**Development of Virtual lab :Round 1 (R1) - Template (Worksheet)**

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| **Name of Faculty:** Tanuj Gupta  **Institute: Institute of Technology, Nirma University**  **Email ID** (as submitted in the registration form)**: tanuj.gupta@nirmauni.ac.in**  **Discipline to which the Lab belongs: Physics**  **Name of the Lab:**  **Name of experiment: Helmholtz resonator**  (only one Experiment per worksheet. for submitting more than one experiments, please fill up another worksheet)**:**  **Kindly Refer these documents before filling the worksheet**   1. **Guidelines :**     1. **Handout for R1 Overall Summary :** [**http://bit.ly/Vlabs-Dev\_Handout\_Summary\_R1**](http://bit.ly/Vlabs-Dev_Handout_Summary_R1)    2. **Handout R1 for topics 1 & 2 :** [**http://bit.ly/Vlabs-Dev\_Handout\_1\_R1**](http://bit.ly/Vlabs-Dev_Handout_1_R1)    3. **Handout R1 for topics 3 & 4:** [**http://bit.ly/Vlabs-Dev\_Handout2\_R1**](http://bit.ly/Vlabs-Dev_Handout2_R1)    4. **Presentation on Learning Objectives:** [**http://bit.ly/Vlabs-Dev\_LO-ppt**](http://bit.ly/Vlabs-Dev_LO-ppt) 2. **Samples of R1**    1. **Fluid-Mechanics: :** [**http://bit.ly/Fluid-Mech\_R1\_Sample**](http://bit.ly/Fluid-Mech_R1_Sample)    2. **Digital-Electronics-Lab:** [**http://bit.ly/Digital\_elec\_R1\_Sample**](http://bit.ly/Digital_elec_R1_Sample)    3. **Numerical-Methods-Lab:** [**http://bit.ly/Numerical-Method\_R1\_Sample**](http://bit.ly/Numerical-Method_R1_Sample) |

**1.1 FOCUS AREA:** To find the resonance frequency of resonating cavity at different volume of a Helmholtz resonator and to verify the Helmholtz formula.

**1.2 About the Experiment:**

**1.3 Learning Objectives:**

Write Learning Objectives that can be achieved using virtual labs and the respective cognitive level, & action verbs.

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| **S.No.** | **Learning Objective** | **Cognitive Level** | **Action Verb** |
| 1. | Will be able to define the concept of resonance. | Recall | Define |
| 2. | Will be able to explain the structure of Helmholtz resonator as well as the Helmholtz equation. | Understand | Explain |
| 3. | Will be able to infer about the analogy between spring mass oscillation and compression of sound waves in oscillator. | Analyze | Infer |
| 4. | Will be able to apply the correction in the neck length to determine corrected resonating volume of the hollow cavity. | Apply | Apply |
| 5. | Will be able to apply the formula and calculate frequency by making use of the volume noted. | Apply | calculate |
| 6. | Will be able to determine the functioning of DSO and function generator. | evaluate | Determine |
| 7. | Will be able to plot graph of 1/V vs. f and compare the theoretical and experimental curves after neck correction. | analyze | Compare |

**2. Instructional Strategy**

**2.1 Instructional Strategy:**

**Method:** expository

**2.2 Assessment Method:** Formative and summative

**2.3 Description of sections:**

Helmholtz resonator is a vessel with a narrow neck. Neck dimensions like length, area, diameter and volume are determined. The speaker-microphone system is placed above the neck. The speaker is connected to the sine wave output of the function generator and a particular value of the frequency is set. The microphone is connected to the DSO. Speakers are switched on and sound is heard. Water is filled up to the brim of the separating funnel. Now 25 ml water is drained out through the funnel using a graduated beaker which creates 25 ml space in the separating funnel, so the resonator volume becomes 25 ml. the frequency of the function generator is increased from 100Hz hearing sound and watching the DSO. At the resonance frequency the sound will have the maximum amplitude and the DSO shows maximum amplitude. The resonance frequency is noted from the DSO. Theoretical frequency is also calculated using the given equation. Trial is repeated by draining out 25 ml water; making the volume of the resonator cavity to 50 ml and the resonance frequency is determined and recorded in table. The trial is repeated until all the water is drained out and the resonance frequency of empty funnel is determined (theoretical and experimental). A graph is plotted taking 1/V along X-axis and f along Y axis which gives a straight line. It is seen that the theoretical curve passes through the origin 0, whereas the experimental curve does not pass through the origin. The slopes of the two curves are determined and the value of corrected neck length is obtained by putting their values in the formula. For empty resonator a certain value of resonance frequency is obtained which corresponds to a certain volume. This volume experimental as well as actual is noted in the conclusion table along with corrected neck length.

**3. Task & Assessment Questions**

Complete the following table with details of the various tasks and assessment questions you will give to the students.

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| **SrNo.** | **Learning Objective to be met**  (choose anyone from you declared above) | **Tasks to be performed by the students** | **Assessment questions aligned to the task** |
| **1** | Will be able to understand the concept of resonance. | **Will answer the mcqs related to resonance.** | 1)The expression of resonant frequency in a series resonant circuit is? a) 1/(2π√C) b) 1/( 2π√L) c) 2π√LCd)1/(2π√LC) |
| **2** | Will learn about the structure of Helmholtz resonator as well as the Helmholtz equation. | **Remember the equation, the spring constant and answer questions related to it.** | 1)How does frequency of a Helmholtz resonator change? |
| **3** | Will be able to understand the analogy between spring mass oscillation and compression of sound waves in oscillator. | **To obtain the formula of frequency and to understand the concept clearly.** | 1)State the correct equation. a) ω=(k/m)^1/3 b) ω=(k/m)^1/2\* c)ω=(m/k)^1/2 d)ω=(km)^1/2 |
| **4** | Will be able to apply the correction in the neck length to determine corrected resonating volume of the hollow cavity. | **Will need to make the conclusion table with the corrected neck length and volume.** | 1)We plot a graph for which of the following?  a)1/V^½ vs. f  b)f vs. 1/V^1/2  c)1/V vs. f  d) none |
| **5** | Will be able to calculate frequency by making use of the volume noted. | **Will fill up the observation table column of theoretical frequency.** | 1)Identify the correct equation.  a)c/2π(A/VL)^1/2  b)c\*2π(A/VL)^1/2  c)both  d)none |
| **6.** | Will be able to observe the functioning of DSO and function generator. | **Will look for the maximum amplitude in DSO in case if resonance condition is achieved and note the frequency displayed. They will also set the required frequency in function generator.** | 1)Which of the following is not a waveform obtained in DSO? a)square b)traingle c)sine d)octagon |
| **7.** | Will be able to plot graph of 1/V^1/2 v-s f and see the difference between the theoretical and experimental curves after neck correction. | **Plot the graph of 1/V^1/2 v-s f and study the nature of graph to answer some questions.** | 1)Mention the type of slope of the graph of 1V^1/2 vs. f. a.postive\* b.negative c. no slope found d. Depends on the process |

**4. Simulator Interactions**

**Complete the following table giving the details of the Simulator interactions**

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| **What students will do?** | **What simulator will do?** | **Purpose of the task** |
| Press the START button. | Show the experimental setup. | Identify the apparatus used in the experiement. |
| Set the frequency and amplitude of the function generator. | Display the values set. | To standardize the values. |
| Switch on the speakers. | Give sound output. | To know the change in frequency. |
| Fill water up to the brim of separating funnel. | Show water filled fully. | For the calculations in formula. |
| Drain 25 ml of water into the graduated beaker by pressing the stop cock. | Display volume in the table. | For the calculations in formula. |
| Fill up the first column for value of volume obtained and second for (1/V)^1/2 | Display 1/V^1/2 in the table. | For plotting the graph. |
| Note the frequency for which maximum amplitude is shown in DSO in the third column by pressing the NOTE button. | Show the value of resonant frequency in the table. | To identify the sound waves produced due to resonator. |
| Calculate the theoretical frequency by substituting (1/V)^1/2 in the formula. | Show the value of frequency in the table. | For plotting the graph. |
| Repeat the above steps by increasing the volume by 25 ml each time. | Fill up the table for different volumes. | For acquiring different readings. |
| Plot the graph between 1/V^1/2 v-s f (experimental and theoretical). And obtain the slopes in both the cases by clicking the SLOPE button. | Display graphs and slope values. | For the purpose of calculation of corrected length of the neck if resonator. |
| Calculate L’ (corrected length) for each volume. | Store the value of L’ calculated. | For calculation. |
| Recalculate the value of frequency using corrected length L’. | Show the frequency in the table. | For calculation. |
| Note the resonant frequency for empty resonator using NOTE button and calculate corresponding volume. | Show both the values in conclusion table. | For calculation. |