Technical Problem Solving

February 9th, 2013

Loyola Invitational

Team Name_____

Team Number_____

Participants' Names_____ _____

Topics

Decomposition Rates
Open Tube Harmonics
Enzymatic Reactions

Information:
Speed of sound: 340 m/s
$v=\lambda f$

Decomposition Reactions

Hydrochloric acid, partially decomposes thiosulfate, causing the beaker to turn cloudy and eventually becomes opaque according to the equation below:

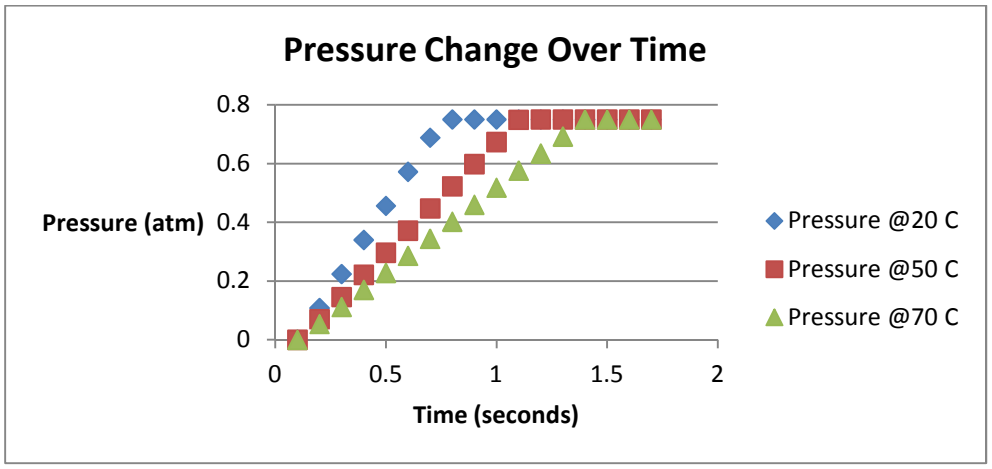
$2\ HCl_{(aq)} + Na_2S_2O_{3\ (aq)} \rightarrow 2\ NaCl_{(aq)} + SO_{2\ (g)} + S_{(s)} + H_2O_{(l)}$

HCl (M)	$Na_2S_2O_3$(M)	Time until opaque (sec)
0.10	0.25	21.30
0.20	0.50	5.11
0.10	0.50	5.06

Use the above table to answer questions 1-5.

1. How is rate related to time?
2. What substance causes the beaker to become cloudy and opaque?
3. Is the reaction above dependent upon HCl, $Na_2S_2O_3$, both or neither? Explain.
4. What order, (Zero, 1st, or 2nd) is HCl? Explain.
5. What order, (Zero, 1st, or 2nd) is $Na_2S_2O_3$? Explain.
6. If 0.00100 moles of $Na_2S_2O_3$ Were used in 35 seconds, how many moles of HCl were used in 35 seconds?

In another experiment, (using the above chemical reaction) the pressure change of SO_2 was recorded for different temperatures and the following graph was made:

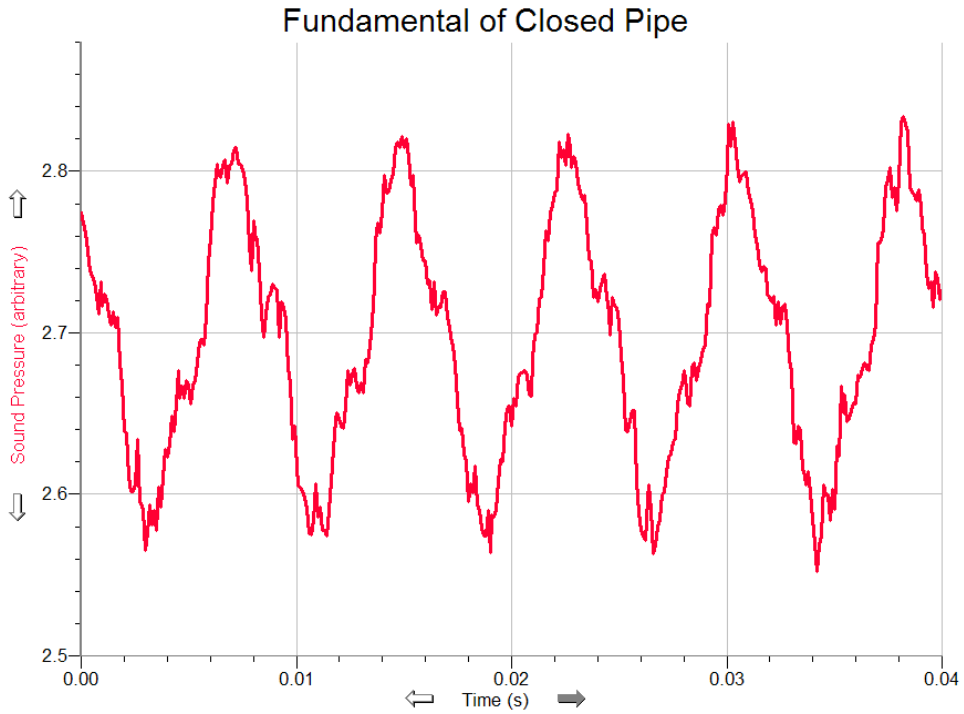


7. Which temperature had the greatest initial rate? Explain.
8. Which temperature had the greatest final rate? Explain.
9. Which temperature made the most moles of SO_2? Explain.
10. How long did it take to make the maximum amount of products at 20 °C?
11. Is the above reaction endothermic or exothermic? Explain.

Error analysis:

12. If water evaporated significantly more at 70°C than at 20°C, how would the graph above change?
13. If more SO2 dissolved at 20°C than at 70°C, how would the graph above change?

Open Tube Harmonics:



Assume this data is for the 1st harmonic.

SHOW ALL WORK!

1. What is the amplitude of the wave shown above?
2. What is the frequency of the wave shown above?
3. If the pipe used above was 0.25m long, what is the wavelength?
4. If the pipe used above was 0.25 m long, give the next three lengths that would produce a "good sound."
5. Explain why a pressure sensor can be used to measure sound.
6. Which images below represents producing a "good sound" from a closed pipe? Explain.

A. 

B. 

C. 

Error analysis:

7. If this data was collected underwater, which question(s) above would have a new answer: 1, 2, or three? Explain.

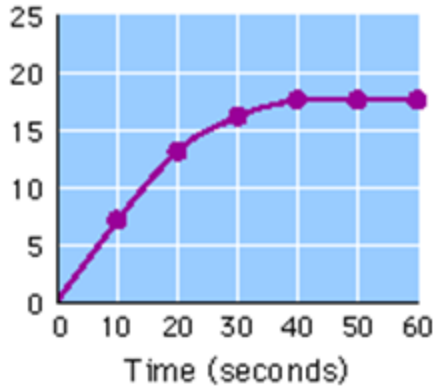
Enzymatic Reactions

The following reaction of hydrogen peroxide decomposition will be investigated using a pressure probe.

$$H_2O_2 \xrightarrow{\text{catalase}} H_2O + O_2$$

1. What is enzyme in the reaction?
2. What is the function of the enzyme?
3. What is the NAME of the substrate in the reaction?
4. What is the definition of denature?

The following data were collected with pressure (Pa) as the y axis.



5. What substance's pressure was measured? Explain how the graph helps to indicate this.
6. What is the initial rate of this reaction? Include units and work.
7. What is the rate of the reaction at 50 seconds?
8. A protist that lives in the stomach of goats is found to have catalase. What pH would you expect to be optimum for this protist? Explain.
9. Why do extremely cold temperatures have slow reaction rates, and extremely high temperature have NO reaction rate?
10. Draw a graph predicting the effect of temperature on the rate of catalase catalyzed H2O2 decomposition ranging from very cold to very hot.

Answer Sheet

Decompostion:

1. _____
2. _____
3.
4.
5.
6.
7.
8.
9.
10.
11.
12.
13.

ANSWERS

Harmonics

1.

2.

3.

4.

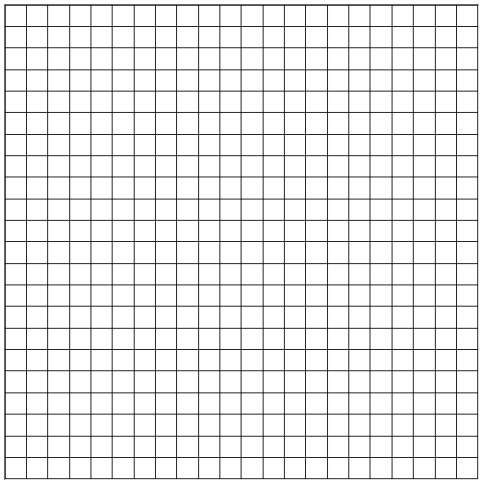
5.

6.

7.

Enzymes.

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.



Answer KEY:

Decomposition Reactions:

1. It is the inverse. [1]
2. Solid sulfur [1]
3. It is dependent upon Na2S2O3 because as its concentration changes, the time changes. [3]
   It is NOT dependent on HCl because as its concentration changes, the time is constant. [3]
4. Zero order. When its concentration changes, the **time** does not change. [3]
5. 2nd order. When the concentration doubled, the **time** was cut to ¼ the time. [3]
6. 0.00200 mol b/c coefficient is doubled [2]
7. 20 °C because it has the greatest slope. [2] Calc not necessary
8. All the same. Flat line for all [2]
9. None. They all had the same pressure so **same number of moles**. [2]
10. 0.7 seconds
11. It is exothermic because as heat is added it favors the reactants. [2]
12. The 70°C final pressure would be higher because water vapor would increase the pressure. [2]
    The graph would start with a pressure above zero. [2]
13. The 20°C graph would have a lower final pressure than 70°C because dissolved SO2 would not contribute to the pressure. [2]

Harmonics

1. $\frac{2.82-2.56}{2} = 0.13\ unit\ not\ needed + 2$

2. $\frac{5\lambda}{0.4sec} = 125Hz + 2$

3. 0.25*4=1.0 m +2

4. ¾ λ so 0.75m +2 Use 3 for ¾*λ
   5/4λ so 1.25 m +2
   7/4λ so 1.75 m +2
5. Sound moves air and the force of moving air can be registered as pressure.
6. A only +3.
   B is a node.+1
   C is not a wave that applies here +1
7. The speed of sound is greater in water, so frequency increases, thus the length of pipe needed to make the graph would change, too. +2 Reason. +2 for 1, and 3 only.

Enzymatic reactions:

1. Catalase [1]
2. To speed up the reaction [1]
3. Hydrogen peroxide. +2. +1 for H2O2
4. To make an enzyme stop functioning [1]
5. Oxygen. +1. The pressure starts at zero indicating a product. [+1]
6. 7Pa/10sec = 0.7 Pa/sec [+3] – work, number, unit

7. Zero. [1]
8. The optimum pH is less than 3 due to acidic stomach conditions. +2
9. Cold temperatures slow particles so fewer particles collide, and fewer particles have enough energy. +3 for both. +1 for 1.
   Hot reactions do not work at all because the protein is denatured. +2