50% in each round advance

Score = maximum millivolts in a 30 second sample measured at several ranges

Teams will compete at 12, 24, 48 and 72 yards until their individual readings go below 12 mV at any range. Then they must stop.

Only the top 50% at each measurement range will go on to the next range.

Breakages must be corrected in the round they occur and if a HW failure cannot be corrected the team is eliminated and cannot compete once the measurement table has been moved to the next yard marker.

If your team requires any assistance from the measurement team other than collecting the measurements a penalty of 20 mV will be subtracted from your measurement for that round.