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SciTalk

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Number 4 – October 2011

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The ***Past HSC Questions by Topic*** guide in this book will enable students to revise topic by topic, or to use the actual exam papers, as in the Biology, Chemistry, Physics and Senior Science books in this series. This *2009-2010 Earth & Environmental Science* book has been released to accompany the *2001-2008 Earth & Environmental Science* book.

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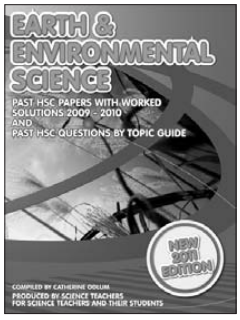

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Winner for *SciTalk 3/11*

Congratulations to Elizabeth Higgins, GLC-Forster Campus, who won *Heinemann Biology Preliminary & HSC (3E)* (rrp $64.95 ea) published by Heinemann.

INSIDE SCITALK ▶▶▶▶

Diary Dates

International Year of CHEMISTRY 2011

OCTOBER 2011

17 HSC Exams start: EES 21/10, Bio 28/10, Chem 2/11, Phys 4/11, Sen Sc 9/11

17, 21, 24, 28 31 Physics is Fun at Luna Park Sydney. Enquiries: ph (02) 9939 6107, fax (02) 9939 6105

29 Astronomy Open Night. Macquarie Uni, 6.30–10 pm, use E7B courtyard entrance, no bookings required, ph: 02) 9850 7111, www.physics.mq.edu.au/community/FFA/opennight/

NOVEMBER 2011

7–11 School Certificate tests take place: Science Test is on 7 Nov ... 12.50–3 pm

4, 14, 18 Physics is Fun at Luna Park Sydney. Enquiries: ph (02) 9939 6107, fax (02) 9939 6105

21, 25, 28 Physics is Fun at Luna Park Sydney. Enquiries: ph (02) 9939 6107, fax (02) 9939 6105

DECEMBER 2011

1–16 Physics is Fun at Luna Park Sydney. Enquiries: ph (02) 9939 6107, fax (02) 9939 6105

22 Summer Solstice (4.30 pm AEDT)

2012 – *International Year of Sustainable Energy for All*

For: Shell Questacon Science Circus 2011 program: www.questacon.edu.au/html/on_the_road.html

tba: Astronomy Open Nights & Lectures: Macquarie Uni, www.physics.mq.edu.au/astronomy

JANUARY 2012 National Youth Science Forum. For Yr 11 selected in mid-2011. Enquiries: 6125 2777.

MARCH 2012

4–10 Seaweek 2012: www.mesa.edu.au & www.ausmepa.org.au Theme: 'Marine debris – Clean it up!'

2 Schools' Clean Up Australia Day. Ph: 1800 282 329. www.cleanupaustraliaday.org.au/

19, 23, 26, 30 Physics is Fun at Luna Park Sydney. Enquiries: ph (02) 9939 6107, fax (02) 9939 6105

20 Autumn Equinox (4:14 pm AEDT)

APRIL 2012

2 Physics is Fun at Luna Park Sydney. Enquiries: ph (02) 9939 6107, fax (02) 9939 6105

22 International Earth Day. www.earthday.net/ & www.earthsite.org/ [Note: 20 March is the original day to celebrate the equinoctial Earth Day, but it is now celebrated on 22 April in many places.]

MAY 2012

2–4 Science at the Shine Dome teachers' program, Australian Academy of Science: Theme: 'Antarctic Science: from Mawson's expedition to today'. Details: www.science.org.au/events/

4, 25 Physics is Fun at Luna Park Sydney. Enquiries: ph (02) 9939 6107, fax (02) 9939 6105

23 Rio Tinto Big Science Competition: www.asi.edu.au/bigscience/ Closing date: 18/4/12

JUNE 2012

1, 4, 8 Physics is Fun at Luna Park Sydney. Enquiries: ph (02) 9939 6107, fax (02) 9939 6105

5 World Environment Day

tba Closing date Crystal Growing Comp. www.chem.unsw.edu.au/RACI/ Ph: (02) 9663 4960

tba (metro) NSW Schools Titration Competition. www.nswtitration.com/ (see website for regional dates)

21 Winter Solstice (9:09 am EST)

JULY 2012

8–11 CONASTA 61 in Canberra. Theme: 'Science is critical'. Details: www.conasta.edu.au/

21–28 National Chemistry Week. www.raci.org.au/national/events/chemistryweek.html

26 National Chemistry Quiz. www.raci.org.au/ in "Events". Details: ph (02) 6331 5125

AUGUST 2012

3 Jeans for Genes Day. www.jeansforgenes.org.au/

8 Chemistry Olympiad Exam. www.asi.edu.au/olympiads/ Close date: 6/7/12. Ph: 6201 2552

10, 13, 17 Physics is Fun at Luna Park Sydney. Enquiries: ph (02) 9939 6107, fax (02) 9939 6105 … come on these dates to celebrate National Science Week

11–19 National Science Week. School theme: tba

13 Biology Olympiad Exam. www.asi.edu.au/olympiads/ Close date: 6/7/12. Ph: 6201 2552

15 Physics Olympiad Exam. www.asi.edu.au/olympiads/ Close date: 6/7/12. Ph: 6201 2552

SEPTEMBER 2012

14, 17 Physics is Fun at Luna Park Sydney. Enquiries: ph (02) 9939 6107, fax (02) 9939 6105

23 Spring Equinox (12:49 am EST)

OCTOBER 2012

14–20 Earth Science Week. www.earthsciweek.org & www.ga.gov.au/education/events, ph (02) 6249 9111

15, 19, 22, 26, 29 Physics is Fun at Luna Park Sydney. Enquiries: ph (02) 9939 6107, fax (02) 9939 6105

NOVEMBER 2012

2, 12, 16 Physics is Fun at Luna Park Sydney. Enquiries: ph (02) 9939 6107, fax (02) 9939 6105

19, 23, 26, 30 Physics is Fun at Luna Park Sydney. Enquiries: ph (02) 9939 6107, fax (02) 9939 6105

DECEMBER 2012

3–19 Physics is Fun at Luna Park Sydney. Enquiries: ph (02) 9939 6107, fax (02) 9939 6105

21 Summer Solstice (10:11 pm AEDT)

JANUARY 2013 National Youth Science Forum. Forms to local Rotary club by 29/5/12, interviews from July. Only for Yr 11 in 2012. Enquiries: 6125 2777, email: nsss@anu.au, www.nysf.edu.au/

While all dates have been checked to ensure that information in DIARY DATES is correct, no responsibility will be accepted by the publisher or Editor for any omissions or inaccuracies in it.

Update on BOS matters

Regularly check the BOS website to ensure you have the latest data – for syllabuses, past exam papers, news, Official Notices, Board Bulletins, statistics archive & more.

Curriculum Requirements for NSW Schools in 2012 (BOS 27/11)

The BOS has advised all schools to continue using the existing NSW K–12 syllabuses for 2012. Non-government schools preparing applications for renewal of registration and accreditation in 2012 should continue to deliver educational programs that are based on, and taught in accordance with, the current NSW syllabuses.

Implementation of the Australian curriculum in NSW (BOS 27/11)

The Minister's announcement on 9 August 2011 about implementation of the Australian curriculum in NSW will mean that new K–10 syllabuses being developed for English, Mathematics, Science and History will not be required to be taught before 2014.

School Certificate Review update

A new *Question and Answer* page has been set up on the BOS website to help teachers, parents and students understand the review of the School Certificate. The School Certificate tests will be held for the last time in 2011. From 2012 onward, a new credential will be provided for students who leave school prior to receiving their HSC. The BOS will soon release a model for a new credential for consultation. The new Q&A page will be added to as needed and has been designed to tell teachers and parents what they need to know for 2011 and beyond.

BOS enquiries

Ph: (02) 9367 8111, fax: (02) 9367 8484

Website: *www.boardofstudies.nsw.edu.au/*

BOS contacts for Science:

- Inspector Science, K–12 & Senior
- Assessment Officer – Science

NOTE: Your purchase of the Odlum & Garner Past HSC Biology, Chemistry and Physics books helps to support the production of their Past HSC books for Earth & Environmental Science and Senior Science. Thank you to all the teachers who support these projects.

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how to live."

… from 'Faust' by Goethe

OUT AND ABOUT

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Session times (up to 12 months in advance) are at: *www.imax.com.au/schooltimetables*

School bookings, call 9213 1600 or email *education@imax.com.au*

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Darling Harbour, Sydney

Wild Life Sydney is open again ... this venue is set around authentically themed Australian habitats, showcasing Australia's diversity of flora and fauna – from our new baby Spotted-tailed Quolls and emus, kangaroos, koalas, wallabies, wombats, birds and our nocturnal party animals, as well as Rex, one of the largest crocodiles in the world. Our daily keeper talks and animal encounters occur every hour and make this a great school excursion destination.

Sydney Aquarium ... the highlight of the new CLAWS exhibition is the world's largest species of crab – the Giant Japanese Spider crab, which can grow to have a claw-to-claw legspan of almost 4 metres. Sharing the exhibition are the colourful Darwin Prawn, Murray Crayfish, Banded Coral Shrimp, Red Bait crabs and more. Also come and visit one of the largest Great Barrier Reef exhibits in the world.

For more information go to: *www.sydneyaquarium.com.au* OR *www.wildlifesydney.com.au/* For school bookings, phone 8251 7801, or email: *sydneyaquarium@merlinentertainments.com.au OR wildlifesydney@merlinentertainments.com.au*

MUSEUM OF HUMAN DISEASE

2011 EXCURSION OPTIONS

The Museum of Human Disease is a pathology museum at UNSW offering interactive programs with amazing insights into the nature and progression of disease in its many forms. We offer 2 hour curriculum-based programs in the following areas:

HSC Biology – *The Search for Better Health*

HSC Senior Science – *Bionics*

JuniorScience–*Infectious&Non-infectiousdiseases,microorganisms*

Further information and bookings:

T 02 9385 1522
E diseasemuseum@unsw.edu.au
W www.diseasemuseum.unsw.edu.au

MUSEUM OF HUMAN DISEASE

UNSW THE UNIVERSITY OF NEW SOUTH WALES

SHIPWRECKS, CORROSION & CONSERVATION

STAGE 6 CHEMISTRY

This program relates to the *Shipwrecks, Corrosion and Conservation* option. Students attend an AV presentation on conservation and restoration, including footage taken during the recovery of material from HMS *Bounty*. Students then participate in a hands-on workshop focusing on desalination of metal objects, metal and corrosion product identification, methods of protecting metals and rates of corrosion.

This is followed by a guided tour of shipwreck material in the museum. Students may also visit the destroyer HMAS *Vampire* and submarine HMAS *Onslow*.

The program is 4 hours, at a cost of $22.00 per student (teachers free).

Bookings & Information:

Phone: 02 9298 3655 Fax: 02 9298 3660
Email: bookings@anmm.gov.au
Location: 2 Murray Street, Darling Harbour

AUSTRALIAN NATIONAL MARITIME MUSEUM

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  - **Changing Worlds and Visions**
  - **Dinosaurs, Fossils & Coal**
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Combine your Fun Park Excursion at Luna Park Sydney booked through **PHYSICS IS FUN** with a visit to either IMAX, SYDNEY AQUARIUM or WILD LIFE SYDNEY for a great action-packed, fun time of interactive learning.

- **DETAILS:**
  IMAX: www.imax.com.au/schools
  SYDNEY AQUARIUM: www.sydneyaquarium.com.au/
  WILD LIFE SYDNEY: www.wildlifesydney.com.au/
  FUN PARK EXCURSION (through Physics is Fun): www.odlumgarner.com
- **WHAT TO DO:** Allow 1 hr for IMAX (any film), or 2 hrs for a Sydney Aquarium/Wild Life Sydney excursion. Allow 2–3 hours for Physics is Fun at Luna Park (rides open 11 am, Mon/Fri only).

BOOK & PAY SEPARATELY FOR EACH EXCURSION

Atomic weights are not 'constants of nature'

The chemistry textbooks and periodic table charts that we have all grown up with have shown the atomic weights of elements as constants of nature. This concept of atomic weight has been the cornerstone of chemistry since Dalton published his list of atomic weights around 1802. But not any more.

Dalton's list showed six elements, namely hydrogen, oxygen, nitrogen, carbon, sulfur, and phosphorus, with the atom of hydrogen conventionally assumed to weigh 1. During the nineteenth century, many more elements were discovered and their atomic weights determined and the concept of valency was developed. By Mendeleev's time, 60 elements and their atomic weights were known. Mendeleev used this data to create his Periodic Table:

> "I began to look about and write down the elements with their atomic weights and typical properties, analogous elements and like atomic weights on separate cards, and this soon convinced me that the properties of elements are in periodic dependence upon their atomic weights."
> – Mendeleev, *Principles of Chemistry*, 1905, Vol II.

Despite problems appearing as early as 1908, there was no change to the idea of a one to one relationship of element and atomic weight until recently. The early 1900s saw large numbers of chemists investigating radioactive materials and, in particular, the three natural radioactive decay series. These chemists isolated the different decay products and investigated their chemical and radioactive properties. As a result, the proposed element ionium was found to be chemically identical to thorium while both mesothorium I and thorium X were found to be chemically identical to radium, but with different atomic weights and different radioactive properties. Fredrick Soddy concluded that he had discovered two elements that should occupy the same place in the Periodic Table because their chemical properties were the same even though they had different atomic weights. Soddy coined the word *isotope* (Greek: in the same place) to account for radioactive species and not conflict with the constant atomic weight concept.

Then in 1912, J J Thomson discovered that the stable element neon was made up of isotopes ^{20}Ne and ^{22}Ne. ^{21}Ne was discovered later. It was soon discovered that many other stable elements existed as two or more stable isotopes. With the discovery of stable isotopes and the use of mass spectrographs to measure the isotopic composition of chemical elements, it was thought that isotopic abundance values could provide an alternative method for estimating an element's atomic weight. However, various scientists soon found this to be wrong. In 1936, Dole had reported the variation in oxygen isotopic abundance between air and water and in 1939, Nier had measured a 5% variation in the isotopic composition of carbon from different sources. By the 1950s, sulfur from different sources was also found to show considerable variation in isotopic abundance. It was becoming clear that atomic weights might not be constants of nature and that they were not fixed for every terrestrial source of stable elements, as previously thought.

Now, due to advances in chemical instrumentation and isotopic analysis, IUPAC has recognised that it is wrong to consider the atomic weights of elements to be constants of nature, other than the 19 mononuclidic elements (elements with a stable single isotope), such as F, Al, Na and Au . The atomic weight of most elements is variable depending on its physical, chemical and nuclear history, i.e. on the source of the material and the number of its stable isotopes.

In 2010, IUPAC revised the atomic weights of 10 elements so that they are expressed as intervals with lower and upper values, rather than as single standard values that are the average of its variations. For example, the atomic weight of hydrogen is expressed as [1.00784; 1.00811], and chlorine as [35.446; 35.457].The revised elements include hydrogen, lithium, boron, carbon, nitrogen, oxygen, silicon, sulfur, chlorine and thallium. For other elements, IUPAC is in the process of assigning a median value for the atomic weight and giving a defined uncertainty in the last figure to encompass known variations. □

[Note: Constants of nature, e.g. the Faraday constant and Rydberg constant, can be measured to very high levels of accuracy, as can the atomic weight of a mononuclidic element, e.g. the atomic weight of F is 18.9984032(5) and for Au is 196.966569(4).]

Sources:

- 'Atomic weights of the elements 2009' (*IUPAC report*)
- 'Atomic Weights: No Longer Constants of Nature' at *www.iupac.org/publications*
- *www.chem.qmul.ac.uk/iupac/index.html*
- *Science News*, *Vol 179 No. 3, 11 Jan 2011*
- *www.usgs.gov/newsroom/ 13 Dec 2010*

New planet that orbits two stars

NASA's Kepler mission has discovered a planet that circles two stars instead of one. This planet is just a mere thousand trillion miles from Earth.

Two years ago, NASA launched the Kepler space telescope to look for Earth-like planets beyond our own solar system. It has found more than 1000 apparent planets around distant suns.

Now, for the first time, it has found a planet in orbit around a double star. The planet, known as Kepler 16b, is about the same size as Saturn and circles its stars in 229 days. These binary stars are 200 light-years away from Earth in the Northern Hemisphere constellation of Cygnus. The stars, an orange and a red dwarf, are smaller and cooler than our Sun and orbit each other in about 35 days.

As one astronomer commented, it reminds one of a scene from a Stars Wars movie, where on the planet Tatooine Luke Skywalker was watching a double sunset. But in this case, the planet is cold, gaseous and not thought to harbour life. □

Sources: *www.nasa.gov/mission_pages/kepler/* and *Sydney Morning Herald, 16 Sept 2011.*

GM animals to fight against pests

Biotechnologists have been able to create 'autocidal' organisms that have been genetically modified (GM) to kill off their own kind, while leaving other species unharmed.

This work follows on from the 'sterile male technique' in which large numbers of a target pest are bred, sterilised and the males let loose. When they mate with wild females, the resulting eggs are not viable, so releasing enough sterile males can eventually exterminate wild populations. This method has helped eliminate screwworm flies from the US and Mediterranean fruit flies from North America. However, it is difficult to sterilise animals without harming them in other ways, e.g. the radiation used to sterilise the males often makes them too weak when released to compete for females.

The first animals being targeted with GM techniques are disease-carrying mosquitoes and bollworms, but it is hoped that it will eventually work with other animals – from invasive fish and frogs to larger pests.

Oxitec, a biotechnology firm in the UK, have developed pink bollworms (caterpillars of the bollworm moth) with a built-in fluorescent marker called DsRed. Bollworms are a major pest of cotton, and in 2002 an eradication campaign was launched in the US, part of which included releasing sterilised bollworms. In 2006, Oxitec's fluorescent bollworm became the first GM animal to be deliberately released into the environment. Over 3 years of successful trials, more than 20 million moths have been released in the US.

Oxitec is also targeting the mosquito *Aedes aegypti*, a vector of dengue fever (see Figure 1). This viral disease affects about 50–100 million people each year and kills 40 000 in tropical regions every year, including a few people in Queensland, Australia. There is no vaccine or treatment, so the only way to combat the disease is to kill the mosquitoes that carry it – and they are becoming resistant to pesticides. As the range of the dengue virus continues to grow, biotechnologists have decided to take the risk of releasing millions of GM mosquitoes.

Oxitec have created a strain of *A aegypti* with a gene that is switched off in the presence of the antibiotic tetracycline, and so used as an artificial 'antidote' to keep them alive prior to release. The insects also have the DsRed marker gene, so they can be monitored. When GM male mosquitoes are released and mate with wild females, the eggs hatch and the larvae develop normally until they reach the pupal stage, when the killer genes kick in and, since no antibiotic is present, the larvae die. Until they die, the larvae compete with wild larvae for resources, further reducing their numbers. It works only by inheritance and does not affect other insects, or predators such as fish or birds that might eat a mosquito. This method was successfully trialled in 2009 in the Cayman Islands where within two months of their release, 80% of the target mosquito population had gone.

Another strain of *A aegypti* that Oxitec have created is one in which the females cannot fly. Their work was based on the discovery that female mosquitoes have a unique flight muscle protein that males lack, perhaps because females have to fly after a blood meal and so must fly with a much heavier load. Any males that hatch from eggs will appear normal, however they can pass the flightless gene to their daughters. Their sons will also inherit a single copy, so they too will produce some flightless daughters.

Many other groups around the world are also working on similar approaches for dealing with organisms that cause disease or are pests in the environment.

Ronald Thresher, at Australia's CSIRO, has come up with a way to create fish that produce only male offspring. Releasing enough of these 'daughterless' fish into the wild, should result in male only populations destined for extinction. He has shown the approach works in lab tests on zebrafish, skewing the sex ratio in favour of males for at least three generations. He hopes to use this method on carp, which are responsible for a decline in native fish species and erosion of riverbanks across the Murray-Darling river basin. Thresher's models also suggest pests such as cane toads and rats could be tackled this way. However, breeding large animals is labour intensive and costly. Nevertheless, if successful, this method will be more eco-friendly than using pesticides and only affects the target species. Most biologists agree the risks of using this form of biotechnology are minimal, as autocidal traits are a great disadvantage and should disappear from the wild within a few generations after releases stop and so should not harm other species.

FIGURE 1: The mosquito *Aedes aegypti*, a common vector of dengue fever, feeding from a human host. The mosquito can be recognised by the white markings on its legs.

[Source: US Department of Agriculture, Wikipedia.]

Scott O'Neill's team at Monash University in Melbourne have developed a GM form of *A aegypti* mosquitoes that have been infected with a fruit-fly bacterium called *Wolbachia*. The bacterium makes the mosquitoes less able to carry the dengue virus, and could therefore limit dengue transmission if it were to become widespread in the mosquito population. Some 300 000 mosquitoes, with the potential to block the spread of dengue fever, were released in Australia in 2011 in a large-scale trial of one of the most promising techniques to rid the world of dengue. In principle, *Wolbachia* can spread quickly as infected male mosquitoes produce viable offspring only if they breed with *Wolbachia*-infected females. What's more, all offspring of infected females will carry *Wolbachia*, whether the male parent is a carrier or not. After this successful trial, the team is now ready for the final test: releasing *Wolbachia*-infected mosquitoes in areas with a high incidence of dengue. Pending government approval, the team hopes to begin trials in Thailand, Vietnam, Indonesia or Brazil within twelve months. □

Sources:
- *NewScientist 24 August & 12 September 2011*
- *www.oxitec.com/*
- *www.wired.com/science/planetearth/news/2008/01/gm_insects*

Senior Science Fun Park Excursion to Luna Park Sydney

Many of the first-hand experiences in the Senior Science syllabus are covered by doing a *Senior Science Excursion* at Luna Park Sydney **through *Physics is Fun***. Worksheets are provided for:

- ★ ***Preliminary Topic 8.4 Humans at Work*** – students assess the impact of science in the design/construction of safe rides; identify & assess potential hazards & factors that increase the risk of injury; perform an occupational health & safety style audit; & determine what safety measures are needed to protect the human body from injury.
- ★ ***HSC Option 9.8 Disasters*** – students explore the possible consequences of a disaster such as the collapse of a ride at Luna Park Sydney, and how emergency services would assist in the minimisation of the effects of such a disaster.
- ★ ***HSC Topic 9.4 Information Systems*** – students investigate the need/use of these.
- ★ ***HSC Option 9.5 Polymers*** – students investigate the types used & their impact.

Interactive learning is a great way for students to learn and have fantastic fun at the same time. What better way to put fun into your lessons than to do a *Senior Science excursion* to Luna Park Sydney through Physics is Fun!

For details, see page 6 of this *SciTalk*. Enquiries: ph 9939 6107, fax 9939 6105, *www.odlumgarner.com* □

2011 editions: Past HSC Papers with Worked Solutions

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Photo Spot 'Colonies' ... mineral growth on quartz

The 'colonies' show in Figure 1 are in fact some delicate mineral growth on a piece of quartz. Quartz is a chemical compound of silicon and oxygen, usually known as silicon dioxide (SiO_2), and is commonly called silica.

Quartz is the second-most abundant mineral in the Earth's crust, after feldspar. Large parts of the Earth's surface are literally covered with it, e.g. in sand left over from the weathering of rocks.

Quartz is an important rock-forming mineral, being a constituent of many common rocks – from granite and other felsic igneous rocks to sedimentary rocks such as sandstone and shale, and it is in most carbonate rocks and metamorphic rocks such as schist, gneiss, and quartzite. Because of its resistance to weathering, quartz is very common in stream sediments and in residual soils. Quartz is also found in hydrothermal veins as gangue along with ore minerals. Large crystals of quartz are found in pegmatites. Well-formed crystals may reach several metres in length and weigh as much as 640 kg.

Pure quartz is colourless, transparent and very hard, scoring 7 on Moh's scale of hardness. Well-formed quartz crystals consist of six-sided prisms with a six-sided pyramid at their ends and have a glass-like look. Pure quartz is used widely in the production of glass and ceramics.

Quartz also comes in a variety of colours due to inclusions of other minerals or built-in trace elements. Some of the coloured varieties of quartz include amethyst (violet), citrine (yellow to pale brown), pink quartz, blue quartz (sapphire quartz), or smoky quartz (grey to brown). Thus quartz has long been used in jewellery. It also occurs in dense forms with no visible crystals, like the multi-coloured agate and the grey flint.

Quartz is the 'ore' from which silicon is obtained for use in integrated circuits for computing needs. Naturally occurring quartz crystals of extremely high purity are necessary for the crucibles and other equipment used for growing silicon wafers in the semiconductor industry. However, these are expensive and rare and so today, most quartz used in microelectronics is produced synthetically. Large, flawless and untwinned crystals are produced in an autoclave via the hydrothermal process. The process involves treating crushed natural quartz with a hot aqueous solution of a base such as sodium hydroxide. The hydroxide serves as a 'mineraliser', i.e. it helps dissolve the 'nutrient' quartz. High temperatures are required, often around 675°C. The dissolved quartz then recrystallises as a seed crystal at slightly lower temperatures.

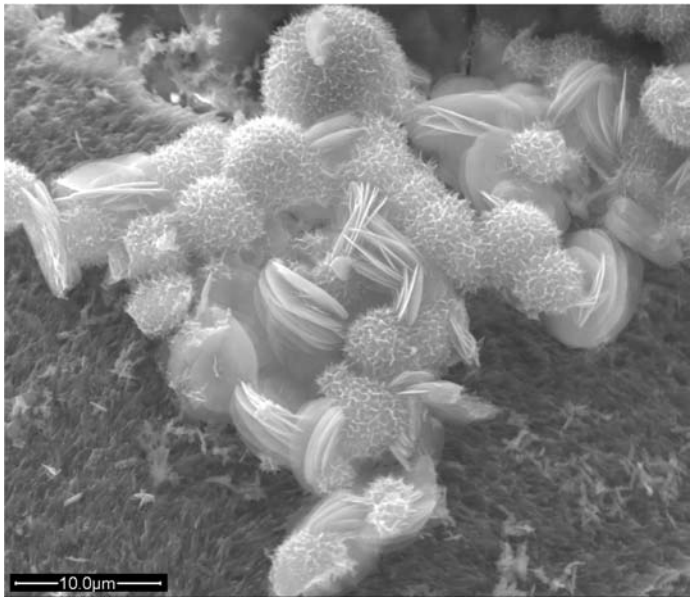

FIGURE 1: 'Colonies': mineral growth on quartz ... taken using a scanning electron microscope by Thor Bostrom, at the Analytical EM Facility, QUT.

Quartz demonstrates great physical and chemical resistance, and has high thermal and chemical stability. At room temperature, SiO_2 in all modifications is almost inert and does not react with most other substances. Even at moderately high temperatures silica is chemically very stable. The reason for the low reactivity of silica is the very strong Si-O bond, but also its macromolecular structure. At room temperatures quartz is practically insoluble in water. Tap water is usually almost saturated with dissolved silica (with respect to quartz), and the dissolution process is very slow, so there is no need to worry about quartz crystals being damaged by repeated cleaning.

Quartz glass, also known as 'fused quartz' or 'fused silica' is produced by quickly cooling molten quartz. It has a number of interesting properties: its thermal expansion coefficient is very low, it is transparent to ultraviolet light, it is chemically almost inert, and it can form very thin but strong thread. It is widely used for chemical apparatus, especially when catalytic reactions of the metal cations in ordinary glass need to be avoided. A well known application of quartz is its use as an oscillator in electric circuits in watches and computers. Less well known is its use as a membrane in ultrasonic devices. Quartz is also widely used in many large-scale applications related to abrasives, foundry materials, and cements. □

FIGURE 2: A quartz crystal cluster from Tibet.
[Source: JJ Harrison, Wikipedia Commons.]

Source:

- *www.quartzpage.de/*

"Genius without education
is like silver in the mine."

... Benjamin Franklin

THE SCIENCE EXPERIENCE 2011–2012

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Students can attend any program on the 'Where and When' page on *The Science Experience* website. The various programs will take place in over 35 universities and tertiary institutions, within many different laboratories and lecture theatres at various times through 2011 and 2012. Each includes a BBQ or social activity.

This program is run by The Science Schools Foundation, which makes arrangements with and assists the universities and tertiary institutions to conduct these annual programs.

For more information, phone 03 8288 1001, or go to: *www.scienceexperience.com.au* □

"Self-trust is the first secret of success."

… Ralph Waldo Emerson

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WINNER: Jenny Perry, Ambarvale High, won a Luna Park Sydney family pass for *SciTalk No. 3–2011.*

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WINNER: Cathy Perri, Wollondilly Anglican College, won a IMAX Sydney family pass for *SciTalk No. 3–2011.*

Astronomy

As Spring skies become Summer skies

... Robert Garner

As Summer approaches, there is much to be observed. Warmer Spring nights make for more pleasant viewing conditions, so now is a good time to get your Science students interested in the night skies.

Remember, viewing the night skies is much simpler if you have a Sky Chart / Planisphere to view the skies. See Box 1 for details on how to easily obtain one of these.

The Planets

Mercury, Venus and Jupiter are visible in the evening sky from mid-October. Mercury and Venus remain close together through most of November. About 30 minutes after sunset, binoculars and a low horizon are recommended to see Mercury and the Moon together on 26 November. Venus will be next to the Moon on 27 November. Mercury is highest in the western evening sky on 14 November. It then begins to sink back towards the Sun reaching inferior conjunction (between Earth and the Sun) on 4 December. Later in December, Mercury appears low in the eastern pre-dawn sky.

Mars initially is in the early morning northeastern sky. It will be found near the Moon on 20 November, about 45 minutes before sunrise. As summer progresses, Mars rises earlier each night and so eventually rises around midnight by mid-December.

Saturn was at conjunction on 14 October (behind the Sun from Earth), so it cannot be seen in October. It will return to the pre-dawn sky at the end of November, about 5° below but near to the bright star, Spica. On 23 November, the thin 27 day-old crescent Moon will be above Saturn and next to Spica.

Jupiter is at opposition on 29 October and provides good viewing all night through the summer months.

December Solstice

A solstice is a bi-annual astronomical event. A solstice occurs at either of the two times in the year when the Sun is at its greatest distance North or South of the celestial equator, which has a declination 22.5° North or South. Australia's next solstice occurs on 22 December at 4.30 pm AEDT. This is our 'Summer' Solstice and so is our longest day (and shortest night) of the year.

The 'Winter' Solstice is our shortest day (and longest night) of the year, and so is when the Sun's daily maximum position in the sky is the lowest. It occurs in June.

The terms 'Summer' Solstice and 'Winter' Solstice are ambiguous, because they are the opposite seasons in the Northern Hemisphere, e.g. December is our Summer Solstice, whereas it is a Winter Solstice for the Northern Hemisphere.

Constellations

In late October/November, Scorpius and Sagittarius are moving into the western twilight, and will soon disappear from view. The summer constellations, Taurus and Orion will soon be prominent overhead at night.

If you have been following the motion of Crux, the Southern Cross, you will find that it has changed from lying on its side during Spring, to being upside down with the two pointers to the west and the bright star, Canopus to the east.

The colourful collection of stars, known as the Jewel Box, will be just above β-Crucis on the western side of Crux and the dark Coal Sack will be just above it. Directly above the long arm of Crux, you should be able to see a small fuzzy patch of light. This is the Small Magellanic Cloud. If you follow a line through α- and β-Crucis towards the north-east, a similar but bigger fuzzy patch of light should be able to be seen. This is the Large Magellanic Cloud. Both are about 200 000 light years away and both are satellite galaxies of the Milky Way.

Meteor showers

On a clear night, you might sometimes see up to five shooting stars per hour. These are known as random or sporadic meteors. Some meteor shows return regularly at the same time each year. One such shower, the Orionids, is quite a reliable meteor shower most years, having produced good rates of between 14–31 meteors an hour over the last two decades. The Orionids are associated with Halley's Comet and will be active from 2 October until 11 November, with a maximum rate occurring this year around 22 October. The Moon is approaching New Moon on 27 October, so viewing conditions this year are favourable. Just look towards the East after midnight for Orion.

Total Lunar Eclipse

On Saturday 10 December, there will be a total eclipse of the Moon. It will be fully visible across Australia. So if you missed out on the Total Lunar Eclipse on 15 June, this is another chance to observe such an event. The whole eclipse will take nearly 6 hours. It can be divided into stages: firstly, the penumbral stage begins at 10.34 pm AEDT, then the partial eclipse will begin at 11.46 pm AEDT. The period of total eclipse will last from 1.06 am AEDT until 1.57 am AEDT on Sunday morning 11 December. After this, the partial eclipse will continue until 3.18 am AEDT and the penumbral eclipse will end at 4.30 am AEDT. □

MACQUARIE UNI OBSERVATORY PUBLIC FRIDAY NIGHT OBSERVING

Located in the grounds of Macquarie Uni (access via Gymnasium Rd), the observatory is open to the public every Friday night, March–Nov inclusive, from 7.30–9 pm (in non-DST), 8.30–10 pm (when DST). Bookings are essential – ph 9850 4409 or email *starinfo@mq.edu.au* before 4 pm. If doubtful weather, ph 9850 8914 after 5 pm or check at *www.physics.mq.edu.au/community/observatory/public/*

On clear nights, our 'starfinder' (planisphere) sessions demonstrate how to identify bright stars, constellations and planets. This is followed by observing with the telescopes. Even with the light pollution of the city, we can easily see double and multiple stars, open and globular star clusters, and the brighter nebulae. The Moon and planets, when in suitable positions, are easily viewed with any of our instruments. On dark, moonless nights with good seeing, we may also observe the brightest galaxies. □

Box 1: Sky Charts & Planispheres

- You can download free sky charts each month to explore the night sky (planets, stars & constellations) from: *http://skymaps.com/downloads.html* Make sure you scroll down to the 'Southern Hemisphere Edition'.
- A planisphere (star wheel) is a great aid for exploring the *stars* and locating *constellations*. These are inexpensive and available from astronomy shops, or you can download one from the internet – make sure it is for the Southern Hemisphere. There is a planisphere (star wheel) to print and use at: *http://members.ozemail.com.au/~starrylady/Planis1.htm* □

Astronomy Open night ... Macquarie University

Date: 29 October 2011 at Macquarie University, from 6.30–10 pm. Use E7B courtyard entrance, no bookings required. Cost: $5 Child (under 18) & seniors, $12 Adult, $27 Family. Enquiries: ph 9850 7111, *www.physics.mq.edu.au/community/FFA/opennight/*

Expansion of the cosmos is accelerating

Professor Brian Schmidt, a 44-yr-old astrophysicist from the Research School of Astronomy and Astrophysics at the Australian National University (ANU), has won the 2011 Nobel Prize for Physics. Schmidt is Australia's 12th Nobel laureate and the first to receive this honour in Physics since 1915 when the Physics Nobel Prize went to Sir William and Sir Lawrence Bragg.

Schmidt, who has dual Australian-American citizenship, was awarded the prize with two other astronomers, Dr Reiss and Professor Perlmutter. Schmidt's team of scientists, which included Reiss, was formed in 1994. Like Perlmutter's team, which began in 1988, Schmidt's team were measuring the rate at which the Universe was expanding by observing distant exploding stars called Type 1a supernovae. They found about 50 suitable supernovae. By 1998, the research of both teams had revealed that the Universe is speeding up as it expands and that there must be a force at work in order for this acceleration to be taking place.

Astronomers refer to the mysterious repulsive force that is driving the expansion of the Universe as 'dark energy'. They do not know exactly what dark energy is. Only a small fraction of the Universe is known matter. It is estimated that the Universe is about 70% dark energy – a concept first proposed by Albert Einstein almost a century ago. Hence the notion that the Universe consists of 'empty space' appears to be incorrect.

FIGURE 1: Professor Brian Schmidt. Photo by Belinda Pratten. [Used with permission.]

Previously, it had been thought that the expansion of the universe was slowing, or proceeding at a steady rate. Some astrophysicists in the past even proposed the idea that the Universe might slow down enough for gravity to take over and result in all matter in the Universe being attracted to each other, causing a Big Crunch. However, these new observations by Schmidt's team of astronomers certainly show that these previous ideas are not the case and so this is a good example to show how scientists modify or reject models and theories as result of available evidence. □

SkyMapper for Southern Hemisphere skies

Brian Schmidt was the astronomer responsible for heading the project that led to the construction of the SkyMapper telescope – an automated wide field survey telescope that was officially opened in May 2009. Located under the dark skies near the summit of Siding Spring Mountain in the ANU's Siding Spring Observatory facility near Coonabarabran, SkyMapper is Australia's first new optical research telescope for 25 years.

SkyMapper's mission is to robotically create the first comprehensive digital survey of the entire southern sky. The survey will be a massively detailed record of over a billion stars and galaxies, to a depth that is one million times fainter than the human eye can see. It is estimated that SkyMapper will generate 100 Megabytes of data per second during every clear night over its first 5 years of operation. At the end of the Southern Sky Survey, this will amount to about 500 Terabytes of data (equivalent to 100 000 DVDs). A distilled version of the survey's data set will be made freely available to the scientific and general community via the internet.

The telescope's advanced 1.35 metre modified Cassegrain optics have an f4.79 focal ratio, making the system highly efficient as a photographic instrument. Its unique digital camera uses 268 million pixels to capture a region of sky 29 times larger than the full Moon every minute. As well as recording the brightness and shape of objects, a series of filters enables the camera to record the spectral type of stars, giving astronomers information about their age, mass and temperature. Because SkyMapper will image each part of the sky 36 times, it will help identify changes occurring within the Universe that would otherwise pass unnoticed. This will enable astronomers to identify targets of special interest and should greatly assist in tasks such as discovering large dwarf planets like Pluto in the outer solar system, tracking asteroids, discovering more about the unknown 'dark matter' and 'dark energy', and helping to create a comprehensive census of the stars in our Galaxy. The SkyMapper Telescope is housed in a 11.5 m tall, 6.25 m diameter dome, as can be seen in Figure 2. □

Sources:

- *http://news.anu.edu.au*
- *http://www.nobelprize.org/nobel_prizes/physics/laureates/2011/info_publ_phy_11_en.pdf*

FIGURE 2: The SkyMapper Telescope facility at Siding Spring Observatory. Photo by Martyn Pearce. [Used with permission.]

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- ***SciTalk* No. 1–January 2012 … Dec 16**
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- ***SciTalk* No. 3–August 2012 … June 8**
- ***SciTalk* No. 4–October 2012 … Sept 21**

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