Name: _______________________________________ Date: _________________________

Guided Learning: Resonance (Part 3)

Driving forces… A closer look

Pushing Jean at the top of her swing has little effect on the period of her cycles. However, if you push earlier, it shortens the cycle because your push causes Jean to stop earlier. This means the system moves with a frequency higher than its natural frequency. Because you are pushing once per cycle, this means you are also pushing more frequently than if you waited for the natural end of Jean's swing.

The reverse is also true: if you paid no attention to Jean's position and just decided to start pushing her once every 2 seconds—wherever she was at the time—soon her motion would match this frequency. This illustrates a very general, important rule about driving forces:

> In most cases when a driving force is applied to a system, the system evolves to match the frequency of the driving force.

This helps explain how sound can shatter glass. A **sound wave** is a regular pattern of high- and low-pressure regions travelling through space. These differences in pressure are due to molecules in the air vibrating at a particular frequency, so sound causes the air near a glass tumbler to move back and forth, colliding against it with a regular frequency. The air is a driving force pushing against the tumbler. As described by the rule above, this causes the tumbler to begin vibrating at that frequency as well. If this frequency is near the glass' natural frequency, it vibrates with greater and greater amplitude. Depending on the volume of the sound, these contortions can overpower the strength of the glass, causing it to shatter.

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1. Before a singer tries to break a glass, she taps it to hear the sound it makes. Why?

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2. Macy has two identical tuning forks, both constructed to vibrate with a frequency of 440 Hz. She strikes one of them and places it near the other. What do you think will happen?

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3. In a city there are two buildings made of different materials. In your journal, on another piece of paper, or in an interactive notebook, explain why one building can be more vulnerable than the other to damage from an earthquake, even if they are of similar size, constructed with materials of similar strength, and equally distant from the earthquake's epicenter.