Simple Small Scale and Low Cost of Galvanic Cells as a Teaching Tool for Electrochemistry

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In this investigation, a simple method for the fabrication of small-scale and low-cost galvanic cells was developed as a teaching tool for electrochemistry of high school students. The method was designed according to the concept of "Green chemistry" reducing use of chemicals, less waste generation, and time consumption while retaining the experimental concepts. In this work, these galvanic cells contain various electrodes, including Cu, Zn, Al, Mg and Fe, and a low cost salt bridge which was made from a cotton thread (with the length of 18 cm) soaked with electrolyte solutions. Our experimental setup corresponded to the conventional platform; however, herein using much less electrolyte volume (2.00 mL). The cells were studied for the optimum conditions including concentration of electrolyte of each cell (0.01 M), the solutions employed as salt bridge (0.01M KNO_3) as well as the study of reagent lifetime of electrolyte (720 h). The results obtained from the constructed galvanic cells were compared to those from the conventional method. According to the t-test, the cell potential values obtained from both methods were comparable (t_{stat} = 2.414, $t_{crictical}$ = 2.447) at p = 0.05. The analysis of pre-test and post-test scores of students (before and after using the developed cells, respectively) was also performed revealing the mean values of 4.69 and 8.15, respectively, with the difference of mean percentage for the pre-test and post-test scores being 34.89 %. CV (coefficient variation) was 24.09% and 15.82% for the pre-test and post-test, respectively. According to the paired-samples t-test analysis, the scores of the two examinations were significantly different ($t_{observed}$ = 9.55, $t_{critical}$ = 2.07) at P = 0.05. The improved post-test scores obtained from the students indicate their increased understanding towards the small scale galvanic cells. The approaches presented herein are expected to be cost-effective and useful teaching method incorporated into high school education.

Keywords Small scale; Galvanic cell; Salt bridge; High school

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Simple and Low Cost Galvanic Cells based on Paper Device

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The simple and low cost galvanic cells based on the paper device have been fabricated. The filter paper was patterned with channels by drawing technique using wax pen and template. The individual half-cells are constructed by placing small pieces metals in the slit in its corresponding channel and adding metal ion solution on the corresponding metal ion. A salt bridge between the half-cells is provided by placing a few drops of aqueous potassium nitrate on the filter paper along the path connecting the half-cells. The cell potentials were measured using a multi-meter. Due to low cost, easy and fast fabrication, the developed device is appropriate for the use in the high school laboratory as a model to introduce the students to galvanic cells and electrochemistry.

Keywords High school laboratory; Hands-on learning; Electrochemistry; Galvanic cells

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Undergraduate Students' Projects on Computer-Assisted Instruction in Chemistry during Year 2005-2013

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The senior chemistry projects were designed to provide undergraduate students with an opportunity to prepare the chemistry skills before being a student teacher in the high schools before they completed a bachelor's degree from the Faculty of Education, Thaksin University, Thailand. During 2005-2013, the numbers of projects on Computer-Assisted Instruction (CAI) were collected in the department of chemistry. The samples used in the study were 29 projects from 49 undergraduate students. Students select a chemical topic and software of interest. The valuations of CAI projects were studied and classified. The CAI was reviewed by experts in chemistry before the oral examination and evaluation. One of the popular topics for CAI in Chemistry was physical chemistry (34.4%). Because of physical chemistry is suitable for creating the CAI in the term of application and application of thermodynamics principles. Authorware, Captivate and Flash software were used for creating the CAI projects. The advantages of each program were discussed.

Keywords Computer-assisted instruction in chemistry

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Esterification of Ethanol and Butanol with Lauric Acid using Amberlyst BD20 Ion-exchange Resin under Continuous Water Removal

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Fatty acid alkyl esters have been used in several applications, produced by esterification reactions of fatty acids with alcohols using appropriate catalysts. The strong acid ion-exchange resin has been proven to be an effective heterogeneous catalyst for the esterification reaction and easier to separate from product than traditional catalysts, such as sulfuric acid. The esterification reaction is a reversible reaction, this reaction usually do not go to completion but reach an equilibrium, then the reactants will always remain in system and low yield of products are obtained. The water removal, by-product of the esterification reaction, is the method to shift equilibrium to forward side of the reaction for achieve high yield of products. In this study, the esterification of lauric acid with ethanol and butanol were studied under continuous water removal condition and using Amberlyst BD20 as a catalyst. The effects of processing parameters, reaction temperature (80-110^{o}C), molar ratio of lauric acid to alcohol (1:1-1:8), catalyst loading (0-12%wt) and water removal by adsorption were studied. The reaction system consists of a batch reactor couple to an adsorption column and using zeolite 3A as an adsorbent. The results showed that Amberlyst BD20 ion- exchange resin was an effective catalyst for the esterification of lauric acid with both ethanol and butanol. The conversion of lauric acid increased with increasing of lauric acid to alcohols ratio. The water adsorption column can enhanced the conversion by up to 20% as compared to the system without water removal, and allowed the use of lower lauric acid to alcohols ratio. The optimum conditions were observed at lauric acid to alcohols ratio of 1:4, temperature of 110^{o}C for the reaction with butanol and 80^{o}C (boiling temperature of mixture) for the reaction with ethanol, under continuous water removal.

Keywords Adsorption; Amberlyst BD20; Esterification

Development of Inexpensive, Self Assembled pH Meter and its Graphical User Interface for High school Chemistry Activities

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With the emergence of Do-It-Yourself electronics and, notably, the arrival of microcontroller like Arduino and Raspberry Pi, many kind of sensors can now be constructed with less effort than ever before. In this work, we reported the development of inexpensive pH meter aimed for high school chemistry activities. The combined hardware was tested against aresearch gradebenchtoppH meter. We observe no significant difference between the pH measurement from our instrument and from a research grade benchtop pH meter. The Graphical User Interface (GUI) was designed and programmed to facilitate the collection of pH data. In addition, the classroom activities involving pH meter were planned and tested with a group of high school students from Suksanari School, Bangkok. The conducted survey clearly indicated that students appreciate this hands-on experience of conducting experiment with such devices.The activities involving the use of inexpensive pH meter help improving their understanding in acid-base chemistry and buffer capacity concept.

Keywords pH meter; High school chemistry activities; GUI development

Gold Nanoparticles as Catalyst for Fermentation of Bananas: Nano Science Project

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Energy from fossil fuel will be depleting soon. Therefore many scientists are working hard to search for alternative energy sources. Here, ethanol was produced from the fermentation of banana in the presence of yeast. Gold nanoparticles were synthesized by electrolysis of golden leaves and used as an additive for the fermentation of banana. The concentration of produced ethanol was determined by the following equations.

$$2Cr_2O_7^{2-} + 16H^+ + 3C_2H_5OH \longrightarrow 4Cr^{3+} + 11H_2O + 3CH_3COOH$$
$$Cr_2O_7^{2-} + 14H^+ + 6I^- \longrightarrow 2Cr^{3+} + 3I_2 + 7H_2O$$
$$2S_2O_3^{2-} + I_2 \longrightarrow S_4O_6^{2-} + 2I^-$$

The results showed that the concentration of ethanol increased when using higher amount of yeast. In addition, the concentration of ethanol was much higher in the presence of additive gold nanoparticles. This project was experimented with students at Thungsong School, Nakhon Si Thammarat.

Keywords Gold nanoparticles; Fermentation; Ethanol

Three Levels of Chemical Representation in Gravimetric Method: Mechanism of Precipitate Formation

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Precipitate formation mechanism is one of the concepts in gravimetric method which is abstract. In order to assist the third year students in science education program to understand more clearly, the designed experimental activity which was relevant to the three levels of chemical representation at macroscopic, sub-microscopic and symbolic level was introduced. There were two mechanisms involved in the precipitation process: nucleation and particle growth. The experiment was designed to study the mechanism of precipitate formation. Firstly, in macroscopic level, the sulfate complex was precipitated in Na_2SO_4 sample by adding $BaCl_2$ solution. At symbolic level, Ion Product (*Q*) was calculated to predict the precipitation. If the *Q* was more than K_{sp}, the precipitate would occur in the supersaturated solution. The observation of the students in the precipitation phenomenon by particle type (ion, colloid and precipitate) was carried out with naked eye and red laser pointer at sub-microscopic levels. Finally, at sub-microscopic level students understood the mechanism of precipitate formation with the connection between macroscopic level and symbolic level. Within this activity, the students were able to explain the mechanism of $BaSO_4$ precipitate formation at the macroscopic, sub-microscopic and symbolic levels in laboratory report.

Keywords Three levels of chemical representation; Precipitate formation mechanism; Barium sulfate

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Electrochemical Synthesis of Silver Nanoparticles for Teaching in the Topic of "Electrolytic Cell"

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The synthesis of silver nanoparticles by electrochemical reaction was studied, because there was economical and safe. The time and electricity were studied. The silver sheets were used as a cathode and anode with the sodium citrate as a reducing agent. The current electrolysis was 18 volt for 3 min. The maximumabsorption (λmax)was 408 nm. The Tyndall effect ofsilver nanoparticles waschecked the tyndall effect by using the red laser pointer andthe particle size werestudied by usingtransmission electron microscopy (TEM). The result showed that the light passes through of the solution and the average particle size was 20 nm. The silver colloid solution was stable for 120 hours. By the way, this is economical, safe and "green chemistry"This experiments can be applied to teach the undergraduate students inthe topic aboutelectrolytic cell or nanotechnology.

Keywords Silver nanoparticles; Electrochemical synthesis; Sodium citrate; Electrolytic cell

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Active Learning of Printing Ink Separation by Column Chromatography

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Active learning for a chromatography experiment was assigned for two groups on 42 undergraduate students' major science - chemistry, Faculty of Education, Thaksin University. This study was conducted to investigate the effects of active learning applications, based on constructivism, considering students' misconceptions and difficulties of chemistry. The objective was desired to improve the students' learning through the academic exhibition. Treatment groups (n = 12) were studied by demonstrating the separation of printing ink by column chromatography to the visitors in the academic exhibition. According to Student's t test, these significant differences were between the treatment group and control group ($p<0.05$). The mean scores of treatment group reports and control group were 8.92 ± 0.92, 7.12 ± 1.78, respectively. The satisfaction scores from visitors were in the most satisfied level (Mean = 4.28, S.D.= 0.06).

Keywords Column chromatography; Active learning; Academic exhibition