Section 10.4: Structural Safety

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1. Answers may vary. Sample answer:
   When a car is stuck in the snow, you should rock
   the tires back and forth rather than only trying to
   move them forward. The movement will create the
   resonating frequency, which will increase the
   amplitude of the movement, and will help get the
   car unstuck faster.

2. Answers may vary. Sample answer:
   Marching in unison across a swinging footbridge
   may cause aeroelastic flutter, which will add more
   energy to the vibrations than could be lost to
   natural damping. Extreme vibrations may cause
   the bridge to break.

3. Answers may vary. Sample answer:
   (a) Due to mechanical resonance, the energy from
       pendulum A transfers to pendulum E along their
       shared string. Pendulum E then starts resonating at
       the same frequency.
   (b) Pendulum A will stop swinging if pendulum E
       has a large amplitude swing.
   (c) Due to conservation of wave energy, the sum of
       their amplitudes must either remain the same or
       decrease.
   (d) Pendulum E should be dunked in the beaker.
       Then, any sympathetic vibrations will lose their
       energy in the water. Pendulum A will be damped
       because pendulum E is damped.

4. Answers may vary. Sample answer:
   Concrete walls are inflexible and can crack and
   collapse when vibrating at resonating frequency.
   Also, the methods used to reinforce concrete
   buildings are very expensive compared to other
   building technologies.

5. Answers may vary. Sample answer:
   Mechanical resonance: physical contact required;
   total mechanical energy is conserved.
   Aeroelastic flutter: no physical contact necessary;
   total energy may not be conserved.
   Both: high amplitudes produced; vibrations occur
   at natural frequency.

6. Answers may vary. Sample answer:
   There is significant disagreement among scientists
   on the primary cause of the collapse of the Tacoma
   Narrows Bridge. It may have been mechanical
   resonance where the wind’s energy was transferred
   into the concrete material of the bridge. Or, it
   could have been because of aeroelastic flutter where
   wind acted as a stimulator to negate natural
   damping.

7. Answers may vary. Sample answer:
   Reducing the size of floors as the elevation
   increases means there is less surface area for the
   wind to blow against and there is less mass higher
   up in the structure.
   Base isolation pads act as shock absorbers for a
   building, especially in an earthquake. They limit
   the building’s contact with the vibrating ground
   and dampen the waves passing into the building.