Team Name:_____   Team #_____
Participants Names:_____

Please fill in the answer sheet with your school name, team number and participant names. Write all answers on the answer sheet to receive credit.

Since this is an invitational and we were limited with supplies, space, etc. we did not have you use probes. However, practice the labs and be prepared to use probes at Regionals! Some of these questions involve problem solving; however, many are to help you see your preparation in studying the topic as well.

A group of formulas are provided, however, if you feel you need to use one that is not here that could be the case. This list is not exhaustive and you were allowed a note sheet.

Show all work on your answer sheet. You may also write on the back of the answer sheet as long as you note you have done so.

$$f = \frac{n\sqrt{\frac{T}{\rho}}}{2L} = \frac{n\sqrt{\frac{T}{m/L}}}{2L} \qquad e^{i\theta} = \cos\theta + i\sin\theta. \qquad v = \sqrt{\frac{T}{\rho}}$$

$$\sin\theta = \sin(\theta + 2\pi k),$$

$$f = \frac{v}{2}\sqrt{\left(\frac{\ell}{L_x}\right)^2 + \left(\frac{m}{L_y}\right)^2 + \left(\frac{n}{L_z}\right)^2}$$

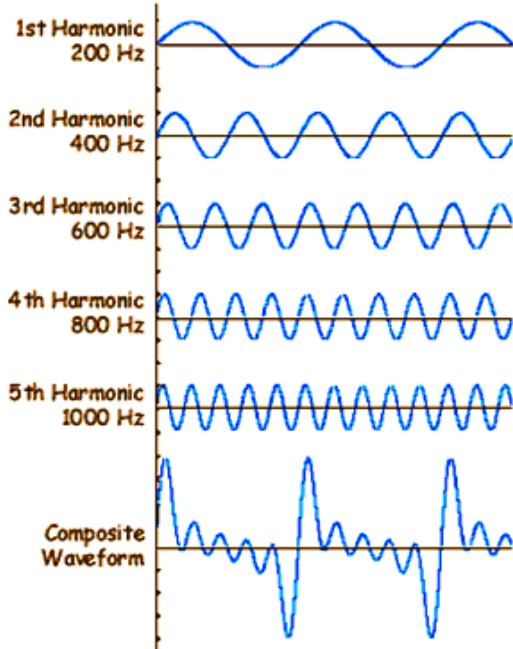$$f = \frac{nv}{2L}\cos\theta = \cos(\theta + 2\pi k),$$

$$f = \frac{nv}{4L}$$

Harmonics

1. The lowest frequency that is resonant is called the

    A. Component frequency
    B. Harmonic Frequency
    C. Resonant Frequency
    D. Fundamental Frequency

2. The harmonics of a string or an open-pipe resonator occur in
    A. Odd multiples of the fundamental.
    B. Integer or whole multiples of the fundamental
    C. Half multiples of the 1ˢᵗ Harmonic
    D. It depends on the length of the tube

3. The harmonics of a closed-pipe resonator occur at
    A. Odd multiples of the fundamental.
    B. Integer or whole multiples of the fundamental
    C. Half multiples of the 1ˢᵗ Harmonic It depends on the length of the tube
    D. It depends on the length of the tube

For the following questions assume that the speed of sound in air is 343 m/s, at 20°C, unless otherwise noted.

4. Which frequency would be the fourth harmonic in a series for a closed pipe resonator if the fundamental is 256 Hz?
    a. 2304 Hz   c. 2048 Hz
    b. 1792 Hz   d. 1024 Hz

5. Which frequency would be the third harmonic in a series for an open-pipe resonator if the fundamental is 440Hz?
    a. 3080 Hz   c. 1320 Hz

    b. 2200 Hz   d. 660 Hz

6. The fundamental tone of an open-pipe resonator with a length of 48 cm is the same as the second harmonic tone of a closed-pipe resonator. What is the length of the closed-pipe resonator?

    a. 32cm
    b. 1.44m
    c. .72m
    d. None of the above

7. A closed-pipe resonator has a length of 1.73 m. Calculate the frequency of its third harmonic if the velocity of sound is 343 m/s.
    A. 560 Hz
    B. 620 Hz
    C. 140 Hz
    D. None of the above

8. A string of length 2.35 m and mass 1.70×10^{-4} kg is stretched so that the tension in the string is 9.76 N. Calculate the frequency of the fundamental note of the string.
    A. 78.2 Hz
    B. 367.4 Hz
    C. 134993 Hz
    D. 156.34 Hz

9. What type of harmonic resonator could be represented by the following graph?

1st Harmonic 200 Hz

2nd Harmonic 400 Hz

3rd Harmonic 600 Hz

4th Harmonic 800 Hz

5th Harmonic 1000 Hz

Composite Waveform

A. Closed tube
B. Open tube
C. External resonator
D. Orbital resonator

10. Two harmonic series from long tubes are given below. Determine if the tubes are acting as an open-pipe resonator or a closed-pipe resonator and explain your reasoning on the answer sheet. (6 pts) (used as a tiebreaker too)
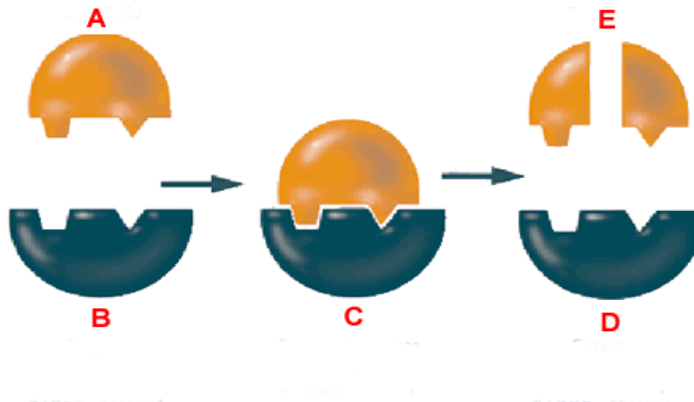
Series A

Frequency
408 Hz
816 Hz
1224 Hz
1632 Hz
2040 Hz

Series B

Frequency
203 Hz
609 Hz
1015 Hz
1421 Hz
1827 Hz
2233 Hz

Enzymatic Reactions

Use this diagram to answer questions 11-12:

11. Which letter(s) represent the enzyme in the diagram above?

12. Is this reaction a catabolic or anabolic reaction? Explain.

13. Name and describe 2 different factors that affect enzyme function and why that occurs

14. What kind of molecule is catalase made up of?
   a. carbohydrate
   b. lipid
   c. cholesterol
   d. protein
   e. vitamin

15. What cell organelle contains catalase?

16. Where does hydrogen peroxide come from in animal cells?
   a. the denaturation of proteins
   b. the phosphorylation of ATP
   c. the reduction of sugars
   d. the oxidation of fatty acids
   e. the detoxification of amino acids

17. In a laboratory setting, what type of probe would one use to measure yeast catalase enzyme activity? (choose all that apply)

   a. hydrogen peroxide probe
   b. carbon dioxide probe
   c. oxygen probe
   d. temperature probe
   e. pH probe

18.   How does the concentration of catalase change the decomposition of H_2O_2?
                                              (choose all that apply)
       a.   as you increase the H_2O_2, the reaction rate increases
       b.   as you increase the catalase, the reaction rate increases
       c.   as you decrease the H_2O_2, the reaction rate increases
       d.   as you decrease the catalase, the reaction rate increases

Here is some sample data from a yeast catalase lab.   **Use for 19-20**

Test tube label	Slope, or Rate (%/s)
5 Drops	0.0045
10 Drops	0.0122
20 Drops	0.0265
0 – 5 °C range: 4°C	0.0097
20 – 25 °C range: 21 °C	0.0137
30 – 35 °C range: 34°C	0.0238
50 – 55 °C range: 51°C	0.0060
pH 4	0.0060
pH 7	0.0148
pH 10	0.0162

19.   At what temperature is the catalase at the highest activity?

20.   Which of the following pH environments does yeast catalase function optimally?
              a.   acidic
              b.   alkaline
              c.   neutral

21.   Which of the following is a competitive inhibitor of catalase?
              a.   cyanide
              b.   dopamine
              c.   water
              d.   copper sulfate
              e.   alcohol

22.   In another catalase experiment, the initial 106.0 mL solution should contain 3.0 g of H_2O_2.
       Calculate the molarity of this solution. (1 mol of H_2O_2 is 34.02 g)

23.

Concentration of Hydrogen Peroxide over Time
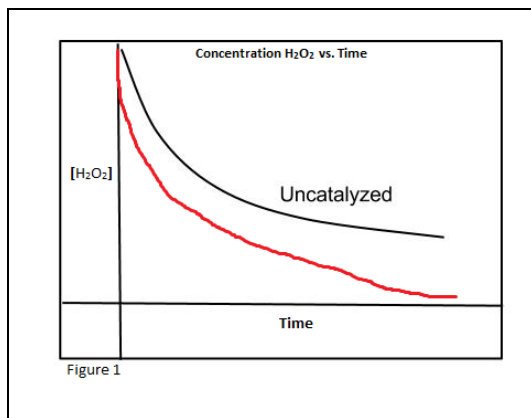
[Hydorgen Peroxide]
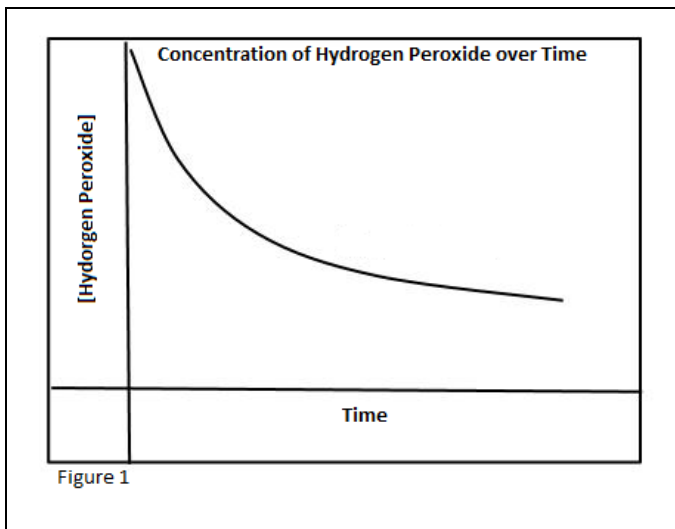
Time

Figure 1

a. The Figure above depicts the decomposition of uncatalyzed hydrogen peroxide over a period of time. Sketch a line on the graph that would depict a catalyzed reaction of hydrogen peroxide de-composition. Label this 'Catalyzed.' (there is a graph on your answer key too, label that one)

Refer to this figure above (#24) for the following questions.

b. What are the products of the decomposition of hydrogen peroxide?

c. Write the balanced equation for the decomposition of hydrogen peroxide.

d. 85.05 g H_2O_2 reacts completely. What mass of O_2 is produced? (O_2 = 32.00 g/mol)

24. In terms of energy, why does the catalyzed reaction occur at a different rate than the uncatalyzed reaction? How does the rate differ?

1. D   1-9 are all 2 pts. each

2. B

3. A

4. B

5. C

6. C

7. D

8. A

9. B

10. Series A is representing an open tube resonator because its fundamental frequency is 408 Hz and the remaining harmonic frequencies of the series occur in multiples of whole numbers. Series B represents a closed pipe resonator because the fundamental frequency is 203 Hz and the remaining frequencies occur in odd number multiples of 3f, 5f, 7f and so on which describes the properties of a closed tube resonation. (6 pts)

11. B, C, and D (1 pt each- 3 total)

12. Catabolic (1), the reaction is breaking apart another molecules into smaller molecules (1) (2 total)

13. pH and temperature. (2 pts) Extreme temperatures and acids/bases denature the proteins (breaks bonds, changes the shape) so that the enzyme shape changes and the active site is no longer able to bind to the substrate.(2 pts) (4 total)

14.   D   (2 pts)

15.   Peroxisome (2)   or more generally, Lysosome (1)

16. C (2)

17. D (2)

18. A and B (2)

19. 34 degrees C (2)   or 1 pt if they said 30-35 range (be specific if given a specific answer)

20. B (2)

21. A (2)

22. $0.83M$ H_2O_2 (3 pts)   (1 pt if they got 3 g = .088mol H_2O_2 but didn't figure for .106 L)

23.

Concentration H$_2$O$_2$ vs. Time

[H$_2$O$_2$]

Uncatalyzed

Time

Figure 1

    a.   (Same start point, concentration decreases quicker, lower end point) (2 pts)

    b   O$_2$ and H$_2$O or Oxygen and water (2 pts)

    c.   2H$_2$O$_2$ → O$_2$ + 2H$_2$O (2 pts)

    d.   40.0 g O$_2$ (85.05g H$_2$O$_2$ X 1 mol H$_2$O$_2$/34.02 g X 1 mol O$_2$/2 mol H$_2$O$_2$ X 32.0 g/mol O$_2$) (3 pts)

24.   Lower the activation energy; it differs by the occurring at a faster rate (2 pts)

Team Name:_____ Team #_____

Participants Names:_____

Write all answers on this sheet. Show all work for your calculations! You may write on the back if you note you have.
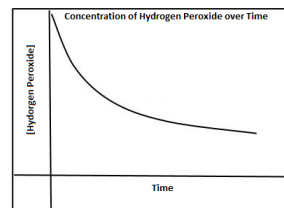
1._____
2._____
3._____
4._____
5._____
6._____
7._____
8._____
9._____
10._____

_____
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11._____

12._____

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13._____

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14._____

15._____

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_____

16._____
17._____
18._____
19._____
20._____
21._____
22._____
23.   a. label graph to the right as needed _____

         b._____

         c._____

         d._____
24._____

Concentration of Hydrogen Peroxide over Time

[Hydrogen Peroxide]

Time

Figure 1