SELECTED WINNING ENTRIES of MTSF SCIENCE EDUCATION AWARD

PEMENANG PENYERTAAN YANG TERPILIH
ANUGERAH PENDIDIKAN SAINS MTSF
(2000 - 2011)

MTSF

Malaysia Toray Science Foundation
(269817-K)
Yayasan Sains Toray Malaysia

In collaboration with/Dengan kerjasama
The Ministry of Education Malaysia
Kementerian Pendidikan Malaysia
and
Southeast Asian Ministers of Education Organisation (SEAMEO)
Regional Centre for Education in Science & Mathematics (RECSAM)

MTSF SCIENCE EDUCATION AWARD - Selected Winning Entries (2000 - 2011)

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Message

TIMBALAN PERDANA MENTERI
(DEPUTY PRIME MINISTER)

I am delighted to learn that Malaysia Toray Science Foundation (MTSF) is publishing the third edition of the MTSF Science Education Award Book, comprising the past winning entries, for free distribution to all Malaysian secondary schools. As good resource and reference materials for the science teachers, the book compilations will further arouse students' interests in the science education which our Government is currently emphasizing.

On behalf of the Education Ministry, I applaud Toray Malaysia Group and its parent company, Toray Industries Inc., of Japan for establishing this private charitable science foundation way back in 1993 to enhance and promote science and technology in Malaysia. I am pleased to learn that MTSF has over the last 18 years carried out the various three prestigious awards and grant programs successfully.

I am impressed with the MTSF Science Education Awards, which reward science teachers and educators for creative and innovative science teachings at schools. MTSF has indeed mooted a genuine platform for Malaysian science educators and teachers to "think out of the box", thus nurturing innovation and creativity.

Besides the liberalization of educational policies to promote school-based management and teacher empowerment, the Education Ministry is revising school curriculum to develop all-round individual, equip basic skills and inculcate moral values. The introduction of cooperative learning will further involve students in sharing ideas and collaboratively complete the academic tasks given.

As innovation depends much on knowledge, experience and skills of our human capital, the Education Ministry together with the Ministry of Science, Technology and Innovation (MOSTI) and other relevant agencies are always working towards a solid framework for science, engineering and technology in the country, through various incentives and support for knowledge transfer.

In concluding, I thank Toray Group for this unfailing CSR contributions, commitments and dedications to Malaysia. We certainly look forward to seeing more of MTSF programs in the coming years.

(Y.A.B Tan Sri Dato' Hj. Muhyiddin Bin Hj. Mohd Yassin)
Deputy Prime Minister Of Malaysia

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ARAS 4, BLOK BARAT, BANGUNAN PERDANA PUTRA
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Tel.: 88881950 Faks: 88880035

Messages

MESSAGE FROM THE CHAIRMAN OF MTSF
YBhg. Academician Professor Emeritus Tan Sri Dr. Omar Abdul Rahman

It gives me great pleasure to pen a few words on the publication of the third edition of selected winning entries of MTSF Science Education Award, for free distribution to all the Malaysian schools. MTSF has indeed accomplished another milestone.

Since its inception in 1993, MTSF has worked untiringly towards fulfilling its noble objectives of promoting science and technology in Malaysia. The Foundation is gratified that the three programs, namely Science & Technology Award, Science & Technology Research Grant and Science Education Award have attracted enthusiastic and growing response over these years.

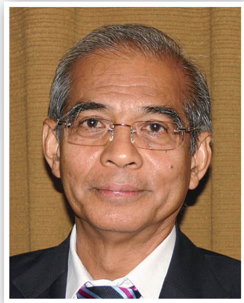
This third Science Education Award Book publication is most timely as it will significantly enhance and promote science education in Malaysian schools. Apart from using this book as a reference book, the science teachers and educators can effectively adopt these innovative and effective teaching methods in their respective secondary schools and pre-university colleges.

The compilation of this book would not have been possible without the strong support and close collaboration rendered by the officers and selected teachers from the Ministry of Education and RECSAM at the MTSF 4^{th} Editing Workshop held from 25 to 28 June 2012. We wish to record our thanks and appreciation.

In conclusion, I would like to extend our gratitude to the Ministry of Education, Ministry of Science, Technology & Innovation, RECSAM and MTSF Committees and Secretariat for all the support and assistance towards the smooth running of the Foundation.

Thank you.

Academician Professor Emeritus Tan Sri Dr. Omar Abdul Rahman



MESSAGE FROM THE CHAIRMAN OF MTSF SCIENCE EDUCATION AWARD EXAMINATION COMMITTEE
YBhg. Academician Professor Emeritus Tan Sri Dr. Syed Jalaludin Syed Salim

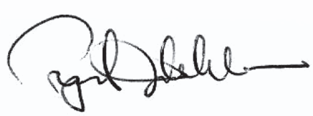
On behalf of MTSF Science Education Award Examination Committee, I am pleased to announce that MTSF has successfully completed and published the third edition of the selected winning entries of MTSF Science Education Award, from the Years 2000 to 2011.

Over the past 18 years since inception, MTSF had awarded a total of RM960,000 to some 289 science teachers and educators, in recognition of their innovative and creative methods in teaching science. I am sure that their respective students have greatly benefited from these innovative science teaching methods. We hope this third book publication will spur other science teachers and educators to embark on better ways of science teaching so as to produce logical thinking students.

It is heartening to note that MTSF has succeeded in generating much interests and enthusiasm among Malaysian science educators and teachers since its inception in 1993. Our success is largely attributed to the strong support and close collaboration rendered by the various ministries, government agencies, universities, institutions, secondary schools and colleges.

Taking this opportunity, I thank the Ministry of Education, RECSAM and MTSF Secretariat for the arduous tasks in compiling this third book publication.

Thank you.



Academician Emeritus Professor Tan Sri Dr. Syed Jalaludin Syed Salim

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MALAYSIA TORAY SCIENCE FOUNDATION
(*YAYASAN SAINS TORAY MALAYSIA*)
(2698 l7-K)

LIST OF 2000-2002 WINNING ENTRIES
(*SENARAI PEMENANG 2000-2002*)

Prizes	2000	2001	2002
Winner Prizes (*Pemenang*) RM5,000 each	▪ Mr. Ching Lee Hook, Selangor ▪ Mr. Tan Chung Yong, Sarawak ▪ Dr. Ivan Douglas Filmer Jr, Penang ▪ Mr. Ooi Gim Ewe, Penang ▪ Mr. Claudius Liew Sze Kiong, Sarawak	*RM8,000 each* ▪ Dr. Ivan Douglas Filmer Jr, Penang ▪ Ms. Jacinta Chan Suan Khin, Sarawak *RM6,000 each* ▪ Mr. Ching Lee Hook, Selangor ▪ Ms. Khaw Ai Guat, Sarawak ▪ Ms. Suria Zunita Bt Nasrul, Penang ▪ Mr. Ooi Gim Ewe, Penang	*RM6,000 each* ▪ Ms. Chan Siok Gim, Kelantan ▪ Mr. Liao Yung Far, Melaka ▪ Ms. Tan Mun Wai, Kuala Lumpur ▪ Ms. Zarina Abdul Naim, Kedah ▪ Mr. Goh Teng Keang, Penang
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Awarded	RM51,000	RM70,000	RM66,000

MALAYSIA TORAY SCIENCE FOUNDATION
(*YAYASAN SAINS TORAY MALAYSIA*)
(2698 l7-K)

LIST OF 2003-2005 WINNING ENTRIES
(*SENARAI PEMENANG 2003-2005*)

Prizes	2003	2004	2005
Winner Prizes (*Pemenang*) RM6,000 each	▪ Dr. Choo Voon Mooi, Penang ▪ Mr. Tan Ming Tang, Sarawak ▪ Ms. Chiang Yu Lian, Sarawak ▪ Mr. Al Mumin Bin Al Kanta, Sabah ▪ Ms. Bhul Vindar Kaur, Perak ▪ Mr. Loh Chee Kwong, Sabah	▪ Mr. Ching Lee Hook, Selangor ▪ Mr. Goh Teng Keang, Penang ▪ Ms. Bhul Vindar Kaur, Perak ▪ Ms. Sia Peng Yee, Johor	▪ Ms. Sia Peng Yee, Johor ▪ Mr. Ling Toh Woon, Kuala Lumpur ▪ Ms. Bhul Vindar Kaur, Perak ▪ Mr. Jong Chung Hian, Sarawak ▪ Mr. Krishnasamy a/l Samynathan, Penang
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Awarded	RM70,000	RM58,000	RM68,000

MALAYSIA TORAY SCIENCE FOUNDATION

(*YAYASAN SAINS TORAY MALAYSIA*)

(2698 l7-K)

LIST OF 2006-2008 WINNING ENTRIES

(*SENARAI PEMENANG 2006-2008*)

Prizes	2006	2007	2008
Winner Prizes (*Pemenang)* RM6,000 each	▪ Mr. Ling Toh Woon, Kuala Lumpur ▪ Mr. Tan Jui Yong, Johor ▪ Mr. Chong Cham Kong, Johor ▪ Mr. Tan Han Bin, Kuala Lumpur	▪ Mr. Yeo Peck Cheng, Sabah ▪ Mr. Jong Chung Hian, Sarawak ▪ Ms. Sia Peng Yee, Johor	▪ Mr. Wong Foo, Sabah ▪ Ms. Sia Peng Yee, Johor ▪ Mr. Yip Chi Kiong, Negeri Sembilan
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Awarded	RM62,000	RM60,000	RM50,000

MALAYSIA TORAY SCIENCE FOUNDATION

(*YAYASAN SAINS TORAY MALAYSIA*)

(2698 l7-K)

LIST OF 2009-2011 WINNING ENTRIES

(*SENARAI PEMENANG 2009-2011*)

Prizes	**2009**	**2010**	**2011**
Winner Prizes (*Pemenang*) RM6,000 each	▪ Mr. Eyu Foo On, Kelantan ▪ Mr. Lau Yong Fuei, Perak ▪ Ms. Lim Ai Lee @ Lim Irene, Kuala Lumpur	▪ Mr. Mohd Ikhwan Hadi Yaacob, Perak ▪ Ms. Tan Mun Wai, Kuala Lumpur ▪ Mr. Lau Pik Ying, Sarawak	▪ Ms. Tan Mun Wai, Kuala Lumpur ▪ Mr. Seow Yoke Hock, Kuala Lumpur ▪ Dr. Tan Ming Tang, Sarawak
Runner-up Prizes (*Naib Johan)* RM4,000 each	▪ Ms. Lau Yoke Yin, Perak ▪ Mr. Wong Foo, Sabah ▪ Ms. Loh Su Ling, Sabah ▪ Mr. Chong Cham Kong, Johor ▪ Ms. Chan Suan Khin, Sarawak	▪ Ms. Lee Bee Swan, Perak ▪ Mr. Chong Cham Kong, Johor ▪ Mr. Wan Zul Adli Wan Mokhtar, Perak ▪ Ms. Sia Peng Yee, Johor	▪ Mr. Lau Yong Fuei, Perak ▪ Mr. Saw Chun Lin, Perak ▪ Mr. Chong Cham Kong, Johor ▪ Mr. Wong Foo, Sabah ▪ Ms. Eng Guan Guch, Sarawak
Consolation Prizes (*Saguhati*) RM2,000 each	▪ Ms. Zarina Bt Abdul Naim, Perak ▪ Mr. Ching Lee Hook, Selangor ▪ Ms. Chan Chooi Seong, Kuala Lumpur ▪ Ms. Bhul Vindar Kaur, Selangor ▪ Mr. Tian Kian Wee, Selangor ▪ Mr. Ling Toh Woon, Kuala Lumpur	▪ Mr. Wong Foo, Sabah ▪ Mr. Ling Toh Woon, Kuala Lumpur ▪ Ms. Tay Kim Lan, Selangor ▪ Mr. Saw Chun Lin, Perak ▪ Mr. Yip Chi Kiong, Negeri Sembilan ▪ Ms. Ho Pui Shan, Sabah ▪ Mr. Mahamad Hanif Bin Mahamad Saad, Sarawak ▪ Ms. Hanizan Bt Husain, Selangor	▪ Ms. See Yike Chu, Selangor ▪ Dr. Suriani Abu Bakar, Perak ▪ Ms. Ho Pui Shan, Sabah ▪ Ms. Loi Lai Wah, Johor ▪ Dr. Yip Chi Kiong, Negeri Sembilan ▪ Mr. Alan Kho Thong Phing, Sarawak
Awarded	RM50,000	RM50,000	RM50,000

1

A SIMPLE HAND-DRIVEN ELECTROSTATIC GENERATOR
(PHYSICS – LOWER AND UPPER SECONDARY)

CHING LEE HOOK
SEKOLAH MENENGAH SRI KUALA LUMPUR
47500 SUBANG JAYA, SELANGOR

Background : Everyone is familiar with the fact that when a pen made of plastic material is rubbed on the shirt sleeve, it will attract small pieces of paper. When dry hair is combed with a plastic comb, it may produce a crackling sound. The crackling sound is caused by small electric sparks that may be seen if the room is in darkness.

This phenomenon of electrical attraction leads to the introduction of static electricity or electrostatic. This simple hand-driven electrostatic generator will charge perspex, acetate or glass sheets for many electrostatic experiments.

Objectives : The objective of this model is to indicate the presence of electrostatic charges. This model is made from easily available materials. Students can perform numerous experiments with static electricity.

Benefits for teaching and learning process : Students can understand the following:

(a) The fundamental law of electrostatic.
(b) Charges are electricity at high voltage. The phenomenon of lightning is related to the high charges in the clouds.
(c) A conductor or a frame made of conducting material can shield off electrostatic charges including lightning.
(d) Electricity is a flow of electrons or negative charges.

Apparatus/ materials :

(a) A piece of ½” thick plywood (12” x 12”).
(b) Two pieces of wood (4” x 1” x 2”).
(c) A piece of wood (12” x 1” x 2”).
(d) Two pieces of ¾” PVC elbow joints.
(e) A piece of ¾” PVC tubing (12” long).
(f) A piece of perspex (12” x 12”).
(g) A piece of acetate or glass (12” x 12”).
(h) Four pieces of ½” thick plywood (3” x 6”).
(i) A piece of wool (3” x 6”), silk (3” x 6”), rubber sheet (3” x 6”) and polyethylene (3” x 6”).
(j) A milk bottle.
(k) A metal can lid or disc, 3” in diameter.
(l) A transparent plastic container or box (4” x 6” x 1”).
(m) A fluorescent lamp and a neon bulb.
(n) A small piece of coloured paper, polystyrene and aluminium foil.
(o) Six pieces of paper clips, small pieces of paper or pieces of polystyrene, 10 strips of tissue paper (1/4” x 8”).
(p) A piece of wire mesh (12” x 12”), a thick piece of wire (14”) and a short piece of wire.
(q) Straw and nylon, a plastic rod.

Construction and Implementation of the teaching aids :	**(a) THE ELECTROSTATIC GENERATOR [Refer 1-D1, 1-D2 and 1-P1]**

The plywood base, ½” x 12” x 12” and the wooden support for the rotating handle are assembled as shown. The rotating handle consisting of the ¾” PVC pipe and elbow joints are fitted through the 1” diameter hole in the wooden support. The friction pad is made up of 4 pieces of plywood, 3” x 6” x ½”. A piece of *polyethylene* (Refer **C** in **1-P1**), *wool* (Refer **D** in **1-P1**), *silk* (Refer **E** in **1-P1**) and rubber sheet is glued to each friction pad. Fix the *friction pad* (Refer **B** in **1-P1**) with the rubber base onto the rotating handle and place the *perspex, 12” x 12”* (Refer **A** in **1-P1**), on the base of the electrostatic generator. Rotate the handle about 20 times. The perspex will be charged. Replace the perspex with acetate or glass and use the friction pad with silk. The charge produced on the perspex, acetate or glass is used for the following experiments.

(b) LIGHTING UP A FLUORESCENT LAMP
[Refer 1-D3 and 1-P2]

A short plastic rod is glued onto the centre of the metal can lid or disc, 3” in diameter. This metal lid is to transfer electrical charges from the perspex to the fluorescent lamp. Place the charge-carrying disc on the perspex. Touch the metal disc with the finger for a moment and then lift the disc by the handle. The disc is now positively charged. Hold the fluorescent lamp at one end and bring the charged disc to the other end. A spark will jump and the lamp will light up briefly.

(c) A PAPER LEAF ELECTROSCOPE
[Refer 1-D4 and 1-P3]

The paper leaves are cut from ordinary paper. The parts are assembled in a milk bottle as shown in the diagrams stated. The charged perspex from the electrostatic generator is brought close to the disc of the electroscope. The leaves will separate, showing that the electroscope has acquired a charge.

(d) ELECTROSTATIC “JUMPING PARTICLES”
[Refer 1-P4 and 1-P5]

Line the bottom of the transparent box with aluminium foil. Put some light materials such as tiny bits of cork, small pieces of paper or pieces of polystyrene into the box. Close the cover as shown [**Refer 1-P4**]. Rub over the cover of the box vigorously with wool [**Refer 1-P5**] and the particles will fly to the cover, staying there for a while and then flying off again and so forth.

(e) ELECTROSTATIC CHARGE DETECTOR
[Refer 1-D6 and 1-P6]

Insert pin through the centre of the lid so that its pointed end sticks upwards. Balance the stiff paper and its centre on the point of the pin so that it can easily rotate. Rub a straw with nylon near the charge detector. The stiff paper will turn and point in the direction of the straw.

(f) ELECTROSTATIC "TREE"
[Refer 1-D7and 1-P7]

Bend a thick piece of wire, 14" long, at each end and form two loops. Cut 10 strips of tissue paper, each ¼" wide and 8" long. Fix the strips of paper through one loop. Support the wire on a stand as shown [**Refer 1-D7**]. Charge the piece of perspex, 12" x 12", with the electrostatic generator and bring it in contact with the free end of the thick wire. The strips of paper will spread out just like a palm tree.

(g) PITH BALLS
[Refer 1-D8 and 1-P8]

Hang the two polystyrene balls as shown in the diagram [**Refer 1-D8**], i.e. the pith balls which are very small, lightweight objects that pick up electric charge quite well. Bring a charged straw near and touch them. Remove the straw and the two polystyrene balls will repel each other.

(h) THE LEYDEN JAR
[Refer 1-D9 and 1-P9]

Wrap aluminium foil on the inside and outside of a glass as shown [**Refer 1-D9**]. Make a chain out of paper clips. Hang the chain on a plastic rod. The chain must touch the bottom of the inside foil. Bring the charged disc from the electrostatic generator near the top clip. A spark jumps to the clip. Repeat this a few times. Connect a short piece of wire from the outer foil to the clip. A powerful spark will be produced. The Leyden Jar can store electrical charges.

(i) SHIELDING THE ELECTROSCOPE
[Refer 1-P10]

Place an electroscope inside a wire mesh frame as shown [**Refer 1-P10**]. Bring any charged material near and there will be no effect on the electroscope. The electrostatic charge cannot penetrate such a shield.

(j) THE COMPLETE ELECTROSTATIC KIT
[Refer 1-P11]

Suggestions for modification :

1. Measurements should be in S.I. units.
2. Be more specific in the instruction with clearer measurements and illustrations.
3. To include extension activities to clarify scientific concepts or principles, e.g. for objective No. (d).

2	**CALENDAR ALIVE** **(PHYSICS – LOWER SECONDARY)** **TAN CHUNG YONG** **SEKOLAH MENENGAH BANTUAN ST. THOMAS** **JALAN MC DOUGALL** **93000 KUCHING, SARAWAK**

Background : The last chapter in the Form 3 syllabus, *The Universe*, is lacking in experiments and teaching aids. Many topics in this chapter are taught theoretically or by using simple charts. The following concepts are often taught isolated from one another:

(a) Changes of moon phases.
(b) High tide and low tide.
(c) Eclipses.
(d) Lunar calendar.

In fact, all these concepts are related with one another. The lunar calendar was used by our ancestors. Now it is still being used by us, especially in fixing the dates for religious festivals or other activities like fishing. The creation of the lunar calendar by various races in the past has shown the scientific wisdom of mankind and this should be appreciated. The lunar calendar is derived from the observation on the duration of the revolution of the moon around the earth. The revolution of the moon also brings about the phenomena of the tides and the eclipses that we experience on earth. Hence, these concepts are interrelated. Therefore, helping pupils to understand this relation inevitably increase their appreciation in science. But at present moment there are no available teaching and learning materials related to this topic.

Objectives :

(a) To enhance the prior knowledge of students and further translating what they have learnt about the concepts of the phenomena of *The Universe* into pictures.
(b) To form a device illustrating the pictures of the above phenomena.
(c) To understand the lunar calendar date, which moon phase, what kind of tide and when eclipses can possibly occur.
(d) To understand how the various concepts of *The Universe* are interrelated.

Benefits for teaching and learning process : The following are the benefits identified **[Refer 2-P1 and 2-P2]**:

- It is a student-centred lesson.
- Pupils can share what they have learnt in their science lesson with their family members.
- The concepts learnt can help pupils to relate science to everyday life.
- This is a simple and cheap teaching aid.
- This activity can help pupils to study the interrelation of the above concepts especially for those who have not experienced tides before.

Apparatus/ materials :
(a) Beads
(b) Wire
(c) Cardboard (Black and White)
(d) Paper (White, yellow, purple and blue)
(e) Geometrical set

Construction of teaching aids : These materials are shown in pictures **[Refer 2-P3]**

(a) Earth
Circular purple paper with radius 2 cm.
(b) Moon
Circular white paper with radius 0.75 cm.
(c) Sun
Circular yellow paper with radius 0.5 cm.
(d) Tide
Oval shape blue paper scaled with a 0.5 cm interval.
(e) Rotation disc
Black circular cardboard with radius 10 cm and center labelled O.
(f) Lunar calendar monthly dates **[Refer 2-P4]**
Consists of a series of numbers from 1 to 29 lined up a circle with outer radius of 9 cm and printed on a piece of paper.
(g) Front cover
Rectangular black cardboard measuring 45 cm x 46 cm.
(h) Back cover
Rectangular white cardboard measuring 45 cm x 46 cm.
(i) Beads and the wire
Two beads are used to hold the earth, the tide, the rotation discs and the back cover together by inserting a wire through the holes.

Implementation of the teaching :

(a) Pupils are given a set of materials (the earth, the tide, the moon, the lunar monthly calendar date, the rotation discs, the sun, the front cover, the back cover, beads and wire). They are requested to explore the making of the device, *Calendar Alive*, by following the steps given below:

(b) Step 1

Gum the papers showing the tide, the moon on the rotation discs as shown below **[Refer 2-D1 and 2-P5].**

(c) Step 2 [Refer 2-P6]

The rotating disc is placed between the earth and the back cover. A wire is inserted through all the holes and held in position by the beads at both ends.

(d) Step 3 [Refer 2-P7]

The lunar calendar monthly date is gummed onto the front cover enclosing the phases of the month and the sun is stuck at the middle of the outer edge. After that it is mounted onto the back cover.

(e) **<u>Step 4</u> [Refer 2-P6 and 2-P7]**

By rotating the rotation disc slowly, the following relationship can be investigated.

(i) How can the monthly date of the lunar calendar be fixed by the phases of the moon?

(ii) Changes in the height of the tide, is governed by the relative position of the moon and the sun. Thus the moon phases are related to the height of the high tide, which is varying at different times.

(iii) Investigate the phases of the moon that eclipses can possibly occur.

(f) Printed questionnaires are given to the pupils to guide them to relate these concepts. The ability and the prior knowledge of the pupils should be taken into consideration when preparing the questionnaire.

Suggestions for modification :

1. Use presentation slide or OHP to demonstrate the setting-up of the apparatus from the aforementioned Steps1-4.

2. Explain to the students the relative sizes of the models for the earth, moon and sun (use ratio if possible) to avoid misconception.

3

THE USE OF MATCHES IN TEACHING SCIENCE

(SCIENCE – CLASS ACTIVITIES)

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Background : The teaching of science in schools usually involves the use of scientific equipment that is purchased using school funds. This equipment is often relatively expensive but essential as pupils need to acquire the manipulative skills in handling scientific equipment in order to become scientists. There is often much apprehension on the part of the teachers when asked to allow pupils to handle equipment that is costly. As such teachers only carry out demonstrations to illustrate their use. Hence, pupils will be denied some vital training in manipulative skills or may even experience some difficulty in remembering certain principles for lack of hands-on inquiry approach.

There are also times when teachers do not have the appropriate equipment to teach certain scientific principles. In such cases, teachers need to innovate and tap their creativity to find substitutions for sophisticated or lack of equipment. The use of matches to teach five different topics in science is one attempt to provide teachers added resource to make the teaching and learning of science economical as well as enjoyable. It will give pupils the chance to perform the activities many times over thereby reinforcing learning. It also provides a non-threatening teaching and learning environment for both teachers and pupils.

Objectives :

(a) To provide an opportunity for pupils to practise science process skills (such as observation, prediction, formulation of hypothesis, experimentation and communication of findings) and manipulative skills.
(b) To make learning non-threatening and enjoyable and to reduce fear of breaking equipment.
(c) To provide an opportunity for pupils to carry out creative science activities.

Benefits for teaching and learning process : The use of matchbox and matches in teaching science will:

(a) arouse the pupils' curiosity to enhance learning.
(b) stimulate the development of more ideas in creative science teaching.

Apparatus/ materials : **Activity 1: Matchbox Lift** *(Friction: Form 2 Science)*

(a) Matchbox
(b) Paper
(c) String

Construction of teaching aids : **[Refer 3-P1]**

(a) Two holes are made at the opposite sides of a matchbox.
(b) A paper partition is placed at the centre of the tray of the matchbox.
(c) A string is passed through the holes in the tray over the paper partition.
(d) The paper partition is slightly longer than half the width of the tray so that the partition will hold the tray in place, once the string is drawn taut.
(e) The tray is then pushed into its case.

Implementation of the teaching : **[Refer 3-P2]**

(a) The matchbox is allowed to pass down the string when placed vertically.
(b) The string is then drawn taut and the matchbox stops moving downwards and remains stationary.
(c) The string is then slackened and the matchbox continues to move downwards.
(d) The teacher then poses the following questions to the pupils.
   (i) Why does the matchbox stop moving?
   (ii) What prevents the matchbox from moving downwards?
   (iii) What hypothesis can you suggest for this occurrence?
   (iv) How would you go about designing an experiment to test your hypothesis?
   (v) What materials would you need?
(e) The pupils are then provided with the necessary materials to test their hypotheses.
(f) At the end of the lesson, the teacher will open the matchbox to reveal the mechanism providing the frictional force to stop the matchbox from moving. Pupils are then asked to give other applications using this principle in their daily lives (examples: brake pads in bicycles and motor vehicles).

Apparatus/ materials : **Activity 2: Match Stick Stethoscope** *(Blood Circulation System: Form 4 Science)*

(a) Match stick
(b) 'Blu tack'
(c) Watch

Construction of teaching aids : A small piece of 'blu tack' or plasticine is attached to one end of a match stick.

Implementation of the teaching : **[Refer 3–P3]**

(a) The match stick with 'blu tack' is placed on the wrist of a pupil to detect the pulse. Adjust the match stick on the wrist until the pulse can be detected.
(b) The match stick may need to be loosened to show greater displacement of the match stick (The match stick measures the pulsation of the heartbeat).
(c) Pupils can measure their own heart beat per minute with the use of a watch.
(d) Pupils are then asked to measure rate of heartbeat of their friends.
(e) Readings must be taken at least twice to check its accuracy.
(f) Pupils tabulate their results and answer the following questions:
  (i) Who has the lowest rate of heartbeat?
  (ii) Who has the highest rate of heartbeat?
  (iii) What is the average rate of heartbeat of pupils in the class?
(g) Pupils are asked to record the rate of heartbeat of their family members. Data obtained can be used to discuss the following questions:
  (i) What are the factors affecting the rate of heartbeat?
  (ii) How would you prove that the rate of heartbeat is influenced by the age, race, height, weight, gender and physical fitness?

Apparatus/ materials : **Activity 3: Match Stick Trap** *(Water absorption and turgor pressure in plant cells: Form 4 Science)*

(a) Match stick
(b) One-cent coin
(c) Bottle
(d) Water

Construction of teaching aids : Match stick is bent into 'V' shape.

Implementation of the teaching : **[Refer 3–P4]**

(a) Pupils place the 'V' shape match stick over the mouth of a bottle.
(b) Then a one-cent coin is placed on top of the 'V' shape match stick.
(c) Pupils put a drop of water at the junction of the 'V' shape match stick and observe what happens.
(d) Teacher poses the following questions:
  (i) Why did the coin fall into the bottle?
  (ii) What caused the match stick to move?
  (iii) Explain the significance of this occurrence in terms of water absorption in plant cells.

Apparatus/ materials : **Activity 4: Match Stick Surfboard** *(Surface Tension: Form 1 Science)*

(a) Match sticks
(b) Basin
(c) Liquid detergent
(d) Water

Construction of teaching aids : (a) Fill a basin with water.
(b) Start the experiment only when the water is still.

Implementation of the teaching : **[Refer 3–P5]**
(a) Pupils drop a match stick gently on to the surface of water in a basin and observe what happens to the match stick.
(b) Pupils are then told to dip one end of another match stick in liquid detergent and place it gently it on to the surface of the water and observe what happens to the match stick.
(c) Teacher poses the following questions:
(i) What was the difference between the movements of both match sticks?
(ii) What caused this difference?
(iii) Give a possible explanation for this difference.
(iv) What is the significance of this principle to our daily lives?

Apparatus/ materials : **Activity 5: Match Stick Oxygen Gauge** *(Composition of Oxygen in Air: Form 1 Science)*

(a) 2 beakers (250 ml and 1000 ml)
(b) Box of matches
(c) Plasticine or 'blu tack'
(d) Rubber band
(e) Cardboard
(f) Water

Construction of teaching aids : (a) A match stick is attached to a piece of cardboard using plasticine or 'blu tack'.
(b) Fill the 1000 ml beaker three-quarters' full of water.

Implementation of the teaching : **[Refer 3–P6 and 3-P7]**
(a) Pupils place the cardboard with the match stick attached to it on to the surface of water in the beaker.
(b) Pupils then light the match stick and place an empty inverted 250 ml beaker over the burning match stick until the rim of the beaker is submerged under water and observe what happens.
(c) Pupils mark the level of water in the inverted beaker using rubber band.
(d) Pupils are asked to explain their observation and findings.

Alternative Approach:
Pupils are asked to devise an experiment to measure the proportion of oxygen in the air when given the necessary materials and apparatus.

Suggestions for modification : 1. To elaborate in greater depth regarding the teaching approach for each activity.

2. To clarify procedures for Activity 2.

4

PRODUCTION AND EFFECT OF ACID RAIN ON PLANTS
(BIOLOGY – UPPER SECONDARY)

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Background : The effect of air pollution in the form of photochemical smog, acid deposition, greenhouse effects and the destruction of ozone shield are major concerns to all. In Sarawak, among the major sources of air pollution are those originating from burning of fossil fuels, wood and automobile exhaust. The concern of the effects of air pollutants, like sulphur dioxide and carbon dioxide on plants is usually stressed to students; but it is usually difficult for them to visualize such effects.

Objectives :
(i) This activity provides a means of linking the presence of air pollutants, particularly sulphur dioxide and carbon dioxide, and their impact on growth of plants.
(ii) The effects of laboratory engineered 'acid rain' on plants can be studied.

Benefits for teaching and learning process : This activity is an example of active teaching and learning of science where students conduct an experiment on acidic gases rather than just discussing the effects of 'acid rain' on their environment. This experiment allows students to see for themselves the effects of 'acid rain'. The following are some of the benefits in this activity:

- Students can see the effect of acidic gases on plants.
- Students should be able to differentiate between quantitative and qualitative results.
- Students are able to relate production of sulphur dioxide and carbon dioxide to sources like burning of wood and fossil fuels.
- Environment and economic implications: student will be aware of the potential harm of continuous deforestation and burning on a long-term basis. Trees are no longer available to act as a 'sink' to take up carbon dioxide during photosynthesis.
- Cost effective – this experiment/demonstration cost little and can be conducted within a few days.
- Safety:
  (1) Students need not leave the school compound.
  (2) Students' health and well being will not be jeopardized.
- Moral values – cooperativeness, cleanliness, responsibility, willingness to be involved, curiosity.
- Thinking skills – identifying, comparing and contrasting, relating, predicting.

Apparatus/ materials	:	(a) Three (3) plastic bottles with covers (1.5 litre capacity) (b) A splinter (c) Matches (d) Duckweeds/vegetable seedlings/moss (e) Water
Construction of teaching aids	:	**Preparation of bottles**

1. Each group of students is required to bring 3 empty mineral water bottles of size 1.5 litres. Each of the bottles is cut into two with the bottom half of about 5 – 8 cm in height **[Refer 4-D1].** The bottom halves are filled with soil and students are asked to plant vegetable seedlings of their choice, collect pond duckweeds or moss. They are encouraged to use plants that are familiar to them and can easily be grown.
2. If seedlings are used, the seedlings need to reach a height of about 3 cm before they can be used **[Refer 4-P1].**
3. One bottle will be used as the control while the other will be used as the tested experiment.
4. To the inside of the upper half of the experimental bottle, students will fix 3 matches with craft glue **[Refer 4-P2].**

5 The matches are then lighted **[Refer 4-P3]**. Immediately, the upper half of the bottle is joined with the lower half and the two halves are sealed together with cello tape. Burning of the matchsticks within the containers releases both gaseous sulphur dioxide and carbon dioxide.

6. Water is sprayed through the mouth of both bottles. Spraying of water droplets simulate rain drops. The gases dissolved in the water will produce ‘acid rain’ **[Refer 4-P4].**
7. The two bottles are left for 2- 3 days to observe the difference of the plants in both experimental and control groups.
8. Students are required to find out the pH of the ‘acid rain’ produced in the experimental and control bottles. A piece of pH paper is placed at the bottom half. The matches are lighted in the experimental bottle and the upper and lower sections of the bottles are sealed. Water is sprayed in the two bottles. Students then checked the pH of the water in both bottles.

Implementation of the teaching : **A. <u>First lesson: Briefing and discussion on the procedures to conduct the experiment</u>**

This activity can be an investigation, a group experiment or a demonstration by the teacher. Students can also change the independent variable by using different number of matchsticks or different types of matchsticks for experimental sets.

Testing of the pH of water after burning will indicate that the water in the experimental bottle is acidic. Students are asked to give alternative ways of testing the acidity of the water in the bottle. They should discuss the advantages and disadvantages of each method. They are also encouraged to make improvement on the experiment.

B. <u>Subsequent days: Students record observations and draw conclusion</u>

Observation:

Most terrestrial plants in the experimental set turned yellow on the second day and died on the third day **[Refer 4-P5].**

Dramatic results are obtained from moss plants mainly because they don't have any protective surface. Pond duckweeds need about 10 days before any qualitative observations can be made **[Refer 4-P6].**

Conclusion:

Students are able to link the burning of wood and fossil fuels to acid rain and its effect on various types of plants.

If different numbers or types of matchsticks are used, they are able to observe the different results produced.

Suggestions for modification : **Food for thought for the students:**

1. Besides pH is there any other factors introduced during the process of carrying out the above experiment that may also affect the growth of plants in the experiment? If so how does it affect the growth of plants?

2. Suggest ways to improve the above experiment.

5

LENS KIT – LENS EXPERIMENTS USING A TUBE
(PHYSICS – UPPER SECONDARY)

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Background and Objectives : For the topic of *Images Formed By Lenses*, a number of laboratory experiments/activities are recommended for the Form 5 Science syllabus. Six of them are as below:

1. Investigate the characteristics of images formed by biconvex lenses.
2. Obtain the approximate focal length of a biconvex lens.
3. Determine the focal length of a biconvex lens.
   (a) using an illuminated object and plane mirror.
   (b) using measurement of object and image distances.
4. Determine the relationship between the object distance, image distance and focal length of a biconvex lens.
5. Build a compound microscope.
6. Build a simple (a) astronomical or (b) terrestrial telescope.

The conventional set-ups for these experiments have the following problems:

- The need for a dark room that some schools do not have.
- Images formed are not in line with the lens and the object, increasing errors in data collection and difficulty in finding images.
- Images formed are not sharp because light does not only pass close to the optical centre of the lens and thus increases error.
- The lens is moved instead of the object moving. This loses the sense of the relative change of image distance with change in object distance.
- Difficulty in obtaining satisfactory enlarged images for the compound microscope and telescope.

The conventional set-ups for these experiments/activities are as below [with reference to six of the aforementioned experiments/activities recommended for the Form 5 syllabus]:

1. To investigate the characteristics of images formed by biconvex lenses **[Refer 5-D1].**

3b. To determine the focal length of a biconvex lens using measurement of object and image distances **[Refer 5-D1].**

4. To determine the relationship between the object distance, image distance and focal length of a biconvex lens **[Refer 5-D1].**

2. To obtain the approximate focal length of a biconvex lens **[Refer 5-D2].**

3a. To determine the focal length of a biconvex lens using an illuminated object and plane mirror **[Refer 5-D3].**

5. To build a compound microscope **[Refer 5-D4].**

6. To build a simple astronomical/ terrestrial telescope **[Refer 5-D5].**

Problems arising from these set-ups result in the experiments either not done or students not getting accurate data. Much time is also lost trying to locate images.

Activities involving the compound microscope and telescope are almost not done as it is very difficult to obtain satisfactory enlarged images with these set-ups. As such students only go through the theory without the opportunity to actually try their hand in building these optical instruments and seeing the effect for themselves. The Lens Kit eliminates all of the limitations above.

Benefits for teaching and learning process : The Lens Kit can be used:

- in any place, it does not require a dark room.
- with minimal apparatus that are cheap and easily available.
- with a ruler on tube that reduces parallax error when reading the object and image distances.

In addition :

- Object, lens and image are aligned inside a tube to reduce errors and increase ease of obtaining images.
- Images formed are sharp because only light close to the optical centre of the lens is allowed to pass through.
- The object moves instead of the lens, thereby retaining the relative sense of movement of the image with the change in object distances.
- Images for the compound microscope and telescope are easily obtained. They are also very sharp and clear.

It is hoped that with this kit, teachers and students will have more opportunities to explore images formed by biconvex lenses and apply their theoretical knowledge to build for themselves functional microscopes and telescopes easily. This will also allow more time to discuss and analyze data obtained instead of spending all the time trying to obtain data.

Apparatus/ materials :

(a) Two PVC pipes a meter long each with slits of about 1 inch (or 2.54 cm) along each pipe with a connector.
(b) A meter rule is placed along each slit.
(c) Cardboards tubes from the core of toilet rolls or tapes as holders for lenses, screens, mirrors, objects etc.
(d) A torchlight as the light source.
(e) Biconvex lenses (f = 5 cm, 10 cm, 15 cm, 30 cm, 50 cm).
(f) Battery (size D).

Construction of teaching aids : The components:

(a) The tubes, connectors and meter rule **[Refer 5-D6].**

(b) Paper tube holder **[Refer 5-D7].**
(c) Cardboard screen, lens holders, mirror holders, objects **[Refer 5-D8].**
(d) Light source **[Refer 5-D9** and **5-D10].**

The set-up:

1. Place the object/screen/lens/mirror onto the tube holder. Shown here, the screen is placed onto the tube holder **[Refer 5-D11].**
2. Place the torchlight into the holder for the light source **[Refer 5-D12].**
3. Connect the tubes, if necessary using the connector **[Refer 5-D13].**
4. Slide the holders into the tube. Place the object, lens, screen, light source etc in positions as required. An example is given in the diagram **[Refer 5-D14].**

The Lens Kit set-ups for experiments/activities are as below [with reference to six of the aforementioned recommended for the syllabus]:

1. To investigate the characteristics of images formed by biconvex lenses **[Refer 5-D14].**
3b. To determine the focal length of a biconvex lens using measurement of object and image distances **[Refer 5-D14].**
4. To determine the relationship between the object distance, image distance and focal length of a biconvex lens **[Refer 5-D14].**

Procedure:

i. Slide in the light source, big object, lens and screen as shown in the diagram.
ii. Mark the position of the lens.
iii. Change and record the object distance by sliding the object together with the light source.
iv. Slide the screen until a sharp image is obtained.
v. Measure the image distance from the meter rule.

2. To obtain the approximate focal length of a biconvex lens **[Refer 5-D15].**

Procedure:

i. Slide in the lens and the screen.
ii. Direct the tube to a bright distant object outside.
iii. Slide the screen to obtain a clear sharp image.
iv. The distance between the lens and screen is the approximate focal length of the lens.

3a. To determine the focal length of a biconvex lens using an illuminated object and plane mirror **[Refer 5-D16].**

Procedure:

i. Slide in the light source, small object, lens and mirror as shown in the diagram.
ii. Slide the lens and mirror together until the image of the small object is sharp and clear beside the object.
iii. The distance between the small object and the lens is the focal length

of the lens.

5. To build a compound microscope **[Refer 5-D17].**

Procedure:
i. Slide in the screen, small object, objective and eyepiece into the tube.
ii. Adjust the position of the objective and eyepiece to get a clear sharp image.

Note:

The small object can be replaced with a thin slice of onion, underside of leaves or pollen grains **[Refer 5-D20].**
The opaque and transparent screen is optional. It is used to detect the position of the image formed by the objective.

6. (a) To build a simple astronomical telescope **[Refer 5-D18].**

Procedure :
i. Slide in the objective and the eyepiece.
ii. Direct the tube to a bright distant object.
iii. Slide the eyepiece until a sharp, clear inverted image is seen.

Note:

The opaque and transparent screen is optional. It is used to detect the position of the image formed by the objective.

6. (b) To build a simple terrestrial telescope. **[Refer 5-D19]**

Procedure:
i. Slide in the objective, erecting lens and the eyepiece.
ii. Direct the tube to a bright distant object.
iii. Slide the erecting lens and eyepiece until a sharp, clear upright image is seen.

Note:

An example is of a distant coconut trunk is given **[Refer 5-D21].**
The opaque and transparent screen is optional. It is used to detect the position of the images formed by the objective and erecting lens.

Implementation of the teaching : **1.** To investigate the characteristics of images formed by biconvex lenses.

Place the object, lens and screen in the tube. Fix the lens at the centre of the two connected tubes. Use the torchlight as the light source for the object. Images formed should be bright and sharp in normal lighting in the lab. If there is a directional light from one side of the lab, turn the tube so that the slit is against the light. Images will also be easily obtained as students slide the screen in the tube. Have students change the object distance and observe the characteristics of the images formed. Students can record their observations and discussions made based on their observation.

2. To obtain the approximate focal length of a biconvex lens.

Place the lens and screen into the tube. Direct the tube towards a bright object a distance away. Move the screen until a sharp image is seen. The distance between the lens and the screen is the approximate focal length of the lens.

3a. To determine the focal length of a biconvex lens using an illuminated object and plane mirror.

Place object with light source, lens and mirror into the tube. Move the object or lens until an image is formed next to the object. This is a simple experiment. The difficulty in the conventional set-up is the alignment of the different components. Usually one or more of the components is not aligned causing difficulty in finding the image. The alignment using the tube is so good that sometimes the image is formed on top of the object. In that instance, the mirror may need to be adjusted a little to see the image. Students can be asked to explain why this arrangement can be used to determine the focal length of the lens.

4. To determine the relationship between the object distance, image distance and focal length of a biconvex lens.

Place the object, lens and screen in the tube. The object distance is changed and the image distance is obtained. An experiment can be done here and graphs drawn can be used to determine a formula for the relationship between the object distance, image distance and focal length of the lens. In the tube, sharp images can be obtained just by sliding along the tube. Images are still clear and sharp more than 1 meter from the object. Data obtained are accurate, thereby allowing better interpretation of the graphs and determining the lens formula.

5. To build a compound microscope.

6 To build a simple (a) astronomical or (b) terrestrial telescope.

A simple project can be done here. Students are to build the compound microscope and the telescope using materials given or requested. This allows students to use all the theory that they know of lenses and images and apply it here. One of the things that students can see here is the image of the first lens that will become the object for the second lens using the opaque and transparent screen. Most students find it difficult to imagine that an image for one lens becoming the object for the second lens.

Suggestions for improvement :

1. The diagrams provided for illustrations could be improved.

2. Some of the concepts could be illustrated using formula and calculation.

6	**GRACE METHOD IN DETERMINING THE ARRANGEMENT OF LOADS IN ELECTRICAL CIRCUIT** **(PHYSICS– LOWER AND UPPER SECONDARY)** **LOH CHEE KWONG** **SMK SUNG SIEW** **90700 SANDAKAN, SABAH**

Background : One of the difficulties in electrical studies faced by secondary school students is determining the arrangement of loads in an electrical circuit, whether they in series or in parallel arrangement. This is due to the misconception of the terms "parallel", "series" and the comprehension of the term "potential difference".

Often teachers are inclined to introduce the parallel and series arrangement of loads in a simple geometrical form **[Refer 6-D1** and **6-D2]**.

As a result, when students are given a much complex circuit **[Refer 6-D3** and **6-D4]**, the students are baffled by the arrangement.

Objectives

Hence the purpose of this entry are:

- To introduce *Grace Method* in rearranging complex circuits to a simpler form.
- To give example to clarify the alternative conception of most students that parallel circuits are just circuits arranged in a simple geometrical form.

Benefits for teaching and learning process : *Grace Method,* a concept originated by the author, was developed in such a way to help students to rearrange complex circuits to simpler circuits which are much familiar to them and thus, clear the alternative conception they may have before. After implementing *Grace Method* the results were remarkable. Students were able to solve the questions at ease. Besides that,

- Students have a better degree of understanding about potential difference.
- Students have a better grasp at using voltmeters to measure the potential difference in a circuit.
- Students are not nervous when trying to solve questions which involve complex circuits, and as a result, they have better grades in the chapter on *Electricity*.
- Students were keen on trying out new methods on the arrangement of circuits.

Use of apparatus/ materials and construction of : Preparation of diagrams illustrating various types of circuits **[Refer 6-D1** to **6-D10].**

teaching aids

Implementation of the teaching : In the middle year of 2003, *Grace Method* was been introduced to teachers in Sung Siew Secondary School. After teaching students the basic arrangement of circuits, the Form 5 Science and Form 6 Science students tried to solve the more complex circuit arrangements as shown in diagrams **[Refer 6-D3** and **6-D4]**. They were initially unable to solve these questions. In the next lesson, the concept of potential difference was explained again and the *Grace Method* was taught to students.

Grace Method and its application

Grace Method
"Points which are not separated by any load are considered to be the same point"

Let us denote the resistors in the diagram **[Refer 6-D5]** as R_1, R_2, R_3, R_4, R_5 and R_6 and the points as P_1, P_2, P_3, P_4 and P_5 .

Applying *Grace Method*, we'll have:

$P_1 = P_2 = P_\alpha$
$P_3 = P_4 = P_\beta$
and
$P_5 = P_\gamma$

Let us rearrange the circuits in a much simpler form.

1. R_1 is connected to P_1. As $P_1 = P_\alpha$, we have the diagram **[Refer 6-D6].**
2. R_2 is connected to P_1, whereas R_3 and R_4 are connected to P_2 respectively. As $P_1 = P_2 = P_\alpha$, we have the diagram **[Refer 6-D7].**
3. R_2 and R_3 are connected to P_3, whereas R_4 is connected to P_4 respectively. As $P_3 = P_4 = P_\beta$, we have the diagram **[Refer 6-D8].**
4. R_5 and R_6 are connected to P_4 and P_3 respectively. Again, applying Grace method, we have the diagram **[Refer 6-D9].**
5. R_5 and R_6 are also connected to P_5. Applying Grace Method, $P_5 = P_\gamma$, we have the diagram **[Refer 6-D10].**

At this level, students will be able to recognize the different arrangement in this circuit as compared to the previous one.

Suggestion for improvement : Diagrams need to be illustrated further with sample students' calculations comparing with elaboration of their understanding of scientific concepts.

7	**AN EYE-OPENER INTRODUCTION TO MAGNETISM** **(PHYSICS– LOWER SECONDARY)** **TAN MING TANG** **MAKTAB PERGURUAN BATU LINTANG** **JALAN KOLEJ, 93200 KUCHING, SARAWAK**

Background : The topic *Magnetism* is found in both the Form 3 *Penilaian Menengah Rendah* (PMR) Science Syllabus and in the Semester 3 Science Teachers' Training Diploma Syllabus. Most science teachers begin this topic in a very direct and predictable way: the action of one bar magnet on another and the production of magnetic flux patterns by the use of iron filings. The utter predictability of such teaching sequences has caused more yawns to be produced than can be counted.

Objectives : There are four purposes of incorporating the use of magnetic toys and iron filings in liquids as part of the teaching process. They are:

(i) To arouse students' interest as they see magnetism at work. Students are able to appreciate the various magnetic toys available in the market and the science principles involved in their designs.

(ii) To introduce the game *Guess the Poles* using various magnetic flux patterns that are produced using the bottle of iron filings in liquid method.

(iii) To challenge students to think analytically and creatively the many daily applications and uses of the concept of "magnetism".

(iv) To emphasize and implement an innovative teaching strategy to further enrich the teaching of 'magnetism' in schools, that is, to put into practice the five phases of the constructivist teaching approach as outlined by Scott Dyson and Gater (1987) in the book *A Constructivist View of Learning and Teaching in Science*.

Benefits for teaching and learning process :

- The magnetic toys do not only complement the teaching and learning process, but they are also an eye-opener for students as they see magnetism at work. These toys are not only cheap but are also easily available in the market. In addition, they can be readily and easily modified by the teacher to enhance the effect of the magnetic field strength.
- As for the sprinkling of iron filings immersed in the bottle of baby oil, they can be readily and easily prepared by the teacher or students. This apparatus will help to prevent the normal mess of iron filings being blown all over the place during experimentation. Moreover, the iron filings can be prevented from rusting in the baby oil for quite a long period of time.
- The *Guess the Poles* game is student-centred and makes learning more enjoyable and meaningful. Thus it increases students' motivation and interest in magnetism.
- To relate science to everyday life, that is, the use of magnets in daily

life.

Apparatus/ materials : (g) Magnetic toys
(h) Iron filings immersed in a bottle of baby oil
(i) Bar magnets
(j) Magnetic burglar alarm

Implementation of the teaching : **A. <u>First Phase: Set Induction</u>**

To begin the lesson, the teacher will perform a demonstration involving two sets of magnetic toys (modified by the teacher so that the effect of the magnetic field strength can be seen clearly by the students).

(a) In picture **[Refer 7-P1]**, toy 1 can perform amazing acrobatics acts whereas toy 2 can only perform simple forward and backward motions. Both toys 1 and 2 are of the same type and brand.

(b) In picture **[Refer 7-P2]**, toy 3 can swing forward and backwards smoothly whereas toy 4's swings are very stiff and erratic and it stopped after a short period of time. Both toys 3 and 4 are of the same type and brand.

B. <u>Second Phase: Brainstorming Session</u>

After watching the demonstration for each set of similar toys, the students will be asked to explain why the toys behave so differently from each other. The teacher will only let them touch and examine the toys if they fail to furnish the required magnetic principles involved, that is "like poles repel and unlike poles attract".

Note: Most students, after figuring out the answer, will ask permission to examine and play with the above toys.

C. <u>Third Phase: Restructuring of Ideas</u>

The teacher will then explain to the students that the space surrounding a magnet in which a magnetic force is exerted is called a magnetic field, and that this magnetic force lines can be mapped by using iron filings.

A *Guess the Poles* game will then be introduced. Each group of students will be provided with the following materials: two bar magnets wrapped individually with a paper to conceal their poles, a sprinkling of iron filings immersed in a bottle of baby oil or coconut oil and a white piece of paper.

Place the bar magnet on top of the white piece of paper. By shaking the bottle lightly and then letting its flat surface rest on the bar magnet, the magnetic flux patterns can be seen clearly. The group that formed the most number of patterns with the various combinations of the two magnets and labelling their poles correctly will win the game. A time span of 15 minutes is given for the game. The winning team will be requested to present their endeavours (drawings) in front of the class **[Refer 7-P3** and **7-D1].**

D. Fourth Phase: Application of Ideas

After the completion of the above challenging game, the students in their own respective groups will be requested to discuss and list down as many uses of magnets as possible in school, at home and also in their surrounding environment.

Note : Uses of magnets as listed and presented by students include some of the following, i.e. pencil case lid, fridge magnet, mosquito netting frame, magnetic wrist-strap for watch, magnetic toys, and book cover-strap lid.

The teacher will then demonstrate the use of the magnetic burglar alarm as a prelude to teaching the topic of electromagnetism during the next lesson **[Refer 7-P4].**

E. Fifth Phase : Recall and Closure

To help students summarize the important information studied so far, the teacher will use a magnetic toy to demonstrate "the floating and spinning object in the air" experiment and the students will be requested to answer the following question:

"*Explain with the aid of a labelled diagram how the object is able to float and spin in the air without any visible support*" **[Refer 7-P5].**

Suggestion for modification : Neutral region should be identified in the diagram given.

8	**LIGHTS! ELECTRONS! ACTION!** **(BIOLOGY – FORM 6)** **BHUL VINDAR KAUR** **SEKOLAH MENENGAH KEBANGSAAN** **HORLEY METHODIST** **JALAN RAJA MUDA, 36009 TELUK INTAN, PERAK**

Background : In Form 6, the light reaction in photosynthesis involves knowledge, not only about the *photolysis* of water, but also details about the existence of *photosystems*, the process of *photoactivation* and the synthesis of ATP through *phosphorylation*. There is an electron carrier system embedded in the thylakoid membrane of the chloroplast molecules. In it, electrons from water or a photosystem (a cluster of chlorophyll pigments) pass from a higher level to a lower level one and energy from their exergonic fall is used for ATP synthesis.

Objectives : The theme of the model is *Lights! Electrons! Action!* and it plans to lift tedium, enlighten and entertain the students and make the lesson on the light reaction an interesting and memorable experience. This model use an interesting display of lights to clarify the new concepts introduced in Form 6 such as 'photactivation', 'photosystems', 'cyclic and non-cyclic photophosphorylation', 'photolysis' and the 'exergonic fall of electrons'.

Benefits for teaching and learning process : Students can understand:

(a) Concepts such as 'photactivation', 'photosystems', 'cyclic and non-cyclic photophosphorylation', 'photolysis' and the 'exergonic fall of electrons'.

(b) what actually happens in plants and how they convert light energy to chemical energy.

Apparatus/ materials :
(a) A 3' by 3' plywood
(b) Black paint
(c) Driller
(d) Two (2) blue light bulbs of 5W
(e) Two (2) green light bulbs of 5W
(f) Eight (8) yellow light bulbs of 5W
(g) Thirty (30) green candlelight bulbs
(h) Two (2) 5-gang one-way switches
(i) One (1) 1-gang one-way switch
(j) One (1) 4 channel running light control switch
(k) One (1) 13 Amp switch socket
(l) Wires
(m) One (1) main plug
(n) Electricity supply

Construction and Implementation of the teaching aid : **(a) THE MODEL OF LIGHT REACTION [Refer 8-P1]**

1. To make the model, a 3’ by 3’ plywood was used and painted black.
2. 12 holes were drilled so as to fit 12 light bulbs of 5W (blue, green and yellow bulbs) and the position of each bulb [**Refer 8-D1**].
3. These 12 bulbs represent the following:
   - the water molecule (blue)
   - the photosystem with its reaction center or *chlrophyll a* molecule (green)
   - primary acceptors of electrons dan electron carrier molecules (yellow)
   - the NADPH molecule (blue)
4. To represent the cluster of chlorophyll pigments that are found in Photosystem I and Photosytem II, thirty (30) green candlelight bulbs were fixed onto the board and arranged in two circles of 15 bulbs each around the central green bulbs numbered 5 and 10. The arrangement would be: 5 outside, 5 in the middle and 5 inside the circle, around the green bulbs numbered 5 and 10. When wired, these fifteen candlelight bulbs should light up from the outer circle into the inner circle.
5. To control the lighting of all the bulbs, the following need to be used:
   - Two (2) 5-gang one-way switches
   - One (1) 1-gang one-way switch
   - One (1) 4 channel running light control switch (model BCC 747)
   - One (1) 13 Amp switch socket
6. Each of the 12 colored bulbs (mentioned in Item 3 above) are wired to a switch each.
7. The green candlelight bulbs (numbered 1 and 12) are wired to the running light control switch.
8. All the switches for the whole model are wired to and controlled by one (1) main plug for electricity supply.
9. The numbers used for the light bulbs also show the order or sequence of lighting up. This, by the way, is under the control of the teacher since the bulbs are individually controlled by their own switches.
10. Each bulb on the model is labeled with the molecule it represents [**Refer 8-D1**]. The lines showing the passage of the electrons, the passage of hydrogen ions from the water molecule and the location of ATP synthesis through cyclic and non-cyclic photophosphorylation must also be drawn in.

(b) **The Guidance Method**

1. The *four* basic concepts of the *light reaction of photosynthesis* in plants are explained by the teacher.

   These are:

   - *Photosystems* - the light harvesting complexes made up of chlorophyll and protein molecules.
   - *Photolysis* - the splitting of the water molecule by light to generate hydrogen ions, electrons and oxygen.
   - *Photoactivation* - the absorption of light by chlorophyll molecules in photosystems to excite electrons contained within their reaction centers to a higher energy level.
   - *Photophosphorylation* - the synthesis of ATP i.e. the phosphorylation of ADP with $P_{i,}$ using energy harnessed from the exergonic fall of electrons as they cascade from one electron acceptor to another.

2. The model is then used to reinforce the above concepts. The teacher makes the bulbs light up sequentially to show *three* important aspects of the electrons involved in the light reaction:

   - the *source* of electrons (water, photosystem II and photosystem I).
   - the *passage* of electrons (molecules in the electron transport chain).
   - the final *acceptor* of electrons for each progressive stage (photosystem II, photosystem I and NADPH).

3. The teacher controls the light bulbs. By making them light up one by one in a slow sequence, she should show the students how electrons pass from one molecule to another in a systematic pattern from donor to acceptor.

   (i) Familiarization step 1: Light up the blue bulbs (no. 11 and 4) to show the water molecule (an electron donor) and the NADPH molecule (the final electron acceptor).

   (ii) Familiarization step 2: Light up the candlelight bulbs (no.1 and 12) to show the cluster of chlorophyll molecules that make up Photosystem I and II.

   (iii) Familiarization step 3: Light up the central green bulbs (no. 5 and 10) to show the *chlorophyll a* molecule (reaction center) in the middle of Photosytem I and II.

(iv) Familiarization step 4: Light up all the yellow bulbs to show the primary electron acceptor and electron carriers (no. 2, 3, 4, 6, 7, 8 and 9). Introduce the name of the electron carriers.

(v) Explain the concept of *photoactivation*. In photoactivation, the "antenna complex" consisting of a cluster of a few hundred molecules of chlorophyll pigments absorb photons or solar energy (light up the 15 green candlelight bulbs no.1 and 12) and they transmit the energy from pigment to pigment (shown by the progression of lighting from the outer to inner circle of green candlelight bulbs) until it reaches the *chlorophyll a* molecule situated in the center of Photosystem I and II (light up bulbs no. 5 and 10). This energy excites a pair of electrons (photoexcitation i.e. photactivation) from the *chlrophyll a* molecule which escape to a higher energy level. The high energy electron is trapped by a specialized primary electron acceptor in the photosystems (light up bulbs 2 and 6). The high location of bulbs 6 and 2 show this.

(vi) Explain the concept of *photophosphorylation*. Progressing through the electron transport chain, show how electrons are transferred from one carrier to another (light up the yellow bulbs – 7 first, followed by bulbs 8 and 9). The electrons are moving from a higher energy level to a lower one (shown by the higher position of bulb 6 compared to 7, then 8 and 9). As they 'fall', they lose energy. This energy will be finally used to bond inorganic phosphate, P_i , to ADP, forming ATP. Thus, light energy (from the sun) has been converted to chemical energy (stored in the ATP molecule).

(vii) Using sequential lighting of the bulbs, explain the concept of *non-cyclic photophosphorylation* by showing how electrons travel from the water molecule (bulb 11) to fill up the electron 'hole' in PS II (bulb 5), created by the loss of electrons of PS II which have been activated to the primary electron acceptor (bulb 6), to electron carriers Pq (bulb 7), cytochrome complex (bulb 8), Pc (bulb 9) and then to fill up the electron 'hole' in PS I (bulb 10). Next, show how the photoactivated electrons of PS I have traveled to its primary acceptor (bulb 2), on to carrier Fd (bulb 3a), to $NADP^+$ (bulb 3b) and finally be trapped in the final electron acceptor – the NADPH molecule. Because the electrons do not cycle back to their origin, the process of converting solar energy to chemical energy in the above pathway is known as *non-cyclic photophosphorylation*.

(viii) Using sequential lighting of bulbs once again, now explain the concept of *cyclic photophosphorylation* by showing how electrons travel from the PS I (bulb 10) to the primary electron acceptor (bulb 2), to electron carriers Fd (bulb 13), cytochrome complex (bulb 8), Pc (bulb 9) and then *back* to fill up the electron 'hole' in PS I (bulb 10). The water molecule and the NADPH molecules (both the blue bulbs) are *not* involved. Because the electrons cycle back to their origin (from PS I back to PS I), the process of converting solar energy to chemical energy in the above pathway is known as *cyclic photophosphorylation.*

(ix) The concept of photolysis can also be explained. Light up the blue bulb (no 11) alone to show how light striking the water molecule is used to break up the water molecule to release electrons, use H^+ ions and oxygen.

Suggestion for modification : The arrows showed the flowing of the electrons can be replaced with running bulbs and blinking bulbs can be used to represent the electrons so that the students can have a better picture of the passage of electrons.

9

'SQUARE PEGS AND ROUND HOLES' A MODEL TO DEMONSTRATE THE TRANSLATION STEP OF PROTEIN SYNTHESIS IN THE CELL

(BIOLOGY – UPPER SECONDARY)

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Background : In the Form 6 Biology syllabus, one topic students find difficult to visualise is *Protein Synthesis*. There are two steps involved in this process:

(1) *Transcription*:
In the first step, a messenger RNA (mRNA) molecule is synthesized based on the template of DNA. The mRNA is, in actual fact, a complementary copy of a segment of DNA from which it "copies". This process of transcribing happens in the nucleus of the cell. The mRNA then leaves the nucleus and heads for the ribosome found in the cell's cytoplasm.

(2) *Translation*:
In this second step, a polypeptide molecule is synthesized under the direction of mRNA. This process happens at the ribosome in the cytoplasm. It begins with the mRNA and ribosome binding together. Then, a polypeptide is synthesized by the stringing together of amino acids brought sequentially by transfer RNA molecules (tRNA) to the ribosome.

To understand protein synthesis, the students must appreciate this: the sequence of nitrogenous bases along the DNA molecule determines the sequence of nitrogenous bases on the mRNA molecule through complementary base pairing.

The bases on the DNA are transcribed and then translated in threes. Each sequence of three bases on the DNA molecule is copied as a sequence of three bases called *codons* on the mRNA molecule. At the ribosome, the mRNA undergoes complementary base pairing (i.e. form hydrogen bonds) with a set of three bases (called the *anti-codon*) on the complementary tRNA molecule which arrives at the ribosome. The tRNA molecule will simultaneously transport a specific amino acid to the ribosome. As the amino acids arrive one by one, brought by tRNA molecules that arrive sequentially at the ribosome, they are strung together by peptide bonds to form a polypeptide. Thus, it is the sequence of base pairing between the mRNA and the tRNA that determines the sequence of amino acids which are joined together to form the polypeptide.

To read, learn, visualize and absorb this new knowledge can be an uphill task for the average student. It is far worse when a teacher of Biology uses the chalk and talk method or a theoretical framework to teach this topic. Due to the introduction of several new concepts, many students find the topic of protein synthesis, especially the translation step, difficult and complicated.

Objectives :
i. To use a simple model to clarify the abstract concepts involved in the translation step of protein synthesis such as 'complementary base pairing', 'codons', 'anti-codons', 'activation of tRNA molecules' and 'polypeptide formation'.
ii. To help students understand the role of mRNA, tRNA, amino acids and the ribosome in protein synthesis.
iii. To help students appreciate the importance of the sequence of nitrogenous bases on nucleic acids such as mRNA and tRNA.

Benefits for teaching and learning process : Some benefits of this activity is as follows:
i. To allow students to "see" for themselves how a polypeptide is actually formed at the ribosome by peptide bonding between amino acids. Seeing is believing and seeing "how it happens" in a model leads to understanding.
ii. To make learning a visual, kinesthetic, contextual and "hands-on" experience
iii. The model is made from simple wood - hence it is easy to construct. It is large enough and painted in different colors, therefore it is attractive to the student's eye. Despite being in Form 6, students get a chance to 'play' with blocks again.
iv. It is easily carried in the boot of a car and portable from class to class.
v. The theme of the model is "Square Pegs and Round Holes" (square pegs on tRNA blocks do not fit into the round holes on the mRNA block) and this drives home the powerful lesson of complementary base pairing between tRNA and mRNA as a prerequisite to protein synthesis in the cell.

Apparatus/ materials : **(a) To create the mRNA molecule block** [**Refer 9-P3**]

A long wooden block 55" (length) x 8.5" (height) x 5.5" (breadth) is constructed.

Square, diamond, round or triangular shapes are cut out:

- Square holes represent the base **guanine (G)**
- Diamond holes represent the base **cytosine (C)**
- Round holes represent the base **adenine (A)**
- Triangular holes represent the base **uracil (U)**

The order, (used in this model) from left to right, is as follows and they represented the base sequences respectively:

Shapes of wooden block	Base sequences
Round-triangular-square	**AUG**
diamond-square-triangular	**CGU**
round- round-round	**AAA**
square-square-diamond	**GGC**
diamond-round- triangular	**CAU**

This sequence of bases is labelled along the mRNA wooden block.

(b) To create the binding capability between mRNA and the ribosome

In front of the mRNA block, a wooden panel containing a longitudinal grove is nailed to the block. This groove will accommodate the square frame representing the ribosome. When fitted in, the square wooden frame (the "ribosome") rests against the mRNA block and this allows the ribosome to look "attached" to the mRNA block. The groove allows the ribosome to be slid in front of the mRNA block, duplicating the effect that the ribosome moves along the mRNA.

(c) To create the tRNA molecule blocks [**Refer 9-P1**]

Five smaller wooden blocks of 10.25" (length) x 4" (height) x 5.5" (breadth) are constructed. Each wooden block has three wooden pegs attached to it. The size and shape of the pegs are as follows:

(i) 4" x 2.25" x 2.75" – the square peg
(ii) 2" diameter – the round peg
(iii) 2.5" (height) x 2" (base) – the triangular peg
(iv) 1.5" x 1.5" – the diamond shaped peg

The 'pegs' represent the following nitrogenous bases on the tRNA molecule:

- Square pegs represent the base **cytosine (C)**
- Diamond pegs represent the base **guanine (G)**
- Round pegs represent the base **uracil (U)**
- Triangular pegs represent the base **adenine (A)**

Each block has three pegs in a specified order which is as follows:

(i) The first block: round, triangular, square.
(ii) The second block: diamond, square, triangular.
(iii) The third block: round, round, round.
(iv) The fourth block: square, square, diamond.
(v) The fifth block: diamond, round, triangular.

So, the order, from left to right on the tRNA blocks (to fit into the 'holes' on the mRNA block sequentially) is as follows: round, triangular, square, diamond, square, triangular, round, round, round, square, square, diamond, diamond, round and triangular. This represents the anti-codons with a base sequence of:

UAC GCA UUU CCG GUA

This sequence of bases is also labelled along each tRNA block.

(d) To create the ribosome [**Refer 9-P4**]

A wooden square frame of 22” (length) x 22” (breadth) x 1” (width) is constructed. The wooden frame is so constructed such that it fits into and can be slid horizontally in the groove nailed to the front of the mRNA block. It has two sites : the **P** site where the tRNA molecule yields its amino acid for peptide bond formation (hence the alphabet **P**) and the **A** site where the new tRNA molecule, bringing a fresh amino acid, arrives (hence the alphabet **A**). These sites are labeled on the wooden ribosome frame.

(e) To create the amino acid molecule and the amino acid holder on the tRNA block [**Refer 9-P2**]

4.5” x 4.5” squares made from stiff cardboard are made to represent the amino acid molecules. Each is labelled accordingly and held by a plastic label holder stuck onto the tRNA wooden block. A hole is punched each in the center at the right hand side and left hand side of each card. This hole allows the demonstration of the peptide bond formation by using a safety pin which threads through the holes of two cards, joining them up.

The five authentic examples of amino acids used are as follows:

1st tRNA block with anti-codon sequence of UAC: **methionine**
2nd tRNA block with anti-codon sequence of GCA: **arginine**
3rd tRNA block with anti-codon sequence of UUU: **lysine**
4th tRNA block with anti-codon sequence of CCG: **glycine**
5th tRNA block with anti-codon sequence of GUA: **histidine**

Note: *Two sets of such cards can be prepared so that two demonstrations can be done using the same model.*

(f) To create the peptide bond between the amino acids

Five 2” *safety pins* are used to join the cards together to demonstrate peptide bond formation between the amino acids.

Implementation of teaching

1. First, the teacher explains the *function* of the *tRNA* molecule. It is to act as a carrier of an amino acid molecule. She uses one tRNA wooden block and shows how it behaves like an empty truck. On its own, it is just a tRNA molecule but when it is activated by the enzyme, *amino acyl tRNA synthetase*, it is able to receive an amino acid which attaches to the tRNA molecule and is then *ferried* by it to the ribosome. The attachment of the amino acid happens at one end of the tRNA molecule. Activated tRNA acts like a “loaded” truck because it now transports or “transfers” a specific amino acid from the cytoplasm to the ribosome.

   At the other end of the tRNA molecule is a set of three bases which is called the anti-codon. The teacher uses the model to explain the meaning of the ***anti-codon***. On the model block, the anti-codon is represented by the ***set of three pegs*** found at the base of the tRNA block. The 3 pegs represent a sequence of 3 bases on the tRNA molecule. It is the sequence of bases on the anti-codon that decides which amino acid a tRNA molecule will transport. For eg. a tRNA molecule with the base sequence of **UAC** will usually ferry the amino acid, *methionine***.**

2. Using the model, the teacher demonstrates the activation step by showing how methionine attaches itself to the tRNA block with the anti-codon UAC. Similarly, she uses the other four blocks of tRNA molecules to show how they are activated to carry a specific amino acid. (In the model, the teacher simply attaches the cardboard card bearing the name of the amino acid to the label holder stuck onto the top of the tRNA block).

3. Now, the teacher explains the *function* of the *mRNA* molecule and the meaning of the word "*codon*". Using the model of the mRNA block, the teacher explains that the mRNA molecule is a single strand of nucleic acid made up of a certain sequence of nitrogenous bases. The codon refers to the sequence of a set of three bases found on the mRNA molecule. In the model, these sets of three bases is represented by the differing types of holes cut out in the wooden block. For instance, a sequence of round, triangular and square set of holes represents the base sequence of AUG The function of the mRNA molecule is to provide a set of directions for the formation of a polypeptide. These directions come in the form of the *base sequence* on the codons on the mRNA molecule.

4. Now, the teacher explains the meaning of the word *complementary base pairing*. This refers to the manner in which the bases on the tRNA molecule (represented by the pegs) form hydrogen bonds (i.e. 'fit') with specific bases on the mRNA block (represented by the holes). In other words, in the model, a square peg on a tRNA block will only fit into a square hole on the mRNA block. This is to demonstrate that the base **cytosine** on the tRNA can only pair up with the base **guanine** on mRNA and vice versa (a diamond peg, guanine on tRNA, will fit into a diamond shaped hole on mRNA which is cytosine). Similarly, **adenine** on tRNA will only pair up with **uracil** on mRNA (a triangular peg will only fit into a triangular hole) and vice versa (the round peg, uracil on tRNA will fit into the round hole, adenine, on mRNA). Generally the base **A** pairs up with **U** and vice versa as well as **C** with **G** and vice versa.

5. The teacher now explains the role of the **ribosome** (the square frame). It acts as a *site for protein synthesis* in the cytoplasm. The square frame is placed in the groove at the front of the mRNA block to show this. The mRNA molecule binds to the ribosome which then moves along the mRNA molecule as polypeptide synthesis progresses. This is shown by sliding the square frame along its groove in front of the mRNA block progressively (three holes at a time).

6. The teacher can now explain the process of polypeptide formation. The first tRNA block arrives at the P site of the ribosome. This tRNA block is one that has the 3 pegs that can fit into the first 3 holes on the mRNA block. (In the cell, this is the tRNA molecule

which has an anti-codon, the set of 3 bases, which are complementary with the codon, the set of 3 bases, on the mRNA molecule). Any other tRNA block won't fit into the first 3 holes of the mRNA block.

7. [**Refer 9-P5**]: Now the next tRNA block arrives at the A site of the ribosome. It, in turn, has its own set of 3 pegs which fit into the next 3 holes on the mRNA block. When the 1st and 2nd tRNA blocks are next to one another at the ribosome, the 1st amino acid carried by the first tRNA block will form a bond with the 2nd amino acid on the 2nd tRNA block. The teacher demonstrates this by using a safety pin to thread the neighboring amino acids (cards) on the tRNA blocks together. The amino acid "card" on the 1st tRNA block is removed from its holder to show that it has been released by the 1st tRNA block.

8. [**Refer 9-P6**]: The ribosome then shifts to the next codon (next set of 3 holes) on the mRNA block. The square frame is simply slid along in front of the mRNA block to show this. The 1st tRNA block is removed to show that it will return to the cytoplasm and be ready to act as a "truck" again to ferry a fresh amino acid if necessary. Meanwhile, the 2nd and 3rd tRNA block are now next to one another. The two threaded amino acids on the 2nd tRNA block are now next to the 3rd amino acid on the 3rd tRNA block. The teacher uses a second safety pin to thread these amino acids together. The total number of amino acids that have been threaded together is now 3. This is how the polypeptide grows in length.

9. The ribosome is slid forward along the mRNA block again and step 8 is repeated with the 3rd and 4th tRNA blocks and then the 4th and 5th tRNA blocks. Using all the 5 tRNA blocks in the model, the resultant polypeptide will be 5 amino acids long. The mRNA block and tRNA blocks can both be used again to produce another similar polypeptide. All that is needed to show this by way of the model is a fresh set of 5 amino acids (another set of 5 labeled cards) and 5 new safety pins.

Results and Benefits of the teaching method

- Students are better able to understand the basic concepts involved in the translation step of protein synthesis such as *complementary base pairing* between tRNA and mRNA, *codons, anti-codons,* and *peptide bond formation*.

- The most important feature of this model is that it highlights the fact that square pegs will only fit into square holes and round pegs only into round holes. Similarly, only when there is a fit or complementary base pairing between the bases on the tRNA molecules and the bases on the mRNA molecule, will there be polypeptide synthesis at the ribosome.

- The model offers a hands-on experience for any student wishing to manipulate the tRNA molecules and try out the amino acid stringing process by himself. The student can practise and test his knowledge on protein synthesis (specifically polypeptide formation) over and over again to remember the sequence of events that take place during the translation process.

- The model makes learning contextual, tangible and a “hands-on” experience. The model uses actual “made-to-fit” tRNA blocks which can be assembled sequentially. The sequence of the pegs on the wooden tRNA blocks and the sequence of the holes on the mRNA blocks mirrors the sequence of nitrogenous base pairs on nucleic acids within our DNA and their importance in determining the sequence of amino acids during the synthesis of a polypeptide.

- Students can actually see for themselves how mRNA, tRNA, ribosome and amino acids interact in the process of protein synthesis. The visual effect offered by the model is more easily recalled than dry text book facts written on a board or offered in a Powerpoint presentation. The difficult concept of protein synthesis in cells becomes a tangible, simple and easy-to-understand concept.

- The students can use the model to demonstrate how translation takes place for reinforcement. As a result, they perform far better in a test on the topic.

Suggestions for modification : This *Square Pegs and Round Holes* model is very effective in putting a concrete hands-on touch to an otherwise abstract ultracellular mechanism of translation in protein synthesis.

The following suggestions may further enhance the use of this model:

(a) Improvise wooden blocks with something smaller and more flexible.

(b) Expand the use of the model with triplet codes for other amino acids.

10

FUN WITH VISKING TUBINGS
(BIOLOGY UPPER SECONDARY– CLASS ACTIVITIES)

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Background : It is surprising to see how a simple visking tubing can be of so much fun in the teaching of Biology. These experiments are useful and full of fun for the pupils to understand the Biological concepts. It also helps them to correlate with what actually happen in real life.

Experiments to study the opening and closing of the stoma, plasmolysis and osmosis of plant cells, crenation of red blood cells, can all be shown by using the visking tubings other than looking at the cells under the microscope. With these experiments designed, the pupils know what to expect before looking at the cells under the microscope.

The experiments on osmosis by using the visking tubing to separate the two solutions are rather fun and exciting for the pupils. Most text-books show diagrams without explaining how to separate the two solutions.

The wilting and turgidity of the plants can also be shown by using the visking tubings. The advantage is that pupils can see clearly the water pressure that builds up and this causes the plants to be turgid, which is not obvious when the stem of a plant is being used.

Objectives : There are four purposes for using visking tubings as part of teaching the concept of osmosis in the classroom. They are:

(a) To arouse the pupils' curiosity and interest as they see how the visking tubings work as plasma membrane.
(b) To give an opportunity for pupils to practise science process skills and manipulative skills.
(c) To make learning fun and enjoyable to understand the concept of osmosis.
(d) To challenge pupils to think analytically and creatively as they carry out creative science activities by using visking tubings.

Benefits for teaching and learning process :

1. The visking tubings do not only complement the teaching and learning process, but they also an eye opener for the pupils as the see visking tubings at work. The visking tubings act as a semi-permeable membrane which separates the two different solutions in the plastic box containers.

2. The visking tubing can be used to show:
   a) The turgidity in plants due to osmosis when water enters the visking tubings.
   b) The process of osmosis, plasmolysis and deplasmolysis in plant cells by the models of the plastic cylindrical containers which act as cell wall.
   c) The mechanism of the opening and closing of the stoma due to

osmosis and different thickness of epidermis in the guard cells.
d) The process of crenation and haemolysis in red blood cells

3. The experiments are useful for schools where microscopes are lacking. The teachers will have no difficulties in getting the results without the aid of a microscope, since these models are big enough to be seen with the eyes. All materials used for these experiments are easily available and can be done in groups or individually. Therefore the teachers can explain the concepts better with these models.

4. These are alternative experiments, other than getting blood samples from students. Especially when majority of the students are afraid to prick their fingers or worry about infection from pricking their fingers.

Apparatus/ materials :

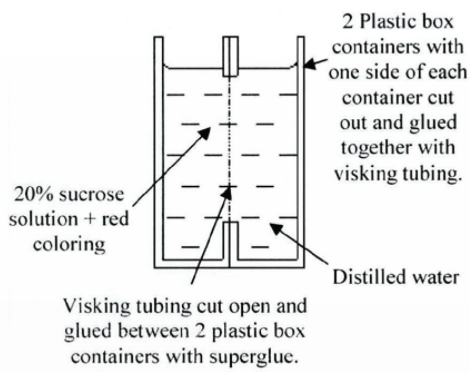
a) Visking tubings
b) 20%, 0.5% and 1% concentration of sucrose solution
c) 0.5% and 20% salt solution
d) Red and green colouring
e) Distilled water
f) First aid waterproof plaster
g) Plastic bowls
h) Super glue
i) Three (3) plastic cylindrical containers of size 5 cm by 1.5 cm with holes made at both ends, which act as permeable cell wall
j) Two (2) soft plastic box containers with one side of each container cut out and glued together with visking tubing to separate them

Construction and Implementation of the teaching aid :

All the materials for carrying out the experiments are easily available; therefore these experiments can be done in groups or individually.

Activity 1: To show the process of osmosis

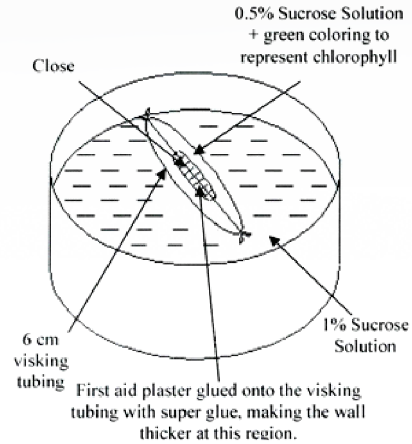
(a) Two soft plastic box containers with one side of each container were cut out and glued together with visking tubing to separate them.



(b) Same volume of red colouring 20% sucrose solution and distilled water were filled in both sides respectively.
(c) The results of the experiment can be observed [**Refer 10-P1**].

Activity 2: To show the opening and closing of stoma

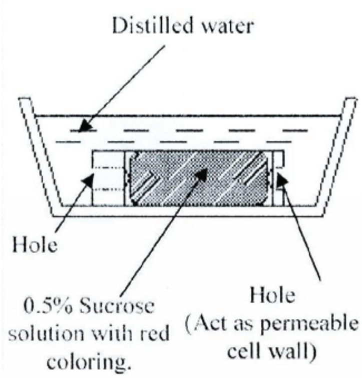
(a) First aid plaster was glued onto two visking tubings with super glue, making the wall thicker at the particular region.



(b) 0.5% concentration of green colouring sucrose solution was filled inside both visking tubings which ends were tied together.
(c) The set of visking tubings and their content was immersed in distilled water and 1% sucrose solution containers and left to be observed during daylight and night [**Refer 10-P2**].

Activity 3: To show the process of osmosis, plasmolysis and deplasmolysis in plant cells

(a) 0.5% concentration of red colouring sucrose solution was filled inside three visking tubings and put inside a plastic cylindrical containers.



(b) The sets were then immersed in three different concentrations of sucrose solution.
(c) The visking tubings were left for 1 hour and observed 1 hour later [**Refer 10-P3**].
(d) Plastic cylindrical containers are taken out from the solutions to be examined. (A) plasmolysis occurred. (B) no change. (C) osmosis occurred.

Activity 4: To show the process of crenation

(a) Two 4 cm long visking tubing were filled with 0.5% of salt solution and tied at both end.
(b) They were then immersed inside 0.5% and 20% concentration of salt solution and left to be observed after one hour.
(c) The observation is shown in picture [**Refer 10-P4**].

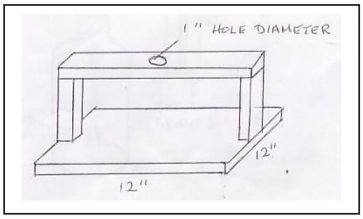
Activity 5: To show the wilting and turgidity in plants

(a) Visking tubing contained 20% sucrose solution and red coloring was immersed in distilled water and left for one hour.
(b) The observation is shown in picture [**Refer 10-P5**].

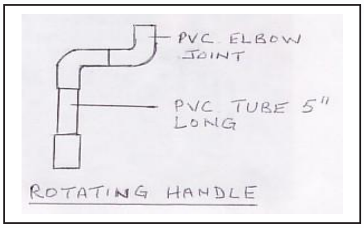
Suggestions for modification :

1. The experiments should be left overnight or at least more than one hour.
2. Red and green colouring can be added to the sucrose solutions so that the results are more obvious.
3. There should not be any air bubbles trap inside the visking tubings or the plastic cylindrical containers.
4. To see the process of plasmolysis and osmosis, the plastic cylindrical containers can be taken out from the solution to be examined.
5. This experiment is not suitable to show haemolysis of red blood cell because the visking tubing will not burst.

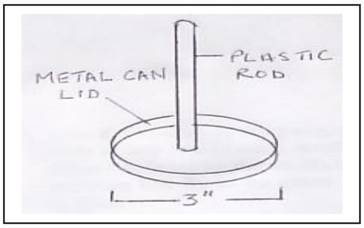
Appendix (1)



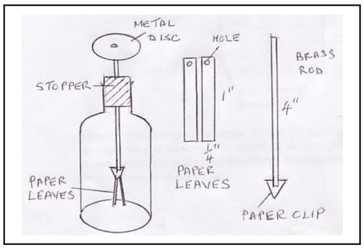
1-D1



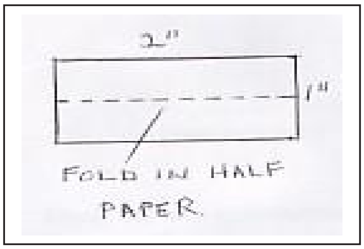
1-D2



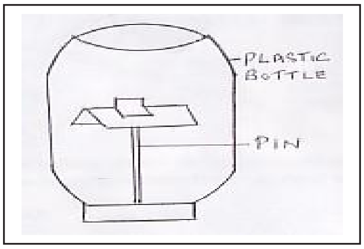
1-D3



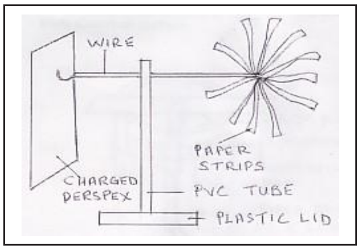
1-D4



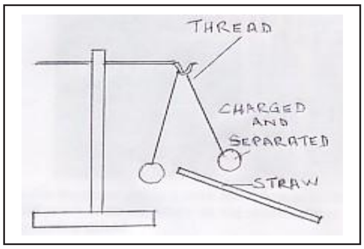
1-D5



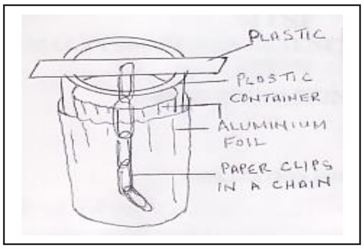
1-D6



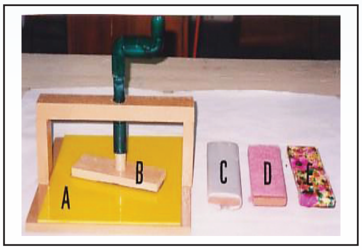
1-D7



1-D8



1-D9



1-P1

1-P2

1-P3

1-P4

1-P5

1-P6

1-P7

1-P8

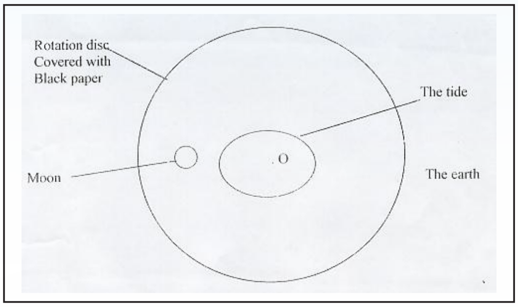
1-P9

1-P10

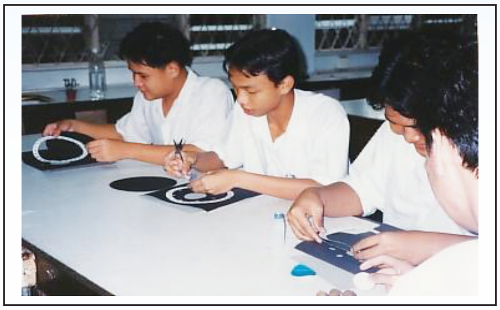
1-P11

1-P1 to P11

Appendix (2)

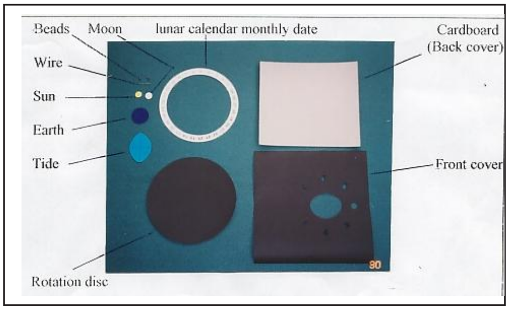


2-D1



2-P1

2-P2



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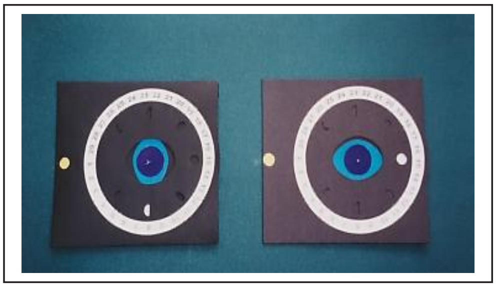

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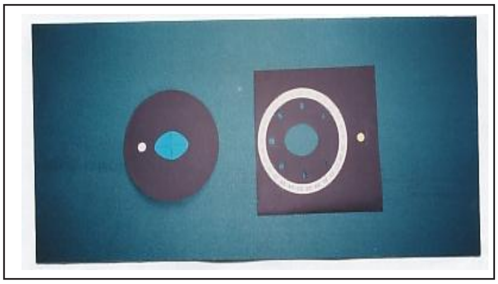

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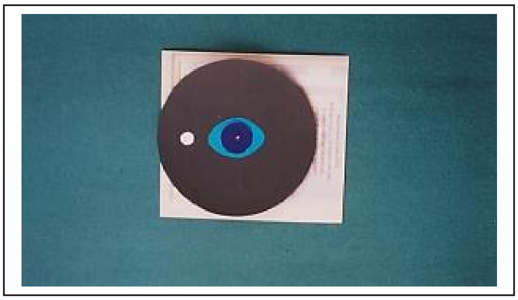

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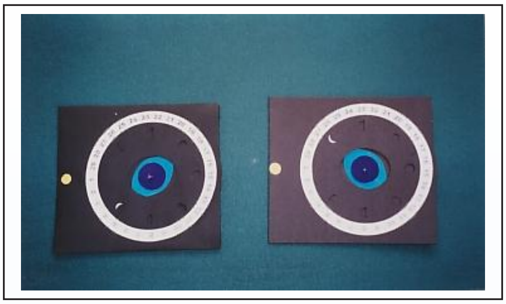
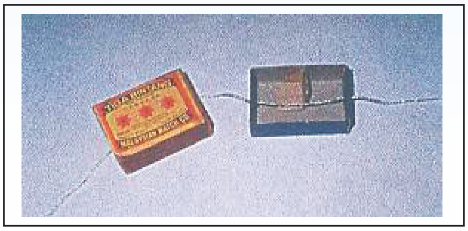
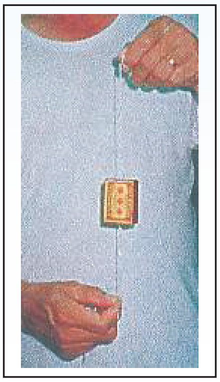


2-P7

Appendix (3)



3-P1



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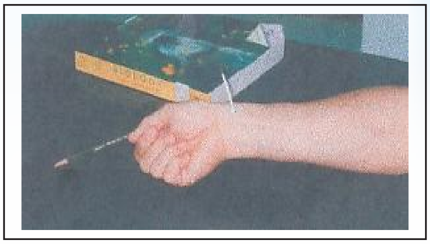
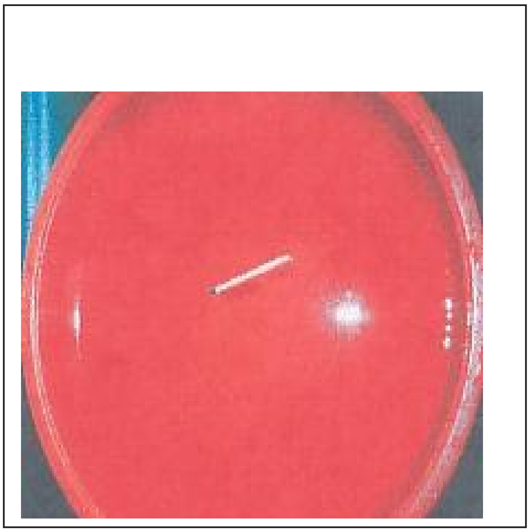


3-P3

3-P4



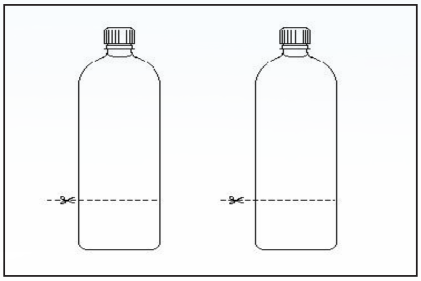
3-P5

3-P6

3-P7

3-P1 to P7

Appendix (4)



4-D1

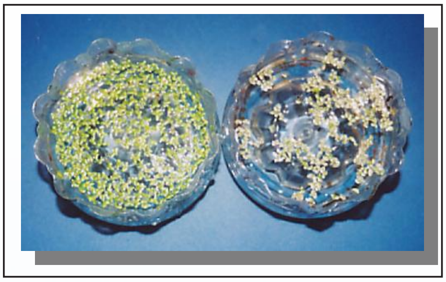
4-P1

4-P2

4-P3

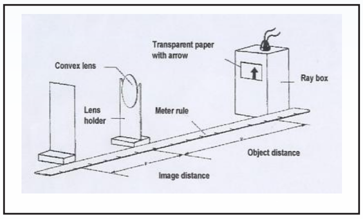
4-P4

4-P5

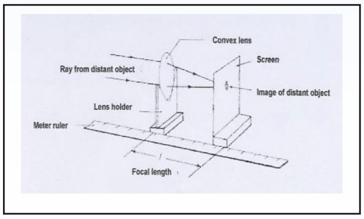


4-P6

Appendix (5)



5-D1



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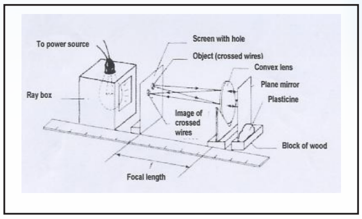

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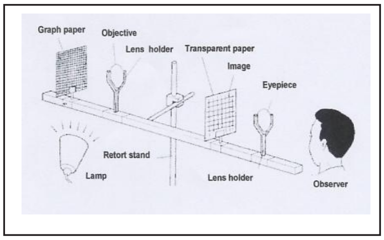

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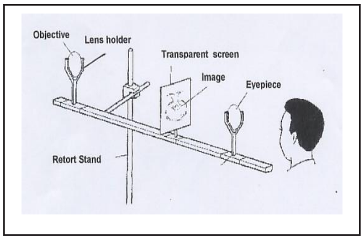

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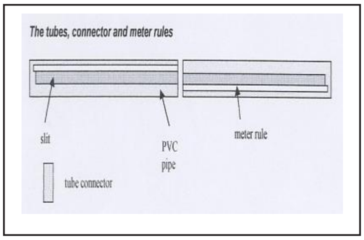

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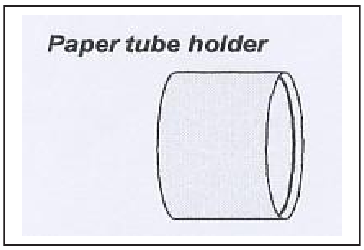

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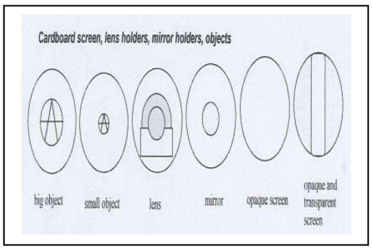
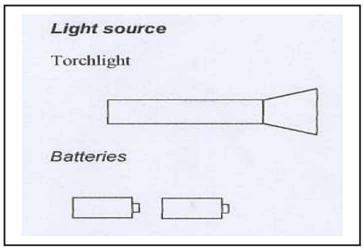
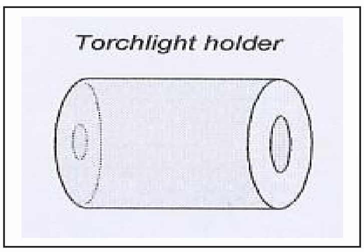


5-D8



5-D9



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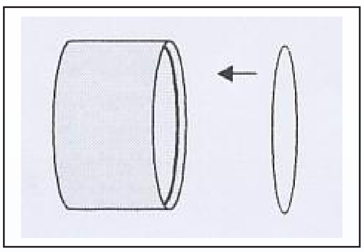

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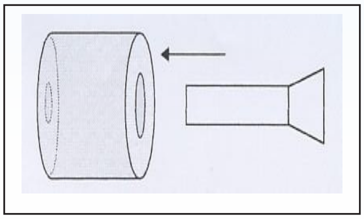

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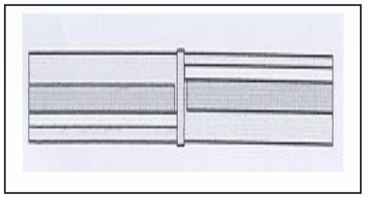

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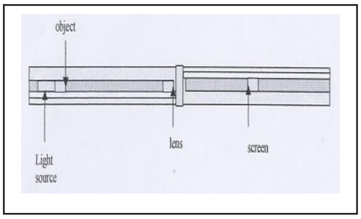

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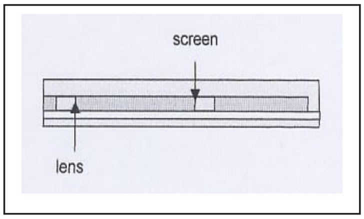

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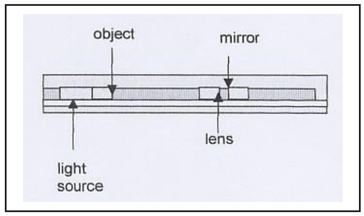
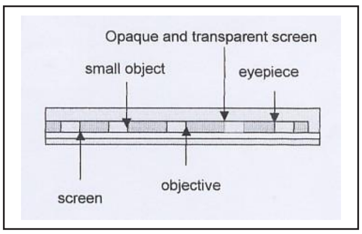
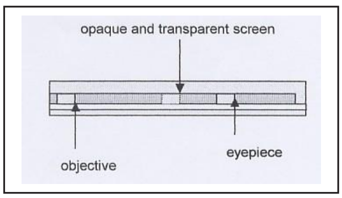


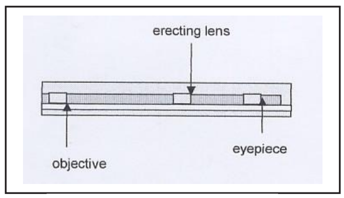
5-D16



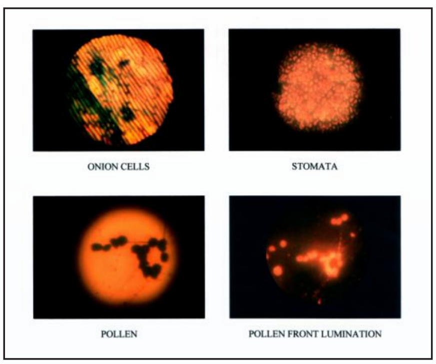
5-D17



5-D18



5-D19

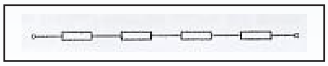


5-D20

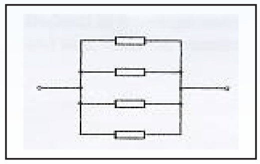
5-D21

5-D12 to D21

Appendix (6)



6-D1



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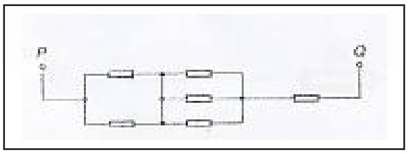

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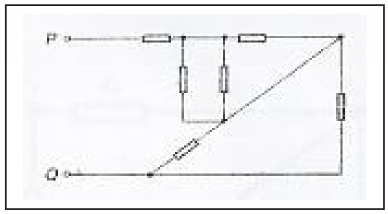
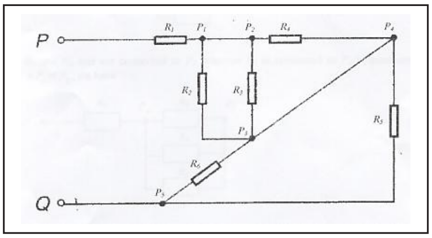
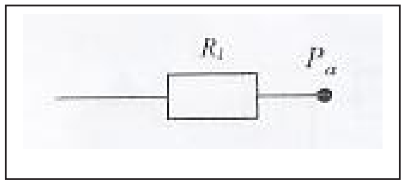


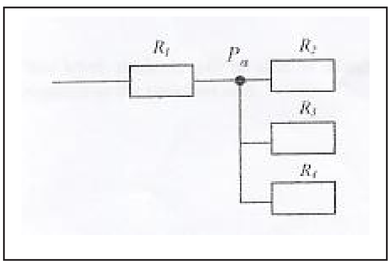
6-D4



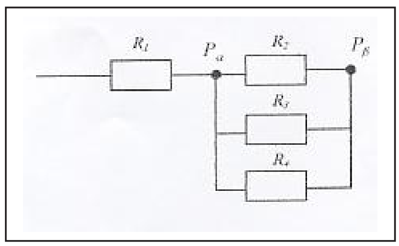
6-D5



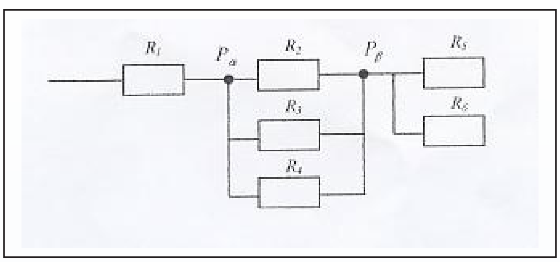
6-D6



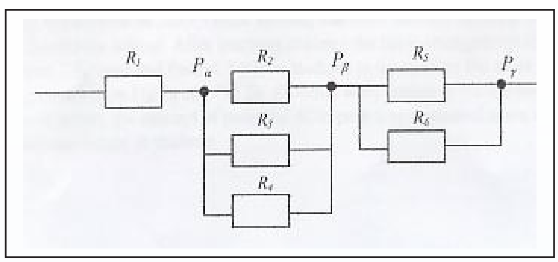
6-D7



6-D8



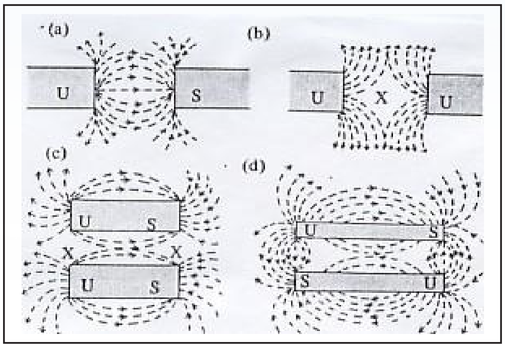
6-D9



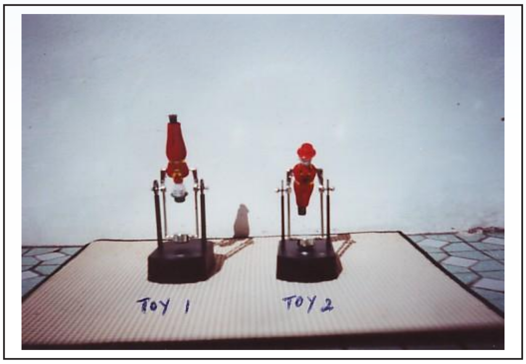
6-D10

6-D1 to D10

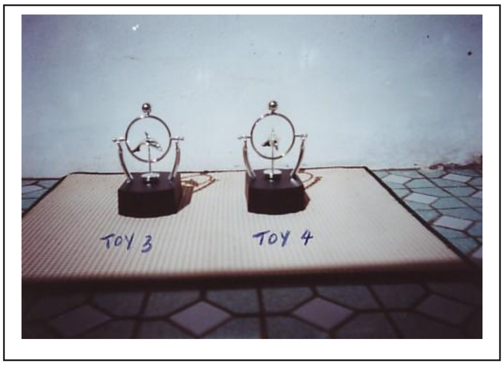
Appendix (7)



7-D1



7-P1

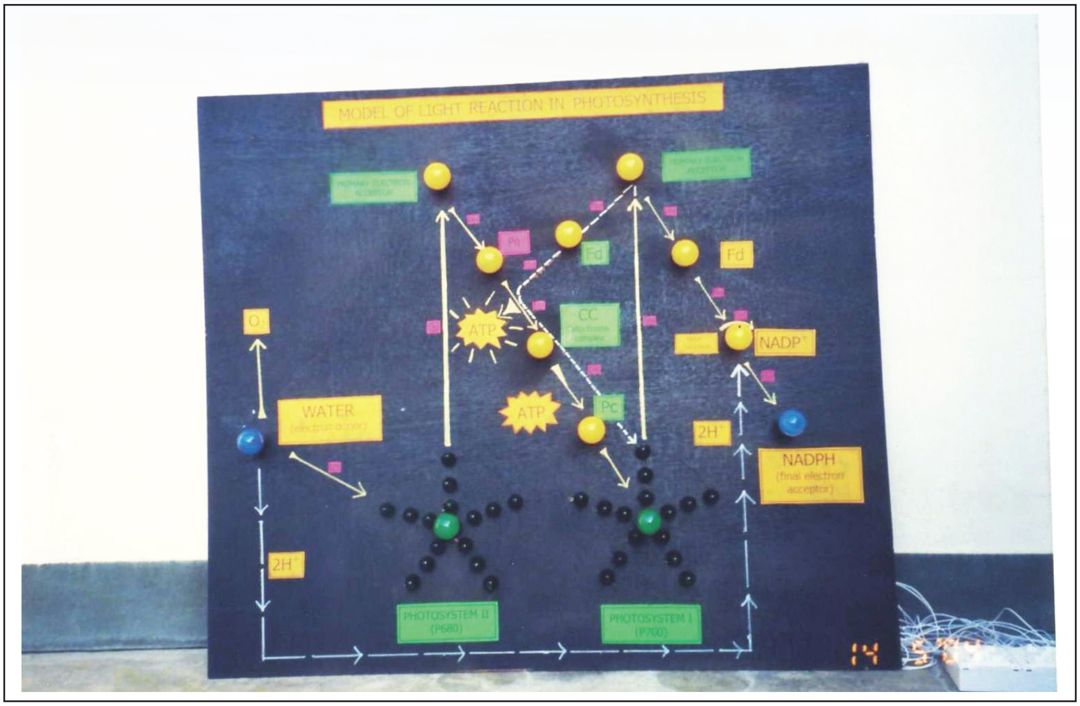


7-P2

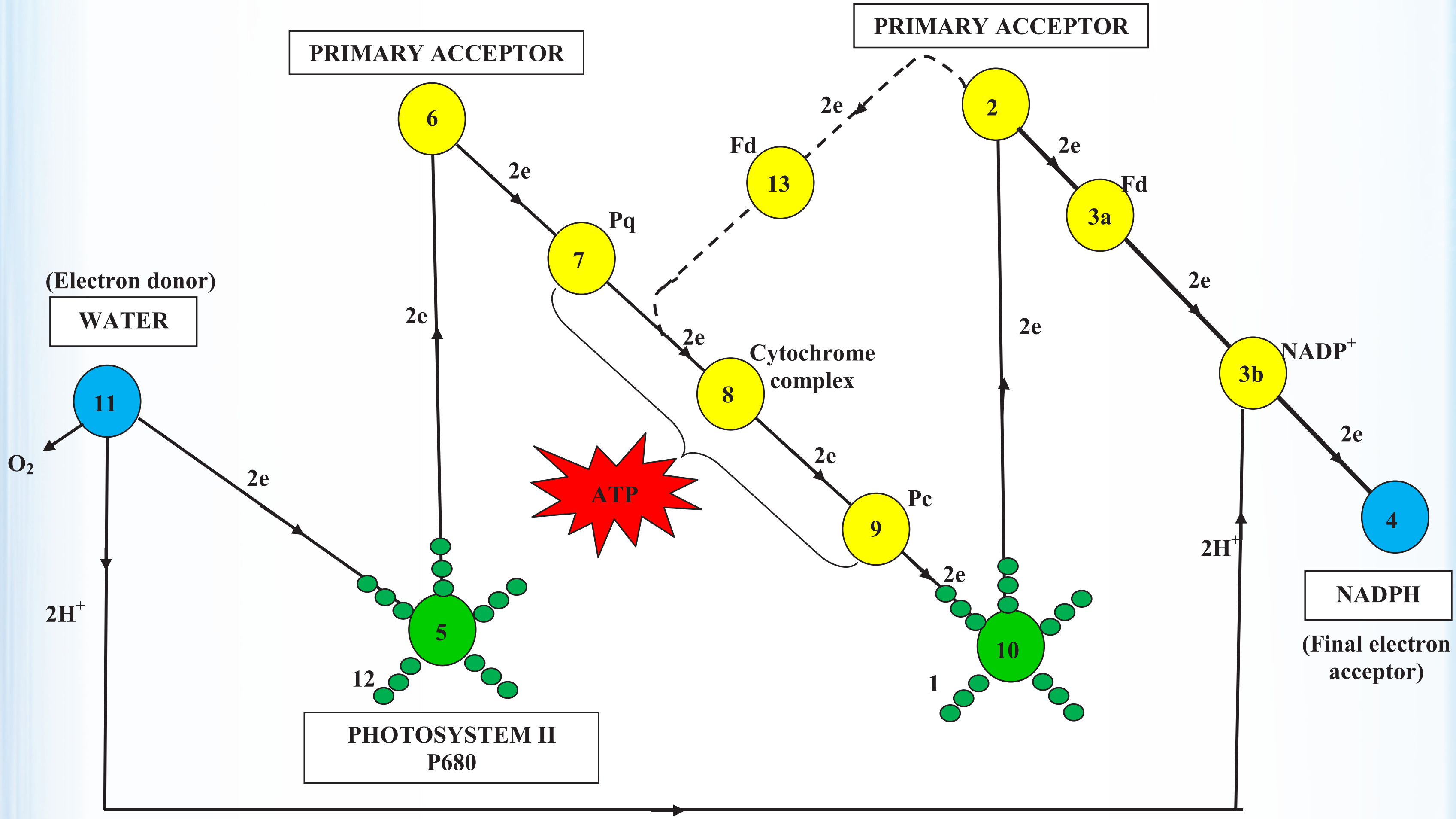
7-P3

7-P4

7-P5



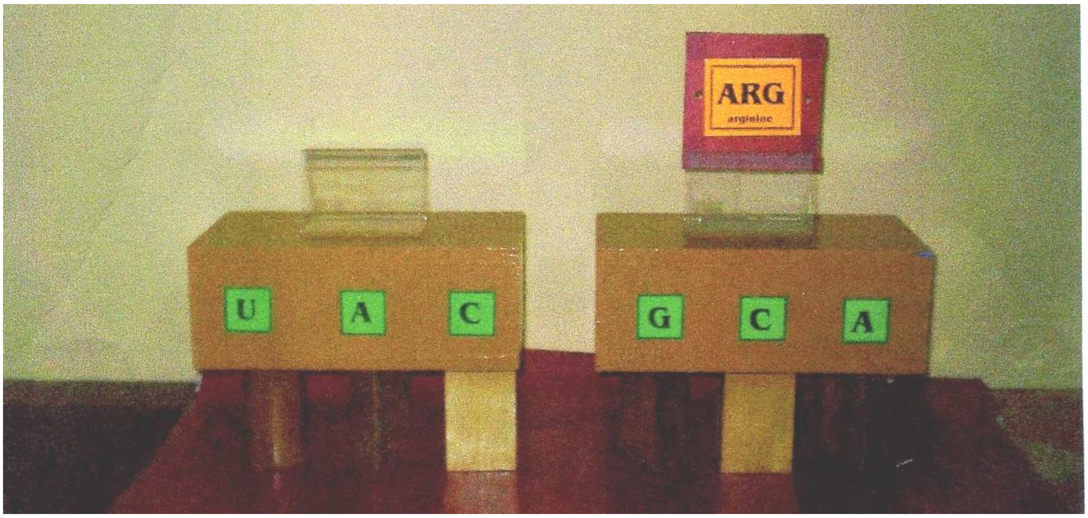
8-P1: Model of light reaction in photosynthesis



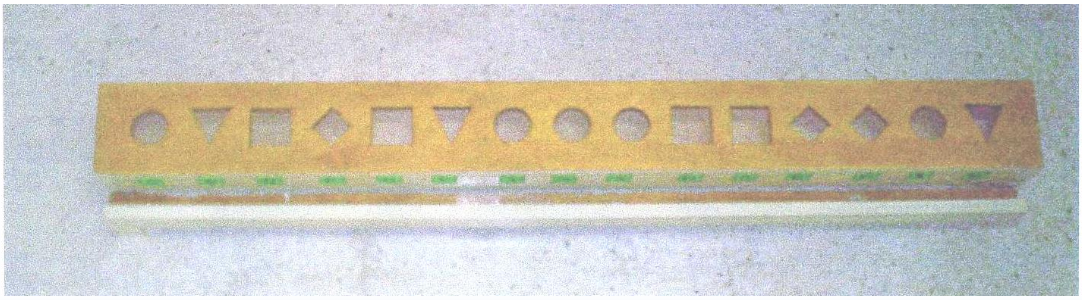
8-D1: Model of light reaction showing positioning and colour of bulbs used

Appendix(9)

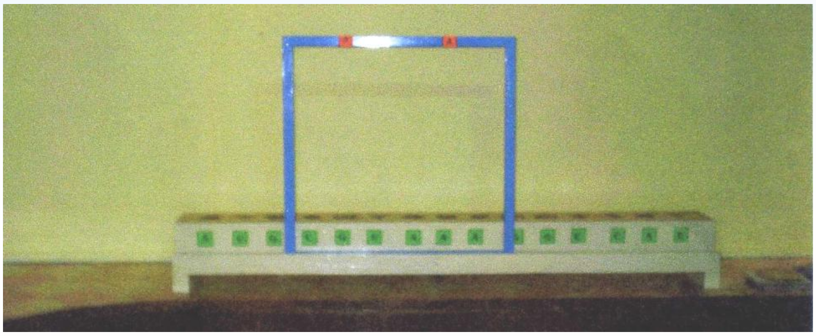
9-P1: The tRNA, represented by this wooden block has two ends. The bottom end has three pegs to hold the different shapes of the nitrogenous bases. The top end has a label holder for the designated amino acid.

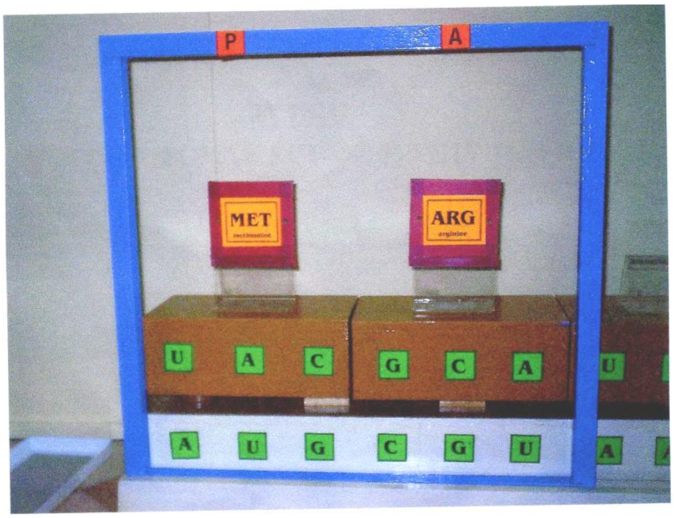


9-P2: The tRNA block on the left is shown to be inactive (not attached to amino acid), whereas the tRNA block on the right is 'loaded' with amino acid.

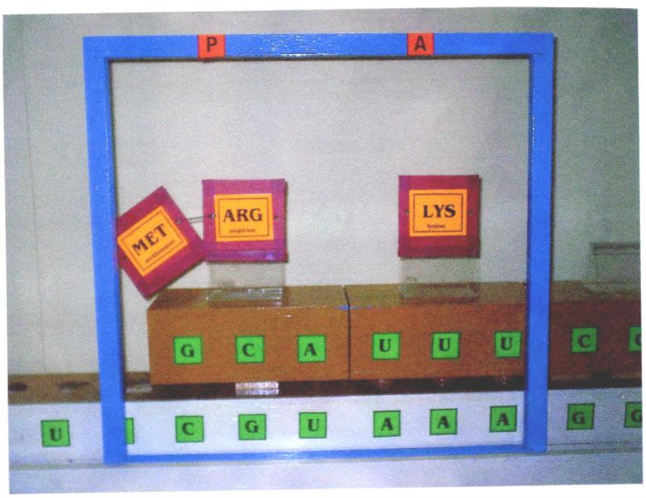


9-P3: This wooden block with different shapes represents mRNA with sequence of nitrogenous bases.


9-P4: The blue square frame represents the ribosome which can slide on the wooden block, representing mRNA.

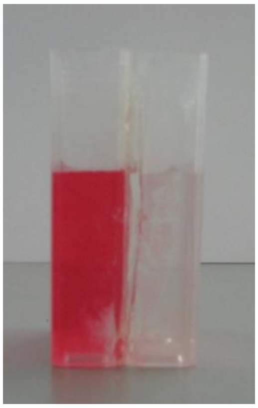


9-P5: Complementary fit between the tRNA and mRNA blocks

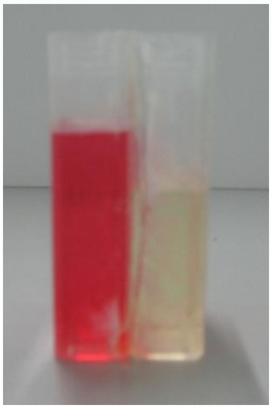


9-P6: The first two amino acids on the left (MET and ARG) are joined by peptide bonds (represented by safety pin) while the subsequent tRNA is ready with the third amino acid (LYS).

Appendix (10)

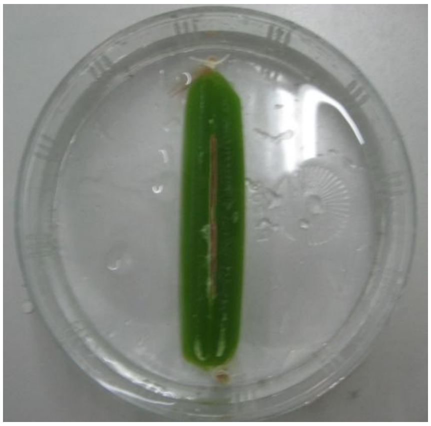


Before (same water level)



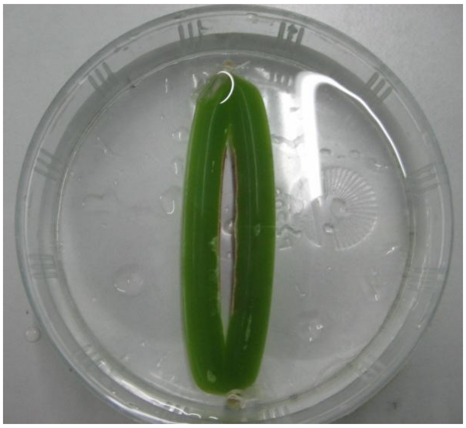
After (different water level)

10-P1: Activity 1: To show the process of osmosis



Daylight (stoma closed)

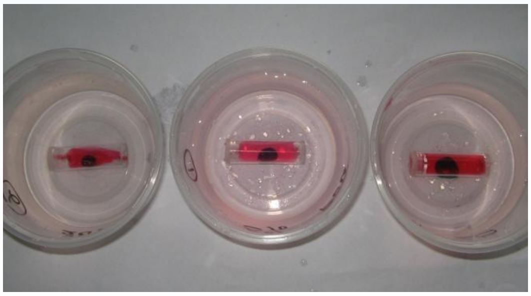
0.5% sucrose solution + green colouring to represent chlorophyll (in visking tubing)
1% sucrose solution (in plastic container)



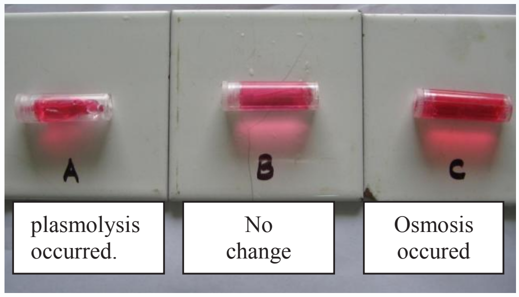
At Night (stoma open)

20% sucrose solution + green colouring to represent chlorophyll (in visking tubing)
1% sucrose solution (in plastic container)

10-P2: Activity 2: To show the opening and closing of stoma

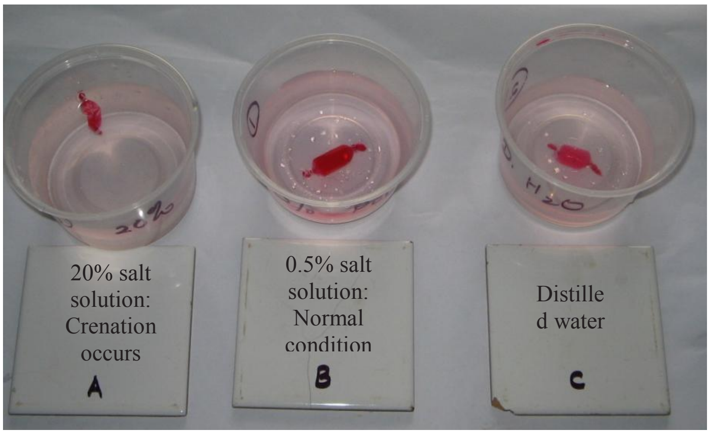


Before

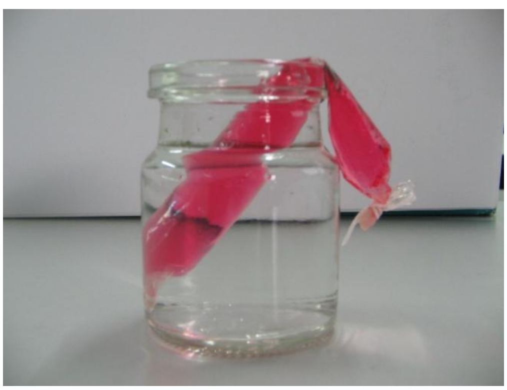


After 1 hour

10-P3: Activity 3: To show the process of osmosis, plasmolysis and plasmolysis in plant cells



10-P4: Activity 4: To show the process of crenation

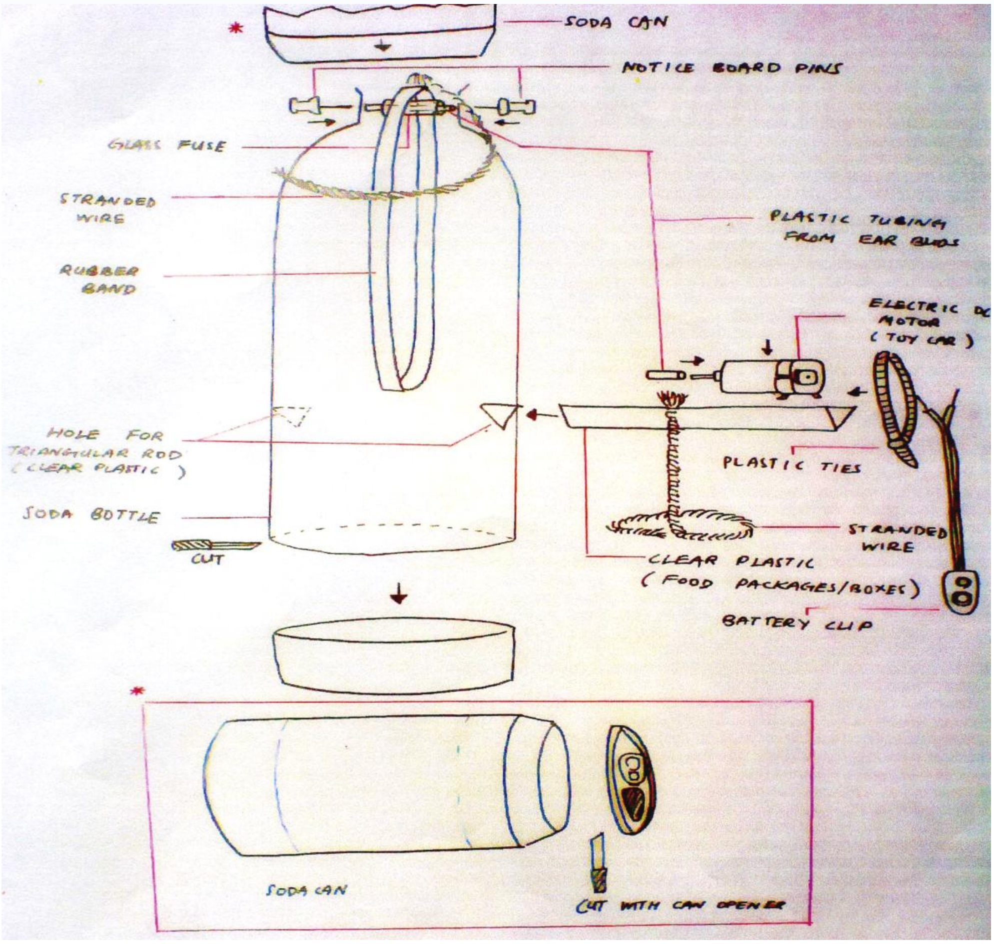


Before

After 1 hour (turgid)

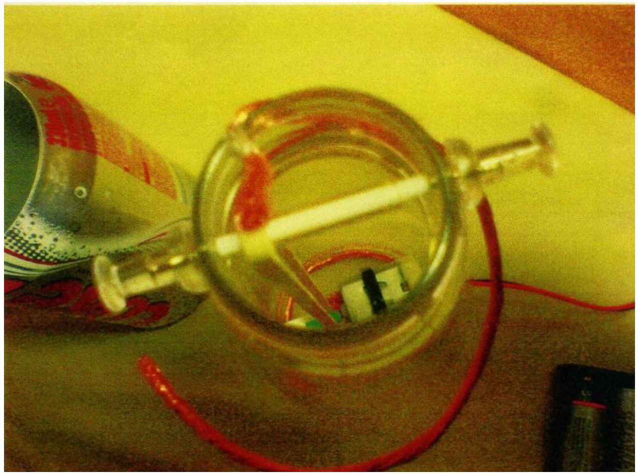
10-P5: Activity 5: To show the wilting and turgidity in plants

Appendix (11)

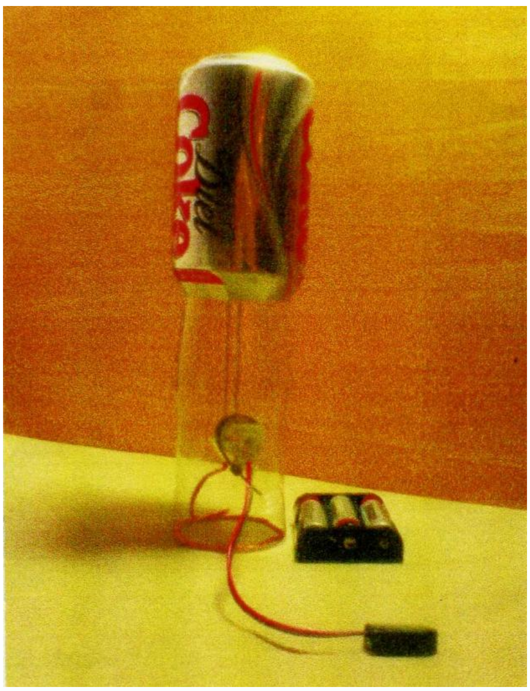


11-D1: The design and materials of the proposed model of Van de Graaf generator

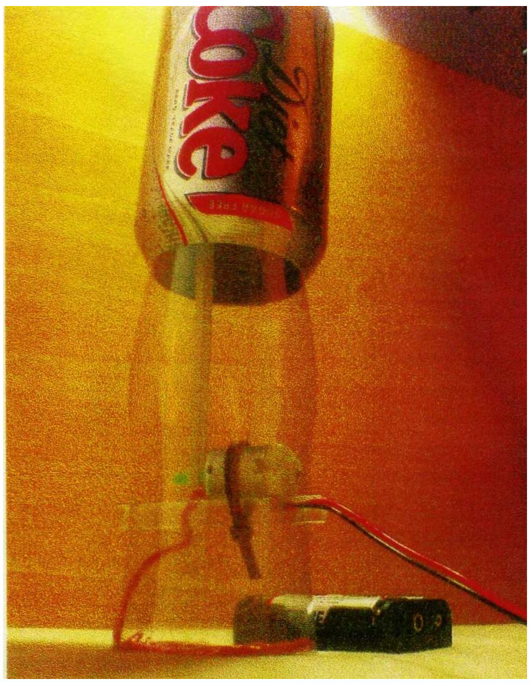
11 – P1:
The body of the model generator made of plastic



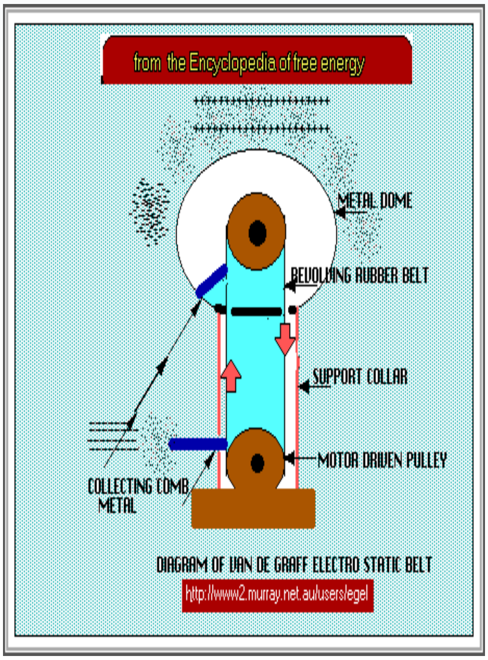
11 – P2:
The model generator seen in top view showing the motor, belt and rollers



11- P3:
The Van de Graaf generator model in its functional state



11 – P4:
The model in a closer view

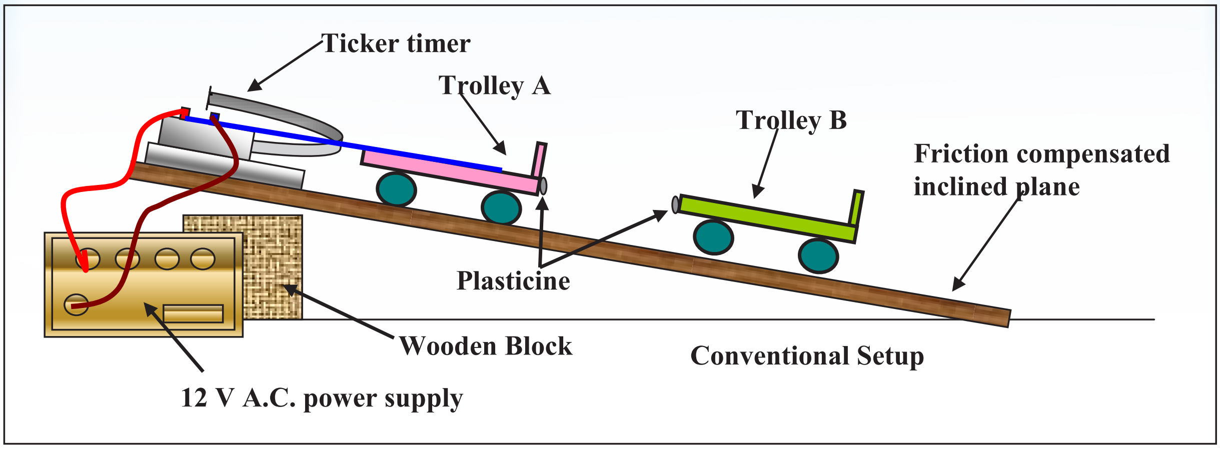


11 – D2:
Diagram of Van de Graaf Electro Static Belt

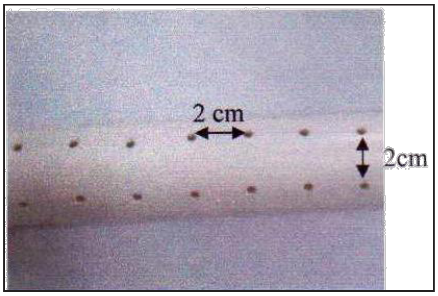
[Source: http://www.linux-host.org/energy/avande.html]

11 – P5:
A commercial Van de Graaf generator

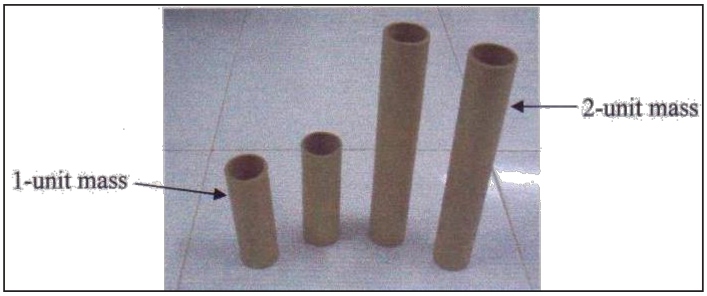
Appendix (12)



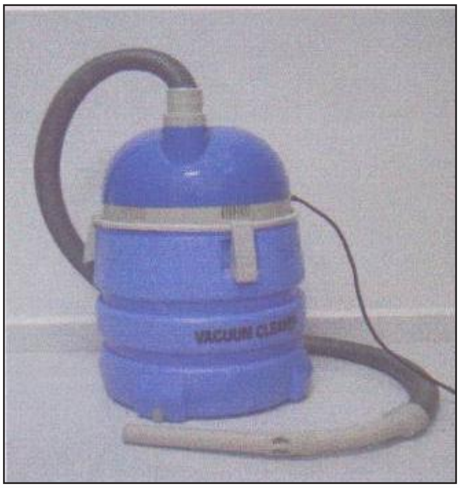
12-D1



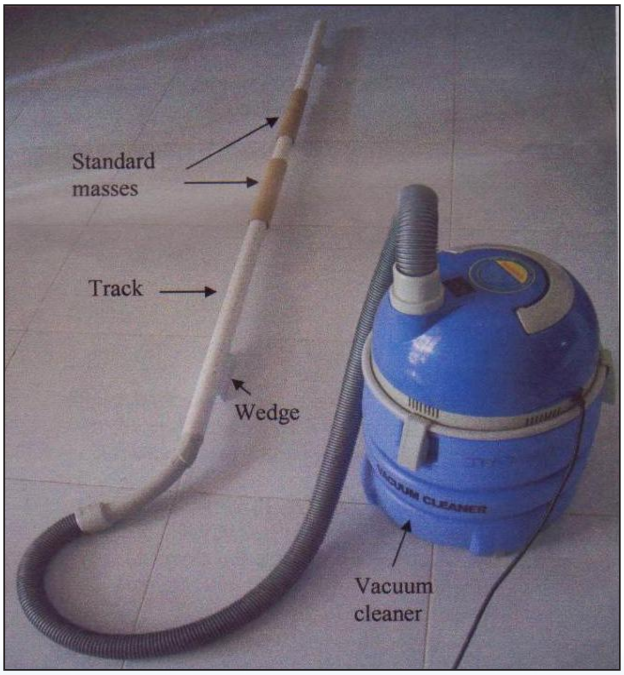
12-P1



12-P2

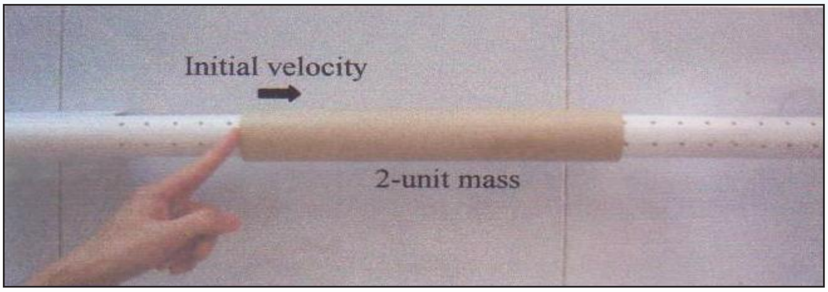


12-P3

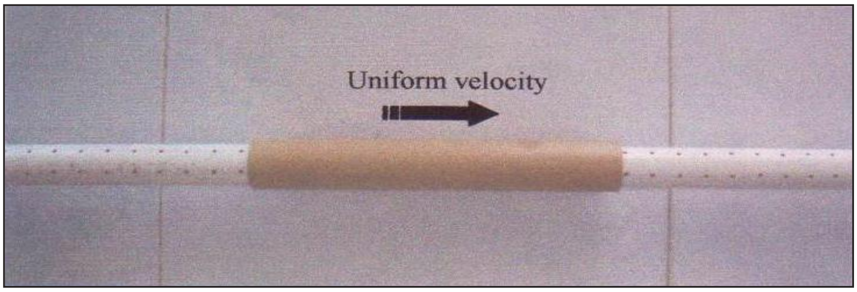


12-P4

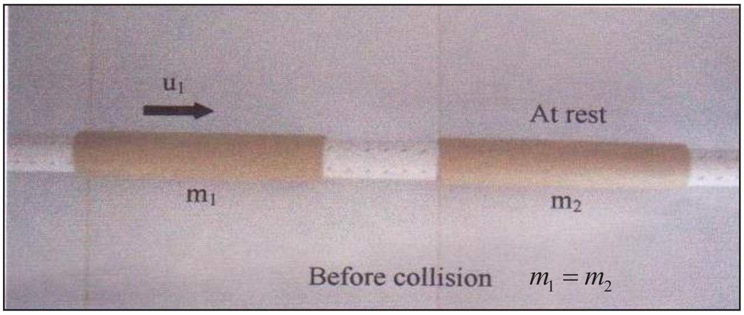
12-D1 & 12-P1 to P4



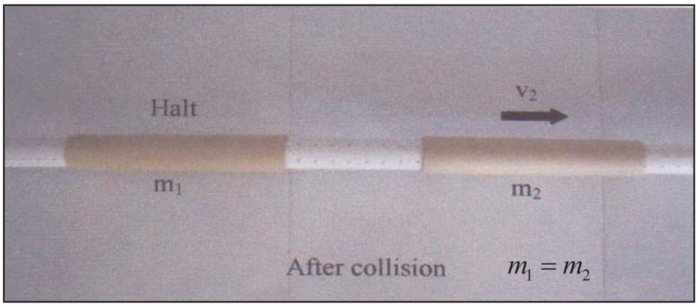
12-P5



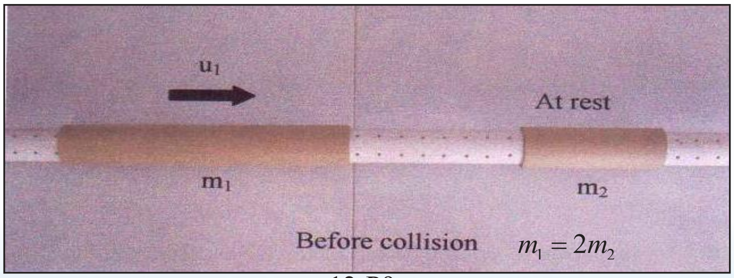
12-P6



12-P7

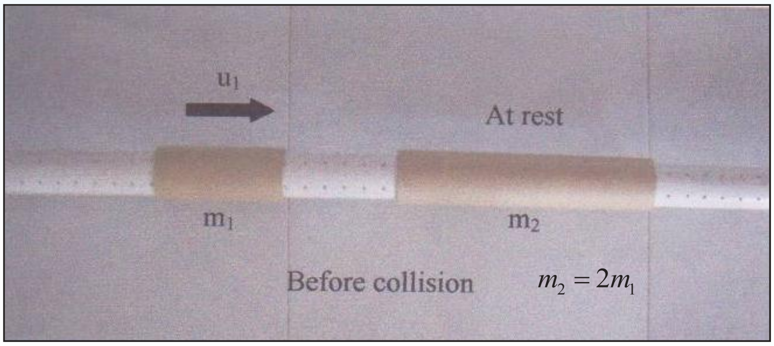


12-P8

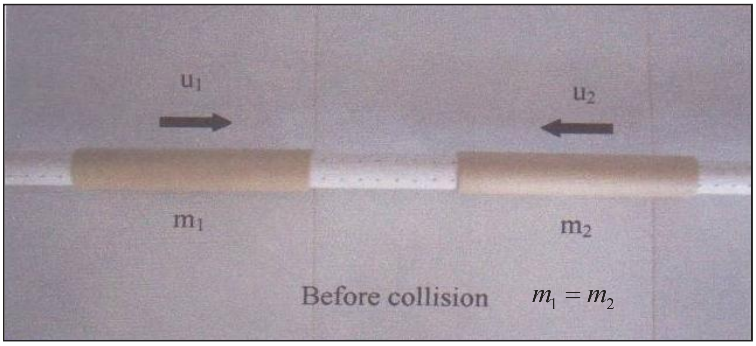


12-P9

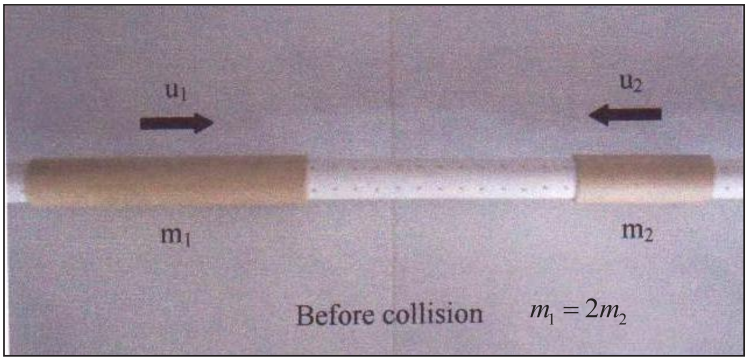
12-P5 to P9



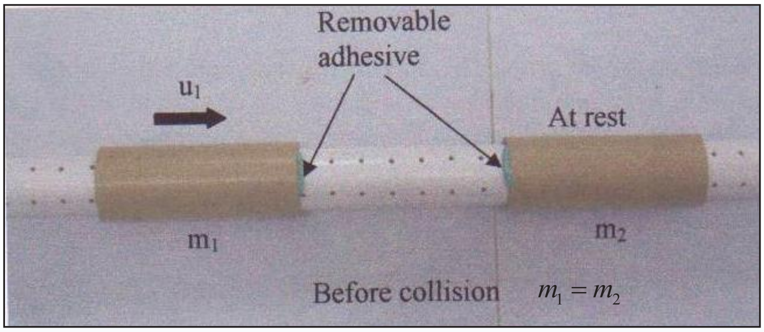
12-P10



12-P11



12-P12



12-P13

12-P10 to P13

Appendix (13)


13-P1: Polishing broken pipette


13-P2: Cutting glass tubing


13-P3: In groups


13-P4: Weighing


13-P5: Filling the tube


13-P6: Setting the apparatus

Qualitative and quantitative results


13-P7: Reactant-Copper oxide-black


13-P8: Product-brown Copper

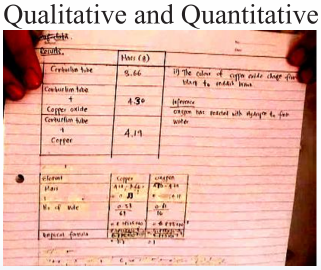

13-P9: Product-brown Copper

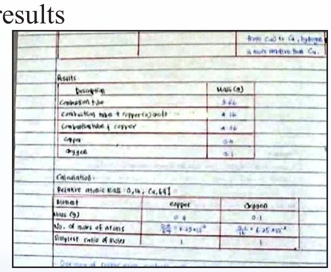
Quantitative results


13-P10: Reactant-Iron(III) oxide-reddish brown

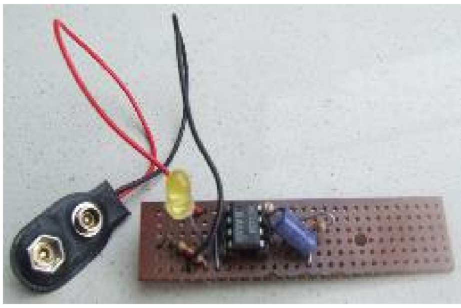

13-P11: Product-Iron -attracted to magnet

Qualitative and Quantitative results

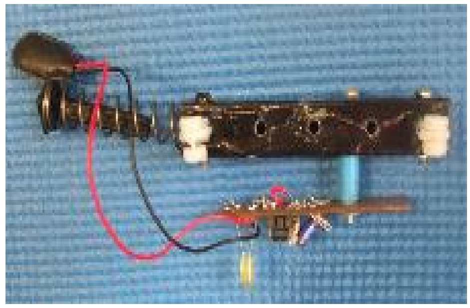

13-P12: Result 1


13-P13: Result 2

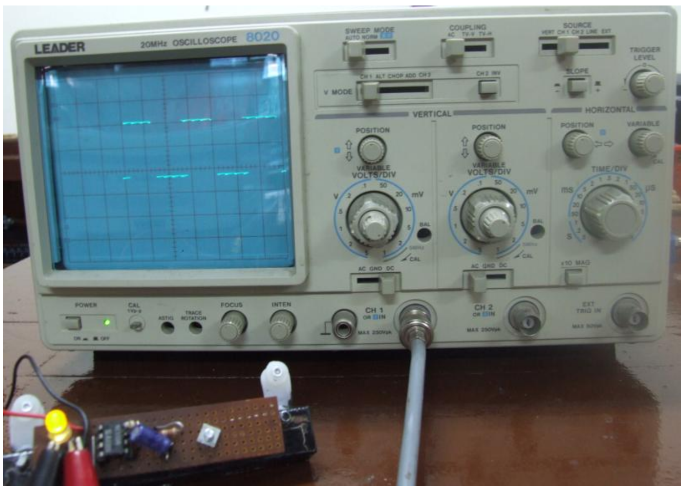
Appendix (14)



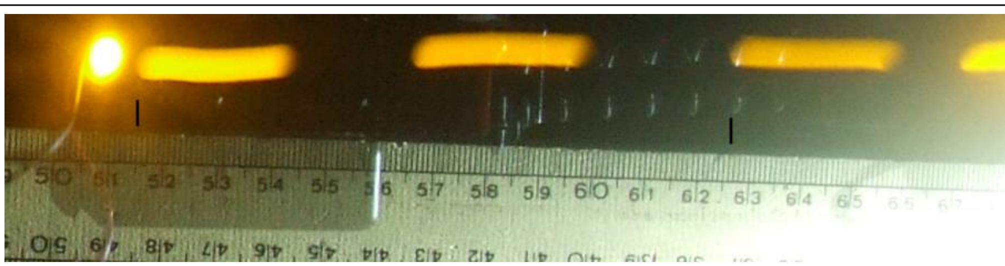
14-P1: The pulse LED device circuit soldered



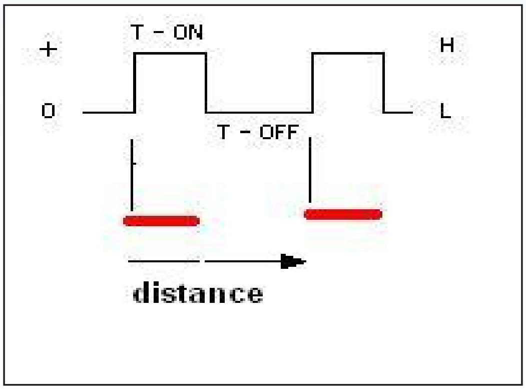
14-P2: The device mounted on a trolley



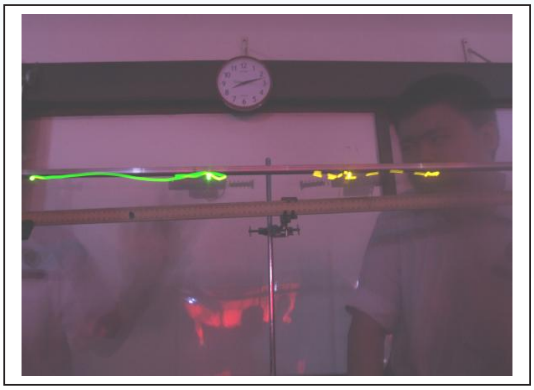
14-P3: Oscilloscope determination of frequency



14-P4: The pulsed light

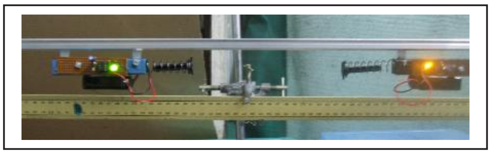


14-P5: Measurement of distance

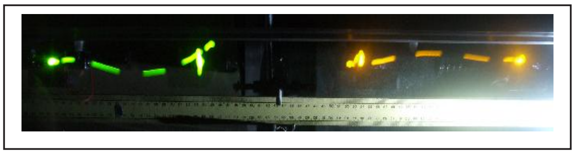


14-P6: Velocity measurement

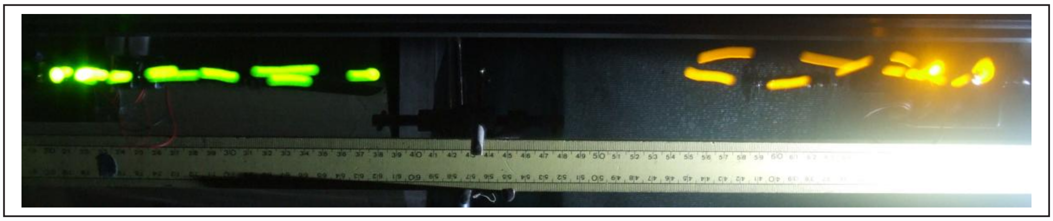
14-P7: The setup in the laboratory



14-P8: Elastic collision between two trolleys of equal mass, one initially at rest– before collision



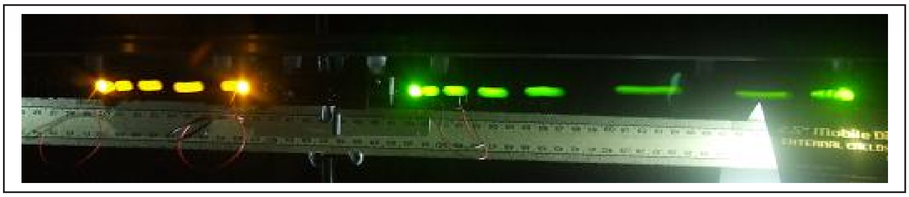
14-P9: Elastic collision between two trolleys of equal mass, one initially at rest– after collision



14-P10: Two trolleys, equal mass, colliding head-on

14-P11: Elastic collision between two trolleys, left trolley 3 times more massive – before collision

14-P12: Left trolley pushed, collides with right trolley (initially at rest)

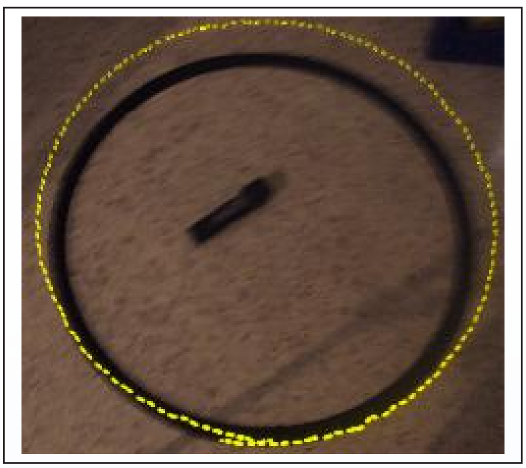


After collision, they move together

Before collision

14-P13: Inelastic collision, using plasticine to stick them together after collision

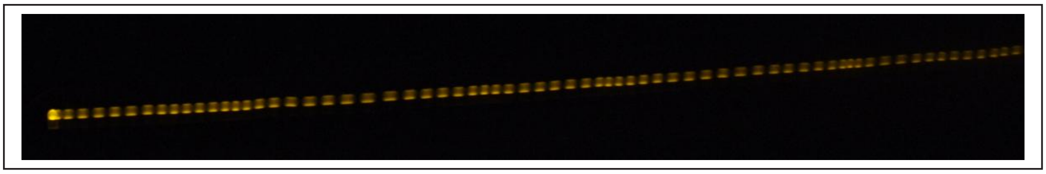
14-P14: Explosive collision



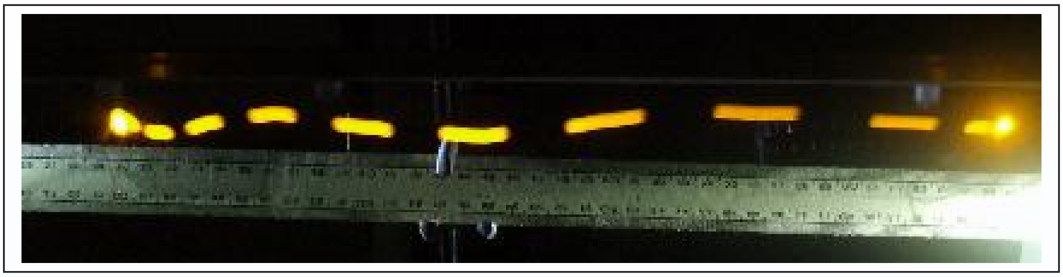
14-P15: Circular motion

14-P16: Swinging pendulum

14-P17: An object falling under gravity. Its acceleration can be determined

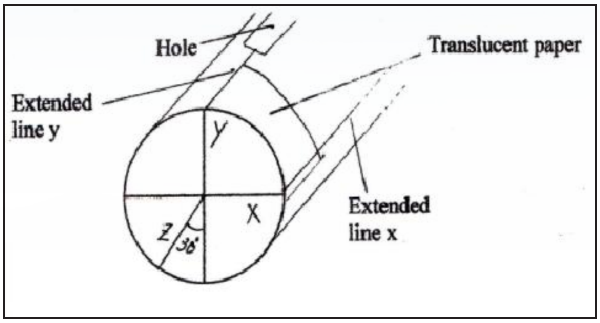


14-P18: Object moving with variable velocity

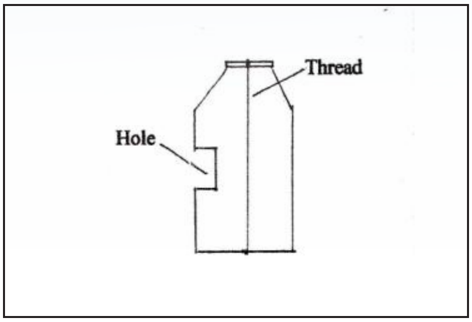


14-P19: Decelerating object

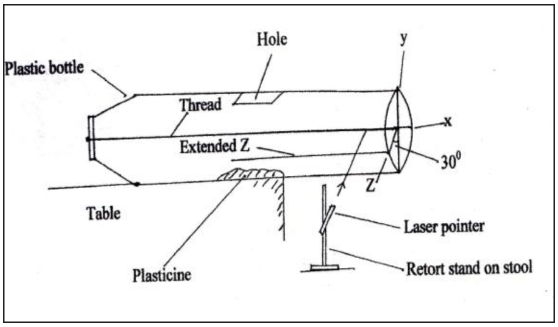
Appendix (15)



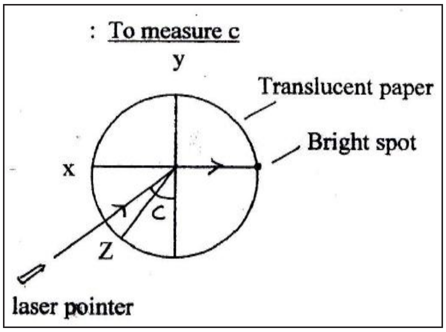
15-D1



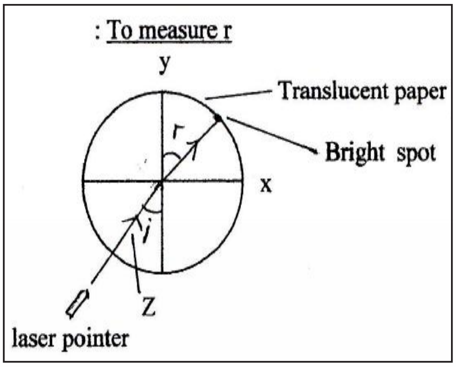
15-D2



15-D3



15-D4

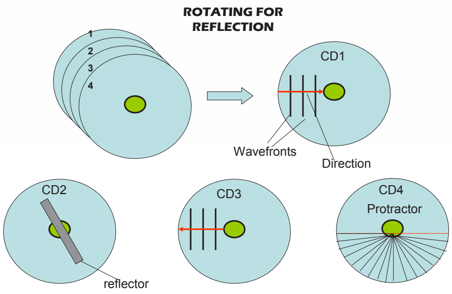


15-D5

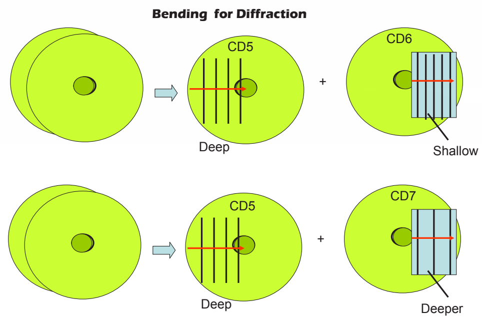
15-P1

15-P2

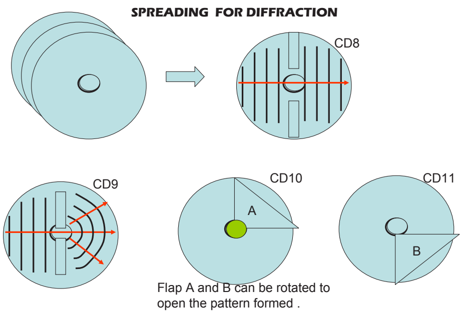
Appendix (16)



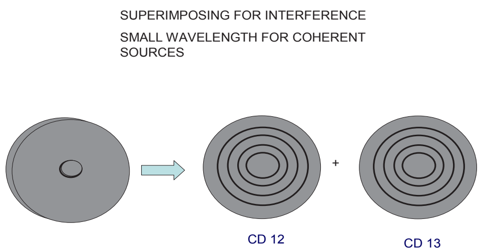
16-D1: Rotating for reflection



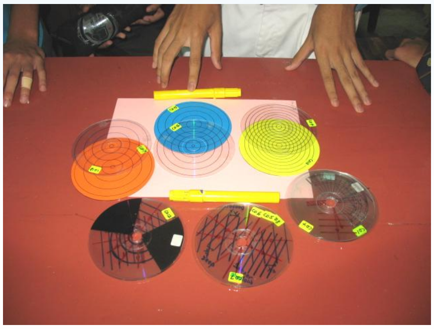
16-D2: Bending for refraction



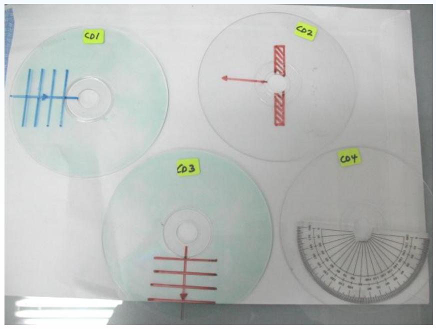
16-D3: Spreading for diffraction



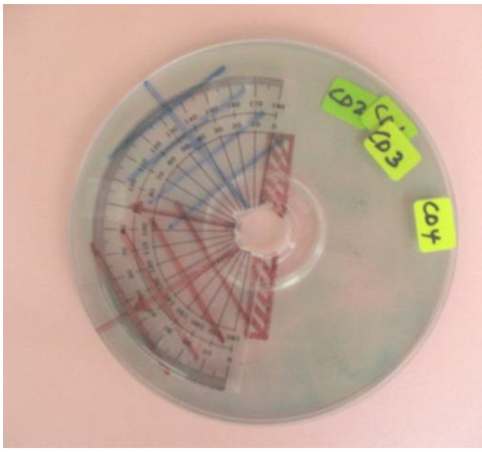
16-D4: Superimposing for interference (Waves of short wavelength)



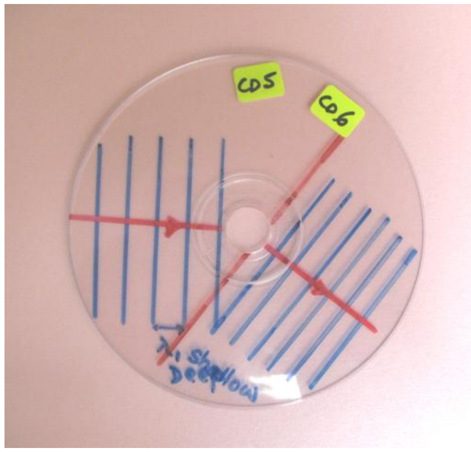
16-P1:
MY WAVES KITS and the CD handle



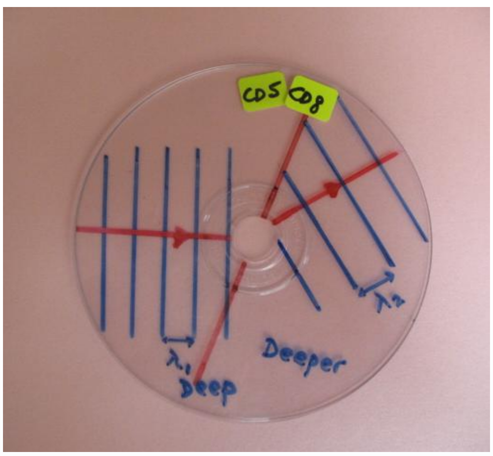
16-P2:
Reflection of Waves
Four CDs for simulating reflection of waves



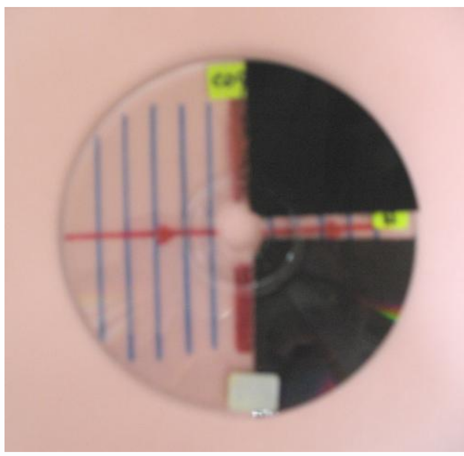
16-P3:
Reflection of Waves
The clear disc (CD 4) is a protractor which can be rotated to measure the angles of incidence and reflection



16-P4:
Refraction of waves moving from a deep to a shallow region CD5 and CD6 are rotated to form the wave pattern



16-P5:
Refraction of waves moving from a deep to a deeper region
CD5 and CD8 are rotated to form the wave pattern

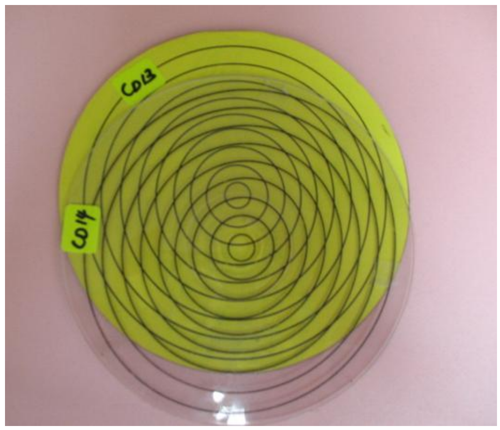


16-P6:
Diffraction of Waves
Two dark quadrants cover the wave pattern of waves after the gap

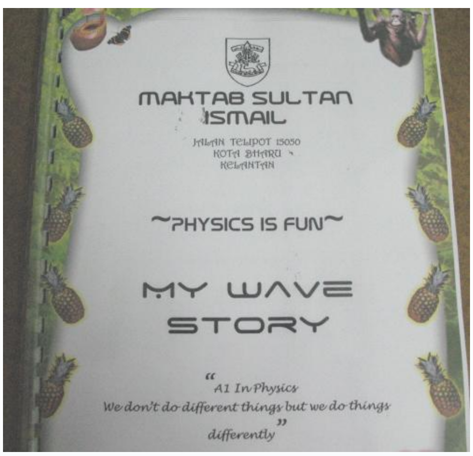
16-P7:
Diffraction of Waves
The two dark quadrants are rotated to reveal the wave pattern of waves after the gap

16-P8:
Interference of Waves
Superposition of waves of medium wavelength

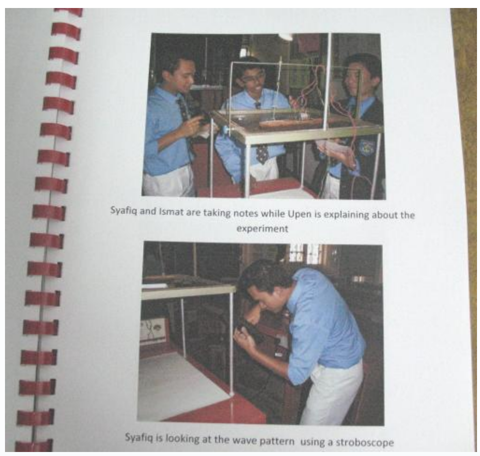
16-P9:
Interference of Waves
Superposition of waves of long wavelength



16-P10:
Interference of Waves
Superposition of waves of short wavelength

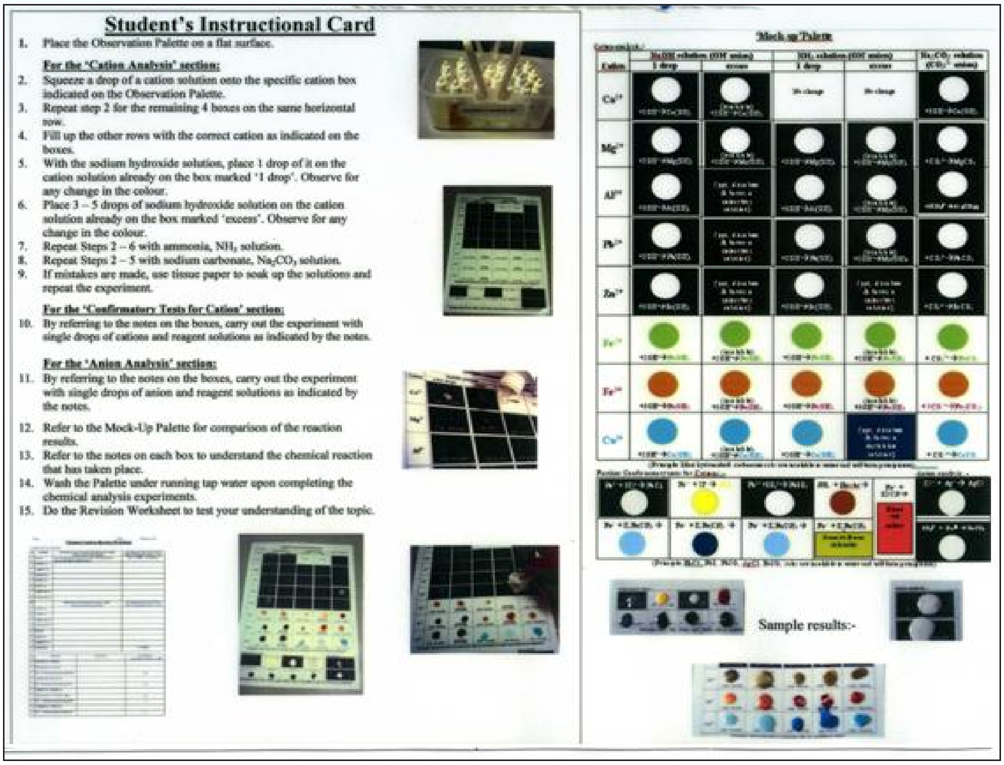


16-P11:
MY WAVES STORY folio



16-P12:
Photographs in *MY WAVES STORY*

Appendix (17)



Student's Instructional Card

1. Place the Observation Palette on a flat surface.

For the 'Cation Analysis' section:

2. Squeeze a drop of a cation solution onto the specific cation box indicated on the Observation Palette.
3. Repeat step 2 for the remaining 4 boxes on the same horizontal row.
4. Fill up the other rows with the correct cation as indicated on the boxes.
5. With the sodium hydroxide solution, place 1 drop of it on the cation solution already on the box marked '1 drop'. Observe for any change in the colour.
6. Place 3 – 5 drops of sodium hydroxide solution on the cation solution already on the box marked 'excess'. Observe for any change in the colour.
7. Repeat Steps 2 – 6 with ammonia, NH_3 solution.
8. Repeat Steps 2 – 5 with sodium carbonate, Na_2CO_3 solution.
9. If mistakes are made, use tissue paper to soak up the solutions and repeat the experiment.

For the 'Confirmatory Tests for Cation' section:

10. By referring to the notes on the boxes, carry out the experiment with single drops of cations and reagent solutions as indicated by the notes.

For the 'Anion Analysis' section:

11. By referring to the notes on the boxes, carry out the experiment with single drops of anion and reagent solutions as indicated by the notes.
12. Refer to the Mock-Up Palette for comparison of the reaction results.
13. Refer to the notes on each box to understand the chemical reaction that has taken place.
14. Wash the Palette under running tap water upon completing the chemical analysis experiments.
15. Do the Revision Worksheet to test your understanding of the topic.

17-D1: Students' Instructional Card (Sample D)

Construction of Teaching Aid

Apparatus/Materials:

- A4 papers
- Laminating Films
- Carrier basket/Basin
- Instructional Cards
- A 'Mock-up' Palette
- A Revision Worksheet
- 21 Plastic dropper bottles to contain the chemical solutions:-

Reagent solutions:

3M Sodium hydroxide solution, NaOH
6M Ammonia solution, NH_3
1M Sodium carbonate solution, Na_2CO_3
Nessler's reagent
0.5 M Barium chloride solution, $BaCl_2$
0.1M Silver nitrate solution, $AgNO_3$
0.5M Potassium iodide solution, KI
50 g dm^{-3} solutions of :-
Potassium hexacyanoferrate (II) solution (Khcf)
Potassium hexacyanoferrate (III) solution (Khcf)
Potassium thiocyanate solution, KSCN

Cation Solutions: 1M solutions of Ca^{2+}, Mg^{2+}, Al^{3+}, Pb^{2+}, Zn^{2+}, Fe^{2+}, Fe^{3+}, Cu^{2+} ions and 5M solution of NH_4^+ ions.

Anion solutions: 1M solutions of Cl^-, SO_4^{2-} ions.

Construction of Teaching Aids:

1. The 21 chemical solutions are prepared and poured into labelled* plastic dropper bottles which are placed in a carrier basket or basin.
2. 'Observation Palettes' are prepared from A4 size papers showing tables for cation and anion analysis reactions.
3. The 'Observation Palettes' can be laminated or placed in plastic protector sheets.
4. Student's Instructional Cards are prepared for students' use.
5. A Mock-up Palette is prepared for students' reference.
6. Revision Worksheets are prepared for students to recall the reactions and equations.

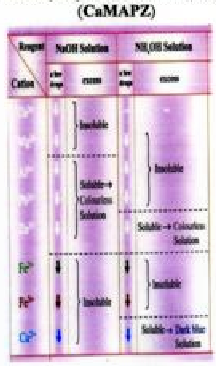
***Labelling of the bottles:-**

1. NaOH	12. NH_4^+
2. NH_3	13. Cl^-
3. CO_3^{2-}	14. I^-
4. Ca^{2+}	15. SO_4^{2-}
5. Mg^{2+}	16. Khcf(II)
6. Al^{3+}	17. Khcf(III)
7. Pb^{2+}	18. Nessler's
8. Zn^{2+}	19. KSCN
9. Fe^{2+}	20. Ag^+
10. Fe^{3+}	21. Ba^{2+}
11. Cu^{2+}	

Method of Implementation

1. Teacher starts off with a Set Induction scenario by posing some questions as follows:
   Would you like to conduct some experiments that Forensic scientists or CSI officers carry out?
2. Teacher can let the students do the Chemical Analysis experiments either individually or in groups of two, three or more.
3. Each station is provided with the following:-
   - A Chemical Analysis kit
   - An Observation Palettes
   - A Student's Instructional Card
   - A Mock-up Palette
   - Revision Worksheets
4. Students are given the opportunity to carry out the cation and anion analysis experiments on the Palettes after referring to the Student's Instructional Cards.
5. Upon completing the experiment, students can refer to the 'Mock-up' Palette for comparison of their experimental results.
6. Students will attempt the Revision Worksheets after completing the experiments in order to reinforce their knowledge of the chemical analysis experiments.
7. Teacher summarizes the Cation and Anion analysis experiments and gives **tips on how to memorize the topic on Chemical Analysis.

**Memory Tip for Cation Analysis: (CaMAPZ)



17-D2: Construction of Teaching Aid and Method of Implementation

Chemical Analysis Observation Palette

Cation analysis :- (Principle: Most hydroxide & carbonate salts are insoluble in water and will form precipitates)

Cation 1drop	NaOH solution (OH^- ion) 1 drop	NaOH solution (OH^- ion) excess	NH_3 solution (OH^- ion) 1 drop	NH_3 solution (OH^- ion) excess	Na_2CO_3 solution (CO_3^{2-} ion) 1 drop
Ca^{2+}	$+2OH^- \rightarrow Ca(OH)_2$	(insoluble) $+2OH^- \rightarrow Ca(OH)_2$	No change	No change	$+CO_3^{2-} \rightarrow CaCO_3$
Mg^{2+}	$+2OH^- \rightarrow Mg(OH)_2$	(insoluble) $+2OH^- \rightarrow Mg(OH)_2$	$+2OH^- \rightarrow Mg(OH)_2$	(insoluble) $+2OH^- \rightarrow Mg(OH)_2$	$+CO_3^{2-} \rightarrow MgCO_3$
Al^{3+}	$+3OH^- \rightarrow Al(OH)_3$	(ppt dissolves) → colourless solution	$+3OH^- \rightarrow Al(OH)_3$	(insoluble) $+3OH^- \rightarrow Al(OH)_3$	$+3CO_3^{2-} \rightarrow Al_2(CO_3)_3$
Pb^{2+}	$+2OH^- \rightarrow Pb(OH)_2$	(ppt dissolves) → colourless solution	$+2OH^- \rightarrow Pb(OH)_2$	(insoluble) $+2OH^- \rightarrow Pb(OH)_2$	$+CO_3^{2-} \rightarrow PbCO_3$
Zn^{2+}	$+2OH^- \rightarrow Zn(OH)_2$	(ppt dissolves) → colourless solution	$+2OH^- \rightarrow Zn(OH)_2$	(ppt dissolves) → colourless solution	$+CO_3^{2-} \rightarrow ZnCO_3$
Fe^{2+}	$+2OH^- \rightarrow Fe(OH)_2$	(insoluble) $+2OH^- \rightarrow Fe(OH)_2$	$+2OH^- \rightarrow Fe(OH)_2$	(insoluble) $+2OH^- \rightarrow Fe(OH)_2$	$+ CO_3^{2-} \rightarrow FeCO_3$
Fe^{3+}	$+3OH^- \rightarrow Fe(OH)_3$	(insoluble) $+3OH^- \rightarrow Fe(OH)_3$	$+3OH^- \rightarrow Fe(OH)_3$	(insoluble) $+3OH^- \rightarrow Fe(OH)_3$	$+ 3CO_3^{2-} \rightarrow Fe_2(CO_3)_3$
Cu^{2+}	$+2OH^- \rightarrow Cu(OH)_2$	(insoluble) $+2OH^- \rightarrow Cu(OH)_2$	$+2OH^- \rightarrow Cu(OH)_2$	(ppt dissolves) → Dark blue colour	$+ CO_3^{2-} \rightarrow CuCO_3$

Confirmatory tests for Cations :-

$Pb^{2+} + 2Cl^- \rightarrow PbCl_2$	$Pb^{2+} + 2I^- \rightarrow PbI_2$	$Pb^{2+} + SO_4^{2-} \rightarrow PbSO_4$	NH_4^+ + Nessler → Brown ppt	Fe^{3+} + KSCN → Blood red colour
$Fe^{2+} + K_4Fe(CN)_6 \rightarrow$ Light blue ppt	$Fe^{2+} + K_3Fe(CN)_6 \rightarrow$ Dark blue ppt	$Fe^{3+} + K_4Fe(CN)_6 \rightarrow$ Dark blue ppt	$Fe^{3+} + K_3Fe(CN)_6 \rightarrow$ Greenish brown colour	

Anion analysis :-

$Cl^- + Ag^+ \rightarrow AgCl$
$SO_4^{2-} + Ba^{2+} \rightarrow BaSO_4$

(Principle: $PbCl_2$, PbI_2, $PbSO_4$, $AgCl$, $BaSO_4$ salts are insoluble in water and will form precipitates)

17-D3: Chemical Analysis Observation Palette (Sample E)

Name:... Class:... Reference No:.........

Chemical Analysis Revision Worksheet

Complete the following tables:

A	Reactants	**Observations** when sodium hydroxide is added, little by little & then in excess	**Ionic equation** when little NaOH is added (if precipitation reaction occurs)
1	Zinc ion	**e.g. White precipitate, soluble in excess sodium hyroxide solution forming a colourless solution**	**$Zn^{2+} + 2OH^{-} \text{-->} Zn(OH)_2$**
2	Iron(III) ion		
3	Copper(II) ion		
4	Calcium ion		
5	Lead(II) ion		
6	Iron(II) ion		
7	Magnesium ion		
8	Aluminium ion		

A	Reactants	**Observations** when sodium hydroxide is added, little by little & then in excess	**Ionic equation** when little NaOH is added (if precipitation reaction occurs)
1	Lead ion	**e.g. White precipitate, insoluble in excess ammonia solution**	**$Pb^{2+} + 2OH^{-} \text{-->} Pb(OH)_2$**
2	Iron(III) ion		
3	Magnesium ion		
4	Aluminium ion		
5	Zinc ion		
6	Iron(II) ion		
7	Copper(II) ion		
8	Calcium ion		

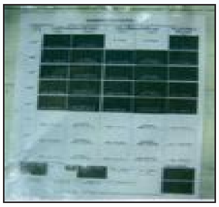
A	Reactants	Observations	Ionic equation (if precipitation reaction occurs)
1	Lead(II) ion + iodide ion		
2	Chloride ion + silver ion		
3	Fe^{3+} + Potassium hexacynoferrate(III)		
4	Lead(II) ion + chloride ion		
5	Fe^{2+} + Potassium hexacynoferrate(II)		
6	Lead(II) ion + suplhate ion		
7	Ammonium ion + Nessler's reagent		
8	Fe^{2+} + Potassium hexacynoferrate(III)		
9	Sulphate ion + barium ion		
10	Fe^{3+} + Potassium hexacynoferrate(II)		

17-D4: Chemical Analysis Revision Worksheet (Sample F)

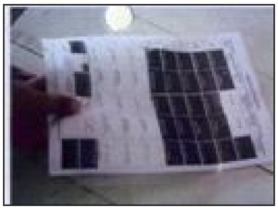
Method of Implementation

17-P1: The chemical analysis kit

17-P2: Bottles of chemical & observation palette (Sample A)



17-P3: Observation palette (Sample B)



17-P4: Place observation palette in sheet protector (Sample C)

17-P5: Drops of cation on the palette

17-P6: Cation/anion on the observation palette

17-P7: Drop the reagent onto cation solutions

17-P8: Wipe any mistakes with tissue paper

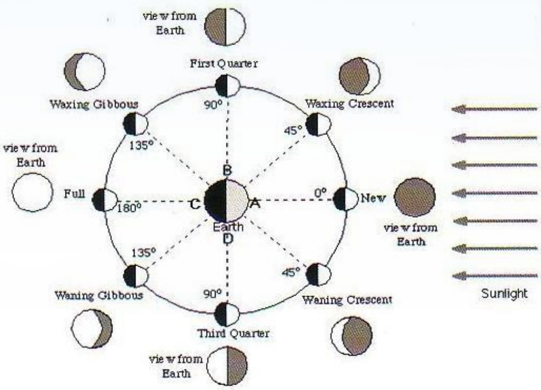
17-P9: The completed observation palette

17-P10: Students' activity

17-P11: Students' activity

17-P12: Students' activity

Appendix (18)



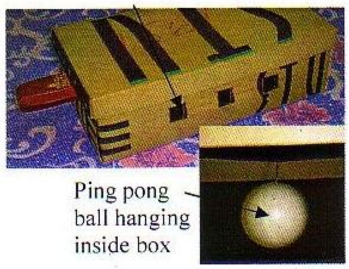
18-D1: The moon from two different views

Material	Cost
Bulb	RM 15.00
Mounting board (2 pcs)	RM 5.00
Mirror (2 pcs)	RM 3.00
Plywood board and wood block	RM 12.00
Wire and plug	RM 6.00
Bottle	RM 1.20
Total	**RM 42.20**

18-D2: The estimated low cost to build the model

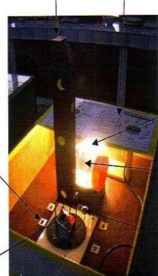
18-P1: Model of moon phases

18-P2: The umbrella model



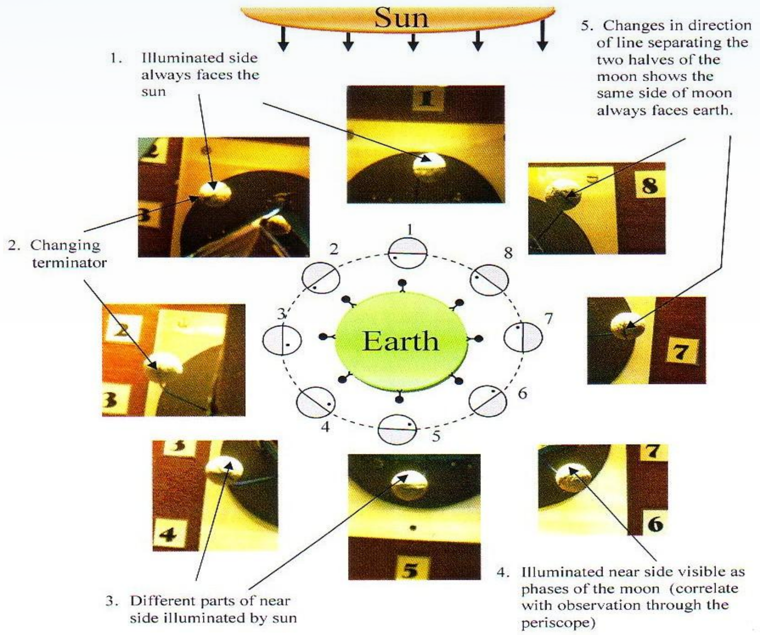
18-P3: The shoebox model

18-P4: The cover to reduce back reflection on the non-illuminated side of the moon

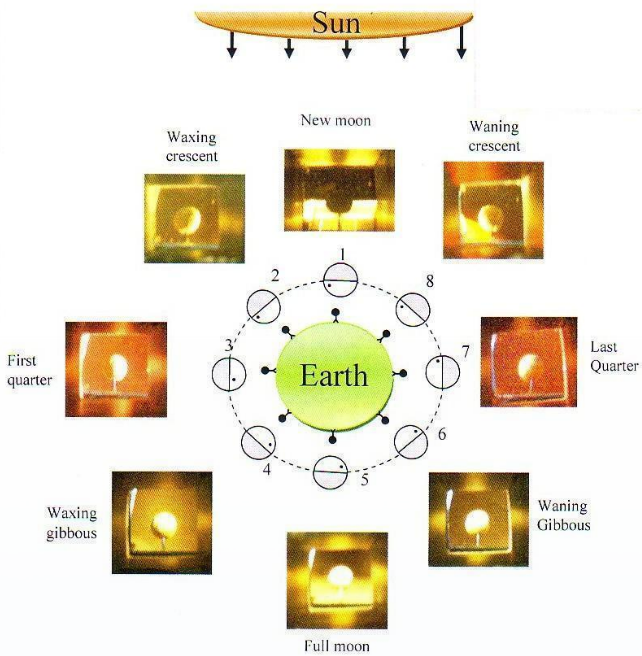


18-P5: The features of the two-view moon phase model

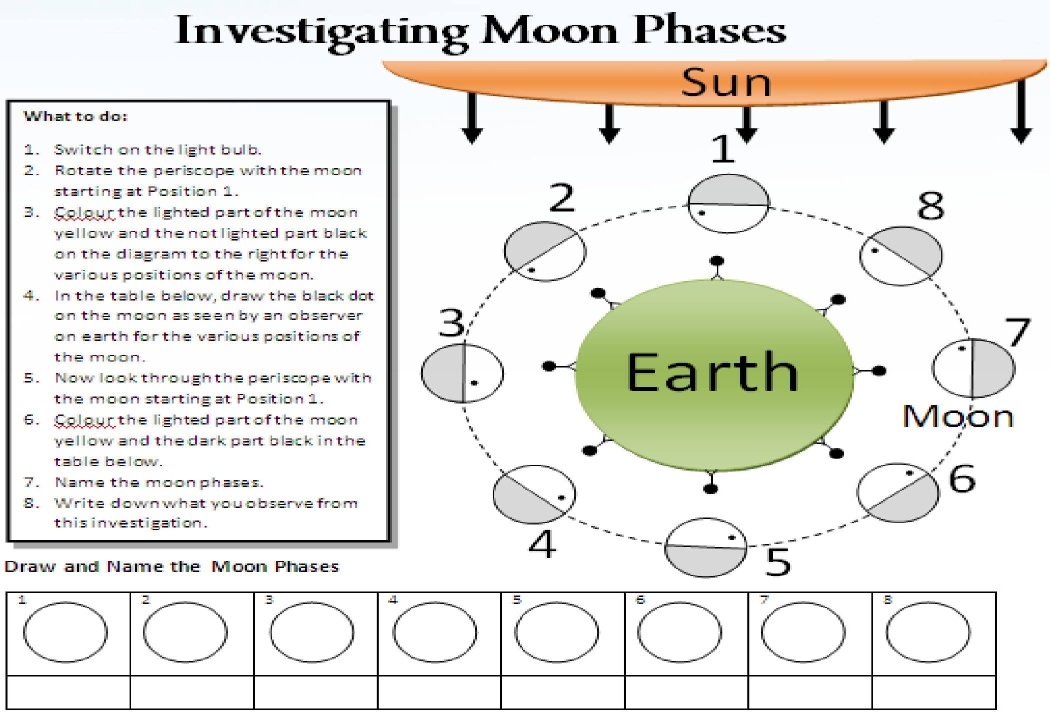
18-P6: Viewing the moon phase model



18-P7: Viewing from the sky (through top of model)



18-P8: Viewing from the earth (through the periscope)



Investigating Moon Phases

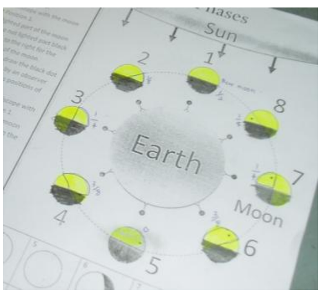
What to do:

1. Switch on the light bulb.
2. Rotate the periscope with the moon starting at Position 1.
3. Colour the lighted part of the moon yellow and the not lighted part black on the diagram to the right for the various positions of the moon.
4. In the table below, draw the black dot on the moon as seen by an observer on earth for the various positions of the moon.
5. Now look through the periscope with the moon starting at Position 1.
6. Colour the lighted part of the moon yellow and the dark part black in the table below.
7. Name the moon phases.
8. Write down what you observe from this investigation.

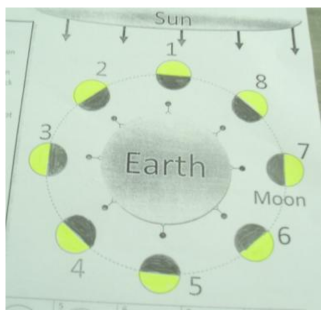
Draw and Name the Moon Phases

1	2	3	4	5	6	7	8

18-P9: The worksheet on *Investigating Moon Phases*



18-P10: Type 1 shading of the illuminated part of the moon for various positions of the moon



18-P11: Type 2 shading showing that the trainees have a problem with direction of light and illumination

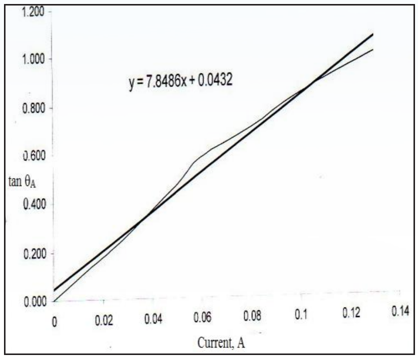
18-P12: Some trainees looking through the periscope

18-P13: Trainees shading the moon phases after checking their observations

Appendix (19)

Current, A	θ	Tan θ
0.00	0	0.000
0.02	10	0.176
0.03	15	0.268
0.04	20	0.364
0.05	25	0.466
0.06	30	0.577
0.08	35	0.700
0.10	40	0.839
0.13	45	1.000

19-D1: Readings of an Experiment

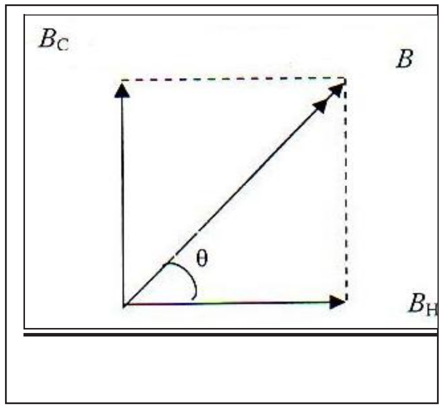


19-D2: Graph tan θ against Current

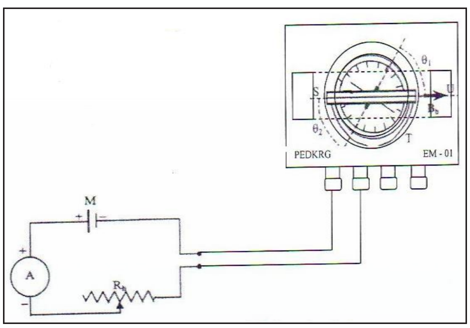
The number of turns for this experiment is 30 and gradient from the graph is 7.8486 A. From formula, $\tan\theta = \frac{\mu_o NI}{2RB_E}$. The gradient, m is equal to m= $\frac{\tan\theta}{I} = \frac{\mu_o N}{2RB_E}$. Therefore, $B_E = \frac{\mu_o N}{2Rm}$. So, the Earth's magnetic field, B_E is $B_E = \frac{\mu_0(30)}{2(5.5\times10^{-2})(7.8486)} = 43.78\mu T$

Standard value is between 30μT to 60μT.

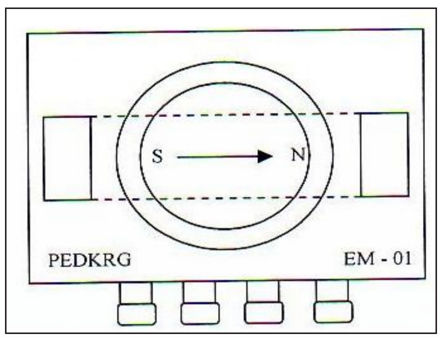
19-D3: An example of calculation to determine B_E



19-D4: Resultant Vector of Magnetic Field



19-D5: Earth's Magnetic Field Experiment Set



19-D6: Compass position

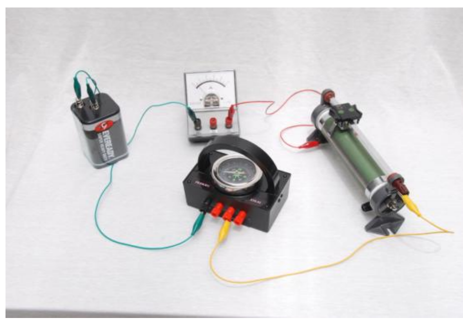
19-P1: Gadget EM-01

19-P2: Cutting of PVC Pipes

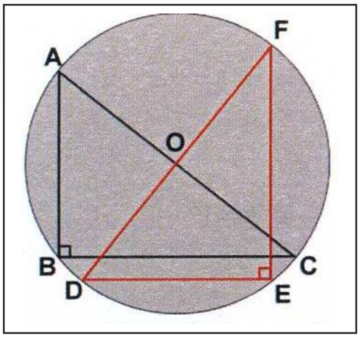
19-P3: PVC Pipe for Coil Fabrication

19-P4: Assembling of EM-01

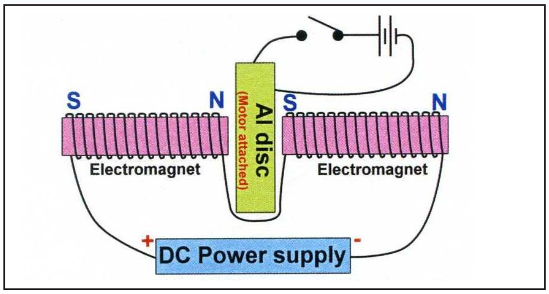
19-P5: EM-01 Ready for Sale



19-P6: Experiment Set-up

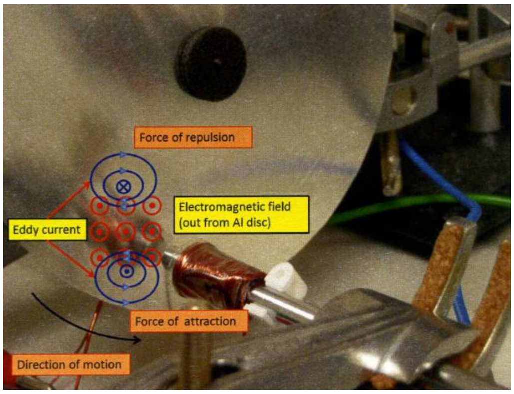


20-D1: Aluminium disc

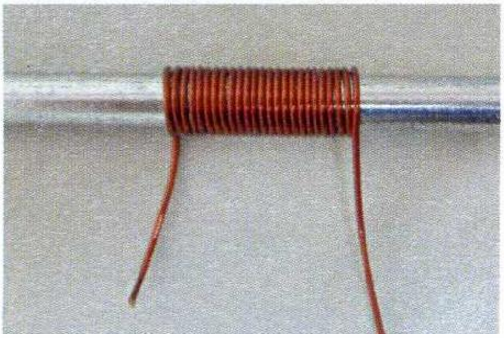


20-D2: Block diagram of system setup

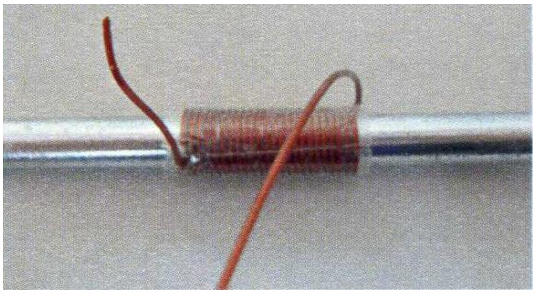
20-P1: Materials and Apparatus



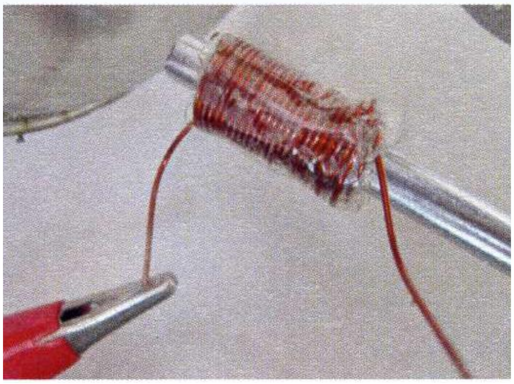
20-P2: Eddy current induced



20-P3: Winding wire on soft iron core

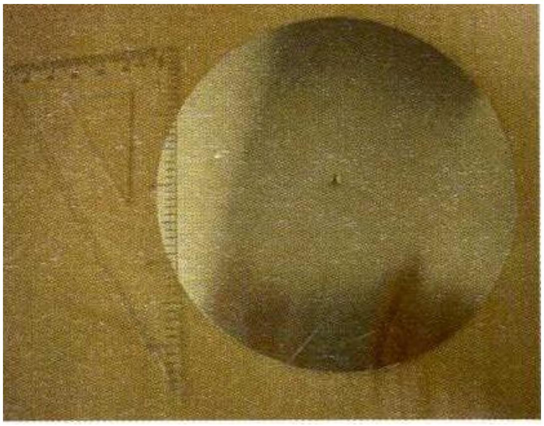


20-P4: Solenoid with cellophane tape

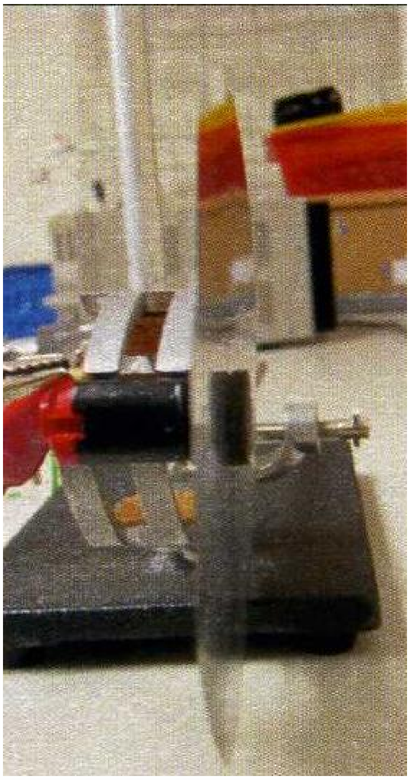


20-P5: Connecting the solenoid to the circuit

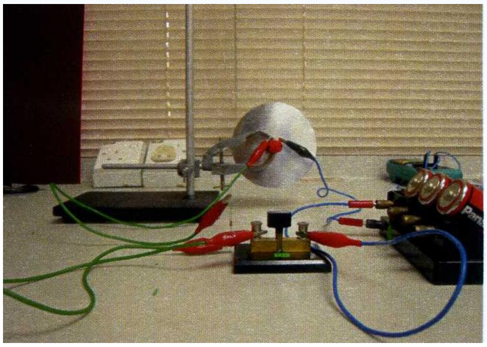
20-P6: Verification of the electromagnetic poles



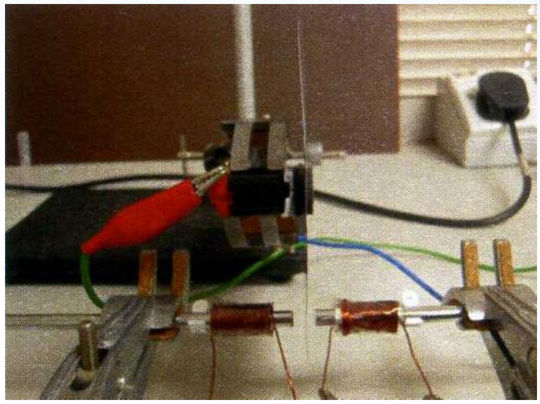
20-P7: Drilled hole on aluminium disc



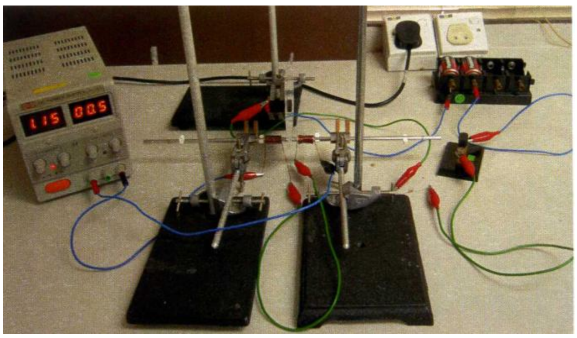
20-P8: Aluminium disc with protective pads



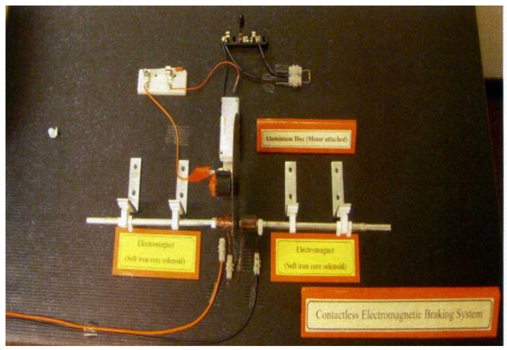
20-P9: Motor circuit



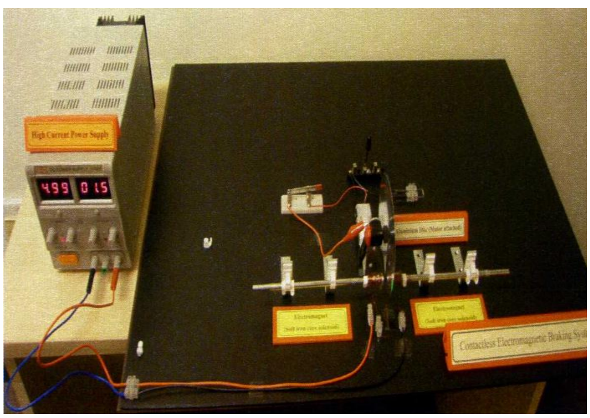
20-P10: Setup for Electromagnetic Braking System



20-P11: Complete Bench Setup for Electromagnetic Braking System



20-P12: Contactless Electromagnetic Braking Model (Without power supply)



20-P13: Contactless Electromagnetic Braking Model (With power supply)

11	**EASY TO BUILD LOW COST HI FUNCTION VAN DE GRAAF GENERATOR** **(PHYSICS– PRE-UNIVERSITY)**

LING TOH WOON
HELP UNIVERSITY COLLEGE
PUSAT BANDAR DAMANSARA, 50490 KUALA LUMPUR

Background : The Van de Graaf generator is a standard equipment in a Physics laboratory. However, commercial Van de Graaf generators are expensive and entail expenses to procure them for school use. This improvised Van de Graaf generator model uses easily available low cost and recycled materials found in the community. Moreover, this Van de Graaf generator model can provide a reasonable potential difference of 10000V – 20000V depending on the battery connected.

Objectives : The construction of this model will serve a number of instructional goals and objectives such as the following:

(i) To enable students to make scientific models by themselves

(ii) To encourage scientific-based thinking through hands-on experience.

(iii) To illustrate the concept of electrostatics.

(iv) To illustrate the concepts of potential difference, particle acceleration and power with the use of related experimental kits.

(v) To show how atomic mass and particle accelerators can be used to determine composition of elements in a sample, hence determining its purity.

Benefits for teaching and learning process :

- This model can serve as a teaching aid in the topic of Electricity. It provides a simple and cost effective introduction to potential difference, making the study of electricity very much more interesting.
- This model can also be used to identify the materials in a solid source through the mass spectrum that is produced.
- This model is much cheaper than a commercial Van de Graaf generator and is sufficiently powerful for school laboratory use.
- This model can be modified to illustrate particle acceleration whenever there is no working model in the classrooms.

Apparatus/ materials : In constructing the model of Van de Graaf generator, the following materials with the descriptions of their functions were used:

(a) Soda can- acts as conducting head (negatively charged) and electron sink

(b) Notice board pins – act as pivots for belt to run

(c) Glass fuse – acts as insulator to ensure charge is transferred to conducting head

(d) Stranded wire – to brush against belt and acts as electron source

(e) Rubber band – acts as belt to transfer electrons from source to sink

(f) Soda bottle – acts a body for the Van de Graaf generator model, to separate electron source and sink

(g) Battery clip – to connect batteries to supply energy for the motor

(h) Clear plastic – serves as stage for electric motor

(i) Plastic tie – to secure motor to clear plastic

(j) Electric motor – to rotate belt allowing it to carry electrons from source to sink

(k) Plastic tubing – act as rollers to minimise friction

(l) Batteries – source of power

Implementation of the teaching : A. **Constructing the Van de Graaf Generator Model**

To construct the Van de Graaf generator model, please refer to the diagram found below **[Refer 11-D1].**

(a) Picture 1 (**Refer 11-P1]** shows the body of the Van de Graaf model.

(b) Picture 2 **[Refer 11-P2]** shows the assembly of the model seen in top view.

(c) Picture 3 **[Refer 11-P3]** shows the model of the Van de Graaf generator in its full assembly and in functional state.

(d) Picture 4 **[Refer 11-P4]** shows the Van de Graaf generator model in a closer view.

B. **Using the Van de Graaf Generator Model**

(a) Connect the battery to clip to the Van de Graaf generator model to supply power so it can start to run.

(b) Cut small bits of paper and place it nearby. The paper will start to levitate indicating that the Van de Graaf generator model is charged up.

(c) The model can be used to deduce the different types of materials from unknown sources.

(d) Students can be provided with tubing and phosphorous screen to understand particle acceleration.

(e) Students can vary the voltage of the battery to understand how potential difference varies in the Van de Graaf generator.

(f) The Van de Graaf generator model can be used for further experiments including spectrometry.

Suggestions for modification :

1. Other lost cost available materials found in the locality must be used in creating a generator model such as plastic tupper ware, PVC pipe, wooden skewer (satay stick), mineral water bottles d.c. motor from hand-held fans, etc.
2. The process of constructing the model generator has to be made more in detail (i.e. mounting the motor, making the housing, attaching the belt and rollers, etc.).
3. A brief description about the Van de Graaf generator as well as its application needs to be included in the background.
4. An explanation of how Van de Graaf generator works needs to be included in the implementation of the teaching such as in diagram 2 **[Refer 11-D2]**.
5. A picture of the commercial Van de Graaf generator needs to be included to compare it with the improvised model for comparison as well as for those teachers who have not seen the real apparatus such as in picture 6 **[Refer 11-P5]**.

12	SIMPLE TRACK (PHYSICS – UPPER SECONDARY) SIA PENG YEE SEKOLAH MENENGAH JENIS KEBANGSAAN SEG HWA JALAN TAHANG RIMAU, 85009 SEGAMAT, JOHOR

Background : Inertia and principle of conservation of momentum are important concepts to be taught to the Form 4 students in Physics class.

Teachers normally explain the situation where "object in motion tends to stay in motion with a constant velocity unless acted upon by external forces" by showing video clips of bus passengers being thrown forward during an emergency brake. The conventional method demonstrating the conservation of momentum usually involves inelastic collisions between trolleys that run down a friction-compensated inclined plane [**Refer 12-D1]**. This method is not only time consuming but is subjected to human errors which render the experimental errors.

Objectives : The objective of this innovation is to redesign a horizontal straight air cushioned track to replace the friction-compensated model which not only is easier to set up but provides a more accurate visual for the students to understand the concept of conservation of momentum.

Benefits for teaching and learning process : **Teacher's aspect:**

a) Enable the teachers to make a low cost but effective model of an air cushioned track.
b) Easy to setup.
c) Enable the teachers to demonstrate the concept of inertia and conservation of momentum in various linear collisions clearly.

Student's aspect:

a) Students are able to visualize the whole experiment better.
b) Less subjected to human errors.
c) Students are able to conceptualize the changes in speed for different masses in various collisions modes.

Apparatus/ materials :
(a) A PVC water pipe − 2 m length, 32 mm diameter
(b) A normal vacuum cleaner with dry blow − 1200 W
(c) 3 paper cylinders (toilet rolls) − 27 mm length and 36 mm diameter
(d) Removable adhesive − double sided tapes
(e) 2 PVC wire concealed bracket (3 cm width × 10 cm length × 3 cm high)

Construction and Implementation of the teaching aids :

(a) BUILDING THE SIMPLE AIR-CUSIONED TRACK [Refer 12-P1]

Drill two rows of holes along the 2 m PVC water pipe with separation 2 cm between rows. Each hole is 3 mm in diameter and 2 cm apart between the adjacent holes.

(b) CREATING THE STANDARD GLIDING MASSES. [Refer 12-P2]

Get three identical (same mass) recycled paper rims or toilet rolls. Two of the paper rims serve as two identical masses with 2 unit mass each. Cut the remaining paper rim into two equal size rims. Each smaller rim serves as 1-unit mass.

(c) VACUUM CLEANER [Refer 12-P3]

Attach the flexible hose of the vacuum cleaner to the blow outlet. The blow outlet is then attached to one end of the PVC pipe.

(d) OVERALL COMPLETED SETUP [Refer 12-P4]

i) Level the track horizontally on a pair of wedges with the holes facing upward.
ii) Attach one end of the track to the outlet hose of the vacuum cleaner.
iii) Slot or slide the desire paper mass or masses through the track and shift it near to the end attached to the hose.
iv) The completed set up is shown in picture **[Refer 12-P4].**

Implementation of teaching aids :

1. Concept of Inertia (Object in motion)

Procedures:

a) Slot one 2-unit mass through the track and place it at the end near to the vacuum cleaner.
b) Do not switch on the vacuum cleaner. Give the 2-unit mass a gentle push so that it starts moving with an initial velocity. Students observe the motion of the mass **[Refer 12-P5].**
c) Next, switch on the vacuum cleaner and again give the 2-unit mass an initial velocity as before. Students observe the motion of the mass and compare it with the earlier experiment **[Refer 12-P6].**

Conclusion:

For the first observation, with the vacuum cleaner switched off, the friction between the mass and the track is high, thus the frictional forces causes the mass to stop almost immediately.

When the vacuum cleaner is on, the cushion of air reduces the friction between the mass and the tube (track). This enables the mass to glide along the track with uniform velocity for a much longer distance before stopping. This simple set up clearly demonstrates the concept of inertia.

2. Conservation of momentum in collisions

Procedures:

a) Slot two identical 2-unit masses through the track.

b) Place one of the mass, m_1 at one end near to the hose of the vacuum cleaner while the other mass, m_2 at the centre of the track.

c) Switch on the vacuum cleaner and give the first mass, m_1 a gentle tap to give it an initial velocity, u_1. It will glide along the track with uniform velocity and collide with the second mass which is at rest **[Refer 12-P7].**

d) Observe the motion of the masses after collision.

Conclusion:

The students will observe that after the collision, the mass, m_1 stops while the initial stationary mass m_2 moves forward with a constant velocity with a velocity almost identical to the first mass before collision **[Refer 12-P8].**

This simple yet effective experiment is able to explain the conservation of momentum during collision.

3. Conservation of momentum using different combination of masses.

Below are other experiments that can be demonstrated by this teaching aid using different combination of masses.

i) A 2-unit mass collides with a 1-unit stationary mass **[Refer 12-P9].**

ii) A 1-unit mass collides with a 2-unit stationary mass **[Refer 12-P10].**

iii) A 2-unit mass collides with another 2-unit mass moving towards each other **[Refer 12-P11].**

iv) A 2-unit mass collides with a 1 unit-mass moving towards each other and vice-versa **[Refer 12-P12].**

For each situation above, the students will observe the speed and the direction and before and after collision. Moreover,

v) If the students attach some removable adhesive (like double sided tapes) to the colliding ends of the masses, then they will be able to observe an inelastic collision where the masses stick together after collision **[Refer 12-P13].**

Conclusions:

The above combination of experiments can be easily done by students and students are able to observe the velocity and direction of the masses before and after collision. Students are able to grasp the concept of conservation of momentum and in an elastic and inelastic collision which can be clearly demonstrated by this teaching aid.

Suggestions for modification :

1. The entire tubing used as air cushion track should be uniformly surrounded with holes, not at the upper part only.

2. The holes should be smaller, perhaps 2.5 mm. Holes should be made using a 2.5 mm drill bit.

3. The experiment did not mention whether the other side of the tube was sealed or not. To ensure that all the air comes out from the holes, the end of the tubing should be sealed.

13	**REDUCTION OF METAL OXIDE TO ITS METAL BY HYDROGEN QUALITATIVELY AND QUANTITATIVELY** **(CHEMISTRY – UPPER SECONDARY)** **YEO PECK CHENG** **SEKOLAH MENENGAH DATUK PETER MOJUNTIN** **89507 PENAMPANG, SABAH**

Background : The *reduction of metal oxide to its metal by hydrogen* is studied qualitatively in Form 4 and quantitatively in Form 5. Nevertheless, new teachers do not do the experiments because they were told that these experiments are dangerous and can explode. A few experienced teachers did them by demonstration only.

Some of the problems faced by teachers were:

(a) Fear of explosion and therefore they won't do the experiments.
(b) The apparatus used is large, not commonly available and teachers don't know how to assemble them.
(c) No budget to buy the large quantity of chemicals required.
(d) Tedious preparation.
(e) Time consuming.
(f) Poor qualitative experimental results.
(g) The combustion tube will break when heated causing the experiment to be abandoned half way through.
(h) Students crowd around the demonstration.

Objectives :

1. To provide opportunity for students to carry out experiment that can be handled safely.
2. To enable students to observe the characteristic of physical and chemical changes of metal oxide reduction by using hydrogen.
3. To provide an alternative and effective procedures for chemistry teachers to perform the experiment.

Benefits for teaching and learning process : The following benefits are identified:

(a) Explosion fear is reduced to zero and it's very safe for the class to do the experiment in small groups.
(b) The apparatus used is very small, commonly available, cheap and made of recycled materials.
(c) Small quantities and common chemicals are required and some can be recycled.
(d) Simple preparation is required and it is mobile.
(e) The activities can be carried out in rural and interior schools especially those with problems of water, chemicals, apparatus and lack of laboratory.
(f) The time for the experiment is short and it is easy to set up, students can even repeat the experiment.
(g) Experimental results are accurate both qualitatively and quantitatively.
(h) The apparatus will not break half way through the experiment.
(i) Chemical waste can be reduced.

(j) The activities are based on student-centred approaches.
(k) Students are fully in control of the experiment.
(l) Students cooperate with each other and show confident.

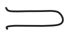
Apparatus/ materials :

(a) Two pieces of silicon/rubber tubing (6 and 9 cm long).

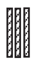
(b) A glass tubing cutter.
(c) Two pieces of glass tubing (5 and 9 cm long).

(d) A piece of 90^{o} bent glass tubing (4+4 cm).

(e) A piece of boiling tube or a broken boiling tube.



(f) A piece of rubber stopper with two holes.



(g) A piece of thistle funnel, broken pipette, burette or funnel.

(h) A lamp filled with ethanol/spirit/ lighter fluid.

(i) A weighing balance.
(j) Eight to 12 granules of zinc / 1 coiled iron wire/ iron nails/ zinc turning (can be reused).
(k) Five to 10 granules of anhydrous calcium chloride.
(l) 10 to 20 cm^3 of 1 mol dm^{-3} sulphuric acid or 2 mol dm^{-3} hydrochloric acid.
(m) 2 g copper or iron or lead oxide powder.

Construction of teaching aids : **PREPARATION BY THE LABORATORY ASSISTANT OR TEACHER**

[Refer 13-P1 and 13-P2]

(i) Cut silicon tubing.
(ii) Cut glass tubing.
(iii) Bent the 9 cm glass tubing using the flame of a Bunsen burner.
(iv) Insert the bent glass tubing and thistle tube into the two-hole rubber stopper.
(v) Divide the class into six groups of 4 to 5 students per group **[Refer 13-P3]**.

Implementation :

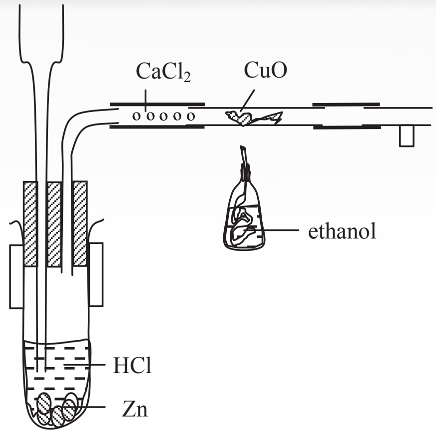


Figure 1 Putting together the apparatus

(a) **THE PROCEDURE**

(i) Fill about 5 zinc granules into a boiling tube.

(ii) Clamp the boiling tube.

(iii) Close it with the rubber stopper with a thistle and bent tube.

(iv) Insert anhydrous calcium chloride into the 9 cm silicon tube and connect it to the bent tube.

(v) *Weigh an empty 9 cm dry glass tube and insert copper (II) oxide powder into it **[Refer 13-P4].**

(vi) *Weigh the filled glass tube and connect to the filled silicon tube **[Refer 13-P5].**

(vii) Connect the 6 cm dry silicon tube with the 5 cm glass tube to the oxide filled glass tube **[Refer 13-P6].**

(viii) Support the glass tube to keep it horizontal.

(ix) Add about 10 cm^3 of dilute hydrochloric acid into the boiling tube.

(x) Wait for 1 minute and start heating the metal oxide with a lamp until no further change.

(xi) Stop heating, cool it and
*weigh the glass tube with its content.

(xii) **Repeat the experiment replacing copper (II) oxide with lead and iron (III) oxide.

Notes:

*For qualitative experiment only

**For quantitative experiment

1. A spirit lamp was used because the fire from a Bunsen burner is too hot. The tube will bend and break. In addition suck back will occur.
2. The fuels used were methanol and ethanol. Do not use propanol because of heavy soot.

(b) **RESULTS AND BENEFITS OF IMPLEMENTING THE TEACHING/ GUIDANCE METHOD, ETC.**:

- Success Rating

(i) Quantitative experiment

Aim of the experiment: Reduction of a metal oxide to metal

Form	Form 4	Form 5
Reactions : F4&5 - Copper oxide + hydrogen **[Refer 13-P7, 13-P8, 13-P9]** F5 - Lead oxide + hydrogen F5 - Iron oxide + hydrogen **[Refer 13-P10, 13-P11]**	Success rate	Success rate
Group 1	100 %	100 %
Group 2	100 %	100 %
Group 3	100 %	100 %
Group 4	100 %	100 %
Group 5	100 %	100 %
Group 6	100 %	100 %

(ii) Qualitative experiment

Aim of the experiment: Determine the empirical formula of copper(II) oxide [**13-P12 and 13-P13]**

	Form 4	Form 5
	accuracy	accuracy
Group 1	High	High
Group 2	Average	High
Group 3	High	High
Group 4	Average	High
Group 5	High	High
Group 6	Average	High

Note: Form 5 results were more accurate because the glass rod was lengthened and the glass tube and content was weighed without the silicon tubing.

Suggestion for modification : For the precautionary steps it is a good practice to use emery cloth to take the edge off the ends of the cut glass pieces and fire-polish the ends of the cut glass tubing. In addition allow the glass tubing to cool after the bending process.

14

PULSED LED VELOCITY MEASUREMENT SYSTEM (PLVMS)
(PHYSICS – UPPER SECONDARY)

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Background : The current method of measuring velocity using ticker tape is messy as it involves throwing away a lot of paper tape. What is most disturbing is that the mere use of a ticker timer where friction is introduced between the point of impact and the paper tape affects the actual value of the velocity that is being measured.

Every Physics teacher is aware that when a trolley is moved, and once the ticker timer is started, the trolley slows down, because of friction. This makes the actual measurement of velocity in collisions very inaccurate. If the trolleys have to move in opposite directions, the measurement of velocity becomes impossible.

Stroboscopic methods solve some of these problems, but the equipment is expensive. Stroboscopes need to be handled carefully, otherwise they can cause eye damage. Also, rebound movements are difficult to measure with certainty.

As a result of these problems we tried many methods, and finally we succeeded in developing the Pulsed LED Velocity Measurement System (PLVMS).

Objectives :

(a) To develop a method for the measurement of velocity and acceleration that is more accurate.
(b) The method involves pulsed light sources that can be recorded using a camera in a darkened environment.
(c) The pulsed light sources are mounted on the moving sources to be studied.
(d) To use the apparatus for the study of collisions.
(e) To measure circular motion.

Benefits for teaching and learning process : The benefits and advantages of the PLVMS are:

1. No wastage of paper.
2. Can measure all types of velocities that can be measured using a ticker tape.
3. Can measure angular velocity or displacement (This is not possible using the ticker-tape method).
4. Very safe, almost no possibility of eye damage through too bright light sources. (Stroboscopic method can cause eye damage).
5. Results in very descriptive photographic images.
6. Very challenging photography, very interesting to look at and also attractive.

7. Electrical source is just a dry cell battery. Very safe (Ticker tape/timer system uses 240V).

The innovations incorporated in this system are:

- Pulsed light is attached on the moving object.
- Different coloured lights can distinguish between different objects.
- Opens up new and creative ways to measure non-linear motion such as circular motion.

The following are the design concepts used:

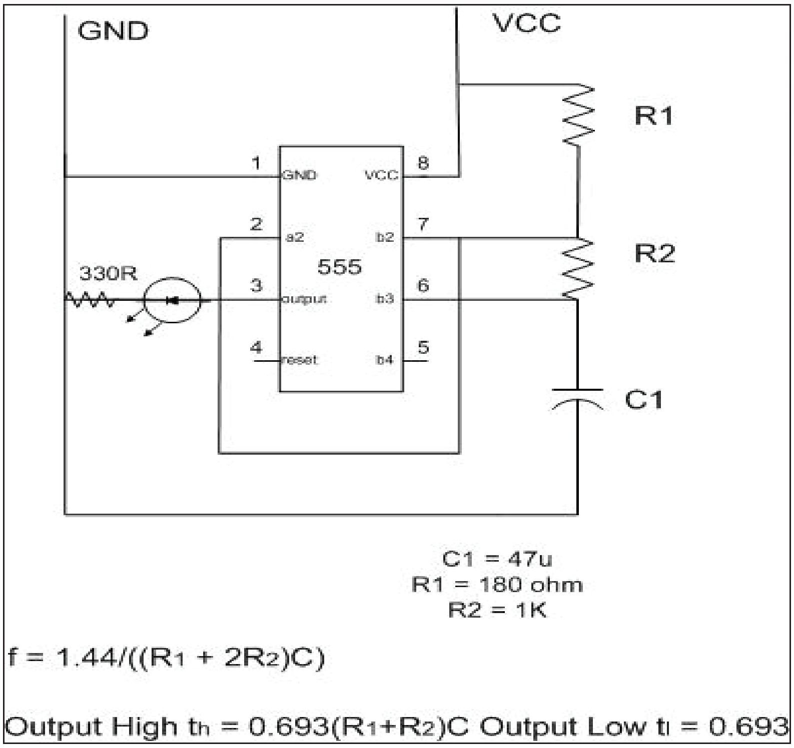
1. The frequency of the pulses should be such that it gives a reasonable spacing between the pulses so that it can be captured using a camera.
2. The sharpness of the images must be sufficient to measure the distance between them against a dimly lighted ruler.
3. From the distance between the images, the velocity can be calculated.
4. Although this device can be mounted on any trolley, for convenience, we make use of the Curtain Rail Motion Study Apparatus presented in the 2007 entry for this competition. However, the focus of this 2008 entry is on the Velocity Measurement System.
5. The parts should be easily available and not expensive.

Apparatus/ materials :

(a) Coloured Light Emitting Diodes
(b) LM555 multivibrator integrated circuit
(c) 1kΩ ¼ W resistor
(d) 180 Ω ¼ W resistor
(e) 47 microfarad electrolytic capacitor (25V)
(f) Printed circuit board
(g) Battery
(h) Mounting screws
(i) Trolleys and curtain rail
(j) Retort stands
(k) Ruler

Construction of the model :

1. The circuit is constructed **[Refer 14-D1]**.



14-D1: Circuit Diagram

2. This circuit has a frequency of 14 hertz, a period of 0.07 seconds, and a duty cycle of 54%.

3. The completed pulse LED device circuit [**Refer 14-P1**] and the device when mounted on a trolley **[Refer 14-P2**].

4. Calibration of the PLVMS device is done by an oscilloscope . **[Refer 14-P3]**. This picture shows a period of 2.7 x 20 ms = 0.054s, which contrasts with 0.07s from the calculated value above. We shall use 0.054s for velocity determination, as the calculated value does not take into consideration of the fact that the marked values of the components used may vary from the real value. The output is a square wave, resulting in a camera image **[Refer 14-P4]**.

5. The image (enlarged) is captured using a time exposure, in this case, of 3 seconds. The camera must be capable of manual setting.

6. This image indicates a distance of 62.6 – 51.5 = 11.1cm over two periods of 2 x 0.054 = 0.108s, giving a velocity of 11.1/0.108 = 103 cm/s. This is how velocity is measured using the Pulsed LED Velocity Measurement System.

7. Measurement of distance must be done from leading edge to leading edge [**Refer 14-P5**].

Implementation of the teaching	:	The implementation of the PLVMS allows students to study elastic collision **[Refer14-P6]**. The setup of the system in the laboratory **[Refer 14-P7].**

(a) Elastic collisions

Two trolleys of equal mass are used. One trolley is initially at rest **[Refer14-P8]**. The orange light shows the initial velocity of the right trolley. After collision, the left trolley moves away with the same velocity. This is measurable **[Refer 14-P9].**

Two trolleys of equal mass moving towards each other **[Refer 14-P10]**. After collision, the trolleys move apart in opposite directions. The velocities before and after collision can be determined. Calculations of energy loss can be done. Even qualitatively, it can be seen that there is a loss of energy after collision by noting that the lengths of the pulsed lights are shorter after the collision. An attempt to change the colour of the lights after collision was not feasible at this point, as the colour-switching methods that were attempted interfered with the collision event itself.

Two trolleys, where the trolley on the left is three times more massive are then used **[Refer14-P11]**. Here, the heavier trolley (green light) starts at constant velocity. The very bright orange light indicates that the lighter trolley is initially at rest **[Refer 14-P12]**. After collision, the right trolley (orange) moves off with a high velocity, decelerating due to friction. The right, heavier object (green) only slows down. They both finally stop.

(b) Inelastic collision

The green trolley (right) **[Refer 14-P13]** moves from the right, collides with a stationary trolley on right. After collision, they both move together to the left with a lower velocity. All these velocities are measurable.

(c) Explosive collision

After collision, they move apart **[Refer 14-P14]**. Energy loss can be seen with shorter pulses towards the extreme left and right.

(d) Circular motion

Track of a toy train moving with almost constant speed **[Refer 14-P15]**. Both the speed and the angular velocity can be determined.

(e) Swinging pendulum

The velocity can be seen to be highest at the middle, and gets lesser towards the edges **[Refer 14-P16]**. It is possible to determine the velocities.

(f) Free fall

An object is released, falling under gravity **[Refer 14-P17].** Its acceleration can be determined.

All measurements can be done using the techniques and principles described previously.

Some results of velocity images are collected **[Refer 14-P18** and **14-P19**].

Suggestion for modification : We suggest the possibility of changing the colour of light when the object changes direction. This will help to track objects that change direction.

15

USING WATER AS A MEDIUM TO LINK UP THE RELATIONSHIP BETWEEN REFRACTIVE INDEX, CRITICAL ANGLE AND DENSITY OF THE MEDIUM
(PHYSICS – UPPER SECONDARY)

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Background : Many students find it difficult to understand the relationship between refractive index, density and critical angle. I would like to recommend an inquiry-discovery approach which can be used to link the three optical properties in one experiment.

Objectives :
1. To relate density, refractive index and critical angle.
2. To derive the formula; 1/n=sin c experimentally.
3. To develop innovative thinking skills using a self-designed experiment.

Benefits for teaching and learning process : Students will understand that:

(a) Materials used are cheap and can be easily obtained.
(b) Preparation of the apparatus can improve the manipulative skills of the students.
(c) Stir up the interest of the students using self-designed apparatus.
(d) Result of the experiment.

Apparatus/ materials :

Materials	Quantity
(a) Salt	500g
(b) Water	4*l*
(c) Container (>1*l*)	4
(d) Plasticine	100g
(e) Retort stand	1
(f) Triple beam balance	1
(g) Measuring cylinder (1*l*)	1
(h) White thread (25cm)	1
(i) Scissors/cutter	1
(j) Flat bottom plastic bottle (0.5-2.0*l*)	1
(k) Translucent paper ($5x8cm^2$)	1
(l) Cellophane tape	
(m) Beaker ($500cm^3$)	1
(n) Nail/sharp pointed object	1
(o) Marker pen	1
(p) Protractor	1
(q) Laser pointer	1
(r) Stool	1

Construction of teaching aids : **(a) PREPARATION OF THE PLASTIC BOTTLE [Refer 15-D1, 15-D2, 15-P1** and **15-P2]**

1. Poke a hole through the centre of the cap of the plastic bottle.
2. Poke a hole through the centre of the base of the plastic bottle.
3. Mark 2 diagonal lines perpendicular to each other through the centre of the base of the bottle to divide the base of the bottle into 4 segments.
4. Label the vertical diagonal line and the horizontal diagonal line as y and x respectively.
5. Draw another line z at the lower left segment of the bottle which sustains an angle of 30^o from the vertical line y **[Refer 15-D1** and **15-P1]**.
6. Draw 3 lines along the surface of the bottle; one extended from line x and the other two extended from lines y and z.
7. Pull a thread through the hole of the cap and hole of the base. Stick both ends of the thread with 2 strips of cellophane tapes **[Refer 15-D2** and **15-P2]**.
8. Along the extended line y, cut a hole (4x7 cm^2) at the middle section of the bottle.
9. Next to the base of the bottle, along the surface of the upper right segment of the bottle stick a piece of translucent paper (5x8 cm^2) firmly.

(b) PREPARATION OF THE SALT SOLUTION FOR 20 GROUPS OF STUDENTS

1. Measure 500g of salt with a triple beam balance.
2. Use a measuring cylinder (1000 cm^3) to measure 10 litres of water into a container.
3. Pour the salt into the container. Put a stopper on the container and shake vigorously to dissolve the salt.
4. Repeat the steps above by dissolving 1000g, 1500g and 2000g of salt into 10 litres of water to prepare the solutions with different densities.

Notes:

- Hot water can be used to increase the solubility of the salt for solution with high concentration.
- All the salt solutions can be reused and shared with other groups.

Implementation : A worksheet is given to guide students to carry out the experiment. Students need to work in pairs.

1. WORKSHEET

Aim:

(a) To find the relationship between:
   (i) Density and refractive index
   (ii) Density and critical angle
   (iii) Refractive index and critical angle

(b) To derive a general formula in terms of refractive index and critical angle.

Procedure:

[Refer 15-D3, 15-D4 and **15-D5]**

1. Place the plastic bottle horizontally at the edge of the table **[Refer 15-D3].**
2. Stabilize the plastic bottle by inserting plasticine on both sides of the plastic bottle.
3. Fill the plastic bottle with water until the level of water touches the thread.
4. Adjust the laser pointer and direct a narrow beam of light from the extended line z towards the thread.
5. Mark the bright spot formed on the translucent paper from the refracted ray.
6. Draw a line extended from the bright spot to the base of the bottle.
7. Use a protractor to measure the angle from line y to the extended line as the refracted angle (r) **[Refer 15-D4]**.
8. Adjust the laser pointer to increase the incident angle gradually until the refracted ray emerges along the extended line from x.
9. Mark the incident ray on the surface of the bottle and extended the line to the bas of the plastic bottle.
10. Measure the incident angle as the critical angel (c) **[Refer 15-D5]**.

Notes:

- Repeat steps 3-9 using solutions with density 1.05 g/cm^3, 1.10 g/cm^3, 1.15 g/cm^3 and 1.20 g/cm^3.

Result:

Density, $l/g/cm^3$	Incident angle, $c/^o$	Refracted angle, $r/^o$	Refracted index, n	$\frac{1}{n}$	Critical angle, $c/^o$	Sin C
1.00	30					
1.05	30					
1.10	30					
1.15	30					
1.20	30					

Notes:

- Light ray refracted from the medium into air, formula to find n is $n=\frac{\sin r}{\sin i}$.

Discussion:

1. Based on the data obtained:
   (a) State the relationship between the density and refractive index.

   ____

   (b) State the relationship between density and critical angle.

   ____

   (c) State the relationship between refractive index and critical angle.

   ____

2. Plot the graph $\frac{1}{n}$ and sin c.

3. Based on the graph obtained:
   (a) State the relationship between $\frac{1}{n}$ and sin c.

   ____

   (b) Find the gradient of the graph (Round up the answer obtained).

   (c) Derive a formula from the graph to show the relationship between $\frac{1}{n}$ and sin c.

2. RESULTS AND BENEFITS OF IMPLEMENTING THE TEACHING/ GUIDANCE METHODS, ETC.:

Evaluation:

1. A survey was carried out to assess the four main aspects of the experiment.
   (a) The understanding of the basic principles of the experiment.
   (b) The technical problems faced.
   (c) The results of the experiment.
   (d) The satisfaction obtained.
2. Target group:
   15 students are chosen from two classes A and C.
   - The standard of the students from A is above average.
   - The standard of the students from class C is below average.
3. To assess the understanding of the basic principles used in the experiment.

Question	Correct answers (%)
(i) Name an apparatus in the lab that resembles the structure of the water in the bottle.	80
(ii) Why is there no refraction occurring when light ray is directed towards the thread in the bottle?	70
(iii) Why is semi-circular glass block not used in this experiment?	70

4. To assess the technical problem faces.

Question	Yes	No
(i) To prepare the plastic bottle for the experiment, do you find the task: -burdening? -interesting?	 10% 95%	 90% 5%
(ii) Do you face difficult to locate the refracted ray?	0%	100%
(iii) Do you face difficult to measure the refracted angle?	5%	95%
(iv) Do you face difficult to locate the critical angle?	20%	80%
(v) Do you face difficult to measure the critical angle?	10%	90%

5. To assess the result of the experiment

Question	Yes	No
(i) Do you obtain a straight line graph?	100%	0%
(ii) Does your graph pass through the point of origin?	90%	0%
(iii) Is the value of the gradient found close to 1 or can be rounded up to 1?	100%	0%
(iv) Can you derive a formula from the graph: -without help? -with the help from the teacher?	 70% 100%	 30% 0%

6. To assess the satisfaction obtained from the experiment

Question	Yes	No	So-So
1. Do you enjoy preparing your own apparatus?	80%	0%	20%
2. Is it exciting to use your self-designed experiment?	100%	0%	0%
3. Is the experiment challenging?	100%	0%	0%
4. Do you feel like a young scientist when you successfully derive the formula?	100%	0%	0%

Suggestions/ recommendation :

1. The response option ‘So-So’ is not an appropriate word to use in a survey.

2. The bottle can be clamped vertically in order to allow measurement of the angles on a horizontal plane with a transparent top surface.

3. A dark cylinder can be used to cover the whole bottle to enable the laser beam to be seen clearly.

16

MY WAVES KITS AND MY WAVES STORY
(PHYSICS– UPPER SECONDARY)

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Background : Ripple tank experiments are used in the school laboratory to investigate wave phenomena such as reflection, refraction, diffraction and interference. *My Waves Kits* and *My Waves Story* reinforce the teaching and learning process by utilising various approaches to increase student participation.

My Waves Kits serve to supplement observations made in ripple tank experiments by simulating wave phenomena using inexpensive and readily available materials such as CDs and marker pens.

My Waves Story is an assignment where each group of students submits a folio detailing their activities.

My Photo Catalogue is a digital folder of images captured during ripple tank experiments.

Objectives : The *My Waves Kits* serve to:

(i) reinforce learning by enabling each group of students to simulate and observe the desired wave patterns for each phenomenon.

(ii) enhance understanding by comparison of ripple tank photographs with their own drawings.

My Photo Catalogue provides a variety of photographs for students to use for their *My Waves Story* folio.

Benefits for teaching and learning process :

- Using a digital camera to record images of wave patterns enables the photographs to be viewed when desired or shown on a screen using a LCD projector. Observations – for example, measurements of the angles of incidence and angle of reflection - can be made from the photographs.
- The *My Waves Kits*, made from discarded transparent CDs, provide a simple yet effective simulation of wave phenomena.
- Students can relate simulated wave patterns to the actual photographs taken during ripple tank experiments.
- Students enjoy taking photographs of themselves doing the experiments and then using the photographs to help them narrate *My Waves Story*.
- The novel approaches provide a fun way to study wave phenomena.

Apparatus/ materials : (a) Digital camera, computer, LCD projector
(b) 18 to 20 pieces of transparent compact discs (CD)
(c) Marker pens (blue, red black)
(d) Ripple tank and accessories

Construction of teaching aids :

A. <u>Preparing *My Photo Catalogue* collection</u>

A digital camera is used to take photographs of wave patterns during ripple tank experiments. Students take as many photos as possible to insert in their *My Waves Story* folio.

B. <u>Preparing *My Waves Kits*</u> [Refer 16-P1]

(a) For reflection **[Refer 16-D1, 16-P2** and **16-P3]:**

Four overlapping CDs are used. The CDs are prepared as shown in the diagram. The tip of a marker pen is used as a pivot. The CDs are rotated to show the desired wave patterns. The students record their observations in the Module.

(b) For refraction **[Refer 16-D2, 16-P4** and **16-P5]:**

The CDs are prepared as shown. Two CDs, CD 5 and CD 6, are used to simulate waves travelling from a deep region to a shallow region. Another two CDs are used to simulate waves travelling from a deep region to a deeper region. The CDs are rotated until the correct wave patterns are observed and then recorded.

(c) For diffraction [**Refer 16-D3, 16-P6** and **16-P7]:**

Three CDs are prepared as shown. CD 10 and CD 11 have opaque quadrants A and B. CD 10 and CD 11 can be rotated to show the diffraction pattern.

(d) For interference **[Refer 16-D4 and 16-P8 to 16-P10]:**

Three sets of CDs, each comprising two CDs, are prepared. Each set has waves of different wavelengths drawn on them. Students observe the effect of the distance between two sources on the interference patterns.

Implementation of the teaching

The activities are carried out in two double-period lessons:

1. Students are divided into groups of five or six.
2. Each group is given a complete set of *My Wave Kits* together with a Module and instructions.
3. Each group will carry out ripple tank experiments according to the procedures in the text book. They take photos of themselves and the wave patterns to create a digital *My Photo Catalogue* folder.
4. Students then use *My Waves Kits* to simulate the wave phenomena investigated experimentally.
5. Students can also observe the phenomena using PowerPoint animations.
6. Students present their findings in groups.
7. Students complete the Module in *My Wave Kits*.
8. Students write a folio entitled *My Waves Story* **[Refer 16-P11 and 16-P12].**

Suggestions for modification :

1. An electronic stroboscope can be used to freeze the wave motion when photographs are taken using a digital camera.
2. Placing a lighted 240 V, 45 W bulb below the transparent CDs will enhance the clarity of the wave pattens.
3. Larger *My Waves Kits* can be made using thick transparencies but they cannot be rotated as smoothly as the CDs.

17	THE CHEMICAL ANALYSIS KIT (CHEMISTRY-UPPER SECONDARY) LIM AI LEE @ LIM IRENE SEKOLAH MENENGAH SAINS SELANGOR 56000 KUALA LUMPUR

Background : The conventional approach to the study of *Chemical Analysis* in the Form 4 Chemistry syllabus does not leave a long-lasting impression on the students. Furthermore, the whole process from the preparation of the apparatus and materials until the cleaning-up and storage of the equipment takes a longer time besides incurring a greater cost.

An innovative, creative and safe approach to the studying of chemical analysis will enhance the teaching and learning process besides being time-saving and cost-saving. This Chemical Analysis Kit consists of the following components:

- A 'Palette' – to replace conventional test tubes
- A 'Carrier basket' – to contain the 21 bottles of chemical solutions and reagents.
- 21 plastic dropper bottles – to contain the chemical solutions and reagents
- Instructional cards

Objectives : At the end of the teaching and learning process, the students will be able to:

1. understand the concept of chemical analysis.
2. remember and explain the reactions involved in the analysis of cations and anions.
3. conduct the chemical analysis experiments in a fun, interesting, time-saving, cost-saving and safe way.

Benefits for teaching and learning process :

- The kit can be used for teaching Chapter 8 of the Form 4 Chemistry syllabus.
- The learning process involves inquiry and discovery methods which are fun, exciting and time-saving so as to create interest in chemistry.
- It enhances memory retention of the chemical reactions carried out.
- It is versatile for use as a revision module in the classroom besides being used in the laboratory during formal lessons.
- Cost-saving: Since micro quantities of chemicals are used, a great amount of chemicals is saved.
- Time-saving: As the reactions involved very small quantities, the experiments are completed very quickly and cleaning up the waste is also very easily done.

Apparatus/ materials	:	• A4 papers (to prepare the 'Observation Palettes') • Laminating Films or Plastic Sheet Protectors • Plastic carrier basket • Instructional cards • A 'mock-up' of the completed Palette • A Revision Worksheet • 21 Plastic dropper bottles to contain the following:

Reagent solutions: Sodium hydroxide solution
Ammonia solution
Sodium carbonate solution
Potassium hexacyanoferrate(II) solution
Potassium hexacyanoferrate(III) solution
Potassium thiocyanate solution
Nessler's reagent
Barium chloride solution
Silver nitrate solution
Potassium iodide solution

Cation solutions: Ca^{2+}, Mg^{2+}, Al^{3+}, Pb^{2+}, Zn^{2+}, Fe^{2+}, Fe^{3+} , Cu^{2+} and NH_4^+ solutions.

Anion solutions: Cl^-, SO_4^{2-} solutions.

Construction of teaching aids :

Construction of teaching aid [**Refer 17-D2**]:

1. The 21 chemical solutions are prepared and poured into labelled plastic dropper bottles which are placed in a carrier basket (Sample A).
2. 'Observation Palettes' are prepared from A4 size papers showing tables for cation and anion analysis reactions (Sample B).
3. The 'Observation Palettes' can be laminated or placed in plastic protector sheets (Sample C).
4. Instructional cards are prepared for students' use (Sample D).
5. A 'mock-up' of the completed palette is prepared for students' reference (Sample E).
6. Revision Worksheets are prepared for the students to recall the reactions and equations (Sample F).

Method of Implementation [**Refer 17-P1 to 17-P12**]:
Photo **17-P1**: The Chemical Analysis Kit (in a carrier basket).
Photo **17-P2**: The bottles of chemicals and the Observation Palette.
Photo **17-P3**: The laminated Observation Palette.
Photo **17-P4**: Placing the Observation Palette in a plastic sheet protector.
Photo **17-P5**: Drops of cation solution are placed on the Palette.
Photo **17-P6**: All the cation/anion solutions in place on the Observation Palette.
Photo **17-P7**: Reagent solutions are dropped onto the cation solutions on the Palette.
Photo **17-P8**: Mistakes can be 'mopped' up using tissue paper.
Photo **17-P9**: The completed Observation Palette.
Photo **17-P10, 17-P11** and **17-P12**: Students doing the experiment – individually and in groups.

Implementation :

1. Teacher starts off with a set induction scenario by posing some questions as follows:
   Do you know who is Sherlock Holmes?
   Do you know what is the modern day equivalent of Sherlock Holmes?
   Do you know what CSI (Crime Scene Investigation) officers do?
   Would you like to carry out some experiments that Forensic scientists or CSI officers do?

2. Teacher can let the students do the Chemical Analysis experiments either individually or in groups of two, three or more.

3. Each station is provided with the following:
   - The Chemical Analysis kit
   - The Observation Palettes
   - The Instructional Card
   - The 'mock-up' of a completed palette
   - The Revision Worksheet

4. Students are given the opportunity to carry out the cation and anion analysis experiments on the Palettes after referring to the instructional cards [**Refer 17-D1**].

5. Upon completing the experiment, students can refer to the 'Mock-up' completed Palette for comparison of their results [**Refer 17-D3**].

6. Students will attempt the revision worksheets after completing the experiments in order to reinforce their knowledge of the chemical analysis experiments [**Refer 17-D4**].

7. Teacher summarizes the cation and anion analysis experiments and gives tips on how to memorize the topic of *Chemical Analysis*.

Suggestion for modification : There should be a written guideline on safety instructions for students to handle wet chemicals and dispose the waste. Some examples of false results may be incorporated in order to show the unexpected outcomes during the experiment.

18

THE TWO-VIEW MOON PHASE MODEL
(PHYSICS – CLASS ACTIVITIES)

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Background : ‘Moon phases’ is one of the topics that is taught in the ‘Earth and Space’ course taken by the teacher trainees in the Bachelor of Teaching Programme for Primary Schools (Science).

The diagram given in most books [**Refer 18-D1**] illustrates the moon from two different views. One is the view from the sky (where the moon rotates relative to earth) and the other view is from the earth (the moon phases).

Most of the trainees have problem relating the two views of the moon leading to inability to understand and explain this moon phase phenomenon properly.

Objectives : The two-view moon phase model is created for the following objectives:

1. To overcome the problem of visualisation from two different views.
2. To build conceptual understanding of how changes in position of the moon relative to earth and sun can cause the moon phases.

At the end of the lesson tryout, the trainees are expected to be able to:

1. draw the side of the moon that is illuminated for the various positions of the moon.
2. state the conditions for seeing the moon phases.
3. explain the correlation between the position of the moon relative to earth and sun, and the part of the moon facing earth that is illuminated, called ‘moon phases’.
4. draw the moon phases at various positions of the moon.

Benefits for teaching and learning process : 1. Advantages of the model for learners:

(a) They are able to see in 3D from two different views at the same time, i.e.
(i) view from a position on earth (seeing through the periscope) and
(ii) view from a position in the sky (seeing from the top).

(b) The two views enable a building of a space-time correlation of the movement, position, illuminated parts facing the earth and moon phases.

(c) They are able to manipulate the position of the moon and observe changes at will.

(d) No need for a dark room for clear images of the moon phases.

(e) Cheap [**Refer 18-D2** for the estimated budget].

2. Results and benefits of using the model:

(a) Checking and rechecking can be done because the model allows the trainees to manipulate and observe changes personally and at will.

(b) The heightened discussions from observing the two views result in conceptual understanding.

(c) Changing of the shaded illuminated parts of the moon by the sun and later the moon phases drawings show the model can help them to correct their misconceptions.

(d) When the trainees no longer needed to use the model to shade the moon phases, it means that the model could help them to translate from concrete observation to mental visualization of the phenomenon.

(e) The ability to explain this phenomenon more clearly and specifically shows a better conceptual understanding after using the model.

Apparatus/ materials : The following are materials used in this project:

Bulb
Mounting board (2 pieces)
Mirror (2 pieces)
Plywood board and wood block
Wire and plug
Bottle of water
Periscope
Papier-mâché ball

Construction and Implementation of the teaching aids or guidance methods	:	A Two-View Moon Phase Model [**Refer 18-P1, 18-P2, 18-P3**] together with a worksheet that allows my trainees to see the two views clearly at the same time and build conceptual understanding of the moon phases.

Existing Models

For the model [**Refer 18-P1**], the phases are only visible with a much more powerful light source and a dark room.

For the umbrella model [**Refer 18-P2**], the phases of the moon are visible when a dark cloth is placed over the umbrella with a medium sized light bulb when we stand at different positions under the umbrella. The problem is there are many 'moons' in this model and we are moving. So, it does not correlate the experience of the movement of the moon relative to the earth and the sun that causes the phases to be visible.

In the shoebox model [**Refer 18-P3**], the shoebox itself becomes the dark room and the phases are clearly visible. The problem is the moon is not moving. We are moving as our eyes move from one square hole to another. The correlation between the relative position of the moon and the illuminated side of the moon visible to earth is not obvious.

Parts and their functions

The model consists of:

- a light bulb that represents the sun that gives out light.
- a bottle of water to focus light.
- a periscope to see the moon from the view of the earth.
- a papier-mâché ball connected to the periscope and moon to rotate.
- a rotating disc that allows the periscope and moon to rotate.
- a mounting board covering to reduce back reflection on the non-illuminated side of the moon [**Refer 18-P4**].
- a line drawn to differentiate the two halves of the moon; one half facing earth and the other half facing away from earth.
- numbers at 8 different positions to show the position of the moon for different phases of the moon as visible on earth.
- a worksheet on *Investigating Moon Phases* to explore the concept of moon phases.

The main feature of the model [**Refer 18-P5**] is the periscope with the moon attached to it that allows the student to see the earth view of the moon (moon phases) clearly. When the periscope is rotated, the moon attached to the periscope moves with the same period of rotation and revolution like the actual moon. This model allows the trainees to see what is in the diagram in the text book; the sky view of moon movement and illumination by the sun, and earth view of moon phases in 3D plus being able to manipulate the movement of the moon and resulting moon phases at will.

The Two Views from the Model

(A) Viewing from the sky (through top of model), we could see:

1. The side of the moon facing the sun is illuminated [**Refer 18-P6**].
2. The changing terminator due to the different positions of the moon relative to the sun and earth.
3. Different parts of the near side of the moon that is illuminated by the sun.
4. Illuminated near side visible as phases of the moon (see through telescope to see the earth view).
5. Changes in direction of line separating the two halves of the moon shows the same side of moon always faces earth [**Refer 18-P7**].

(B) Viewing from the sky (through the periscope), we could see:

The phases of the moon [**Refer 18-P8**].

The lesson tryout and feedback : The model was tried out on 18 trainees from the Semester 1 Bachelor of Teaching Programme for Primary Schools (Science) who have not taken the *Earth and Space* course.

1. The trainees were shown different phases of the moon.
2. They were asked what they observed and then asked the question: Why do we see different phases of the moon?
3. Answers were jotted down on the board to be discussed later.
4. A discussion on the concept of seeing was done.
5. The trainees were then given a worksheet [**Refer 18-P9**].
6. The trainees were asked to colour yellow the part of the moon that is illuminated by the sun and black for the non-illuminated parts of the moon for the various positions of the moon.
7. The trainees were then asked to draw the moon phases in the table given in the investigation sheet.
8. At this time, they were allowed to use the model to explore and compare what they have drawn in the investigation sheet and what they see from the model.
9. A final discussion was done to answer the question posed at the beginning of the lesson.

Response of trainees

1. The trainees observed that different fractions of the moon are illuminated for the different phases as stated below.

Crescent – 1/8	Gibbous – 3/8
Quarter – 1/4	Full moon – ½

2. Some answers to why we see the different phases of the moon at the beginning of lesson: Rotation, revolution, reflection, refraction. They were not able to string a sentence to connect the concepts that they gave.

3. Discussion on the concept of seeing resulted in stating that we see an object when light from the object reaches the eye. An object is lighted if the object is a light source or it reflects light from another source.

4. There were two types of shading of the illuminated part of the moon for various positions of the moon [**Refer 18-P10** and **18-P11**]. The Type 2 picture [**Refer 18-P11]** shows that these trainees have a problem with direction of light and illumination.

5. When the trainees were asked to draw the moon phases, some started drawing, others were hesitant.

6. When they were allowed to look through the model, they were eager to see from the two views. There were discussions and then changing of the shading of the illuminated part of the moon that they had done before.

7. After a few rounds of checking their shading of the moon phases, many were seen doing it without the aid of the model.

8. When asked the question on why we see different phases of the moon at the end of the lesson, the answers were more specific and we finally came up with a statement of explanation of the moon phase phenomenon [**Refer 18-P12** and **18-P13**].

Some comments of the trainees concerning the usage of the model and investigation sheet.

This kit really helps student to understand better. We can see every phase of moon clearly. Other than that, we can understand the concept and why it happens. Then for the worksheet, it let us to draw how does the moon look when we are on the earth. Before this, I never knew how its happen, but now, my understanding getting better.

Good for children to understand more about phases of the moon. Children can understand further about reflection of light. Children can learn how position of moon can affect the different lighted parts of the moon.

This teaching aid helps teachers and students to understand about the moon phases clearly. Students can explore and try to use the model to get better understanding. 'Hands-on' activity is very good for students to remember the moon phases.

The kit is very interesting and good for student to learn well about the moon phases. Excellent innovation. The sheet given can help students understand more about the topic.

I think this idea is very suitable to let the students get more understanding about moon phases. The student can actually experience the phases of the moon by using the model. The worksheet is simple and easy to get better understanding about what are moon phases. Combination of model and worksheet is really rational and good.

The idea is very interesting because I can see clearly how phases of the moon occur and see it live even though it is not the real moon and just a model, yet *the transfer of learning is successful. The worksheet is also helpful as I watched and tried the model, I could apply the information that I get on the worksheet to show my understanding about the topic and think critically and analytically.*

It is helpful as the students can feel and think about the moon phase clearly. Students can see the moon rotate and the angles that give different parts of light on the moon. The worksheet is simple and effective.

It is helpful for children to understand this concept because: students can see themselves the phases of the moon clearly. The worksheet and model are related, so student can easily understand what's going on. Worksheet is easily to understand. The model is interesting.

The teaching aid model was very helpful. The student can see very clearly moon phase through this model. The model should be used for every lesson/class. Worksheets given enhance understanding of the students.

Suggestions / recommendation :

1. Be more specific in the instructions with clearer illustrations.
2. Claims need to be supported by literature review preferably with references.
3. Include extension activities to reinforce understanding of scientific concepts.

19

LOW COST EARTH'S MAGNETIC FIELD EXPERIMENTAL KIT
(PHYSICS – UPPER SECONDARY)

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Background : The experimental kit known as EM-01 which was developed from PVC pipe insulated copper coil and a compass, is an alternative approach in measuring the Earth's magnetic field. The kit is used with several other instruments namely ammeter, rheostat and battery. The vector addition between the coil's and Earth's magnetic field produces a resultant magnetic field that can be detected by a simple compass available in the market. From this simple data collection, the Earth's magnetic field can be measured. This special low cost experimental kit can be used as an experimental set-up at a physics laboratory as well as a demonstration kit that enhances the teaching and learning processes. This experimental set-up provides exposure to students in understanding topics related to vector and electromagnetism. The results obtained using EM-01 has a smaller deviation from the standard value.

Objective : To measure the horizontal Earth's magnetic field.

Benefits for teaching and learning process :

1. Three matriculation centres have run this experimental kit and their results are in good agreement with the standard value **[Refer 19-D1** and **19-D2]**. An example of the calculation and the value obtained is as shown **[Refer 19-D3].**
2. Low cost measurement kit.
3. Battery operated.
4. Light weight, portable and easy to operate.

Apparatus/ materials :

(a) Earth's magnetic field measurement kit (EM-01) **[Refer 19-P1]**
(b) A compass
(c) Banana wire connector/cables
(d) Analogue ammeter
(e) Rheostat (variable resistor)
(f) DC power supply or battery

Background knowledge : The magnetic field strength, $\vec{B}$ is a vector quantity. Therefore, the addition of two magnetic fields obeys the parallelogram law. For example, if $\vec{B}_H$ is the horizontal component of Earth's magnetic field and $\vec{B}_C$ is the magnetic field of a coil which is perpendicular to $\vec{B}_H$ then, the resultant of the two fields will produce a resultant field and can be measured by a low cost compass. A compass needle situated at the place where the two fields meet will be aligned to the direction of the resultant field, $\vec{B}$ **[Refer 19-D4].**

Background theory : Biot-Savart's Law states that the magnetic field strength of a coil, B_C is given by $B_C = \frac{\mu_o NI}{2R}$ where $\mu_o = 4 \times 10^{-7}$ H m^{-1} (free space permeability constant), I is the current in amperes, N is the number of turns in the coil and R is the radius of the coil in metres.

Construction of teaching aids :

The experimental kit, EM-01 was built using a PVC pipe, an insulated copper coil and a compass. This was done by cutting the PVC pipe **[Refer 19-P2]**, fabricating coil from the PVC pipe **[Refer 19-P3]**, assembling the EM-01 **[Refer 19-P4]** and the final product EM-01 as shown in picture **[Refer 19-P5]**. All the apparatus were connected as shown in diagram **[Refer 19-D5].**

Implementation of the teaching :

(a) The following steps were carried out to determine the horizontal Earth's magnetic field **[Refer 19-P6** for experimental set-up].

(b) **Step 1**
Place the compass at the centre of coil with 0 degrees or north scale pointed perpendicular to the axis of the coils.

(c) **Step 2 [Refer 19-D6]**
Rotate the coils so that the coils' plane is parallel with the compass pointer as shown.

(d) **Step 3 [Refer 19-D5]**
Connect the given apparatus as shown.

(e) **Step 4**
Set the DC power supply at 2V and choose 1A range from the ammeter.

(f) **Step 5**
Connect the negative terminal of the power supply or battery to the common knob of the EM-01 and connect another lead from the rheostat to the 10 turns' knob.

(g) **Step 6**
Adjust the rheostat so that the magnitude of the current that flows through the circuit is 0A.

(h) **Step 7**
Starting from this point, slowly adjust the rheostat until the current value increases and reaches readable values. Adjust the current for several values until the needle points to about 70 degrees. Record the angle θ_1 that is pointed by the compass' needle and the current values in Table 1.

Coil Radius, R= _______________ m

Number of turns, $N = 10$

Table 1

Number	Current, I (A)	θ_1 (°)	θ_2 (°)	Average θ_A (°)	tan θ_A
1					
2					
3					
4					
5					
6					
7					
8					
9					

(i) <u>Step 7</u>

Repeat step 7 by changing the polarity of the common connection. Record angle θ_2, pointed by the compass' needle in Table 1.

(j) <u>Step 8</u>

Repeat steps 5 to 7 by connecting 20 and 30 runs of EM-01. Record the data for 20 and 30 turns of coil in Tables 2 and 3 respectively.

Number of turns, $N = 20$

Table 2

Number	Current, I (A)	θ_1 (°)	θ_2 (°)	Average θ_A (°)	tan θ_A
1					
2					
3					
4					
5					
6					
7					
8					
9					

Number of turns, $N = 30$

Table 3

Number	Current, I (A)	θ_1 (°)	θ_2 (°)	Average θ_A (°)	tan θ_A
1					
2					
3					
4					
5					
6					
7					
8					
9					

(k) Students were posed with the following questions:

- Plot graphs of tan θ against current for all the set of data. Find the gradient of all graphs. What does the gradient represent?

- Manipulate your findings and find the value of Earth's magnetic field, B_E by using the formula $\tan\theta = \frac{\mu_o NI}{2RB_E}$. Compare and discuss your results in detail with the standard value of B_E.

- List out and discuss all possible errors that might affect the results of this experiment.

- Calculate the magnitude of the magnetic field at the centre of the three coils for each number of turns of EM-01.

(l) Students were requested to attach the results together with the conclusion in their reports.

Suggestions for modification :

1. Claims need to be supported by literature review.
2. Steps on implementing the teaching should go beyond the steps of conducting the experiment and the questions posed. A possible suggestion is to include the discussion conducted with the students that consolidates the steps of the experiment to the questions that lead to students' self-discovery of the magnitude of magnetic field.

20	**CONTACTLESS ELECTROMAGNETIC BRAKING SYSTEM** **(PHYSICS– UPPER SECONDARY)** **SEOW YOKE HOCK** **HELP ACADEMY** **KOMPLEKS PEJABAT DAMANSARA** **BLOK D, JALAN DUNGUN** **50490 DAMANSARA HEIGHTS, KUALA LUMPUR**

Background : One of the physics topics at the upper secondary school and pre-university level is about eddy currents due to the electromagnetic induction effect which obeys Lenz's Law. The conventional pendulum method shows the damping of the pendulum as it cuts through a magnetic flux which indicates the presence of eddy current.

This experiment can show how eddy currents provide opposing forces which slow down a moving object. However, if a permanent magnet is used, eddy currents in the aluminium disc, which contributes to the braking effects, remains as long as the aluminium disc rotates. This is not preferable as the constant slowing down of the car while driving is very fuel consuming and produces unwanted heat. Therefore, the electromagnetic brake should be controlled by the driver so that it works only when the driver wants it, either for braking or slowing down the vehicle.

This proposed design is low in cost and is environmental friendly.

Objectives : There are three purposes of this project. They are:

(i) To provide a picture on how eddy current can be related to the electromagnetic braking system.
(ii) To promote students' interest in learning science by applying what they have learnt on electromagnetism to the electromagnetic braking model.
(iii) To implement a more practical and hands-on approach in teaching electromagnetism.

Benefits for teaching and learning process :

1. The concept of electromagnetism can be introduced in an interesting and beneficial approach which can also develop students' analytical and problem-solving skills through experimentation and observations.

2. This exploratory learning activity encourages students to develop their investigative and innovative skills besides developing students' interest in physics which in turn will spur them to acquire more knowledge and consequently enable them to improve in the subject.

3. The materials used to build this model are cheap and easily available. This will provide an alternative teaching aid which can clearly illustrate the application of the concept of electromagnetism in real life.

Apparatus/ materials : The following are list of apparatus/materials **[Refer 20-P1]:**

(a) Aluminium disc (1 pc)
(b) Protective pads (2 pcs)
(c) Set squares
(d) Cutter
(e) Scissors
(f) Soldering iron
(g) Rosin core solder (60/40)
(h) Toy car motor (1 pc)
(i) 1.5 V Type D dry cells (2 pcs)
(j) Battery holder
(k) Soft iron cores (2 pcs)
(l) Enamelled copper wire, s.w.g. 22
(m) Pliers
(n) Sand paper
(o) Cellophane tape
(p) Retort stand and clamp
(q) Direct current power supply (0-30 V, 0-5 A)
(r) Connecting wires
(s) Switch
(t) 10 Ω resistor (1pc)
(u) Compass

Working Principle of the Contactless Electromagnetic Braking System [Refer 20-P2]

<u>Faraday's Law of Electromagnetic Induction</u>
The electromotive force (emf) induced is directly proportional to the rate of change of the magnetic flux linkage.

<u>Lenz's Law</u>
The direction of the induced current is such that it will oppose the change producing it.

<u>Explanation on the working of the model</u>

- As the aluminium disc rotates, it cuts the upper region of the magnetic flux of the electromagnet.
- Eddy currents will be induced on the aluminium disc resulting in a magnetic force of attraction on the upper region and a magnetic force of attraction on the lower region.
- Therefore, an opposite force to the direction of motion of the aluminium disc will be produced which will cause the rotation of the aluminium disc to slow down.

Building Process Part A to Part C [Refer Attachment (20)]

Implementation of the teaching : A. **First phase: Building the solenoid**

After the teacher explains the concepts of electromagnetism and eddy current, he can deepen the students' understanding on these concepts by linking what they have learnt to the electronic braking system.

(a) The teacher will perform a demonstration to show the process of building a solenoid by winding the enamelled copper wire round the soft iron core **[Refer 20-P3].**

(b) Students will be divided into groups and they will start building a solenoid based on the steps and materials shown earlier.

(c) Then the students will be asked to predict the polarity of the electromagnet by using the Right-Hand Grip Rule.

(d) Finally, the electromagnetic effect and the polarity of the solenoid are verified by using a compass.

B. **Second phase: Setting up the electromagnetic braking system**

(a) Once the students understand how to build an electromagnet and find the polarity, the teacher will explain the ways to fix the aluminium disc to the motor and show them how to set up the entire electromagnetic braking system **[Refer 20-P8].**

(b) Then, the teacher demonstrates how the electromagnetic braking system works.

C. **Third phase: Investigating the factors that affect the braking effect**

(a) After the students understand the working principle of the electromagnetic braking system, students can start to investigate the factors affecting the braking effect, e.g. time taken to slow down the aluminium disc significantly after it has reached its maximum speed.

(b) The following factors are to be investigated:

- Number of turns of the solenoid for the electromagnet
- Magnitude of the electric current used for the electromagnet
- Distance between the solenoid and the aluminium disc

D. **Fourth phase: Analysis of experimental data**

(a) Students are asked to write a report and discuss the results of all the investigations and determine a suitable combination that they think will produce the strongest possible braking effect.

(b) Students are also required to search from the Internet the real life application of the electronic braking system and link the information to the results that they have obtained.

Suggestion for modification : An aluminium disc is not practical in application systems due to its small braking force and low strength. Therefore, more work can be done to investigate the performance of the braking system using other materials.

Attachment (20)

Building Process (Part A – Electromagnet)

1) 25 turns of the enamelled copper wire (s.w.g. 22) are wound around the iron core **[Refer 20-P3].**
2) The cellophane tape is used to wrap over the copper wire **[Refer 20-P4].**
3) A second layer of copper wire is wound on top of the first layer using 25 turns of the enamelled copper wire.
4) Steps 2 and 3 are repeated until 3 layers of copper wire with a total of 75 turns of wire are formed**.**
5) The extra enamelled copper wire is then cut off by using a pair of pliers.
6) After that, the ends of the enamelled copper wire are polished using sand paper to remove the enamelled coating [**Refer 20-P5**].
7) Steps 1 to 7 are repeated for the second iron core and the direction of the turns for the solenoid is similar to the first iron core.
8) The polarity of the electromagnet is checked by putting a compass next to the soft iron core while both ends of the copper wire are connected to a d.c. power supply **[Refer 20-P6].**

Building Process (Part B – Motor and Aluminium disc)

1) Chords AB and BC are drawn on an aluminium disc using a set square so that they are perpendicular to each other. Then points A and C are joined by a straight line. This line is the diameter of the aluminium disc **[Refer 20-D1].**

2) Another triangle, DEF is drawn and the point of intersection of lines AC and DF is the centre of the aluminium disc **[Refer 20-D1].**

3) A hole of diameter, 2.0 mm is drilled at point O on the aluminium disc **[Refer 20-P7].**

4) The point O is then polished using sand paper.

5) The axel of the motor is inserted into the hole and clamped to a retort stand.

6) Then, protective pads are pasted onto the disc and attached to the axel **[Refer 20-P8].**

7) Finally, the motor is connected to the dry cells to test its working condition **[Refer 20-P9].**

Additional Materials and Apparatus For Electromagnetic Braking Model

(a) Knife switches (2pcs)
(b) Plastic terminals
(c) Hard boards (2 pcs)
(d) Small battery holder
(e) Double-sided tape
(f) Stoppers (4 pcs)
(g) Metal stands
(h) Plastic holders (4 pcs)
(i) AA size dry cells (2 pcs)
(j) Labels
(k) Glue

Building Process (Part C – Electromagnetic Brake)

1) Both electromagnets are clamped and the aluminium disc is placed between the electromagnets **[Refer 20-P10].**

   (Note: Polarity of electromagnets which face each other should be opposite)

2) Then the electromagnetic circuit is connected to a d.c. power supply while the motor circuit is connected to the dry cells **[Refer 20-D2].**

3) The switch of the motor circuit is closed to let the aluminium disc rotates.

4) Once the speed of rotation of the aluminium disc is at its maximum, switch on the power supply in the electromagnetic circuit and set the electric current flowing to the circuit at about 5 A.

5) If the aluminium disc is slowing down significantly, then the electromagnetic brake model is functioning **[Refer 20-P11]**!

Precautions:

- Both ends of the enamelled copper wire are polished thoroughly with sand paper to ensure contact between the crocodile clips and the wire.

- The turns of the solenoid are wound as closely as possible to maximize the magnetic field strength.

Transferring the Bench Setup to the Model Setup

1) When the bench setup is working properly, the entire system is transferred on to a board to set up the model.
2) The retort stands and clamps are replaced by holders.
3) Two AA size dry cells are used to power up the motor circuit.
4) Two terminals are made for the connection of the d.c. power supply (0 – 5 A).
5) Final testing is done to check the working of the entire system.
6) The circuit and the important components of the model are labelled **[Refer 20-P12** and **20-P13].**

MALAYSIA TORAY SCIENCE FOUNDATION

INFORMATION ON APPLICATION FOR
<u>SCIENCE EDUCATION AWARD</u>

1. Objective

In view of the essential role science education plays in the intellectual development of an individual, this Award aims at encouraging innovative and creative science education in the secondary schools. We look forward to receiving not only essays and proposals but also cases already in practice, for example:

a) Guidance for better science education, e.g. ways which will help to kindle and deepen students' interest in science.
b) More effective methods for conducting experiments, ways to utilize equipment and means to urge spontaneity in learning.
c) Designs for teaching materials/apparatus for experiments, observation and seminar (simple devices, easy-to-obtain materials, audio-visual education devices, etc) and actual examples of how they are used.
d) Other related activities.

2. Science Education Award

Certificate of Award and prize money of RM6,000 to RM10,000 per award. Five awards are earmarked per year. Recipients of runner-up awards (certificate and prize money of RM4,000) and consolation awards (certificate and prize money of RM2,000) will also be selected. The outline of award winning entries will be published and distributed to secondary schools and other educational institutions nationwide to promote their use.

3. Eligibility

All Applicants and Co-Applicants must be Malaysian citizens and qualified teachers or educators who are involved in science education at the secondary school level (Form l up to Form 6/"A" levels) e.g. teachers of secondary schools or technical schools and teaching staff of educational research institutes and registered educational centers (exclude students).

4. Application Procedure

a) Complete the application form supplied by MTSF and send the completed form to MTSF at the mailing address stated herein. You may request for forms by postcard or facsimile or download from the MTSF website. Please check for the latest application form via MTSF website.

b) If the achievement is the work of more than one person, please nominate the "Main Applicant" from among them.

c) Deadline : Forms must reach the Foundation on or before 31 May every year. Late entry and incomplete forms will not be processed.

5. Method of Selection

There are 3 stages in the selection process :

1st Stage	:	The applicants will be selected on the basis of information on the application forms.
2nd Stage	:	Those shortlisted in the first stage will be asked to attend an interview to explain their ideas using the teaching materials, apparatus, etc by September of each year. The Committee will then recommend the winners to the Board.
3rd Stage	:	Approval of the winners by the Board of the Foundation. Applicants will be informed of the results by October of every year.

Note : (1) Unsuccessful entries are eligible for re-application in the following years, if the content has been improved.

(2) The decision of the Committee is final. No correspondence regarding the decision will be entertained.

6. Examination Committee

The winners shall be selected by the Examination Committee and approved by the Board of the Foundation. For the list of the Examination Committee Members, please visit our website.

7. Presentation of Science Education Award

The presentation ceremony shall be held not later than the end of January of the following year.

8. Publication of Award Winning Entries

a) After selecting the award winners, the outline of award winning entries will be announced in the press. In so doing, the contents will be made known to the general public. Therefore, in order to protect and retain intellectual property rights to the entries, applicants are advised to seek the prior advice and service of a qualified patent lawyer. The Foundation shall not be held liable for any infringement of intellectual property rights including copyright, patent or trademark and/or any losses or damages what so ever arising from the announcement or publication in the press.

b) Copies of CD/VCD/DVD used in award winning entries must be made available free of charge to the Foundation in order that the relevant contents may be reproduced and distributed to educational facilities for use.

9. Award Prize

This Award is not taxable in the hands of the recipient.

10. Communication

Send requests for entry forms and the completed forms to :

Malaysia Toray Science Foundation
c/o Penfabric Sdn Berhad,
Block B, Prai Free Industrial Zone 1, 13600 Prai, Penang.
Tel : (04) 385 4151/390 8157 Fax: (04) 390 8260
Email : mtsf@toray.com.my, Website : www.mtsf.org

MALAYSIA TORAY SCIENCE FOUNDATION
SCIENCE EDUCATION AWARD

GUIDELINES FOR PREPARATION OF APPLICATION FORM

1. To fill in the Form
   Type or print clearly in English language. Photocopy of the form is allowed.

2. Application Form (Pages 1 to 3)
   Enter accurately name of school or institution, final educational qualification and job experience.

3. Background and Purpose (Page 4)
   (a) Briefly explain purpose (itemize).
   (b) State clearly the special features of your idea, design or practice and define how it is different from past cases or past entries.

4. Details of Content (Page 5)
   (a) Write as briefly and concisely as possible, preferably itemized.
   (b) Do not take time to explain well-known principles; concentrate on conveying your own ideas and designs.
   (c) If content is about teaching guidance, give concrete examples that explain its purpose and effectiveness.
   (d) Be sure that the idea is completely conveyed in this part of the form only. Include all necessary diagrams and photographs here.
   (e) Indicate list of references if appropriate.
   (f) If there is not enough space, up to four pages of the same size may be added for the "Details of Content" only (total pages of application must not exceed eleven pages). If "Details of Content" exceeds five pages, the application will not be examined.

5. Implementation of the Teaching/ Guidance Methods (Page 6)
   Describe clearly the process and method of and the reaction to implementing the teaching/guidance methods, ideas, etc. Give examples, if possible.

6. Results and Benefits of Implementing the Teaching/Guidance Methods (Page 7)
   (a) Give actual examples of results of teaching/ guidance.
   (b) Give examples of benefits in education, such as positive influence on students' interest, degree of understanding, scientific manner of thinking, spontaneity, etc. State the influence on the students' attitudes towards science.

7. Accompanying Materials
   If your entry includes game sets, CDs or other accompanying materials, please submit relevant photographs only. Actual specimens are not required.

8. Specimen of Past Projects
   For general guidance, please refer to the specimen of past winning entries at MTSF Website.

9. Remarks
   (a) It is the responsibility of the main applicant to share the award money with his/her co-applicants (if any).
   (b) Publication may not be identical to that submitted on the application form.

MALAYSIA TORAY SCIENCE FOUNDATION
(269817-K)

SCIENCE EDUCATION AWARD

YEAR:________

APPLICATION FORM

To : MALAYSLA TORAY SCIENCE FOUNDATION
c/o PENFABRIC SDN BERHAD
BLOCK B, PRAI FREE INDUSTRIAL ZONE 1
13600 PRAI, PENANG
Tel : (04) 3854151/3908157 Fax: (04) 3908260

(Read the Information/Guidelines before completing the form. This form should be typed or printed.

Use a separate form for each application. Photocopy of this form is allowed. **ALL APPLICATION FORMS AND ENCLOSURES SHOULD BE SUBMITTED IN DUPLICATE. PLEASE USE BINDER CLIPS, DO NOT STAPLE OR BIND**).

Title of Project :____

(*Note : Title should describe the content briefly and accurately*).

Area of Study : (*please tick*)		Subject (#) :	
Lower Secondary School	☐	Physics	☐
Upper Secondary School	☐	Chemistry	☐
Pre-University	☐	Biology	☐
Class Activities	☐	Physical Geography	☐
Others (please specify)	☐	Others (please specify)	☐

I hereby nominate ______________________ as applicant for the Science Education Award.

______________________ ______________

Principal's Signature & rubber stamp Date

Name of Principal : ______________________________________

(*please circle* : Dr. / Mr. / Miss / Madam)

Name of School/Institution : ______________________________

(#) Tick the appropriate area of study. If content covers more than two areas or is difficult to classify, mark the closest with an asterisk (*).

Note : Only forms nominated by the Principal are accepted.

Particulars of Applicant :

Full Name : ______________________ (*Please circle* : Dr. / Mr. / Miss / Madam) Chinese character (*if applicable*) : ____________ Date of Birth : __________ Place of Birth : ____________ Age : __________	PHOTO (compulsory)

Identity Card No : (New) ____________________ (Old) ____________________

Nationality : ____________ Sex : Male ____________ Female ____________

Home Address : ____

Tel : ______________ Fax (if any) : ______________

Email (if any) : ____

Name of School/Institution : ____

Present Position : ____

Address : ____

Tel : ______________ Fax : ______________

Final Education (date of graduation, name of school, department, major) and Job Experience :

Signature : ____________________ Date : ____________________

<u>Co-Applicants</u> : (limited to only 4 members)

(Members must be Malaysian teachers and/or educators)

(*please indicate*: Dr. / Mr. / Miss / Madam) (*)

<u>Full Name (*)</u>	<u>Present Position</u>	<u>Name of School/Institution</u>
(1) ____________	____________	____________
(2) ____________	____________	____________
(3) ____________	____________	____________
(4) ____________	____________	____________

Remarks : (*Tick, underline or complete the appropriate answer*)

(A) Originality & Implementation

I hereby certify that the abovementioned project :

(i) ☐ is my/our original creation.
☐ is an improvement from other existing project.
Source : ______________________________

(ii) ☐ has been implemented in the school.
☐ has yet to be implemented.

(B) Other Award(s)

Have you already received an award or have made presentations of the same content elsewhere ?

☐ Yes
☐ No

If Yes, indicate the most noteworthy :

When : ______________________________

Where : ______________________________

RM : ______________________________

(C) Past MTSF Application(s) / Award(s) :

Have you applied for this MTSF Science Education Award before?

☐ Yes …… If Yes, applied__________ times, received award __________times.
☐ No

List the year(s) awarded:

Year	Amount	Year	Amount

(D) Patent:

Registered / Registering / Intend to register / Will not register

(*Underline the appropriate answer*)

1. **Background and Purpose**:

2. **Details of Content**:

(Please use additional A4 paper, if necessary. Maximum of 4 additional pages only).

3. **Implementation of the Teaching/Guidance Methods, etc**:

4. **Results and Benefits of Implementing the Teaching/Guidance Methods, etc**:

OUTLINE OF THE
MALAYSIA TORAY SCIENCE FOUNDATION

(269817-K)

Foundation Establishment

The Malaysia Toray Science Foundation (MTSF) was established in 1993 through a RM4 million endowment by Toray Industries, Inc., Japan. The Foundation is registered with and recognized by the Malaysian authority as an organization formed to advance the objective of promoting science and technology in Malaysia.

Foundation Objective

To contribute to the progress and advancement of "Science and Technology" in Malaysia.

Foundation Activities

MTSF commenced its first program in 1994. Annually, approximately RM600,000 in research grants and cash prizes are awarded to deserving Malaysian scientists, researchers and secondary school science teachers through the following three programs:

(A) **Science and Technology Award (STA)**

Two (2) awards of RM30,000 each to deserving Malaysian scientists in recognition of his/her outstanding achievements/discoveries/contributions in Science and Technology.

(B) **Science and Technology Research Grant (STRG)**
(inclusive of grants funded by Toray Science Foundation, Japan)

Ten (10) to fifteen (15) grants of up to RM60,000 each for Malaysian researchers below 40 years of age pursuing basic research in science and technology (limited to the fields of natural sciences, including the environment, but excluding clinical medicine and mathematics). Some of these research grants are funded by Toray Science Foundation, Japan.

(C) **Science Education Award (SEA)**

Fifteen (15) or more prizes, ranging from RM2,000 up to RM10,000 each, for Malaysian Science educators in secondary schools and pre-university colleges in recognition of their innovative and effective teaching methods in science education.

Scale of Foundation Operations

The annual scale of operations of approximately RM600,000 is financed by interest income from the MTSF endowment fund and contributions from Toray Science Foundation, Japan and Toray subsidiaries in Malaysia.

ACKNOWLEDGEMENT

MTSF would like to put on record our sincere thanks and appreciation to the following members and agencies who have contributed to the success of the Foundation :

Chairmen

- The late YBhg. Tan Sri Khir Johari (July 1993 to September 2003)
- Yang Mulia Royal Professor A. Ungku A. Aziz (September 2003 to June 2004)
- YBhg. Tan Sri Law Hieng Ding (June 2004 to March 2011)

Managing Directors

- Mr. Kazuo Tomiita (July 1993 to June 1995)
- Mr. Tatsukiyo Ijichi (June 1995 to June 1997)
- YBhg. Dato' Tsuyoshi Watanabe (June 1997 to June 1999)
- Mr. Junichi Suwa (June 1999 to July 2001)
- Mr. Eiji Doi (July 2001 to July 2002) and (June 2005 to June 2006)
- Mr. Shigeru Okabe (July 2002 to June 2005)
- Mr. Munehiro Se (June 2005 to June 2011)

Directors

- The late YBhg. Tan Sri Khir Johari (July 1993 to September 2003)
- YM Ungku A. Aziz (July 1993 to June 2004)
- Mr. Masatake Kashiwagi (July 1993 to August 1993)
- Mr. Bunzo Adachi (July 1993 to July 1996)
- Mr. Seishiro Inoue (July 1996 to June 1999)
- Mr. Naohiko Kusakari (June 1999 to June 2002)
- Mr. Katsumasa Nakano (July 2005 to June 2008)
- Mr. Yasuhiko Sasada (June 2008 to October 2010)
- Mr. Hiroshi Yoshimura (October 2010 to June 2011)
- Mr. Kazutoshi Toyama (June 2011 to June 2012)

Committee Members

- Yang Mulia Royal Professor A. Ungku A. Aziz , Chairman of Examination Committee (January 1994 to June 2004)
- YM Dr. Tengku Mohd. Azzman Shariffadeen (January 1994 to December 1996)
- The late Hj. Mohd. Khairuddin Bin Hj. Ashaari (January 1994 to April 1999)
- Mr. Ibrahim B. Md. Noh (August 1999 to December 2000)
- Professor Sim Wong Kooi (January 1994 to December 2001)
- YBhg. Dato' Professor Emeritus Mohd Sham Mohd Sani (January 1994 to December 2005)
- YBhg. Dato' Professor Emeritus Tan Wang Seng (January 1997 to December 2005)
- YBhg. Dato' V.G. Kumar Das (January 1994 to December 2007)
- Dr. Chuah Chong Cheng (November 1993 to 31 December 2009)
- YBhg. Tan Sri Dr. Omar Abdul Rahman, Deputy Chairman of Selection Committee (November 1993 to March 2011)
- YBhg. Professor Dato' Goh Sing Yau (November 2005 to December 2011)

Collaborators/ Supporters

- Ministry of Science, Technology & Innovation
- Ministry of Education, State Education Departments, Secondary Schools, Pre-University Colleges
- Universities and Institutions

and to all those who have contributed in one way or another to the success of the Foundation.

Note from the Editorial Committee

This book publication is a collection of projects selected from the winning entries of the Science Education Award (SEA), accorded by Malaysia Toray Science Foundation from the years 2000-2011. Seven (7) winning entries were selected during the first (2004) and 13 winning entries were compiled during the second (2012) workshops. The editorial committees for both the workshops (comprising practising teachers and teacher educators from a wide range of specializations) shouldered the difficult tasks in selecting and editing projects from the winning entries. The selection was based on the following criteria, i.e. originality, uniqueness, value-oriented, user-friendly, material easily accessible, relevance to the curriculum, variety of topics and can assist in teaching-learning activities. Using Turnitin software (in 2012 workshop), the analysis of originality showed that all the projects fulfilled the requirement of less than 50% 'Similarity Index' with other published works from Internet sources, publications and student papers. While keeping the content of the write-ups as original as possible, the projects have been reformatted with an additional section 'Suggestion for modification' by the editorial committee. It is hoped that these efforts will boost the teachers' initiatives and creativity, besides helping students to make science learning sensible and ensuring that active learning is taking place in the classroom at all times.