611-2340 (35-155) Bell in Vacuum

Additional Materials Required

- Vacuum Pump (preferably electric)
- Hose, for connecting vacuum pump to Bell in Vacuum
- AA batteries (2)
- Small Phillips head screwdriver

Warranty, Replacement Parts:

We replace all defective or missing parts free of charge. Additional replacement parts may be ordered toll-free. We accept MasterCard, Visa, checks and School P.O.s. All products warranted to be free from defect for 90 days. Does not apply to accident, misuse or normal wear and tear. Intended for children 13 years of age and up. This item is not a toy. It may contain small parts that can be choking hazards. Adult supervision is required.

Introduction:

The purpose of this device is to demonstrate the propagation of sound waves with and without a medium (air). Nature, of course, abhors a vacuum - and sound waves won't travel through one. We can prove it with a ringing bell inside a sealed glass jar. As air is gradually pumped out of the jar, the bell becomes faint, then dies.

Sound travels through air as longitudinal waves. In longitudinal waves the displacement of the medium is parallel to the propagation of the wave. A wave in a coiled spring is a good visualization. A physical disturbance (our bell) will cause the medium (air) to compress and decompress, forming a wave. The sound wave will propagate through the medium until it is picked up by a receiver (our ears).

As the air is pumped from our bell jar, the medium is removed, and the sound wave has nothing to travel through. This allows the bell to ring in our jar without making a sound.

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Care and Storage:

The batteries should be removed during long term storage. A small film of vacuum grease may be left on the rubber seal to prevent dry rot over the long term.

How to use:

Set up:

1. Place two (2) AA batteries in the rear of the bell assembly and flip the switch on the front to test the bell.
2. Attach the bell to the vacuum plate as in the picture. Use a screwdriver to hand tighten the included screws. Do not overtighten, the bell is mounted to rubber brackets to reduce vibration.
3. Connect a vacuum pump to the vacuum plate using a rubber hose. Position the valve to the open position as in ***figure 1***.

Demonstration:

1. Turn on the bell and let everyone hear that the bell is ringing loud.
2. Place the bell jar onto the vacuum plate. The bell jar should be able to obtain a tight seal with only vacuum pressure. If the bell jar does not obtain a tight seal due to age or warping, a small amount of vacuum grease may be applied.
3. Turn on the vacuum pump and allow the air to be evacuated from the bell jar. Different pumps will evacuate the air at different rates. It will usually take two to five minutes to completely evacuate the air from the bell jar. The negative pressure necessary will vary by your altitude, but in general, a negative pressure of 1 atmosphere (30 inches of mercury) is desired.
4. Once the desired negative pressure is reached, turn off the vacuum pump and close the valve at the base of the vacuum plate. At this point the bell should be inaudible. If the vacuum pump being used is not powerful enough, the bell may still be heard, but the reduced volume should be enough to demonstrate the principle.

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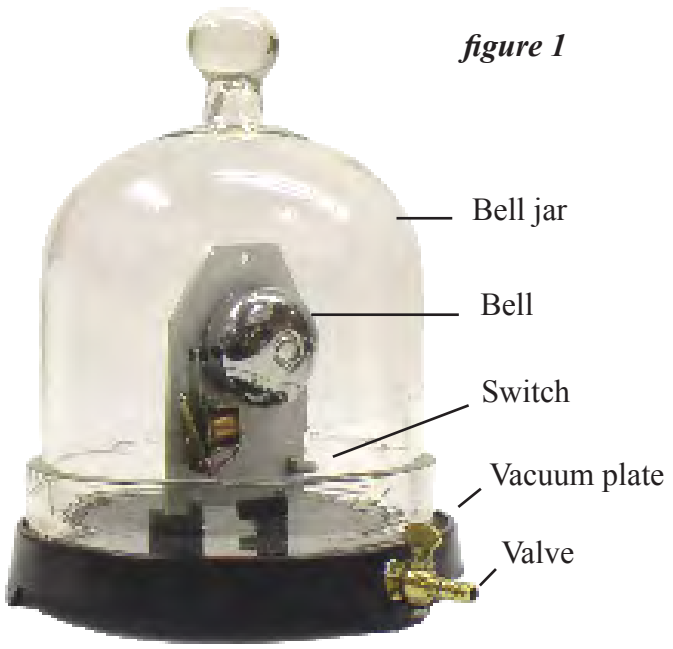
5. There may be a small vibration heard from the bell. This is a result of the striker physically hitting the bell. If audible, this can be reduced by performing the demonstration on a vibration isolated surface. This can be as simple as placing the vacuum plate on a towel.
6. Finally, slowly turn the valve at the base of the vacuum plate to let air into the bell jar. If this is done slowly enough, the sound of the bell will become louder and louder until all of the air pressure has been returned.

figure 1



Discussion:

As the air was being pumped out of the bell jar, the sound of the bell became quieter and quieter. Eventually the sound became completely inaudible.

Sound is described as pressure waves created by a physical force acting upon a medium. In our case, the striker hitting the bell created pressure waves in the air surrounding it. The sound waves propagated though the air and were received by our ear drums. As the air was removed from around the bell, there was less and less of a medium to transfer the pressure waves. As the air pressure was reduced, there were fewer molecules of air gasses in the bell jar, and the sound became quieter. Eventually, when the air was removed, there was no medium for the pressure waves to propagate through. Sound can propagate through liquids and solids as well as air.

Other Experiments:

With the bell removed from the vacuum plate, the bell jar may be used for various other demonstrations.

Marshmallows and Shaving Cream: Place a marshmallow into the bell jar and evacuate the air. The Marshmallow contains a large amount of air trapped inside of it and will grow to an enormous size as the pressure inside the jar is reduced. The same effect will happen with a beaker of shaving cream. Don't use too much, it grows very large!

Balloons: Place a balloon with only a little air in it in the bell jar and evacuate the air. The balloon will expand as the air pressure around it is reduced. Try the same experiment with a water balloon and watch the difference.

Boil Water: Place a beaker of room temperature water in the bell jar. Evacuate the air, the water will begin to boil with no heat added. Follow with a discussion of pressure on fluids.

Try other pressure kits from Science First™:

611-2370 Vacuum Lifter. Study the effect of air pressure and lift up to 30lbs!
611-2325 Magdeburg Hemispheres. Duplicate the experiment of 1652 in Germany, try to pull the spheres apart.
611-2360 Vacuum Pump. Designed to provide vacuum (negative pressure) for laboratory experiments.

35-155 Bell in Vacuum Teaching Curriculum:
Content Standards:
Grades 5-8: *Motions & Forces, Transfers of Energy*
Grades 9-12: *Motions & Forces, Interactions of Energy and Matter*

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