IDEATION

- Theremin
  Cool Microtonal Instrument, although complex in nature.
  - heterodyne oscillators, 2-stage amplifier
  - The engineering involved would be related to choosing the fixed pitch oscillators, amplifiers, inductors, very complex things that a 6th grader couldn't understand even alone under grad EE's.

- Quality of a Speaker as a Microphone
  Turn CHEAP SPEAKER into mic by connecting it to an amplifier and to another speaker.

  Engineering concepts: Waves, Electricity, FETs, Amplifier, EM induction. Choosing the best resistor values to achieve the optimal gain.

  Cons: May require use of Algebra to maximize gain, and may be hard to explain to 6th graders.

  Implementation: 2 speakers, wires, Resistors, Op amps, breadboard or printed chips and allow kids to solder!! Danger!! Probably want battery operated, therefore output level may be limited.
**TEAK Senior Design**

- **Acoustic/Electric String Instrument**
  
  - **Sound Hole**
  - **Standing Wave Creator**

- **Resonator Box**

  - May add electronic pickup to amplifier to speaker.
  - Also, what about something metallic under the strings that can increase the pitch like a sliding capo?

- **Electric Vocoder**

  - Vocoder circuitry may be complex.
  - Could have kids assemble amplifier.

- **Push button triggered oscillator** (simulating keyboard)

  - Have class make different notes.

  - Design oscillator to provide specific note compared to reference pitch to play.

- **MP3 player and effect/study filter design**
- RING Oscillator To Amp To Speaker
- Many teams to work on individual parts
- Have groups play together to form chords
- Create Mechanical Instrument
  - PVC Tube xylophone
  - Wind
  - Thumb Piano
  - Steel Drum Kit
  - Or Metal Mixing Bowl

[Diagram of a mechanical instrument]
Kit Activity Ideas

1. Using a slinky to demonstrate how sound waves move

   EX:
   \[\text{Transverse} \quad \text{Longitudinal}\]

   - The student on one end represents the sound source. The student on the other end represents the sound receiver (the ear).

Teaching Points:
1. How sound travels - waves, molecules, movement, energy transfer
2. How we are able to hear sound
3. Sound wave characteristics

Learning Outcomes:
1. Difference in transverse/longitudinal waves
2. Why molecule movement is important
3. What sound waves can travel through

Engineering Connection

Engineers are involved in the design of systems that involve sound and music (stereo systems, hearing aids, musical instruments, etc.). They need to understand how sound waves move and how we hear them in order to make a good product.

Reference
www.smm.org/sound/noise/activity125.htm
2. Make a stringed instrument

EX: Pegboard

- can change string length or string tightness to change pitch
- use eyebolts to secure strings to the board
- eyebolts can also be used to tighten/loosen strings
- use different material types

Teaching Points:
1. How string length changes frequency/pitch
2. How string material affects sound
3. Relate stringed instrument to vocal cords

Learning Objectives:
1. Create an "instrument" with different notes
2. Explain why/how a stringed instrument works
3. Explain similarities/differences between a stringed instrument and vocal cords

Engineering Connection
Stringed instruments need to be designed so that they can create each of the notes. Students will get to see this process by designing their own instrument.

Reference
www.smm.org/sound/noises/activity/handson.htm
3. MAKE A PVC PIPE INSTRUMENT

EX: Blue Man Group Drumbone

- Made of PVC pipe
- Hit with rubber mallets
- Each piece has a slider to make different notes
- Pieces fit together to make one instrument

EX: PVC INSTRUMENT

- Have tubes of different lengths to make different notes
- Hit with rubber mallets

Teaching Points:
1. How tube length affects sound pitch
2. How sound waves travel in a tube
3. Material selection of tube, mallet and how it changes sound

Learning Objectives:
1. What is pitch
2. Explain why length of a PVC instrument matters
3. Explain why material selection matters

Engineering Connection
In a PVC instrument, each pipe section needs to make a different note. These different notes can be created by different pipe lengths. Students will see how designing an instrument with correct tube lengths will create an optimum sound.

Resources
www.bmgconstruction101.com/drumbone.php
www.bluelan.com/making_waves/
4. **Acoustics**

**Example:**
- A small radio/MP3 player placed in a box
- The box will be filled with different insulating materials

**Teaching Points:**
1. What is acoustics
2. Material selection to dampen/enhance sound
3. Sound wave amplitude

**Learning Objectives:**
1. Explain what acoustics means
2. Understand where and why acoustics are used
3. See how materials affect acoustics (amplitude/sound)

**Engineering Connection**
Acoustics are very important in building/room design. Students will see how material selection affects acoustics, and pick the material that gives the best sound.
5. Guitar Design

- Why does the body of a guitar amplify the sound of a plucked string?

EX:

The sound made by plucking a string resonates inside the body of the guitar, amplifying it.

Teaching Points:
1. What is resonance
2. How do sound waves travel
3. How does design affect instrument sound

Learning Objectives
1. Understand what resonance is
2. Explain what sound waves are
3. See how design changes sound pitch/volume

Engineering Connection
While it may not seem so, the physical design of a guitar body significantly impacts the way that guitar sounds. By testing different designs, the students will see how the design process works, as well as how the sound from a guitar can vary.
a. Organs

- How a pipe organ is different from an electronic organ, yet produces the same sounds

Pipe
  - Compressed air is forced through different length tubes to create a note

Electronic
  - Uses electrical components to make the notes

Teaching Points:
1. Similar different components of each organ
2. How sound waves are produced (mech vs. elec)
3. Pitch and how its achieved

Learning Objectives:
1. Explain what sound is - how its produced
2. Hear the difference between mech and elec produced sound
3. Understand how pitch is changed

Engineering Connection:
Have the students test each organ, and then go testing to determine which method of making sound they like best. Since engineering decision involves testing / decision making, this will allow the students to see how the process works.
3. Seeing Vibrations

It is easy to feel vibrations, but what about seeing them?

EX:

- cling film wr rice on it
- speaker set-up

- Make the speaker as Pt. A of the kit
- Have the students use the film rice to "see" the vibrations

Teaching Points:
1. How sound waves travel
2. How an electrical circuit can produce sound
3. How sound waves produce vibrations

Learning Objectives:
1. Explain what sound is and how it travels
2. See how a circuit can be used to make sound; how components can change to make different pitches
3. See how sound waves produce vibrations

Engineering Connection:
This activity relates mechanical and electrical concepts; first by showing the students how a speaker is quiet, and second by allowing them to see how sound produces mechanical vibrations.
Brainstorming Ideas for Kits

1. Make stringed instruments.
   - Key concepts: Sound, Vibration, Frequency, Wavelength
   
   Objective: Students will be able to explain the relationship between changing physical components and frequency.

2. Design an instrument out of given materials that can play several different tones to create a song.
   - Key concepts: Engineering Design, Energy Transfer (Energy), Vibration
   
   Objective: Students will be able to design an instrument using the principles of energy transfer. Students will be able to identify an example of an energy transfer process within a system.

3. Design a sound booth.
   - Key concepts: Sound Dampening, Energy Absorption, Materials
   
   Objective: Students will be able to explain why some materials absorb more sound than others. Students will be able to explain how surfaces reflect sound waves.
4. Sound through tubes
   Key concepts: sound
   - frequency
   - wavelength

   Objective: Students will be able to explain the relationship between changing physical components and frequency.

5. Make a speaker
   Key concepts: electricity, current, magnets, electromagnets

   Objective:
   - Students will be able to explain how a speaker works.
   - Students will be able to create an electromagnetic field by running current through a wire coil.
   - Understand electricity and magnetism are related.
   - Describe properties and characteristics of magnets.

Sources: [WWW.TEACHENGINEERING.ORG](http://WWW.TEACHENGINEERING.ORG)