

Physics Integration Lesson 20 – How Do You Respond?

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Why do objects respond to each other? At the personal level, it involves communication and the 'why' question is often taken for granted. However, at the physical level it is not so obvious and warrants further investigation. When considering fundamental particles and forces, the response is more of a description than a reason why. A mass responds to other masses through a gravitational force. An electric charge interacts with other charges through the electromagnetic force. Once the position, velocity, mass and charge are known; the force and resultant acceleration can be calculated. The result is not open to discussion, it just is.

When working with a collection of particles, the amount of complexity increases exponentially. However, this complexity moves beyond predetermined outcomes and allows for a response that can be 'designed.' Kinetic theory uses physics to find a relationship between pressure, volume and temperature for randomly moving air molecules. When these random air molecules are placed in a tube and excited by a tuning fork, a collective behavior arises that is dependent on the length of the tube, the velocity of sound in air and the frequency of the tuning fork. This collective behavior is called a resonance and allows maximum energy transfer between the vibrating tuning fork and the sound waves propagating through the air within the tube. This was demonstrated in a lab from the first semester of physics.

In like fashion, a designed resonance can be established in an electromagnetic system that extends beyond the fundamental interaction of charged particles. This collective behavior involves a capacitor, which stores energy in the form of an electric field, an inductor, which stores energy in the form of a magnetic field, and a resistor, which dissipates energy. The signal generator acts like the tuning fork, which adds energy to the system. If the frequency of the signal generator matches the resonant frequency of the LRC circuit, the current oscillating within the circuit reaches a maximum amplitude.

This resonant response may be a novelty when observed in the laboratory, but LRC circuits can be designed to achieve phenomenal effects. The signal generator can be replaced by electromagnetic waves propagating through the atmosphere. Attaching our LRC circuit to an antennae, allows us to isolate a particular frequency, which corresponds to our favorite radio station. Designed response goes beyond electric circuits. Biological systems use molecules to respond to specific frequencies of electromagnetic waves. As a result, we can distinguish between red, green and blue light through three specific configurations of photopsin proteins located in the cone cells of our retina.

1. Response requires communication. The sophistication of the response depends on the means of communication and the complexity of the transmitter and the receiver. Dr. Werner Gitt, a German engineer and young-earth creationist, makes an argument for God using information theory in his book *In the Beginning Was Information*. In it, he states that information is communicated with different levels of meaning from letters, words, phrases to sentences. The rules by which these different levels have meaning are not accidental, but designed so there is a specification match between the transmitter and receiver. Is this engineering approach to design effective at arguing for the need of a designer (Creator)? What illustration could you use to effectively communicate this concept to a person without technical training?

2. The fact that particles respond to each other based on their inherent properties have led some to believe that this can explain all interactions that occur in the physical universe. As a result, philosophical naturalists would treat your response to the environment and other humans as nothing more than a complex physical process. Is there a fundamental difference between how you respond and how particles respond? What evidence or argument would you present to someone who believes differently than you on this issue?