2013 Regional Competition

March 3rd, 2013

Illinois Math Science Academy

Technical Problem Solving

Team Name_____ V or JV_____

Team #_____

Participant's Names_____, _____

Topics covered

Closed tube harmonics

Open Tube Harmonics

Catalase reaction

Required materials –

- Rubber stopper per group
- Deep sink or large graduated cylinder
- 480 Hz Tuning fork per group or key must be adjusted.
- 2" diameter PVC pipe of ~15 inches per group
- Meterstick per group
- 1 thermometer total.

Part One Closed tube harmonics

1. The speed of sound is 332 m/sec at 273 K and increases 0.6 m/s for each degree above zero celsius. What should be the speed of sound in this room?
2. What is the frequency of the tuning fork provided to you?
3. Strike the tuning fork on the rubber stopper to produce a frequency. Draw a picture indicating which way the tines vibrate.
4. Insert the PVC pipe in water and use the tuning fork (with rubber stopper) to find the **loudest** sound you can make. What height of PVC makes that sound?
5. Determine the wavelength using the height found in number four.
6. Assuming that your tuning fork was exactly at the top of the pipe, calculate the speed of sound. Show work.
7. Calculate your % error. Show work.
8. What is the place in a standing wave of maximum displacement?
9. What is the phenomenon called where waves reinforce each other?
10. What is the place in a standing wave of zero displacement?
11. What part of a sound is the amplitude equivalent to?
12. What part of a sound is the frequency equivalent to?
13. At what fractions of a wavelength do open ended pipes resonate?

Catalase reaction

The following data were obtained by decomposing hydrogen peroxide with catalase:

	0.20 M H_2O_2	0.30 M H_2O_2	0.40 M H_2O_2
Time (sec)	Pressure (atm)	Pressure (atm)	Pressure (atm)
0	0	0	0
20	0.30	0.45	0.60
40	0.60	0.90	1.20
60	0.90	1.34	1.34
80	1.20	1.34	1.34
100	1.34	1.34	1.34
120	1.34	1.34	1.34

1. What is the unit (unabbreviated) for pressure? [1]
2. Write the balanced reaction that occurs for the decomposition of H_2O_2 with catalase. Include catalase. [5]
3. What substance in your reaction produces the pressure recorded? [1]
4. Using the data table above, explain why H_2O_2 is first order. [2]
5. Use the data table given to construct an appropriate graph. Include ALL parts of a quality graph. [15]
6. How would your GRAPH above change if H_2O_2 was 2^{nd} order? [2]
7. What concentration had the fastest initial rate? Explain [3]
8. What concentration had the fastest final rate? Explain [3]
9. Draw a prediction of the line that would form for 0.50M H_2O_2. [2]
10. What is the unit for rate in the above graph? [1]
11. How would the graph change if a substantial amount of H_2O_2 decomposed before measurements were taken? [3]
12. How would the graph change if the student adding the catalase could not immediately attach the pressure sensing cap? [3]
13. What substance(s) in the above reaction is an enzyme? [2]
14. What substance(s) in the above reaction is a substrate? [2]

Another experiment was performed where the temperature was measured at 10°C, 20°C, and 150°C.

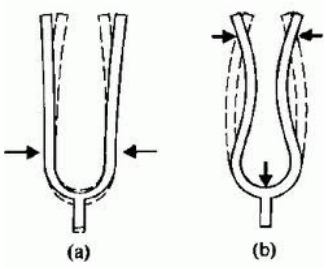
15. Which temperature would you expect to have the fastest initial rate? Explain. [4]
16. Which temperature would you expect to have no rate? Explain. [3]
17. Catalase was taken from pig liver. What pH would you expect to have the fastest rate? Explain. [3]
18. If a cell did not have any catalase, does the reaction proceed faster, slower, or not at all? [1]

Two different sources of catalase were tested. Source A came from a hot spring of pure water. Source B came from a cold water fish that lives in an acidic lake.

19. How would you expect the conditions of optimum functionality to differ between Source A and Source B. Explain. [4]

KEYKEYKEY

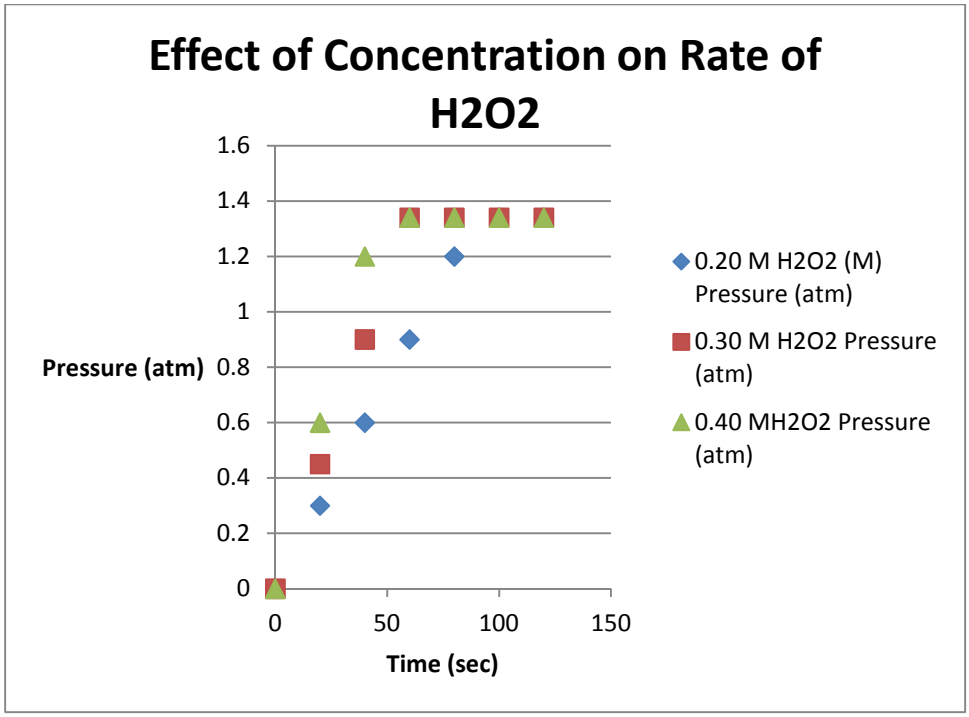
Answer Key Technical Problem Solving Regional 83pts. High score wins. First lab 1-13 is tie breaker.

1. 22° is room temp. so (0.6*22)+ 332=345 m/sec. +1 # +1 unit [2]
2. 480 Hz is what we used and it is labeled. +1# +1 unit [2]
3. 

[1]
4. 15-18 cm or so. +2 within tolerance +1unit [3]
5. .17*4=.68 m or 68cm [2]
6. c=fλ 480*.68=326 m/sec +1 m not cm, +2 answer, +1 unit[4]
7. (345-326)/345=5.5% Note: answer to #1 and #6used. [2] 1pt for yield instead
8. Antinodes [1]
9. Constructive interference [1]
10. Node [1]
11. Intensity of sound [1]
12. Pitch [1]
13. ¼, ¾, **multiples** of ½ after ¼ [2]

Catalase Reaction

1. Atmosphere [1]
2. $2H_2O_2 \xrightarrow{\text{Catalase}} O_2 + 2H_2O$ +1react+2prod, +1cat,+1bal [5]
3. Oxygen [1]
4. As the concentration of H_2O_2 doubles, the time cuts in half [2]
5.
   - **+1 Title**
   - **+2 for Axis labeled Time and Pressure**
   - **+2 for units of sec and atm**
   - **+2 for appropriate scale for y axis**
   - **+2 for appropriate scale for x axis**
   - **+3 for plot (increasing taper at top)**
   - **+3 for using at least half of the graph paper, but not going "off" the paper.**



6. The slope of the line would be steeper at first. [2]
7. 0.40 M because it has the steepest slope. +1 answer+2reason [3]
8. All the same. The slope was the same. [3]
9. Added line with steeper slope +1 and same plateau+1 [2]
10. Atm/sec [2]
11. The slope would be less and the plateau would be lower+1each +3 both [3]
12. Plateau would be lower and slow faster (See above) [3]
13. Catalase only [2]
14. H2O2 only [2]
15. 20 C. It is warm, but not so hot it destroys the enzyme [2]
16. 150 C because it would denature the enzyme so rx'n so slow no rate [4]
17. pH of 6-8 b/c that is what living things basically have. [3]
18. slower. [1]
19. A—higher temp and neutral pH. B lower temp and lower pH [4]