Bell Jar & Ringer Lesson Plan

Amount of time Demo takes: 5 mins.
Don’t try this at home!

Materials
- Bell jar assembly: bell jar, base plate, electric bell, 2 AA batteries, and gasket
- Vacuum pump, vacuum pump oil, and vacuum tube
- Small funnel for pouring vacuum pump oil into vacuum pump
- Requires half a table
- Requires electricity

Set-up Instructions
1. Check to make sure the vacuum pump oil is filled to the “oil fill” line.
   a. If the pump oil is not full, follow the attached instructions for filling.
   b. If the pump oil is full, proceed with bell jar set up.
2. Check to make sure that the bell jar and base are not damaged (no cracks, etc.).
3. Attach the electric bell to the base (there are two nuts and bolts on the base and corresponding holes on the bottom of the bell assembly).
4. Test the bell to make sure the batteries are work. If necessary, replace batteries.
5. Attach the tube between the vacuum pump and the bell jar base.

SAFETY!
- Be cautious of vacuum oil spills. Clean them up immediately!

Lesson’s Big Idea
- Sound is a physical vibration that requires a medium, like air, to travel. In a vacuum, sound cannot propagate.
- Sounds travels through air. Without air, sound isn’t possible.

Background Information
- Vocabulary and definitions:
  - Medium: A substance, such as air, through which a force acts or an effect is produced. Mediums can be solid, liquid, or gas.
- Frequency: Rate of occurrence such as waves per unit time.
- Propagate: To travel through space or a physical medium.
- Amplitude: The height of a wave.

- Sound is produced when vibrations travel through a medium. When a medium is more dense, the vibrations will propagate faster. Frequency determines the pitch of a sound; high frequency waves producing high pitched sounds. The amplitude determines the loudness; larger amplitudes cause louder sounds.
  - Sound is a physical vibration, so without a medium to travel through, sound isn’t possible and the sound will not propagate. In a vacuum, there is no air or any other medium for sound waves to propagate through so sound is not possible.

**Instructional Procedure**

1. Turn on the bell ringer with the white switch on the bell assembly.
2. Place the bell jar over the base, making sure it is aligned with the gasket so that the vacuum will seal. The sound should still be audible.
3. Make sure that the valve on the base is open.
4. Turn on the vacuum pump; keep it on for approximately 20-30 seconds.
5. Simultaneously turn off the vacuum pump and close the valve.
6. At this point, the bell should be silent or at least very faint (as this is not a perfect vacuum).
7. Remove the hose from the pump hose and then re-open the valve on the base to let air back into the chamber. The bell should become audible again.
8. Lift the bell jar and turn off the bell!

**Additional Experiments**

- Investigate gas laws! A small balloon or marshmallow can be placed in the bell jar and vacuum to demonstrate Boyle’s Law, which is the relationship between pressure and volume. With the increased pressure inside the vacuum, the size of the volume or marshmallow will decrease!

**Assessment/sample questions you can ask**

1. Where might this really happen?
2. In movies that take place in space, we often hear explosions or hear zooming spacecrafts. This is not actually true because space is like the vacuum we created here-- there is no air. But when the astronauts are
inside the spacecraft would they be able to hear each other? Why or why not?

3. Have you ever tried to talk underwater? Water has a higher density than air so how did that denser medium effect the sounds you made?

Clean Up

- Make sure there is no pump oil on any of the equipment. If there is, wipe it and dry it before putting it away.
- The bell jar and base, bell assembly, and vacuum pump should all be put back into their original styrofoam packing.

References

- Arbor Scientific Bell Jar & Ringer Instructional Sheet

Next Generation Science Standards

- K-5
  - 1-PS4-1
  - 3-PS2-1
  - 4-PS3-4
- 6-8
  - MS-PS2-5
Instructions from Vacuum Pump:

Set Up Instructions:
1. Read vacuum pump instructions.
2. Remove vacuum pump and vacuum pump oil from box.
3. Inspect vacuum pump and electrical cord for damage.
4. If damage is found, it should be immediately reported to the freight carrier.
5. VACUUM PUMP IS SHIPPED WITHOUT OIL - DO NOT OPERATE UNTIL OIL IS ADDED.
6. WARRANTY IS VOID IF VACUUM PUMP IS OPERATED WITHOUT OIL.
7. Place vacuum pump on a level surface. Remove oil fill plug from top of pump housing and add vacuum pump oil until oil level is even with oil level fill marks on front of vacuum pump housing on each side of the oil sight glass.
8. Use only EJC vacuum pump oil or equivalent. If the wrong type of oil is used, the vacuum pump will not operate properly. (see photo)
9. Reinstall oil fill plug. (see photo)
**Instruction for changing Vacuum Pump Oil:**

1. Operate vacuum pump until vacuum pump oil becomes warm.
2. Turn vacuum pump switch off and disconnect electrical cord plug from electrical outlet.
3. Place vacuum pump on a level surface. Unscrew and remove oil plug from bottom of pump housing and let oil drain from pump until all oil has drained. (see photo)
4. Reinstall drain plug back into pump housing. (see photo)
5. Remove oil fill plug in top of pump housing. (see photo)
6. Add oil as noted on specification chart or an amount of FJC vacuum pump oil, part #2200, to raise the oil level to the full oil level marks on the front of the vacuum pump housing on each side of the oil sight glass.
7. Reinstall oil fill plug. (see photo)
8. Operate vacuum pump for a short period of time.
9. Check oil level through oil sight glass. (see photo)

**Troubleshooting:**

Pump will not run.

1. Check electrical outlet for low voltage or no voltage.
2. Check to ensure switch is turned on.

Pump does not pull low vacuum.

1. Check oil level.
2. Check for contaminated oil.
3. Check manifold and system servicing for leaks.
4. Check for low voltage at electrical outlet.
5. Check type of oil. If incorrect type of oil is used vacuum pump will not operate properly.

**Warranty:**

This vacuum pump is warranted to perform as stated in FJC literature for a period of 1 year from date of purchase. As we cannot control the use of this vacuum pump, the warranty shall not exceed the purchase price. We make no other warranty of any kind expressed or implied. This vacuum pump is warranted to be free from defects in material and workmanship for a period of one year from date of purchase. A copy of the original invoice must be returned with the pump or warranty is void. FJC’s sole obligation under this warranty shall be to repair or replace any defective part or parts thereof, which are returned to our factory. The warranty shall not apply to any vacuum pump, which has been subject to misuse, negligence or accident. This includes the failure to provide the proper maintenance. FJC, Inc shall not be responsible for any special or consequential damages and the warranty as set forth is in lieu of all other warranties either expressed or implied.

**Operating Instructions**

1. Check oil level. Oil level in sight glass should be even with “oil level full” marks on each side of sight glass on front of vacuum pump. If oil level is low, add oil until oil level reaches full oil level marks. (see photo)
2. Make sure vacuum pump electrical switch is turned off. (see photo)
3. Plug electrical plug into a grounded 115 volt electrical outlet.
4. Connect yellow hose from manifold gauge set to inlet of vacuum pump. Make sure pressure in system is less than 5 psi. If pressure is over 5 psi vacuum pump may be damaged.
5. Turn switch to on. (see photo)
6. Vapor from exhaust port is normal during operation. This is the result of moisture in A/C system and humidity in shop.
7. Allow pump to operate until desired vacuum is reached.
8. Close manifold gauge set valves.
9. Turn switch to off position. (see photo)
10. Disconnect yellow hose from vacuum pump.
11. Remove electrical plug from outlet. Grasp plug and pull from outlet. Pulling wire to disconnect plug from outlet will damage electrical plug.

**Maintenance**

- Check oil level through oil sight glass before each use. The main cause of vacuum pump failure is low oil levels and contaminated oil. (see photo)
- Always disconnect vacuum pump from electrical source before performing any maintenance.
- Replace vacuum pump oil every week during heavy usage periods or after every service of a system with excess moisture.
- Keep vacuum pump in a clean dry place.
- Use FJC vacuum pump oil Part #2200 or equivalent.
- Check electrical cord and plug for wear or damage each week. If damage or excessive wear is found, have cord replaced by a licensed electrical technician.