**EMERALD ROYAL INTERNATIONAL SCHOOL, MPAPE ABUJA**

**LESSON PLAN AND NOTE FOR WEEK 2 ENDING FRIDAY: 20th JANUARY, 2023**

**TERM:** 1st

**WEEK:** 2nd

**DATE**: 16th – 20th January 2023

**SUBJECT:** Physics

**CLASS:** SS 2

**TOPIC:** Sound Waves

**SUB - TOPIC:** i. Noise and music

ii. Forced vibration

iii. Stationary waves

**PERIOD:** 5th

**TIME:** 11:10 - 11:50am

**DURATION:** 40 minutes

**AVERAGE AGE:** 16 years

**NUMBER IN CLASS:** 5

**SEX:** Mixed

**SPECIFIC OBJECTIVES:** By the end of the lesson, students should:

1. Define noise and music
2. Explain forced vibration
3. Define resonance

**RATIONALE:** To enables students understand the concept of forced vibrations

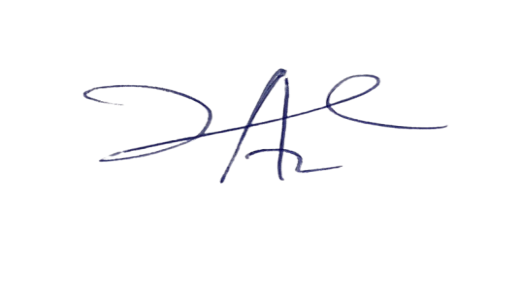
**PREVIOUS KNOWLEDGE:** Students have being taught sound waves

**INSTRUCTIONAL RESOURCES:** Charts showing sources and transmission of sounds

**REFERENCE:** Senior Secondary School Physics by P.N. Okeke et al, New School Physics for Senior Secondary Schools by Anyakoha, M.W, Comprehensive Certificate Physics by Olumuyiwa Awe and Okunola, O.O, Science Teachers Association of Nigeria Physics for Senior Secondary School, Book 1. New Edition and Melrose Physics for Senior Secondary School, Book 1 by Akano, O and Onanuga, O.O.

**LESSON DEVELOPMENT**

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| **STEPS** | **TEACHER’S ACTIVITIES** | **STUDENTS’ACTIVITIES** | **LEARNING POINTS** |
| **INTRODUCTION** | The teacher introduces the lesson by asking the following questions:   1. What is music and noise? 2. Explain forced vibration 3. What is resonance? | The students respond based on their previous knowledge | To arouse the students interest toward the lesion. |
| **STEP 1** | The teacher explains the sources of sound | The students pay attention. | To keep them focus. |
| **STEP 2** | The teacher explains the transmission of sound | The students listen carefully | To encourage critical thinking |
| **STEP 3** | The teacher list and explains the characteristics of sound waves. | The students participate in the class discussion | To encourage students retentiveness |
| **BOARD SUMMARY** | **Sub topic 1: Noise and music**  Noise is an irregular  **Sub topic 2: Forced vibration**  A vibration is said to be free if a body is disturbed in a short period of time and allowed to vibrate with its own natural frequency. Examples are the vibration of a turning fork and a loaded test tube oscillating in water. The vibration is said to be forced if the body is continually disturbed so that it does not vibrate with its own natural frequency. Musical instruments such as flutes, drums, are either open or closed pipes. A closed pipe is closed at one end only while an open pipe is closed at both ends. Experiments show that the frequency of vibration of air in these pipes increases as the length of air column decreases. i.e f  **Vibrations in a closed pipe:** Forced vibration can be demonstrated using a tall tube filled with water. The column or length of air can be varied by letting water out of it. A column of air in the tube will have its own natural frequency of vibration. Suppose we have a turning fork of frequency fo and we set it to vibrate over a column of air in the tube with length ‘l1’. If the length of the air column is gradually increased by running off water, a large sound will be heard. (forced vibration). When this happens it means the air column now vibrates with a frequency that is the same with that of the turning fork. The incident wave will be reflected at the closed end of the tube and the reflected wave will combine with the original wave to produce a standing wave. The close end is a node since the air at that point cannot move. The open end is an antinode. This resonance is the first one.  c = end correction  c  Incident  Wave  **Overtones of a closed pipe**  The wavelength λ is given as or  Since  The fundamental frequency fo is given as  Where v is the speed of the sound in air. f0 is the fundamental frequency of the closed pipe. If we further increase the air column by running off water from the tube, a point will be reached when another loud sound will be heard. In this position, a second node will be formed so that the wavelength at this point is obtained from  .  The frequency at this point is given as:  This frequency is called the third harmonic or first overtone of a closed pipe. A **harmonic** is a note with frequency equal to an integral multiple of that of the fundamental note. The next overtones are 5, 7, 9 and so on. Only odd harmonics are present.  If we consider the end correction ‘c’,  At first resonance,  At second resonance,  The end correction ‘c’ arises from the fact that the antiinode at the top does not exactly coincides with the top of the tube but projects slightly above it by a length ‘c’. if we subtract equation 1 from equation 2, the end correction will be eliminated so that  . Hence,  but  Therefore v = 2f(). With this equation, the velocity of sound can be obtained from the values of and the frequency ‘f’ of thee turning fork.  Note the above set up is a resonance tube experiment which can be used to determine the velocity of sound in air.  **Vibrations in an open pipe**.  In an open pipe, the two ends of the pipe must end in an antinode. The first harmonic or the fundamental note has a mid-point as the node. Hence, . The fundamental frequency is given as:  The second harmonic has frequency  The third harmonic is  The next harmonics are: 4, 5, 6 and so on. Thus, for open pipes all harmonics are possible.  (a) (b) (c)  **Overtones in an open pipe**  Note: The velocity of sound wave in air using resonance tube is given as v = 2f()  Where v= velocity of sound in air, f is frequency of the vibrating air column, is first resonant length. is length of second resonant.  Overtones in strings  Musical instruments such as guitar, violin,… produce sound when string attached to a sound box vibrate. The frequency of the sound produced is depends on the following factors   * Length of string: the frequency is inversely proportional to the length of the string. * Tension in the string: the frequency is directly proportional to the square root of the tension in the string. * Linear density of the string: the frequency is inversely proportional to linear density of the string.   Linear density of the string can be defined as the ratio of the mass of the string to its linear.   * Velocity: the velocity of sound wave in string is given as   Where T is the tension in the string and  μ – linear density of the string.  When the string vibrates in its fundamental mode  L  Distance between successive node:  For the first overtone (2nd harmonic)    L  **For the second overtone ( 3rd harmonics)**    L  **For the nth overtone ;**  **Sub topic 3: Resonance**  This is a phenomenon whereby a vibrating body makes another body to vibrate when its frequency of vibration is the same with the natural frequency of the second body.  **Solved problems**  **Example 1.**  The frequency of a fundamental note from a closed pipe is 200Hz. What is the frequency of the next possible note from the same pipe?  **Solution**  For a closed pipe, the possible harmonics are f0, 3f0, 5f0 e.t.c f0 = 200Hz  The frequency of the next harmonic is 3f0 = 3 x 200Hz = 600Hz.  **Example 2**  A pipe of length 45cm is closed at one end. Calculate the fundamental frequency of the sound wave generated in the pipe if the velocity of sound in air is 360m/s (neglect end correction) Jamb.  **Solution**  For a closed pipe, given  Therefore  **Example 3**  The shortest length of the air column in a resonance tube at resonance is 0.12m and the next resonance length is 0.37m. Calculate the frequency of the vibration. (speed of sound in air is 340m/s).  **Solution**  v = 340m/s, 1 = 0.12m, 2 = 0.37m, f =?  Using the formula  v = 2f(2 – 1)  f = v / 2(2 – 1)  = 340/2(0.37 – 0.12)  = 680Hz.  **Example 4**  A string of length 20cm fixed at both ends and set into vibration. If the velocity of sound in air is 340m/s, calculate (a) the wave length (b) the fundamental frequency (c) the second harmonic frequency.  **Solution**   1. Length of string ‘, velocity of sound = 340m/s, wavelength ‘          1. v = fo λo   340 = fo x 0.4  fo = 340/0.4 = 850Hz   1. The second harmonic is 2fo = 2 x 850 = 1700Hz   **Example 5**  A string has a length of 80cm and a mass of 1.92 x 10 – 3 What is the tension in the string, if its fundamental frequency is 156.25Hz?  **Solution**  fo  Fundamental frequency fo = 156.25Hz , Length of string = 80cm = 0.80m, Tension T = ? Mass per unit length of string ‘m’ = 1.92 x 10 – 3 / 0.80 = 2.4 x 10– 3kg/m,  156.25  Squaring both sides, 156.252 =  24,414.0625 x 0.0024 = 0.390625 x T  T = 24,414.0625 x 0.0024/0.390625 =150N. | The students copy notes into their exercise book | For future reference. |
| **Evaluation** | The teacher evaluates the students with the following questions:   1. List the sources of sound 2. Explain transmission of sound 3. State the characteristics of sound waves | The students attempt the questions. | To ascertain their level of understanding. |
| **Conclusion** | The teacher concludes the lesson by making corrections where necessary and go through their notes. | The students copy the note on the board. | For future reference. |
| **Assignment** | The teacher gives the students assignment as follows:   1. Light require a material medium for its propagation true or false? 2. Mention 5 sources of light 3. What is an echo? Give 2 applications of echo | The students copy assignment solve at home and submit for marking endorsement. | To encourage further studying at home. |



7/3/2023

Principal Head Instructor