Turn Up the Heat With Good Vibrations!

We are down to the last two letters in our MELTS acronym for the five basic forms of energy, and our last lesson for the semester on physics! Since I am combining these last two forms of energy into one lesson we are going to keep it short and stick to three main points for each energy form that I feel are most important to know. I have included a "More to Explore" section for each if you would like to study these subjects further. There is certainly more to know about these two energy forms, but I will leave it up to your scientific curiosity to seek more info.

To understand both thermal and sound energy it is important to recall the lessons learned in chemistry about what all matter is made up of— tiny particles of atoms and molecules. Do you remember our class demonstration of the three states of matter using a hula hoop? Boy! Little did we know that that demo was breaking all the rules of social distancing in the months to come! With classmates acting as "particles" we packed them tightly together to demonstrate particles in a solid. We then had a few student "particles" step out of the hula hoop which allowed for more freedom of movement which demonstrated a liquid. To demonstrate a gas, we left only two student "particles" within the hula hoop with even greater freedom to spread out and move around. No matter the state of the matter and how tightly or loosely packed the particles are, there is movement of particles in one form or another. These movements of the particles can give us both thermal and sound energy. With this refresher of chemistry, let's look at the basics of thermal and sound energy.

T is for Thermal Energy—Turn Up the Heat!

What do the following words all have in common?: thermos, thermometer, thermostat, and thermal underwear. They all have something to do with heat. The root word "therm" comes from Greek and means heat. Thermal energy is heat energy and all objects have thermal energy, even when frozen! Objects with greater mass have more thermal energy.

Heat Vs. Temperature

The first thing you need to know is that heat is not the same thing as temperature. **Heat is the thermal energy movement of molecules within matter transferring from warmer to cooler objects. Temperature is a measurement of that heat energy or how fast the particles in matter are moving or transferring.** The scientific unit of measurement for temperature is degrees Celsius (not, degrees Fahrenheit as Americans commonly use regarding weather). The faster the particles move, the greater the thermal energy, thus the higher the temperature which makes things "hot." The slower the particles move, the lesser the thermal energy, thus the lower the temperature which makes things "cold." Think about water as a solid. With the particles tightly packed together there is hardly any movement of the water molecules and therefore the water freezes into a solid. With water in gas form (or steam) the water molecules are highly active and the temperature is hot.

The Transfer of Heat Energy

The key word to remember with heat is **transfer.** Heat is a type of kinetic energy that is transferred from these moving particles when two things, of different temperatures, touch or are combined. Without added energy such as an oven or a refrigerator, heat will keep transferring thermal energy from warmer objects to cooler objects until it reaches a state of **thermal equilibrium**. Those sound like big words, but the concept is quite simple. Equilibrium is a fancy word for a state of being equal, so thermal equilibrium means the state of having the same temperature. Heat is no longer transferred once thermal equilibrium is achieved. You can think of heat as a molecule's desire for equal rights or being the same as all other molecules! That may sound silly, but I don't think you will forget the idea! What happens when you set a mug of boiling hot water and a glass of ice water on the kitchen counter and come back several hours later? Will you still have a mug of boiling water and a glass of ice water? No, both containers of water will be room temperature, in a state of thermal equilibrium with each other and the molecules of air. How does it achieve this? Energy cannot be created nor destroyed, but it certainly does move around, changing forms. Thermal energy has a few ways of transferring...

Thermal energy travels or is transferred in three ways:

Radiation: the transfer of heat through electromagnetic waves which move through space. The sun, otherwise known as solar power, is our greatest source of radiant energy. No physical touch is required for radiant energy transfer.

Conduction: the process of heat transferring from one object to another. This transfer requires direct contact of objects. An example would be a frying pan sitting on a hot stove.

Convection: transfer of heat through liquid or gas. An example would be water heated on a stove transferring into steam.

Conductors and insulators

Conductors and insulators are both properties of matter. They describe how different matter naturally behaves. Knowing these properties helps people decide what materials to use for different tasks. You learned this in our lesson on electricity. Electricity also causes heat energy so copper is chosen for wires because it is a good conductor to let the electricity and heat pass through, but you also need to coat the copper wires with a good insulator of plastic to keep the heat and electricity contained within the wire. The same is true for cooking equipment where heat energy is often used. Would you want your frying pan to be made of plastic or your pot holder to be made of copper fibers? I would think not!

Conductor: an object that allows heat to pass through easily

Insulator: an object that is difficult for heat to pass through

Watch these videos on thermal energy/heat to reinforce the basics and to peak your curiosity to learn more:

*** Heat (Study Jams):** http://studyjams.scholastic.com/studyjams/jams/science/energy-light-sound/heat.htm

*** Conduction-Convection-Radiation-Heat Transfer**:https://www.youtube.com/watch?v=HpCvWuvCUoA

Thermal Energy Videos continued…

*** Why is Fire Hot? SciShow Kids:** https://www.youtube.com/watch?v=_4NoW8BIocY

*** Turtle Diary-Heat Energy:** https://www.youtube.com/watch?v=xGKg3TSO4v8

More to Explore on Thermal Energy:

Good review of Energy: https://www.youtube.com/watch?v=Q0LBegPWzrg

*** Heat (Bill Nye):** https://www.youtube.com/watch?v=uXlkyNRfBGM

Expansion and Contraction: https://www.youtube.com/watch?v=4FutJrhTWDA

Thermodynamic Laws: http://www.physics4kids.com/files/thermo_laws.html

Solar Power: https://www.youtube.com/watch?v=av24fEMhDoU

The Power of Sunlight (Solar Updraft Tower Project): https://www.youtube.com/watch?v=0Qmgdz9E47s

Thermal Energy Experiments: https://sciencing.com/thermal-energy-science-experiments-kids-8484153.html

S is for Sound Energy—Good Vibrations!

You may be too young to know about the band, The Beach Boys, but you have probably heard at least one of their songs at some point in your life. One very popular one is called Good Vibrations. You can't have a song without sound and you cannot have sound without vibrations! Sound is all about vibrations!

Sound starts with some type of motion. Here we are talking about movement of molecules again, except the type of movement is a little different. The motion of mechanical energy causes the molecules in matter to vibrate. To vibrate is to move quickly back and forth. Remember that even the air is filled with molecules. The initial vibration causes a chain reaction of waves of vibrations that spread out into the surrounding molecules causing them to bump into each other which is what helps sound to travel. Kind of like when you drop a rock into a pool of water and watch the ripples radiate out from where you dropped the rock. Sound vibrations travel in waves. Sound waves can travel through three states of matter: solids, liquids, and gases. As long as there are molecules to vibrate, you can have sound.

Demo Activity of How Sound Travels: https://www.education.com/download-pdf/activity/23790/

Frequency

If you turned an "S" (for sound) on its side, it looks like a wave which can remind you how sound travels. Vibrations travel in waves, but not all waves are shaped the same. Some waves are long and stretched out, while others are more tightly packed. One way sound is measured is by its **frequency**. If I said that I was a frequent visitor to the grocery store this month, you would know that I have been to the grocery store way more than I should because I went "frequently." So, **frequency** of sound means how frequently waves repeat within a given space in one second. Sound travels in waves, but again, not all wave shapes are the same. The more waves that travel within that given space in one second, the higher the

frequency. The less waves that travel, the lower the frequency. Frequency is measured in hertz (Hz).

Pitch and Volume

There is not just one kind of sound that is made from these vibrations. If there were, we would not be able to enjoy music or recognize the voices of friends and family members. You would not know the difference between a baby's cry or a grandfather's laugh. There are many different kinds of sounds from high to low. What causes this? It goes back to frequency…the higher the frequency, the higher the pitch or "high sound" with its waves in a tightly-packed shape. The lower the frequency, the lower the pitch or "low sound", with a very long, loose wave-shape. **Pitch is the highness or lowness of a sound.** You have vocal chords in your throat that you are able to vibrate in order to make the sounds of talking or singing. Some of you practice this more than others! Ha! When you are very young, your vocal chords are short and thick, giving you a higher pitch to your voice. As you get older, the vocal chords get longer and thicker, giving you a lower pitch. Think about the strings on a harp. The low deep sounds are made by plucking (or vibrating) the long, thicker strings, while the high sounds are made at the top where the short, thin strings are.

Volume is the measurement of the loudness or softness of sound. The unit of measurement for volume is the decibel (db). Volume is affected by how tall the shape of the sound waves are which is called amplitude. The louder the sound, the higher the decibels and taller the wave-shape.

Bendy and Bouncy Sound Waves

Unlike light waves that travel in a straight line, sound waves are "bendy!" They can bend around most anything. They are also "bouncy!" The sound energy in the waves can bounce off of objects. This is what makes an echo…bouncy sound waves of vibrations! This property of how sound waves behave in being bendy and bouncy leads to many fascinating studies in sound. I encourage you to check out some of these subjects on sound in the more to explore section below.

Watch these videos on sound energy to reinforce the basics and to peak your curiosity to learn more:

***Sound (Study Jams):** http://studyjams.scholastic.com/studyjams/jams/science/energy-light-sound/sound.htm

***What is Sound? (Dr. Binocs):** https://www.youtube.com/watch?v=gdGyvGPZ1G0

***What is Sound (SciShow Kids):** https://www.youtube.com/watch?v=3-xKZKxXuu0

More to Explore on Sound Energy:

Questions about sound to explore with the help of a parent: how do instruments work, can a person's voice break glass?, how do vocal chords vibrate, how does the ear hear sound, what is a vocal range, how does sonar radar work, inventions in sound, how do hearing aids work.

Echolocation: https://www.youtube.com/watch?v=laeE4icRYp4

What is a Sonic Boom?: https://www.youtube.com/watch?v=L38joISddbA

Doppler Effect (in light and sound): https://www.youtube.com/watch?v=kdiHmSWI2Ks

More to Explore Sound Energy continued….

Physics Waves: https://www.youtube.com/watch?v=KWzyQKcJBYg

The Science of Sound: https://www.pbs.org/video/sound-the-science-of-sound-syzigq/

Bill Nye on Sound (23 min video): https://www.youtube.com/watch?v=BwRi_N6Nq8E

Biography of Alexander Graham Bell (Free School): https://www.youtube.com/watch?v=JsRt5lBdBfE

FINAL WORDS

Well, my lego-building, much-loved, Jedi Padawan science students, this concludes our year of study in the fundamentals of chemistry and physics. I have truly enjoyed teaching and learning along side of you and am not only sad to see this study end, but am also sad at how it ended in being apart. I hope you have learned many fundamentals that you can build on in the years to come to increase your scientific knowledge of the world around you. I also hope that you view chemistry and physics, not as school subjects that are scary-hard, but now as school subjects that are crazy-fun and fascinating! However, if you have only learned one thing this year (although I hope you have learned much more) I pray that it is how amazingly orderly and interconnected our Universe truly is, from its very smallest pieces of "God's Lego blocks" to the surrounding forces in motion that are always with us, holding it together and keeping it in motion. God's Creation is perfection and is held and working together in amazing ways. That knowledge alone will serve you well in life. God truly has the whole world in His hands!

Until next year, be observant, be curious, and seek answers to your questions about the world around you, but above all else, give ALL glory to God, our Creator for its unmatched DESIGN!

—Mrs. Sonya