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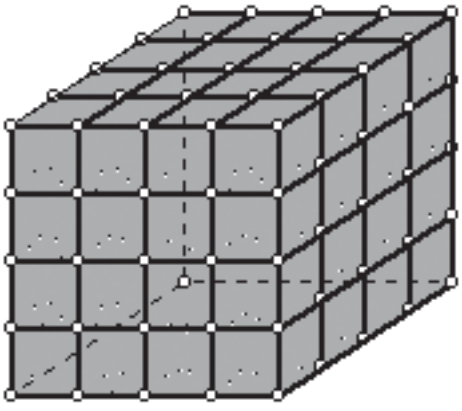


Brain Teasers

1. A solid, four-inch cube of wood is coated with blue paint on all six sides. Then the cube is cut into smaller one-inch cubes. These new one-inch cubes will have either three blue sides, two blue sides, one blue side, or no blue sides. How many of each will there be?

2. Four adventurers (Anand, Brinda, Chris and Tariq) need to cross a river in a small canoe.

The canoe can only carry 100kg. Anand weighs 90kg, Brinda weighs 80kg, Chris weighs 60kg and Tariq weighs 40 kg, and they have 20kg of supplies. How do they get across?

3. How many steps are required to break an m x n bar of chocolate into 1 x 1 pieces? Here m is the number of squares along the length and n is the number of squares across. You cannot break two or more pieces at once (so no cutting through stacks).

From www.mathisfun.com

Brain Teasers

1. **Covent Garden Puzzle:** Mrs. Smith and Mrs. Jones had equal number of apples but Mrs. Jones had larger fruits and was selling hers at the rate of two for a penny, while Mrs. Smith sold three of hers for a penny. Mrs. Smith was for some reason called away and asked Mrs. Jones to dispose of her stock.

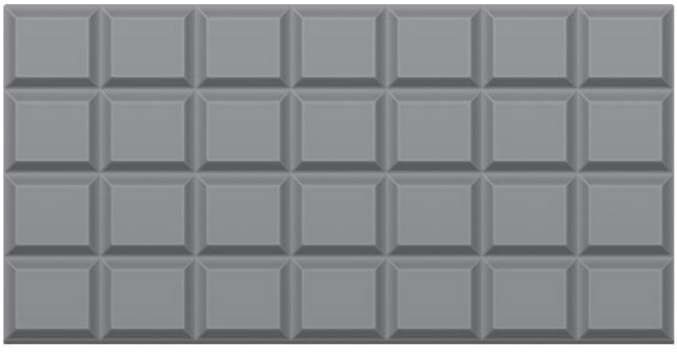
Mrs. Jones mixed them together and sold them of at the rate of five apples for two pence. All were sold but when they came to divide the proceeds they found that they were seven pence short of what they should have got if they had sold them at the original price.

Supposing that they divided the money equally, each taking one-half, the problem is to tell just how much money Mrs. Jones lost by the unfortunate partnership?

From <http://www.mathsisfun.com/aboutmathsisfun.html>

Ans: The mixed apples were sold off at the rate of five apples for two pence with none remaining. So they must have had a multiple of five i.e. 5, 10, 15, 20, 25, 30, etc., apples.

There must have been an even number of apples, otherwise they could not divide up their shares. Suppose there were 10 apples. Then the 5 apples of each could not have been sold at either two a penny



or three a penny, without leaving a remainder (or a fraction of a penny). With 20 apples total, Mrs Jones could get 5 pence for her 10 apples, but Mrs Smith has to sell in threes and she would have an apple left over. If you keep going through the numbers you will see that the minimum number of apples they could have together is 60; so that 30 would have been of Mrs. Smith's that would fetch her 10 (an integer) pence and the other 30 of Mrs. Jones's that would fetch her 15 (also an integer) pence.

When sold separately it would fetch them 10+15=25 pence altogether. But when sold together it would fetch them 60X2/5=24 pence i.e. a loss of one (25-24)=1 pence.

Since they lost 7 pence altogether, they must have had had altogether seven times this number of apples, i.e., 7X60=420 apples. This fetched them only 420X2/5=168 pence so they shared 84 pence each.

But Mrs. Jones could have sold her 420/2=210 apples for 210/2=105 pence so she "lost" (105-84)=21 pence. But without working Mrs. Smith earned 14 extra pence! Not very fair! (Perhaps Mrs. Johns was not very good at math)!

Note that this puzzle can easily be solved algebraically:

Suppose each lady has w apples. They lost 7 pence altogether. Then this loss can be written as w/2 + w/3 - 2(2w/5) = 7. Multiplying throughout by 30, 15w + 10w - 24w = 210. Solving, we have w = 210.

2. Look at the set of three squares in the figure. The angles A, B and C

are marked. Can you show that the sum of angles B and C equals A

(C=A+B)? (Not A=B+C; note error in original question).

Ans: The simplest way to do this is to actually calculate the angles using trigonometry. That is, tan (angle) of a right angled triangle equals the length of the opposite side divided by hypotenuse. Since the angle C corresponds to a single square, it must be 45^o; tan C = 1/1 = 1 or C = 45^o.

Now tan B = 1/2 or B = 26.565^o (using a calculator) and tan A = 1/3 or A = 18.435. Clearly, A+B=C, at least to three decimal places.

To convince yourself that this is exactly true, you can generalise this result by using the formula

tan(A+B) = (tan A+tan B)/(1-tan A X tan B) so that

tan(A+B)= (1/3+1/2)/(1- 1/3X1/2) = 1 = tan C so A+B=C.

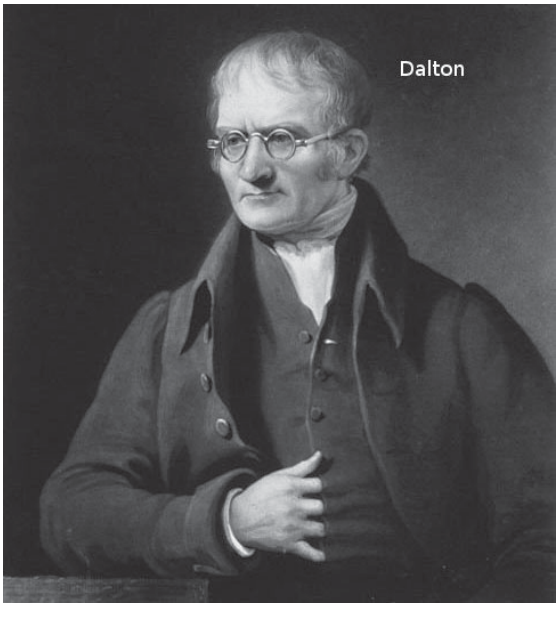
fig2 must come near section called Grammar of atoms

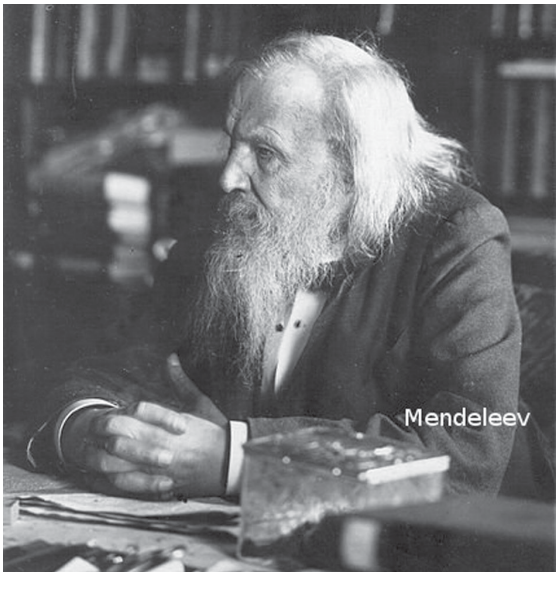
fig6 must come in the box on newlands.

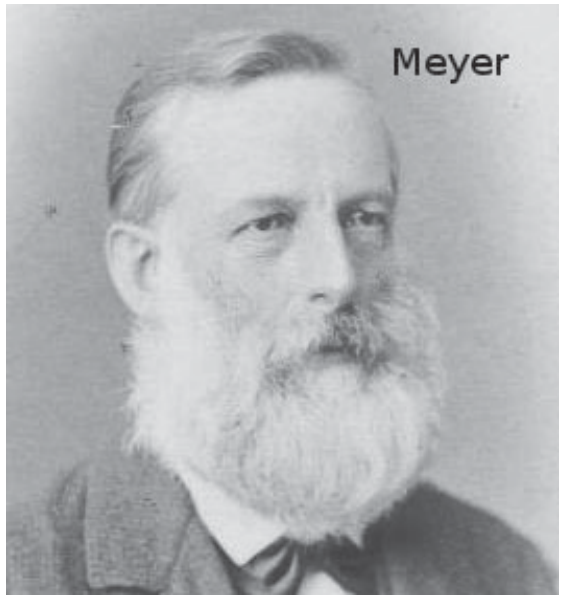
fig7 can come somewhere in the end.

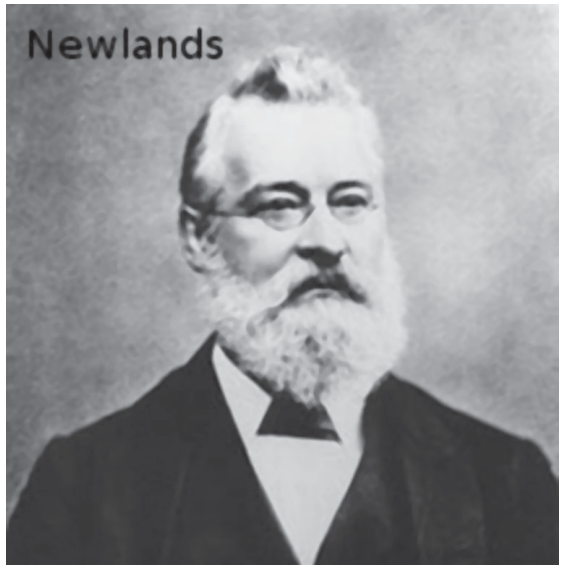
Dmitry Mendeleev: Playing cards with atoms II

M.V.N. Murthy, The Institute of Mathematical Sciences, Chennai









In the last issue of JM we read about **Democritus** who first talked about the existence of atoms, I**saac Newton**, who believed that all matter was made of corpuscles or particles, **Torricelli** and **Robert Boyle** who discovered the absence of air (vacuum) and that air exerts pressure,

and **Lavoisier** who split water molecules into hydrogen and oxygen gas and began the field of chemistry.

However, Lavoisier did not think in terms of atoms. That was left to Dalton.

The grammar of atoms

John Dalton (1766-1844), an English school teacher, was considered an amateur among scientists. To the extent we know, he was the one to revive the word atom again after a long gap from Democritus. They were variously and vaguely called corpuscles, particles, elements etc by others including Newton.

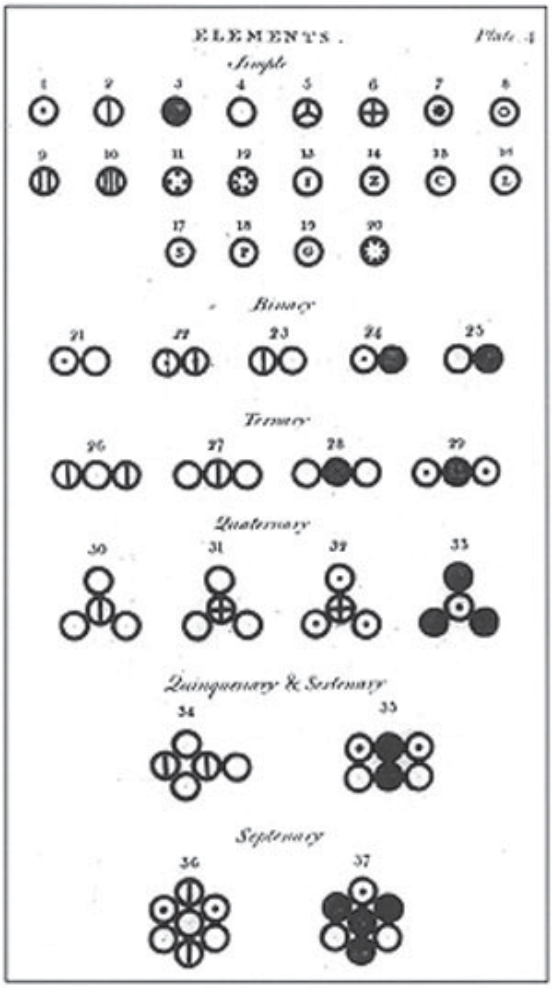
Dalton's atomic theory as we call it today is based on the classification of chemical elements and determination of their weights by Lavoisier. It defines atoms and their properties as well as how different atoms interact.

Dalton made a list of known atoms, a crude version of the periodic table. He also classified "molecules" as *binary*, *ternary* and *quarternary* depending on whether it is a combination of two, three or four atoms.

Various atoms and molecules as depicted in John Dalton's "A New System of Chemical Philosophy (1808)" are shown in the figure (source: Wikipedia).

Unlike Lavoisier he was not very careful with numbers. He got many right and also many wrong. He had the wrong relative weight between hydrogen and oxygen and therefore a wrong composition for water—he thought it was HO and not H_2O. Nevertheless, coming 2,200 years after Democritus, his was a profound discovery.

Journey's end



Finally we come to the end of the journey in the quest for atoms—namely to **Dmitri Mendeleev** (1834-1907)—the man who played cards with the atoms. Mendeleev was born in the Russian province of Siberia. Life was not easy for Mendeleev. He had tuberculosis during his early years, he survived on a diet of sour milk (sort of medical fad).

He first studied and then taught in the University of St. Petersburg until the University fired him for backing the students in a protest. Mendeleev was responsible for

BOX:

Dalton's Atomic Theory:

The main points of Dalton's atomic theory consisted of few simple statements based on the experimental results available at that time including his own:

. All elements are made up of indivisible and indestructible particles called "atoms".

. Atoms of a given element are identical in size, mass, and other properties no matter where they occur.

. Atoms of different elements have different size and different mass.

. As a consequence of their indivisible nature, they can combine only in whole number ratios.

. In chemical reactions, atoms combine, separate or rearranged. The number of different of atoms initially present is the same as in the final product after the reaction.

the periodic table of elements, a modern version of which may be found in every school chemistry laboratory. This revolutionised our understanding of the structure of matter. However, during his life he was subjected to a lot of derision for his periodic table by his colleagues and contemporaries.

Mendeleev started by ordering his atoms by their atomic weights. He apparently enjoyed playing the game of patience, a kind of card game. He did so with atoms as well. He wrote each one of them on cards listing the symbol, atomic weight and properties. Around 1863 about 56 elements were known and many more were being added at approximately one every year at this time. He arranged these cards in increasing order of their atomic weight. In doing so he discovered an important periodic property. He found that the chemical properties of the atoms appeared to repeat after every eight cards—for example the properties of hydrogen (1), florine (9), and chlorine (17) are similar being active gases. Similarly lithium (3), sodium (11) and potassium (19) were all found to be active metals. (Mendeleev put hydrogen together with flourine and chlorine. It is now understood that it is different from them since the latter are what are called electron acceptors.)

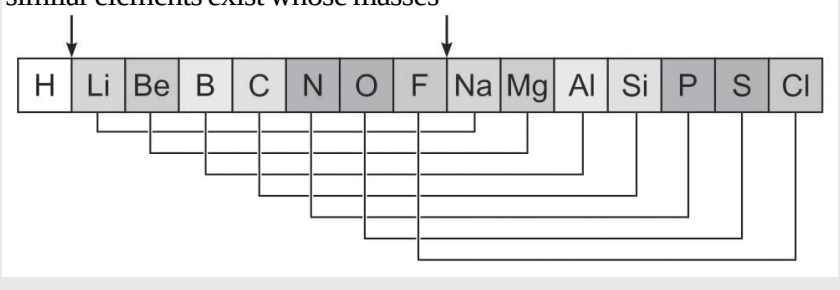
Fill in the blanks!

So Mendeleev started making a table with eight columns. Elements with similar properties were arranged in a column. So below lithium came sodium, potassium, etc. It was not perfect, but he was on the right track. The grid of elements so formed had many empty slots. Mendeleev did something that is revolutionary—he gave names to these blanks even though the element was not known in his time! The blank below aluminium was called *eka-aluminium*, the blank below silicon and boron were called *eka-silicon* and *eka-boron*. These were discovered later and given the names gallium (eka-aluminium), germanium (eka-silicon) and scandium (eka-boron) about ten years after he predicted them. The elements that were known and ordered in 1871 is shown in the figure.

Sometimes there were two missing slots, not just one. For the blank below *eka-* he used the prefix *dvi-* and below that he called it *tri-*. He predicted the existence of eight such

John Newlands and the law of octaves

A similar table was also prepared by **Lother Meyer**, in Germany, with 28 elements, but he did not make any prediction about new elements. However, around the same time John Alexander Newlands, in England, also devised a periodic table based on the "law of octaves", also known as "Newlands Law". He arranged all 56 elements known at that time into eleven groups. He noticed that many pairs of similar elements exist whose masses differ by some multiples of eight. That is, an element will exhibit similar properties to the eighth element following it in the table. He likened this to the octaves of *musical scales*. He also alluded to the existence of as yet undiscovered elements like Germanium. Like Mendeleev he was also ignored and ridiculed by contemporaries and the society of chemists refused to accept his work for publication.



elements. The Sanskrit sounding prefixes that he used, eka-,dvi-,tri-, (these are to be pronounces as eka, dvee, tree) meaning 1,2,3, has a nice history. In using these names Mendeleev was actually showing his appreciation of Sanskrit grammarians of ancient India whose works inspired his periodic table in the first place.

Indian grammar

One of Mendeleev's colleague at Saint Petersburgh, **Otto von Bohtlingk**, was a German *Indologist* and Sanskrit scholar who wrote a Sanskrit dictionary. He wrote a book with German commentary on Sanskrit grammar of **Panini** called *Astadhyayi*. Mendeleev learnt from him about the organisation of Panini's grammar where basic sounds are organised in a two dimensional pattern. We all learn this organisation when we learn alphabets in school—in fact the same pattern or arrangement is used in all Indian languages. All the consonants are written in several rows—kavarga, chavarga, etc. with well-defined relationships between the letters in a row and the letters in a column. These sounds are then combined to form words, sentences etc.

The analogy with the periodic table and phonological table of Panini are striking—just as the sounds in the language is formed out of articulatory properties, the chemical properties of compounds are a function of the atoms that make up the compound. Mendeleev indeed had arrived at the grammar of elements. It was the standard model of the nineteenth century.

Mendeleev died in 1907 in Saint Petersburg. He was never fully appreciated by his contemporaries. He was never awarded the Nobel prize though he was nominated twice.

Reihen	Gruppe I. — R^1O	Gruppe II. — RO	Gruppe III. — R^2O^3	Gruppe IV. RH^4 RO^2	Gruppe V. RH^3 R^2O^5	Gruppe VI. RH^2 RO^3	Gruppe VII. RH R^2O^7	Gruppe VIII. — RO^4
1	H=1							
2	Li=7	Be=9,4	B=11	C=12	N=14	O=16	F=19	
3	Na=23	Mg=24	Al=27,3	Si=28	P=31	S=32	Cl=35,5	
4	K=39	Ca=40	—=44	Ti=48	V=51	Cr=52	Mn=55	Fe=56, Co=59, Ni=59, Cu=63.
5	(Cu=63)	Zn=65	—=68	—=72	As=75	Se=78	Br=80	
6	Rb=85	Sr=87	?Yt=88	Zr=90	Nb=94	Mo=96	—=100	Ru=104, Rh=104, Pd=106, Ag=108.
7	(Ag=108)	Cd=112	In=113	Sn=118	Sb=122	Te=125	J=127	
8	Cs=133	Ba=137	?Di=138	?Ce=140	—	—	—	— — — —
9	(—)	—	—	—	—	—	—	
10	—	—	?Er=178	?La=180	Ta=182	W=184	—	Os=195, Ir=197, Pt=198, Au=199.
11	(Au=199)	Hg=200	Tl=204	Pb=207	Bi=208	—	—	
12	—	—	—	Th=231	—	U=240	—	— — — —

He however received the ultimate honour for a teacher—his students followed the funeral procession upon his death holding aloft the periodic table, the chart that adorns every chemistry class room. Now we have a a crater on the Moon named after him. Element number 101 is named after him, *mendelevium*.

The periodic table today

The modern periodic table has grown since Mendeleev's time. Now we have 118 elements arranged in a more modern way though the basic idea of Mendeleev pervades the arrangement.

This was the standard model of elementary particles of 19th century. All matter was made up of indivisible atoms. As long as only chemical reactions are involved this is indeed the end of the story.

The discovery of electron and nucleus in the beginning of 20th century started yet another inward-bound journey. The understanding of the structure of the nucleus required new types of interactions. The new periodic table, the so-called standard model, had to wait another century to be completed. In fact the last piece of the new periodic table, namely the Higgs boson, has just been discovered after almost exactly 100 years after the discovery of the nucleus by Rutherford. Will there be another standard model a century later?

Acknowledgement: This article is partly inspired by the beautiful book "The God Particle—If the universe is the answer what is the question?" by **Leon Lederman** along with biographical accounts of various people as given in Wikipedia.

Two elephant are about one km far from each other. They are talking to each other; Yet, if you stand between them you will not be able to hear their talk. Surprised? Yes incredible but true.

Elephants trumpet for all to hear; but they too make noise at much low frequency that are not audible to human ear but can travel longer distances. Such sound is called infrasound and they are one of the hot areas

of scientific research today.

In fact in most cases what we feel as muted tranquillity is in fact too noisy. Earth is an incredibly noisy place. Of course the noise is infrasounds that are inaudible to our ears.

Infrasound

Like all types of sound, infrasound also travels in waves. Waves in sea or lake at times are bigger and at times smaller. In like manner, sound waves can have different heights (called amplitudes) Higher waves mean louder sound and small waves implies softer sound. Sound waves also have different wavelengths, measured from the crest of one wave to the top of the next. And they have different frequencies, measured by the number of crests that pass by a particular position per second.

Infrasound- sound of silence

T V Venkateswaran
Vigyan Prasar

Short, rapid waves make high-pitched sounds, like a whistle. Long, slow waves make low-pitched sounds. For example in Mridangam (a double sided drum) the side with very small skin generates high pitched sounds and the other, wider, for low pitched sounds. Below the lowest note on Mridangam, below what people can hear, there's infrasound.

Infrasound is created when something sets a large amount of air in motion. The resulting sound waves travel through the air, sometimes for thousands of kilometres.

Studying Infrasound

Scientists originally started studying infrasound to eavesdrop on the secret nuclear explosions. During the nuclear explosion the sound that is generated will travel to many kilometres but the infrasound that is generated travels many thousands of kilometres. Therefore sitting in faraway counties one could monitor the secret nuclear explosion. This was done using infrasound arrays that can detect blast waves from thousands of kilometres away. One such array is shown in the inside back cover.

Recently scientists have understood that not only nuclear explosions but many natural events, in particular natural disasters, are accompanied with infrasound. Avalanches roar down mountains, volcanoes rumble, and hurricanes blast through coastal areas. All these natural phenomena are found to generate characteristic infrasound.

The massive earthquake that occurred off the coast of Indonesia in December 2004 bringing destruction to south India produced infrasound that had been recorded at the lab in the University of Hawaii. As seen from the figure the infrasound waves arrived about three hours after the seismic ones (this is a recording at Diego Garcia, an island south of India but was also recorded all over the

world).

Infrasound to our rescue

Scientists have picked up infrasounds from two more tsunamis during 2006 in the pacific ocean. To study the phenomena systematically the researchers have recently set up a tsunami infrasound project in Hawaii. The scientists hope to learn how the giant waves produce infrasound, which is currently a mystery. By monitoring the infrasound would it be possible to forecast the onset of Tsunami?

Scientists are also using infrasound to listen in on volcanoes. For example Sakurajima volcano in Japan, when it erupted in 1998, stronger infrasound signals became stronger and stronger. Scientists are hoping to use infrasound patterns to warn people if a nearby volcano is about to blow. Infrasound gives researchers a more complete picture of how volcanoes work. Infrasound produced by hurricanes and thunderclouds are also part of research effort to forecast and forewarn in the likelihood of natural disaster. Other researchers are using infrasound to detect avalanches, the northern lights, ocean waves, bumpy air that causes airplane turbulence, and mountains shaking from earthquakes.

Animal calls

While people are deaf to infrasound, other animals appear to use it to communicate. When elephants trumpet, for example, they also produce infrasound that can reach other elephants as far as 10 kilometres away. Other researchers have suggested that whales, rhinos, and big birds called cassowaries can create or pick up infrasound. It is believed that even some dinosaurs might have had this ability.

Recent studies have indicated that though human ears cannot pick-up infrasound directly, people can detect infrasound in special ways. In one experiment, researchers in England played infrasound during a music performance. Although listeners were not able to hear the super-low notes, they seemed to have stronger emotions during the performance than did people who heard music without infrasound. In like manner when sound of roaring tiger was played it created an emotion of fear; so was the case when only the infrasound was filtered and played back. Emotion of fear was less when the sound was played without infrasound. Possibly infrasound played a part in human evolution to warn of the dangerous wild animals in the past. Today scientists are proposing to use the very same infrasound to predict natural disasters and protect us from the potential damage.

. fig1 near top of article

. fig2 and fig3 where Tughlaq is mentioned

. fig4 where Akbar/Salim is mentioned (full page pic)

. fig5 where Akbar/Salim is mentioned

. fig6 and fig7 close together near end

. fig8 near bottom of article

Daawat and Khaana

Kamal Lodaya, The Institute of Mathematical Sciences, Chennai

In *Jantar Mantar*, we have looked at how wild "goat grasses" like wheat and rice were developed

by farmers over the last 15,000 years, after the last Ice Age was over, into the major food crops that the world grows today. We also looked at the plants which give us *dals*, oils and spices. Almost 2500 years ago the Jain religion was preached by Mahavira. It influenced the Hindu Brahmins into giving up meat and becoming vegetarians. This was made possible by the fertility of the soil, the variety of plants developed and the profusion of dishes invented.

We should not imagine that all Indians were vegetarians.Abu al-Rayhan Muhammad ibn Ahmad al-Biruni, an Uzbek scholar, was taken to Ghazni by Mahmud, the raider prince. An imaginary rendition of Al Biruni on a 1973 Soviet post stamp is shown in the picture. Mahmud took al-Biruni to India on one of his raids and he spent many years in the north of India (perhaps from 1017 to 1030 CE), and later wrote a famous book of travels called the *Kitab tarikh al-Hind*. He may even have learnt some Sanskrit.

In his book Al-Biruni says that the rules which do not allow animals to be killed applied only to the Brahmins, because they were the guardians of religion. Other castes did not face this prohibition.

Kings were certainly those who relished meat. At a feast of King Someshvara of Kalyana (in Bidar district of Karnataka) a pig was roasted whole and carved to yield

portions called *sunthakas*, minced liver shaped into balls and strips of bacon marinated in curds and spices.

The early Muslim raiders like Mahmud Ghazni and Muhammad Ghori were interested only in looting, but from the 13th century CE they settled down in north India and began to rule as Sultans. While the ingredients of our cooking did not change much under the Muslim rule, what changed were the styles of cooking, and what changed dramatically were the elaborate table manners for serving meals.

Here is Al-Biruni writing (long before the Delhi Sultanate):

The Hindus eat singly, one by one, on a long tablecloth made of dung. The earthen plates from which they have eaten are thrown away after the meal. They have red teeth on account of eating areca nuts (supari) with betel leaves (paan) and lime. They drink wine before eating anything.

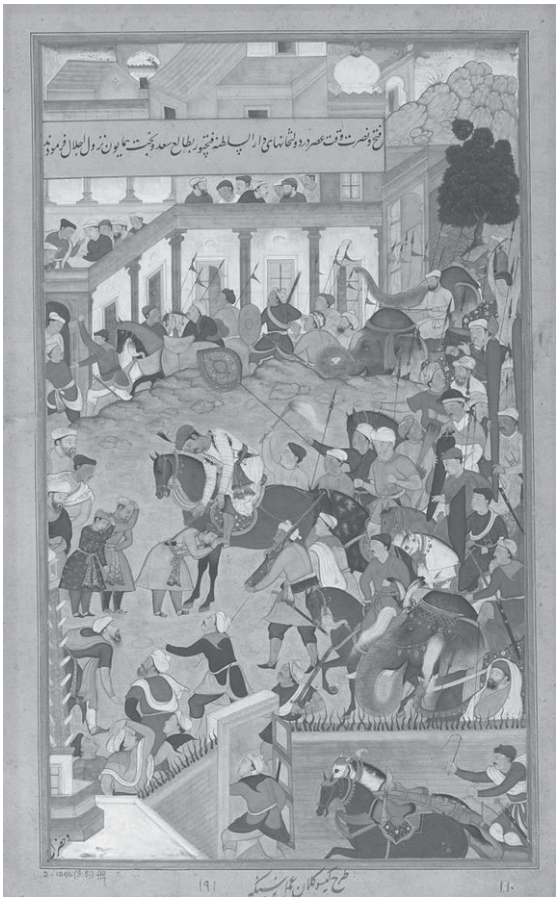
They sip the stall (urine) of cows but do not eat their meat.

Al-Biruni was sympathetic to the prevalent practice of not eating beef. He pointed out the many uses to which cows and oxen were put to.

A later traveller, Abu Abdallah Muhammad ibn Abdallah i-Lawati t-Tangi ibn Batuta, came to India all the way from Morocco, and lived here from 1335 to 1345 CE while the sultan Muhammad bin Tughlaq was ruling. Tughlaq made him a *qazi* (judge), but he says it was possible to enforce Islamic law only in Delhi, the capital of the sultanate. In his book *Rihla*

(travels) is his description of one of the sultan's dinners:

The *qazis* (judges), *khatibs* (orators), *shorfa* (jurists), *saiyids* and *dervishes* (saints) sit at the head of the dinner carpet. Then come the Sultan's relatives, then the *amirs*



(noblemen) and then the rest of the people. Everyone sits at his appointed place, there is no confusion among them. The cup-bearers come holding in their hands gold and silver and copper and glass vessels filled with sherbet, which they drink before the dinner. As they drink the chamberlains call out "Bismillah", then the eating begins. Every one has a set of dishes before him from which he eats alone, no one shares his plate with another. When they finish eating the *fuqqa* (a sherbet based on barley water) is served and as soon as the people take it, the chamberlains call out "Bismillah". Then are brought trays full of betel leaves and pounded spices (*paan*), everyone is served with 15 *paan* tied with a red silk thread. As soon as the people take the *paan* the chamberlains call out "Bismillah". Then the whole gathering gets up, the *amir* (noble) supervising the feast bows to them, and they bow too.

This was the "public" dinner where a hundred people might be invited. Even at the "private" dinner where the Sultan himself ate, there would be about 20 people. If the king wanted to honour a particular guest, he would place some *naan* or *roti* on a plate and give it to the person. The recipient would hold the plate in his left hand and would bow with his right hand touching the ground.

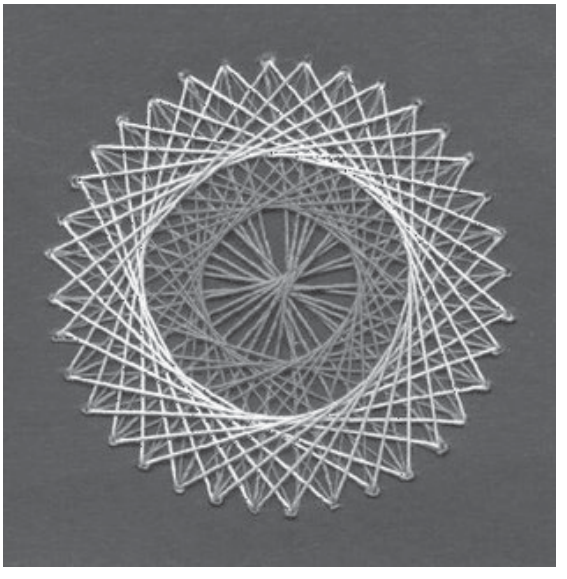
Although the dinner was very sumptuous it was meant for the guests. The king might not

eat everything. The Mughal emperor Abulfath Jalaluddin Muhammad Akbar (16th century CE) was nearly a vegetarian since he did not like meat. Almost 40 courses might be served in the meal but the emperor might only eat half a dozen. Akbar had a passion for growing fruits, especially mangoes.

Akbar's son Salim Nuruddin Jahangir (17th century CE), on the other hand, was always curious to try anything new. He ate the meat of mountain goat, wild ass, antelope, whatever was brought to his table. On the days he did not eat meat (Fridays) his favourite food was *lazizan*, a Gujarati *khichdi* with pista, raisins and spices. He also liked *falooda*, a rich drink made from boiled wheat strainings mixed with fruit juices and cream. The picture shows Akbar welcoming his son Salim from the Akbarnama.

This was very far from what the poor Muslim would eat at home: *naan* with *kheema* (minced mutton), or rice with onions seem to have been the main meals. Hindu cooks used onions very sparingly, the popularity of the onion in Indian cooking dates back to the Muslims. Hindu meals either had fried *puris* or *bhaturas* with vegetables, or they might have had rice and dal, or just *khichdi*. Very poor Hindus might eat boiled rice with a little green ginger for taste.

Some people wrongly believe that *pulao* is an invention of the Muslims, in fact, it is found in Sanskrit texts. The *Ramayana* says that Sita's favourite food was *pulao* with deer meat. But the *biryani* comes from Muslim cuisine, here the meat is cooked until it almost disintegrates and becomes part of the rice. The Muslims also refined the practice of eating meat cooked on spits over an open fire (again described in the *Ramayana*) into the making of delicate *kababs* and mince cutlets.



Curves from lines
D. Maya, Chennai

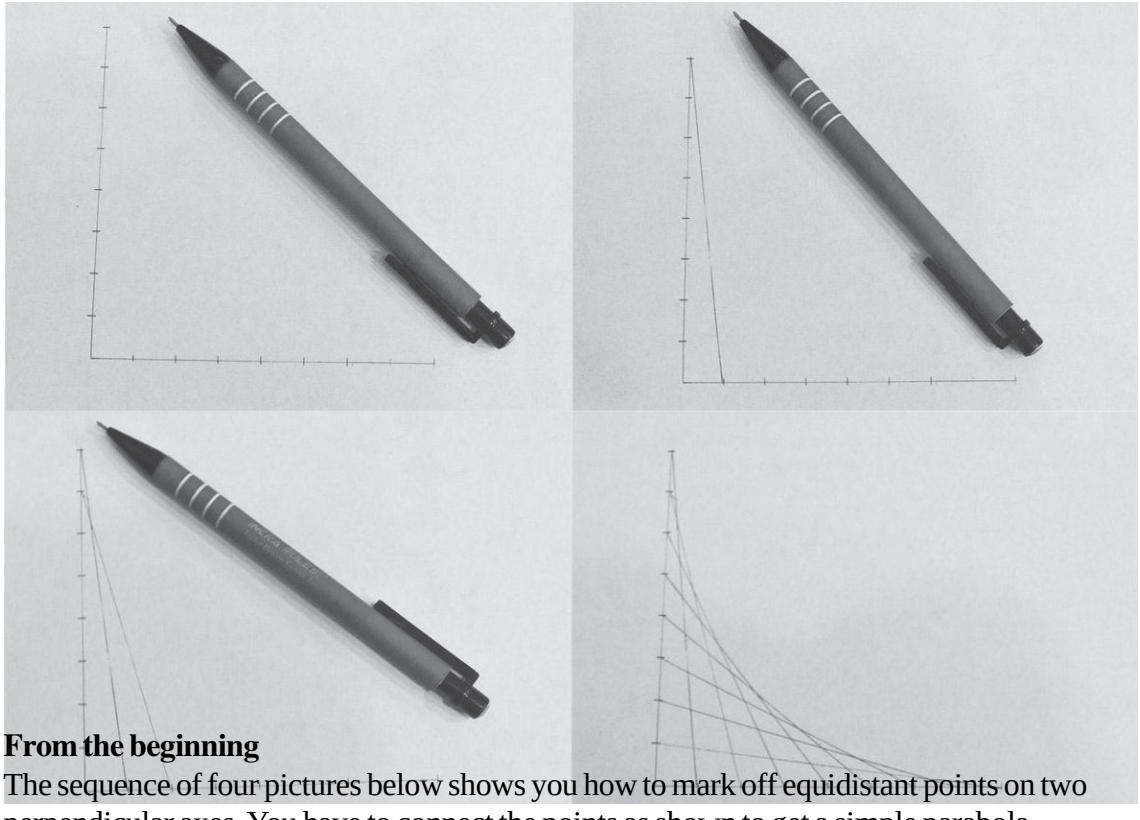
Curve stitching is a form of string art where smooth curves are created through the use of straight lines. A bunch of nails are hammered into a wooden base and coloured string is used to make lovely geometric designs. By making use of the height of the nails, patterns can be woven over patterns, giving a 3D effect. People have also used trees and ropes to get curves from nature!

But you don't need to go rushing off to buy hammer and nails. You can make the artwork with paper, pencil, ruler, and a very steady hand! I had a lot of fun making many of the designs that are shown here, but you need to have a clearly marked ruler and you have to be able to place the dots accurately to get the really awesome ones.

Most of those shown in this article use a set of straight lines to get a curve called a *parabola*. It doesn't matter if you don't know what a parabola is; all you need to know is how to draw straight, neat lines with ruler and pencil. Once you do that, a parabola will pop up and you'll know what that shape is! A lot of string art is available on the internet and I took many of the pictures from a site called MathCraft, http://mathcraft.wonderhowto.com

Actually, if you have seen water gushing out of a hole in a pipe (or your water bottle) that shape is a parabola. In fact, just swirl the water in a bucket with your hand to get a 3d-parabola. The curious thing is that we drew all these shapes in school with just straight lines but they all come together and form such beautiful curves. Amazing, isn't it?

Just follow the instructions, and enjoy!

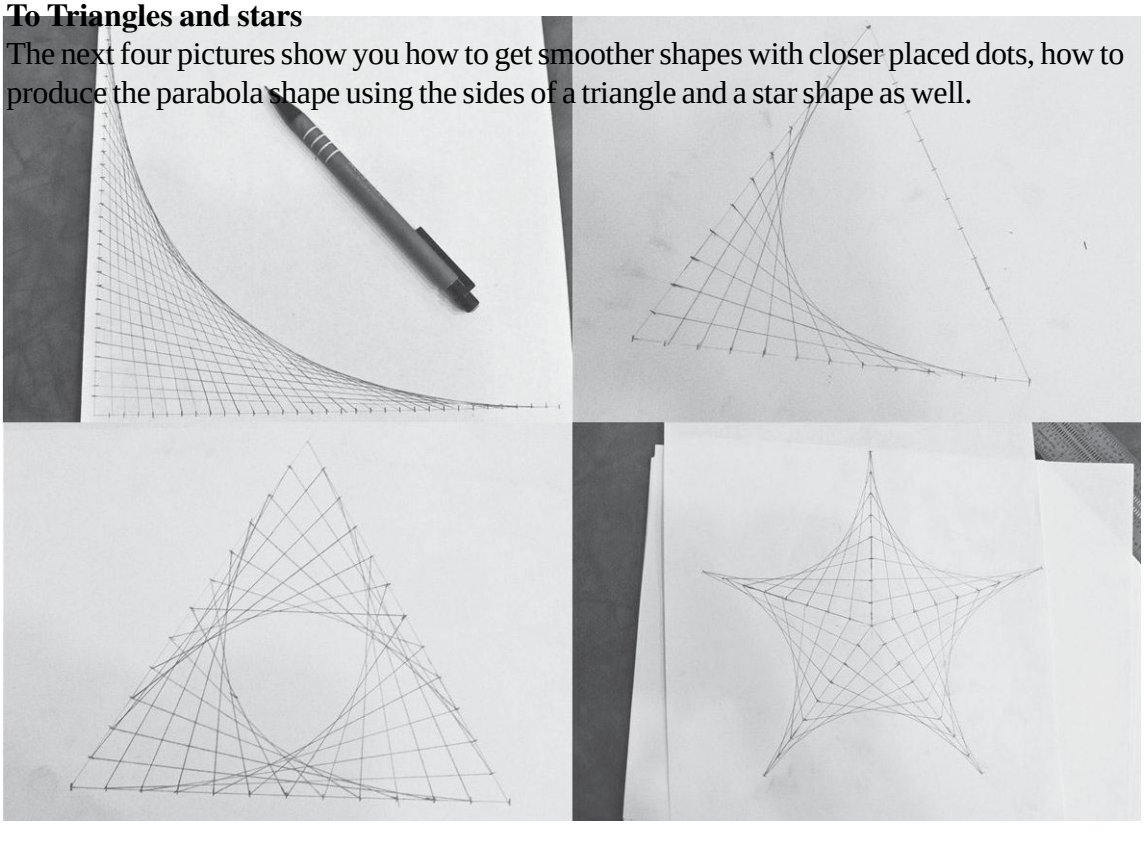


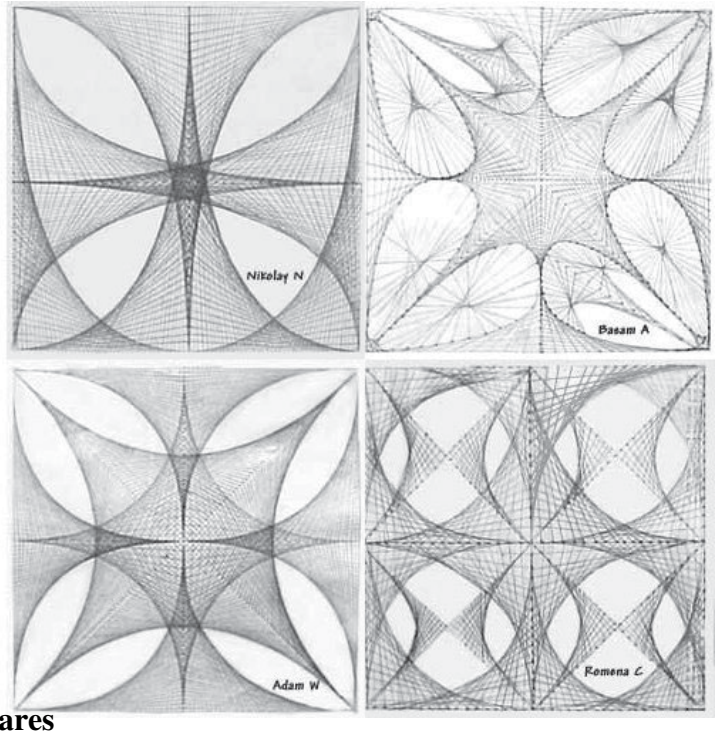
From the beginning

The sequence of four pictures below shows you how to mark off equidistant points on two perpendicular axes. You have to connect the points as shown to get a simple parabola.

To Triangles and stars

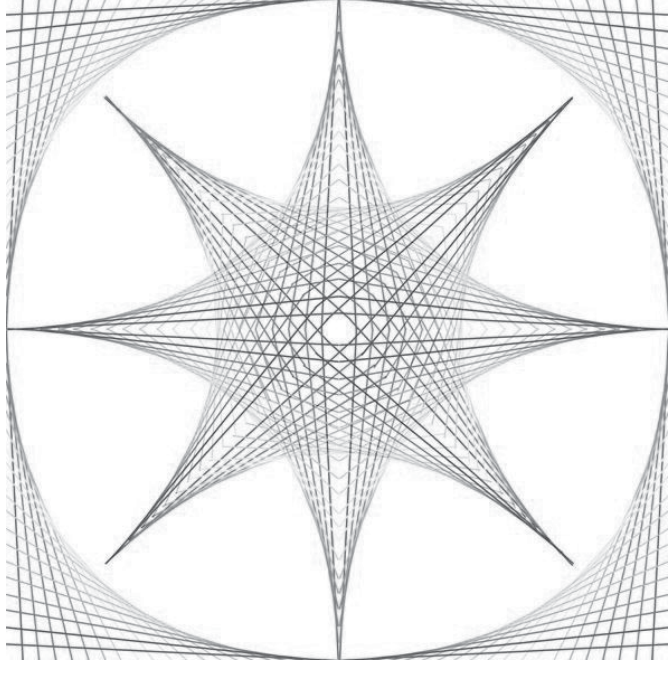
The next four pictures show you how to get smoother shapes with closer placed dots, how to produce the parabola shape using the sides of a triangle and a star shape as well.

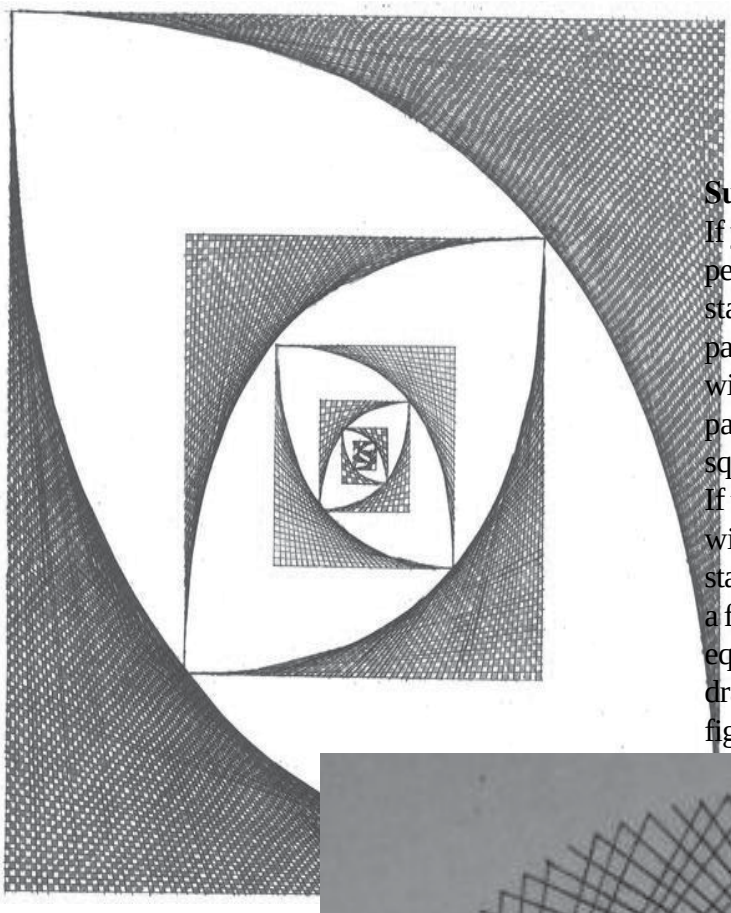




And then to squares

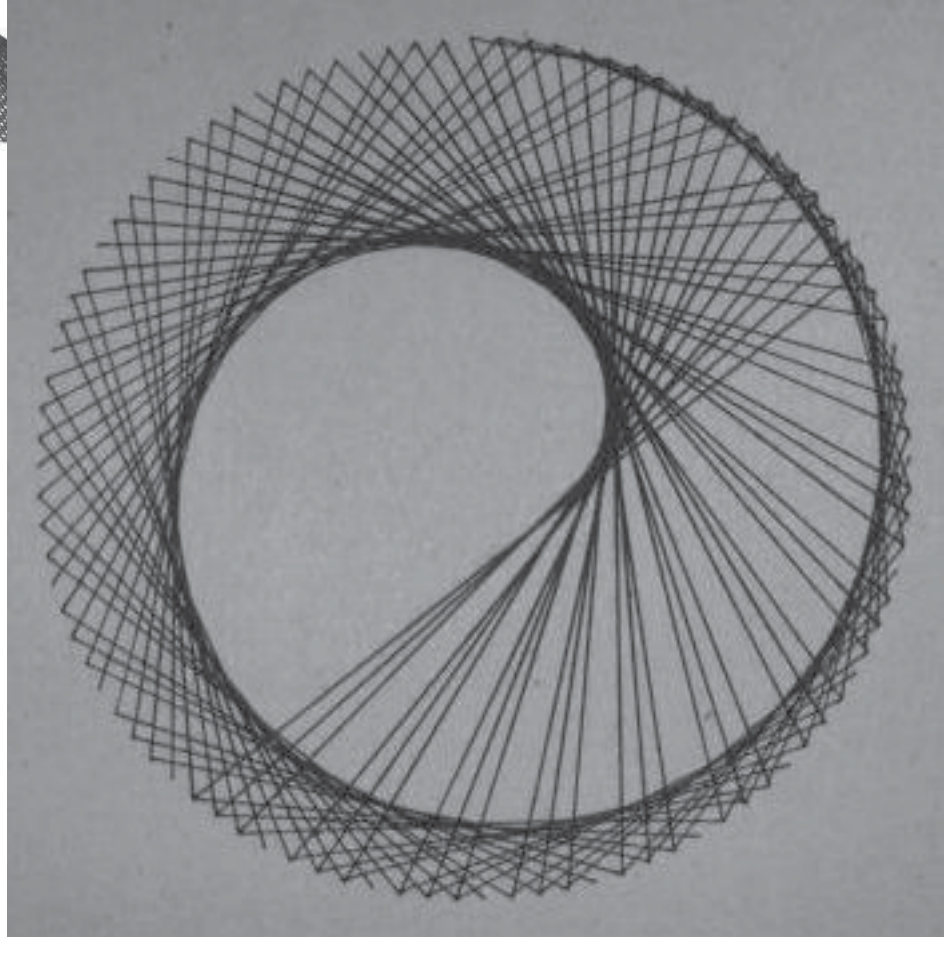
The next set of pictures show the pattern repeating, but this time enclosed in a square. Patience is required to get that densely filled effect, but the results are worth it (from http://www.mmwindowtoart.com).





Super figures

If you are confident, use colour pencils or ink pens for a really spectacular effect. Try the star in a circle where you draw the two parabolas from a common vertex of the "star" with two different colour pencils. The two parabolas from the same outer edges of the square are also drawn with different colours. If this works, try the square-inside-a-square with the "eye" effect! If you are tired of starting with lines and angles, try starting with a free-hand curve. Mark off points equidistant on it. Make sure that you always draw the lines in the same direction or the figure will not come out right.



Do You Know?

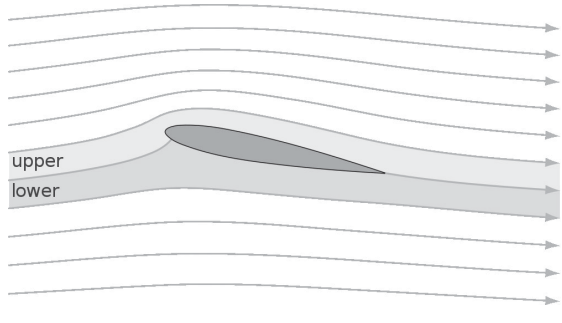
1. I have heard of the dance of bees, but how do ants know to gather in large numbers when one of them, presumably, has discovered a tasty bit in our kitchen?
2. What would we see if we had glasses that converted sound waves into light waves?
3. What causes or inhabits the black cracks that form on old, infrequently used bars of soap?
4. Why is it that on the surface of an apparently homogenous potato a new sprout bursts forth? Is there something special at that point?
5. My birthday cake had some "trick" candles on it that I couldn't blow out, however hard I tried. How do these work?
6. Why is it warm in the hay? Can it actually catch fire on its own?

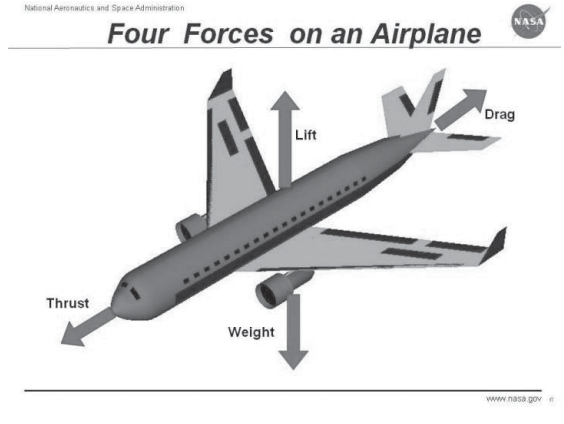
Answers to last issue's Do You Know?

1. How do planes fly?

Ans: Four forces keep an aeroplane in the sky. They are lift, weight, thrust and drag.

Lift pushes the aeroplane up. The way air moves around the wings gives the aeroplane lift. The shape of the wings helps with lift, too. The aeroplane's wing is shaped (called an aerofoil) so that it takes a longer time for the air to travel under it than above. This is because the air approaching the wing prefers to sweep past it without breaking up (these are called streamlines). Since the wing is shaped flatter below, the distance the upper part of the streamline has to travel is more. To "keep up" with the lower part, it therefore travels faster over the top than the bottom. As air speeds up, its pressure decreases. This is known as Bernoulli's principle. So there is more pressure below the wing and less above. This leads to an upward push or lift that causes the plane to lift up into the air. Both the angle and shape of the wings





are very important. Just imagine, some puffs of air that hardly weigh anything can push up a few hundred kilo aeroplane with this lift!

Thrust is the force that moves the aeroplane forward. Engines give thrust to aeroplanes. Sometimes an engine turns a propeller. Sometimes it is a jet engine. It does not matter as long as air keeps moving over the wings.

Weight is the force that pulls the aeroplane towards the earth. Airplanes are built so that their weight is spread from front to back. This keeps the aeroplane balanced.

Drag slows the aeroplane. You can feel drag when you walk against a strong wind. Aeroplanes are designed to let air pass around them with less drag. The thrust and lift are the forces that move the plane forwards and upwards while the weight and drag slow it down. An aeroplane flies when all four forces work together. But, most aeroplanes need one more very important thing: they need a pilot to fly them! So please do not forget the important control element!

Source: NASA

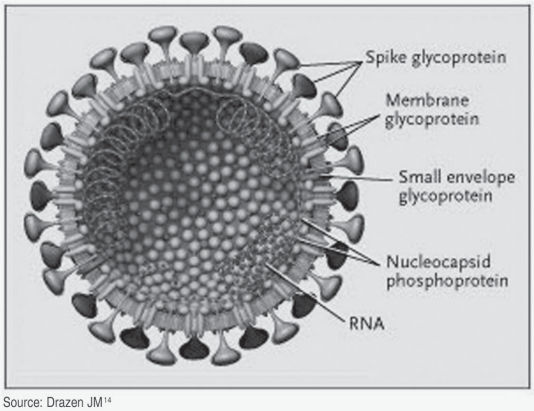
2. What is the world's most dangerous animal?

Ans: Typically when this question is asked, children guess sharks, lions, or grizzly bears as the answer. Try bats!

When new infectious diseases are discovered, one of the first questions is, —where did this come from? More often than not, the answer is one of our animal friends—a kind of disease called a zoonosis. Studies have shown that about 75 percent of emerging infectious diseases (diseases that are newly discovered, are increasing in frequency, or have moved into a new geographic area) are of animal origin, as are 60 percent of all known pathogens (those that lead to diseases). Even diseases that have spread freely in the human population, such as tuberculosis, HIV, measles, and smallpox, have their roots in infections carried by animals.

Which animals are the most likely to carry these

Schematic drawing of SARS coronavirus



Source: Drazen JM[14]

"pathogens"?

For reasons that are not currently understood, bats are able to be infected with a huge variety of viruses. They pass these viruses to other animal species via bites. The classic bat-origin virus is rabies, but bats have also been implicated as possible carrier species for the Ebola and Marburg viruses, Nipah, Hendra, and others. Even influenza has recently been found in bats. Bats also appear to be the carrier for the SARS virus, which surfaced in 2002 in Asia. SARS eventually infected more than 8,000 individuals around the world and killed almost 800 of them between November 2002 and July 2003, spreading to at least 37 countries. A new SARS-related virus has recently surfaced in Saudi Arabia, and speculation is that it's also from bats.

While bats appear to be responsible for a disproportionate amount of novel pathogens, every

animal species carries its own unique microbiota — the collection of microbes that live on in an animal's body. Some of those can also spread to humans. As mentioned above, birds can spread many different types of influenza viruses. In fact, wild waterfowl serve as the ultimate reservoir for all known types of influenza viruses. Birds also can transmit a number of encephalitis viruses, such as West Nile. Because many migrate long distances, birds may be particularly efficient at introducing pathogens into new areas.

Please note: while we often consider humans the victims of such pandemic events, that's not always the case. Humans can also spread our own native microbes to other species. Recent studies have shown that humans have spread antibiotic-resistant strains of Staphylococcus aureus to many different species, including domestic chickens, pigs, and even chimpanzees and dolphins. We, too, are a walking biohazard! Many would say that humans are the most dangerous animals, since we kill of a great many organisms, wipe out many species, and have simply taken over the Earth!

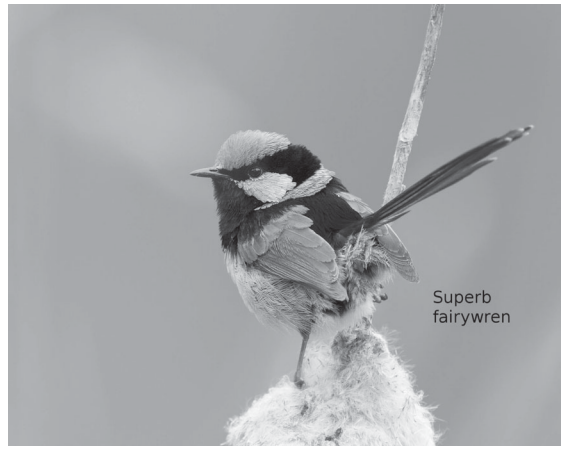
Source: New Scientist

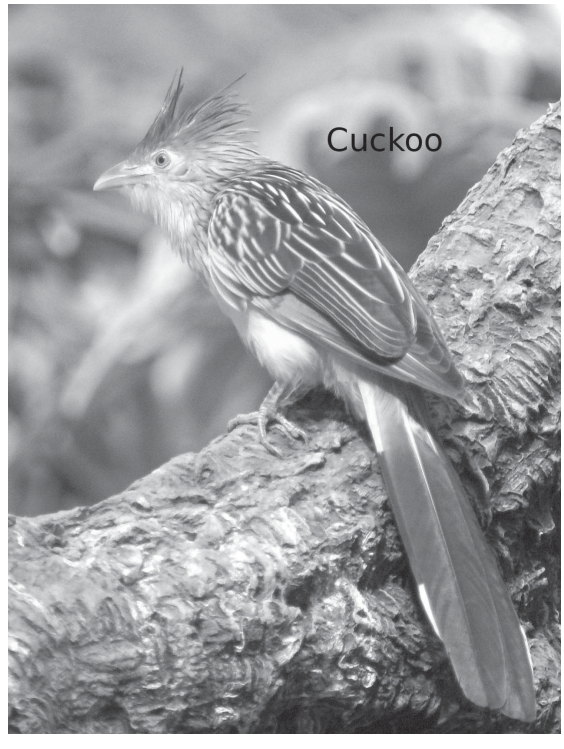
3. Can singing birds learn to sing new tunes?

Ans: This is a very interesting question, and some researchers say, yes, and point to the Australian superb fairywren, which seems to have developed a call that seems to have been learned. In a neat trick, it tells its fledgling warblers from intruders by their begging calls. If its trill isn't right, the hatchling goes hungry. This is their evolutionary response to cuckoos which lay eggs in their nests. Cuckoo eggs mimic those of the host. And cuckoo chicks, which grow rapidly and have quite an appetite, sometimes push the legitimate nestlings out.

Australian researchers stumbled on the answer after studying the wren's 15-day incubation cycle. They noticed that the mother would typically start singing to its unhatched brood on day nine or ten and stop whenever the eggs hatch (cuckoos' incubation cycle is a few days shorter than wrens' is). A tiny microphone tucked inside 22 nests picked up the incubation calls. When these were later compared to the warbler's chirping the two notes turned out to be almost identical. The female uses the same note to solicit food from its pair-male, in effect teaching it too the unique "password".

Researchers then concealed loudspeakers inside





a few nests to play back the nestlings' begging calls. Parents would swoop down to the nests with food only if the replayed calls matched those of their brood. Otherwise, they abandon the nest altogether. This was suggestive, but not enough to rule out that the mother's chirping matched its offspring's because it stemmed from one genetic source. So the researchers swapped around the eggs in eight nests, while leaving another seven nests untouched to serve as a control. Sure enough, hatched chicks were found to reproduce the tune taught to them by their nest mothers — whether biological or not. In other words, the song is learned.

Why, then, do fairy wrens succeed in spotting the infiltrator just 40% of the time? Cuckoos, it turns out, have developed an additional trick. Cuckoo hatchlings try a few random chirps before settling on the one that works. This trial and error has a chance of success because, in order to avoid too many false negatives, parent wrens will give chicks a number of attempts to get the tune right before abandoning the nest. And so the arms race goes on!

Source: Current Biology

4. In theory, how fast would your average human have to wave her / his arms to remain airborne?

Ans: No frequency would help because arms have the wrong form. A bird can't fly if you cut four or five important feathers, however fast it flaps its wings, it has just to wait until they grow again.

Big birds flap their wings slower than most small ones. Often they just glide, not waving their wings at all.

A human can remain airborne for quite a time with the help of a hang-glider, which doesn't flap either.

You could try some calculations anyway. In principle you could become airborne by moving your hands down with palms facing the ground and upwards with palms vertical. That way there would be a net displacement of air downwards and Newton's third law would give you lift, but it would be hopelessly

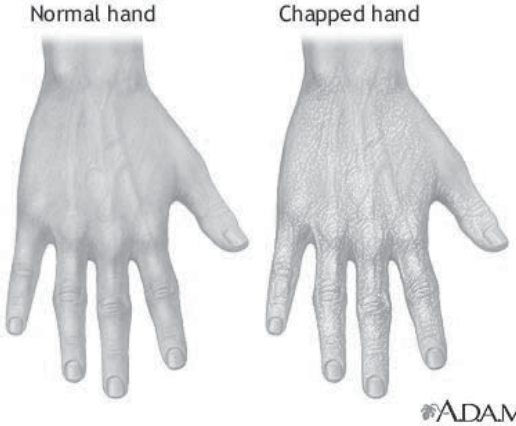
inefficient compared with an aerofoil, and your hands are the wrong shape anyway.

Say the area of both palms minus the area of both hands side-on is 100 cm^2 = 0.01m^2. You weigh 80kg = 800N and you're getting net lift half the time (the half cycle when your hands are moving downwards). Air density is 1.3 kg/m^3 at sea level. Then the minimum velocity of your hands to achieve lift-off is square root of (1600/0.012)=365m/sec, which is slightly more than the speed of sound. Not much hope, is there?

Source: New Scientist Forum

5. When I went to Delhi, the cold weather made the skin on my hands so dry that it split. Why does this happen?

Ans: Air at a given temperature can hold only a certain amount of water vapour: the colder it is, the less it can hold. In cold weather, this saturation level is so low that there is very little water vapour in the



air, even if the relative humidity (the ratio of the amount in the air to the saturation value) is high.

The rate of evaporation from a moist surface depends on the difference between the concentration of vapour in the air right at the surface and the concentration in the bulk of the air. The former depends on the temperature of the moist surface: in the case of your skin, it is warm even in cold weather, whereas the vapour concentration in the bulk is low in cold weather. So evaporation takes place at a higher rate than in warm weather.

This is true even in a heated room, because heating the air that has come in from outside does not increase its water vapour content. Humidifiers can add water, but they consume a lot of energy. (Large buildings sometimes have systems that can transfer water between incoming and outgoing air, which are more energy-efficient.)

Though water evaporates faster from your skin in cold weather, your clothes drys more slowly. Because it is not heated by your body as your skin is, the level of water vapour right at the surface is quite low, so the rate of evaporation is low too. So if you want your clothes to dry quickly, just wear them!

So the physical properties of the air are largely to blame but our own biology plays a part too. When we are cold the blood flow to extraneous parts of the body (such as the skin, hands and feet) is restricted. This will naturally take some of the life out of our skin as it is prevented from receiving replacment water and nutrition from the blood. The movement of our fingers will also feel sluggish and painful until a few fist-clenches revive the blood flow. In extreme cold, parts of the skin (as well as fingers and toes) may be completely cut off and effectively die, something which no amount of skin cream can cure.

Source: New Scientist Forum

Science News

Headlines

. Genetic memory: DNA as computer memory

. Shrinking ice sheets contribute to rising sea levels

. Animals respond to chemical messages

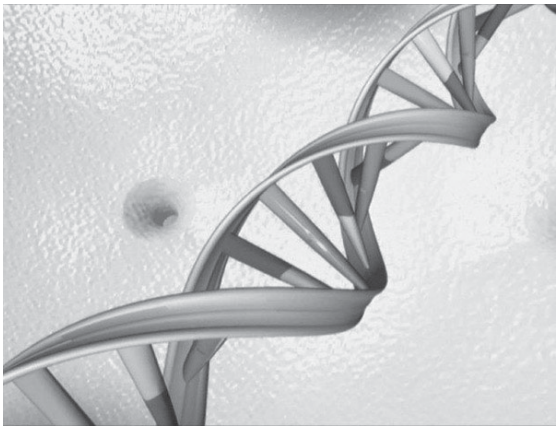
. Sleeping in space: preparing for a journey to Mars

. India's air among the world's unhealhiest

. Cats may pose the single greatest threat to birds

. There is indeed ice on Mercury

Read more about some of these below.



Genetic memory: DNA as computer memory

DNA can be found in nearly every cell of every living thing. The molecule is a chemical blueprint that effectively instructs cells on how to work. If holding the blueprint of life isn't impressive enough, consider this: Scientists have now shown that DNA also offers a good way to store data.

In the Jan. 23 issue of the journal Nature, European researchers showed how DNA could be used to store different types of information. These included text files, an image, even an audio recording. And DNA may even work better than magnetic tape, which is currently used to store large amounts of data, the new study finds.

For their new device, the European researchers didn't use DNA from a living organism. Instead they created a synthetic, or lab-built, mimic of DNA.

You might think of these DNA-based storage systems as futuristic thumb drives. But never fear: The new findings don't suggest some version of these will ever involve your actual thumbs. The researchers are merely using the structure of biological materials in your thumb—and other parts of your body—as inspiration for new devices. These lab-built DNA systems could one day beat the data-holding ability of DVDs and electronic storage devices.

A DNA molecule looks like a twisted ladder with rungs made from pairs of molecules known as nucleotides. Key chemicals in DNA nucleotides are represented by the letters A, T, C and G.

The researchers used their lab-built DNA to store such things as a photograph and a text file with all 154 sonnets penned by William Shakespeare. Another file stored on the new DNA included a 26-second audio excerpt of the famous "I have a dream" speech by Martin Luther King, Jr.

The storage process had many steps. First, the researchers converted their files into computer code. Then, they translated that code into another code. This one used those A's, T's, C's and G's from DNA. The researchers sent that code to a laboratory in Santa Clara, Calif. Scientists there built billions of new strands of DNA based on the code, putting every A, T, C and G in its place. The lab then sent the DNA to the researchers in a small test tube.

To test their technology, the European researchers sequenced the DNA. That means they figured

out the coded order of nucleotides. The DNA recordings came back without any errors. That means those files were translated perfectly into DNA and back again.

The information is remarkably compact, which means it takes up little space. For instance, one of those Shakespeare sonnets, the researchers estimated, could be stored in less than a trillionth of a gram of DNA. DNA is also compact, lightweight, and can potentially remain intact for thousands of years if stored in a dark, cool environment.

Especially important, the new technology might avoid a potential problem that all storage devices experience today: quickly becoming outdated. Data stored on old tape formats like Betamax are all but unreadable because the machines needed to read them are no longer widely available. (Another tape format, VHS, replaced Betamax. DVDs have since replaced both of those.)

But human beings are never going to stop caring about DNA! Because people will always want to be able to read DNA, future devices should always be able to read the files stored on it.

The technology isn't new (it was reported last year) but it is getting cheaper to use, say the authors of the new study. They project that within 10 years or so, DNA-coded information may offer a reasonably priced way to store digital data for decades or longer.

Shrinking ice sheets contribute to rising sea levels

When an ice cube melts, it creates a puddle. When an ice sheet melts, it raises sea levels. It sounds simple, but scientists have debated for decades whether both the Antarctic and Greenland ice sheets actually were shrinking—and how much that melting contributed to rising sea levels.

Now, a new study has provided the best evidence yet of how the polar ice sheets are responding to our

warming world. In the study, published in November, an international team of scientists looked at 20 years of data on the ice sheets, collected by 10 satellite missions. The team's conclusion? The Greenland and Antarctic ice sheets both are losing ice overall. The researchers also found that between 1992 and 2011, meltwater from those shrinking ice sheets caused sea levels to rise by about 11 millimeters or just over a centimeter. That's just the contribution from the two ice sheets, though. In all, the ocean rose about five times as much during that period.

Over the 19 years studied, the Greenland ice sheet lost 2.7 trillion metric tons of ice. The Antarctic ice sheet also shrank, by about 1.3 trillion metric tons. Previously, scientists disagreed whether the Antarctic sheet, the largest mass of ice in the world, was shrinking or growing (or neither).

While the Earth is warming overall, the effect of climate change varies from region to region. Over the last 15 years, for example, scientists have sometimes disagreed over how climate change has affected the polar ice sheets. Many studies found that the sheets lose a lot of ice when icebergs break off of them—and that not enough snow falls on the sheets to make up for the loss. But other studies found that the loss of ice to icebergs or melting was balanced by the gain in snowfall. Many of those studies looked at different areas, and over different time periods. In addition, the studies didn't all use

the satellite data in the same way. Those differences made it difficult to compare the results.

The data in the new study matched time periods and areas. The study also combined measurements from multiple satellites and are considered more reliable. The scientists also confirmed that ice loss in Greenland, the world's largest island, is accelerating: It lost ice five times faster between 2005 and 2010 than it did between 1992 and 2000.

The new findings provide a better starting point for scientists studying future sea level rises. Such predictions are still difficult to make, since the new study shows that changes in the ice sheets vary widely from year to year.

The work has some scientists calling for a similar, far-reaching study of all of Earth's glaciers.

Animals respond to chemical messages

Chemicals called pheromones act as messengers between individuals. Many plants and animals including squid respond to such secret chemical signals.

Pheromones were discovered as early as in the 19th century. Female moths attract males through these chemicals, which the males could smell.

Ants, for example, lay down pheromones as they walk back to their nest after a meal. These scented trails signal the route to food to other ants in the colony. Meanwhile, a different pheromone might tell wanderers to turn back, because there's no food ahead.


Squid


Orchid with hornet

Aphids too release pheromones when attacked by predators. Their chemical messages tell nearby aphids to drop off a leaf and flee. And many, many other creatures, from lobsters to elephants, emit pheromones as if they were perfume—a perfume that members of the opposite sex find irresistible.

Pheromones initially evolved in animals to help them survive. Some plants evolved to take advantage of those pheromones and trick animals. One such plant is a white and red orchid that grows only on one island in China.

To reproduce, blooms must spread their pollen to other flowers of the same species. Many plants rely on insects for help. An insect lands on a flower, often seeking nectar (and sometimes pollen) for food. As the insect alights, some pollen grains may stick to its body. Later, when the bug lands on another flower, pollen can rub off and fertilize that flower.

The orchid in China, called *Dendrobium sinense*, relies on hornets for pollination. The flower lures the hornets by mimicking a pheromone made by honeybees, which is a favourite prey for hornets. Strangely, the orchids offer no nectar, but the hornets would make repeated visits: the orchids were releasing a lure the hornets couldn't resist.

It's highly likely that people also emit pheromones, though none has been identified.

Scientists are still learning about these chemical messages. Not surprisingly, people also have learned to harness pheromones to deceive destructive pests, sometimes luring bugs to their deaths.

India's air among the world's unhealhiest

India has the worst air pollution in the entire world, beating China, Pakistan, Nepal and Bangladesh, according to a study released during this year's World Economic Forum in Davos.

Of 132 countries whose environments were surveyed, India ranks dead last in the 'Air (effects on human health)' ranking. The annual study, the Environmental Performance Index, is conducted and written by environmental research centers at Yale and Columbia universities with assistance from dozens of outside scientists. The study uses satellite data to measure air pollution concentrations.

India's high levels of fine particulate matter are one of the major factors contributing to the country's abysmal air quality. Levels of so-called PM 2.5, for the 2.5 micron size of the particulates, are nearly five times the threshold where they become unsafe for human beings.

Particulate matter is one of the leading causes of acute lower respiratory infections and cancer. The World Health Organization found that Acute Respiratory Infections were one of the most common causes of deaths in children under 5 in India, and contributed to 13% of in-patient deaths in paediatric wards in India.

It is not just India's big cities which are grappling with air pollution, said Anumita Roychowdhury, executive director of India's Center for Science and Environment, a non-profit organization which was not involved in the study. Air pollution also is worsening in smaller cities, she said.

The main culprit, Ms. Roychowdhury said, is the growing number of vehicles in India. While the country still has far fewer vehicles per capita than developed nations, India's cars are more polluting, Ms. Roychowdhury said. Other air pollution experts also cite India's reliance coal and polluting industries like brick-making that are located close to densely-populated areas.

Particulate matter comes from boilers, thermal power plants and cars, as well. This issue has been taken up seriously for several years in Delhi, but it is time for all Indians to care about it.

Activity page

Boggle'd

Boggle is a word game designed by Allan Turoff and trademarked by Parker Brothers and Hasbro. Here we play a smaller version of the traditional game.

How to play

L	I	U
E	S	R
Y	T	E

Search for words that can be constructed from the letters of sequentially adjacent squares, where "adjacent" squares are those horizontally, vertically or diagonally neighboring. Words must be at least three letters long, may include singular and plural (or other derived forms) separately, but may not use the same letter square more than once per word.

An example "LIST" is already done for you.

The original game has a time limit of 3 minutes and uses 4 X 4 squares. Here, your time limit is the next JM issue! Do write in your word list to the JM address given in the magazine and we'll print the ones with the most number of words. Don't forget to write in your name and address.

Sudoku

Rules

. Use the numbers from 1 to 6.

. Every row must have all the numbers from 1 to 6

. Every column must have all the numbers from 1 to 6

. Every sub-rectangle must have all the numbers from 1 to 6

. The central shaded square (in the medium puzzle) must have the numbers 1 to 4

(A sub-rectangle is the 2 X 3 rectangle; the 6 X 6 square is broken up into 6 such sub-rectangles.)

Use the numbers already filled in as hints to complete the grid. Each Sudoku puzzle has a unique solution.

Send in your answers to us at the JM address given elsewhere in the magazine. Don't forget to write in your full name and address.

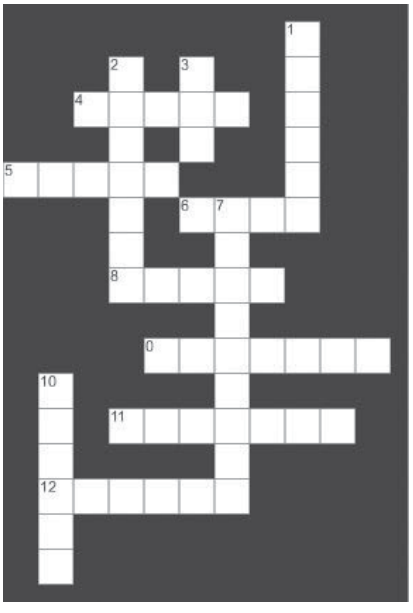
EASY

	3				
			5		6
4			1		
		2			3
5		6			
				4	

MEDIUM

4				5	
	3				
					1
2					
				1	
	5				3

Cross Word



How well do you know your Solar System? Can you solve this cross word from http://education.jlab.org?

Across

4. Although not the closest to the sun, this planet is the hottest because of a thick atmosphere of carbon dioxide.

5. This object is no longer considered to be a planet.

6. Its two satellites are named Phobos and Deimos (Fear and Panic).

8. You were born on this planet, hopefully.

9. The closest planet to the sun, it orbits the sun once every 88 days.

11. This planet is more massive than all of the others combined.

12. This planet's axis is so tilted that it orbits the sun on its side.

Down

1. Made mainly from ices and dust, these objects can form tails millions of kilometers long when they pass near the sun.

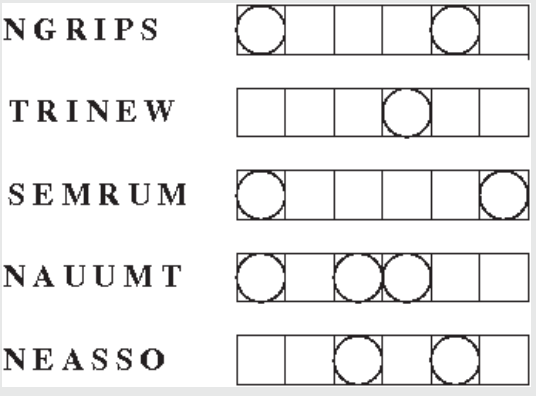
2. Named for the Roman god of the sea.

3. This object is at the center of the Solar System.

7. Chunks of rock, most of which are found between the orbits of Mars and Jupiter.

10. This planet possesses the Solar System's most impressive system of rings.

Jumble



Unscramble the letters to get five ordinary English words. Fill them in the adjoining boxes. Make a word with the circled letters and guess the answer to the puzzle below.

Neil Armstrong, Buzz Aldrin, Michael Collins.

Ans: _ _ _ _ _ _ _ _ _ _ .

Send in your answers to JM at the address given in the magazine. Don't forget to write in your name and address.

Solutions to Septmber-October issue's Activities

Boggle'd

Possible words are den, dice, die, din, dine, disc, disk, ice, kin, neck, nice, nick, scene, scenic, science, sick, sin, skein, skid, skied, skin.

Alas. No-one sent in solutions to Boggle'd. Try out the one in this issue: it's a great way to improve your visual skills.

CrossWord

Across

5. Quotient 8. Measure 11. Circumference 12. Estimate

Down

1. Solve 2. Square 3. BODMAS 4. Angle 6. Force 7. Circle 9. Aces 10. Mean

Jumble

1. ALGEBRA 2. HISTORY 3. PHYSICS 4. ZOOLOGY 5. GEOLOGY

It's the green in the leaves.

Ans: CHLOROPHYLL

Sudoku

EASY

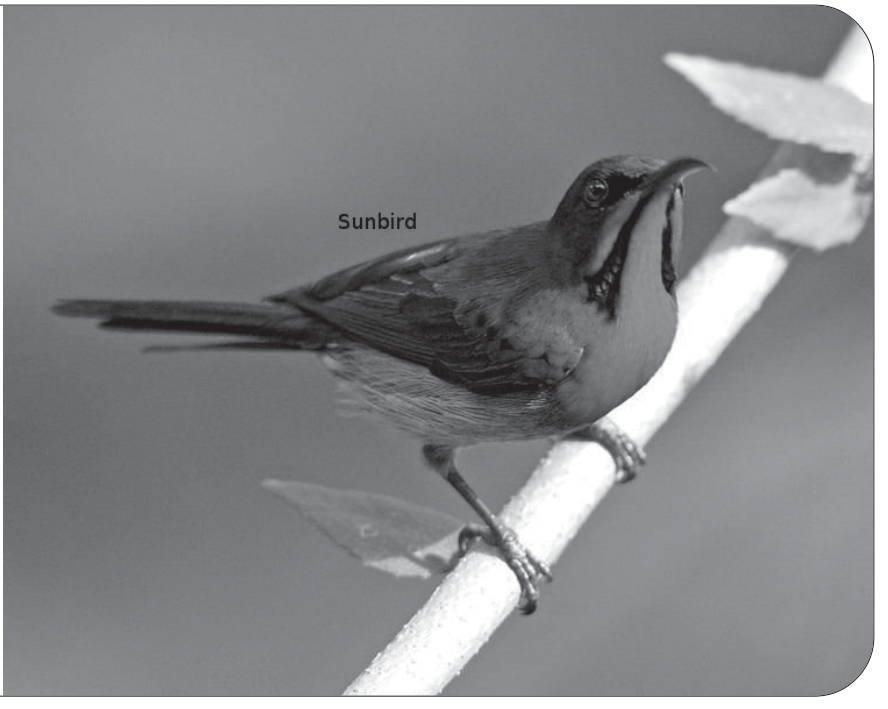
1	5	2	6	3	4
3	4	6	5	2	1
2	6	3	1	4	5
5	1	4	2	6	3
6	3	5	4	1	2
4	2	1	3	5	6

MEDIUM

4	3	5	6	2	1
6	2	1	5	4	3
2	6	3	1	5	4
5	1	4	2	3	6
3	5	6	4	1	2
1	4	2	3	6	5

Nature Diary

Scarlet Cordia



This is a species of flowering tree native to the American tropics, including south America, growing about 10 m high. It is an ornamental plant common in gardens and on the road-side, growing in profusion on the pavements in Chennai, perhaps having been brought here from Cuba. Unlike many other imported trees, it attracts a lot of birds like sunbirds. It has dense foliage; the tree also spreads out a lot.

The tree has dark green, oval shaped largish leaves, which are rough to the touch. The veins are very deeply defined and clearly stand out.

Its point of beauty are its small intensely scarlet flowers that appear almost all the year around—look for them in your neighbourhood now! Or else look at the cover photo! The flowers occur in clusters at the tips of branches. The flowers start as tubes, which give way to six curved petals, which are pleated and slightly ruffled. There are several blooms in each cluster, and these highlights of red in a dense green tree make it a beautiful sight.

The flowers give way to rather unusual pear-shaped fruit roughly the same size as the flowers, that are white in colour and have a pleasant fruity smell. The fruit are said to have some medicinal qualities. Despite its softness, the wood is strong and durable and is claimed to be one of the timbers used to make Egyptian Mummy cases.