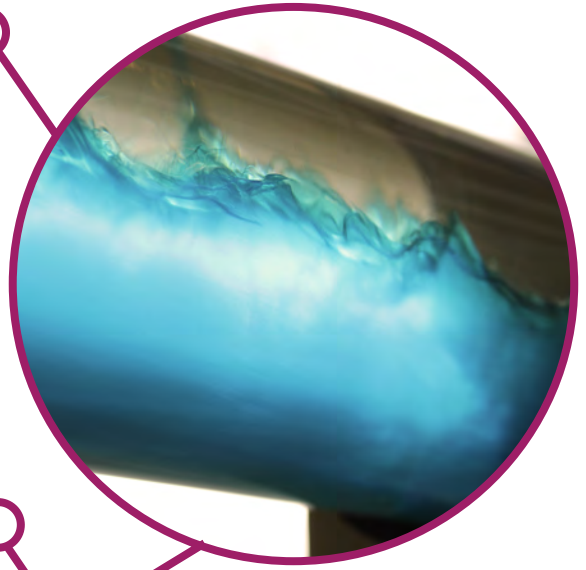
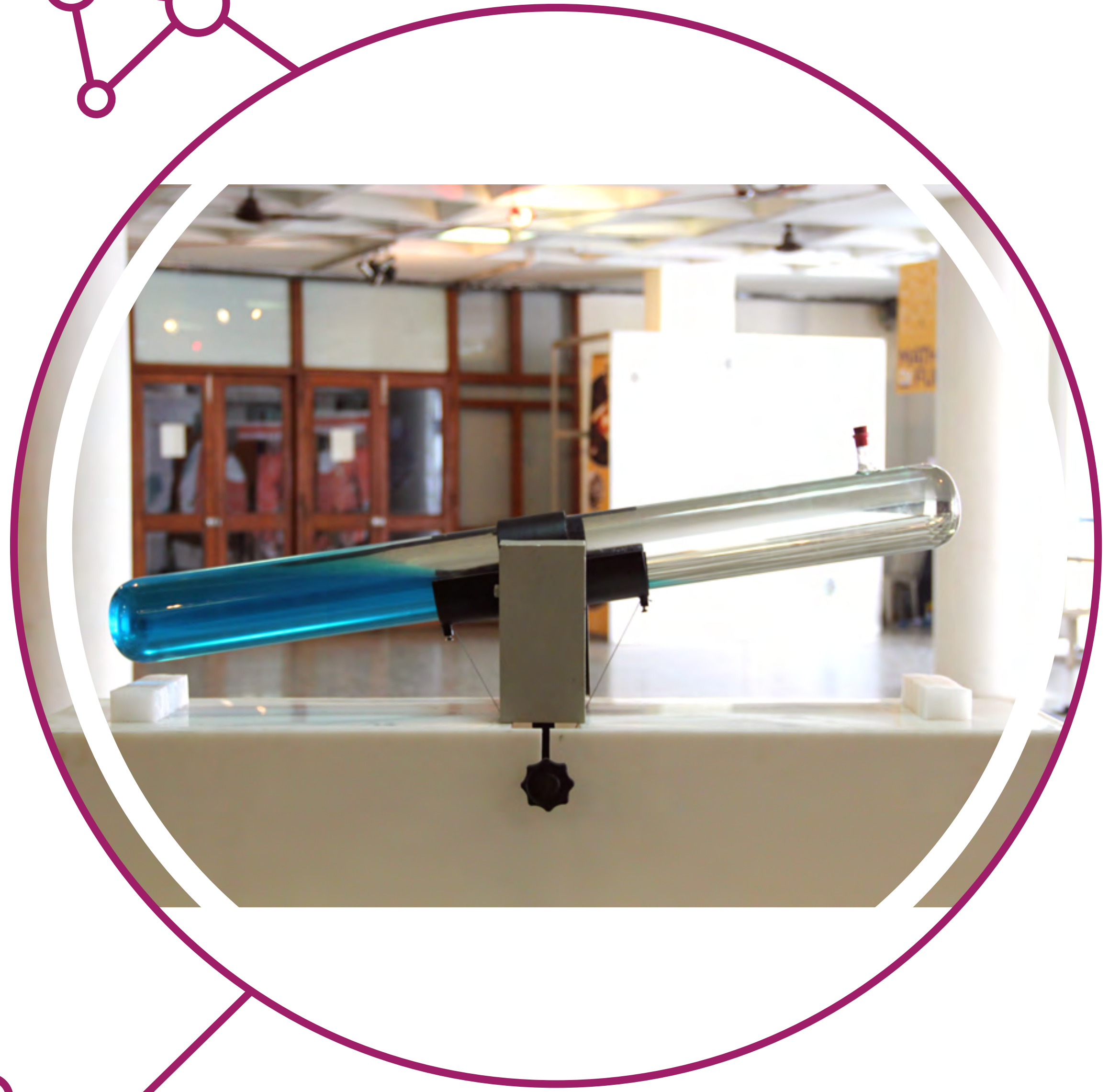
5.3

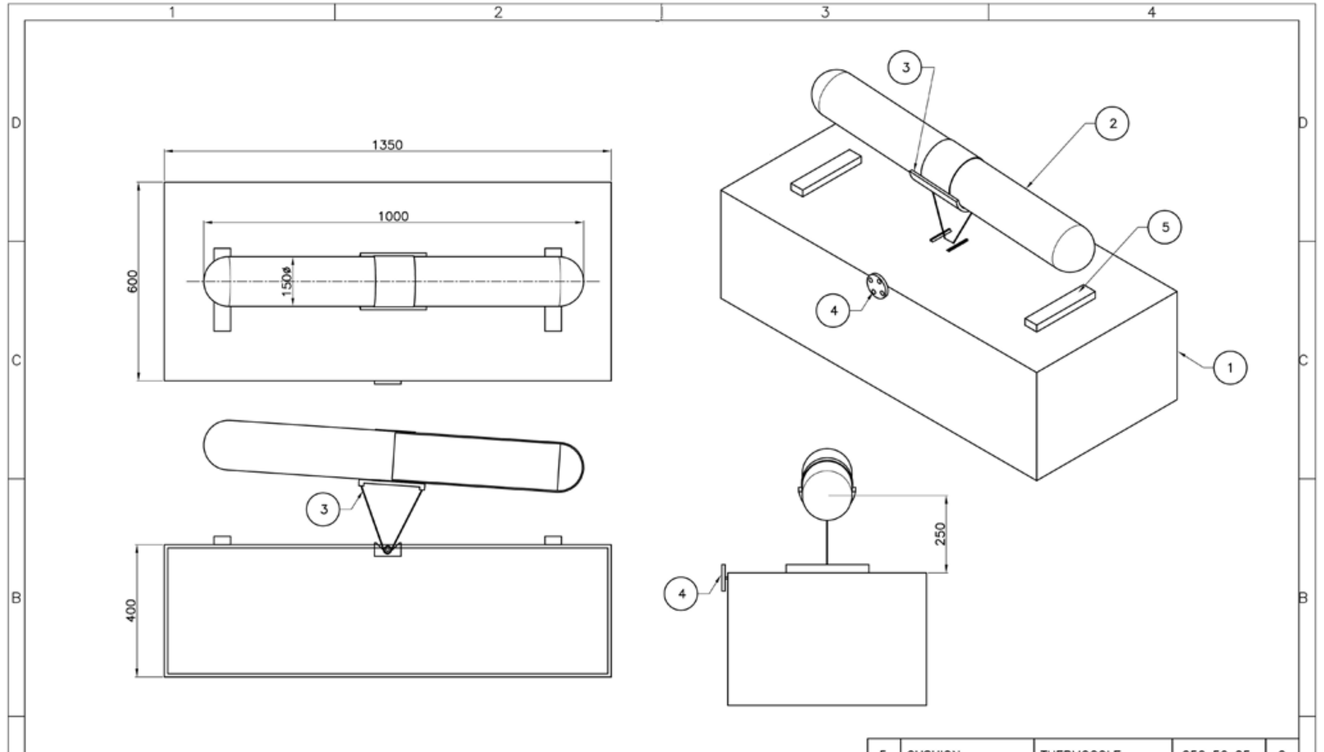
Wave Tube

The waves that we see on the interface of the two fluids in this exhibit clearly remind us of waves that you can see on a river, on the surface of a lake or the sea, even in the clouds in the sky – or if you stretch your imagination a little, a tsunami (though tsunami is quite a different type of wave than those seen here). There are many different descriptions of these various types of waves, but all of them can be mathematically described by a combination of the basic type of wave described in the wave equation above.





Turn the knob to tilt the glass tube to one side and observe the formation of waves in the blue liquid. The upper half of the tube is filled with a lighter, colourless liquid - kerosene, while the lower half contains a viscous liquid - tinted glycerol. The waves formed in the interface of the two immiscible liquids demonstrate the characteristics of both the transverse and the longitudinal waves at the same time. Do you see any similarity between these waves and the waves on the surface of the ocean?



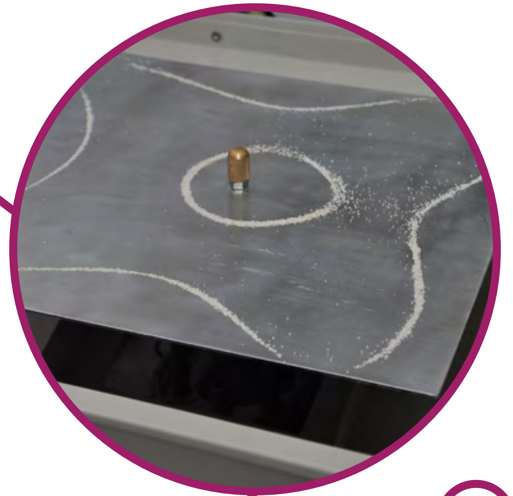
Sl.No.	DESCRIPTION	MATERIAL	SPECIFATON	SIZE	QTY
5	CUSHION	THERMOCOLE		250x50x25	2
4	KNOB WITH ROD	PLASTIC		100øX15	1
3	FULCRUM SUPPORT	AL.ALLOY			1
2	WAVE TUBE	GLASS		150øx1500Lx4thk	1
1	BASE SUPPORT	WOOD		1350X600X400	1

5.4

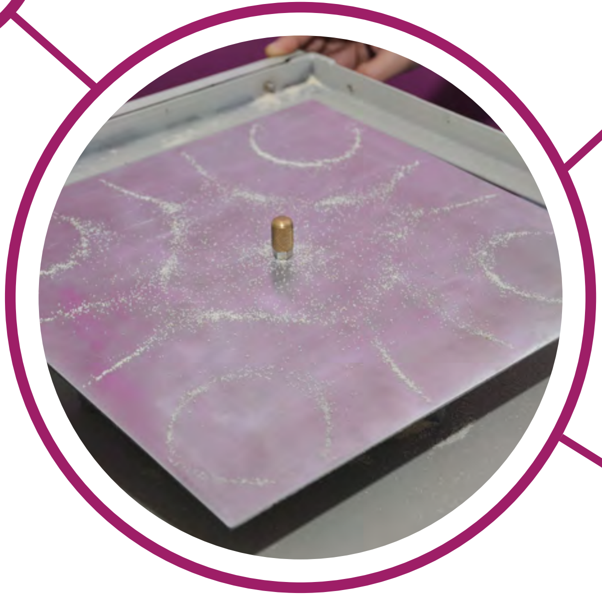
Chladni's Plate and the Standing Waves on the Spring

Vibrations of any structure - a building, a bridge, a violin string - show characteristic patterns and characteristic frequencies. These patterns depend on the shape and size of the structure, on the material used, on its mass. When winds or earthquakes shake these structures at these characteristic frequencies, they "resonate" and this resonance can lead to large oscillations.

Knowledge of these vibrations, which can be calculated using mathematical equations describing them, helps engineers build structures which can withstand earthquakes, or strong winds and waves.

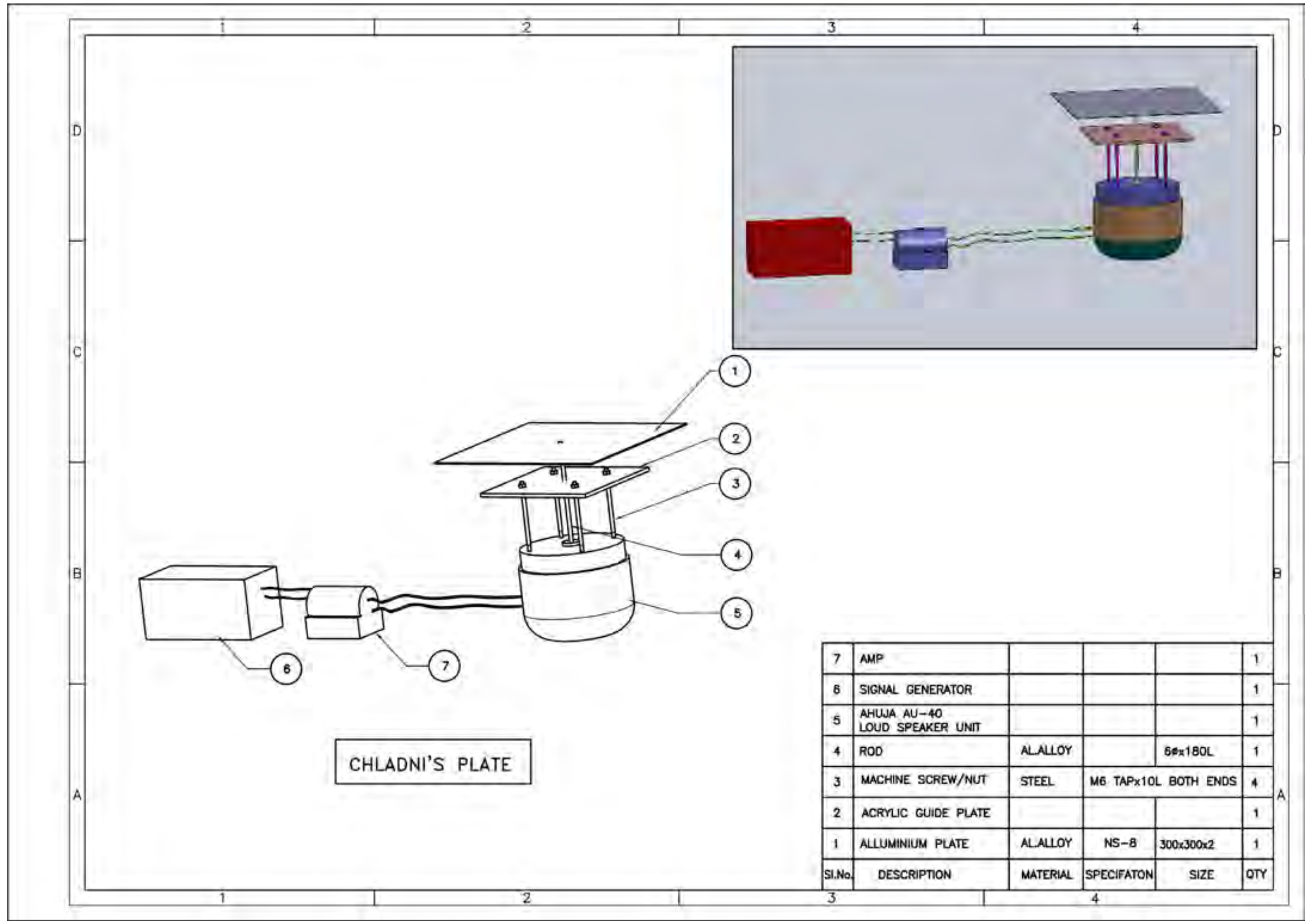


5.4



This exhibit shows the vibrating patterns of a square aluminum plate. Add a little sand (sooji!) and adjust the frequency and see how the patterns are formed.

There is a natural relationship between these vibrations and waves. As we saw earlier, vibrations of one part of the plate cause adjacent parts to start vibrating, and this leads to waves moving on the surface of the plate. What we are seeing here is the result of many different waves coming together to cause what are known as standing waves.



Sl.No.	DESCRIPTION	MATERIAL	SPECIFATON	SIZE	QTY
7	AMP				1
6	SIGNAL GENERATOR				1
5	AHUJA AU-40 LOUD SPEAKER UNIT				1
4	ROD	AL.ALLOY		6ø x 180L	1
3	MACHINE SCREW/NUT	STEEL	M6 TAPx10L BOTH ENDS		4
2	ACRYLIC GUIDE PLATE				1
1	ALLUMINIUM PLATE	AL.ALLOY	NS-8	300x300x2	1

The standing waves on the plate have interesting, complicated shapes. The simplest form of standing waves is seen on the spring. The equation for them is very similar to the basic equation for the wave we saw earlier. In particular, for the spring, if x is the distance of a point along the length of the spring, and y is the distance by which that point is displaced from its original position of being in a straight line, the equation for y as a function of x and time t is given by

(6) $$y(x,t) = A\sin(2\pi ft)\sin\left(\frac{2\pi nx}{L}\right),$$

where n is the number of points on the spring that are not moving at all (called the *nodes*), and the frequency is related to n by the following relation: $f = nc/L$, with c being the speed of the wave on the spring.

The strings on a sitar, a guitar, or any string instrument, or the air pressure in a flute, a shehnai, or most wind instruments vibrate according to exactly this same equation above! As you may imagine, the equation for the Chladni's plate or for the membrane of a tabla or mridangam is a bit more complicated, but the basic idea remains the same.

One way to look at the standing waves is as follows: the far end of the spring is fixed while the front end is sliding free. Waves generated from the free end reflect from the fixed end. Hold the handle and create a transverse wave pulse with one quick snap of the wrist. The pulse will travel the other end of the spring and reflect back.

Does the reflection pulse return on the same side as the original pulse or on the opposite side?

Now slide the handle in quick succession to create waves that reflect from the other end. Standing waves can be created when the reflected waves interfere with the incident waves at specific frequencies.

Find the right rhythm such that the incident waves and the reflected waves interfere to produce standing waves. How many standing waves can you create? By measuring the length of the spring, the frequency with which you oscillate it, and counting the number of nodes, can you find the speed of this wave?