contents

Contents

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The Community of Numbers

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Whenever we think of the word *community* we always think of people. People coming together on the basis of some thing in common form a community. They may be just friends, they may be relatives, they may just be people happy to be together or simply solitary people who have no one to care. Sometimes it is used for colonies of ants and such other groups or families of living organisms. We normally use these adjectives happy, perfect, friendly, solitary to describe persons or groups of persons.

Did you know that numbers are sometimes referred to by these same colourful adjectives? While this may show that mathematicians have a sense of humour, the adjectives do have deep meanings.

So let us start from the beginning—the **natural numbers**, 0,1,2,3,... A study of these natural numbers and beyond is often called **Number theory**. We all know that these may be divided into *even numbers*, numbers divisible by 2, and *odd numbers* which do not have 2 as a factor. ((What is a factor?: If you divide a number by another number and there is no remainder, that number is called a factor). Of course all numbers have 1 as their divisor.

Perfect Numbers

Among these natural numbers some are called **perfect numbers**. What is perfect about them? Number theorists tell you that they are perfect since all the factors (except the number itself) add to give the number itself. For example 6 is a perfect number since its factors 1,2,3 add to give you 1+2+3=6, the number itself. Such numbers have been known for a long time, more than about 2000 years. Surprisingly, such

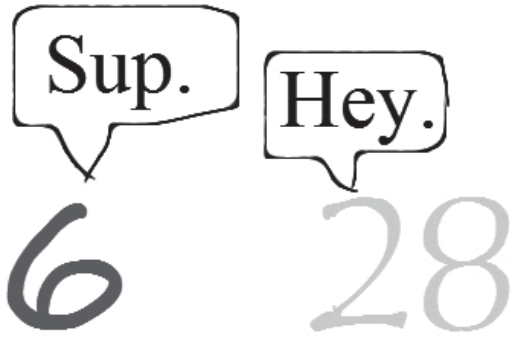
numbers are very rare. In fact it was known early that the numbers 6, 28, 496, and 8128 are the first four perfect numbers. It took a long time, almost 1500 years, to discover the next perfect number and it turns out to be a large number, 33,550,336. In 1772, the famous mathematician Euler discovered a very large number, for his time, 2,305,843,008,139,952,128 as a perfect number. The largest such perfect number known today has more than 34 million digits and the list has less than 50 such perfect

numbers. Rare indeed.

Notice that all these perfect numbers are even. Is there any perfect number that is odd? Are there infinitely many perfect numbers or is their number finite? These are some open questions for which we do not have answers yet.

Friendly Numbers

Then there are these f**riendly numbers**. Take any number N. Collect all its divisors and construct a function S(N) which is the sum of all the divisors including the number itself. Then take the ratio of this function to



the number itself: S(N)/N.Two numbers N and M are friendly if this ratio is the same: S(N)/N = S(M)/M.

There may be more than two numbers that share this friendliness! This is called an *equivalence relation* and numbers having the same ratio belong to the same equivalence class or simply clubs.

For example,

S(6)/6=(1+2+3+6)/6=2;

S(28)/28=(1+2+4+7+14+28)/28=2.

So we say 6 and 28 are friendly numbers. In fact all perfect numbers are also friendly numbers since they all yield S(N)/N=2 by definition of perfect numbers.

As an exercise you can check that 30 and 140 are friendly numbers since S(30)/30 = S(140)/140 = 12/5. You may also add 2480,6200 and 40640 to this club of friendly numbers since they also have share the same ratio 12/5.

Solitary Numbers

Are there number that are not friendly? Indeed yes—these are simply called **solitary numbers**. Easy to guess. All prime numbers, which have no divisors (except 1 and the prime number itself), are solitary. For

example if p is a prime number then S(p)/p=(1+p)/p, which is different for each prime number p. In fact, any number which is a power of a prime (example, 2^2, 5^3, 7^4),is also solitary by the same token.

Are there other numbers which are solitary but not prime? It is conjectured that 10 is a solitary number but has not been proven. It is possible that it is not solitary but then its smallest friend may be a very large number that is not yet known. Unfortunately, there is no known general method that can be used to determine a number, for example 10, as solitary or friendly except by actually searching for and finding it!

Amicable Numbers

Some times two numbers are said to be **amicable numbers**. These are different from friendly numbers though they also involve divisors of a pair of numbers. For example consider the pair of numbers 220 and 284: The sum of proper divisors of 220 is 1+2+4+5+10+11+20+22+44+55+110 = 284. ("By proper divisor, we mean that the number itself is excluded). Similarly the sum of proper divisors of 284 is 1+2+4+71+142 = 220.

We say that the pair (220, 284) form an amicable pair. In fact this is smallest such pair. The next few are (1184, 1210), (2620, 2924), (5020, 5564), etc.

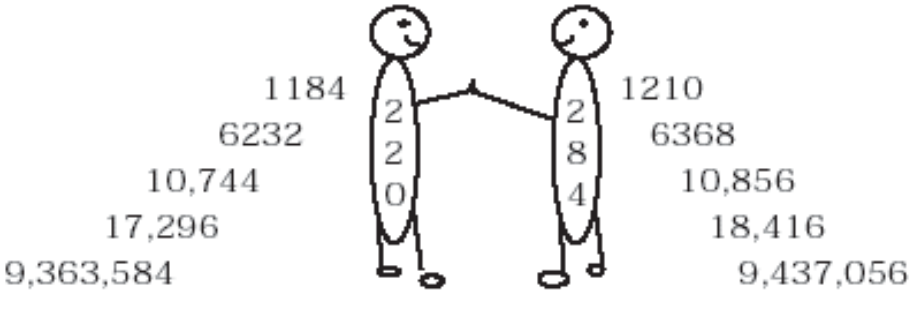
Such pairs of numbers were known from the time of **Pythagoras** and were thought to have some mystical properties. We now know that there are more than 12 million such pairs. In all the cases the numbers in the pair are both even or both odd. It is not known whether even-odd pair of amicable numbers exist.

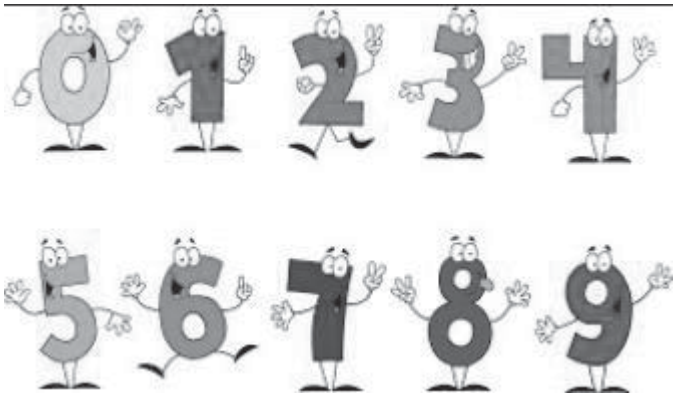
Happy Numbers

If numbers can be perfect, friendly or solitary, can they also be happy or unhappy? Indeed they can be provided they satisfy the following **happiness criterion**! A number is called a happy number if the sums of the squares of its digits added sequentially reduce ultimately to a single digit given by 1. Trivially 1 is a happy number since its square is always 1. Let us take the next one, 7, and compute the squares: 7^2 = 49. Now add the squares of each of these numbers, 4 and 9: $4^2+9^2=97$. Continue on to get $9^2+7^2 = 130$, $1^2 + 3^2 + 0^2 = 10$, and finally, $1^2 + 0^2 = 1$. So 7 is a happy number.

You can easily check that the numbers 1, 7, 10, 13, 19, etc., are all happy numbers. Happiness of a number is unaltered if you interchange the digits or add any number of zeros in between.

You may think of variations on the happiness theme by using cubes instead of





squares. For example you can check 1579 is a happy number with cubes replacing the squares. If you are adventurous you may even consider higher powers. However, you will soon realise that there are not many when you go for higher powers.

And many more

These are some examples of numbers which have some interesting properties. We give funny names to some of their properties. In fact there are more: For example you may have heard of Twin Primes which are prime numbers that differ by 2 like (3,5), (5,7), (11,13), etc. But there are also Cousin Primes which differ by 4 like (3,7), (7,11), (13,17), etc. If they differ by 6, they are called Sexy Primes.

Apart from just the names, sometimes there are some deep results hidden in these classifications. **Number theory** deals with such problems related primarily to the study of natural numbers. This is one of the oldest branches of mathematics, which used to be called simply Arithmetic, which originated in many older traditions like the Babylonian, Chinese, Greek, and Indian.

In number theory, if a number belongs to a certain category or variety, then one immediate question that mathematicians try to ask is if there are finite or infinite numbers in that category. Sometimes there are conjectures (guesses) whether a number belongs to one category or the other. For example, you may ask if there are infinitely many clubs of friendly numbers just as you can ask if there are infinitely many perfect numbers. These are still *open problems* (that is, unsolved); in fact, there may be many unproven conjectures.

In contrast to many other branches of Mathematics, the problems and theorems in Number theory may be stated in such a way that it is understood by even non-experts. However, the solutions and proofs may require very sophisticated background and techniques. Often the solutions may indeed take decades or sometimes even centuries.

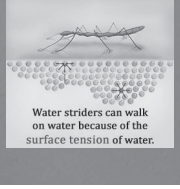
Surface Tension Meaning and Practical Applications

Surface tension is a physical phenomenon that we observe in our daily life. Raindrops take a spherical shape; formation of spherical soap bubbles - all these are examples of surface tension.

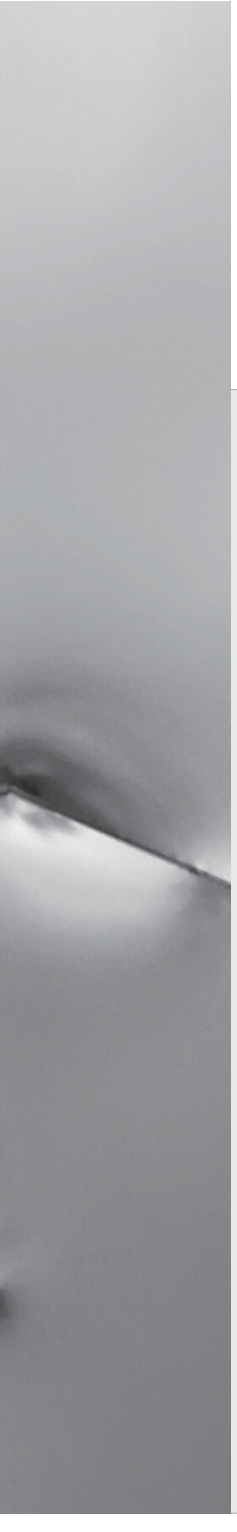
Surface tension in water arises from high interactions between water molecules, known as *hydrogen bonding*.

Water is the chemical compound called H_2O. That is, two atoms of hydrogren and one of oxygen bond together to make the water molecule. There is only one type of molecule — H_2O — in water, so they are called *like-molecules*.

The force of attraction between like-molecules in a liquid causes them to hold together in liquid form; if the forces are small or negligible, the bonding is less and you get a gas instead of a liquid. An molecule fully inside the liquid is uniformly pulled in all directions due to the force of attraction from molecules all around it. However, molecules at the surface are only pulled downwards since there are no molecules above them. So this results in a surface tension with a tendency for the liquid to contract at the surface. It is like a stretched cloth, under tension.



Water striders can walk on water because of the surface tension of water.



Effects of surface tension

Surface tension causes 'capillary action', due to which water travels upwards, against gravity, through the stems of plants, and blood flows through the small vessels in our body.

As the value of surface tension of water is high, water has a high boiling point.

Forces acting in a liquid

Following are the basic concepts about molecular forces that we need to know before understanding surface tension.

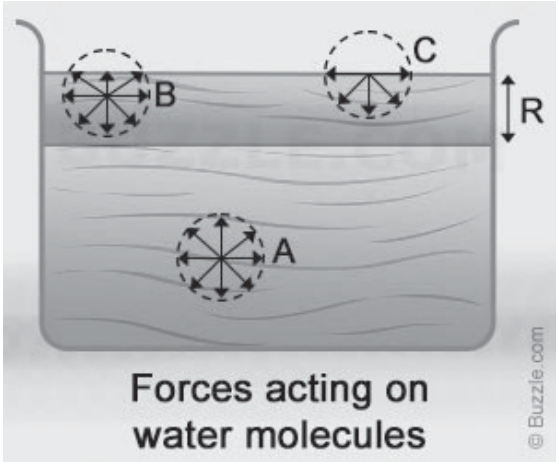
. *Cohesive forces* are intermolecular between similar molecules. For example, the force of attraction between two water molecules is cohesion.

. *Adhesive forces* are intermolecular forces between dissimilar molecules. The force of attraction between a water molecule and air is adhesion.

. *Range* of molecular forces is the maximum distance up to which intermolecular forces are effective.

. A sphere drawn with the molecule as the center and the range of molecular forces as the radius is known as the **sphere of influence**.

. Surface film is the layer of surface of liquid whose thickness is equal to the range of molecular forces of attraction of the molecules at the surface.

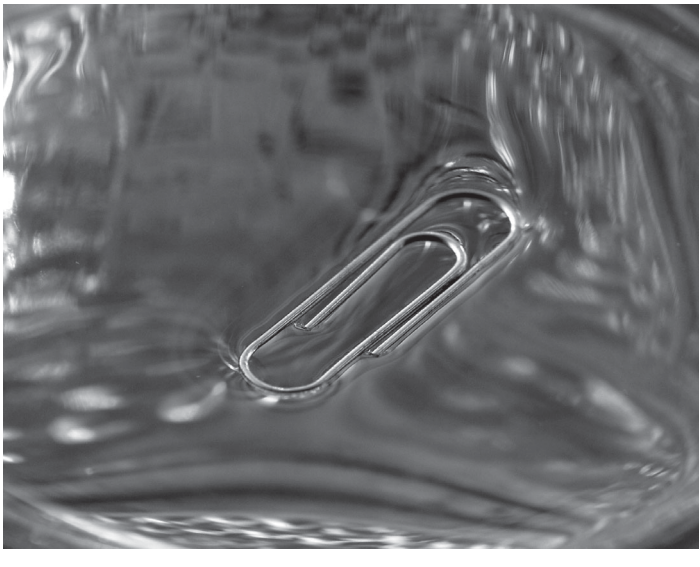


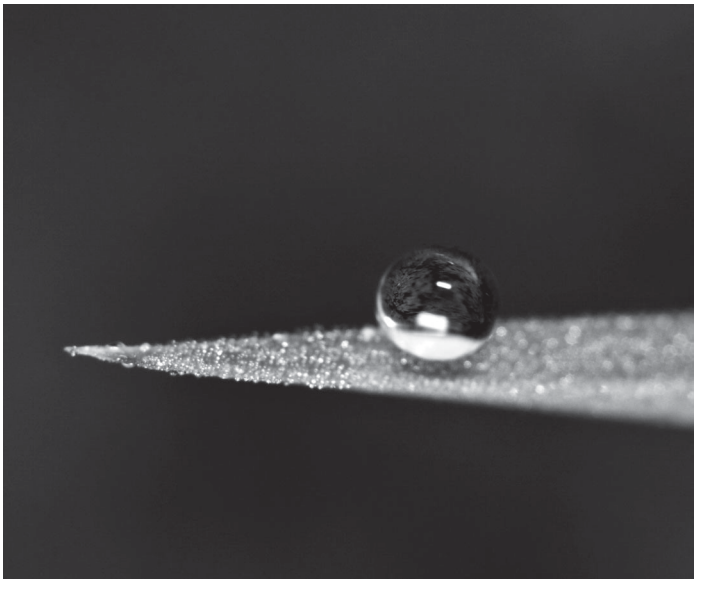
Forces acting on water molecules

What is Surface Tension?

Consider the molecules A, B, C of a liquid (let us say, water) as shown in the adjoining figure. Molecule A is well inside the water, B is at the surface film (R), and C is on the surface. The sphere of influence of molecule A is totally inside the liquid. Hence, it is acted upon with an equal and opposite cohesive force from the remaining molecules. Therefore, the net force acting on molecule A is zero.

A part of the sphere of influence of





molecule B is above the surface of the water. Hence, adhesive forces from air molecules act on molecule B. Due to this, the cohesive forces from molecules below and around B pull it down. Thus, the net unbalanced downward resultant cohesive forces pull molecule B down in the water. Half of the sphere of influence of molecule C lies in the water, while the other half is in the air. The cohesive forces act against the adhesive forces, and C is pulled inside due to the resultant unbalanced cohesive force.

All these cohesive forces cause the surface area of the liquid to reduce and the surface to get stretched, resulting in surface tension. If the amount of water is very small, it will curl up into a ball. So dew-drops on leaves are round because of surface tension.

Practical Applications

Apart from mercury, water has the greatest surface tension of any liquid. Let us take a look at some applications of surface tension of water.

. Water striders are insects that can walk on the surface of water because of surface tension of water

. Mosquito eggs can float on water because of its surface tension. Kerosene is sprayed on water so that the mosquito eggs sink and the breeding stops.

. Warm water is used for washing purpose as heating increases the surface area and reduces surface tension.

. Soap and detergents reduce surface tension. This allows the water to enter the small holes in woven cloth and shake off the dirt that collects in these spaces. For example, if the surface tension of clean water (at 20°C) is about 0.07 N/m, that of soapy water is about half that, typically 0.037 N/m. (Newtons per meter is the unit for surface tension).

. A needle or clip placed on water can be made to float due to the surface tension of water. If the surface is ruffled, the paper clip will quickly sink.

Other Examples of Surface Tension

. The test for jaundice involves the use of surface tension properties. Sulfur powder is sprinkled on the urine sample. If it does not contain bile, the sulfur powder floats due to surface tension. If bile is present in the sample, the surface tension of urine reduces and the sulfur powder sinks.

. Toothpaste contains soap, which reduces the surface tension and helps it spread freely in the mouth.

. Disinfectants have low surface tension, which allow them to spread through cell walls of bacteria.

Read more at Buzzle: http://www.buzzle.com/articles/surface-tension-meaning-and-practical-applications.html

Does the Fourth Dimension of Time Exist?

Time is the fourth dimension, other than the three dimensions of space. Time makes change possible or else we would be living in a static universe. Let us explore what we mean by time. While doing this, we will find out about Einstein's special theory of relativity and how it dealt the fatal blow to the concept of absolute time of Newtonian mechanics.

The time has come for you to question the very nature of time. Can time be considered to be a fundamental physical dimension, on par with the space dimensions? If it is indeed so, then why can't we travel back and forth in time, just as we move through the space dimensions? Let's find out.

What is Time?

Time is our way of keeping track of changes that are constantly happening in the universe. Time arises due to the dynamic nature of the universe or one could say, that the dynamism is possible, because there is time.

In a way you could say that time must have been invented, so that all things do not happen instantaneously! By time, we mean a series of changes or events that occur. Those events that happen periodically, like the rising and setting of the Sun, the rotation and revolution of the Earth, around the Sun are used as references to calibrate and measure time. Our clocks are synchronized with these periodically repeating events to keep track of time. So in a way, time is felt or understood, only as a

result of changes in the material world we perceive. To put it simply, time is change.

What Does a Dimension Mean?

A dimension is a degree of freedom of a system. In simple words, it is the number of ways or directions in which change can take place in a system. Let us understand what do we mean by the dimension of our universe, our world. Imagine an ant walking on a very thin thread. The width of the thread is such that it can either move forward or backward on the thread, it cannot move sideways. That is, its freedom of movement is restricted to one dimension.

It is said to have one degree of freedom and therefore one dimension. Similarly, an ant moving on a flat disk can move forwards or sideways but not up and down, so its degrees of freedom are two. Hence it's moving on a two dimensional surface.

Now imagine a flying ant that can move straight ahead or back, sideways, as well as up and down. Its degrees of freedom are three, so it's moving as we all do in three space dimensions.

How is Time the Fourth Dimension?

Now ask yourself, how would movement in all these dimensions be possible, if there was no concept of time? You will find that dynamism in space would not be possible if there was no time. When all of those ants were moving, they moved in time too. So the ant on the thread had not one, but two degrees of freedom. One was space and the other is time. That is, it was moving in two dimensions. Similarly in this world, we move in three space dimensions plus one time dimension.

However, time as a dimension is unique and different from other space dimensions. In space dimension, you can move ahead and backwards, there is no restriction on that. In time, however, you can only move in one direction. In time, you cannot move backwards, only forward.

This has far-reaching implications which we will discuss further, but first let us understand how Einstein's special relativity theory changed our perceptions of space and time.

Einstein and the Unification of Space Time

In 1905, Albert Einstein put forth a theory called special relativity which dealt the fatal blow to the old established ideas of Newtonian mechanics. The theory revolutionized the way we see nature and the universe.

The **first basic postulate** of special relativity is that no information can travel faster than the velocity of light in vacuum and, further, that the velocity is constant.

The **second postulate** is that all laws of the physical world should remain the same in any inertial reference frame. By inertial reference frame, we mean a coordinate system of reference moving at a constant velocity or which is stationary. Any other co-ordinate system moving with constant velocity with respect to a coordinate system at rest is also an inertial reference frame.

Newton's mechanics had the concept of absolute time. That is, no matter which reference frame people are using, their clocks if compared show the same time.

Special relativity changed this perception. The necessity that the speed of light should be constant forces us to abandon the absoluteness of time! That is, different observers in different reference frames show different times in their watches, but the laws of physics will remain the same.

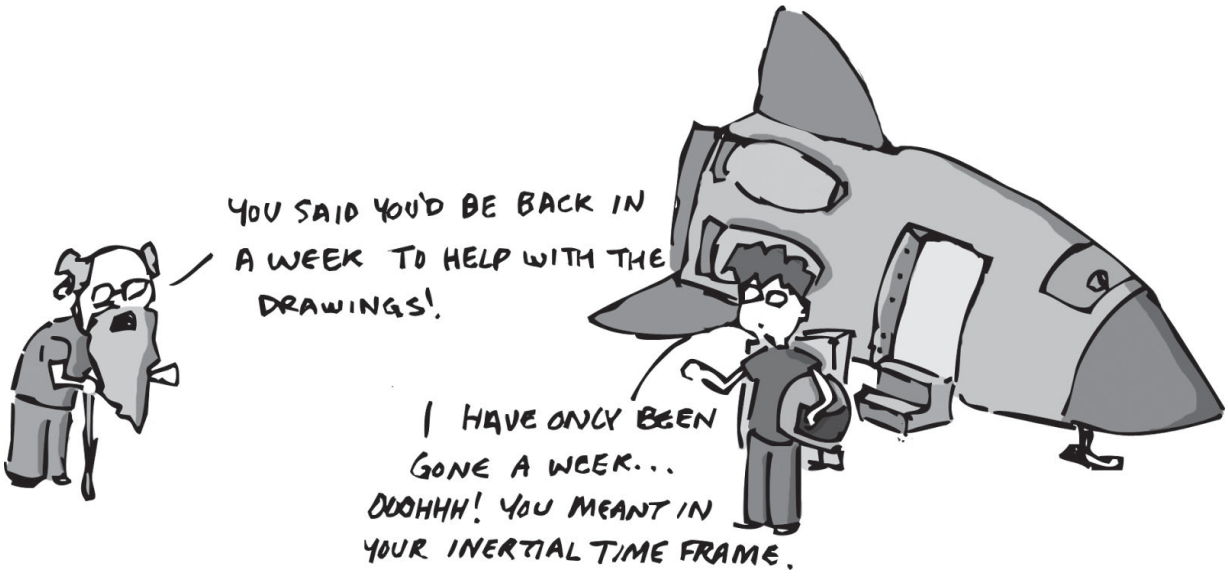
In fact the faster you move in space, the slower you move in time. This is often termed as time dilation. Time is not absolute, it is relative. This forced the world to abandon the concept of separate ideas of space and time and a single unified concept of spacetime came into existence. Some found it in Einstein's name itself. 'Ein' means 'one' in German. Split up his name as ' EIN+ST+EIN', ST meaning space time. If you see, it literally means 'one space time'; just a lucky coincidence one would say! Time was realized as the 4th dimension.

Time Dilation

Let us try to understand what time dilation is. We are all continuously moving not just in three dimensional space but in four dimensional spacetime. Consider a racing car moving on an absolutely straight race track at a constant velocity. It is moving in one dimension and takes some time to reach the finish line.

Now consider that it's trying to reach the finish line, but on an oblique path. That is, it doesn't keep to a straight line but keeps weaving to the left or right. Its velocity is now distributed over two dimensions and therefore it's taking longer for the car to cover the same distance. Its velocity in the original one dimension has reduced. If the side-ways motion is not too much, then the velocity is still mostly in the forward direction, but there's also some velocity in the transverse direction.

In a similar way, all objects in the real world are moving in a four dimensional spacetime, at a constant velocity as that of light. Sounds astounding but it's true. Only



the velocity is distributed over dimensions and most of it is in the time dimension. When the objects are at rest, they are considered to be moving only in the time dimension! Physically, it means that time is moving on, while the object stays at the same point in space.

Now when they start moving, their velocity increases in the three space dimensions, and therefore it slows down in the time dimension.

Therefore, the faster you move in the three space dimensions, the slower you go in the time dimension. This causes time dilation. That is, time goes slow when you are going fast! This is a bit difficult to understand, but if you give it adequate time to sink in, it's simple.

This is explained in Physics by the famous Twin Paradox: one twin stays at home and another goes off on a rocket and comes back after 30 years. The twin at home would have got 30 years older, but for the twin that was travelling at great speeds, time slowed down and she would have hardly aged!

Of course, one of the things to realise is that all this happens when things are moving really fast, that is, at speeds close to the velocity of light, which is $3\ 10^8$ m/s (if light could bend around the Earth, it would wind more than 7 times around the equator in a second!) So if you are running a race, don't expect to see any noticeable effects of time dilation. This is why Newton's mechanics is good enough to describe motion in every-day life.

The Arrow of Time

The uniqueness of time dimension is that you can travel only forward in it, not backward. This fact has profound implications. It protects causality, that is the law of cause and effect. That is, cause should precede effect and it should not be the other way round. This irreversibility of time is inbuilt through a concept of entropy in thermodynamics (study of effect of temperature on objects).

Entropy describes the disorder in the universe; it always increases, never can it

decrease.

You can understand the law of entropy by just observing the irreversible nature of natural phenomena. That is, a cup falling down and breaking, can never be restored to the same condition, with every atom in place, as it was. The irreversibility implied by entropy could be described by the popular line from the Humpty Dumpty nursery rhyme, which says: All the King's horses and all the King's men, couldn't put Humpty together again!

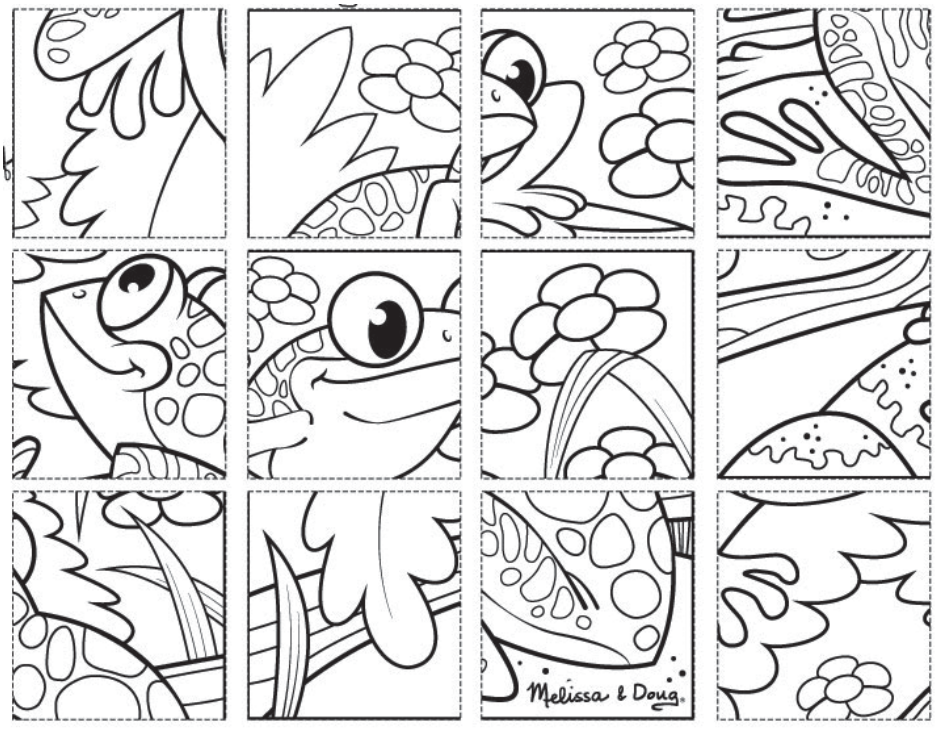
For every system, disorder always increases. Entropy increase is unidirectional, just as the unidirectionality of time. Thus it is no coincidence that the thermodynamical arrow of time and the arrow of time flow, point in the same direction, as they both preserve causality. As a consequence, traveling back in time impossible, as it would violate causality and the law of entropy.

However, special relativity does allow for the possibility of time travel to the future. Creatures living in a two dimensional flat world will find it difficult to imagine what a three dimensional world would look like. Similarly, we, living in a world of three space dimensions find it impossible to imagine four dimensional spacetime! Still, through many indirect experimental tests the idea of four dimensional space time has been tested beyond doubt.

Concept of time as the fourth dimension is very subtle and elusive. I hope the time you have spent reading this article has lifted the veil over the mystery of time just enough, for you to investigate it further.

Read more at Buzzle: http://www.buzzle.com/articles/does-the-4thfourth-dimension-of-time-exist.html

The bits are mixed up. Re-arrange them and get the picture right!



Find the way!

Help them reach mother!

Dr. A. P. J. Abdul Kalam

15 October 1931 — 27 July 2015

A rare leader who won the hearts of the Indian public

"Your birth could be a mere event, but your death should be part of history".

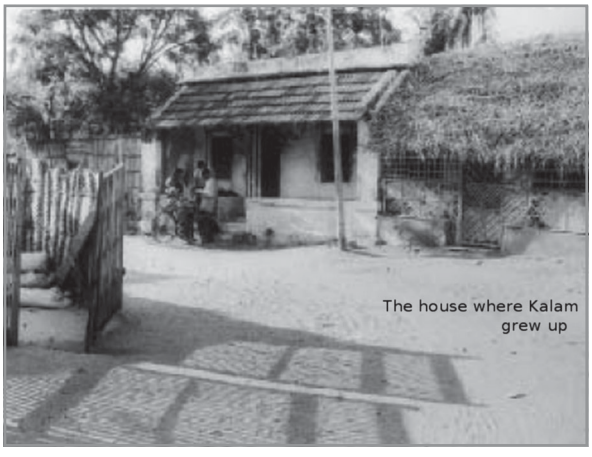
This is one of the many inspirational statements from A.P.J. Abdul Kalam, who used to talk effortlessly in this vein, especially to students in schools and colleges to dream big, to achieve on a large scale, and most importantly, do all that in the service of the nation.His own birth in an ordinary Muslim family in Ramanathapuram in October 1931 was a mere event, and his death on July 27, 2015 was one of historical importance, the entire nation mourning and the world taking note. That he died of heart attack during a lecture to students in Shillong, working till the last minute, is befitting the man.

His achievements

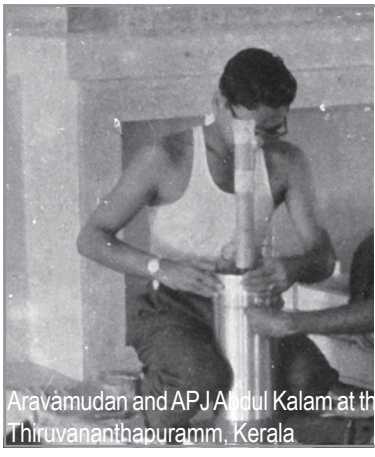
Lauded widely as India's "missile man", Kalam led major science and technology (S&T) projects of the country in a `mission mode', placing India's space satellite programme and missile programme among the successful ones of the world, earning great respect for India's S&T capability. He led the Defence Research establishment on many projects, played a significant role in nuclear weapons development (by the Department of Atomic Energy) and advised the government on S&T policy.In 1997 he was awarded the Bharat Ratna, India's highest civilian honour for his contributions to scientific research and modernisation of defence technology in India. He was the 11th President of the nation from 2002 to 2007. A long way to come indeed, for the son of a humble boat owner (and Imam) from Ramanathapuram, who earned a living by ferrying Hindu pilgrims.

His contributions to society

Kalam was famous for his ability to spot ideas and talent, providing encouragement and leadership. When he realised that a metal byproduct of Defence Research could be used in orthopaedic implants and thus bring down the cost of orthopaedic surgery, Kalam directed DRDO to take this up. He devised a low-cost cardiac stent in collaboration with a scientist for use in heart surgeries. In these, what must be especially lauded is his recognition of an idea and his determination in seeing its implementation through to its conclusion. As President and later, Abdul Kalam had a grand vision for India's development. He identified five core areas "for integrated action to double the growth rate of GDP" (Gross Domestic Product) in India. These areas were *agriculture*, *infrastructure*, *education and healthcare*, i*nformation and communication technologies*, and c*ritical technologies and strategic industries*.



The house where Kalam grew up



Aravamudan and APJ Abdul Kalam at th Thiruvananthapuramm, Kerala

His early years

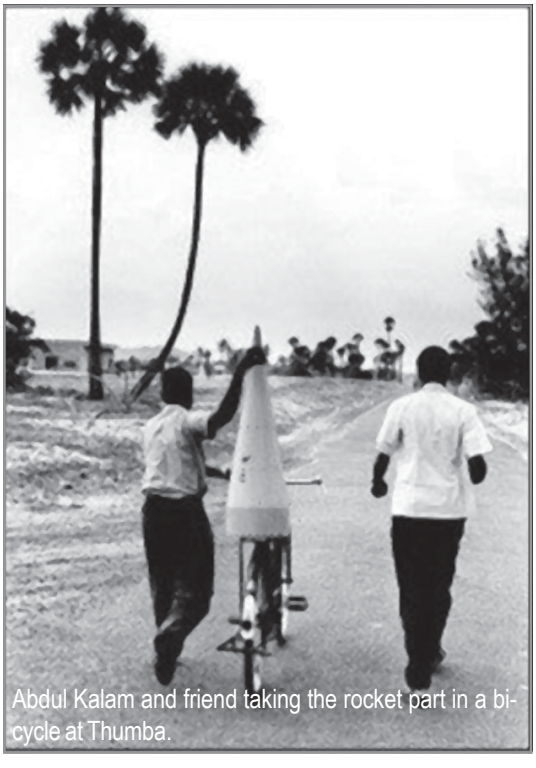
Kalam was the youngest of five siblings, and at an early age, he used to deliver newspapers to augment the family income. There was no electricity in Kalam's town when he was a boy, they used kerosene lamps and in that light the boy Kalam used to study early mornings and at night. He was a bright student and the school teachers supported him. All his life, Kalam would remember his teachers with gratitude.During his school days, the boy's ambition was to fly aircrafts, later he wanted to *make* them, this got him interested in Physics. Kalam did a BSc in Physics in St. Joseph's College, Tiruchirappalli and studied aerospace engineering later in Madras Institute of Technology.

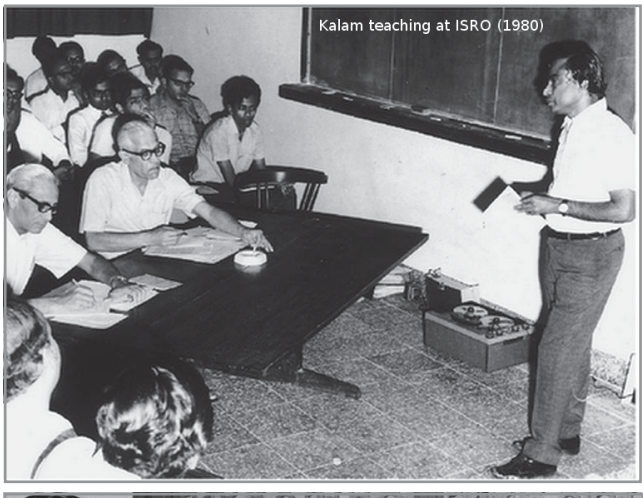
His simplicity and generosity

Perhaps what appealed to people most about Kalam was his essential simplicity. He never owned a television, ate very simply, and his few personal possessions included his books, his veena, some articles of clothing, a CD player and a laptop. He was vegetarian and a devout Muslim, keeping month-long fast during Ramzan.Personally very generous, he was popular with staff wherever he served, for his unfailing courtesy and readiness to help people in need. During his tenure at Rashtrapati Bhawan, he opened the aristocratic premises to common people. He was responsible for developing a 'smell and touch' garden there for the benefit of visually challenged visitors. He is said to have not allowed glass to be put on the walls of DRDO (for security) because it hurt perched birds.When President Kalam visited Thiruvananthapuram at Kerala Raj Bhawan, two special persons who came as Presidential guests attracted media attention. They were a road-side cobbler and owner of a very small hotel. Kalam had remembered them from his days in ISRO, Thiruvananthapuram and called them. Such gestures dotted his life.

His popularity with children

At meetings he would address everyone as equals, reserving his special attention for students and children. He once spent 4 hours with school children answering a variety of questions. The world had never seen such a head-of-state as Kalam: one who was well versed in science and technology, could converse with leaders on world affairs and yet one who cared to spend time with children, who never lost sight of the ordinary people.Some of Abdul Kalam's famous statements of advice that inspired young people:. Don't take rest after your first victory because if you fail in the second, people are waiting to say that your first victory was just luck.. All birds find shelter during the rain. But the eagle avoids rain by flying above the clouds.. Thinking should become your capital asset, no matter whatever ups and downs you come across in your life.. All of us do not have equal talent, but all of us have an equal opportunity to develop our talents.. Man needs difficulties in life because they are necessary to


Abdul Kalam and friend taking the rocket part in a bi-cycle at Thumba.




With Indira Gandhi

enjoy success. You have to dream before your dreams can come true.Tamil Nadu Science Forum was fortunate to host President Kalam when he came to Erode in 2006 to participate in the State level Children's Science Congress. As usual, he talked to children of the pleasures of doing science and of dedicating onself for the nation's development. His nationalistic vision and emphasis on military strength for power may not have been to the liking of some people who think that science should serve peace and not war, but Kalam's greatness lay in inspiring ordinary people and giving them a sense of hope and direction.When Kalam died, there was genuine outpouring of grief all around the nation. In Tamil Nadu, we saw ordinary people paying respect in a hundred ways. According to a poster printer, personal expenditure to print tributes to Kalam exceeded that by political parties (with his company) for elections.GlobalSat, a global satellite for earth observation and disaster risk reduction proposed under the United Nations Framework, is to be named after Abdul Kalam. When Kalam addressed children, he used to refer to his age as his N^{th} orbit around the Sun, whatever N it was. This is an entirely appropriate tribute for a man with a global vision for science in service of humanity.

Chimps Can Spot Faces Like Humans Do

Charles Q. Choi,
Live Science Contributor

Chimpanzees can quickly identify the faces of other chimps, as well as those of human adults and babies. These new findings could shed light on human and chimp evolution, scientists say.

Faces are key to human social lives, conveying key data about how one feels. As such, humans are wired to pay special attention to faces. For example, when pictures of faces are mixed in with pictures of other items such as cars and houses, people can detect the faces effortlessly.

Holistic View

Previous research has also shown that humans see faces differently from how they see other objects; for instance,people have severe difficulty when they are shown upside-down faces: facial recognition is said to be severely hampered in such a case. Similar is the result when the faces that are shown are modified in an unusual way, for example, so that the nose and mouth are located beneath the eyes. These past findings suggest that the human brain analyzes faces in a holistic manner — that is, it understands images of faces by looking at the whole rather than at the parts.

Increasingly, scientists find that chimps, humanity's closest living relatives, also see faces differently than they do other items. To learn more about the chimp response to faces, scientists first trained three adult chimpanzees named **Chloe**, **Pendesa** and **Ai**

to find pictures of a chimp face, a banana, a car and a house among groups of other images on a touch screen.

Chimpanzee faces

The researchers found that the apes recognized the chimp face very efficiently. "Chimpanzees very quickly find a face in the pile of various objects," said study lead author Masaki Tomonaga, a primatologist and comparative cognitive scientist at Kyoto University's Primate Research Institute in Japan.

However, the chimps' ability to detect a chimp face was significantly hampered when the face was upside down. This suggests that chimps may analyze faces holistically, like humans do.

In subsequent experiments, the scientists also found that the chimpanzees efficiently detected the faces of human adults and babies, but were unable to identify monkey faces. The researchers suggest this gap may result from longlasting social experiences between chimps and humans. Faces seen from the front were more easily detected than faces seen from the side, suggesting that eye-to-eye contact is important for chimps, just as it is in humans.

"Both humans and chimpanzees have developed a specialized ability for face processing," Tomonaga said. "This implies that the face plays a very important social role in both species. These results are quite suggestive when considering the evolution of social intelligence. Both species may use facial information for their social lives in the same manner."

Does colour affect processing?

Chimpanzees also detected a photo of a banana as efficiently as that of a face. However, further examination showed that the quick ID of the fruit had to do with its distinctive yellow color. When a black-and-white image of a banana was shown, the chimps took significantly longer to spot the fruit, while no such problem was seen with black-and-white versions of faces.

Future research could explore how well other primates detect faces and at what age chimps learn to quickly detect faces. How and when chimpanzee babies acquire such abilities, is another question for future research.

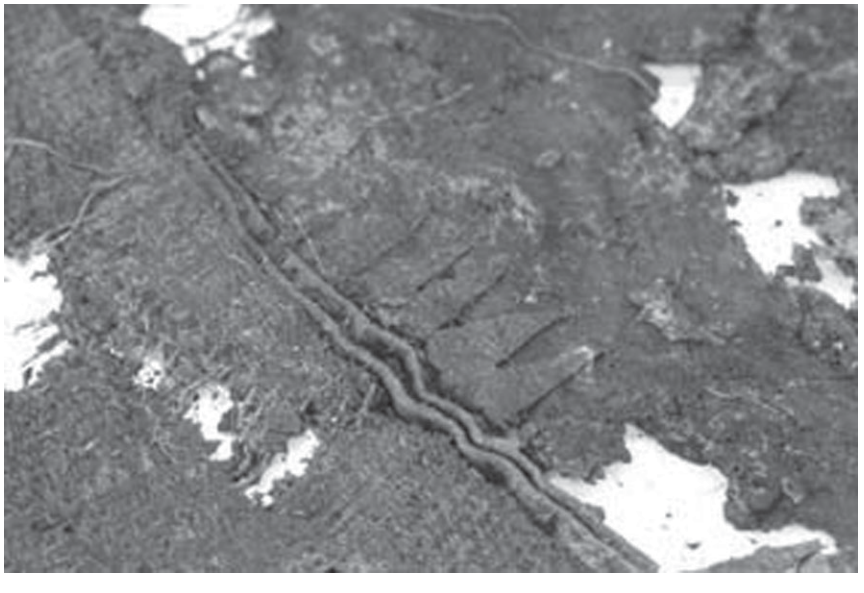
The Naked Truth

(or A Brief History of Clothing - I)

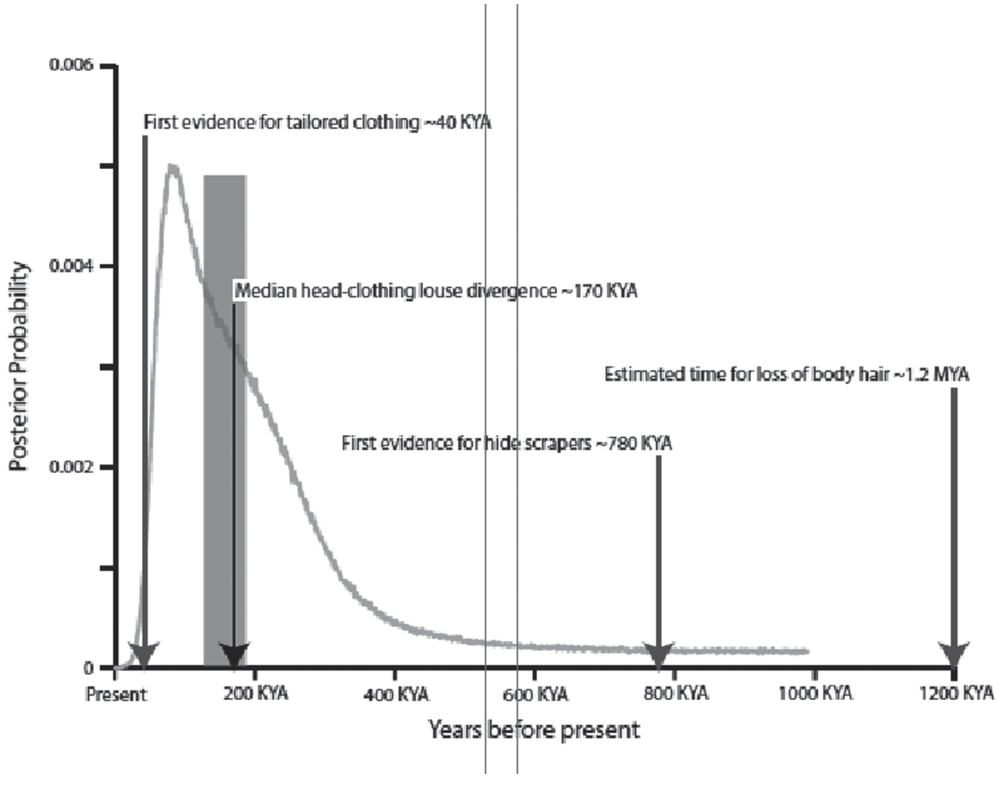
Thiagu Ranganathan

Have you ever wondered why kids say *"Shame Shame, Puppy Shame"* if they see someone naked? Is it that only puppies roam around naked? Why don't they say *"Shame Shame, Hippo Shame"!* It does sound better, atleast to me. Actually, this is something where we have so many options – mosquitoes, bacteria, elephant, dinosaurs, mango trees, sun flowers, apples… You name it and we have it. Tens of thousands of living species around us do not wear clothes. So, it does seem strange that we are the probably the only species who have evolved this method of covering our bodies by cloth.

Not just that, clothing is such an aspect of our lives today that many political leaders across the world seem to win elections based on their promise to provide clothing along with food and shelter. *"Food to eat, clothes to wear and a home to stay"* is a popular political slogan/promise for all times. Clothing is thus considered a very basic need of human beings today. It just doesn't stop being a basic need; it goes beyond that. We wear so many different clothes in our lives of different materials, sizes and colours in our life. We spend significant time of our lives in choosing, buying (for them and others), and wearing clothes. There is also a lot of human and mechanical energy that goes into producing these clothes. There is significant employment generated in the world for production, marketing, transportation and sales of clothes and materials used to make these clothes. Trade between countries involving clothes and materials for making clothes (silk, cotton, wool, flax, etc.,) have existed over thousands of years between countries of different continents. This trade seems to have made and destroyed the fortunes of many economies of the world. An integral part of every culture is about the type of clothes people wear. Yet, we don't seem to know why we, the human beings, started



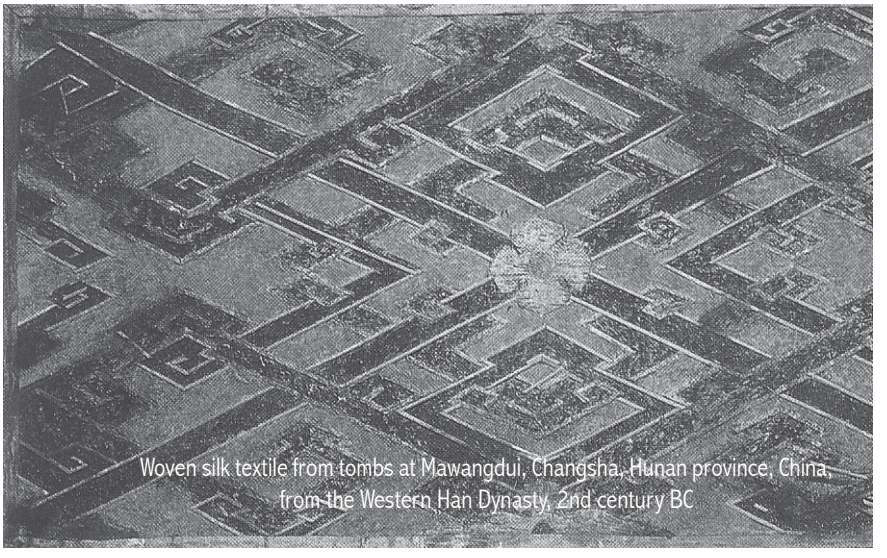
The picture shows a textile and animal skin object found in Dartmoor in Englan measuring 345mm x 260mm made from finely woven nettle fibre. Its fine decorative work suggests it was an item to be worn, possibly as a sash or belt, around the Early Bronze Age about 1900-1500 BC.



clothing ourselves and when we started doing so? Did our grandparents and their grandparents and their grandparents and parents of their grandparents wear clothes? Did we start wearing clothes a 1000 years ago or 10000 years ago or 20000 years ago?

Recent research has put a tentative date to when we started clothing ourselves and it seems human beings have been wearing clothes from 83,000 years to 1,70,000 years ago. The natural question you might ask is how the researchers came up with this date. The earliest clothes human beings worn were probably made of animal hides. If animal hides were the first dresses for human beings, it can get decayed and it makes it difficult to find the exact time since which human beings wore these clothes.

This would mean we look at some other means. Archaeologists had found the hide scrapers and put the date of earliest hide scrapers to 780,000 years. The problem with saying that the clothes would have been worn since then is that animal hides were used by human beings for various other purposes other than clothing. So, the animal hide scrapers could have been used to take animal hides for shelters. We also know that eyed needles existed atleast 40,000 years ago. But, the problem in putting that as the date from which we began clothing is that early clothing might not have needed the use of needles. So, the invention of needle just indicates the existence of tailored clothing, but not necessarily clothing itself. The other evidence we have with regard to clothing is that we now know that human beings lost body hair 12,00,000 years ago and clothing was



Woven silk textile from tombs at Mawangdui, Changsha, Hunan province, China, from the Western Han Dynasty, 2nd century BC

probably not needed when we had body hair. Only when we dropped body hair, did we need clothing to protect ourselves from the cold temperatures. Though there is no single reason that indicates why we are the only primate without dense bodily hair, dropping body hair probably provided human beings the advantage of agility to move and also protected us from blood sucking leeches/ lices. Given that presence of body hair would have meant that clothes were not required, human beings were supposed to have started wearing clothes from 40000 years ago to 12,00,000 years ago. This gap is quite wide and research has happened in other field to come up with a more precise date.

An interesting finding from the field of molecular biology has indicated a more precise date of start of human clothing. This research has identified the start of human clothing by identifying the divergence of two lice – clothing lice and head lice. The head lice prefer to stay in human head while the cloth lice prefer to live in clothes of human. The findings are based on few assumptions. Assumption one is that the clothing lice would have diverged from head lice only after human beings started wearing clothes. This does seem to be a reasonable assumption. The other assumption is that the changes required to be made in the genes of related species happen at a somewhat constant rate. Given these two assumptions, the researchers analysed the degree of divergence on the genetic content of head lice and cloth lice. The changes in genetic content of these two lice were identified and the time at which the cloth lice emerged has been estimated as roughly between 83,000 to 1,70,000 years. Interestingly, this also coincides with the outset of ice age (Marine Isotope Stage VI) which is estimated to have occurred between 1,30,000 to 1,90,000 years ago. The invention of clothing could thus have also helped human beings living outside tropics to cope with cold stress caused from this age onwards. Thus, clothing could be one along with invention of other technologies that was the reason that has helped in evolution and survival of human beings.

We thus have some answers to why and when we started clothing ourselves. But, there are various other questions remain: Why do we cloth ourselves with ornaments? What are the different materials that are used historically to cloth ourselves and which of them was used when? How are/were demand and supply of such materials for clothing dealt with? and so on. Not just these questions, there are also questions like why don't sport person wear cotton clothes? We can look at these questions in future articles.

Do You Know?

1. Do yoga and meditation actually cause internal changes in the brain?

2. If a human could be fed with energy via USB ports rather than food, how long would it take to fully charge an average human being with, say, 1000 or 2000 calories of energy?

3. Do other mammals have blood types like human beings do?

4. In the deep oceans where the pressure may be very high, why are the creatures which have evolved there not simply crushed by the force?

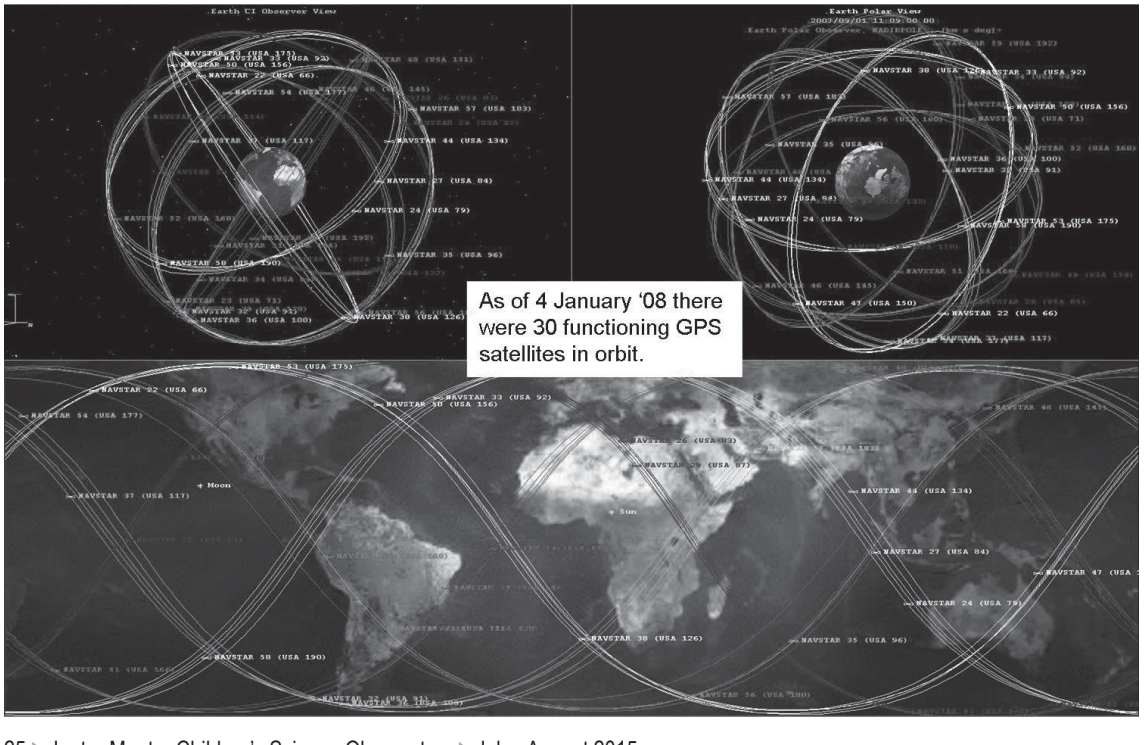
5. How do amateur astronomers discover comets?

Answers to last issue's Do You Know?

1. We send up so many satellites into space. Can they collide?

Ans: There are actually hundreds of thousands of objects in space. In fact, there are an estimated half a million pieces of what is called space debris, particularly in low Earth orbits. These are not the communication satellites that we use for broadcast or for mobile phone calls around the world, but the sort of satellites that observe the Earth. For instance, the International Space Station is in this particular orbit.

Now, these half a million objects vary from little flecks of paint to big objects. Even these flecks of paint can cause severe damage: imagine things going around the



Earth at almost 8 meters per second. The biggest of these is about 20,000 pieces of space debris and this is tracked carefully using radar. It sounds like a lot but the Earth is pretty big. Of course we do not want to hit one of these when we are launching a satellite. So, we launch into orbits where there are no stuff. For this it is important to track the debris continuously. We do not know where tiny bits like flecks of paint are. But then the probability of hitting a fleck of paint is low.

So, when we are planning an orbit for satellite, it is basically about how fast and exactly the sort of the angle we shoot it up over the Earth at. Coming to telecommunication satellites, they sit in what are called geostationary orbits. Essentially, they orbit the Earth at the same speed as the Earth rotates. They sit above the same part of the Earth all the time. These satellites actually have to navigate their way through the space debris without hitting the low-Earth satellites that are orbiting. This is actually planned and sometimes they have to divert their course. Imagine crossing the road, when you have to weave between the traffic, this is what they do to get up to their high orbit. These are all things taken into account, while planning a launch.

2. We usually feel the forehead or neck of a person to check for fever. Does fever raise temperature equally over the entire body?

Ans: Let us first ask why we run a temperature at all. We get fever because some chemical is being produced in our body that triggers the brain's temperature regulating centre called hypothalamus. It says, turn up the thermostat.

Why does this happen? Usually, this happens because of an an infection. When

microorganisms cause inflammation, they damage tissues. They release various inflammatory chemicals and also, particles from the surfaces of the microorganism. The bacteria for instance have chemicals called lipopolysaccharide, LPS, which is part of the wall of the bacterium. This triggers the hypothalamus to sense that there is an infection and it turns up the set point for body temperature. This triggers the release of more thyroxin which increases metabolic rate and that makes one hotter. It also triggers release of adrenalin which increases metabolic rate and that makes one hotter, it causes blood to move more towards the centre of the body, slowing down the rate at which one loses heat. This puts your temperature up.

There are other reasons why one might run a temperature, but those are the most common reasons. This means that the core body temperature will go up and usually, it can go up from a normal of about 37 degrees C to perhaps 40. The highest ever recorded temperature in a human being actually was 45 degrees and they survived. But most people cannot go much beyond 40. The body does this because when you

increase temperature, you make it harder for infecting microorganisms to grow. You make it easier for your white blood cells to move around, and you therefore frustrate the bug and benefit the body. So, it is a kind of defensive mechanism.

This cannot happen equally everywhere for the simple reason that one is shunting blood towards the core so the core will be warmer, but the peripheries may actually be shut down and be cooler. There will be a global increase in body temperature right across the body when one is running a temperature. So, if you put your hand on that person's forehead, yes, it is going to feel warmer.

Best measurements are made where there are body cavities close to major blood vessels. Such places are the mouth, rectum, under-arm and ear-drum. The forehead is often used because it is the least invasive. But the best way of measuring temperature is to get the core temperature; for this using the thermometer is a must. For this, oral or under-arm measurements are preferred although the rectal measurement is most accurate.

3. Sometimes rain has a certain smell and sometimes it does not. What is it that is giving the rain its smell?

Ans: Rainsmell is called petrichor because petros in Greek means rocky and chor means smells. Nobody really knows why this happens. In the 1970's, a scientist named Nancy Gerber did some chemical experiments and made some measurements.

Gerber found that there were several chemicals, some of which coincide with a soil microbe called actinomycete. These filamentous bugs live in the soil and grow throughout the soil. They break down

various detritus and a product of their metabolism are these chemicals.

When the raindrops come down, they splat into the ground and they elevate particles of these microorganisms, their by-products and their metabolic waste into the air and it happens to have this kind of smell. One name given to it is geosmin after one of the chemicals. Scientists believe that as the drop hits the ground, it compresses and captures a little bit of matter and air (some bubbles) as it lands. This then has to come bubbling up through the liquid. As it does so, it carries with it some of these particles from the soil. Like from an aerosol spray they get distributed out into the air. Then you smell them.

This does not happen all the time, so presumably, for the smell the conditions need to have just the right weight of rain and the right kind of soil. If you have had relentless rain day after day, it has damped down all the particles probably anyway. They have all been washed away or you are already used to the smell. Thus if you had a long pronounced dry spell, lots of the chemical is in dry soil, easy to release into the air. As rain comes down, they splat up

into the air, you breath it and then you really notice. That is what geosmin is supposed to be.

4. When we make ice cubes at home they are always white, but I have seen clear ice cubes in restaurants. How can we make clear ice cubes?

Ans: First of all, why is ice not clear? Snow is ice but looks white, whereas ice on a pond is transparent. Why this difference?

Well, snow particles are lots of tiny ice crystals. If you have lots of tiny crystals, when light goes into the crystals then it gets reflected and it gets bounced about all over the place and all of the different colours of light come back towards you. That is why it looks white because when you mix all those colours together, you get white light.

So, when you have an ice cube that is not clear, it is because there are lots of little, either fractures in the ice cube or more commonly, lots of little crystals that have all formed to produce one giant ice cube.

How then can you end up with a single ice cube that is a single crystal which is what you need in order to not disrupt the path of the light? You need to do what is called nucleation, the formation of the ice cube from one position only.

In fact, when you are making a jet engine, you need to do exactly the same thing because when you make the metal parts of the engine, the strength is in growing your engine parts as one single metal crystal. So, you pour molten metal into a mould and then you drop in, or you initiate, one tiny form of crystal into one place and the whole thing then crystallises following the same crystal structure.

So, in an ice making machine, usually, there is a stainless steel tube which will conduct heat really well. First, you make that cold. So there is a central core which is also cooled and this way, there is a lot of surface area in contact with ice. This makes the temperature drop really fast, so the freezing process starts around that central cooling probe. The crystal will then grow out from there towards the margins. Therefore, you are more likely to have a single crystal, and hence more likely to have nice clear ice.

This is one reason why such ice cubes are circular shaped, with a hole in the middle. Because that way, you have got as much contact of the metal that can take the energy away from the water, as possible. This drops the temperature quickly and you make ice cubes fast. The by-product is that you generally get them starting the freezing process in one place. They nucleate from one place, you get one crystal, nice clear ice.

For the same reason, if you happen to drop and break a clear water-glass so it shatters, you will get white fragments, not bits of clear glass.

5. Can one sneeze in sleep?

Ans: There is no reason why you should not sneeze in your sleep.

What happens when we sneeze? You have a circuit in your brain which detects movements or irritation of the lining in your nose. There are many tiny hairs there which if tickled or plucked, strongly stimulate this reflex. These signals go back to the brain

stem which connects the spinal cord to the top part of the brain. This is where we have the centres which control breathing, coughing, blinking, the amount of saliva and eye secretions and tears. Sneezing and hiccupping is coordinated there as well.

When we're awake, particles, allergies or an illness can stimulate the nerve cells in the nose. The nerves then send signals to the brain in order to initiate a sneeze to get rid of whatever is irritating it.

But during a certain stage of sleep called REM (rapid eye movement) sleep, certain neurotransmitters shut down—this is called REM atonia. This means that the motor neurons are not being stimulated, so they aren't sending these signals to the brain.

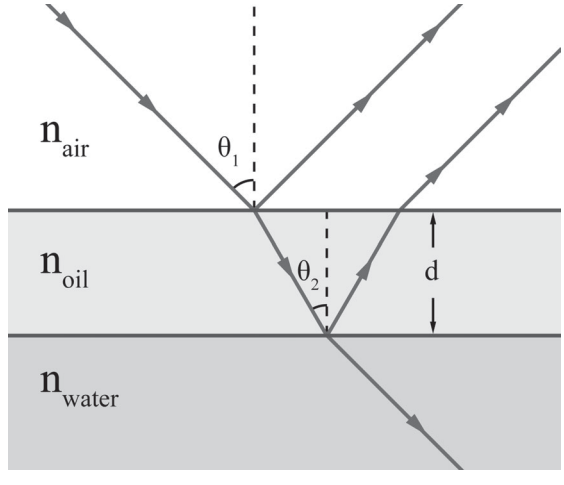
It is possible sometimes that you receive enough stimulation to sneeze while you are asleep. But the amount required would wake you up long before you could actually sneeze!

Of course, if you are in very deep sleep, there is no reason why you should not sneeze, though you may not remember doing it when you awaken.

6. Why does petrol create a rainbow on water?

Ans: When you see an oil film on the road on a rainy day, it gives rise to bands of beautiful colours. Small amounts of oil are usually present on the road surface (for instance, lubricating oil from cars). When it rains, drops of oil float on the layer of water that collects on the road because the density of oil is less than that of the water. This is the same reason that wood floats on water. Commercial oil formulations usually contain an additive that causes the oil drops to spread out into a thin film atop the water. That film is thickest in the center of the patch, or oil slick, and thinnest at the periphery.

Both the top and bottom surfaces of this oil film can reflect light. If the path difference between two light rays is a multiple of the wavelength, there will be what is called constructive interference. A



light ray will pass through different thickness of oil when the angle of reflection varies. The wavelength corresponding to the constructive interference also differs and this causes the reflected light to have various colours. As a result, a rainbow-like colour pattern is shown on the oil surface and this phenomenon is called thin-film interference.

In the figure, the interference between the two outgoing light rays that have been reflected from the top and bottom of the oil/petrol film causes the effect.

Sources: Science Forum, Cambridge University; Scientific American; Physics World

Science News

Headlines

- Earth's close cousin: Exoplanets
- How the brain purges bad memories
- Forests suck up less carbon after drought
- How T. Rex kept its teeth sharp
- World's largest modern wooden building

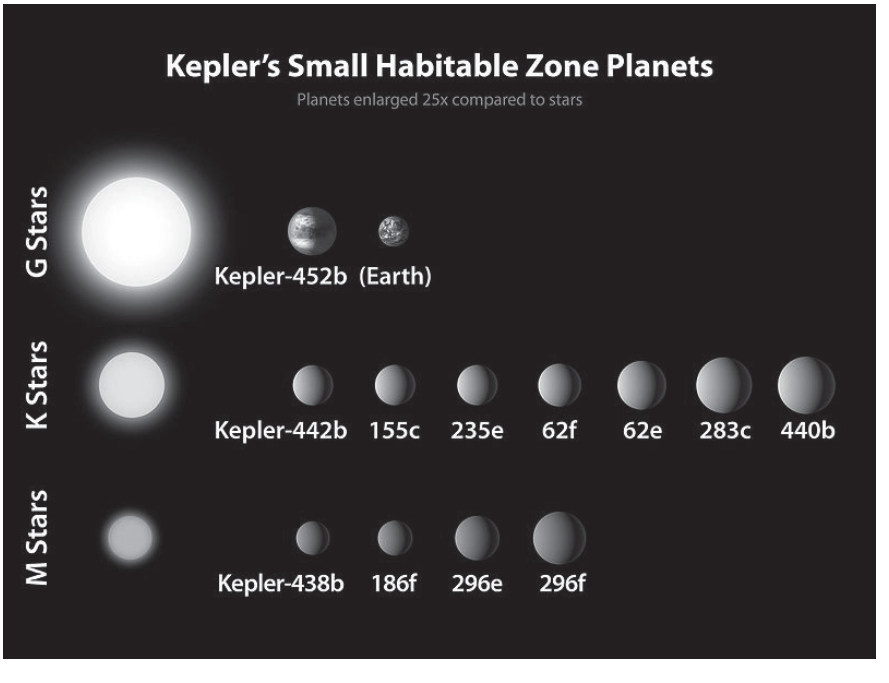
Read more about them below.

Earth's close cousin

The Kepler Space telescope has recently (July 23, 2015) found an exoplanet orbiting the G-class star Kepler-452. It is the first potentially rocky super-Earth planet discovered orbiting within the habitable zone of a star very similar to the Sun.

The planet called Kepler-452b is about 1,400 light-years away from the Solar System. At the speed of the New Horizons spacecraft, about 59,000 km/h, it would take approximately 26 million years to get there. So it is not very close by.

The planet takes 385 Earth days to orbit its star. It is 60% bigger than Earth, and lies within the conservative habitable zone of its parent star. It has a probable mass five times that of Earth, and its surface gravity is twice Earth's. The clouds on the planet would be thick and misty, covering much of the surface as viewed from space. From the surface, its star Kepler-452 would look almost identical to the Sun as viewed from the Earth.



The surface gravity of Kepler-452b is considerably stronger than the pull people are used to on Earth. Any hypothetical explorers would thus feel about twice as heavy on the alien world as they do on Earth. The high-gravity environment would probably lead to significant changes in the bodies of Kepler-452b colonists over longer time spans.

How the Brain Purges Bad Memories

A brain circuit has been found that allows us to forget fear and anxiety, according to a recent article in the journal Science.

The brain is extraordinarily good at alerting us to threats. Loud noises, noxious smells, approaching predators: they all send electrical impulses buzzing down our sensory neurons, triggering our brain's fear circuitry and, in some cases, causing us to fight or flee. The brain is also adept at knowing when an initially threatening or startling stimulus turns out to be harmless or resolved. But sometimes this system fails and unpleasant associations stick around, a malfunction thought to be at the root of post-traumatic stress disorder (PTSD).

New research has identified a neuronal circuit responsible for the brain's ability to purge bad memories, findings that could have implications for treating PTSD and other anxiety disorders.

Like most emotions, fear is neurologically complicated. But research has consistently implicated two specific areas of the brain as contributing to and regulating fear responses.

The amygdala, two small arcs of brain tissue deep beneath our temples, is involved in emotional reactions, and it flares with activity when we are scared. If a particular threat turns out to be harmless, a brain region behind the forehead called the prefrontal cortex steps in and the fright subsides.

Our ability to extinguish painful memories is known to involve some sort of coordinated effort between the amygdala and the prefrontal cortex. The new study however, confirms that a working connection between the two brain regions is necessary to do away with fear.

Until now investigators were unsure whether the amygdala–prefrontal cortex communication pathway could on its own control fear extinction. Both structures interact with many other brain regions, and so isolating their effects of on behaviour was a challenge. A technique called optogenetics has made the discovery possible, allowing scientists to precisely assess the connection between the two brain regions in real time, providing a more accurate correlation between neuronal activity and behavior.

Forests Suck Up Less Carbon after Drought

How do trees respond to drought? It is generally known that drought damages trees, and that it can take a while for trees to repair this damage and recover. Measuring this damage is important.

According to a report in the journal Science, ecologists recently examined tree ring data from more than 1,300 sites around the world. By comparing the rings with known drought records they found that trees do not simply return to normal as soon as rains return. Drought actually puts the trees' water transport systems under a huge amount of tension, causing air bubbles to leak in, which damages or blocks those pipes. It is a sort of a heart attack for a tree. In some cases it can be lethal and in some cases that blockage can be repaired.

That drought effect can cause tree growth to lag five to ten percent below

normal for several years following the dry spell. This is a problem because forests currently take up about 25 percent of human emissions of carbon dioxide (CO_2). The less CO_2 the trees are able to take up the warmer it gets.

This study makes it clear that predicting climate change is hard. These models have a challenging task of representing processes that occur from a leaf scale to a continent scale in space, and from several seconds to hundreds of years or at least a hundred years in time. Perhaps a better understanding of how much carbon trees soak up, and how much they do not, will make climate forecasting just a little bit easier.

How T. rex kept its teeth sharp

A group of carnivorous dinosaurs have been found to have much more complex teeth than previously expected. Known as theropods, this group includes the most well known of dinosaurs: the Tyrannosaurus rex, as well as several other equally vicious species, all of which dominated the food chain in different periods.

Scientists cut open fossilised teeth from eight different species of theropod. The cut surfaces were studied using an electron microscope, which revealed a surprising level of complexity. On the outside, the teeth have large serrations – a series of bumps to help slice through flesh, like those you would find on a meat knife.

Normally, these would cause the teeth to weaken and wear away over time, which would leave the animal unable to feed. To counteract this, theropods evolved unique arrangements of the two main tissues that make up teeth, dentine and enamel, to strengthen each serration and prevent erosion. Armed with this dental adaptation, the teeth maintained their flesh-tearing properties for much longer, helping the theropods to stay at the top of the food chain.

Tooth structures like these had not previously been seen in meat-eating dinosaurs, although they are present in the teeth of the present-day Komodo dragon, which has a feeding pattern similar to its theropod ancestors.

Herbivores, animals that eat exclusively plants, often have well-developed teeth, as chewing plant matter can otherwise cause very rapid dental erosion. However, meat is far softer and easier to chew, and so a much simpler tooth construction was expected. Unlike us, reptiles have a constant cycle of teeth, with a 'spare set' forming in their gums at all times, getting ready to replace the ones that currently being used when needed.

There are still many more types of Theropod that are yet to be investigated,

providing an obvious future step for scientists. However, more intriguingly, there is also potential to investigate the teeth of early birds, as they too have been found to have serrations, used for similar meat-tearing purposes. This analysis has been presented in the journal 'Scientific Reports'.

World's largest modern wooden building

The Woodproject, a building project in Hackney in London is going to use more than 3,5000 cubic meters of wood. A method of layering wood with glue solves many of the problems with building with wood, providing a light, low carbon option.

This is a laminated sort of wood, but

unlike plywood, rather than just lots of thin layers, you have here strips of wood which are aligned at right angles to one another and all bonded together using an adhesive and a big press. That gives enormous strength, because wood is strong in one direction but weak in another. By putting them at 90 degrees to each other, we effectively share the benefits of both directions.

Wood, in its natural state, starts to shrink in different ways and twist and bend. If you artificially bond it together, you can make flat boards stay flat for a long time.

There are two important reasons for such wood based constructions. One is that we need to produce a lot of carbon dioxide when making concrete, so environmentally wood is more friendly. The other is that many such city developments are situated over many holes under the ground like the Metro, and hence need to be lightweight buildings.

The builders claim that these wood buildings can last longer than concrete if treated properly.

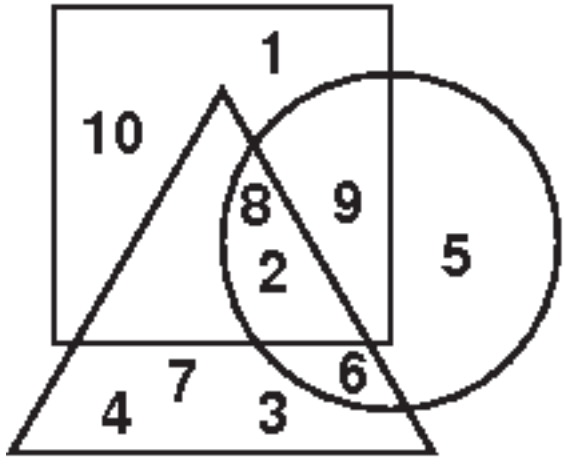
The pictures show details of the Wood Innovation and Design Centre, a 6-storey, nearly 100 foot-tall, 51,000 square foot structure built almost entirely out of engineered wood components in Prince George, British Columbia, Canada. Most appropriately, it houses the local University's wood engineering program, and was completed last October. There are other such large wooden buildings around the world, in U.K. and in Australia, and more people are getting interested in the concept.

Sources: Science, Scientific Reports, Scientific American, Science News.

Brain Teasers

Get the tennis ball

Your last good table tennis ball fell down into a narrow metal pipe embedded in concrete one foot deep. How can you get it out undamaged, if all the tools you have are your tennis bat, your shoe-laces, and your plastic water bottle, none of which fit into the pipe?



Lotus Count

A lotus pond has a healthy growth of lotuses. Every day the number of lotuses in the pond doubles. On the 24th day, the lotus pond was 1/2 full of lotuses. When will the pond be full of lotuses?

Adapted from brainden.com

Answers to last issue's Brain Teasers

Find the numbers See the figure.

Triangle Sums The four totals are eighteen, twenty, twenty four and twenty six.

The solutions that adds up to 18 is shown in the figure. The solution can be read row-wise as (6,1,7), (9,3,4,10), (8,2,5). The other possible solutions, reading row-wise from the top are

(4,9,5), (7,1,2,8), (6,10,3) adding up to 20,

(9,6,2), (4,8,7,3), (1,5,10) adding up to 24, and

(5,10,4), (2,8,7,1), (3,9,6) adding up to 26.

Adapted from the book by Steve Ryan