THREATS TO HUMANITY

AN INTERVIEW WITH SAL KHAN!
Have you ever visited Khan Academy to save your grades? Have you ever wondered how Khan Academy was started? In this issue, Catapulta is featuring an exclusive interview with Salman “Sal” Khan, the founder of Khan Academy, in which he answers any questions you may have had! Also included is a recap of our Pi Day Fundraiser and updates on recent scientific events like the development of the Zika virus. We hope you enjoy all there is to explore in this issue. As always, do not hesitate to email us at catapultasciencebls@gmail.com if you would like to contribute in the future!

**Want your article to be featured in the next issue? Email us for info about the article submission process.**

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**In this issue**

*An Interview with Salman Khan Founder of Khan Academy*
On March 14, Catapul- the Boston Latin School’s Pi Day Fund- raiser—had an extraordinary turnout this year, and raised over $1,000! Thank you all so much for your support and we promise that next year will be even better!

So, why the huge fuss about pi and pie? Many of you already understand the scientific and mathematical advancements that pi has brought. Using pi, it is possible to enter a whole field of geometry that was inaccessible prior to its discovery. But what about pie? Actually, a lot of science goes into the making of a good pie.

For example, the crust of a pie should be thin, but not too thin. It should have a balanced flavor, and crack when bent. When flour meets water, it reacts with gluten, a protein in the flour, to give the dough strength. Since the reaction can cause the crust to become very tough, adding vinegar or carbon dioxide to the water can allow the crust to settle in that perfect medium.

How about color? Color is often a direct indicator for the fla- vor of a pie and thus is important beyond cosmetic purposes. The chemical reaction that occurs be- tween amino acids is responsible for color change, and it happens faster at higher temperatures. Therefore, preheating your oven to above 350 degrees Fahrenheit can work won- derful pies? Due to the presence of fat, butter is important when considering flakiness. Upon being heated, the water in the butter turns to steam, and re- sults in air pockets after expanding. In this case, butter with higher wa- ter content can be more beneficial than butter with high fat content.

Speaking of steam, depend- ing on the pie ingredients, it may be essential to cut steam vents in your pie. If you were making an apple pie, for instance, all the water that the apples contain will evaporate. Considering that apples are about 85 percent water, steam trapped inside of your pie could cause it to bloat.

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Pathogens have had an important impact on humans since the beginning of history—documents going back thousands of years record plagues and large outbreaks that occurred regularly among ancient civilizations. For example, researchers have found smallpox DNA in Egyptian mummies as well as in ancient Chinese and Japanese ones; the Black Death, or the bubonic plague, killed a third of the population in Europe. In the last few centuries, however, epidemics have begun to develop on a truly global scale. Cholera roared out of the jungles of India to kill millions of people. The Spanish flu swept the globe in 1918, killing around fifty million people. People back then lived in constant fear, as contracting a disease was often a death sentence; mortality rates for some diseases reached 70%. However, modern medicine has drastically improved. An arsenal of vaccines, antibiotics, and other treatments protects us against disease. Some scientists declared the war on disease won with the eradication of smallpox in 1980. Yet infectious disease has remained the leading cause of death worldwide. For example, the human immunodeficiency virus and the resulting autoimmune deficiency syndrome (HIV and AIDS, respectively) have killed thirty-four million people since their emergence in the 1980s. Cholera still kills an estimated 120,000 people every year. Additionally, in 2010, the H1N1 (swine flu) outbreak spread to 214 countries within a year after being detected in Mexico. All it takes to start a pandemic is one infected individual.

The threat from infectious diseases is growing, further outbreaks of new, dormant, or even well-known diseases are a certainty.” The report further states, “There are very few risks facing humankind that threaten loss of life on the scale of pandemics.” A global pandemic that could kill millions of people is very much possible. Why is this, and more importantly, how can we prevent it?

Many aspects of our modern society present significant risk factors for the spread of pandemics, as globalization and the advent of rapid air travel have increased the rate at which microbes can spread exponentially. Now, travelers from all over the globe live in close proximity to farm animals. For example, in Guangzhou, China, the H5N1 (avian flu) outbreak originated, poultry workers live in shacks contaminated with bird excreta. In addition, selective breeding and factory farming have drastically reduced the genetic diversity of our livestock. Animal populations without a large gene pool are extremely susceptible to outbreaks because they often lack any resistance to new diseases.

Global warming has also had a significant impact. Rising temperatures change animals’ migratory patterns, causing them to travel to new areas, where they can then spread their diseases to the local population. For example, scientists worry about the potential for migratory birds to cross over from Siberia and spread devastating avian diseases to North America. Another terrifying effect of global warming is the potential for the development of fungal pathogens. Typically, humans have nothing to fear from fungi because our high body temperatures present a hostile environment to them. This, however, means we have no natural defenses against fungal infections. As temperatures rise from global warming, fungi have begun to adapt to higher temperatures and may eventually be able to infect humans more easily. Some species of bats and amphibians have already been driven close to extinction by new fungal pathogens.

How can a global pandemic be prevented? Eliminating risk factors such as international travel and livestock-human contact is logistically unfeasible. Instead, governments and international organizations should invest heavily in research and early detection of new outbreaks. The recent Ebola outbreak revealed a woefully inadequate international public health infrastructure as well as public indifference; containment of the initial outbreak would have saved thousands of lives as well as billions of dollars. This year’s Zika virus outbreak will provide an important test of whether the global health community can effectively contain a localized infection before it develops into a pandemic.

THE REAL THREAT OF A GLOBAL PANDEMIC
**ROACH BOT**

In the current day, cockroaches induce cringes in many humans, but one day they may help save our lives. Researchers at North Carolina State University, led by Alper Bozkurt, were able to remotely steer a cockroach via a backpack and electrodes on the cockroach’s body. The researchers created a “biobot,” short for “biological robot,” which is the name for the first step of making an insect cybernetic organism (cyborg). The distinction between the two is that the insects are controlled by the researchers right now, while they will become cyborgs when they are able to use the technology independently.

When asked by National Geographic’s Amanda Fiegl about the process of surgery on roaches, Bozkurt said that the procedures were not complicated. He went on to say that insect anesthesia involves simply freezing them, which creates a state similar to hibernation. The rest of the procedure involves attaching electrodes to the front and rear sensors of the cockroach, called the antennae and cerci, respectively. Finally, a “backpack” filled with electronics is attached by gluing small magnets onto the back of the cockroach with medical grade epoxy as an adhesive.

A practical use of one such roach might be to act as a locator, carrying a beacon and a miniature microphone in order to pick up cries for help, though it would still have to be operated by a computer or a human. Similarly, the load could contain a camera or any other small sensor.

The roaches are steered by sending electrical impulses to their sensor cells within the antennae, which trick them into thinking that there is an obstacle present and cause them to go in the opposite direction. For example, a left turn could be triggered by activating the right antenna and vice versa. Additionally, forward motion can be triggered by activating the cerci in the rear of the roach. These impulses do not hurt the roaches, because they are invertebrates and therefore do not perceive pain in the same way humans do. Rather, the impulses cause the roaches to move reflexively. The researchers also explain that they used real cockroaches instead of synthetic duplicates, because they already have a built-in self powered locomotion system which can be channeled with the technology. In addition, the insects can naturally move quickly and run away when danger is sensed. This is key in unpredictable environments such as a rescue site. Utilizing the pre-existing knowledge of the biology of cockroaches, scientists are testing mainly on females, who are theoretically better and have more experience with carrying loads, as they have to carry eggs. So, these little creatures who scuttle away from you may one day help save your life.

**SpaceX**

Throughout civilization, humankind has looked up to the stars and dreamed of traversing its vast expanse. But it was only when Yuri Gagarin completed an orbit around the Earth in 1961 that the dream of space travel finally seemed possible. Yet, even with all the excitement and anticipation, space travel brought several inconveniences with it. The most prominent, it seemed, was the huge bill. In fact, since the National Aeronautics and Space Administration (NASA) began its Space Shuttle Program, it has spent nearly two-hundred billion dollars.

The answer should be simple. Find a way to spend less money on space travel. But even after decades of research, scientists were at a loss as to how exactly to cut down on their expenses. With that in mind SpaceX was founded in 2002.

With the ultimate goal of launching a series of manned missions to Mars in order to colonize it, SpaceX’s first goal was to lower the price of space missions. Its advances have been so promising that NASA itself is among SpaceX’s funders.

Just this April, SpaceX had a huge breakthrough. It launched a supply rocket to a space station, had its contents unloaded, flew it back to Earth, and made it land on a drone ship in the Atlantic in one piece. The implications of this achievement are huge. Instead of rebuilding a rocket for every resupply, the same rocket can be reused multiple times. This saves a lot of time, and a lot of money.

For now, SpaceX has its sights set on repeating this incredible performance. But exploration enthusiasts and stockholders alike take notice: SpaceX is ready to accomplish great things.

“implications of this achievement are huge”
Dr. Edward Osborne Wilson, University Research Professor Emeritus at Harvard University, has published over twenty books and established the sciences of conservation biology and sociobiology. He has also spent years of his life watching ants. Through his observations, Wilson realized how complex ant colonies are. He was among the first to agree with kin selection—the idea that one ant helps its sibling because some of its genes are passed on through its sibling’s reproductive success. Because of Dr. Wilson’s research, the scientific world has also accepted kin selection.

However, after further research, Wilson realized that kin selection was incorrect, and should be replaced with group selection, a theory in which “groups of cooperators can out-compete groups of non-cooperators, thereby ensuring that their genes—including the ones that predispose them to cooperation—are handed down to future generations.” This made him an outcast to much of the scientific community, even leading one scientist to pour cold water on him at a meeting. In reply, Wilson said, “I think that’d be a pretty poor scientist, who couldn’t reverse his view from new evidence.” Wilson’s new evidence for group selection has wide repercussions, including the origin of our humanity.

In many ways, ant and human societies are similar. Ants specialize in labor; most ants are workers that find food, return it to the colony, and feed the queen. Ant colonies also battle other colonies for resources, taking “prisoners of war.” Ants have reproductive specialization—the queen is the colony’s only fertile female. This is called eusociality, and in traditional Darwinian evolution, should not exist, as usually any individual that does not reproduce does not pass on their genes, so for the individual it would seem most beneficial to do whatever he needs to do to reproduce.

Helping each other even when it impedes one’s own survival happens in many other species as well. Wolves share their kills at the expense of eating less; monkeys call out to warn others of predators at the cost of giving away their location; African buffaloes rescue each other from lion attacks by endangering themselves. This altruism is beneficial to the group as a whole, even though it hinders the individual. Biological altruism became Wilson’s evidence against kin selection and is the reason he now believes in group selection.

Wilson further proposes that group selection causes tribalism, or the “expression of the widespread need to be in groups that you find in the animal kingdom as well as in human behavior.” In today’s society, tribalism is seen in sports, religion, and cultural traditions. When humans were diverging from our ape-like common ancestors, tribalism helped us to develop into a eusocial species, which exhibits “the most advanced form of social behavior.” A mutual dependence on each other to raise children has allowed us to become compassionate, which separates us from most other species. Also, specialization of labor within groups allowed early humans whose job was not reproduction to make tools, create fire, conquer neighboring species, and build complex societies.

Wilson finally hypothesized, “Human bonding and morality must have a biological basis; it must have evolved.” A biological explanation for the origin of our morality is a sticky issue; it can be misinterpreted to justify racism and eugenics. But to E. O. Wilson, a biological explanation for our humanity means that we all have genes that make us kind, curious, and unique among all other species, even among eusocial species. We have not found these genes yet, but if we do, we could be looking at the physical source of our very humanity.
Earlier this month, editor-in-chief, Michael Gan, had the privilege to speak with Salman Khan, founder of Khan Academy. Here is a transcript of the interview that took place.

MG: Hi Mr. Khan! It’s really a great honor to speak with you. We’re really thankful for the time you’re taking to do this with us.

SK: No problem. Thanks for reaching out.

MG: Viewers know a lot about your videos, of course, but are also curious about what you do when you’re not making videos. I’d like to start off by asking: what do you do in your free time?

SK: Yeah, so there’s, I suppose, two parts to that question: “What do I do when I’m at work not making videos?” and “What do I do when I’m not at work?” As you probably know, Khan Academy is much more than a purely intellectual environment. You’ll see people reading great novels on the Red Line, something you don’t see elsewhere. Combined with the actual history of the city, Boston becomes an “Athens of America.” I also love its walkability. It’s very livable: there’s very few cities built with a human scale where you can walk across the Charles with ease. Overall, I’m a huge fan of Boston.

MG: That’s great. So is there an average work day at Khan Academy?

SK: Well, every day is a little different, but I probably have two broad categories of days. One type of day, the more common type, is when I’m in town (I don’t like traveling). These days I come to work at around 8 o’clock in the morning. Then I drop my kids in the Khan Academy lab downstairs, so I actually go to work with my kids. Then by around 8:30, I’ll quickly read my email and then get my mind set on what I would like to work on for the day. That could range from helping with more math content to giving other content creators feedback. It might be writing a Vision document for our organization, or prepping for video content in subjects like Biology, Chemistry, and History. I enjoy doing any of those activities until about lunch time, which is when I’ll have meetings with internal people, the press, and funders. Then I like to use the last two hours of my work day to reflect on how the day went. The rest of the day and all of weekend I spend time with family. The other type of day is when I’m traveling or giving talks locally instead of working in the office.

MG: Khan Academy started when your cousin Nadia was visiting you in Boston. You actually lived in the city for a few years and our readership is in Boston—we’re a high school of about 2400 kids. As a former Bostonian, what would you say was the most interesting part of Boston?

SK: I don’t know if you necessarily appreciate it when you grow up entirely in Boston, but I came from New Orleans, which is also a great city in its own right. Therefore, I remember when I came to Boston that it felt like an intellectual Disneyland. Something about the environment of Boston makes you want to learn, and makes you want to learn for the sake of learning. Silicon Valley, where I’m living now, is a lot of “What’s the next innovation?” but Boston, on the other hand, is a rare kind of a purely intellectual environment. You’ll see people reading great novels on the Red Line, something you don’t see elsewhere. Combined with the actual history of the city, Boston becomes an “Athens of America.”

MG: So where exactly do you see Khan Academy in ten years?

SK: Well, our mission statement is world-class education for anyone in the world. I hope that in ten or twenty years we live in a world where if you’re a student at Boston Latin, or a student in a rich or middle-income country, you can use Khan Academy to complement your schooling and learn on your own time. Hopefully by then students can be part of a global community, and teachers can get resources that will help them do their work and have more fun doing so. But for students in a large
segment of the world that may have no access to school- ing, as long as they are able to get their hands on a cheap smartphone, then Khan Academy can hopefully help them self-educate and integrate themselves into society. We’re already starting to touch on some of this, but I hope in ten years that we’re able to offer all of the sub- jects that are core to education, that we’re able to find more ways of allowing students to prove what they know to the world, and that we’re able to connect them to em- ployers and colleges that will take seriously the work they have done, both on Khan Academy or in conjunction with Khan Academy. Also, as we’re continuing to translate Khan Academy videos to many languages of the world, I hope that in ten years we’ll be teaching billions of people.

MG: With Khan Academy, you’ve taught many people, whether virtually or in person. What exactly have you learned from teaching people?

SK: I think it was a great benefit that Khan Academy originated from me working with my cousin. It helped me learn that most people are capable of learning “hard” subjects if they just approach it right, as I saw it happen with my cousin. And then I started seeing it happen with the videos as I made them. Usually when you come into contact with reality, it makes you more cynical, but teaching my cousin in the early phases made me more optimis- tic. People are way more capable than others may think.

MG: As high school kids at our school, we’re definitely thinking quite a lot about college. Many of us are interest- ed in STEM careers. Do you have any advice for students seeking to work in a STEM career and make an impact on their community, as you have?

SK: I would give the advice to pay attention to your school work, because that’s always important, but potentially put more emphasis on your ability to create things and work on a portfolio. The creation process will definitely be more meaningful to you and it will make you learn more at a deeper level. Also, when you apply for a job after college, your degree will matter but showing a company the things you’ve created already carries more weight, and it will continue to carry more and more weight in the fu- ture. When at college, try to learn and do as much as you can. Always try to be searching for great mentors—you’d be surprised at how many people would enjoy mentor- ing you. If you’re always open to stretching yourself and taking feedback and are willing to act on it, the world will come out and try to help you. And then when you get into the workforce, make sure you always have space for your passions. You can do any career, but if that career requires you to be spending all your time trying to pay the bills, then it squeezes out all other parts of your life.

MG: Some of us may still be still trying to find our pas- sions. Any advice?

SK: At this time, the important thing is to create space for you to try multiple activities and experiences. If you have the mindset of “I’ve never tried improv comedy before, let me try out,” it might be the worse experience you ever had, but you’ll grow from having had that experience. Or, it might become something that you’re really into. You never know; so don’t try to shy away from things that you might not be good at. There’s recently been much litera- ture about having a growth mindset: be okay with failure, embrace it, that’s how you’ll grow the most.

MG: I think it’s interesting that you mention the growth mindset because our school is the oldest public school in the nation and we’re definitely very steeped in tradi- tion to some degree. But many of our classes are now shifting to towards the newest thinking strategies like the growth mindset. Particularly in our science department, we’re adapting a lot of the growth mindset concepts. I appreciate your insights on that. On a similar vein, what would you say is the most important quality in a student?

SK: Again, I would say it’s the growth mindset, coupled with the openness to feedback and reflecting on feedback. That’s what really correlates to success later in life, as studies have repeatedly shown. If you can take feedback and reflect on it, and you keep asking for more, that’s a powerful signal to others.

MG: What would you say is the most important quality in a teacher?

SK: Well, I don’t know if I’m fully qualified to comment on that, but I think it’s a lot about having an empathy and respect for the students. Students don’t know the mate- rial yet before you teach it, so I think it’s ineffective to make the students feel small or intimidated for not know- ing that topic yet. Treating them as equals who just don’t know it yet is much more effective, which I try my best to do in my videos.

MG: You’ve made so many videos. Which Khan Acade- my video/course has been your favorite?

SK: I think it’s a great idea! I don’t want to do it person- ally. I’m happy here on Earth. But I’d love to see more effort identifying exoplanets suitable for life and more re- sources towards finding other sources of intelligent life. Colonizing the moon makes a lot of sense too, for other reasons.

MG: Random question: What’s your own opinion of col- onizing Mars?

SK: That’s nice to hear. I always tell people at Khan Acad- emy to only make a video on something if they’re truly passionate about it.

MG: Hope that in ten years we’ll be reaching billions of people. I think it was a great benefit that Khan Academy helped me through high school! Have a nice day!

SK: That’s nice to hear. I’d like to again thank you so much for taking the time to talk with me. Personally I feel very privileged to be speaking to someone who has impacted the education of so many people, and whose videos have helped me through high school. Have a nice day!
A mosquito. About half a centimeter long. How dangerous could it be? If it is an *Aedes* mosquito, perhaps very dangerous. That is because it could be carrying a disease like dengue or the Zika virus.

The Zika virus was discovered in Uganda in 1947 in rhesus monkeys during a study on sylvatic (single) yellow fever, another mosquito-transmitted disease. The virus is actually named after the Zika rainforest in Uganda. Five years later, the first cases of Zika virus in humans were reported in Uganda and Tanzania. Since then, Zika virus infections have occurred around the world in tropical areas of Africa and Asia. The virus, however, did not raise much attention until recently, possibly because the people there have built up immunity against Zika, and because the disease has symptoms similar to that of other diseases transmitted by the *Aedes* mosquitoes like dengue and chikungunya. A person can be infected with Zika through a bite from an infected mosquito, but the Centers for Disease Control and Prevention (CDC) also states that the virus can be transmitted from a pregnant mother to her newborn child and through sexual contact.

Transmission through blood transfusion has occurred in previous outbreaks and has been reported in Brazil. The Zika virus has received significant media attention because of the recent outbreak in the Americas, especially Central and South America. Brazil is in the midst of an outbreak that started in 2015. The Zika virus has impacted other places before as well; there was a large Zika outbreak in French Polynesia in 2013. Texas reported the first American case two months ago. As of March 23, 2016, the CDC has reported 273 cases of Zika virus, including 19 pregnant women, in the United States, which were all contracted due to travel. On March 28th, the Arizona Department of Health Services confirmed the first Zika case in Arizona, adding Arizona as the thirty-seventh state to report a case of the Zika virus. The increasing number of countries reporting cases of Zika virus demonstrates its quick geographic expansion.

Zika has mild symptoms. The incubation period, or the time from exposure to the virus to when the symptoms occur, is unclear, but likely is a few days. The symptoms include fever, muscle and joint pain, conjunctivitis (pink eye), headache, and skin rash, much like other arboviruses (viruses transmitted by arthropods). These symptoms usually last up to a week, but the virus can remain in the blood for a week or more. Many people do not experience symptoms, and so do not know that they have been infected. Therefore, the number of reports is just a small fraction of the number of actual infections, since the CDC estimates that eighty percent of infections will not be diagnosed. There is no vaccine or medicine for the Zika virus, but rest, hydration, and painkillers usually treat the symptoms. Although few people die from this disease, Zika virus causes a birth defect known as microcephaly in newborn babies if the mother is infected. Microcephaly is a condition in which a newborn baby's head is smaller than average, often due to a lack of brain development, and there is currently no known cure. This is serious because microcephaly is linked to many other problems later in life, such as seizures, developmental delay, and intellectual disability. This has resulted in a huge debate over women’s rights to contraception and abortion, especially in Latin America. The Brazil Ministry of Health has also recorded an increasing number of people with Guillain-Barré syndrome (GBS) correlating to the increase in Zika virus infections, as well as an increase of people who have both Zika and GBS. GBS is a rare autoimmune disease, in which the immune system attacks healthy cells, in this case nerve cells, resulting in muscle weakness and perhaps neurological damage. The CDC is attempting to work with Brazil to find a possible link between Zika and GBS. One possibility is that Zika triggers GBS in a small percentage of infections, since GBS is often reported to follow a bacterial or viral infection. Massachusetts has already had three cases of Zika virus, but the likelihood of a huge outbreak is low because Massachusetts does not have a tropical climate. If you have the symptoms mentioned above and may have had contact with a Zika-infected person recently, laboratory tests can determine whether or not you are infected based on the presence of Zika virus ribonucleic acid (RNA) in bodily fluids.

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*JUST HALF A CENTIMETER LONG BUT DANGEROUS*

*uncovered*

CAUSES A BIRTH DEFECT IN INFANTS CALLED MICROCEPHALY
As early as the mid-nineteenth century, greenhouse gases, such as carbon dioxide, have been known to trap heat in the Earth’s atmosphere. Over the last 400,000 years, our atmosphere has never had a carbon level above 300 parts per million (PPM). Ever since the Industrial Revolution, however, the level of carbon dioxide in the air has skyrocketed to levels previously unseen, reaching well past 400 PPM. Yet, global warming’s direct and indirect impacts on our world have been highly debated, and there are many disagreements over how exactly it will impact our daily lives in the future. But one thing is certain: ice melts in warm temperatures, and this is no different for the ice caps at the extreme ends of our planet.

In the recent past, renowned scientists from highly regarded institutions have published studies stating that by the year 2100, sea levels will have risen by three to four feet. Even with this conservative estimate of sea level rise, the United States would suffer from losing land the equivalent of the size of the entire state of Massachusetts—that is, unless we take timely action to cut carbon emissions or spend billions of dollars on coastal fortifications. Very recently, however, two scientists released results from a study based on computer-generated models of the Antarctic climate. They show startling results: the West Antarctic ice is very vulnerable to collapsing with only little warming of the water, and just this area of ice contains enough to cause a 15-foot rise in sea levels if melted. Once this collapses, the rate of melting would accelerate even faster. For instance, the Thwaites Glacier in West Antarctica has already gained a head start on its journey to being converted to water—it already has begun creating tall, unstable cliffs that are very vulnerable to warming.

Furthermore, the Earth has limited resources of fossil fuels, which cannot be replenished. With the rate at which we consume them today, they will soon run out—likely by the end of the twenty-first century. If we burn all of the reserves, several studies confirm that all the ice on earth would most likely melt. We cannot continue pursuing the path of recklessly abusing our fossil fuels—it will lead to a diminished and gloomy future for both mankind and our Earth. Living in First World countries, we do not feel the direct impacts of this climate change today. People living in the Pacific islands, however, have already started to feel the strong and sudden impacts of rising sea levels.

Island countries such as Tuvalu, Kiribati, and the Maldives are situated primarily near sea level, and are surrounded by water. While some of these reef islands are capable of growing and changing shapes as a result of sediment shifts, the infrastructure on the islands cannot move. As a result of rising seas, people are forced to move out of their homes, and higher tides have routinely washed out entire low-lying portions of the islands. While these impacts are not currently seen in the United States and will likely not be seen for a while, they have already become unavoidable facts of life for people living in those Pacific nations. As a result, the countries themselves are often, if not always, much poorer than Western nations. Thus, the impacts on these countries are much greater, and the people have a harder time recovering from these disasters. If we do not work together to curb fossil fuel usage, such devastation will strike us sooner than we think.
THE HUNT FOR PLANET X

Once there were nine planets in our solar system: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune, and Pluto. In 2006, the International Astronomical Union (IAU) redefined what constitutes a planet: following the discovery of the dwarf planet Eris. In order for an object in the solar system to be a planet, it must now meet the following requirements: the object must orbit around the Sun; the object must be massive enough to be rounded by its own gravity; and the object must have cleared the neighborhood around its orbit. This means that the object must be gravitationally dominant and that there may be no other objects of similar size besides its satellites underneath its gravitational influence. Pluto does not pass the third requirement and is now considered a dwarf planet.

Planetary scientists Konstantin Batygin and Michael Brown of the California Institute of Technology have found evidence that there may be another planet in our solar system, theorized to be a gas giant about the size of Neptune. They inferred its presence from a peculiar clustering of six objects orbiting beyond Neptune, finding that there is only a 0.007 percent chance that this clustering could be a coincidence. Instead, it is likely that a planet with the mass of ten Earths has brought the six objects into their strange elliptical orbits, which are tilted out of the plane of the solar system.

The orbit of the inferred planet would be similarly tilted. Its closest approach to the Sun would be seven times farther than that of Neptune, which is approximately 30 Astronomical Units (AU). An AU is the distance between Earth and the Sun, which is about 150 million kilometers. This planet could roam as far as 600 to 1200 AU from the Sun, orbiting it every 15,000 years. A theory for why Planet X is so far away is that when the solar system was created 4.5 billion years ago, this giant planet was knocked out of the planet-forming region near the Sun and then slowed down by its own gas before it settled in a distant elliptical orbit.

Since Planet X is so far away from Earth, there is no visual of it as of yet. However, there have been many gravitational effects pointing to an unseen celestial body somewhere in our solar system. For example, in 1846, French mathematician Urbain Le Verrier predicted the existence of a giant planet from irregularities in the orbit of Uranus. From this prediction, astronomers at the Berlin Observatory found Neptune where he predicted it to be.

There were additional disturbances in Uranus's orbit, however, which led scientists to believe that there might be another planet. In 1906, Percival Lowell began the search for Planet X at his new observatory in Flagstaff, Arizona. More than half a century later, new calculations based on measurements by the Voyager spacecraft revealed that the orbits of Uranus and Neptune were undisturbed, and thus its existence was disproved.

People all over the world are still looking for Planet X. In the 1990s, scientists explained that a Jupiter-sized planet at our solar system's edge could explain the origin of certain, random comets. Just last month, researchers claimed to have detected the faint microwave glow of an outsized rocky planet some 300 AU away by using an array of telescope dishes in Chile called Atacama Large Millimeter Array (ALMA). Brown was, one of many skeptics, saying that the ALMA's narrow field of view made the chances of finding such an object slim.

Brown got his first clue of his current hypothesis of Planet X in 2003, when he led a team that found the object known as Sedna, an object a bit smaller than both Eris and Pluto. Sedna's odd and far-flung orbit made it the most distant known object in our solar system at the time. Its closest point to the Sun lies at 76 AU, which is beyond the Kuiper Belt, a region outside the influence of Neptune's gravity. It was clear that there was something massive that must have pulled Sedna into its distant orbit.

Astronomers have some ideas about the approximate location of Planet X, but spotting it will not be easy. Since objects in highly elliptical orbits move fastest when they are close to the Sun, the planet spends very little time at 200 AU. The problem is, if it were there right now, it would be so bright that astronomers would have already spotted it.

Planet X likely spends most of its time between 600 and 1200 AU from the Sun. Most telescopes capable of seeing a dim object at such distances, such as the Hubble Space Telescope or the Keck telescopes in Hawaii, have extremely tiny fields of view.

However, there is one telescope that can help. Subaru, a telescope in Hawaii, has enough light-gathering area to detect such a faint object. This allows astronomers to scan large parts of the sky each night. Batygin and Brown are currently using Subaru to look for Planet X. Brown says it will take about five years for them to search most of the area where it could be. Through this long process, Brown's team is hopeful for a groundbreaking discovery.
Snowy owls are snow-white birds, hence their name, which live in the arctic tundra. They feed mostly on small, mouse-like creatures called lemmings, although they also eat other animals such as rabbits, birds, and fish. Since the bare tundra they live in does not have many trees, snowy owls perch on short posts or simply on the ground, where they keep a sharp eye out for their prey. The snowy owl has excellent eyesight, which is helpful for locating exposed prey, and it makes use of its keen sense of hearing when prey is hidden under leaves or bushes. Once it has located its prey, a snowy owl will attack with its formidable talons. Unlike most other species of owls, the snowy owl is not nocturnal, but active from dawn to dusk, especially during the summer.

Another unusual trait of snowy owls is the fact that they adjust the number of eggs they lay based on food supply. If their main source of food decreases, they will lay fewer eggs until it increases again. Some seasons, when there is simply not enough food, owls will go without laying any eggs. When they do, though, the mother snowy owl will incubate them while the father catches food and feeds her. One month after they are laid, the eggs will hatch and the chicks will be born with a soft white down, which is eventually replaced by light brown feathers. The male chicks’ plumage will grow to be white as they get older whereas the females’ will remain slightly darker with brown markings. Though snowy owls are capable of flying about a month and a half after hatching, their parents keep them in their care for at least the next ten weeks. Later, when the snowy owls mate, they remain mates for life, and are often observed very close and affectionate with their mates. Whether you study the snowy owl carefully or simply look at a picture of it, the creature is sure to invoke much curiosity and interest.

Astronomers have discovered a new planet, which they have named KELT-4Ab, about 685 light years away from Earth in the constellation Leo. This planet is one of the only four transiting planets in triple star systems that have been discovered thus far. Star systems occur when a group of stars orbit each other because they are bound gravitationally to one another. A triple star system, the second most common type of star system after the binary star system, involves three stars orbiting each other. In addition to being one of the few planets discovered in one of these star systems, KELT-4Ab is also a Hot Jupiter planet. Hot Jupiters are giant planets that are more massive than Jupiter, but orbit closer to their star than Jupiter does to the Sun. KELT-4Ab is considered a Hot Jupiter because it is about one and a half times the size of Jupiter, the largest gas giant in our solar system.

Currently, astronomers are studying planets similar to KELT-4Ab because their discovery will have implications for our understanding of planet formation and evolution. The first Hot Jupiter was discovered in 1995, and the presence of two or more stars in a system could help scientists learn how planets settle into their orbits. In addition, planets that do form within multiple star systems may arise in regions between the stars that present climates suitable for terrestrial life. At any rate, more and more new discoveries are being made daily, and better technology is being developed to help scientists understand more about the mysteries of our universe.
The Science

Torque is the measure of a force’s tendency to rotate about a point or axis. In seesaws, this rotation point is the fulcrum, or balancing point. The formula to find torque is \( t = F \cdot d \), where \( t \) is the torque, measured in Newtons-meters, \( d \) is the perpendicular distance of force from the axis of rotation, measured in meters, and \( F \) is the force, measured in Newtons, applied by the object. In a fully balanced seesaw, the torque of an object is simply the force exerted by the object (10 times the mass) multiplied by the object’s distance away from the fulcrum. The force is equal to the mass multiplied by ten due to the force of gravity exerted on every object (10 N/kg). Also, in a balanced seesaw, the torques on one side of the seesaw must cancel out the torque on the other side.

The Activity

Observe the diagram above. Masses and distances have been given. Based on the givens, identify \( x \), using your knowledge of torque. The answer is a positive integer.

Example

Left Side:
\[
F = 10 \text{ N/kg} \times 20 \text{ kg} \times 10 \text{ m} = 2000 \text{ Nm}
\]
Right Side:
\[
F_{\text{smaller ball}} = 10 \text{ N/kg} \times 3 \text{ kg} \times z \text{ m} = 30z \text{ Nm}
\]
\[
F_{\text{larger ball}} = 10 \text{ N/kg} \times 14 \text{ kg} \times (7+z) \text{ m} = (980 + 140z) \text{ Nm}
\]

Now, using algebra, we can determine the value of \( z \).

\[
2000 = 170z + 980 \\
z = 6 \text{ m}
\]