**Lab Journal 3 (8%): Colour and Sound.**

If you work as a group, complete Part 1 and Part 2, graded out of 20 points. If you work alone select only one part, graded out of 10 points. Send your draft MS Word file as an email attachment for intermediate feedback. The final versions of all lab journals have to be uploaded to Assignments on Blackboard by April 16 (Monday).

Search for relevant resources in Seneca’s Library catalogue, on reliable internet sites, in physics textbooks. Make sure you add relevant in-text citations and list all your sources at the end, in Works Cited list. You are encouraged to insert illustrations with figure captions and references under each one.

Please cite your reference sources in the text according to MLA citation style (<https://seneca.libguides.com/mla>), and list them at the end of the work under “Works Cited”. Note that presenting parts of your references without proper citation is a violation of the Academic Honesty Policy: <http://seneca.libguides.com/academichonesty>. In case of detected plagiarism you will receive ‘0’ on the work and a comment in the student record.

**Part 1. Mechanisms to generate color. (10 pts.)**

Choose one spectral color and discuss 4 different ways to produce it in nature. For each way explain the physical mechanism of color production in details. You are expected to write one paragraph about each mechanism, and add illustrations and/or sketches, where applicable. Do not forget to add in-text citations to your reference sources.

**Part 2. When sound causes light (10 pts.)**

Search reliable scientific sources about the following phenomena and discuss their modern scientific explanations:

* Sono-luminescence. Use at least 3 sources that describe actual scientific research on this strange phenomenon. Explain what is observed and outline the necessary conditions to produce the effect. Discuss the explanations of this effect according to current physical theories.

1. According from Gary Williams at University of California, single bubble or multi bubbles produce the same pulse of light and they are very identical in term of light. Previous experiment which was conducted in 1988 using sound waves to expanded the bubbles was failed because it was succeeded for a single bubble but not for multi bubbles. Scientist later found out that, when a single bubble collapse, it exploded, heated the gas inside and created a glowing plasma. While using the same method for multi bubbles, scientist found that they were missing an emission line, in which is the OH molecule that caused the multi bubbles not to emitted the pulse of light. Learning from that, Gary Williams now tries with the laser pulse to create the bubble in different size. As the bubble get larger, the pulse of light also get bigger. He then concluded that depends on the size of the bubbles, it can determines how big the pulse of light will be. However, he didn’t concluded that in which method the bubbles will created light
2. An experiment was found with the mantis shrimp, that the attack speed of the shrimp was so fast that it produced light in the shock wave. What happen was, the shock wave produced by the shrimp has higher frequency than what human can hear, touch the water, leave the water unable to respond because the act was so fast, reduced the pressure of water. Low pressure water then form into tiny bubbles, bubbles increase the heat and the pressure and collapse, increase the pressure inside the bubbles, product a tiny flash of the light. It is still, depends on how big the bubble is in order to see the light clearly or not. Scientist explained this could happen due to chemical reaction. For example, H20, when the Oxygen receiving energy, it will rip apart one of the hydrogen, as soon as the Oxygen finish receiving energy, the other part of hydrogen will then, come back to the molecule and that’s the time where energy being released. Since the flash of light only last for a very very tiny fraction of time, scientists now can’t even sure what was happening during the time.
3. Sonoluminescence can also be found in cavitation, that is, an action that caused water to drop it pressure suddenly, creating tiny small of bubbles that can produce a very high pressure and heated upto giga kevin. Bubbles you see at swimming pool or ocean are just normal bubbles, pressure have time to drop so there will be less heat produced. This reaction will most likely to occur in chemistry lab, where a compound of chemical could react and product sonoluminescence. As mentioned before, the hotter the bubble get, the longer the light will be, but the longest time scientist can measure is 700 picosecond (7.0\*10^-10 second). Scientists, also performed another example in which they created a sound in to the liquid to make the wavelength interact with the liquid, and to produce bubbles. They found that, depends on the size of the container and the type of liquid (condensed or more liquid), different frequency need to apply to produce cavitation.

* Synesthesia – when certain sounds make some people see colors. Describe 2-3 cases of specific manifestations of this effect and the possible explanations, according to modern research. A reliable starting source can be:

“The Synesthesia Project”. <https://www.bu.edu/synesthesia/faq/>. Web. 26 March 2018.

1. Grapheme-color synesthesia: the effect of which a person can see colors or personality from a number or letter. Given a bunch of number on the image and with one or two slightly different one inside that, a normal person would have a hard time to figure out where is the “different number” located while a synesthesia person can picture out instantly because they see each letter and number at a different color. The color is not the same for everyone, a person can see, for example, number 1 in blue colour but other person could see it in green. Until now, scientist can only explain that Grapheme-color can happens in multi-generation is through a gene which involved cell migration and axonogenesis, which mean, this particular cell can transfer from a person to a person when give birth. Daphne Maurer, a psychologist at McMaster University believes that this was happening to all of us when we were young, but then as we grow up, we begin to lose that ability. Most of the scientist, till now can’t explain how is that happen. The best we’ve known so far is a particular gene in our brain has developed, which will give the person the ability to see colours in sound. This ability can last depend on how strong it was developed.
2. Sound-touch synesthesia: the effect that people can feel the sound at a very low frequency. According from *Wired,* sound can be feel due to a connection between an auditory part (usually ears or part that absorb noise) and somatosensory region, which you feel things when you touch. In some case, like I do, when I set my phone to silent mode (no vibration at all), and I put the phone away. At some point, I do feel that my phone is receiving text or phone calls because it’s generated sound (but in silent) and sound generated waves, in which will go through my body. Scientists have discovered that people with a normal hearing will likely to feel the sound and vibration at a very high frequency. In order for a person to actually feel the sound, the frequency of sound and the frequency of skin must be the same to produce connection. Another examples that you might partly feel the sound a little louder is when you turned on music from a speaker, 2 persons both stand at the same distance. The person who touch the speaker will absorb more sound (or frequency) than the person who just stand there doing nothing. This is due to the fact part of the sound have been transmitted to your body, make you feel that you are listening louder.

Reference (MLA):

Brumfiel, Geoff. “Focus: Size Matters for Flashing Bubbles.” *Physics*, American Physical Society, 17 May 2001, [www.physics.aps.org/story/v7/st23](http://www.physics.aps.org/story/v7/st23).

“Sonoluminescence Is Light Made From Sound.” *Curiosity.com*, 30 Oct. 2016, [www.curiosity.com/topics/sonoluminescence-is-light-made-from-sound-curiosity/](http://www.curiosity.com/topics/sonoluminescence-is-light-made-from-sound-curiosity/).

Moss, Laura. “What Is Synesthesia and What's It like to Have It?” *MNN - Mother Nature Network*, Mother Nature Network, 13 Mar. 2018, [www.mnn.com/health/fitness-well-being/stories/what-is-synesthesia-and-whats-it-like-to-have-it](http://www.mnn.com/health/fitness-well-being/stories/what-is-synesthesia-and-whats-it-like-to-have-it).

Powell, Devin. “Feel the Noise: Touch, Hearing May Share Neurological Roots.” *Wired*, Conde Nast, 3 June 2017, [www.wired.com/2011/05/hearing-touch-synesthesia/](http://www.wired.com/2011/05/hearing-touch-synesthesia/).

“What Is Sonoluminescence?” *Physics Forums - The Fusion of Science and Community*, 26 Oct. 2005, [www.physicsforums.com/threads/what-is-sonoluminescence.96883/](http://www.physicsforums.com/threads/what-is-sonoluminescence.96883/).