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'Music': What it means?

Introduction:

Read following conversation between Rahi and her music teacher.

Teacher: For the annual programme, I need one person from your class to sing national anthem from the stage.

Rahi: All of us like our national anthem. So you can select anyone of us.

Teacher: True. But I will take an audition and select the student who can sing it 'properly'.

Rahi: What you mean by properly? All of us know the exact words of anthem.

Teacher: Yes. But you don't have to just 'recite' it, you should be able to 'sing' it.

Rahi: But all of us also know the tune of the national anthem. So all of us can sing it.

Teacher: Singing is not just knowing the tune. You should sing with exact 'सुर'.

Rahi: I know the seven सुर. They are सा, रे, ग, म, प, ध, नी.

Teacher: Correct. Singing properly means each sound from your vocal chord should hit correct position of the respective सुर.

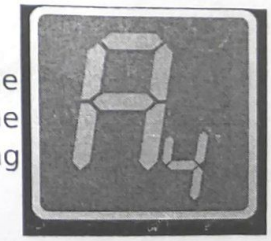
Rahi: Correct position? What is that? Are they standing somewhere?

What do you think the teacher is trying to say? Do you understand what she means by 'correct position'?
Let us take the example of a harmonium.

For the following tasks, we will need a smartphone. There are many smartphone apps which show you frequency of sound played in the vicinity of the phone. We will use one of those apps.

Session-1

Task 0 : Familiarization with the 'Tuner - DaTuner' app

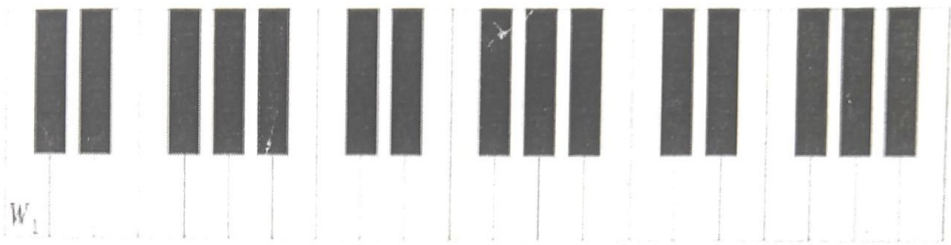


Da Tuner App

1) We will be using 'DaTuner Lite' app throughout this LU to measure the frequency of different musical notes. When you open the app, the frequency is shown on the bottom left side of the screen. The scale along the left edge shows volume level. Note units of both the quantities.
2) Just to test the app, we will need some volunteers. Take the phone from the teacher. One of you can try saying the vowel 'आ' in an extended way and see what frequency gets displayed. Tell the frequency to the entire class and the pass the phone to next group.

Task 1:
Understanding the relation between different notes on a harmonium

For convenience, let us agree to a convention. On the harmonium, you will see a pair of black keys and then a set of three black keys. The white key just before the black pair (first key in the figure) will be called White 1 (W1). As you proceed rightwards from this key, next key will be called Black 1 (B1), the next one is W2 and so on. Note that B3 comes after W4.



Now, note the frequency of the keys in the table below.

Key	Freq		Key	Freq		Key	Freq	
W1	104	Hz	W8	208	Hz	W15	415	Hz
B1	110	Hz	B6	220	Hz	B11	440	Hz
W2	116	Hz	W9	233	Hz	W16	466	Hz
B2	123	Hz	B7	247	Hz	B12	493	Hz
W3	130	Hz	W10	262	Hz	W17	524	Hz
W4	138	Hz	W11	277	Hz	W18	554	Hz
B3	146	Hz	B8	294	Hz	B13	587	Hz
W5	155	Hz	W12	311	Hz	W19	622	Hz
B4	164	Hz	B9	329	Hz	B14	660	Hz
W6	174	Hz	W13	349	Hz	W20	699	Hz
B5	184	Hz	B10	370	Hz	B15	740	Hz
W7	196	Hz	W14	392	Hz	W21	784	Hz
						W22	830	Hz

What patterns do you observe in these frequencies? Note down your observations below.

① Frequency is increasing ② Along a row Frequency is doubling.
③ Frequency is increasing by a constant 1.059.

Session-2

Task 2 : Understanding the seven सुर for any given scale

In the beginning, Rahi spoke about seven सुर in Indian music. Let us find the relation between सुर and harmonium keys (in a particular scale). Refer to the table above (in Task 1) and note down frequencies of the keys given in table below (in the second row). In the third row of the table, write the ratio of frequency of each key to the frequency of the key W1.

		1	1.15	1.25	1.32	1.49	1.67	1.88	2
Sur		सा	रे	ग	म	प	ध	नी	सा
Key		W1	W2	W3	W4	W5	W6	W7	W8
Freq.		104Hz	116Hz	130Hz	138Hz	155Hz	174Hz	196Hz	208Hz
Ratio		---- 1	9/8	5/4	4/3	3/2	5/3	15/8	2

Harmonium or piano uses pre-defined frequencies which are set to a fixed frequency ratio. This is called 'equi-tempered scale'. However, one may note that there are other ways of defining scale, which give almost same frequencies. Looking at the decimal ratios in Task 2, one may notice that these ratios can also be expressed as fractions where both numerator and denominator are both integers less than 20.
Write the ratios in that form. The sequence of ratio you get is known as 'Ptolemaic Sequence'.

Task 3 :

Finding the frequency of seven सुर in any scale

Different scales in music just mean starting your first सुर at another key. Now suppose your first सुर (i.e. सा) is starting with B1 instead of W1. Use the ratios you found above and in the table on the previous page to decide which keys will correspond to other सुर. Here B1 is taken just as an example and you can choose any other key instead of B1,

Sur	सा	रे	ग	म	प	ध	नी	सा
Ratio	3/2	5/3	15/8	2	9/8	5/4	3/2	5/3
Fre.	155Hz	174Hz	196Hz	208Hz	233Hz	262Hz	272Hz	311Hz
Key	W5	W6	W7	W8	W9	W10	W11	W12

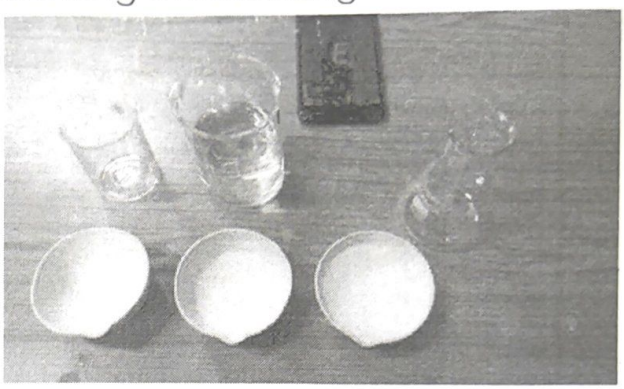
Play this sequence on harmonium to see if you get similar sequence of sounds as playing W1-W7.

Session 3

Task 4: Understanding the working of Jaltarang

Take ceramic bowls / metallic bowls / beakers of different kinds and a measuring cylinder.

Place the 3 bowls / beakers side by side and tap them with a pencil and note down the frequency in each case. Which bowl has the highest frequency?



Description (size and material) of the beaker	Frequency observed
50 ml (Empty)	1772 Hz
250 ml (Empty)	3771 Hz
500ml (Empty)	3260 Hz

Take the largest beaker, keep adding a fixed amount to water to it (say 25 ml each time) and note the frequency.

Volume of water added	Frequency observed
50 ml (full)	1100 Hz
500ml (full)	526 Hz
250 ml (full)	2471 Hz

Is it possible to change the frequency of this bowl/beaker to match that of the smallest bowl/beaker and at what water level will that occur?

Ans ⇒ Yes, it is possible at 75 ml in any bowl / beaker.

What all parameters are important in deciding vibrating frequency of the beaker?

Ans ⇒ Density, size, mass, amount of water added, material, volume etc.