Drinking Bird

Introduction

Watch a glass bird that "drinks" from a cup for hours to demonstrate important chemical properties.

Concepts

- Evaporative cooling
- Gas pressure

Materials

Drinking bird

Cup of water (a coffee mug works well)

Safety Precautions

When setting up and beginning this demonstration, watch the drinking bird very closely. If it falls, it will break. The liquid inside the drinking bird is flammable and is poisonous by ingestion.

Procedure

1. Assemble the drinking bird by placing the metal prongs into the tops of the legs. Be sure that the beak is facing the same way as the feet.
2. The metal pivot should be approximately halfway between the bottom bulb and the red-colored neck of the drinking bird. The metal pivot should also be bent slightly so that the bird tends to lean forward. This will keep the drinking bird from doing backflips (and breaking!).
3. Submerge the entire head of the drinking bird into a full cup of tap water.
4. Set the bird next to the cup, facing it so the beak can "drink" from the cup. Observe.
5. The liquid inside the drinking bird will rise up the tube until the bird is top-heavy. The bird will then tip over as if it is drinking the water. In the horizontal position, air bubbles enter the tube and the liquid drains into the bottom bulb. Now the bottom-heavy bird rights itself, only to begin the process again.

Discussion

The bird's drinking action is based on evaporative cooling and its effect on gas pressure. The process takes place in a number of steps.

1. The bird's head is dipped into the water.
2. As water evaporates it causes a cooling effect on the upper bulb.
3. The vapor pressure in the upper bulb is lowered due to the decrease in temperature.
4. The higher vapor pressure in the lower bulb and the position of the tube in the lower bulb causes the liquid inside the bird to be forced up the tube.
5. The drinking bird becomes top-heavy causing it to tip over.
6. When the bird is in the horizontal position, gas bubbles enter into the tube—this equilibrates the pressures and allows the liquid to drain back into the lower tube. (Figure B.)
7. The bird rights itself and the process begins again.

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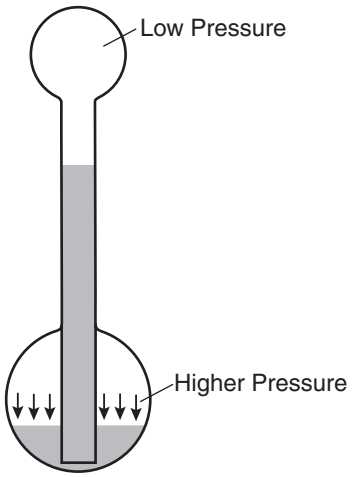

Figure 1A. Pressure differences forces liquid up the tube.

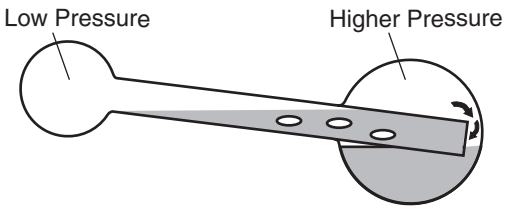

Figure 1B. Tipped over position allows gas into tube.

Evaporation is an endothermic process—*water* evaporation can be represented by the following chemical equation:

$$H_2O(l) + \text{Energy} \rightarrow H_2O(g)$$

Adding energy in the form of heat to water will cause it to evaporate more quickly (as in heating up a tea kettle). In the absence of an outside source of heat, the water will take energy from the surrounding water molecules. The evaporating water molecules then leave behind water that has less energy (i.e., it is cooler). This cooling effect is very small for a large container of water with very little surface area for evaporation. However, the cooling effect is very high when the amount of water is small and the surface area for evaporation is high; such as in this demonstration or when sweat evaporates from your skin.

In the case of the drinking bird, evaporative cooling on the outside of the bulb reduces the temperature inside the bulb. Pressure and temperature are directly related when volume is held constant. Therefore, the temperature reduction lowers the pressure in the upper bulb. The pressure in the lower bulb pushes the liquid up the tube and starts the process described above.

A common question is "When will the bird stop drinking?" There are three situations where the bird will stop drinking: (1) When there is not enough water left in the cup to wet the bird's head, (2) When the relative humidity is 100%. This is verified by placing a bell jar over the cup and bird. In this case, the bird will stop drinking within a few minutes. When the bell jar is removed, the bird will resume drinking, (3) When the demonstration is performed in a room with high relative humidity. If this occurs, the bird can be made to drink by adding a small amount of alcohol (either methyl or ethyl) to the water in the cup.

References

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The *Drinking Bird* is available from Flinn Scientific, Inc.

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