

Why?

You ask, physics answers ...



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From the time immemorial human beings ask questions and seek explanations. Human is the only animal who asks and searches for knowledge. Since the primary man, he has a thirst to know why phenomena happen and how nature goes on around him. This thirst is called curiosity.

Curiosity is born with us and with time it may be crushed by society, family or school. How many times do you meet a child who asks: why is the moon following us? Why is the sun shining? Why the stars appear at night? Why I can't reach the sky? Why I can't fly like birds? etc. Then you see the same scenario that happened to you when you were a kid, when your parents or teachers shouted at you. Why? Undoubtedly, they didn't know the answer. Maybe you're now remembering each question you asked and left behind without an answer. And as the great American cosmologist Carl Sagan said: "Every Kid starts out as a natural-born scientist, and then we beat it out of them".

Living without knowing can be considered as ingratitude for grace and greatness of nature. The blue of the sky, the darkness of night, the warmth of the sun, the glitter of the stars, the tides in the seas, the motion of galaxies, planets and even the vibrations of particles and so on. All such great natural phenomena and scenes are very interesting to know about.

In this book we answer 100 “why?” questions in a brief and simple way. While reading you’ll become aware of what really happens around you, from galaxies to quarks. Your curiosity will be revived and you may ask more “why?” questions that we didn’t answer or questions no one ever answered or even asked.

- Thanks to Muharrem Çiftçi for the proofreading .

*The most important thing is not to stop
questioning . Curiosity has its own reason of
existence.*

Albert Einstein(1879-1955)

*“My goal is simple .It is complete
understanding of the universe ,why it is as it is
and why it exists at all.”*

Stephan Hawking

English cosmologist and physicist (1942)

1. Why is air invisible ?

___ Air does affect visible light, but not much, so it seems transparent. First reason is that the average air molecule is about 1 nm across, while light waves are on the order of 500 nm across. In other words the visible light doesn't have enough energy to be absorbed by the electrons in air molecule. Hence, it continues its way not being affected. Another reason is that atoms are widely spaced where light pass through, since it has a small chance of interacting with air. However, if there is a lot of air, light can affect molecules in a phenomenon called "scattering" later we will discuss it in the question 'Why is the sky blue ?'

2. Why do astronauts feel weightless ?

Most people will answer that they are weightless because there is no gravity, this answer is wrong !. Space stations are very close to earth and there is a strong gravitational pull on astronauts. The truth is that astronauts have weight but they feel weightless since they are always falling toward Earth!. To explain, the space station and everything inside it, is in free fall (force of gravity is the only force acting upon them) toward Earth. So they feel the weightlessness exactly like the feeling of a parachutist falling toward the ground(ignoring air resistance).





3. Why do athletes jump backward over the bar ?

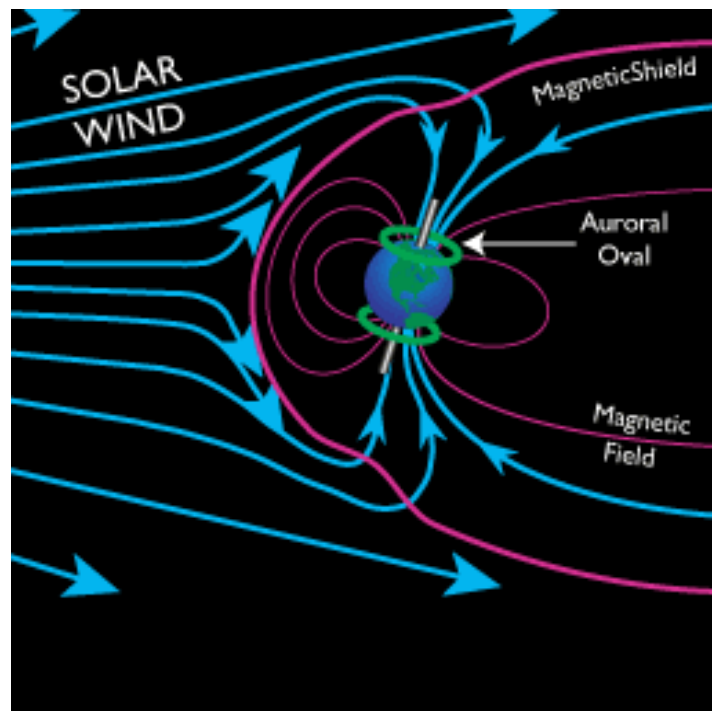
Actually this technique is based on a physics concept called center of mass. A center of mass is a point not necessarily inside the body—where the whole mass of the object is concentrated. We humans have a center of mass, when stand up the center of mass is around the belly. It moves all the time according to how our body is positioned even it can be outside our bodies. The jumper runs very fast so he can divert his horizontal velocity to vertical velocity and jumps. When he jumps backward above the bar his center of mass becomes below his body. If he was not jumping backward he has to apply more force to lift not only his body but also his center of mass.

4. Why do asteroids burn when entering the Earth's atmosphere ?

An asteroid comes from space with a very high speed thousands miles per hour. When it hits the atmosphere, air in front of it compresses rapidly. Since air is compressed, its temperature rises to a very hot degree. Hence, asteroid burns up into pieces. (According to the laws of thermodynamics)

5. Why does aurora occur?

The story starts with the sun, in some places where the magnetic field is very high it pushes itself out of the surface via plasma (ionized gas). When several tons of plasma leaves the sun it is called solar storm. The storm continues its way till it becomes close to the Earth's magnetic field. Therefore, the magnetic field of Earth deflects the storm by coupling together (see image below). What happens is that the electrons from the solar storm interact with the Earth's atmosphere following the field lines to north and south poles. Again, the interaction of electrons with the gas atoms causes them to release both light and more electrons.



6. Why are bubbles round ?

Bubbles are made of soap and water, where water molecules contain two hydrogen atoms and one oxygen atom. Hydrogen has positive charge and oxygen has negative charge, this causes water molecules to attract each other giving water a surface tension. Surface tension makes the thin film of soapy water assume the smallest surface area which is a sphere (sphere has smallest amount of surface area and lowest energy).

7. Why don't birds get electrocuted on the power lines?

To be electrocuted the bird needs to complete the circuit by creating potential difference between two wires. But the bird is sitting only on one wire where there is no potential difference. If it sits on 220 V power line, it will not get electrocuted unless its wing touches the other line .



8. Why do scientists support the Big bang theory ?

Big bang theory states that from 13.8 billion years ago our universe has begun as an infinitesimally small, infinitely hot, infinitely dense point called singularity. This singularity expanded and cooled, going from very, very small and very, very hot, to the size and temperature of our current universe. Scientists have gathered a lot of evidence and information about the universe, where the big bang theory seems to be the most correct one out of the all theories about the origin of the universe.

First evidence: In 1929, astronomer Edwin Hubble discovered that the universe was expanding where the galaxies appear to be moving away from us (redshift), this supports the idea that the universe was once compacted.

Second evidence : In 1965, Radio astronomers Arno Penzias and Robert Wilson discovered what we now call the cosmic microwave background radiation (CMB) that comes from everywhere in the sky, which supports the idea that after the big bang the early universe was very hot and it cooled down, since radiation have been shifted from visible light to the microwave background radiation we see today.

Third evidence : The observed abundance of hydrogen, helium, deuterium, that is a proof the entire universe was once a really big star where fusion chains occur to create deuterium helium and other elements (as proposed by big bang theory that protons and neutrons could fuse to make stable deuterium nuclei ,deuterium nuclei react to make Helium-3 nuclei, and Helium-3 nuclei react to make the stable Helium-4 nucleus).

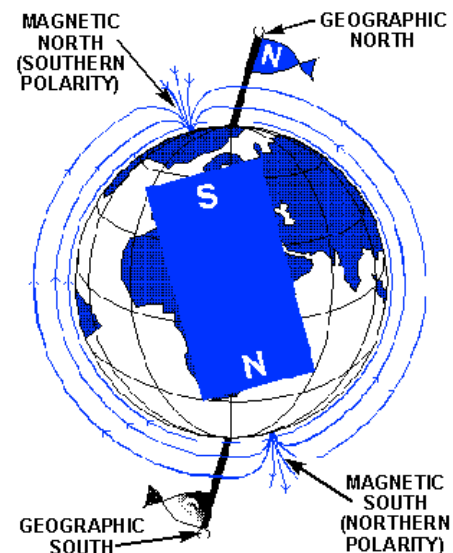
Forth proof : in the early 2014 scientists discovered the existence of gravitational waves that means the rapid expansion of the universe in the moments after the Big Bang actually happened. (Philosophically, big bang should be a reference to start universe creations. Otherwise, we should seek for a back ground to allow big bang to happen. And then we need to seek for creation of the back ground. This procedure is infinitive).

9. Why change of phase (state) is at constant temperature?

There is a difference between temperature and heat. Temperature is a number proportional to the kinetic energy of the particles, while heat is energy. During change of state as in melting of water, there is an increase in energy. This energy is responsible for the change of bonds between atoms but not change in the kinetic energy consequently no change in temperature. We call it 'latent heat'. In other words, the energy can change allowing a change in the bonds but no change in temperature (Kinetic energy of particles).

10. Why compass needle always points north ?

The Earth has its own magnetic field. It acts like there is huge bar magnet buried inside, but this bar magnet is not on the earth rotational axis it is shifted by some angle. The south of the bar magnet is on the magnetic north and the south polarity is on the magnetic north (image). As opposite polarities attract the magnetic needle (north) is attracted to the south polarity in the magnetic north. That's why the needle always points north. If you want to know "why earth has magnetic field?" go to letter E.

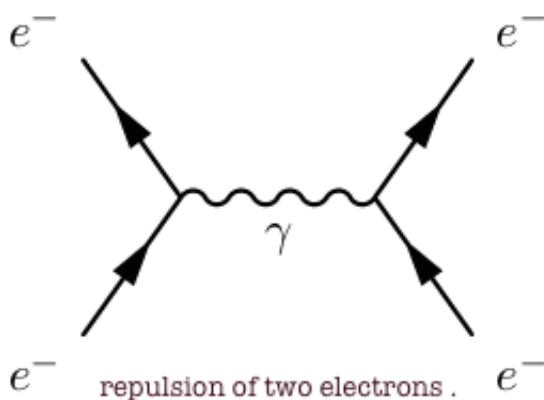


11. Why are clouds white ?

This is due to what we call light scattering (thrown in various random directions) where light strikes a particle or a collection of particles, thereby changing its direction. Clouds are made up of water or ice droplets and they are just the right size to scatter all colors of light. When the white light from the sun hits the cloud, water and ice droplets scatter all the wavelength of light (which we perceive as white) in all directions to reach our eyes.

Note : But rain clouds tend to be grey that is because the clouds block sunlight due to their thickness. The thicker the cloud, more light it blocks.

12. Why do similar charges repel each other and opposite charges attract each other ?



Since we started learning science they teach us that similar charges repel and opposite charges attract. They show us countless of experiments and we take it as a fundamental law without knowing the reason. This

question can't be answered using classical physics, the modern theory of quantum electrodynamics solve this puzzling question. The charged particles interact by emitting and absorbing photons (photons: particles that transmit electromagnetic force). The particles

exchanged photons is the force of interaction (repulsion or attraction) because interacting particles change speed and direction. So one particle emits a photon and the other particle absorbs it, and the way particles are moving in space-time determines whether this force is attractive or repulsive. The possible predicted ways are represented in what we call Feynman diagrams like in image above.

13. Why do scientists start thinking about extra dimensions ?

In Einstein's general theory of relativity he combined the three spatial dimensions with additional dimension of time into four-dimensional space-time. From the curvature and wrap of space-time he described gravity. Then a German physicist named Theodor Kaluza said that there are other forces beside gravity like electromagnetic force. Hence, he tried to unify gravitational and electromagnetic field where he proposed there might be extra dimension (we don't see). The curve and wrap of those extra dimension describe electromagnetic force. And he was right! when he examined Einstein's math and work them in 5 dimensions (one additional dimension), he got one additional equation which was Maxwell equation of electromagnetism. Hence, scientists start thinking about extra dimensions.

14. Why can we see only three dimensions ?

String theory proposes that there are more than 3 dimensions. We haven't seen them either because those

dimension are bigger than to see or smaller than to detect. If you look at the wire in the power lines you will see it as one dimensional because you are far away, in which visually you are unable to see that this wire is three dimensional. But in this case you can easily detect the true dimensions by coming close enough or by using binoculars. Maybe we see our universe in the same way we see the wire from far away and we are unable to detect the true dimensions of it.

15. Why are there only 11 dimensions in the universe not more or less?

We are familiar with 4 dimensions, up-down, forward-backward, left-right and time. In a theory called M-theory physicists assume there are 7 more dimensions. We have as a total of 11 dimension. Why 11? For mathematical constancy to unify quantum mechanics and General Relativity it requires 11 dimension. Where it turns out that if we write the theory in 17 , 16 ,.. dimensions the theory is unstable. Also, to put electromagnetism with gravity with nuclear force in four dimensions is not big enough, when they expand to 11 dimensions everything form perfectly well.

16. why is Earth spherical ?

The answer for this question is somehow similar to the answer of the question "why is bubbles round?" , that's how nature works. Earth and other planets are spherical since spherical shape has lowest energy a material can be. Due to the gravitational

force that pulls the masses together equally in all directions. The stronger the force of gravity is more spherical the shape becomes. That is why Mars has larger mountains than Earth (force of gravity of Mars is weaker). Moreover, as long as the maximum mountain size is small compared to the radius of the planetoid the body will be spherical.

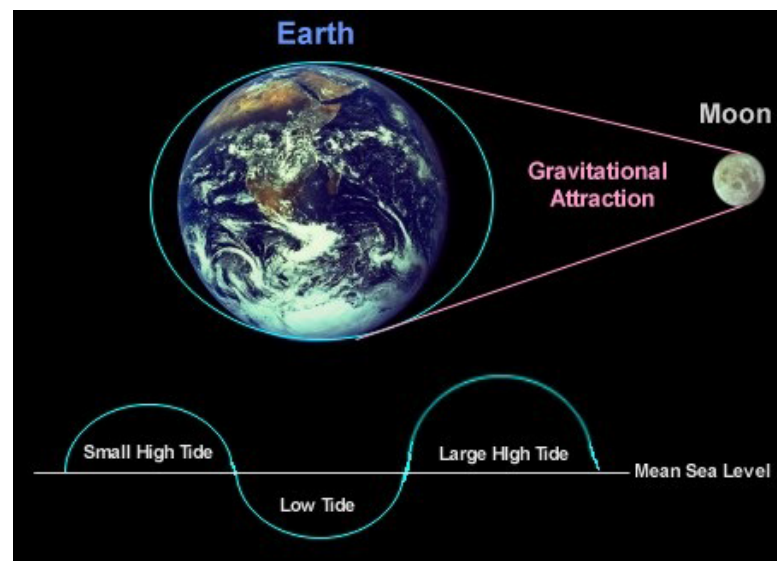
Note: Earth is not perfectly a sphere, it is approximately spherical.

17. Why Earth spins around itself ?

Earth has formed from a spinning cloud of gas and dust that collapsed due to the gravitational force. As things collapse they spin faster (like an ice skater spinning faster and faster as they bring their arms in). Earth continues spinning since mass maintains its state of motion unless acted upon by a force, due to inertia.

18. Why is Earth slowing down in its spinning ?

As Earth is rotating around its axis, the Moon has a gravitational pull on Earth's oceans and some of the crust below (the Moon causes tides on Earth). It turns out that the Moon attracts the ocean tides. Roughly every 100 years, the day gets about 1.4 milliseconds, or



1.4 thousandths of a second, longer. But this is a small effect because the tides aren't very high and the moon is very faraway.

19. Why does Earth have water?

Earth is the only planet in our solar system that has water that has a rate of 70% on its surface. The weird thing is that everything we know about how planets formed, says that earth must be dry.

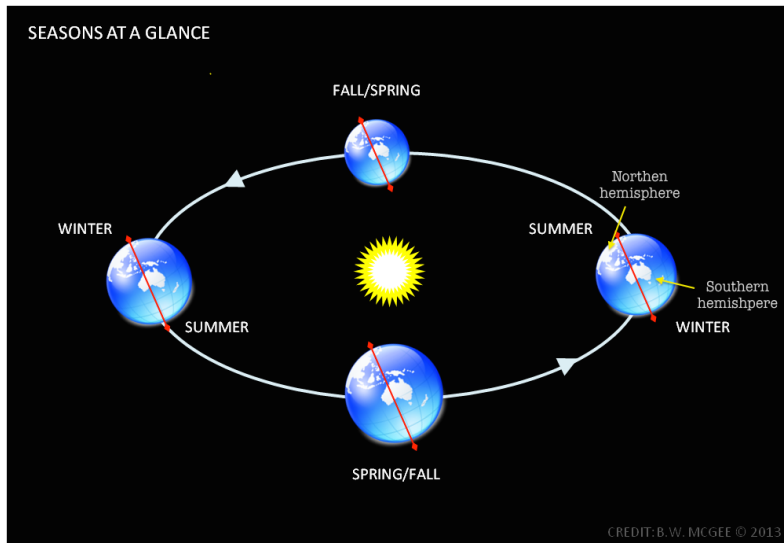
As we know after some minutes from the big bang, hydrogen and helium has formed (being the lighter elements on earth). Time goes over other elements appear including oxygen. But the formation of hydrogen and oxygen and the formation of water are two different things!! So scientists concluded that water must come from outside source "astroids and comets". Recently this theory also collapsed since researches discovered that comets have more heavy water than Earth's oceans. There are some other theories but we are uncertain about why Earth is the only planet with water. While some say it is our fortune others believe the reason is God and we exist for a purpose.

20. Why does Earth have seasons?

Here on Earth-as we all know-we have four seasons: Spring, summer, winter and autumn. The Earth axis of rotation (red arrow-an imaginary line the passes through the poles and cut the earth into two equal parts) is not parallel to the sun's axis, actually is it

tilted by an angle of 23.5° . Therefore the tilt of earth's axis causes the

hemispheres to receive different amount of sun's energy. This tilt not only affects the angle the places on earth receive from the sun, but also, the duration of day and night. For six months of the year, the Northern hemisphere is tilted



towards the Sun, while the Southern hemisphere is tilted away. For the next six months, situation is reversed. The part that is tilted toward the sun experiences more heat energy to warm up.

Something to know: The equator is an imaginary line on Earth's surface equidistant from the North pole and the south pole, dividing earth into northern hemisphere and southern hemisphere.

21. Why does Earth have magnetic field?

Magnetic field protects Earth from solar winds. Our Earth has strong magnetic field. Why? Magnetic field is generated in the Earth's core. The core is rich in iron and nickel liquids, the flow of this hot liquids due to Earth's rotation around its axis generates electric currents, that in turn produce magnetic field.

22. Why is the Earth's temperature increasing ?

Carbon dioxide(CO₂)is found in nature and everywhere around us.The proportion of CO₂ is regulated by forests,seas and so on.Due to deforestation (cutting trees) part of the CO₂ is no longer absorbed,so that the amount of CO₂ is increasing.And the problem with CO₂ is that it absorbs radiation from the sun and radiates out heat (infrared radiation).Moreover, methane from greenhouse gases trap the heat within the atmosphere never allowing it to get out to space.Hence,earth gets warmer.

23. Why do earthquakes occur?

Earth's crust is made of tectonics plates that float on mantle.Since, these plates are free to slowly move, they can either drift towards each other, away from each other or slide past each other. Many earthquakes happen in areas where plates collide or slide past each other.

24. Why doesn't electron fall into nucleus ?

We can't answer this question using classical physics as we did in the previous questions. According to classical physics the electrons would spiral into the nucleus within a tiny fraction of a second(by treating the electron as a ball that can fall into the nucleus under electrostatic attraction).That means all matter would collapse,that's why quantum mechanics became the model for describing what happens at the microscopic level .In QM we know electrons occupy certain energy levels,and there is possibility of finding

an electron everywhere in the universe so the question is more like : what is the probability of finding an electron in the nucleus ?.

This is explained in the uncertainty principle

$$\Delta x \Delta p \geq \frac{h}{4\pi}$$

Δx : uncertainty in position .

Δp : uncertainty in momentum .

h : plank's constant .

$$\Delta x \cdot \Delta p_x \geq \frac{\hbar}{2}$$

In other words , $\Delta p \geq \frac{h}{4\pi \Delta x}$,as the electron collapses to the nucleus $\Delta x \rightarrow 0$ so $\Delta p \rightarrow \infty$.**But** as we know $p=mv$ (mass times velocity) and since mass of electron is very small,velocity should tends to infinity($v \rightarrow \infty$) which is impossible since nothing can exceed the speed of light **c** .

25. Why do some objects conduct **electricity** and others don't do?

The materials that conduct electricity are called conductors. Conductor has free electrons and they are loosely connected to the nucleus they jump around from an atom to another and this what makes it easy for electricity to flow. While in insulators electrons stick with their atoms.

26. Why is the **entropy** of the universe increasing ?

Entropy is the measure of the disorder of the system. Entropy of the universe always increases since the universe is in irreversible cycle, we are all born, then age ,then die; never the

$$dS \geq 0$$

change in entropy greater than or equal to zero

other way around. We remember the past, but not the future. Also, entropy tends to increase because using mathematics we can tell there are more ways to be high entropy than low entropy (probability).

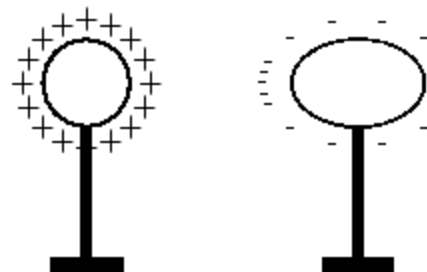
27. why do our ears pop in plane ?

There is air in our ears, the pressure of this air is equal to the outside pressure to hear. When we are on plane the pressure is less than the pressure on the surface. This difference in air pressure can be felt by the ears, where the ears have a small tube to equalize the pressure between inside and outside that is opened when you swallow. When the pressure is equalized you feel a pop.

28. Why is the electric field inside a conductor zero ?

In conductors electrons can move freely from one atom to another. When there is excess of charge, the charges move in a way the conductor is in electrostatic equilibrium. To attain this equilibrium the excess of charges and the free electrons are distributed in a way to reduce the total amount of repulsive force, till there is no further motion of charges. To sum up,

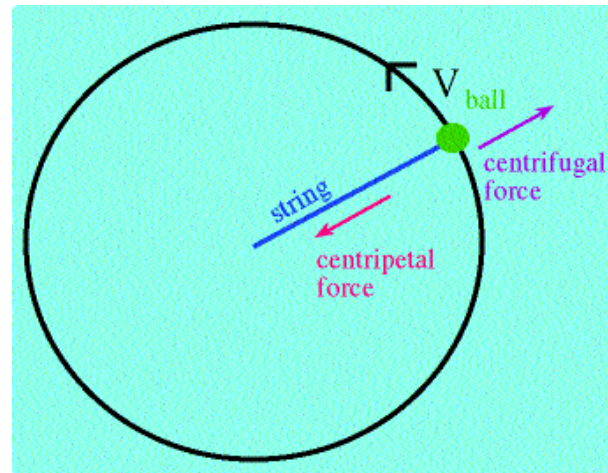
when conductors are in electrostatic equilibrium the electric field inside the conductor becomes zero. Why? We will explain this by contradiction. Let's suppose we put an electric field inside the conductor (negative charge) so electrons which are free in conductors would move. But, charges are stationary in electrostatic equilibrium (2nd condition for electrostatic



equilibrium). So, our supposition was wrong there is no electric field inside .

29. Why doesn't centrifugal force really exist (fictitious)?

Before answering the question I should mention what is centrifugal force by giving some examples you experience everyday in your life. For example, when you are sitting in a car and it accelerates forward you feel a force or a push dragging you in the opposite direction of motion!. Another



example from your childhood when you were playing on merry-go-round you almost felt a force dragging you out of it. Even when you have an open bottle of water when you are rotating it at high speed water doesn't fall down!. But why does this happen?. This is due to a force we call centrifugal force (an outward force) that is opposite to centripetal force which is a real force

pushing things to the center.

Now, why is this force unreal?. When the car is accelerating you are in a non-inertial frame, and the illusive force you feel is merely the tendency of your body to resist the acceleration and to remain in its state of rest (inertia). The car is

accelerating out from under your

body, leaving you with the false feeling of being pushed backwards. Moreover, if an observer is in an inertial



frame observing you in the car or in a rotating platform, he/she will notice that this force is pseudo-force.

30. Why does the flame of a fire go upward against gravity?

The flame goes upward even when there is strong gravitational pull like on Earth. The fuel reacts with oxygen to release heat and other gases. The released gases are hotter than the surrounding air. This means that the obtained gases are denser than air, so an upward buoyant force pushes the gases. Applying Archimedes principle : A force equal to the weight of the air displaced lifts up an object surrounded by air. When we are talking about weight we conclude that gravity is the reason for the flame shape and without it hotter gases won't move upward.

31. Why do flames have different colors ?

There is a relation between the fuel burned and the color. Explanation of it is that electrons in the atoms of the fuel used are excited due to heating (energy). They move from ground state to higher energy level and when they return back they emit photons of different wavelengths. Each wavelength corresponds to a certain color.

Sodium emits orange light when burned. If you see blue in wood flames, it is because of the burning of carbon and hydrogen. Red comes from lithium, and copper will make green or blue flames when burned.

32. Why does an iron/steel nail sink but an iron/steel ship float ?

The condition of floating as first discovered by Archimedes. That discovered is when the weight of the floating object is equal or less than the weight of the displaced liquid. Where there is a force called buoyant force that pushes on an object when it displaces water. In other words, objects float when their density is equal or less than the density of liquid.

Applying Archimedes' principle : Floating condition
 weight of object \leq weight of displaced liquid
 $\text{mass of object} * \text{gravity} \leq \text{mass of displaced liquid} * \text{gravity}$
 $\text{density of object} * \text{Volume of object} \leq \text{density of liquid} * \text{Volume of liquid displaced}$
 but Volume of liquid displaced = volume of object
 Therefore, density of object \leq density of displaced liquid.

The steel/iron nail sinks because its density is more higher than the density of water. Which means that the downward force (weight of nail) is much more than upward force (buoyant force). But the steel/iron ship is not completely steel/iron, it is full of air!. So, average density of the ship as a whole, is less than density of water. It is easy to shape a boat in such a way that weight of the boat is equal or less than the weight of displaced water.

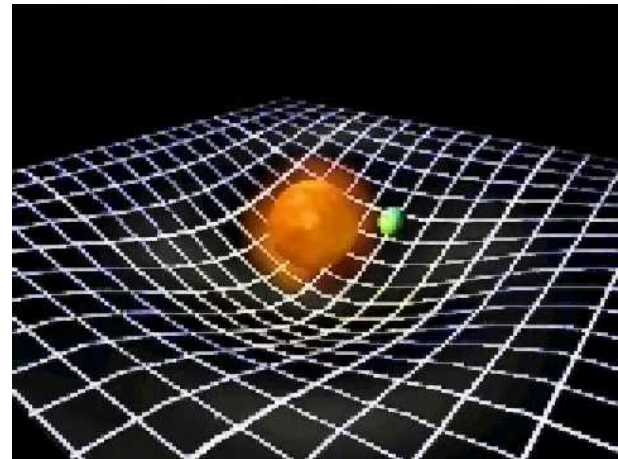
An analogue: if you have a deflated balloon it would not rise up in air because of its density, but if you fill balloon with helium it will rise up.

33. Why do things float more in dead sea?

The dead sea has more salt than other seas or fresh water has. It is six to eight times saltier than the ocean. Dissolved salts make water more dense. Increased density results in greater buoyancy for any object placed in the water.

34. Why does gravity exist ?

Gravity is a force responsible for everything to fall down. Gravity is what prevent us from falling out in space. First, sir Isaac Newton discovered gravity. He put the gravitational law where every two objects with mass at a certain distance from each other exerts a



gravitational force ($F = m_1 m_2 / d^2$). Then Albert Einstein explained gravity as it is more than a force, the curvature in the space-time continuum. This is often portrayed as heavy ball on a rubber sheet and other smaller balls fall in toward the heavier object because the rubber sheet is wrapped from the heavy object (figure). Some scientists had proposed particles called gravitons carries of gravitational force. But gravitons have never actually been observed.

Satisfied about I have just explained!. I just explain what is gravity as we know it till now but I didn't answer why it exists ?. Or why things with mass and energy attract each other gravitationally?. Frankly

speaking physicists don't know the answer since that's how our universe works .

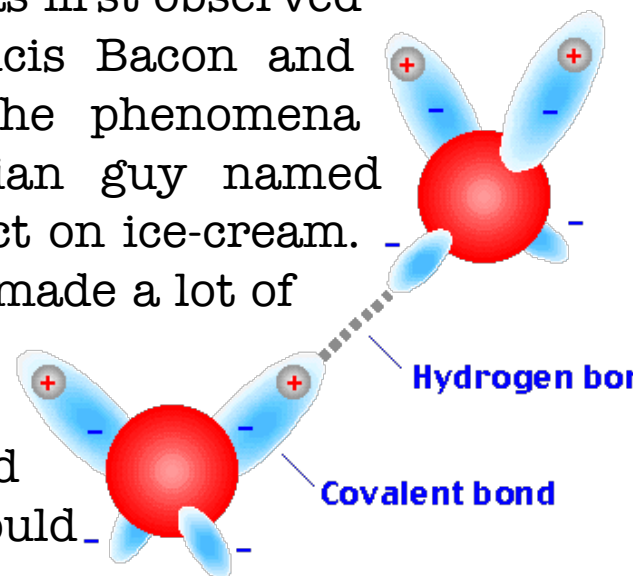
35. Why is there less gravity on moon than on Earth?

In newtonian (Newtonian) physics, gravity is a force between two objects with mass. $F = m_1 m_2 / r^2$, if m_1 is your mass, m_2 is the mass of earth or moon and r is the radius of the earth or moon or other planet. When the ratio m_2 / r^2 increases the force of gravity increases. Now, if we take mass of Earth $m_{2E} = 5.97 * 10^{24}$ kg and its radius is $r_E = 6378$ km... after calculation $F_E = 9.8 m_2$ N . For moon, $m_{2M} = 7.34 * 10^{22}$ kg and $r_M = 1737.4$ km and after calculation $F = 1.62 m_2$ N . The pull of gravity on you on earth is greater than on moon. In a nutshell less gravity is due to less mass.

According to Einstein, gravity is the curvature of space-time created by massive objects. Greater the mass is , greater the curvature, more the pull.

36. Why does hot water freeze faster than cold water?

This is a very old question. It was first observed by Aristotle, then later by Francis Bacon and René Descartes. Today we call the phenomena Mpemba effect after a Tanzanian guy named Arasto Mpemba observed the effect on ice-cream. Scientists all over the world have made a lot of theories but none has completely explained the phenomena . The Royal Society of Chemistry offered a £1,000 prize to anyone who could



explain how the Mpemba effect worked. A scientist named Nikola Bregovic at university of Zagreb won the prize. His theory was that water develops convection current as it cools and those convection currents allow warm water to overtake the cooler water in freezing. In 2013 scientists in Technological University in Singapore claim they found the explanation. Where the reason goes to the bonding between water atoms more precisely the hydrogen bond. As water molecules are close to each other their natural repulsion causes water covalent bond to stretch and store energy and as water warms the molecules are farther and hydrogen bond stretch allowing the covalent bond to compress and release energy and that is cooling. This means hot water are able to release energy faster.

Actually no one knows “why”. Scientists are trying to explain how!!!

Something to know : Water molecule is built up of one oxygen atom that has a slightly negative charge and two hydrogen atoms that have slightly positive charge joined by covalent bonds. When we have many molecules, take for example two molecules of water, oxygen in the first molecule will attract the hydrogen in the second molecule forming a bond called **hydrogen bond**.

37. Why does Helium balloon rise up in air?

The reason of why things float in water; (can be applied to air...) applies to air as well. Helium and the balloon

displace an amount of air, and as long as Helium is less dense than air. Air contains oxygen and Nitrogen that are much heavier and have larger molecules than that of Helium. Then, the weight of the displaced air is more than the weight of helium and the balloon introduced. Hence, the balloon will float in the air (this is the law of buoyancy).

38. Why does Helium make your voice squeaky?

When we exhale the lungs push air up to the larynx, the vocal cords in the larynx (V shaped) open to let the air exit to mouth without producing any voice. But when we are ready to talk the muscles of the larynx pull the cords making them vibrate, the vibration of the cords excite air molecules (nitrogen and oxygen) that surrounds them which in turn makes a sound wave. The speed of sound in air is about 350 m/s. If helium is introduced which density is much less than air's density, the speed of sound is about 1000 m/s. As we know that $v = \lambda * f$ (v : velocity, λ : wavelength and f : frequency), and experiment shows f stays constant.

That means as v increases, when inhaling helium, wavelength λ increases to keep f constant. This change in the wavelength alters the resonant characteristics of the airway. In other words, helium changes the Timbre of your voice by increasing velocity and wavelength that in turn changes the resonant characteristics of the airway.

Something to know : There is a misconception. Helium doesn't change the pitch of your voice, your vocal cords don't vibrate faster but the resonant

frequency of your throat and mouth increase then timbre(quality of the sound) changes.

39. Why is ice slippery ?

What makes ice slippery is the water layer on its surface. The cause of this water layer is the pressure applied by the skate, the pressure increases the melting point of ice causing the outermost layer to melt. And after the skate would slide across, a sheet of water would refreeze again as soon as the skate passed. Also scientists claim that the reason is friction between the skate and the ice. The friction generates heat that melts outer layer of ice.

40. Why is salt sprinkled on ice roads in the winter?

If you live in a place where ice covers it, you probably noticed that salt is sprinkled on roads.

When we add salt to ice, the salt dissolves with the thin layer of water on the surface of ice. When it is dissolved the freezing point of water becomes lower (since the combined salt and water molecules need to lose more heat to slow them down), then the water molecules from the solid layer of ice move from the solid to the liquid. Thus ice begins to melt and lowers the freezing point preventing the formation of ice at 0°C. Moreover, the addition of ice will help in decreasing the amount of slippery. The ice molecules form a crystal lattice structure so it form slippery crystal surface where salt breaks this structure.

41. Why does an ice skater spin faster with her arms in?

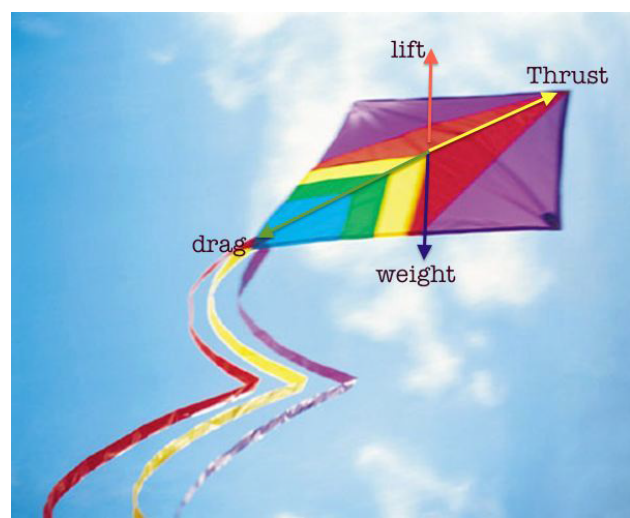
This is a result of the conservation of angular momentum. In physics, angular momentum is a measure of the amount of rotation an object has, taking into account its mass, shape and speed. To keep the angular momentum conserved rotation speed must increase when someone pulls his/her arms and leg in.

To explain it more, using mathematics: angular momentum $L = I\omega$ (I is the moment of inertia and ω is the rotational speed). However, the moment of inertia $I = MR^2$ (where M is the mass and R is equal to average distance of the mass from the axis). So if the ballerina pulls in her arms, he/she becomes closer to the axis, and R decreases.

Her/His mass M doesn't change but the moment of inertia I decreases, too. Because $L = I\omega$ has to be conserved and I decreased, ω must increase. That is why the skater draws her/his arms and a leg in and speeds up tremendously.

42. Why do kites fly?

Just like an airplane there are four forces acting on the kite: upward force (lift), downward force (weight), backward force (drag) and forward force (thrust). The lift is an upward force that pushes the kite up since kites are shaped so that the air moving over the top moves faster than the air moving over the bottom to make the pressure below the kite more than the pressure above it (Bernoulli's law). The weight is the downward force due to

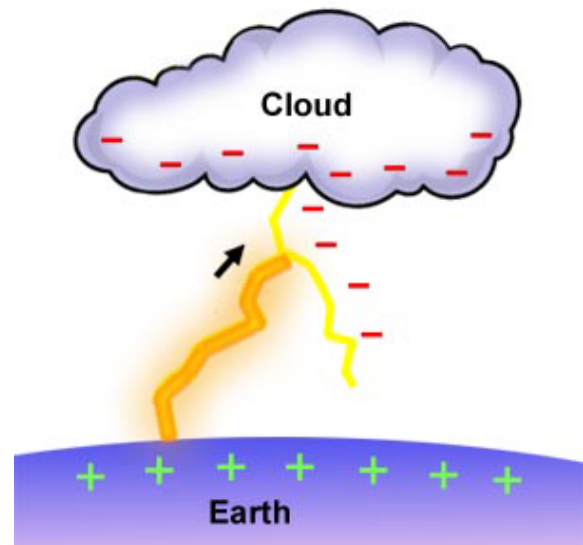


gravitational attraction. The thrust is forward force toward direction of motion due to tension force from the kite's rope and the forward motion of the flyer while the drag is due to friction of the air moving over the surface of the kite. To launch a kite into the air the force of lift must be more than the weight. To keep a kite flying steady the four forces must be in balance.

43. Why does lightning occur ?

Clouds become electrically charged, the upper portion is positively charged and the lower portion is negatively charged. There are many explanation for how the cloud acquire charge, the best explanation is that electric charge is due to the collision between ice, water and water vapor.

When the electric field in the cloud increases and increases, electrons in the cloud start to repel electrons in the ground surface causing it to become positively charged. Now, we have negative charge-air-positive charge (see figure), but air is an insulator and the lightning needs a path, here comes air ionisation process where air become ionised. Then what's called a stepped leader which is an invisible discharged path that moves downward from cloud to ground. And another leader is then created upward from Earth to cloud. When both make contact visible lightning occurs.



44. Why does light slow down in a medium ?

This is one of the difficult questions to answer. Think of light as photons associated with oscillating electric and magnetic field. When these photons pass through the solid, the electrons of the medium start to oscillate. Now, there are the original wave and all the other electromagnetic waves (due to the electrons that have been oscillating). The waves interact with each other and this interaction slows the propagation of the photon down. That was the classical explanation!. In the language of QM light slows down due to the formation of a particle called Polariton. Polariton is the result of the mixing of a photon with an excitation of a material (oscillation of atoms in the material). Because polaritons get mass from the atoms, they move slower than c .

Something to know: * Light is an electromagnetic wave and photons. Photons are particles with no mass and no charge .

* On the internet there are two widely spread answers which are wrong : first wrong answer : That in a material there are more atoms, where people think of light as in a macroscopic way that photon is like a game of pinball like atoms are barriers so that light travel longer paths and needs more time to get out of the medium. If this answer is true then when laser beam enters glass it should leave it out in all directions but that's not what happens.

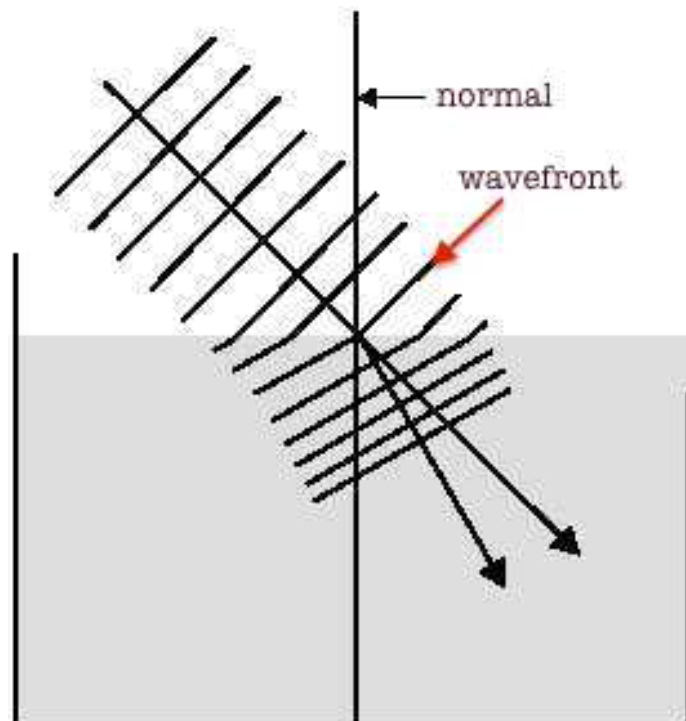
Second wrong answer : When a photon enters the material it is absorbed by certain atom then another photon is reemitted and the process of absorption and reemission will cause light to slowdown. Electrons do absorb photon and reemit it after a sort of time but this is a random process according to how many atoms each photon interact with ,so how much each atom delay time is just a random process. But in reality light always takes the same amount of time.

45. Why can't objects travel at the speed of light ?

When the speed of objects increases their mass also increase (according to special theory of relativity). More mass increase more energy it needs to accelerate. And at the speed of light mass becomes infinity so we need infinite energy to do so!. And that is impossible in our time. The only particles that travel and always travel at the speed of light are particles with no mass like photons.

46. Why does light refract ?

Refraction happens when light passes from one medium to another, where it changes its direction. Think of light as a wavefront (see image). When light hits the surface of separation with an angle what happens is that the first part of



the wavefront starts to slow down while the other part after it are coming with the same speed. Hence, one part of wavefront is moving at a slower speed than the other. So, light bends applying the principle of least time (Fermat's principle).

47. Why is light affected by gravitational field ?

Light can only be affected by **very strong** gravitational field, like that of the massive stars (according to general theory of relativity). You are now wondering since light has no mass, but the reason goes that the massive star makes a distortion in the space-time so that photons of light are affected by this curvature of space-time.

something to know: The bending of light due to strong gravitational field was first predicted by Einstein in his general theory of relativity in 1916, then in 1919 Eddington made experiment that was an observational test of General Relativity.

48. Why do we have a leap year?

A year is the time it takes Earth to orbit the sun. The calendar is divided into 365 days. It takes for the Earth to orbit the sun not exactly 365 days but about 365.25 days. So, every four years we throw in an extra day.

49. Why are not 1700 , 1800 and 1900 leap years but is 2000 ?

Every year is divisible by 4 is a leap year according to explanation in previous question .But 1700 , 1800 and 1900 are divisible by 4 and not leap years. because of the earth needs exactly 365.242199 days not 365.25 to orbit the sun. So, a year is a leap year if it is not only divisible by 4 but also by 400.

50. Why does the moon appear at day time?

The moon is up in daytime as often as it's up in night time. The moon's sets and rises have nothing to do with the sun's. There is a misconception that the moon is always opposite to sun ,but it is only true when it is full moon ,where the full moon rises from the east as the sun sets from the west. In other words , the moon doesn't set up yet when the sun rises.

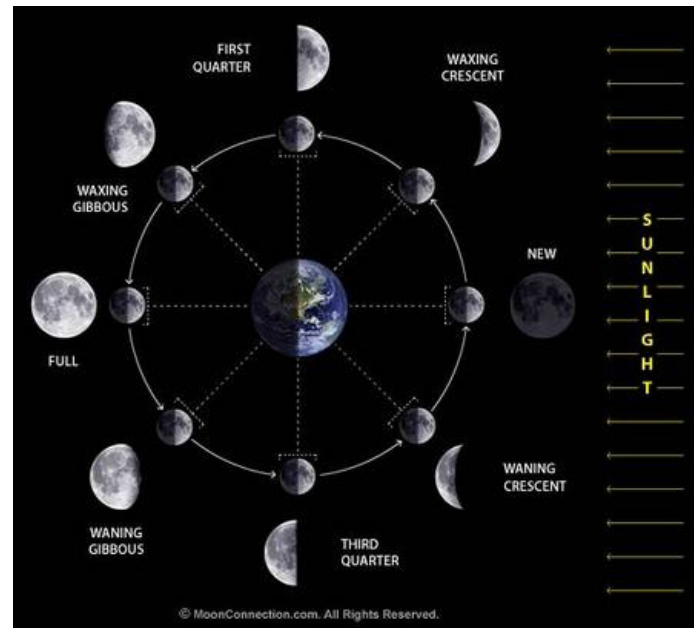
51. Why do we see only one face of the moon?

Here on Earth we see exactly the same features of the moon's surface because the moon spins once around its axis. It spins in the same amount of time it needs to orbit the Earth, which is about 27.32 days. If we're spinning fast as we're spinning right now we would see the whole surface of the moon.

52. Why does the moon change its shape every night?

The shape of the moon depends on the part that is lighted from the sun. Since Earth, sun and the moon are connected. It takes 265.25 days for earth to rotate the

sun and 27.32 days for moon to orbit earth. But we only see half of the moon (one face) which is always illuminated by the sun. The proportion of the illuminated part visible to us varies from 0% (new moon) to 100% (full moon).



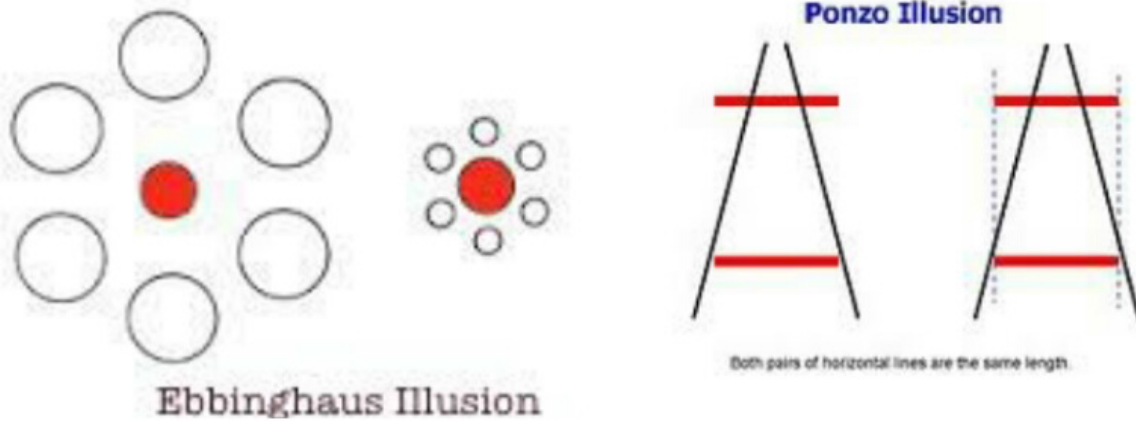
53. Why does the moon look bigger at the horizon ?

Since ancient times people have wondered about this strange effect. Aristotle, Ptolemy, Da Vinci and Descartes have all thought about this question and till now we don't have a satisfactory explanation. This is called moon illusion, physics has nothing to do but psychology.

First explanation is due to Ebbinghaus illusion. When the moon sets on the horizon it looks bigger, the theory suggests that near the horizon are tiny trees and houses compared to the moon, so the brain gives the illusion that the moon is bigger. While, when the moon is higher up it is surrounded by vast dark sky. So it looks smaller in comparison. The second explanation is Ponzo illusion, the closer something is to the horizon the smaller you have to draw it.

If you don't believe the idea try to take a photo of the moon near the horizon and the moon high in the sky you'll find out that they are of the same size. It seems we solve the mystery by those two explanations, but, unfortunately, the moon also appears

larger at horizon even for pilots traveling high above the clouds where no small objects appear near the horizon .



54. Why is the moon drifting away from Earth ?

Before in letter **E** we answered a question “why is Earth slowing down in its rotation ?”. So we already know earth is slowing down that means it is losing energy (due to tides). This energy is transferred to the moon and the moon is speeding up. The moon will have faster orbital speed and the faster something orbits the further it goes.

55. Why doesn't the moon fall on Earth's surface ?

Actually the moon does fall on earth all the time!. The moon is in free fall but never falls down. Though there is a large force pushing the moon toward us ($F = G \frac{M_{\text{earth}} M_{\text{moon}}}{d^2_{\text{earth to moon}}}$) . But the moon is faraway and moving with a very high orbital speed (sideway speed) that prevent it from falling . So it falls on the Earth with a continuous circular path.

56) why mirrors flip horizontally ?

you look at the mirror, and let's say you put your hand on the right side you see your hand on the mirror on the left side. The image left-right is mixed up, it's not top-bottom mixed up. And the question is how the mirror knows the right-left mixed up and not the top-bottom? If you wave your one hand then the one that waves in the mirror is the opposite of it. The hand on the east is the hand in the east and the hand on the west is the hand in the west. The head that is up is up and the feet that are down is down. Everything is really alright! but what is wrong your nose is in the north of your head but in the mirror your nose is to the south. So what happens really in the image is neither right-left mixed up but the front and back being reversed. When we think of the image we think of it as another person it is a psychological think, but we don't think of the idea that the person has been squashed and pushed backwards-forwards with his nose and his head.

This was answered by Richard Feynman (cut) his explanation is much interesting than me explaining it.

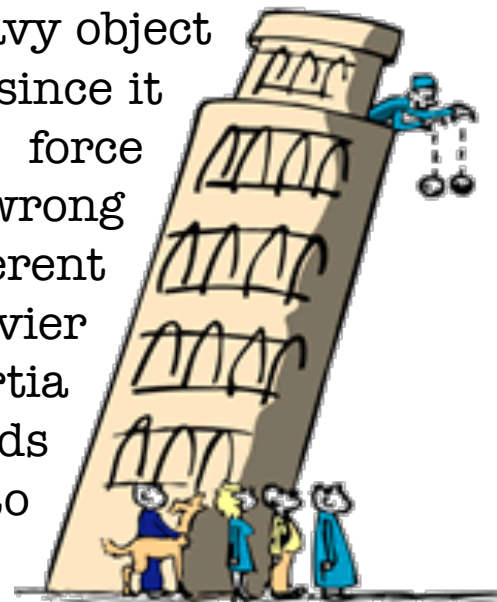
57. Why don't we feel the motion of Earth?

The earth is rotating at a very high speed around itself (1000 miles per hour) and around the sun (67000 miles per hour). But, we don't feel the motion when things move at constant velocity!. For example, if you are in a car and it is moving with constant speed and you close your eyes not to see things outside moving

you feel that you are stationary (That is what we call relative motion) and so is Earth. Though there is an outward force pushing us away from earth due to its rotation, gravity over comes this force. We can only feel its rotation if Earth changes its speed increasing or decreasing.

58. Why do objects of different masses reach ground at same time?

Before Galileo it was thought that heavy object weighs more. So it must fall down faster, since it has more weight (greater downward force applied to it). But that was proved wrong when Galileo threw two balls of different masses from Pisa tower. When the heavier object get more mass it gets more inertia (more resistive to motion). Hence, it needs more gravitational force (weight) to accelerate it at the same rate as the light one.



59. Why do Subatomic particles has mass ?

The answer of this question was proved right in 2012 , when experiments at Large Hadron Collider proved the existence of Higgs boson. To explain, the Higgs boson is associated with Higgs field .So the subatomic particles that interact with this field have mass like electrons and that don't interact with the field don't have mass (like photons). While matter (which is made of particles) got their mass from energy ($E=mc^2$)

60. Why does the (relativistic) mass increase when speed increases ?

When we want to speed up an object we give it energy. As special relativity tells us energy and mass are equivalent ($E=mc^2$). Then some of this energy is transferred into mass.

$$m = \frac{m_0}{\sqrt{1 - \frac{v^2}{c^2}}}$$

61. Why does magnet attract some metals?

Metals are conductors of electricity, and as known conductors have free electrons. Each electron acts as a bar magnet and it has a north and a south pole. When we put the metal next to magnet, the tiny magnets (free electrons) all line up in a certain way that they are attracted to the magnet. For example, if I approach the south pole of a magnet to a piece of iron, the tiny magnets (free electrons) in the iron piece will line up where all the north poles face the south pole of my magnet. And unlike polarities attract.

Something to know: If you want to know why electrons behave like tiny magnets you might ask why they are charged in the first place. Actually no one knows!.

62. Why are not other elements attracted by magnets?

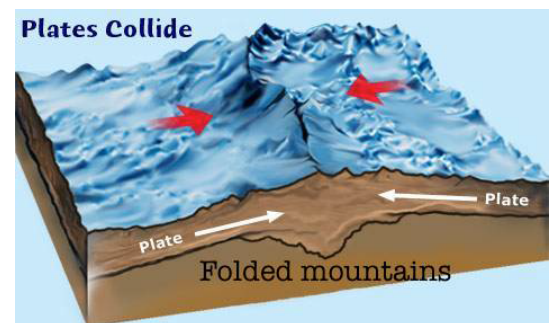
Other elements just have electrons that also act like tiny magnets. But, these electrons come in pairs in opposite directions and so they cancel each other. Also, the unpaired electrons in non-metals are shared for bonding.

However, sometimes (in iron, nickel, and cobalt for example) there are one or more un-paired electrons. The magnetic fields of these electrons aren't cancelled out by another.

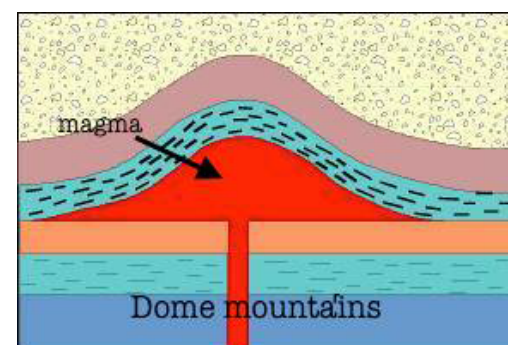
63. Why do mountains form ?

There are several different ways that mountains can form:

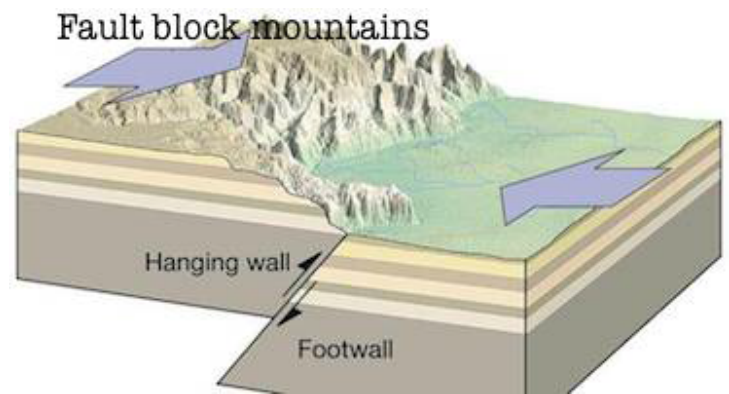
First way is by folding, when the Earth's tectonic plates collide they cause high pressure. Under high pressure layers are compressed and rise up in air. These layers are called folded mountains. The Himalayas formed by the same way when the plate carrying India collided with the Asian plate.



The second way is from volcanic activities. Where magma rise up and push the crust to form a dome shape then it cools down (not necessarily erupted).



The third way is faulting, the earth crust is filled with cracks where some cracks are called faults. What happens is that one side of a fault tries to move in one direction and the other side moves in the opposite direction, due to stress one part (block) move vertically upward forming what we call Fault block mountains.



64. Why are mountains top full of ice while deserts hot (though mountains are closer to sun)?

We get sun heat via radiation, so most people wonder why mountains are colder than valley, while mountains are closer to the sun. They are indeed correct since radioactive energy decreases with distance from the source. But the sun is over 150 million Km away and the difference between the highest mountain (Everest) and the lowest desert is 8000 m which is negligible compared to 150 million km. Therefore, it is not the distance!.

It has to do with the pressure. The pressure is low in the mountains (thin air/less molecules) and higher at the valleys (thick air/more molecules). Where denser thick air can store more heat. As we go up a mountain, the air becomes less dense and less heat can be absorbed.

But something else is going on. As we know the warmer air rises up (since it is less dense) while the colder air stays down, so in the process where the hot air rises its temperature drops down since it loses pressure (gas law). By the time the air reaches the high mountain it has lost a lot of pressure and so it freezes.

65. Why does a nucleus need neutron(s)?

Since a neutron has no charge many people ask why does an atom need a neutron. Actually, a nucleus won't be stable without neutrons. To explain, the nucleus consists of protons where protons have positive charge, those charges repel each other (electrostatic force). Here comes the role of the neutrons, where there is a force between the protons and neutrons called strong nuclear force. So the balance between the electrostatic force and strong nuclear force causes stability. For a given number of protons, there is an "ideal" number of neutrons required for a stable nucleus. Too many or too few neutrons lead to a radioactive, unstable atom.

66. Why does nuclear fission release enormous energy?

Nuclear fission occurs when a nucleus splits into smaller parts. This process releases very large amount of energy. The mass of the product after the fission is less than the original mass of the fissionable atom. The difference in mass is called mass defect this mass is

converted to enormous energy (as gamma rays and kinetic energy) according to mass-energy equivalence $E=mc^2$.

67. Why does nuclear fission needs very high temperatures?

Nuclear fusion is the reaction in which two or more nuclei combine together (usually hydrogen) to form a new heavier element releasing high energy. To combine two nuclei together we should overcome the repulsive electrostatic force between them. At very high temperatures like in the sun the elements become plasma where electrons are stripped from atomic nuclei. Under such condition the repulsive force can be overcome. The sun achieves these temperatures by its large mass and the force of gravity compressing this mass to the core.

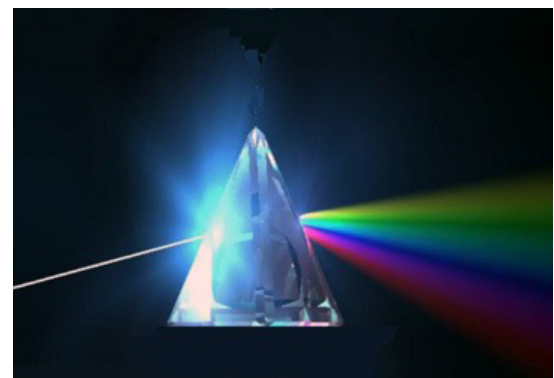
68. Why do stationary objects appear to move when we are in a moving car?



The motion of any object depends on the motion of the observer since motion is relative. If we have many observers, each one measures certain velocity relative to (compared to) the frame of reference that objects are standing in. When you are in the car it is at rest relative to you and if the car is moving with a 'constant speed' your brain can hardly tell that the car is even moving on the road. So relative to you the road, trees and the power lines will be moving with a speed equal to the speed of the car and the car is at rest.

69) Why does the prism show the color of the rainbow ?

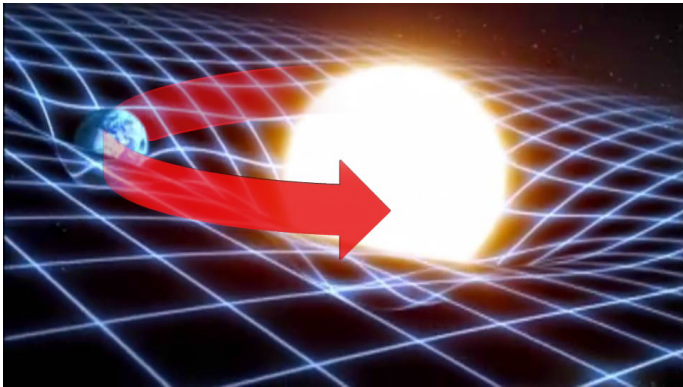
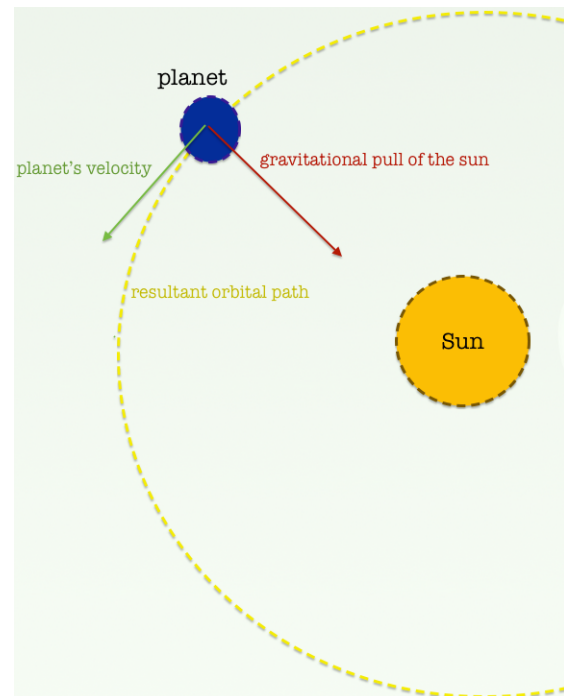
Visible light consists of different colors, specially the colors of the rainbow, and these colors together constitute white. Each color has certain wavelength and frequency. Starting with violet that has the lowest wavelength (higher frequency) to red with highest wavelength (lowest frequency). When light enters a medium it bends (refracts)-in letter L we explained why light refracts-so when light enters a glass, each wavelength of light refracts with certain angle. Because different frequencies of light travel through a medium at different speeds (since index of refraction is wavelength dependent). In which short wavelength light travels more slowly and bends with greater angle compared to long wavelengths.



70. Why do planets orbit the sun ?

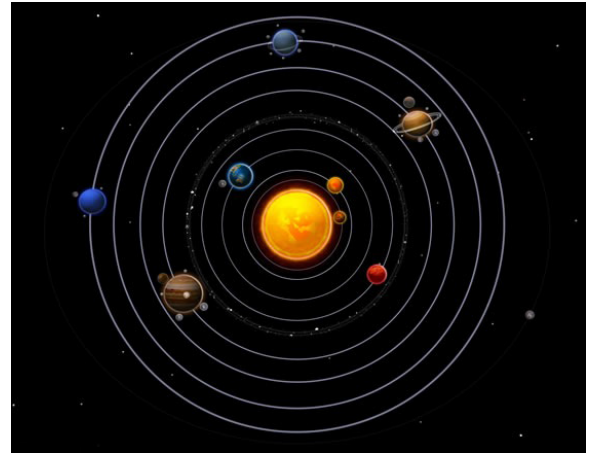
The same reason as “why does moon orbit the earth?” or “why does satellite orbit the earth?”. There are three ways to answer this question:

Using Newtonian physics, we know that there is a gravitational force between the sun and each planet. Where the gravitational force of the sun on planets is an attractive force towards it. But the planets also has a side way velocity preventing from falling to the sun. The inward force and the planets' velocity keep them in orbit around the sun.



Using general relativity, the effects of gravitation are ascribed to space-time curvature instead of a force. Heavier the object is more the curvature of space-time is. Lighter objects like planets will orbit the heavier (sun) following the curvature in the fabric of space. To visualize it think of a rubber sheet with heavy ball in the center.

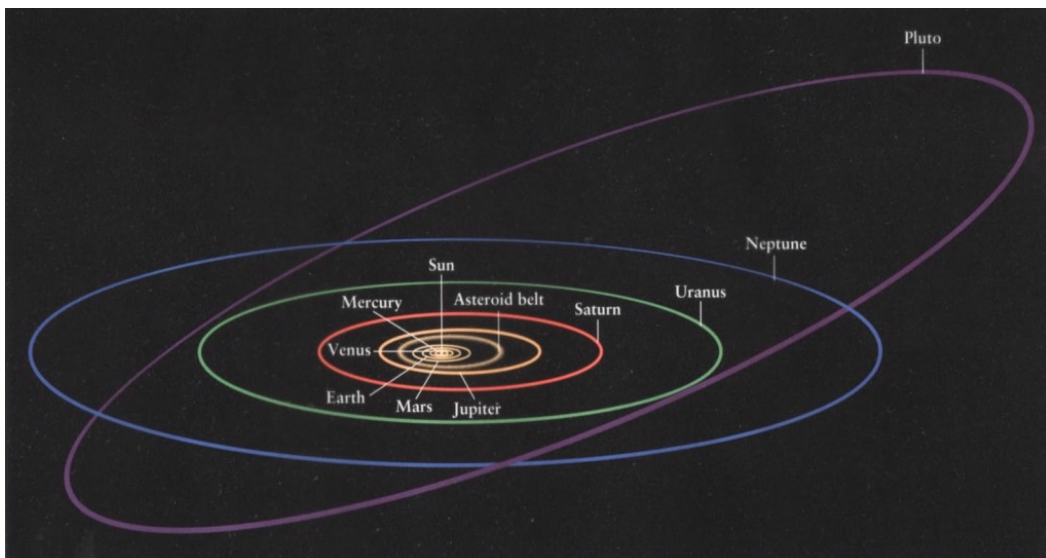
Third way by looking back 4.6 billion years ago. A cloud of gas called Nebula-which was filled with particles of ice, dust and other particles-collapsed. The cloud started to spin faster as it start contracting (like when an ice skater spins faster when closing her arms), then the contracting nebula begins to flatten as a disk. Most of the collapsing mass collected in the centre forming the sun. Around the sun a thin rotating disk gives birth to planets. And they keep rotating till now due to the conservation of angular momentum.



71. Why do planets form ?

4.6 billion years ago a cloud of gas and dust (called nebula) gravitationally collapsed. Most of the collapsing mass collected in the center forming the Sun and the rest flattened into disk forming planets, moons, asteroids, comets, dwarf planets and other small bodies formed (less mass).

72. Why is not Pluto a planet anymore ?



Pluto was thought to be a planet when it was first discovered. Thus, after technology and telescope improved and according to the definition of the planet that was put by astronomers in 2006 Pluto was proved not to be a planet anymore. First reason is that the orbit of Pluto is inclined by 17° compared to other planets. Not only this but also Pluto's orbit intersects with Neptune's orbit. Moreover, Pluto is smaller than Earth. Also, scientists find many other objects similar to Pluto, even they found an object named Eris bigger than Pluto in the same region with Pluto. Hence, scientists decided to call all these objects dwarf planets.

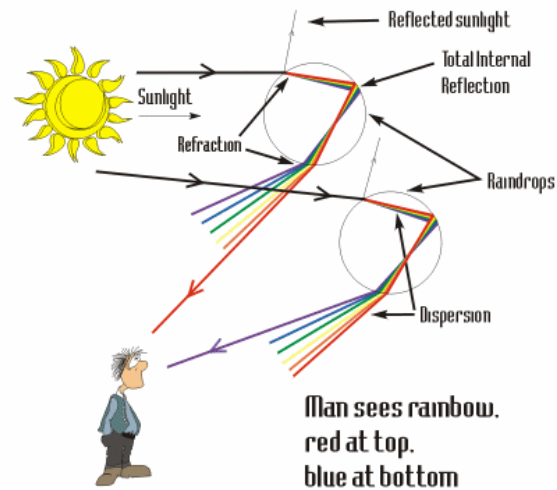
73. Why do Quantum mechanics and general relativity conflict each other ?

General relativity deals with gravity and governs large scale dynamics, while, quantum mechanics deals with subatomic particles. The incompatibility lays when describing gravity. To GR space is not empty, anything heavy can create a gravitational field that space can be bent and twisted like a fabric. To QM vacuum of space is filled with virtual particles that come in and out of existence (according to the uncertainty principle). Also with black holes, to GR in a black hole gravity is infinite, time stops, information is destroyed and nothing can escape a black hole even light. To QM, black holes cannot destroy information and that certain quantum particles should be able to escape a black hole, but they would be too small for anyone to detect, this process is called Hawking radiation (As Stephen Hawking famously showed, quantum theory predicts that

material falling into a black hole will reemerge as formless radiation).

74.why do we see rainbows ?

Before reading this answer, go back to letter P and read “why does prism disperse light?”. Actually, each raindrop acts like a tiny prism where the white light enters a droplet and each color exists the droplet with different angle(see image) according to its wavelength. For example, red-light will exist the drop at 42° from the angle at which sunlight entered. Moreover, rainbows only happen when sunlight is coming from behind you and is low in the sky. As the sunlight enters certain rain droplets, only one color from each droplet will enter your eyes at the exact angle needed to reach it exactly. So in one part of the sky only red color will bounce to your eyes and other colors will scatter from other parts of the sky creating the illusion of the rainbow.



75. Why are not rainbows arced circular ?

We see a rainbow when the sunlight hit the right droplets that are just in the right place to hit our eyes. While, other droplets send their sunlight somewhere else. But we actually don't see a full circle because the earth gets in the way. Moreover, the closer the sun is to the horizon more the arc we see.

76. Why do some metals go rusty ?

Iron and steel rust when they come in contact with water and oxygen. When water hits iron for example it reacts with carbon dioxide (CO_2) in air to form carbonic acid, then iron is dissolved. Some of water will break into its component oxygen and hydrogen. This oxygen reacts with dissolved iron to form iron oxide. Iron oxide is rust.

77. Why do things go rusty faster at sea level ?

As mentioned before, rusting of the iron is due to the electrochemical reaction. It requires the presence of both air (the oxygen) and water. If salt (Sodium chloride) is present in air as a salt-water vapor this greatly increases conductivity (electron flow) of the solution due to a higher concentration of ions. Then iron tends to rust more quickly as a result of electrochemical reaction.

78. Why does it rain ?

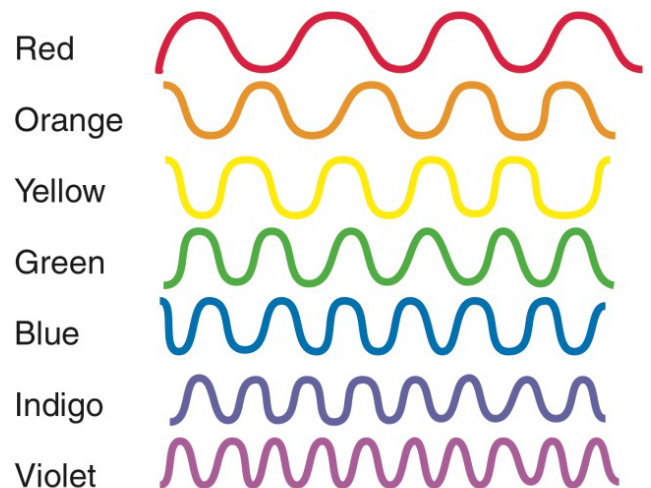
It begins with the vaporization of water near the Earth's surface, in the form of rivers, lakes, oceans or ground water. Then water vapor rises and condenses with dust and pollen particles. Therefore, when the amount of water vapor reaches the maximum number a certain temperature can hold, clouds are formed. Where clouds are visible tiny droplets and ice particles - then water droplets fuse to form larger water droplets (due

to air turbulence) and when that drops become heavy enough to overcome air resistance they fall as rain.

79.why do we see different colors?

Light is a wave,the frequencies of light that we can see are called colors.Lowest frequency color we can see is red and highest frequency is purple .In between all the other frequencies called the visible spectrum.for example,when sunlight (white color) hits the apple,it absorbs all colors except red that is reflected to your eyes and your brain perceives it as red according to frequency of the electromagnetic wave.

Visible Light - Wavelength



80) Why are spaceships best being launched from near the equator ?

As we know the Earth is rotating around its axis,the greater the distance between any point on Earth's surface and Earth's rotating axis, the greater its speed is ($v=r\omega$).Hence, the land near equator moves faster than any other place. In other words,if there are two points each one on a latitude, first one on the equator and the other is on any latitude you choose near the poles.Both points takes 24 hours to get back to their

initial position but that on the equator will take longer distance which means faster speed.

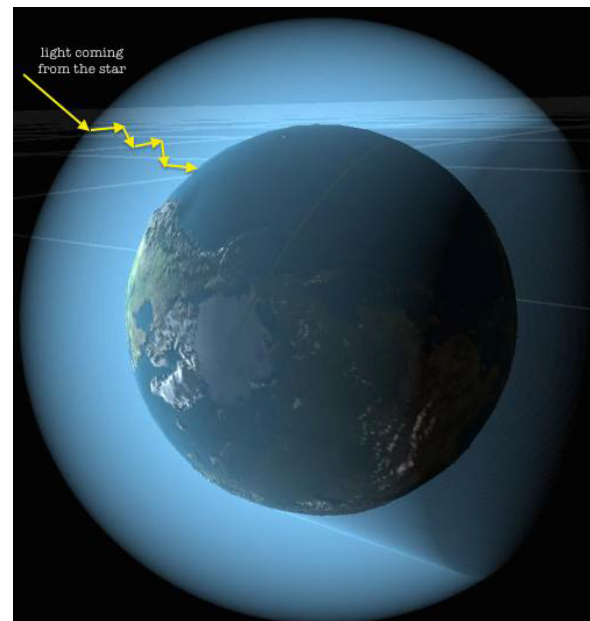
In order to launch a spacecraft it should be given a thrust so it is launched at near the equator because earth rotates at greater speeds there that means spaceship gets biggest boost possible from earth.

81. Why do we get static shock ?

You almost feel it in winter days, that is when you rub your feet with the carpet you cause the electrons to flow to your body. When you touch a conductor (knob of a door) or another person you cause the electrons to flow from your body to the body you touched, makes electric shock. Dry air encourages the accumulation of charges and increases the chance of getting shock since water molecules in air allow excess of electrons to dissipate into the atmosphere.

82. Why do stars twinkle ?

The scientific name for the twinkling of stars is stellar scintillation. The light of the star is bent (refracted) many times and in random directions from moment to moment because light passes down through many layers of air and each layer has different temperatures, pressures, densities and other factors. Each layer will bend and affect light in a certain way. So from our perspective the light will



appear in a location then after millisecond it will appear in other location and this seems like twinkling.

83. Why doesn't the sun twinkle like other stars ?

The stars are much further away than the sun from us. They appear like a single points to us where light comes from one direction and it can be highly affected by atmospheric turbulence. While the sun is much closer and it is like a big disk where the effects of scintillation are negligible.

84. Why do stars die?

Stars are fuelled by nuclear fusion of Hydrogen atoms to form Helium. Deep in the core of the star the fusion produces radiant energy that provides the star with the necessary pressure to prevent it from collapsing under its own gravity. When the core runs out of Hydrogen, the fusion ceases and the core begins to collapse into itself and becomes very hot. But hydrogen is still available in the outer layers. Very hot core pushes the outer layer to expand and then cools to become what we call red giant. Finally after all nuclear reactions stop red giant starts to shrink. Small stars become white dwarfs. While large stars become either neutron star or Black holes.

85. Why is the sky blue ?

This is due to what we call Rayleigh scattering, in which light is scattered when the molecules of the transparent medium (air or water) are much smaller

than the wavelength of light. As mentioned many times in the answers above that light from the sun is white and white light consists of all the colors we see. Each color has a certain wavelength. It starts with violet then blue with the shortest wavelength to red with the longest wavelength. Toward the violet end of the spectrum, wavelengths are shorter and more energetic, scatter better than those toward the longer, less energetic, red end. As light passes through the atmosphere, it is scattered, and how much each color is scattered depends on the wavelength. The shorter the wavelength, more it is scattered (according to Rayleigh's formula: the intensity of scattered light varies inversely with the fourth power of its wavelength). That is why blue is scattered more efficiently than other colors.

86. Why doesn't the sky appear violet instead of blue?

In the question above we said that the shorter wavelength seems to interact more than other colors. But violet color wavelength is shorter than blue, so the sky should be violet!!! However, sunlight sends more blue than violet as shown in the solar radiation spectrum. Also, our eyes are more sensitive to the blue wavelength range (due to the cones in our eyes) than violet or indigo.

87. Why is the sky red at the sunset?

At the sunset, the sun is lower in the sky, and light must travel farther through the atmosphere

before it gets into your eyes, it needs more time for the blue color to be scattered in all directions, leaving the red light (longest wavelength) to hit our eyes. In conclusion, the more atmosphere you pass the sun through, the more blue light gets scattered away, and so the redder it appears.

88. Why is the sky dark at night ?

Space is full with billions of shining stars billions of galaxies in all directions. The sky should be bright !! but why is it still dark at night?. Many have been thinking about this puzzling question from a long time. From 1550 by Thomas Digges to Kepler in 1610 to Edward Halley in the 1800s till Heinrich Olbers in the 1900s where it becomes known as Olbers' paradox. In Olbers' age he was told that the universe is static and infinite (never created and always existed). According to the calculation he proved that all space not even the sky should be bright!. Then there were two possibilities either the universe is not static or finite or even both. But in the 20th century we have known that the universe is not static it is expanding and it has a beginning started from the Big Bang. Again the universe is expanding and the stars, galaxies and everything in the universe are getting away from us. Thus, the stars are red shifted (Doppler effect) and the further away the star is from us the faster it is traveling away (Hubble's law). So the wavelength of light coming is stretched enough to become infrared (not in the visible spectrum) and our naked eyes can't see infrared. In other words, the space is bright but we can't see it with

our naked eyes only using Hubble telescopes. Where, only in the early universe the sky is bright with visible light.

89. Why is the sun yellow ?

This is a misconception. The Sun isn't yellow or orange but it's actually white (mixture all the wavelength of light). The reason why we see sun as yellow coloured is related to why sky is blue. When sunlight enters the atmosphere blue and violet are scattered (as we mention in the two answers before) where the result of the remaining colors all mixed together appear yellowy orange to our eyes.

90. Why is seawater salty ?

All water even rain water contains dissolved chemicals that scientists call salt (sodium chloride NaCl), but not all water tastes salty. The ocean contain 50 billion million tons of salts. Rain contains some dissolved carbon dioxide from the surrounding air. The carbon dioxide dissolved in water forms weak carbonic acid which dissolves minerals. So when the rain falls on land the acids chemically break down the rocks and carries minerals (especially sodium, chlorine, sulfur, calcium, magnesium, and potassium), along in a dissolved state as ions. The ions in the rainfall are carried to the streams and rivers (which are slightly salty) and then to the seas. But sea is more salty than river, because the sea collects all of the salt and minerals from all of the rivers that flow into it. In addition, sea water is evaporated from the surface but the salt is too heavy to be evaporated and remains in the sea (where the extra heat in the tropics makes

water there saltier than toward the poles). Thus, the salinity of the sea increases. Moreover, there is another reason for the increase in salinity of the sea what we call Hydrothermal vents which is an opening in the sea floor out of which heated mineral-rich water flows. In addition to volcanic eruptions underwater.

Something to know : You might think that the salinity of the sea is increasing over time but actually the salinity of oceans have reached equilibrium.

91. Why does time slowdown the faster you go?

Einstein postulated that all observers will measure the same speed of light regardless of the state of motion. But speed is the measure of the distance in a certain amount of time, so to agree on the same speed of light the observers must disagree on distance and time. Noticeable slowdown in time can occur when an observer approaches the speed of light.

That experiment is a famous thought experiment to explain the relativity of time. If there are two mirrors facing each other and a beam of light bouncing between them. As a stationary observer, you'll see the laser beam moving vertically up and down. While if I attach it with a clock and let the mirrors move. You'll see the laser beam traveling in a longer diagonal path and the clock starts to tick slower. The reason of the slowdown of time is that the speed of light is constant (186000 miles per second) and light is traveling a longer distance.

In short, we conclude that time slows down for objects traveling near the speed of light, because it explains

how light continues to travel at its constant speed c , despite the speed of the observer .

92. Why do scientists care a lot about having a theory of everything ?

There are four forces in nature: Gravity, electromagnetic force, weak and strong nuclear force. We have general relativity that focuses on gravity for understanding big things like stars, galaxies.. etc. On the other hand we have Quantum mechanics that focuses on the other three forces for understanding very very small things like molecules, atoms and subatomic particles. These two separate theories are incompatible! {to know why go back to letter Q}. But we have one universe, we should have one theory that works for everything. And if we want to understand the Big Bang and how the universe began we can't divide it up into big and small . So scientists care about this theory to understand how the universe had begun.

93. Why does the sap of the tree move up (against gravity)?

There are two mechanisms that allow the passage of the sap from the roots to the leaves : Root pressure and transpiration. In first mechanism, roots absorb water and minerals from the soil creating pressure inside the root. Hence, water with dissolved minerals (ions) squeeze up to lower pressure area. But, this pressure is weak especially when talking about long trees. The second mechanism is probably more important. Inside

each xylem-like the vessels in human body-there is a chain of water molecules due to the hydrogen bonds. However, here there is additional hydrogen bonds between water molecules and the nitrogen atoms (that are found on the walls of the xylem), which prevent gravity to pull the chain down. Forming water molecules chain from roots to leaves. Here comes the role of the sun which evaporates water in the leaves, every time water molecule is removed (due to evaporation) the chain gets up. That is the main reason why sap (water + dissolved ions) gets up .

94. why is the temperature higher at the equator than at poles?

There is a misconception that the equator is warmer than the poles because it is closer to the sun than poles. But that is not true, sunlight hits the equator directly (vertical) such that the sun's rays are concentrated most days of the year. Unlike the north and south pole where the sunlight falls indirect making those places the coldest due to the spherical shape of Earth. Also, ice and snow at the poles reflect back to space some of the sun's energy that reaches the earth while sunshine is absorbed to heat the earth at the equator. In addition, sunlight that is warming the equator has to travel through the least amount of atmosphere to reach it and thus is much effective.

95. why is the universe expanding ?

The distant galaxies are moving away from us and most distant galaxies are moving faster (Hubble's

law). All galaxies are moving away from us and away from each other, that space itself is getting bigger. Scientists thought that the universe is expanding but slowing down in its expansion due to the gravitational field between massive objects! But the result was shocking !!! The surprise is that they are not just expanding but also speeding up. The reason of the expansion and acceleration is due to what scientists call dark energy “the energy of empty space/nothing” as a repulsive force against gravity and this energy pushes space itself. Einstein formed his general theory of relativity he decided to test it on the static universe (as was thought), but he couldn't balance his equation to equal a static universe. Hence, the universe should be either expanding or contracting then he proposed a cosmological constant, a constant energy that would hold the universe in balance. But, now, theoretical cosmologists aren't sure if the universe is expanding due to the existence of dark matter which is this cosmological constant that Einstein proposed or it is another thing we still don't know or even reasons of the expansion is due to a modification of Einstein's general relativity, our theory of gravity.

96. Why is [uranium-235](#) the commonly used element in nuclear fission?

U-235 is commonly used in nuclear fission since it is what scientists call “Fissile”; which means it is capable of sustaining a nuclear fission chain reaction. To explain

U-235 has a very high probability to undergo fission by a low-energy thermal neutron, that is because the resulting binding energy from the absorption of neutron is greater than the critical energy required for fission. Uranium-235 has isotopes as Uranium-238 and Uranium-233. Uranium-238 is fissionable but not fissile, what is meant that it can undergo fission reaction by high-energy thermal neutron with a low probability. Moreover, it cannot sustain a neutron chain reaction. While Uranium-233 is not found naturally but it can be made by neutron irradiation of Thorium-232.

97. Why does our [voice](#) sound different in recording?

When you hear your voice via recording, happening event is that air molecules that surrounds the recording are excited and starts to vibrate. The vibrations reach your ear drum where in your ear the vibrations are transferred into electromagnetic wave (nerve message) that reach your brain and you perceive your voice. While when you speak the voice are coming from two ways, the first way is from your mouth vibrating air to your ear. The second way, when your vocal cords vibrate they cause the skull to vibrate. Thus, the combination of the sound wave traveled by the bones with the sound wave traveled in air makes your voice such that its frequency decreases (lower pitch). Actually, what you hear in the recording is your real voice!

98. Why does water expand when it freezes ?

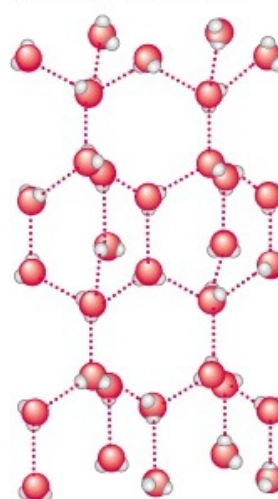
Water ,unlike most liquids , its volume expands when passing from liquid state to solid state.Due to hydrogen bond that makes water so special.Water has enough energy for molecules to move, but when it reaches 40C the atoms slowdown to form this hexagonal form (see image).Where it forms solid crystal structure that takes up more room(space) than water.

99. Why do we see like water ponds on roads at summer time ?

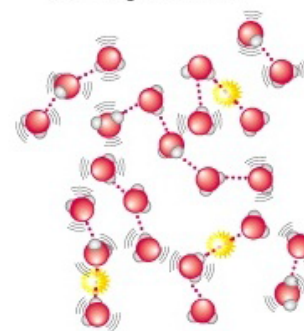
It is kind of optical illusion commonly occurs in hot days.When the air directly above the asphalt road is heated in such a way there become two mediums hot air and cold air that is more dense.Therefore,cold air has greater refractive index allowing light to refract(bend) upon passing from cold to hot. The result is an image of

the sky above appears on the ground. To our eyes the distorted rays looks like they are coming from the ground.Thus,brain interprets it as there is water responsible for the reflection,which seems more reasonable to the viewer.

(a) Solid water (ice)



(b) Liquid water



100. Why do we move our hands while walking ?

It is curious that human swing their arms as they walk. That is, your right arm swings forward when your left leg steps forward and vice versa. The first reason is that we swing our hands naturally because it takes less exertion than when holding the arms down. Also, swinging arms in an opposing direction reduces the angular momentum of the body, balancing the rotational motion produced during walking. To explain, during a step your legs try to make your body spin about a vertical axis but swinging your arms cancels this out.



$$(u, v) = \left(\frac{-2m}{m^2+1}, \frac{1-m^2}{m^2+1} \right)$$

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$$\pi^{-\frac{s}{2}} \Gamma\left(\frac{s}{2}\right) \zeta(s) = \pi^{-\frac{1-s}{2}} \Gamma\left(\frac{1-s}{2}\right) \zeta(1-s)$$

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$$\frac{\partial u}{\partial x} + v \frac{\partial u}{\partial y} + w \frac{\partial u}{\partial z} = g$$
$$\frac{\partial v}{\partial x} + v \frac{\partial v}{\partial y} + w \frac{\partial v}{\partial z} = h$$

$$f = \frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} + \frac{\partial^2 u}{\partial z^2}$$
$$g = \frac{\partial^2 v}{\partial x^2} + \frac{\partial^2 v}{\partial y^2} + \frac{\partial^2 v}{\partial z^2}$$
$$h = \frac{\partial^2 w}{\partial x^2} + \frac{\partial^2 w}{\partial y^2} + \frac{\partial^2 w}{\partial z^2}$$

$$\frac{\partial^2 x}{\partial y^2} + \frac{\partial^2 y}{\partial x^2} + \frac{\partial^2 z}{\partial w^2} + \frac{\partial^2 w}{\partial z^2} = g$$
$$\frac{\partial^2 w}{\partial x^2} + \frac{\partial^2 x}{\partial w^2} + \frac{\partial^2 y}{\partial z^2} + \frac{\partial^2 z}{\partial y^2} = h$$

$$\frac{\partial v}{\partial x} + v \frac{\partial v}{\partial y} + w \frac{\partial v}{\partial z} = g$$
$$\frac{\partial w}{\partial x} + w \frac{\partial w}{\partial y} + v \frac{\partial w}{\partial z} = h$$

$$\sum_{n=1}^{\infty} \frac{1}{n^s} = \zeta(s)$$

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$$\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} + \frac{\partial^2 u}{\partial z^2} = f$$
$$\frac{\partial^2 v}{\partial x^2} + \frac{\partial^2 v}{\partial y^2} + \frac{\partial^2 v}{\partial z^2} = g$$
$$\frac{\partial^2 w}{\partial x^2} + \frac{\partial^2 w}{\partial y^2} + \frac{\partial^2 w}{\partial z^2} = h$$