GNOMON

Newsletter of the Association for Astronomy Education

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GCSE astronomy could be under threat

The examination organisation EdExcel is reviewing the future of GCSE Astronomy. As it has only about 600 candidates each year it might be "rationalised" out of existence.

If you have any interest in this subject, please write a constructive note to the subject officer, explaining why EdExcel (London Examinations) should maintain the subject.

For background, about half the candidates are from schools where study occurs out of the classroom and the others are from adult education classes. Both of these seem important areas.

Write to Mr Mark Burton, Astronomy GCSE Subject Officer, EdExcel Foundation, Stewart House, 32 Russell Square, London WC1B 5DN

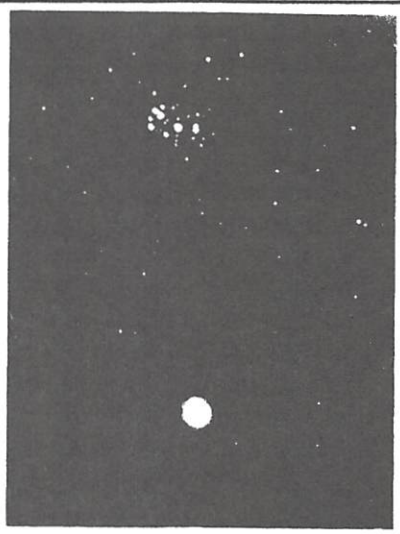
Alan Pickwick

Physics on stage

For a week in November, 400 educators from across Europe will converge on CERN in Geneva to discuss and see presentations of the best in physics education for children of school age.

If you have a project or event in action this year, you should send brief details to the Institute of Physics Education Department. If approved, you may use the Physics on Stage logo to help promote your event. It is important to alert the Institute of Physics so that your project will be brought to the notice of the UK Physics on Stage committee which has to select 40 delegates from the UK education community to attend the event.

Funding is sufficiently generous to cover transport and accommodation costs for the delegates! Institute of Physics, 76 Portland Place, London, W1N 3DH. (Tel: 020 7470 4816 Fax: 020 7470 4848.)



MARS AND THE PLEIADES. *September 16, 1952, 1·05 hours. Photograph by*

Spot the gaffes

This photograph appeared in a beautiful and authoritative book, published over 20 years ago. But mistakes will happen! Can you spot three serious errors in the photo and its caption (other than the removal of the photographer's name!). Answers by e.mail to the Editor by end of May for the next issue please.

Astronomy research projects for schools

Have you even felt that astronomy research was very remote from the classroom? There are moves afoot to reduce that gap! Schools in the UK will soon have access to two professional telescopes, one in the Canary Islands and one in Hawaii.

If you want to find out more, come to an open seminar entitled "Astronomy research projects for school and university students" to be held on Friday August 18th at Manchester University.☞

GNOMON - definition from the **Concise Oxford Dictionary:**
Pillar, rod, pin or plate of sundial, showing time by its shadow on marked surface, column, etc. used in observing Sun's meridian altitude.

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There will generally be a 10% discount to AAE members on all publications and advertising rates.
Practising teachers may claim their subscriptions as an allowance against income tax, thereby effectively reducing their contributions.

All communications (except those to the Editor) should be addressed to:

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Prices above are quoted for *one* issue.
A 25% reduction is made for advertising in all four issues.

Publication Dates:

These are at the equinoxes and the solstices, that is four times a year.
Copy deadlines are two months *before* these dates.

☞ For details contact: Alan_C_Pickwick@compuserve.com (or by post: 19 Edale Grove, Sale, M33 4RG).

Further information about the telescopes can be found at Liverpool Telescope Schools' Observatory and Faulkes Telescope Project web sites.

http://telescope.livjm.ac.uk/schools/top.htm
http://hoku.ifa.hawaii.edu/faulkes/index.html

Novae remnants

- The AAE's Annual General Meeting will be held at University of London Observatory, Watford Way, Mill Hill on Saturday 10th June at 11:00. The AGM will take about one hour, after which there will be time for lunch. In the afternoon there will be a talk and a multitude of demonstrations involving the observatory's telescopes. Have you ever seen a star in the daytime?
- A recent MORI poll showed that of 1109 people in a sample, a 20% majority thought Space Research and Exploration was not beneficial to society. We obviously have plenty of work to do !
- If you want to read science articles then buy the following newspapers. Best were The Times and then the Telegraph. In the middle group were the Mail, Independent, Express and Guardian, followed by the Mirror and FT. The Sun and Star brought up the rear. (From Science and Public Affairs, February 2000.)
- More details of the schools water rocket competition announced in the last issue are available. The competition will be part of the August 6 opening celebrations of the International Astronomical Union's conference to be held at Manchester University. There will be prizes for the highest flight, the greatest range, the longest time in the air and also for the most attractive design. Information on the design of such rockets may be found at

http://www.brad.ac.uk/acad/cybernet/rockets/chal.htm

Registration details from:
Alan_C_Pickwick@compuserve.com (or by post: 19 Edale Grove, Sale, M33 4RG)

Eclipse competition results

The winners of the RAS's Eclipse Newspaper competition are:

- *7-11 Years*: All Saints' School Wrexham; Broadmoor Primary School, Crowthorne; Fletching CE School, Uckfield.
- *11-14 Years*: First: Withington Girls School, Manchester. Joint Second: Devonport High School, Plymouth; King Edward VI High School for Girls, Birmingham; and Nailsea School, Nailsea; Treviglas Community College, Newquay.
- 14-16 Years: William Brookes School, Much Wenlock.
- 16-18 Years: Not Awarded.

Some of the winning entries are on the RAS web site.

http://www.ras.org.uk/ras

For Your Library

Space Encyclopedia. Heather Couper and Nigel Henbest. Dorling Kindersley. 300pp; £20.00 ISBN 0-7513-5413-9

This book is excellent value for the early teenager interested in space and astronomy. Beautifully illustrated in the DK style, are all the popular topics. Each topic receives the two-page spread treatment and there is a good biography, glossary and time-line.

The opening chapters deal with optical telescopes and artificial satellites that gather information from the radio, infrared, ultraviolet, X-ray and gamma ray parts of the spectrum. The next section deals with rockets and earth observation satellites and with living in space. Then there are sections on the planets, the stars and the galaxies and beyond. Finally there is a section on practical stargazing.

Along with the book comes the *DK Encyclopedia of Space and the Universe* CD-ROM for Windows (only). This presents the material at a slightly lower level than in the book. However, that might make the subject more accessible for the younger teenager. In conclusion then, an excellent buy for a present, for the school library or for a teacher who wants a quick reference for National Curriculum topics.

Alan C Pickwick.

Unfolding Our Universe. Iain Nicholson. Cambridge University Press. 294pp. ISBN 0 521 59270 4; £24.95

Coffee table books such as this are getting to be hard work for authors who have to cope with the accelerating growth of new information from super telescopes, space probes, the Hubble Space telescope and the associated academic work on the enormous amount of data which has been won. In this sense the "Universe" of the title is certainly "unfolding", although I'm not too sure about the "Our"!

This book is really very topical, and wide-ranging in its coverage, from the sky at night throughout the year, to a summary of most of the modern theories of the birth, life and death of the Universe, even mentioning the "Theory of Everything". The illustrations are very good, and as up to date as could be expected from a big glossy publication.

Nicholson is easy to read and this book would be ideal for young people wishing to find their own answer to life the universe and everything. The blurb on the inside front cover concludes that the book is a "delight for the casual reader to browse, while the clear and concise explanations will appeal to amateur astronomers, science teachers and college and university students taking an introductory course on astronomy" – a description with which I concur.

Richard Knox

Astronomy, Anglia Multimedia, PPARC and ASE. £50 ex VAT

This new CD ROM is designed to help teachers deliver the astronomy content of the National Curriculum to Key Stage 3 & 4 or the Scottish equivalent and for those who teach astronomy to Scouts, Guides and adults.

There are seven sections on the disc, each containing a wealth of separate modules using video, animation and audio on such themes as "The moving Moon", "The life cycle of a star", "How simple telescopes work", "A guided tour of the Solar System" and lots more. The disc also has an astronomical glossary, a photo gallery and numerous fact files. Each section also contains a multiple-choice quiz to test what has been learned. If you score 10/10 you get the chance of landing a craft on the Moon! The accompanying booklet contains curriculum links and several activities to do in the classroom. A glossy wall poster completes the package. The cost of the disk covers a 10-user network licence and it is available on approval. For more details see the Anglia Multimedia web page:

http://www.anglia.co.uk/science_Astronomy.htm.

Alan Pickwick

Hackney girl astronomers invade French Guiana

In the last issue of Gnomon *we published the winning essay entry of the ESA's XMM competition, from pupils of Haggerston School, Hackney. Their teacher, AAE Council Member Sue Flanagan, describes what happened.*

It was the Thursday mid-morning before the Autumn half term. I was heading through the foyer. Our receptionist was waving a phone at me. Oh no! What now?

"Sue Flanagan? I'm from ESA, European Space Agency. Congratulations, your entry has won".

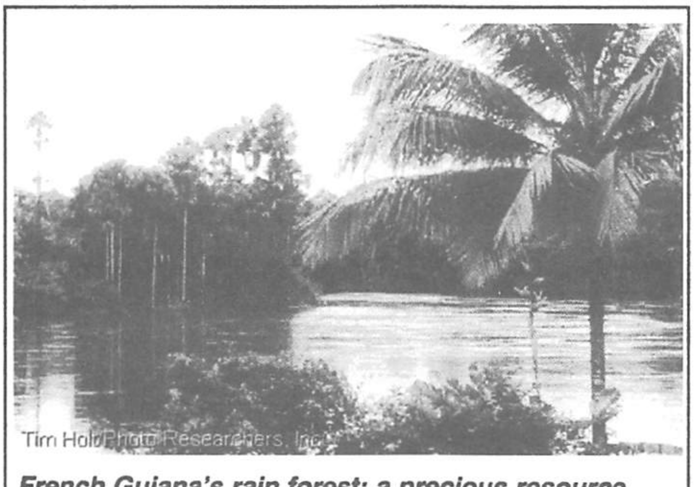
Won? I tried to remember. Oh yes, the XMM Competition. The results had been due the day before, and my year 11 astronomers had haunted me for the last week.

"There's only one problem," continued the little voice "you've got to take 25 pupils and we need to know the names by Monday. By the way you'll be flying out to French Guiana on the 19th of November".

More details followed: yellow fever jabs (compulsory); UK passports, and so on. I was already working out the logistics of who was to go, and how to get 25 kids immunised and passports ready in under a month! The Head was as amazed as I was at the magnitude of the prize and we quickly worked out who to add to my 18 astronomers and which colleague to take.

The Astronomy Club was told, and the excitement spread quickly around the school. The next few days were even busier than usual: phone calls and letters to parents; coming in to school during the holiday to collect and photocopy passports and immunisation records. I now know just how long it takes to send a 33-page fax to France! Several parents had to dash up to the passport office, and others had to race around to get their daughters immunised.

By the start of term I had my 25 ready (or so I thought) with three weeks to go; just a couple of passports to arrive and a few more girls to be immunised. I had an endless stream of girls coming up and saying that they had heard I was going to Africa and could they come. Actually it was South America but it was nice of them to offer! It started to sink in that we were really going when the *Hackney Gazette* contacted us, and we appeared on the *front page* - even more excitement! We are, after all, an ordinary Hackney comprehensive but we were off to see the latest European rocket in some exotic spot. PPARC invited us to the Science Museum to meet Patrick Moore and have some photographs taken as part of the UK publicity for XMM. (The UK produced the X-ray telescope for this trans-European project). Dr Moore was very kind to the girls and signed loads of autographs for them, and they were fascinated, listening intently as he told them how his own interest in astronomy had begun.



***French Guiana's rain forest: a precious resource.* (Encarta World Atlas, *1998*)**

With 11 days to go, three girls had to drop out for various reasons. Further flurry of activity as replacements were found - the yellow fever jab has to be done at least 10 days before travel! I was so relieved when we all finally boarded the plane.

We left a gloomy English November day: 12 hours later we were in a warm, sunny French Guiana, all glued to the coach windows as we transferred to our hotel, tropical trees with the odd sloth hanging from them contrasted strangely with French road signs and gendarmes. French Guiana is a departement of France, so its infrastructure is the same. ESA had laid on a really super programme for us, along with the Spanish and Norwegian winners (the competition had a winner from each EC state and the journeys were staggered over two weeks in three national groups at a time).

Slow journey by rocket

On the first day we went to the Space Centre at Kourou and listened to some of the scientists talk about the project and their role in it, with Mission Control as a background. We then toured the centre and watched the huge Ariane 5 rocket travel slowly from one side of the base to another, where the XMM module would be fitted.

We then visited the Space Museum and had a chance to buy souvenirs. Next day we went on a canoe journey along one of the rivers, with rain-forest on either side. We saw amazingly shaped trees and spotted some of the local wildlife. This was followed up by a walk through the rain-forest with a local guide who was able to point out things that would otherwise have been hidden. On our final day we went to a local wildlife park and zoo. We became acquainted with some friendly tapirs and came into very close contact with a jaguar - a beautiful creature with a silky coat who, in common with all cats, sought out those who did not like him!

Those brief three days in French Guiana, provided a multitude of experiences, which look very pale in writing. How can I describe the growth in confidence that I saw in some of my girls, the wonder and interest that they showed at the new and strange things that they saw? The beauty of the night sky, with Orion on his side and the Moon right above our heads? We have loads of photographs and video between us, but for each the experience was different and special. Each has different memories and every time two or more of us meet up something new is said. We are trying to share this with the others in our school and already our display has been a centre of attraction.

Our adventures didn't quite finish with our return, we were invited to the press launch just before the UK scientists went out to French Guiana, so we had the chance to meet them. We were then invited to see the launch via live satellite link by Logica, one of the companies involved in the project and so on December 10th we watched 'our' launch and relived some of our experience.

Sue Flanagan

Curriculum Corner

Gravity - what's it all about?

Who invented gravity? It is clear that Isaac Newton did not discover gravity and neither did Galileo. Falling objects have been known about ever since Eve picked up an apple to tempt Adam - and probably before that! Scientists through the ages have struggled to understand gravity on two levels.

Firstly, they have tried to measure the effect of gravity - how strong the forces are and how the forces change with distances and masses.

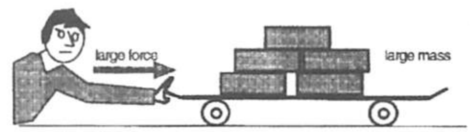
Secondly, they have tried to explain how gravity works - what mechanism exists for causing masses to be attracted to each other

.*How strong is gravity?* We live on the surface of the Earth and for us the strength of gravity can be measured using a spring balance. A one kilogramme mass will be pulled down with a force of about 10N. We can say that the strength of gravity on the Earth's surface is about 10N/kg. (An accurate balance will show that the actual value is 9.8N/kg, however 10 is an easier number to use, provided you realise it is approximate). If you lived on the top of a high mountain you will find that the strength of gravity would fall a little, perhaps to 9.7N per kg. This is because you are further away from the centre of the Earth, and the force of gravity falls as the distance to the centre of the Earth increases.

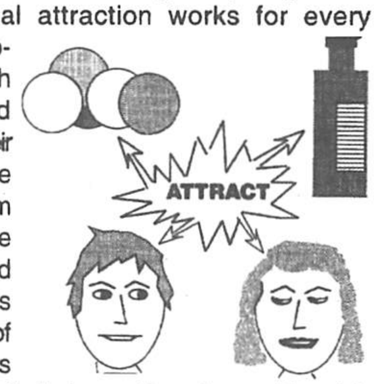
What is the difference between mass and weight? This is a piece of science which confuses many people. To think about the mass of an object think about all the millions of tiny particles, atoms, which make it up. This is the amount of 'stuff' in the object. These parts add up to a total mass measured in kilogrammes. If you eat half an Easter egg you reduce it's mass. You can see the effect of a mass by imagining it on a skateboard. Try making the skateboard roll. It is harder to get something moving if it has a bigger mass. It is also harder to stop it moving! Trains need stronger brakes than bicycles to stop their bigger mass.

Weight is something you can feel when you try to lift something or when you carry something. You can feel gravity forcing the object down to the ground. This force is the weight of the object. It is a *force* which can be measured on a spring balance or a weighing machine. Weight, like all forces, is measured in Newtons, N. Of course most masses can be lifted up (unless they are mountain-sized or so) and so these masses can have weight. But the weight of any object will change depending on where it is. A 3kg bag of potatoes will weigh about 30N in the shop. On the top of a high mountain a 3kg bag of potatoes will feel a shade lighter - the gravity is weaker there. The mass is still 3kg (you have the same potatoes) but the force due to gravity is less. Taking the potatoes to the Moon where the gravity is much less (about 1.6N per kg) our 3kg mass will weigh about 4.8N. There will be the same number of jacket potatoes for lunch but they will be much easier to carry.

What happens when something falls? Gravity makes things fall to the ground. Without gravity an apple will remain on a tree. The effect of the force is to make objects speed up as they fall. A falling apple gets faster and faster as it approaches the ground. The speed it gains is about 10m/s each second it falls. So if it takes three seconds to hit the ground it will have gained a speed of 30m/s. Speeding up is called acceleration. Gravity causes falling objects to accelerate at 10 m/s every second. This is sometimes written as 10m/s^2. (Remember that this is not anything about a distance of 10m. It is about gaining a speed of 10m/s every second). The effect of gravity is to make all masses accelerate equally. This means that heavy and light objects will hit the ground at the same time if dropped together for the same distance. Even when objects are thrown sideways or upwards they are still subject to the force which will make them fall to the ground eventually. Gravity forces them to accelerate downwards at 10m/s every second.



Universal gravity. Isaac Newton realised that when objects fell there were two masses involved - the falling object and the Earth. Gravity was a force which appears between two masses: each mass is attracted the other. He realised that this was true for all masses everywhere. Two bottles on a supermarket shelf are attracting each other with a force of their own gravity. Two jars or marmalade do the same. In fact every object in a supermarket attracts every other object. All the shoppers attract everything and of course the Earth will also be attracting everything in the supermarket! Gravitational attraction works for every object everywhere. All objects attract each other with this force, which is caused by, and increases with their mass, but decreases as the distance between them grows (as the square of the distance). Huge stars and planets attract each other, as do galaxies, and groups of galaxies. The Earth orbits the Sun and the force of gravity between them keeps it in orbit.



Misconceptions with gravity. Some people think that the Earth's gravity reaches out to above the clouds and then finishes. This is not true. It does get rapidly weaker, the further from the centre of the Earth one is. But its effect reaches deep into space – in fact never disappearing entirely (in theory). You can never escape the effect. This is true for all masses. Some people think that there is no gravity on the Moon, but there is plenty. The Moon has a large mass and so it has its own gravity. This forces objects to crash into the Moon's surface and make craters. It also helped Neil Armstrong to walk on the surface of the Moon in 1969. There is no atmosphere it is true but atmosphere is not the same as gravity.

So what causes this gravity? This is one of the great unanswered questions of science. We just don't know how gravity works. Some scientists three hundred years ago thought that all objects were attached to all other objects by invisible strings. More recently there have been suggestions that all objects exchange particles with all other objects. These particles are invisible and are called gravitons. The truth is that we just don't know how gravity works.

Bob Kibble

Astronomy during the day

A recent New Zealand newspaper article featuring the Pipehenge at the Auckland Observatory went on the international wire service. It brought inquiries from around the world (even Patagonia) for more information about how the principles of astronomy could be taught during the daytime. I was interviewed on Radio New Zealand and that brought 150 'hits' on the observatory's Pipehenge web page 🖳 www.stardome.org.nz

Southern hemisphere schools have just started back for their first term. There are several who would be interested in email exchange with schools in the UK (and other countries). Initial contact could be through my email.

To make understanding astronomy easier many activities need to be done over a period of time and not as "one offs". Experiments that can be carried out during the day have obvious advantages for schools! The following activity is an example. The best time to do this activity is at or near a solstice, and a six-month period will give interesting results.

At or near solar noon, a student stands in the Sun on the end of a strip of paper 50cm wide and 3m long so that his shadow lies along the paper. Draw around the shadow and record the student's name, date, time and his actual height. Repeat this activity with the same student, on the same paper, at solar noon at monthly intervals. What explanations can be given for the changes? How do they relate to the changing seasons? An interesting additional activity is to have the student hold a length of string on the top of their head while someone else holds the other end on the end of the shadow of their head. Using a protractor measure the angle where the string meets the ground and record it on the paper. This measures the height (altitude) of the midday Sun for this day and season. Compare this record each time the shadow is drawn around.

I would be pleased to have people email me their records and I'll have schools here do the same activity.

Measuring the potential for solar power

Measuring how the spread of sunlight affects the seasons. Measuring the amount of sunlight that the falls on the school yard is a way of understanding seasonal change.

Make a strip of card 50cm long by 10cm wide (500 cm^2) and stand it vertically in the sunlight at solar noon local time so that it casts a shadow on the ground. Measure the length and width of the shadow and work out the area covered in shadow.

Run a string from the top of the card to the end of the shadow and measure the angle (the Sun's altitude) with a protractor. Record the time, date, area of shadow, and the angle. Do this again a month later and compare results.

If this is done at both solstices, the area of shadow is markedly different showing that the amount of sunlight that reaches the Earth is related to the angle at which it strikes the surface, thus governing the amount of energy that is spread on the Earth's surface. The records could be made throughout at other times to watch the rate of change of the measured values. Where a class does this activity, say in the UK, I could arrange for a class in Australia, the USA or New Zealand to do it on the same day so that results can be compared.

Eric Jackson

THE THINGS PEOPLE ASK!

I am doing a project on stars and I was wondering how you know how stars were and are made. How can you determine their mass? *Julie Thibault, a school pupil, asks.*

These are very complex subjects (you have asked two questions!) and it is possible to give only outline answers here. Part of one answer is that we know that some stars are much younger than others, because the young stars are extremely luminous and must be using up their hydrogen in nuclear reactions at a rate that cannot be sustained for long. Regions containing very young stars are often found to have a lot of interstellar gas and dust. These are called *nebulae*, (Latin *clouds*). They often glow from the light of the stars embedded in them. Some dust clouds contain smaller objects that look like dark disks, with hotter objects at their centres. It is believed that these are stars in the process of being formed.

The same clouds also contain the T Tauri type of variable star, that has many of the characteristics expected of newly formed stars: they are surrounded by a small cloud of gas, and appear to be still contracting into a completely formed star.

Some newly formed stars appear to be shooting out jets of gas from their poles. This seems to be how the stars get rid of the spin they acquire as they condense from a slowly spinning cloud into a rapidly spinning star. They have to get rid of most of the spin if they are to condense further and become fully-fledged stars.

The masses of stars can be determined accurately only when the stars are found as binary or double stars which orbit their common centre of gravity. The orbital period can be found from observation. The absolute dimensions of the orbit determined either by measuring the relative positions of the two stars in the sky as they orbit their common centre of mass, or by measuring the speeds of the two stars in the line of sight. These two methods complement each other, as the first is useful for binaries with very long periods (decades or centuries) and the velocity method can be used for short period binaries. The astronomer can then apply Kepler's third law to determine the combined mass of the two stars.

The velocity method can be applied accurately only if we know the inclination of the orbit to our line of sight. This is known in cases where the orbital plane is close to the line of sight, because then the two stars eclipse each other during the orbit, and we can also measure the relative sizes of the two stars by measuring the way in which the light varies. **Query**

It has been suggested that I study a variable star(s) and need help on how to choose a star, what to measurements etc. *Laura Reid, 6th year CSYS Physics pupil.*

You should contact the British Astronomical Association Variable Star Section (🖳 http://www.ast.cam.ac.uk/~baa/). This can supply data on many variable stars. You can study archives going back over 100 years in some cases. Follow links on their Web site to "Help" on variable stars. You will see who to contact. There is a lot of data, and examples of analyses done by others. ☞

One major area of investigation is long-term changes in the periods or amplitudes of variables. There are also many helpful explanations of different types of variable stars there. If you wish to make your own observations I doubt that you could find enough telescope observing time available for a complete project study. An analysis of archive data could be more productive.

If you do not have access to a telescope you could try making your own observations of a variable star with the unaided eye or with binoculars using the methods explained by the BAA Variable Star Section. The only star that lends itself to straightforward visual observation is the cepheid variable star δ Cephei. These estimates are done by comparing the brightness of the star with other nearby stars of known brightness, and are usually accurate to about 0.1 magnitude.

The BAA gives a link to the Society for Popular Astronomy which discusses Delta Cephei and other variables (I suggest Delta Cephei mainly because it is always varying over a few days so you do not have to wait years to see if your results make any sense):

http://www.u-net.com/ph/spa/sections/vs.htm

If you explore these sites thoroughly and contact some of the people involved, I am sure they could give you very useful tips. You might also try to contact astronomers at the University of Glasgow, which is the nearest large University to your location. Best wishes for success in your project!

Query

List of astronomy speakers in UK for schools and societies *asked Jane Bendall, somewhat cryptically.*

A list of speakers is maintained by Dr Ian Crawford and may be found at a link "Astronomy Talks" on the AAE home page: http://www.star.ucl.ac.uk/~aae/aaehomep.htm. The link points to http://www.star.ucl.ac.uk/~iac/aae_list.html. There is also a printed version available through the AAE, but as the enquiry came via the AAE home page presumably you can access it via the Internet.

Query

My daughter must chart the phases of the Moon for a school project. This week, it has been impossible because of the cloudy evenings. Would the Moon we see in the early hours of morning suffice for the Moon of the night before? *(From "RubDuck" !)*

This is a standard (and very good) early scientific project used in the UK National Curriculum for primary pupils. It teaches the need to make careful records over a period of time to study a natural phenomenon. It also teaches patience and persistence! At the end of it all, pupils actually do gain a better understanding of the monthly variation of the Moon.

I don't see why she should not observe the Moon the following morning. Many people do not realise it, but the Moon can also be seen quite well in full daylight, as long as the sky is reasonably clear and it is well above the horizon.

The crescent of the Moon during the first days after new moon would be visible in the late afternoon and evening sky, but not visible early the following morning, as it would not have risen yet.

During the second week after full moon her observations of the waning crescent would have to be made in the early morning hours, or in daylight. Your daughter's drawings should make allowance for the fact that the Moon would appear to be in different orientations - but that is a minor problem. She should draw what she sees to the best of her ability, including daylight sightings. It is important to record the time of each drawing as well as the date so that the observed phases could be plotted with their date and time of observation. She should also try to note the way in which the crescent is orientated with respect to the Sun. Does the illuminated side face towards the Sun or away from it? Best of luck with the project, and here is wishing you some clear skies!

Query

Can there ever be a time when all planets, excluding Pluto, come into a line? (A pupil asked teacher K. Boylan this question.)

You have to give some idea of the margin for error that would be allowed. For example, is it acceptable to call an "alignment" a conjunction within a sector of 5° as seen from the Sun? Could some planets be on one side of the Sun and others in the opposite direction? There is also a problem with the word "ever" which, as you might gather, suggests a very long time indeed! Such a calculation would lose accuracy if extended far back in time, because the orbits of the planets change slowly over millions of years, so that use of today's orbital periods could not be extrapolated safely.

Astronomer Jean Meeus recently described some calculations he made to look for close groupings of the five naked-eye planets (*Sky & Telescope*, August 1997, p 60). For a span of 5000 years, the smallest grouping (as seen in the Earth's sky) was a bit under 6° on June 25, AD 710. This must have been a spectacular sight, and there is evidence from the Mayan culture of Mexico that this date was important to them for some reason - perhaps this grouping was the cause (D. Olsen and B. White, *Sky & Telescope*, August 1997, p. 63). There were only six groupings under 10° in all that time. Groupings of the planets as seen in our sky do not mean that the planets are all in a line from the Sun.

Meeus also considered the question you asked for the planets Mercury through Neptune. Over a 4000-year period, he found 39 cases where all the planets were within a 90° wedge. The smallest spread was 40° wide. These would not look like very exciting line-ups if you drew them on graph paper. This calculation suggests that much tighter alignments (say, within 5°, which would look "interesting" on a plot) must be exceedingly rare. He concluded that the planets can never all exactly align with the Sun. Although such a line-up is theoretically not impossible, the probability is so small that it is likely never to have occurred even once in the 4.5 billion-year history of our Solar System.

Query

See also the notes about this Spring's "Grand Conjunction" in Sky Diary *in this issue: Ed.*

Ask an Astronomer

"The Things People Ask!" is selected from the many questions received, and answers given by the Association of Astronomy Education's "Ask and Astronomer" Service conducted by Dr. Mike Dworetsky, University College, London. The service is available to members of the AAE by email: *query@ulo.ucl.ac.uk*, or via the AAE home page: http://www.star.ucl.ac.uk/~aae/aaehomep.htm.

LETTER FROM DOWN UNDER

Aloha! Or perhaps that should be "G'day" now that I have relocated from Hilo to Sydney. An astronomer's life is generally an itinerant one, and after 21/2 years in Hawaii, I now find myself back in Australia, where I lived previously! I now hold a Staff Astronomer position at the Anglo-Australian Observatory which, although not a permanent appointment, does give me some security for the next five years.

In some ways, moving to the AAO is nothing more than a case of "aperture fever" - at 3.9m diameter, the primary mirror of the AAT just eclipses the 3.8m diameter of UKIRT! Despite their similar sizes, the two telescopes are rather different:

- Commissioned in 1974, the AAT is funded jointly by the UK and Australian governments, and observing time is shared equally between the two countries. UKIRT came along five years later, constructed on more of a shoestring budget, and is wholly operated by the United Kingdom.
- The AAT sits nearly six storeys above the ground, and has an enormous dome because of having to interchange the top-end, depending on the instrument in use. UKIRT has a somewhat more compact mounting and dome.
- The AAT sits 1164m above sea level, overlooking the lush beauty of the Warrumbungles National Park. UKIRT is nearly four times higher, at 4194m, and sits atop the stark, barren summit of Mauna Kea.
- The AAT has a vast array of instruments, only one of which can be mounted on the telescope each night, covering wavelengths all the way from the ultraviolet to the mid-infrared. UKIRT has a smaller number of instruments, all optimised for the near to mid-infrared, and switching between them takes only a matter of minutes.
- The median seeing at Siding Spring is 1.4 arcseconds, and skies are clear for 50-60% of nights. At UKIRT, the median seeing is closer to 0.6 arcseconds, and as much as 80-90% of all nights are clear.

One might wonder, after the last statement, how a telescope like the AAT can be competitive with much larger facilities located on better sites in the Southern Hemisphere? Part of the answer is the range and quality of instrumentation available. The AAT has the most powerful wide-field, multi-object spectrograph available anywhere in the world.

The "2 degree Field" (2dF) allows us to trade high resolution for field-of-view. A high-speed robot positions optical fibres on a plate, which is then placed behind some focal-reducing lenses to record spectra of up to 400 galaxies, quasars, or stars *simultaneously*. This instrument has already doubled the number of known quasars in the Universe, as well as measured the redshifts for over 80000 galaxies.

The Taurus Tunable Filter (TTF) allows astronomers to take images at many different wavelengths (e.g., the H-alpha line of ionised hydrogen) without the need for expensive, custom-made filters.

The UCL Echelle Spectrograph (UCLES) and Ultra-High Resolution Facility (UHRF) are used to study extremely narrow and weak features in the spectra of nearby stars, as well as look for minute velocity changes. This is the cornerstone of the Anglo-Australian Planet Search, led by Paul Butler, which is the only serious search for extrasolar planets in the southern hemisphere.

No matter how superb the site, a telescope is only as good as its people, and here again the AAT benefits from a very low staff turnover rate. Because of its rural location, many of the AAT staff have the chance to enjoy a farm-based lifestyle while working in a technically-challenging environment.

Most of the astronomers prefer the cosmopolitan atmosphere of Sydney (though as the pace and chaos of Olympic preparations intensifies, the peace and quiet of Siding Spring begins to look more attractive also!).

I had some fabulous experiences working for UKIRT in Hawaii, and now I look forward to keeping you updated on what's happening in astronomy "Down Under" in future issues of *Gnomon*.

Stuart Ryder

SKY DIARY SPRING 2000

The chart for this quarter shows the southern horizon about two hours after midnight on May 15, as seen from somewhere in about the centre of England. The large empty area of sky in the centre of the chart is the heart of the constellation of Ophiuchus.

The ecliptic passes through the southern part of Ophiuchus, to the north of Scorpius. In fact the Sun spends more time passing through Ophiuchus each year than through Scorpius. Ophiuchus contains several globular clusters catalogued by Messier, and is well worth study in binoculars and small telescopes.

It is now 70 years since the discovery of Pluto as a faint dot on a photographic plate by Clyde Tombaugh on February 18 at Flagstaff Observatory, Arizona. During that time, Pluto has moved only just over a quarter of its orbit round the Sun. It was discovered in Gemini, and is now on the western edge of that large blank area in the centre of Ophiuchus (shown with a small cross on the chart).

Pluto reached perihelion in 1989, and its orbit is so eccentric that from 1979 to 1999 Pluto was closer than Neptune to the Sun. However, even though still almost at its closest to Earth, it is no use searching for it in any telescope much less than 250mm aperture. Thanks, I suspect, to Mr. Disney, young people are fascinated by this body, which may not even be a planet worthy of the name, being more likely just one of the most prominent lumps of rock and ice in the Kuiper Belt.

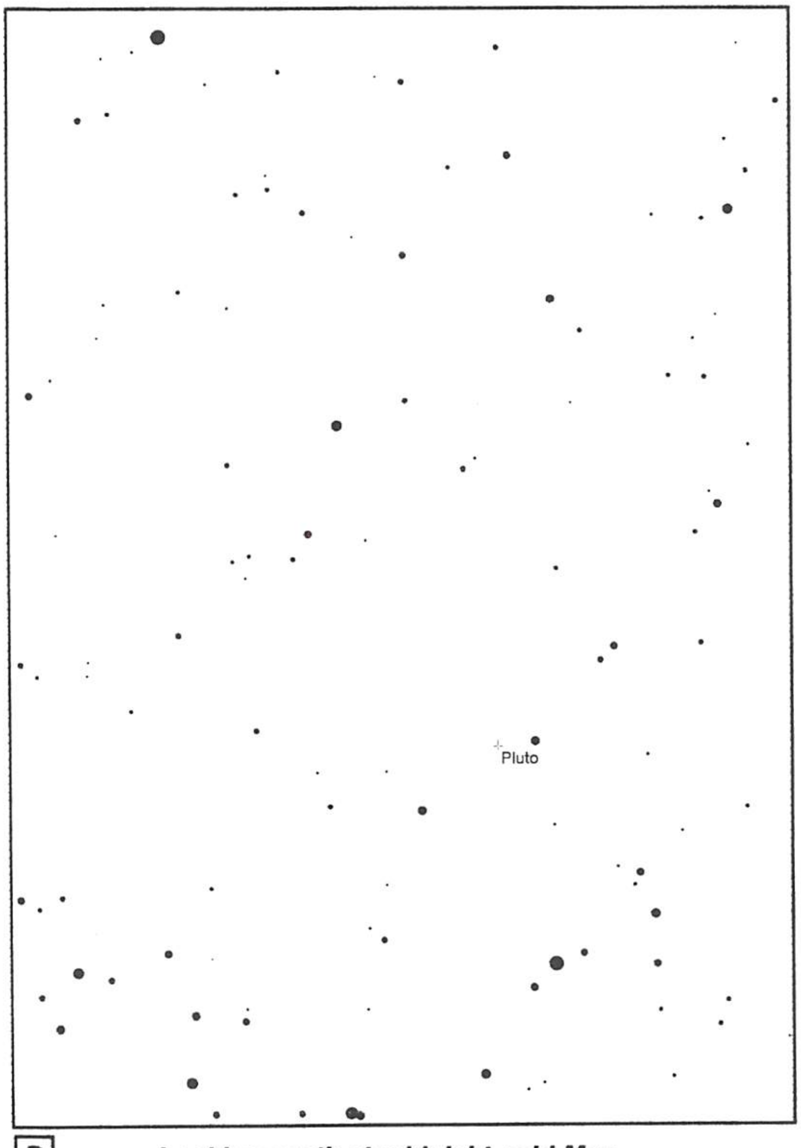
To the south of Ophiuchus is the Scorpion. This magnificent constellation is too far south to be properly enjoyed from British latitudes. As is par for the course in astronomical mythology, the more splendid the constellation, the more obscure the mythology. Orion the Hunter is the best example of this, and oddly enough, the little that is known about him also involves the Scorpion. Orion boasted of his prowess as a hunter, and challenged the gods to find a creature he could not fearlessly slay. So (with some typically ironic Olympian humour) they sent a little Scorpion which bit the mighty hunter on a

Approx. rising and setting times: lat. 52N; long 3W

	April 15		May 15		June 15	
	Rise	Set	Rise	Set	Rise	Set
Sun	05h 15m	19h 09m	04h 18m	19h 59m	03h 51m	20h 33m
Mercury	04h 41m	17h 55m	04h 31m	20h 49m	05h 40m	22h 02m
Venus	04h 41m	18h 08m	04h 08m	19h 11m	03h 56m	20h 38m
Mars	05h 57m	21h 11m	04h 53m	21h 13m	04h 07m	20h 57m
Jupiter	05h 55m	20h 38m	04h 13m	19h 21m	02h 29m	17h 59m
Saturn	06h 14m	21h 00m	04h 25m	19h 24m	02h 33m	17h 43m
Uranus	02h 48m	12h 11m	01h 30m	10h 54m	23h 28m	08h 51m
Neptune	02h 10m	10h 56m	00h 51m	09h 37m	22h 49m	07h 33m

foot and killed him. Then, taking pity on them both (a bit late, arguably) they were both placed in the sky, but opposite each other so that as one rises the other sets and they never see each other again.

The Scorpion is easy to make out, although very low in the sky. His claws radiate from the bright red giant star Antares, which means "rival of Mars" in the Greek name, and the sinuous body curls down below the British horizon to terminate in a nasty-looking sting! Have a look for the Scorpion if you have the fortune to be travelling south on holiday. Even in Toronto (about latitude 42° north) the complete constellation is visible.



Looking south at midnight, mid-May

To the east of Scorpius is the "Teapot" of Sagittarius, the most southerly of the zodiacal constellations. It has a small inverted "dipper" on the north-eastern side, the brightest stars of which form the handle and part of the lid of the teapot. The triangular spout is on the western side and the lid seems to be a high dome. (What do you mean "I've got too much imagination"?). Sagittarius marks the centre of our galaxy in the Milky Way, and (together with Scorpius) contains many beautiful objects for binoculars and telescopes.

The promise of summer is offered by the appearance of the Summer Triangle - or at least a corner of it! In the north-east corner of the chart, the brilliant star Vega can be seen. To the west of Vega is the "Keystone", the centre of Hercules. The amazing globular cluster M13 can be found one third of the way down the western side of this four-sided figure. It is the brightest globular cluster of the northern sky (alas completely shamed by ω Centauri in the southern sky and never rising in British skies. But the Great Globular Cluster in Hercules is still a magnificent object in a small telescope, and well worth searching for in binoculars.

Moon phases for the second quarter of 2000

Month	New Moon	First Quarter	Full Moon	Last Quarter
April	4	11	18	26
May	4	10	18	26
June	2	9	16	25

Then to the west of the Keystone and in the north-west corner of the chart is the faint, but distinctive semicircle of the Northern Crown, Corona Borealis.

Events during the quarter include the unusual, but by no means unique, "Grand Conjunction" which has got the astrologers wasting more time than usual. During early May, and at its best in the first week, all the naked-eye objects of the Solar System will be very close to each other in the sky. Since one of these is the Sun, it is largely of no interest to observers, other than to note that Mars is the only planet that might be glimpsed very low in the twilight after sunset. In the run up to the closest grouping,

Jupiter and Saturn might be spotted in binoculars. It is only a few weeks later, about May 25, that Jupiter finally passes Saturn after a long and patient pursuit, and although now "morning stars" they are too close to the horizon still at sunrise to be seen at conjunction, but they will become progressively easier as a widening pair in the morning sky, rising well before the Sun by the end of June (see table) with a slim old crescent Moon making a triangle with sides of only about 4°-5° over 14° high at the beginning of civil twilight.

Mercury becomes visible in the evening sky at the end of May and beginning of June. The northern summer solstice is on June 21.

Richard Knox