

JEREMY



**SPECIAL SECOND SEMESTER
CALENDAR EDITION**

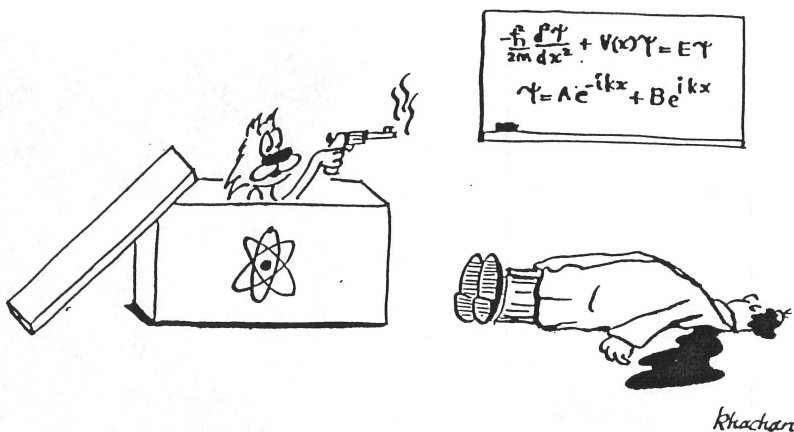
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Finally ... Schroedinger opened the box

Editorial

Welcome all, to this, the all new Second Semester issue of Jeremy.
You failed your post examinations... Oh well, better luck next time.

As promised Jeremy is running several competitions. You could win big prizes so you had better read on. But whatever the outcome pull out those bigger brains and submit those entries! We are still running the Physicist of the Year Competition with awards galore, whether you are an artist, a mathematical genius or just plain good.... You will be a winner!

Finally Finally.. Send in those DOODLES, prose, poems, songs, pictures and of course serious physics questions and articles. BECAUSE you might be crowned "Physicist of the Year 2000 minus 1" and because we need something to publish in the next issue.

Just sit back and enjoy.



JOKES

Two cats are on a roof. Which slides off first?
The one with the smaller mew (mu).

A neutron walks into a bar; he asks the bartender,
"How much for a beer?"
The bartender looks at him, and say
"For you, no charge."

Two atoms bump into each other. One says
"I think I lost an electron!"
The other asks, "Are you sure?", to which the first replies,
"I'm positive."

Heisenberg is out for a drive when he's stopped by a traffic cop.
The cop says "Do you know how fast you were going?"
Heisenberg says "No, but I know where I am."

THE KINGS REPORT

Welcome back... I bet you are all excited to be here and I trust you did not think about Physics during the break! Not even for a nano-second plus or minus 10% with error bars!

As you can see the Jeremy team have patched together another splendid editorial masterpiece. A special thank you to all the loyal subjects who submitted cartoons, made suggestions and provided jokes. Your work, as you can see is in now published upon the pages of this prestigious journal.

Now due to popular demand an ASTRONOMY PARTY NIGHT! is planned. Towards the end of the semester the King will be hosting a night of astronomical proportions! The planets Saturn and Jupiter will be visible in the mid-evening sky. A guest speaker will talk, some light supper will be served and we will all peer through telescopes into the clear pristine skies over Sydney. The Kings Astrologer will be present to tell of fortune etc... Our talks organiser Aioni will announce further details after the mid-semester break.

No one ever reads the Kings Report so I thought I would test my theory by running a simple competition with cash prizes. If you step outside the Palace and gaze back upon the architectural splendor of the Physics Building you will notice the names of many a physicist. You will also find some other names in the central foyer. And if you carefully look you will perceive that there are some blank spots. You will also discover that they are all old dead physicists, mostly pre-1920s. These amazing facts were pointed out by Professor XXX whilst gazing upon the city skyline and it was suggested that we ran a competition. Well here it is. A) Twenty Dollars to the first email I receive guessing who Prof XXX is (Note - Professor XXX is ineligible). B) Twenty Dollars to the 30th email I receive with all the names around the building and in the central foyer (Note - The names must be ordered from east to west AND you must use a university email account AND only one email per entrant OR you will be digested in the moat!). C) Two Twenty Dollar prizes for the New Names Contest. As stated in the aforementioned there are some blank spots that need to be filled. So email me your top three names to fill in the holes. Some process will occur and two winners will be triumphant! One stupid entry and one sensible entry. The Kings decision will be final in all matters pertaining to the judging... remember this is no democratic establishment!

Well until the next edition, I leave you in the hands of the editors. And I'll have a word to them about the next editions cover!

King Fletch

July 1994
**PARTICLE
PHYSICS**
BOOKLET

From the Review of Particle Properties
Physical Review D50, 1173 (1994)
(Next edition: July 1996)

Particle Data Group

M. Aguilar-Benitez, R.M. Barnett, C. Caso,
G. Conforto, R.L. Crawford, S. Eidelman, C. Grab,
D.E. Groom, A. Gurtu, K.G. Hayes, J.J. Hernández,
K. Hikasa, G. Höhler, S. Kawabata, D.M. Manley,
A. Manohar, L. Montanet, R.J. Morrison, H. Murayama,
K. Olive, F.C. Porter, M. Roos, R.H. Schindler,
R.E. Shrock, J. Stone, N.A. Törnqvist,
T.G. Trippe, C.G. Wohl, and R.L. Workman
and Technical Associates:
B. Armstrong, K. Gieselmann, P. Lantero, G.S. Wagman

AIP

AMERICAN INSTITUTE OF PHYSICS
Available from LBL and CERN

NOTES

Errata

The "centimeters" on the ruler on p. 227 of the Booklet are 0.97 cm long, because:

- The booklets were returned from the printer at 0.25 times the speed of light;
- A theorist is in charge of the Particle Data Group;
- The PDG feels it has the right to redefine anything it wants;
- There is a general decline of standards;
- There is an international conspiracy;
- It was a congressionally-mandated cost saving measure;
- PDG gives you more cm/inch than anyone else.

SOME ADVICE FOR FIRST YEAR STUDENTS

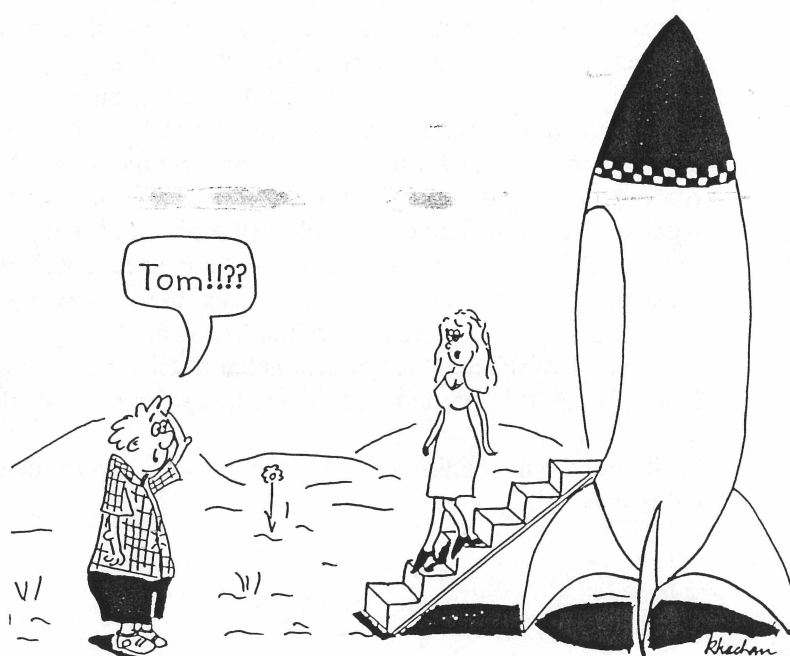
So you have to do an end of year experiment in Physics! Well why not try exploring this one!

Does Antimatter Fall Up or Down?

This question has never been subject to a successful direct experiment. In other words, nobody has ever directly measured the gravitational acceleration of antimatter. So the bottom line is that we don't know yet. What an ideal end of semester experiment. However, there is a lot more to say than just that, with regard to both theory and experiment. You might even get a Nobel Prize! Good luck and we look forward to your report!

PHYSICS TRIVIA QUIZ

1. Complete this quote from Albert Einstein :
“...politics is for the present, but an equation is something...”
2. Galileo's influential book The Two New Sciences is written as a discussion between three characters. What are their names?
3. Of the four bright stars in the Southern Cross, which one is closest to the Earth?
4. The second is defined in terms of the frequency of light emitted by a certain type of atom. Which atom?
5. What are the two largest members of our local group of galaxies?
6. A superconductor is a material which conducts electricity with no electrical resistance. What was the first superconductor discovered?
7. In what year was the greenhouse effect first proposed?
8. If you hold two credit cards together and look at a filament light bulb through the narrow slit between the cards, you can see coloured fringes around the light. What process causes this?
9. Quarks are elementary particles which make up other subatomic particles such as protons and neutrons. What is the heaviest known quark?
10. kilo is the prefix used for 1,000, and mega is the prefix used for 1,000,000 (e.g. kilogram, megabyte). What is the prefix for 1,000,000,000,000,000,000,000,000?



The relativistic twin paradox finally resolved

ERRATUM

The past orbit of Halley's Comet by T. Kiang was published in *Memoirs of the Royal Astronomical Society*, Volume 76, part 2, pages 27-66.

Page 39, Table VII, column 3, 11 lines down.

These characters were printed upside-down and should appear as follows.

開元占經

Dr Tim Bedding

Our Feature Lecturer whom so educates the masses.



"Since I am in a philosophical mood this equation here belongs to a class of equations describing forces."

"The world is not as kind as the real theory"

"In physics we want to know who or what does work. It's not the students!"

"... Maxwell's equations, which I happen to have here. I never go anywhere without them."

"That just shows you that physicists use words in stupid ways."

"Take a plastic rod and a piece of dead cat."

"If you want you can copy them out and leave"

"If you need to know this charge here aall you need to know is all the other charges in the universe. Tedious but straight forward."

"We use them because they make our lives intersting... I was going to say lazier... but maybe not. Anyway... the water molecule looks like Mickey Mouse."

"Why that happens is up to the Chemists to explain.... I never did like Chemists!"

Historical Quotes

"Professor Goddard does not know the relation between action and reaction and the need to have something better than a vacuum against which to react. He seems to lack the basic knowledge ladled out daily in high schools." (1921 New York Times editorial about Robert Goddard's revolutionary rocket work.)

"Very strange people, physicists - in my experience the ones who aren't dead are in some way very ill"

(Mr Standish "The Long Dark Tea-Time Of The Soul" by Douglas Adams)

Deep Time : How Humanity Communicates Across Millennia – A Review

Physicist Gregory Benford of the University of California is one of the people most concerned with the messages and monuments which are passed from age to age. On Tuesday the 24th of August he gave a public lecture on what has survived from previous epochs, and what our culture is leaving for the future.

Prof. Benford contended that a culture lasts roughly one thousand years, and it is difficult to communicate over a longer time scale. Written works, particularly scriptures, are often passed on, but they have to be translated and copied. Inevitably something is lost in this process. Cultures of antiquity such as the Egyptians and Romans had great museums and libraries, but not one has survived to the present day. Most monuments and relics (such as six of the seven wonders of the world) were torn down for building materials. Even the monuments which survived, such as the pyramids and the Roman Parthenon, have lost their paintings and writings. I thought Prof. Benford was rather dismissive of the ability of religions to transmit the meaning of their sacred works, but I do recognise the difficulty of sending a specific message.

The talk then moved on to Prof. Benford's work in sending messages to the future. Near the Carlsbad Canyon in New Mexico is the site of the major American waste dump, which will hold most of the United States' nuclear waste for years to come. The U.S. Congress has ruled that the site must have clear warning signs, which anyone could work out, for the 10,000 years after it is filled in about 2020.

Congress' committee, of which Prof. Benford was a member, came up with several key recommendations. The first was that any message should be non-linguistic, as no one would be able to read English in a few millenia. The general idea is to make the whole site look menacing, in order to convey the messages "This site was man-made" and "This site is dangerous". Some ideas were sharp, hard rubble to discourage digging, jagged earthworks pointing out in a threatening fashion, a black granite surface which would absorb the sun's heat and get unpleasantly hot, and large jagged edge blocks.

At the centre would be an underground information room, to tell people that they were standing on a radioactive waste dump. There would be a plan of the underground site, cartoons warning people away, a periodic table of the elements showing the dangerous radioactive ones present (in case the discoverers knew some nuclear physics) and a map of the world showing other radioactive waste sites. I learnt that a primate skeleton or a snake are the two warning signs recognised by all human cultures (and also chimpanzees). There were some clever ideas for making the information durable. The world map and periodic table would be curved to let sand and water run off the edges.

One idea raised by the audience was that all this might pose an intriguing puzzle to later generations of humanity and actually make our descendants interested in the site. Perhaps we should just leave a bare, unmarked desert? Prof. Benford conceded that this would not be a bad idea, but that Congress insisted on leaving a message, and all the archaeologists, geologists and physicists were keen on the idea.

We then moved on to the Cassini spacecraft, presently on route to Saturn. In 2003 it will arrive at Saturn and send back heaps of pictures and data for a couple of years and land a probe on Titan, Saturn's big, interesting moon. Both the orbiter and the probe will carry a small (~5 cm) diamond message disc. The orbiter will only last a couple of centuries, but its pieces and the diamond disc will stay in a stable orbit for millions of years.

The disc has a description of the binary digital number system, a schematic map of the Solar System (with the distances from the Sun to the planets marked in units of the disc width !) showing that the probe came from the third planet, and a stereographic photo of the "Family of Man". This photo has a group of people representing all of humanity's major racial groups, standing on a beach with plants, shells and the ocean in the background, to show that the disc came from a living, watery world. One person is holding the diamond disc itself, so that the discoverer would know we had made the disc (and not the trees or the shells).

As Prof. Benford observed, we don't know whether we can communicate over such vast lengths of time, but it was fascinating to learn about how we are trying.

Edward Boyce.

BORED?

Well are you getting bored in those endless physics lectures? Why not try exciting the lecturer with some thought provoking questions. Or just simply ponder them yourself if you passed the earlier indicator test. Anyway listed below are some starter questions... Note to the geeks - So do plenty of research and ask around before you try to cook up a theory that'll answer one of these and win you the Nobel prize! You can expect to really know physics inside and out before you make any progress on these.

Condensed Matter and Non-linear Dynamics

1. What causes high temperature superconductivity? Is it possible to make a material which is a superconductor at room temperature? Superconductivity at very low temperatures has been understood since 1957 in terms of the BCS theory, but high temperature superconductors discovered in 1986 are still unexplained.

Cosmology and Astrophysics

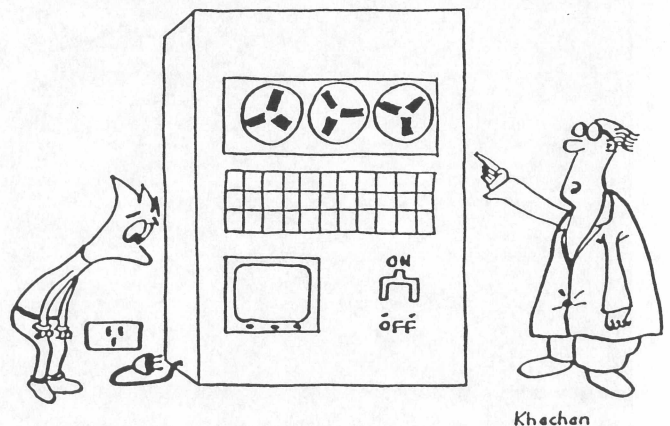
1. Why is there an arrow of time; that is, why is the future so much different from the past? If the universe is finite and it recollapses, will the thermodynamic arrow of time be reversed during the collapse towards the big crunch?
2. Is spacetime really four-dimensional? If so, why - or is that just a silly question? Or is spacetime not really a manifold at all if examined on a short enough distance scale?
3. Do black holes really exist? (It sure seems like it.) Do they really radiate energy and evaporate the way Hawking predicts? If so, what happens when, after a finite amount of time, they radiate completely away? What's left? Do black holes really violate all conservation laws except conservation of energy, momentum, angular momentum and electric charge? What happens to the information contained in an object that falls into a black hole? Is it lost when the black hole evaporates? Does this require a modification of quantum mechanics?

Particle and Quantum Physics

1. Why are the laws of physics not symmetrical between left and right, future and past, and between matter and antimatter? I.e., what is the mechanism of CP violation, and what is the origin of parity violation in Weak interactions? Are there right-handed Weak currents too weak to have been detected so far? If so, what broke the symmetry? Is CP violation explicable entirely within the Standard Model, or is some new force or mechanism required?
2. Why are there 3 generations of leptons and quarks? Why are their mass ratios what they are? For example, the muon is a particle almost exactly like the electron except about 207 times heavier. Why does it exist and why precisely that much heavier? Do the quarks or leptons have any substructure?
3. What are the gravitational effects, if any, of the immense (possibly infinite) vacuum energy density seemingly predicted by quantum field theory? Is it really that huge? If so, why doesn't it act like an enormous cosmological constant?

Then the Big Question

How do you merge Quantum Mechanics and General Relativity to create a quantum theory of gravity? Is Einstein's theory of gravity (classical GR) also correct in the microscopic limit, or are there modifications possible/required which coincide in the observed limit(s)? Is gravity really curvature, or what else -- and why does it then look like curvature?



"I believe this device is not working due to incorrect phase feedback in its multidirectional vector encoder"

CONFUSED?

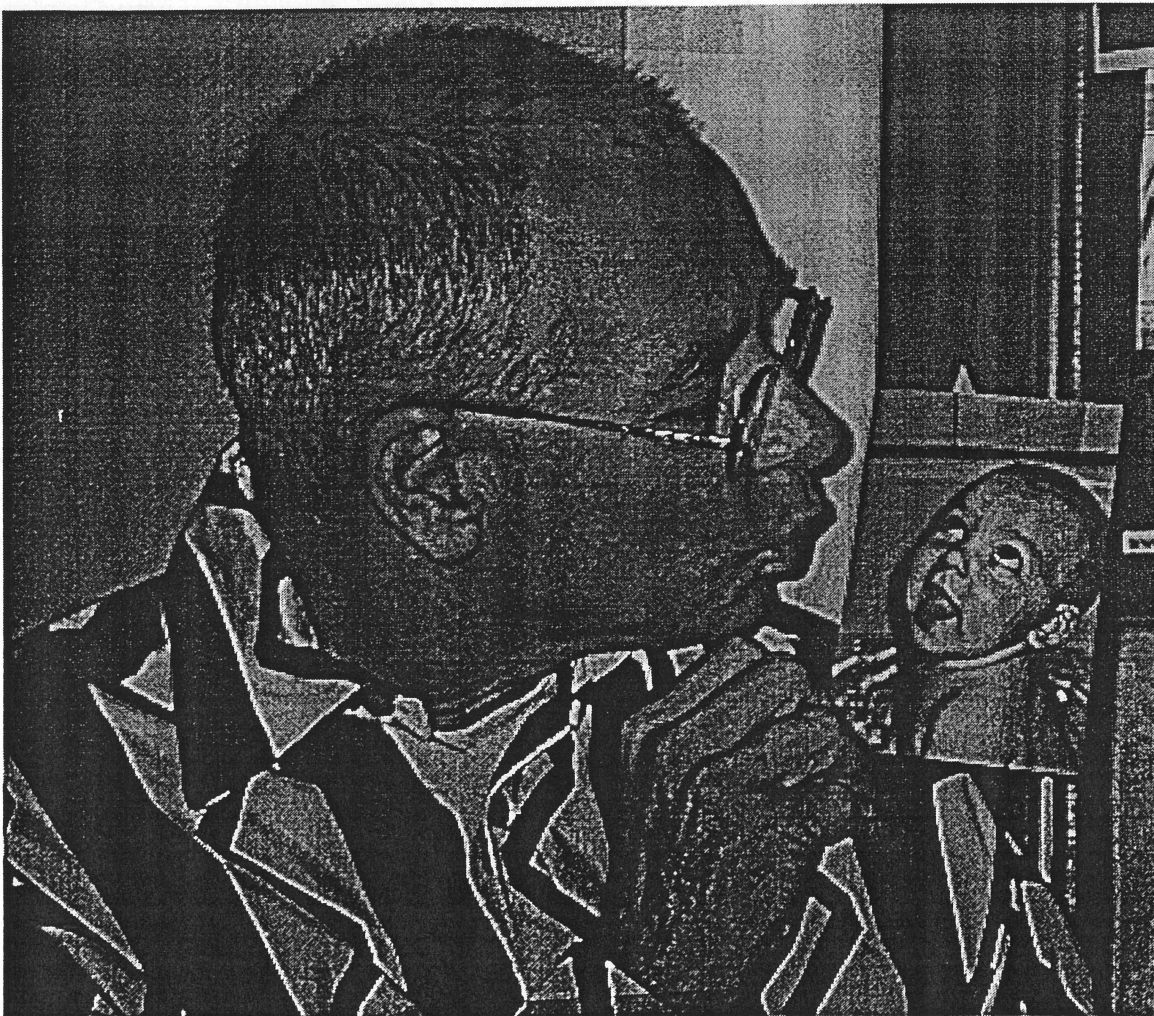
Are you wondering about your life? Pondering where are you going and who you are? Is it time to make that BIG ACADEMIC CAREER Choice or just reassure yourself. You never know... You might be a physics major...

This small list of indicators might help you remember or decide what you really are.

IF you have no life – and you can PROVE it mathematically.
IF you enjoy pain.
IF you know vector calculus but you can't remember how to do long division.
IF you chuckle whenever anyone says "centrifugal force."
IF you've actually used every single function on your graphing calculator.
IF when you look in a mirror, you see a physics major.
IF it is sunny and 30 degrees outside, and you are working on a computer.
IF you always do homework on Friday nights.
IF you know how to integrate a chicken and can take the derivative of water.
IF you hesitate to look at something because you don't want to break down its wave function.
IF you have a pet named after a scientist.
IF you laugh at jokes about mathematicians.

IF the Humane society has you arrested because you actually performed the Schrodinger's Cat experiment.
IF you avoid doing anything because you don't want to contribute to the eventual heat-death of the universe.
IF you consider ANY non-science course "easy."
IF when your professor asks you where your homework is, you claim to have accidentally determined its momentum so precisely, that according to Heisenberg it could be anywhere in the universe.
IF the "fun" center of your brain has deteriorated from lack of use.
IF you'll assume that a "horse" is a "sphere" in order to make the math easier.
IF you understood more than five of these indicators.
IF you make a hard copy of this list, and post it on your door

YOU MIGHT BE A PHYSICS MAJOR...?



DR KARL MEETS HIS MATCH

DOES HOT WATER FREEZE FASTER THAN COLD?

You put two pails of water outside on a freezing day. One has hot water (95 degrees C) and the other has an equal amount of colder water (50 degrees C). Which freezes first? The hot water freezes first! Why? It is commonly argued that the hot water will take some time to reach the initial temperature of the cold water, and then follow the same cooling curve. So it seems at first glance difficult to believe that the hot water freezes first. The effect is definitely real and some people claim to have duplicated it in their refrigerator.

This question is a favourite of popular science magazines where it is often referred to as the Mpemba effect after a Tanzanian student who observed it while making ice cream and raised the question in 1969. However, the folklore on this matter may well have started centuries ago when wooden pails were usual. Sir Francis Bacon, Descartes and even Aristotle are said to have remarked on it.

Every "proof" that hot water can't freeze faster assumes that the state of the water can be described by a single number, the temperature, but remember that temperature is a function of position. There are also other factors besides temperature, such as motion of the water, gas content, etc. With these multiple parameters, any argument based on the hot water having to pass through the initial state of the cold water before reaching the freezing point should be examined very carefully.

There are a number of factors which contribute to this effect. Each one of them may have greater or lesser significance depending upon relative temperatures, air conditions, container dimensions and material etc. Here we describe five of the most important factors. In any real situation a combination of these processes and possibly others may be at work.

Although detailed research has been done on some specific cases where hot water freezes faster than cold, the classic experiment with pails of water has probably not been studied in enough detail to establish the correct conditions for it to happen and the most significant causes of the effect. The answers given here should not be considered definitive without further studies. In principle it should not be difficult to devise the appropriate experiments to test the significance of the factors given, or even to do a good quantitative analysis of each one. If anyone ever does, please send us the results!

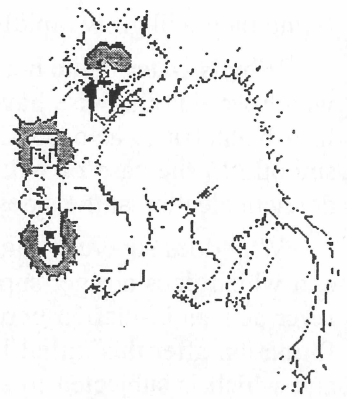
First Factor: Evaporation - The cooling of pails without lids is partly Newtonian and partly by evaporation of the contents. The proportions depend on the walls and on temperature. Evaporation is more important while the temperature is high and there is a large exposed surface area. If equal masses of water are taken at two starting temperatures, more rapid evaporation from the hotter one may diminish its mass enough to compensate for the greater temperature range it must cover to reach freezing. In one experiment, water cooling from 100C lost 16% of its mass by 0C.

The cooling effect of evaporation is twofold. First, mass is carried off so that less needs to be cooled from then on. Also, the temperature drops due to heat lost in causing the phase change from water to vapour (latent heat of evaporation).

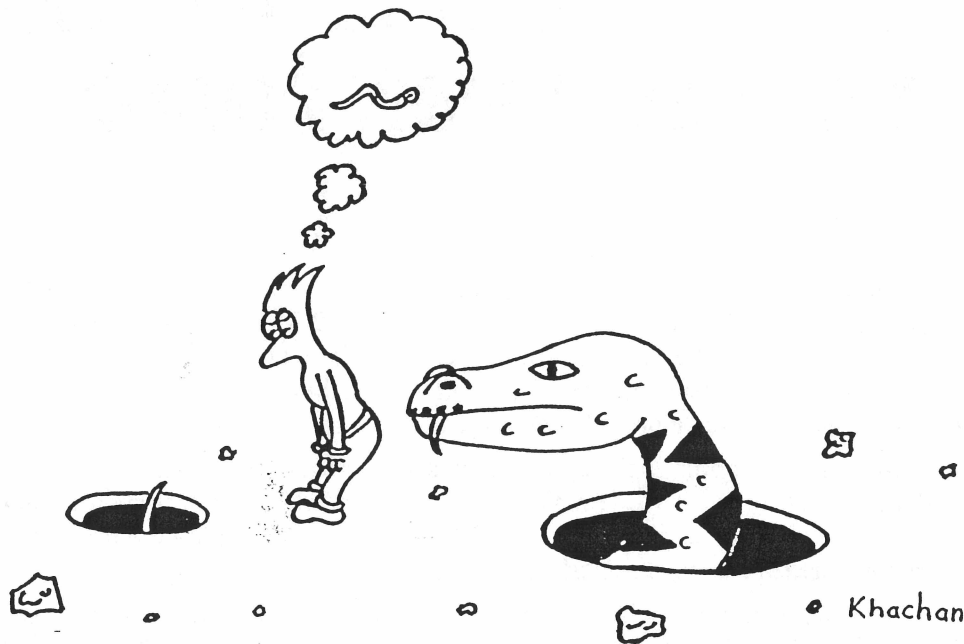
Thus experiment and theory agree that hot water freezes faster than cold for sufficiently high starting temperatures, if the cooling is by evaporation. Cooling in a wooden pail or barrel may often be predominantly by evaporation. In fact, a wooden bucket of water starting at 100C would finish freezing in 90% of the time taken by an equal volume starting at room temperature.

Second Factor: Supercooling - When water cools below 0C it does not always freeze. In some conditions it can undergo supercooling, remaining liquid at temperatures below its freezing point. Sometimes it may remain liquid at temperatures as low as -20C.

The reason is that ice crystals require nucleation points to start formation. Nucleation points may be gas bubbles, dust particles or a rough surface. If these are not present in the liquid then supercooling will occur until



A radioactive cat has 18 half lives



the temperature goes so low that ice crystals form spontaneously. Once they start to form in a supercooled liquid they will grow rapidly forming a slush which then freezes further to solid ice.

Why is water in the hot bucket more likely to supercool? Firstly, heating the water will remove dissolved gases which would otherwise have formed bubbles as the liquid cools, and which might have acted as nucleation points. In a bucket it is also possible that nucleation will start on the inner bucket surface unless it is very clean and smooth. In the case of wooden buckets the wood itself may retain sufficient heat from the initially hot water to delay nucleation at the sides.

Why does supercooling result in the hotter water freezing faster? First consider the water which started colder and which does not get supercooled. In this case a thin layer of ice is likely to form quickly on the surface. This layer acts as insulation between the water and the cold air and also prevents further evaporation. The rate of ice formation after this initial layer has formed is considerably slower. In the case of the water which started out hot and which is subjected to supercooling, the supercooled water no longer has this protective layer of ice. It loses heat at a much faster rate through its exposed surface. When the supercooling ends and it finally does freeze much more heat will have been lost and more ice will form than in the other bucket.

A considerable amount of experimental support has been offered for the significance of supercooling and some experts now believe that it is the most important factor in the cause of the Mpemba effect. However, most of these experiments have been carried out in rather ideal experiments. For example, sealed glass containers filled with water are plunged into freezing cold liquid. Such experiments are designed to produce supercooling and it is not clear how well they represent the classic case of water in a bucket.

Third Factor: Convection - A peculiar property of water is that it is most dense at 4C. If you start with a bucket of water at 4C and place it outside at a lower temperature, the water at the surface will cool rapidly. Because this water is less dense than the water below which remains at 4C, it will stay at the surface forming a thin cold layer. Under such conditions a thin layer of ice will form on the surface after only a short space of time, but this layer will then act as an insulator protecting the water below most of which is still at 4C. Further freezing is then very slow assuming that the bucket itself is made of a good insulating material.

The situation with the hot bucket is rather different. The surface water cools even more rapidly due to evaporation and the large temperature difference. However, the cooled water is now more dense than the hot water below. It sinks, pushing more hot water to the surface. Significant convection currents are driven by the water cooling from the surface and sinking. This circulation of water ensures that the temperature drops rapidly.

But why doesn't it reach a stable state with the water at 4C and then follow the same course as the colder water? This is a very good question! To explain the Mpemba effect through convection alone it would be necessary to show that hot and cold water currents are separated in the process and that convection can continue after the average temperature had dropped below 4C.

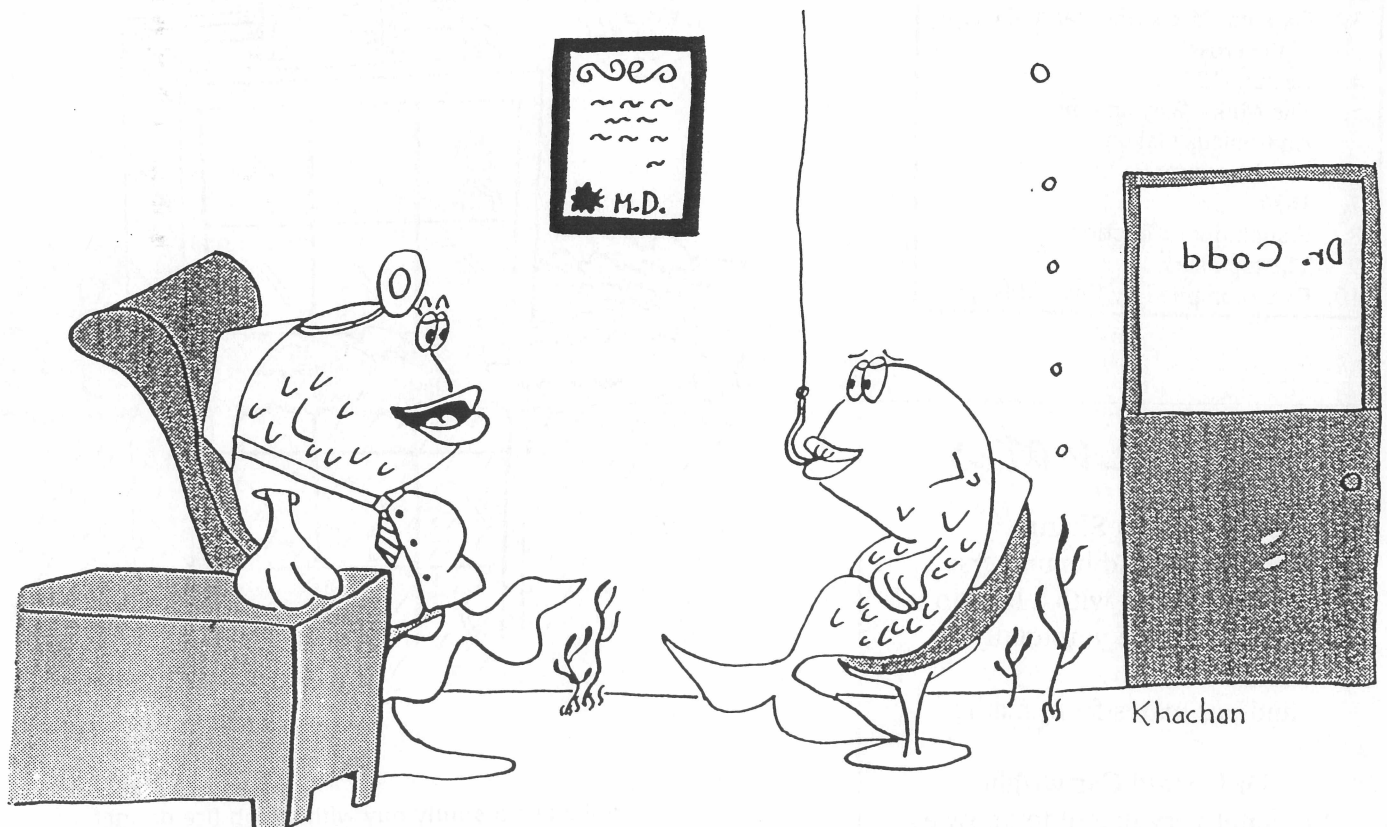
However, no experimental evidence has been found to support the hypothesis that cold and hot water are separated by convection in this way. If convection plays any role at all, it is more likely to be in aiding the rapid cooling down to temperatures of 4C.

Fourth Factor: Dissolved Gasses - Water always contains dissolved gases such as oxygen and carbon dioxide. These impurities have the effect of lowering its freezing point. When water is heated, much of these gases are driven out because their solubility in water is less at higher temperatures. When the hot water cools it then has less dissolved gas than water which was not heated so it has a higher freezing point and freezes first. This is often cited as a an important factor but no references to experimental evidence or quantitative analysis have been given.

Fifth Factor: Conduction - This final mechanism is more relevant to the case where water is placed in a freezer in small containers. In such circumstances it has been observed that the warmth of the hot water container can melt ice encrusting the surface on which it is placed. When this refreezes it creates a good connection between the container and the surface which allows much better conduction of heat than the frost on which the colder container rests. As a result, heat is drawn out of the warmer container more rapidly.

This factor can be easily tested by setting up the right conditions in a freezer.

Note - Some Dweeb submitted this question without putting their name on the scrunched pitiful yellow post-it note.



"Relax Stan - mouth pains aren't serious. If it bothers you again just take an asprin."

...QUOTES FROM THE UNKNOWN...

"An exam is a strange thing -- It's not the way things are done in the real world, and once you realise that, it's called cheating."

"Let's say I'm standing on one side of the road, and let's say that you're standing on the other side of the road, and let's say that you want to throw a rock at me."

"And if next Wednesday comes and you still don't know how to do this problem, then you should drop the course."

"I will not try to bludgeon you with this."

"This is the cute way I would like to introduce the Coriolis force."

"Just think about the wheels as blocks."

"Let's complete our numerical calculus experience by investigating... where I can get more chalk."

"This problem here is a problem that will scare you to death."

"Suppose we live on a cylindrical world."

"If you were gonna set up integration for this, you would really want to look for other employment."

"There are some words we use that are not in anybody's spell-checker."

"If you set up integration for this problem, it would be a painful experience."

"Don't be so constipated about this."

"The unit vectors are the hat guys."

Do you recognise your Quote?

PHYSICS TRIVIA QUIZ

Answers :

1. for eternity
2. Sagredo, Simplicio, Salviati
3. Gamma Crucis (the star at the top of the cross)
4. Cesium-133
5. The Milky Way and the Andromeda Galaxy
6. Solid mercury
7. 1827
8. Fraunhofer diffraction
9. The top quark
10. Exa (compiled by Edward Boyce)

More Quotes

Dr Manju Sharma

"... this engine and its universe..."

"consider a cavity with a hole in it"

"Did I confuse you totally?"

and our mates from maths

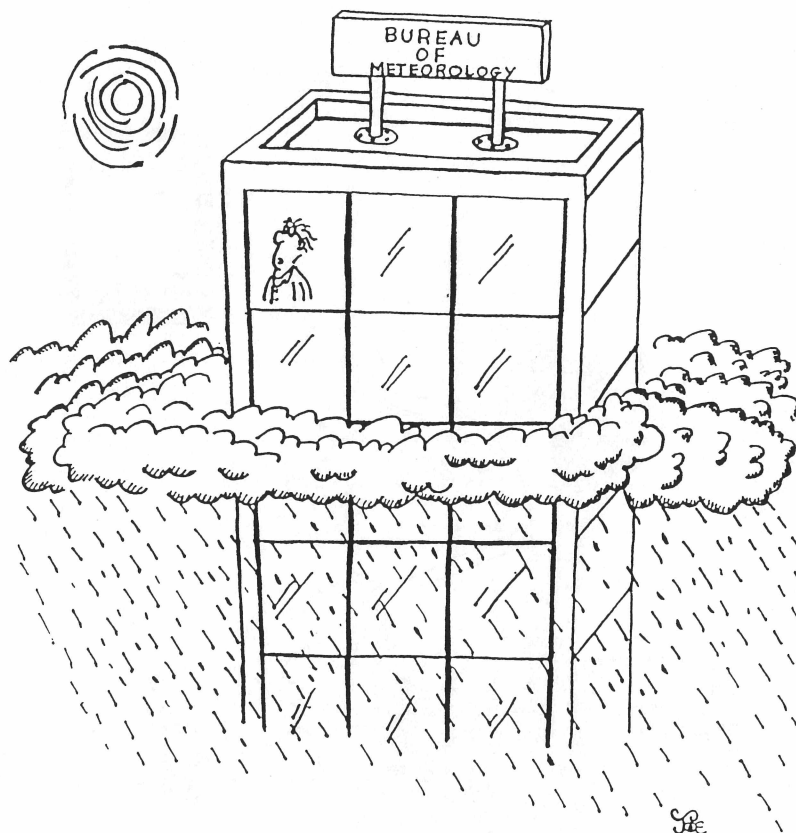
Dr Donald Cartwright

"It is not very useful to know a number is less than infinity."

"You have to dream that up. They are all in the same ball park."

"The sum tends to the sum..."

"Conventions are convenient."



Looks like a sunny day with a high fire danger.

september

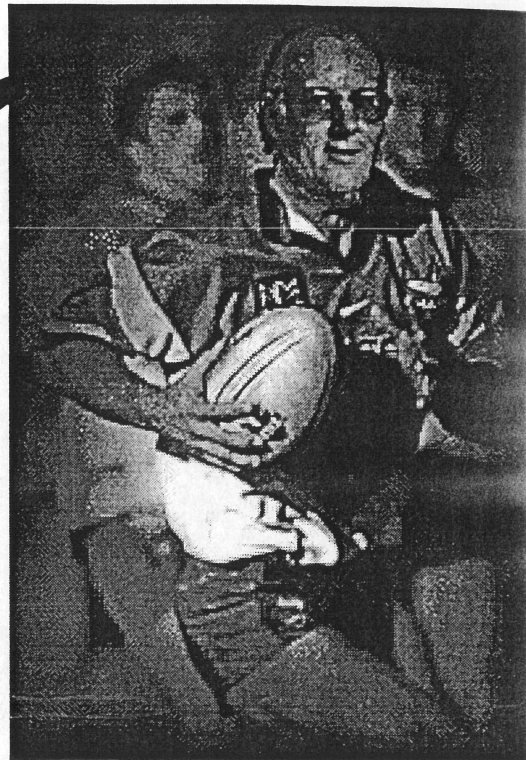
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Rod Cross



Rosemary Millar

october

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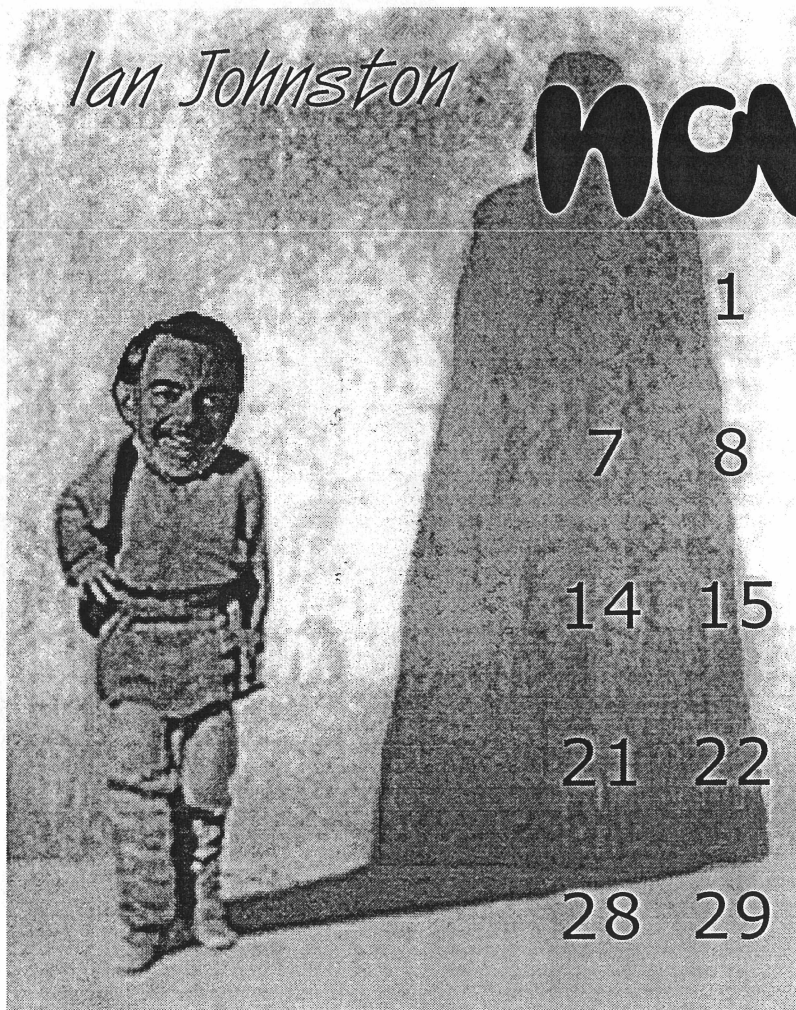
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Ian Johnston

november



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december

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Tony Turtle