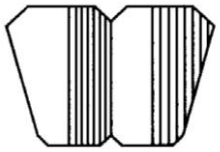
THEMATIC RESEARCH II

Annual Report on Research Activities

Abstracts in English



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Kyoto Prefectural Rakuhoku High School

Contents

Biology

Physics & Earth Sciences

Difference in Freezing Point Depression between Concentrated and Dilute Solutions

Shiori HIRAHARA, Mana YOSHIFUJI, Aya NAKAYAMA, Moe YASURA

Abstract

Have you ever wondered what happens in the world below 0°C? Our experiment began with a simple question: “How cold can ice water get when salt is added?” To explore this, we examined how the freezing point of sodium chloride solutions changes with concentration and compared our results with theoretical values. In dilute solutions, the freezing point decreased exactly as theory predicts. However, in concentrated solutions, factors such as uneven cooling and changes in concentration due to partial freezing caused significant deviations, with markedly higher values appearing at concentrations like 4.0 mol / L.

Keywords: freezing point depression, dilute solution, concentrated solution

Accelerating Catalytic Reactions Using Light ~ Using Titanium Dioxide to Make a Blue Solution Colorless ~

Sakura TAKEKAWA, Yumiko HIRONAKA, Ami MATSUI

Abstract

We search about Accelerating catalytic reactions using light. Our hypothesis is Anatase Form TiO2 has higher reaction than Rutile Form TiO2 because the former has higher photocatalvtic activity than the latter, adding glycerins supplies electrons to holes and has more readily reactions and adding NaOH makes the solution basic and has positive reactions. We experiment by mixing each TiO2 with water,baking it, dipping it in methylene blue, and exposing it to UV light. The results showed that adding NaOH to methylene blue promotes decomposition, the Rutile Form exhibits lower absorbance than the Anatase Form, and 300°C was optimal for both forms. We consider that under basic conditions, the decomposition of methylene blue pigment occurs rapidly. The UV light used in this experiment was suitable for the rutile type. At 200°C, the firing was insufficient.

Keywords: TiO2, catalytic reactions, methylene blue

Which Cold Pack Stays Cool the Longest?

~ Battle of the Cold Pack by Chemical Comparison ~

Risa TANDA, Ayaka TAKAHASHI, Risa KAWANO, Saika SHIRAI

Abstract

The purpose of this project was to find a better combination of substances that enhances cooling performance. Most cold packs are made of 99% water and 1% superabsorbent polymer. In this experiment, we changed the water component of the ice pack to another aqueous solution. Water 100 g and 150 g, 5% and 20% glucose solutions, 5% and 20% urea solutions, 5% and 20% starch solutions, and 5% and 20% ethanol solutions were prepared, and cold packs were made using each of these as the base material. Each cold pack was placed in a bag and frozen. After they were completely frozen, the temperature was measured every five minutes to determine the minimum temperature and cooling time. Our results show that ice packs made of water maintain the lowest temperature for the longest duration compared to other aqueous solutions and that ice packs made of aqueous solutions have a lower initial temperature. This effect can be explained by freezing point depression, the decrease in a solvent's freezing point when solutes are added.However, this also lowered the melting point and reduced the overall durability of the cooling pack. Therefore from our results, we conclude that water is the most effective and durable phase-change material, maintaining lower temperatures as its proportion increased.

Keywords: cold pack, superabsorbent polymer, freezing point depression

Let’s Make Strong Bioplastic!

Kurumi ANAZAWA, Maho MASUDA, Sae ADACHI, Tamaki MIZUSHIMA

Abstract

The purpose of this project was to develop bioplastic with high tensile strength. We blended water, starch, glycerin and vinegar (acetic acid), heated it and dried it. Now, we define this products as bioplastic. We changed some conditions such as whether to use glycerin and vinegar or not, the kinds of starch and the amount of starch. These products' tensile strength is measured by a Digital Force Gauge (Mxmoonfree). We found out that plastic which was made from equal parts of starch and rice starch was strongest. Therefore, blending the best rate of water, amylose and amylopectin is important to make bioplastic with high tensile strength.

Keywords: bioplastic, amylose, amylopectin

Is It Possible to Produce Threads from Recycled Paper?

Yuta OKAMOTO, Takuma MATSUNAGA, Ikumi YAMAGATA, Motoki YOKOYAMA, Yuki YOSHIDA

Abstract

The purpose of this study is to produce regenerated fiber from recycled paper. First, by combining NH3(aq) with CuSO4, we made Schweitzer Reagents, which are able to dissolve cellulose. Second, in order to determine if other substances have an effect on the regenerated fibers in addition to cellulose, we dissolved three kinds of paper varied in their content rate of cellulose, including cotton, filter paper and PPC. Third, we produced generated fibers by spouting this from hypodermic needle into H2SO4(aq). Finally, we measured the strength of each fibers. We proved that the more is cellulose content rate of materials , the stronger its fiber is and that impurities have an effect on its strength.

Keywords: regenerated fiber, rayon

Impression is Determined by Color! Blueprint of the Brochure

Koume FUJII, Saki UCHIDA

Abstract

Our research is about the impression of colors. Our goal is to make a brochure that many people are attracted. We sent questionnaires to all of the students in our high school. The questionnaire has two types of questions: one with multiple choices and the other for free responses. Our hypothesis is that more people will choose bright colored brochure, and people will write “cheerful” and “energetic” in the questionnaire for free responses. The data shows that our hypothesis of the questionnaire with multiple choices is correct, but that of the questionnaire for free responses is incorrect. Many people wrote “freedom”. However, our study is not enough to complete our final task. We should keep doing our study.

Keywords: questionnaire, brochure, optional questionnaire (multiple questionnaire)

Exploring the Use of Casein Plastic
~ Turning Milk into a Straw ~

Fumina KONDO, Misaki SATO, Saho SHIMIZU

Abstract

The purpose of the study was to make straws from casein plastic using milk. Vinegar was added little by little to boiled milk, and the solid casein that formed was filtered with gauze and shaped into straws. The straws were dried, then tested by soaking in water to see if they could resist water, and buried in soil to see if they would break down naturally. It was possible to make straws from milk, but they had a bad smell. When soy milk was used instead of cow's milk, the smell was better. However, in the water test, the straws became soft and soggy. In the soil test, a small loss of weight was seen, showing that they could slowly break down. We think that it was hard to use these straws for real life because they could not resist water. In the future, other ways to use casein plastic will be studied. Examples include disposable forks, spoons, and buttons.

Keywords: straw, casein, casein plastic

It’s Coming! It’s Coming! The Age When People Don’t Litter.

Reiya HAMAGUCHI, Syunsuke HAYASHI, Minoru YAMAGUCHI, Yuto NAKATA

Abstract

A survey was conducted on litter around Rakuhoku High School, mapping and analyzing the amount found in each location. Littering was especially common in busy areas, shopping streets, and around bus stops. The amount tended to increase in places without nearby trash cans. This study concludes that installing trash cans should be prioritized in shopping streets and school commuting routes. Going forward, the plan is to use GIS to visualize the locations of existing trash cans and the amount of litter, and to consider the optimal placement of new trash cans.

Keywords: environmental science, pollution, trash cans, mapping, littering

Removing Heat from Gymnasiums Using Airflow ~ As Emergency Shelters without Electricity ~

Haruna KUROKAWA, Hana KONDO, Sayako NOGUCHI

Abstract

Gymnasiums, which are used for various purposes such as educational activities and emergency shelters during disasters, have recently experienced rising indoor temperatures due to global warming. According to previous studies, the WBGT inside gymnasiums can sometimes exceed the outdoor value. The main factors contributing to the increase in WBGT are radiant heat and insufficient air circulation, the latter of which is attributed to the lack of effective ventilation pathways in typical gymnasium structures. Previous research has also shown that improving ventilation can reduce WBGT. Based on this, the present study focuses on the effectiveness of ventilation as a means of cooling gymnasiums. First, the current airflow inside the gymnasium was examined to identify areas with poor ventilation and zones where warm air accumulates. To explore methods for increasing the ventilation rate, different window opening conditions were tested and the resulting changes in airflow were analyzed. Since cross-ventilation through diagonally positioned windows is known to be the most efficient in ordinary rooms, it was hypothesized that similar effects would be observed in gymnasiums.

Keywords: Airflow, Ventilation, Cross-Ventilation

Development of Allergy-free Pudding

Yuu MIZUTANI, Mako IMAI, Suzuna OKUDA

Abstract

Pudding is a popular dessert, yet allergy-friendly versions made without eggs and milk are still not widely available. Our goal was to identify substitute ingredients that allow the creation of an allergy-free pudding that can be easily prepared at home and that matches the taste, texture, and color of traditional pudding made with eggs and milk. We produced five types of puddings: a control pudding made with milk and eggs, and four allergy-free puddings prepared using different plant-based milks and coagulants. Pumpkin powder was added to each allergy-free sample to provide color. We compared the puddings based on four characteristics: sugar level, moisture content, color, and shape retention. Results indicated that that the allergy-free puddings were less yellow than the traditional pudding. Based on taste testing, the pudding made using a mixture of soy milk and almond milk and coagulated with agar and gelatin in a 1:1 ratio was the closest in quality to the control pudding.

Keywords: pudding, agar, gelatin, plant-based milk, culinary science, allergy-free

How Can We Design Good User Agreements for High School Students? ~ An Attempt Using Emoji ~

Naho FUJISAWA, Nanami TAKEDA

Abstract

We want to prevent high school students from having problems caused by skipping reading user agreements. We created two types of user agreements: a normal version and an emoji version, and conducted a comprehension check for second-year students at Rakuhoku High School. As a result, the number of students who scored high on comprehension on the emoji version was larger than that of the students who took the normal version. Therefore, we think that emojis have a positive effect on understanding user agreements for high school students. However, the number of students who scored 0 points on the emoji version was twice as large as that of the students who took the normal version. Thus, emojis can also hinder their understanding.

Keywords: emoji, user agreement, questionnaire, comprehension, linguistics

One-sided Metric Space ~ Investigation of Removing Symmetry from Metrics ~

Sanaka AOYAMA

Abstract

In mathematical studies, there are a lot of papers that generalize the conditions of existing theories and develop the previous studies. My study is the same type of developing existing theory, removing symmetry in axioms of metric. Similar previous pseudo metric studies are well-known to mathematician. The reason why I would consider removing symmetry condition is that I felt there were few propositions which use it in their proof. Although this idea eventually turns out false during my research, at the same time, I found the importunateness of symmetry condition through comparing metric space and one-sided metric space. And I discovered that there are some “good” laws holding in one-sided metric space.

Keywords: mathematics, geometry, metric space, quassi metric, asymmetrical metric

Can the Scent of Perilla Kill Microorganisms!?
~ Let's Lead to Death Them in the Bathroom! ~

Ayane FUKUI, Ouka AMANO, Haruka HIRAOKA, Haruna NUNOME

Abstract

Perillaldehyde is said to kill microorganisms. We hypothesize that perillaldehyde can lead microorganisms to death and it can be applied to daily life, such as in the bathroom. We have three reaction time conditions and four perillaldehyde concentration conditions to test the effect of perillaldehyde against microorganisms. Our results showed that perillaldehyde at a concentration of 0.5% or above can kill microorganisms. Perillaldehyde may be able to be applied to daily life. We plan to test the effect of the perillaldehyde vapor against the microorganisms.

Keywords: Perillaldehyde, perilla, antibacterial, microorganisms

Investigating Dubia Roaches' Ability of Phototaxis and Sharing Information

Koichi ISODA, Tamaki FUKAMI

Abstract

We studied the phototaxis and information-sharing ability of Dubia roaches. Our hypothesis was that if we could observe a positive or negative reaction to light, we would be able to examine their phototaxis. The information-sharing ability here refers to the idea that their feces contain aggregation pheromones. If the feces contained these pheromones, we expected the roaches to gather more in that area than in places without them. Both experiments were carried out using devices we made ourselves, and we were able to observe negative phototaxis.

Keywords: phototaxis, information-sharing ability, Dubia roaches,

What Factors Are Related When Zebrafish Try to Distinguish Human Faces?

Misaki YAANA, Sayaka SUZUKI

Abstract

Our purpose is to find detailed conditions for what enables fish to discriminate between human faces. We put the shapes in different places of an aquarium tank. We secured the position of the shapes, and we fed only in the side of shape A. We put the shape alternating left and right without feeding and recorded the number of fish which were in the A area. Zebrafish moved to the right side because we feed them only in the right side. Then, We changed the position of shape A in random. To test them, We guided zebrafish in each side and put the shape in the other side. When the partition which separated them completely was taken out, we counted the number of zebrafish passing under the partition. There was no large differences between the rate of shape A and B. Zebrafish didn't memorize the shape. Going forward, we will try another way to make zebrafish memorize the shape.

Keywords: ichthyology, fish psychology, zebrafish, two shapes, partition, training, testing

Creating a More Efficient Electricity Generating System

Amane YAMASHITA, Takumi HATAYAMA, Atsuki HABU, Mana FUJISAWA

Abstract

When winds hit a building, it makes vortexes around the building. These vortexes make “vortex-induced vibrations”, which cause the building to shake. The purpose of this project is to create an efficient system to generate electricity making use of vortex-induced vibration. We used PVC pipe and a plastic pipe to create vortexes and winds created by a circulator hit the pipe, generating electricity. We measured the intensity of the current and voltage, and evaluated whether this system could generate electricity, and whether it was efficient. We made four kinds of this system; using a spring, a string, lifting up the metal rod, and changing the materials of the pipe. These experiments show that the third system was the most efficient of the four. The data also demonstrates that the material used for the pipe doesn’t have an effect.

Keywords: vortex-induced vibration, wind, pipe

The Best Curve to Launch a Marble

Kouei YAMADA, Yukio KATSURA, Koichi SAWABE, Yusei TAKAHASHI,
Shoichi MATSUMOTO, Daichi OZAKI

Abstract

We became interested in whether the efficiency of converting motion direction varies for each curve under conditions involving air resistance and friction. Then, we aimed to find the curve that can convert horizontal kinetic energy into vertical kinetic energy with the least amount of loss. We used five curves including Cycloid, Clothoid, Arc, Cycloid rotated 90° and Clothoid rotated 90°. Based on the length of each curve, we expected that the Cycloid curve would be the most efficient one. We made a apparatus that has the following three parts. Straight section for accelerating the marble, where we installed a Gauss accelerator consisting of 5 neodymium magnets and 1 iron ball. Curved section to convert the direction of motion from horizontal to vertical. To standardize conditions, we unified the curve height to 30cm as shown in the diagram. Straight section for measuring the converted velocity.A glass marble was launched into the apparatus using a Gauss accelerator, and its initial velocity is measured. Then, the velocity of the marble after its direction of motion is converted is also measured. The result showed that Cycloid rotated 90° was the most efficient curve. Our hypothesis was incorrect. We had expected that the rank of the curve of cycloid would be first place. However, it was fourth. We learned that there was another factor other than we had expected. We can't expect friction and air resistance only by considering the length of each curve. We will have to think about rotational kinetic energy and the friction from normal force coming from centripetal acceleration.

Keywords: dynamics, curve, air resistance, friction

Hyperboloid Structure ~ Twisting Makes It Stronger~

Arisa SAKAMOTO, Izumi IMAI, Mizuki WATANABE, Rumi UKAII, Chiu HIRATA, Misaki TANIGUCHI

Abstract

The purpose of this project was to determine what effects the strength of hyperboloid structures. We made hyperboloid structure models with pastas, wooden board, and straws. We cut the board into a circle and glued eight short straws along the circumference. These are pasta attachment points, so we inserted the pastas into each straws with angles which is set as θ. We made models with different θ and φ patterns(let φ be the twist angle). This experiment showed that the larger the twist angle is, the stronger the hyperboloid structure is. Since hyperboloid structures are said to have high strength against lateral forces, we plan to investigate that force in the next experiment.

Keywords: hyperboloid structure, the twist angle, buckling load

Is Dilatancy Water? ~ Dynamics of a Rotating Body Slowing Down in a Shear-thickening Fluid ~

Kohei HASHIMOTO, Kazutoshi HORATANI, Keigo MURAI, Yoko SASAKI, Ririka NAKATSUKASA

Abstract

When making fried pork using flour, water, eggs, and other ingredients, you may notice that the flour–water mixture can behave like a solid when stirred or pressed. This type of mixture is often referred to as a dilatant fluid. Scientifically, this is a fluid whose apparent viscosity increases with increasing shear stress. A well-known example is a cornstarch and water mixture at a certain ratio, which exhibits the peculiar property of behaving like a solid when an external force is applied. This observation led us to wonder about the specific relationship between the external force applied to such a fluid and the “hardness” we perceive. In this study, we investigated the behavior of a dilatant fluid when a cylindrical rod was rotated within it. By constructing a theoretical model and comparing it with experimental data, we evaluated the model’s validity. Furthermore, assuming the model is valid, we used it to estimate parameters such as the viscosity coefficient and flow index of the dilatant fluid.

Keywords：dilatancy, flow index, torque (rotational force), condensation

Why Is the Two-half Hitch So Tight?

Shinya Kashima, Ryota OKI, Koudai TORISHIMA, Ichito HIKOSO, Kenta FUJIWARA

Abstract
The two-half hitch is made by tying a half-knot twice. For this experiment, we will understand why the two-half hitch is a secure knot, and how much strength it actually is. We consider friction to be a major factor in this experiment and we hypothesized that the two half-hitches knot tightens as friction increases with applied force and changing the force leads to a proportional change in the knot's internal pressure. We measured the friction coefficient between rope and rope, and between rope and metal. To do this, we hooked a rope onto either the rope or the metal, suspended a weight from that rope, and then hooked a spring scale onto it. We measured the value when the rope moved, repeating this procedure 20 times for each different weight. The friction was 1.205 for rope and rope and 10.17 for rope and metal. In the rope and rope test, the highest force was about 3 N, while in the rope and metal test it was about 2 N. The friction for rope and metal became very large, probably because the rope surface was damaged by rubbing against the metal. Such as rope stretching, slipping, and mistakes when reading the video also affected the results.
In conclusion, I was able to measure the friction between the rope and the materials. The results show that friction is a major factor in how strongly the Two-Half Hitch tightens. However, I could not measure the pressure inside the knot. For future work, I want to check if the knot is really hard to loosen, try using silicone spray to change friction, and compare these results with other knots.

Keywords: two-half hitch, secure knot, friction, rope, metal

Which Megaphone Is the Best Efficient to Deliver the Sound?

Toshiki KIYOKAWA, Tomohiro YOKOYAMA, Kohei KIMURA, Yoriaki SAKATA, Minoru SUGIHARA

Abstract

We investigated the conditions for a "highly directional megaphone" to project voices farther. To do this, we attached a megaphone to a speaker and measured the sound at a point directly ahead, a fixed distance away, and three points to the left and right, the same distance apart. The results showed that the sound was louder on the right side when a megaphone was attached, but the number of experiments was small, so the results were not very useful. This could be due to a malfunction of the speaker or the small number of trials. Therefore, we would like to increase the number of trials to obtain more useful results.

Keywords: megaphones, directional, increase the volume