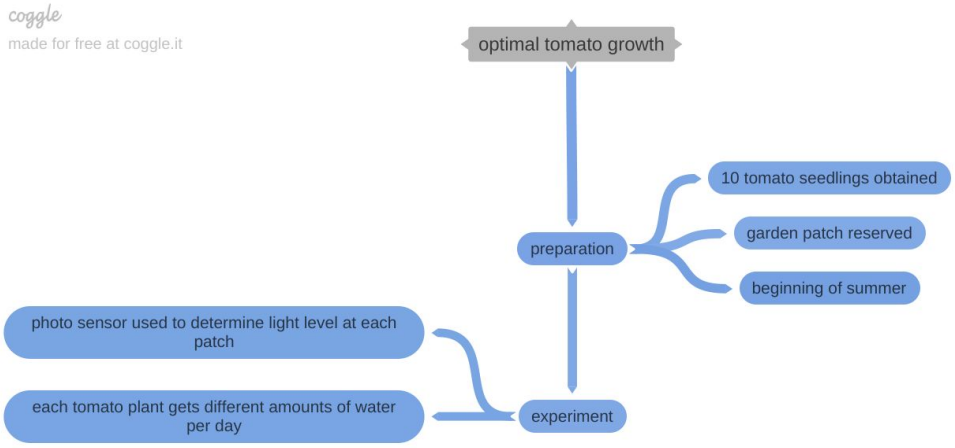
Elise Hansen
INTD-100-21

Midterm

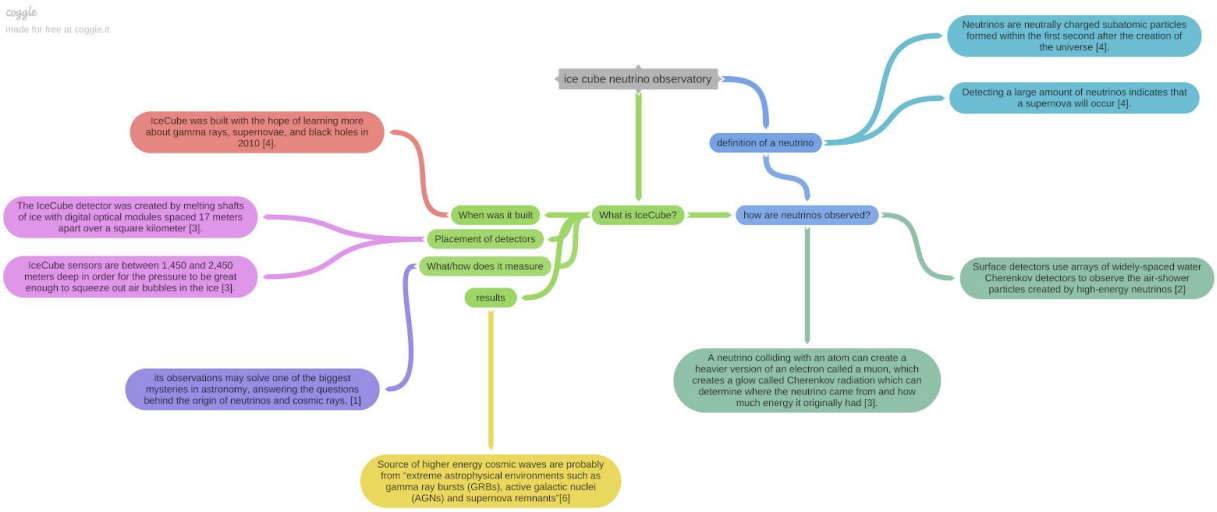
I.

1.
   a. Scientists use the known orbits of the stars around the center of the galaxy to calculate the object in the center; it is assumed to be a black hole because of its size.
   b. Epidemiologists use the reproduction parameter, R0, to determine the number of new infections stemming from one infected person.
   c. According to Newton's Laws of Motion, acceleration due to gravity is constant for all objects.

2. In order to determine the optimal conditions for growing tomatoes, ten seedlings were obtained and a patch in the garden was reserved for the plants. The seeds are planted at the beginning of summer with a photo-sensor to determine the light intensity at each spot in the patch, and are given different amounts of water each day.



II.



1. The IceCube Neutrino Observatory in Antarctica was built in 2010 to build understanding of black holes, supernovae, and gamma rays, and could explain the origins of neutrinos and cosmic rays [4][1]. Neutrinos are neutrally charged subatomic particles formed within the first second after the creation of the universe, and large amounts indicate that a supernova will occur [4]. To build the observatory, shafts of ice were melted with digital optical modules (DOMs) spaced 17m apart, with sensors between 1450-2450ft deep to avoid complications with bubbles in the ice [3]. Surface detectors observe the air-shower particles created by high-energy neutrinos [2]. When a neutrino collides with an atom, a heavier version of an electron called a muon is created, and the subsequent Cherenkov radiation can determine where the neutrino came from and how much energy it originally had[3]. Results from the observatory show that the source of higher energy cosmic waves are probably from “extreme astrophysical environments such as gamma ray bursts (GRBs), active galactic nuclei (AGNs) and supernova remnants” [6].

[1] Nola Taylor Read. IceCube: Unlocking the Secrets of Cosmic Rays. Space.com. https://www.space.com/41170-icecube-neutrino-observatory.html
[2] A. Albert et al. Search for High-Energy Neutrinos from Binary Neutron Star Merger GW170817 with Antares, IceCube, and The Pierre Auger Observatory. The Astrophysical Journal Letters, Volume 850, (2), 2017. https://iopscience.iop.org/article/10.3847/2041-8213/aa9aed
[3] Stephen Crass. The IceCube Neutrino Detector at the South Pole Hits Paydirt. IEEE Spectrum, 2018. https://spectrum.ieee.org/tech-talk/aerospace/astrophysics/the-icecube-neutrino-detector-at-the-south-pole-hits-paydirt
[4] University of Wisconsin-Madison Department of Astronomy. Neutrinos! Astro.wisc.edu.

http://www.astro.wisc.edu/~larson/Webpage/neutrinos.html#:~:text=Neutrinos%20are%20fundamental%20particles%20that,nuclear%20reactions%20here%20on%20earth
[5] Alden L. Coke. The Detection of Neutrinos in IceCube. IceCube Masterclass. https://masterclass.icecube.wisc.edu/en/learn/detecting-neutrinos
[6] Dawn Williams. Recent Results from IceCube. International Journal of Modern Physics: Conference Series Vol. 46 (2018) 1860048, 2018. https://www.worldscientific.com/doi/pdf/10.1142/S2010194518600480

III.

1. The baby was long and heavy when it was born.
   The baby quickly grew longer by 1 year old.
   Radio transmission took [X] hours between the Earth and the Moon.
   A hiker walked 60 km in 4 days at a moderate speed.
2. Standing in the back doorway next to the washing machine, turn left into the kitchen and turn on the oven to pre-heat at 325 degrees (bake > start), then continue forward and open the refrigerator. Grab the eggs, ham, and cheese from the drawer and close the door. Next to the fridge, there is a drying rack with a muffin tin on it; grab the tin and set everything down on the counter. Next to the stove is a can of cooking spray, salt, and pepper. Spray the tin liberally with Pam and crack an egg into each pocket. Add salt and pepper over the egg, fold a piece of ham over each egg, and sprinkle cheese on top to taste. Cook for 10 minutes and serve with garlic bread.

IV.

1. A 20cm pendulum was used to measure the acceleration due to gravity (g). The pendulum was allowed to reach its resting position, and then displaced 5cm to the right. Once released, the number of times it returned to the initial position was recorded for one minute, and it was calculated that the interval was 0.90 seconds. Using the formula predicted by Newton's Laws, g was found to be 9.81 m/s^2.
2. In order to measure the average horizontal distance bacteria travel when a person sneezes, a trial was conducted in a room with no air flow. First, a sample of 20 infected people, all 5-6 ft tall, were gathered. Second, petri dishes were arranged on the floor in front of the subject in 0.5 meter intervals for 10.0 meters. Third, the subject was required to sneeze down the line of petri dishes without covering their mouth. Finally, bacterial colonies were allowed to grow in dishes for one week under ideal conditions, and the largest colonies were found at the 8.0 meter mark. These results show that when a person sneezes, they can infect someone up to 8 feet away; this information can be used to inform the epidemiology of spreading bacteria.