

Optional

Friday, June 4, 2021 10:42 AM

Supernova: a star that suddenly becomes much brighter because it is exploding.

A neutron star must have a minimum mass of at least 1.4x solar masses (that is, 1.4x mass of our Sun) in order to become a neutron star in the first place. See Chandrasekhar limit (pauli exclusion related pressure and gravitational collapse pressure competing| mass above which white dwarf becomes either blackhole or neutron star)

A neutron star is formed during a supernova, an explosion of a star that is at least 8 solar masses. Maximum mass of a neutron star is 3 solar masses. If it gets more massive than that, then it will collapse into a quark star, and then into a black hole.

We know that 1 electron + 1 proton = 1 neutron;

1 neutron = 3 quarks = up quark + down quark + down quark;

1 proton = 3 quarks = up quark + up quark + down quark;

A supernova results in either a neutron star (between 1.4 and 3 solar masses), a quark star (about 3 solar masses), or a black hole (greater than 3 solar masses), which is the remaining collapsed core of the star.

During a supernova, most of the stellar mass is blown off into space, forming elements heavier than iron which cannot be generated through stellar nucleosynthesis, because beyond iron, the star requires more energy to fuse the atoms than it gets back.

During the supernova collapse, the atoms in the core break up into electrons, protons and neutrons.

A red giant is a luminous giant star of low or intermediate mass (roughly 0.3–8 solar masses ($M_{\odot}$)) in a late phase of stellar evolution.

Dark matter and Dark energy

25%: Dark matter and 70%: Dark energy| invisible which does not emit or reflect light| it has been found that gravity of visible matter is not sufficient to make complex structures like galaxy| observations also suggest places with dense dark matter bend light implying interaction of gravity with dark matter| Dark matter is not anti matter because it does not produce gamma rays when it interacts with normal matter| seems to scattered all over place unlike compacted black hole.| dark matter slows down the expansion of the universe, while dark energy speeds it up.

Gravitational red shift

The light from distant stars and more distant galaxies is not featureless, but has distinct spectral features characteristic of the atoms in the gases around the stars. When these spectra are examined, they are found to be shifted toward the red end of the spectrum. This shift is apparently a Doppler shift and indicates that essentially all of the galaxies are moving away from us. | Hubble said red shift was due to fact that universe was expanding. Hubble's brilliant observation was that the red shift of galaxies was directly proportional to the distance of the galaxy from earth. That meant that things farther away from Earth were moving away faster. In other words, the universe must be expanding. He announced his finding in 1929.| It is observed there is more to it, that empty space is being created which is attributed to dark energy.

Space-time is a mathematical model that joins space and time into a single idea called a continuum| In Einstein's view of the world, gravity is the curvature of spacetime caused by massive objects unlike newtonian concept of gravity as force.| Large objects such as the Sun and planets aren't the only masses that warp the fabric of space-time. Anything with mass—including your body—bends this four-dimensional cosmic grid. The warp, in turn, creates the effect of gravity, redirecting the path of objects that travel into it.

India's nuclear program status:

Why Uranium only: U-235 is the only [nuclide existing in nature](#) (in any appreciable amount) that is [fissile](#) with [thermal neutrons](#)

What is fast breeder reactor?: A breeder reactor is a [nuclear reactor](#) that generates more [fissile material](#) than it [consumes](#).| U-238 bombarded by neutron then double beta decays into Pu-239.

How is nuclear fission made sustainable under what conditions? : Absorbing neutrons by control rods like cadmium, boron, indium.

Total installed capacity of nuclear power & Number of nuclear power stations: 22 reactors with a total capacity of 6780 MW in operation

Recent developments in astronomy

first photograph of a black hole was revealed by scientists recently | Gravitational waves

71. Can you explain quantum physics to me in simplest terms?

Quantum mechanics is a fundamental [theory](#) in [physics](#) that provides a description of the physical properties of [nature](#) at the scale of [atoms](#) and [subatomic particles](#). It **uses wavefunctions to explain state of an object**. |One consequence of the mathematical rules of quantum mechanics is a **tradeoff in predictability between different measurable quantities**.

73. What do you understand by the term micro fabrication?

Microfabrication is a technique that **use semiconductor manufacturing processes** such as ion etching, diffusion, oxidation, sputtering etc. in combination with **specialized micromachining techniques**.

76. Who got the recent Nobel prize in physics and for what contribution?

Awarded to three astrophysicists Roger Penrose from the UK, Reinhard Genzel from Germany, and Andrea Ghez from the USA for their research on blackholes.

77. What are Black holes? What does the work of the recent Nobel prize winners in Physics tell us about Black holes?

A black hole is a place in space where gravity pulls so much that even light can not get out. The **gravity is so strong because matter has been squeezed into a tiny space**. This can happen when a star is dying.| There's a **boundary at the edge of a black hole called the event horizon, which is the point of no return — any light or matter that crosses that boundary is sucked into the black hole. It would need to travel faster than the speed of light to escape, which is impossible**.| Also, while anything past **the event horizon is invisible**, outside that boundary there is sometimes a **spiral disk of gas that the black hole has pulled toward — but not yet into- itself which can be detected by X ray telescope**|

Recent nobel prize:

At the centre of a black hole, where the density became infinite, the laws of physics, would no longer apply. Penrose proved that a **black hole formation is a robust prediction of the general theory of relativity**.| **Genzel and Ghez received the second half of the prize for the discovery of a supermassive black hole at the centre of the Milkyway galaxy, now known to be the Sagittarius A*.**

78. Difference between resistor and semiconductor?

79. Difference between right hand thumb rule and left hand thumb rule.

80. Difference between 'Thermodynamics and Heat Transfer'

81. Different types of communications? Explain

82. What is Quantum Physics?

Basic postulates of quantum mechanics:

83. What do you know about Thomas Edison and his achievements?

88. **Why entropy change of reversible adiabatic process zero?**

No heat exchange

89. Why is a counter flow heat exchanger better than a parallel flow heat exchanger?

90. **Why are manholes in vessels usually elliptical in shape?**

Elliptical shape has **minimum area** of opening and thus plate is **weakened the least**. Further it is very **convenient to insert and take out the cover plate from elliptical opening**. Because rectangular shapes that would be human-friendly involve **large stress concentrations near the corners**. Round manhole cover can't fall through its circular opening, because **no matter how you position it, the cover is wider than the hole**. But a square, rectangular, or oval manhole cover could fall in if it was inserted diagonally into hole.

91. **Why was tungsten chosen to be used in electric bulbs? What other alternatives were considered and why were they dismissed?**

High melting point| first was carbonized cotton thread.

92. **Without using relativistic concepts, is it possible to transfer an object through a closed wall using material science or similar principles?**

Quantum tunneling using potential barrier| applications in **nuclear fusion**| **SQUID used for sensitive magnetic field detection in brain**

93. Describe the use of 4D printing.

94. Explain the working of a 4-stroke engine? Why is it named 4 strokes?

95. Explain what is dextro-rotatory and levo-rotatory?

96. Suppose if a capacitor is connected to a generator load. What will happen?

Connecting a capacitor across a generator always improves power factor, but it will help depends up on the engine capacity of the alternator, **other wise the alternator will be over loaded due to the extra watts consumed due to the improvement on pf.**

97. What are chuck gliders? With what mechanism do they fly?

98. **What is Curie point?**

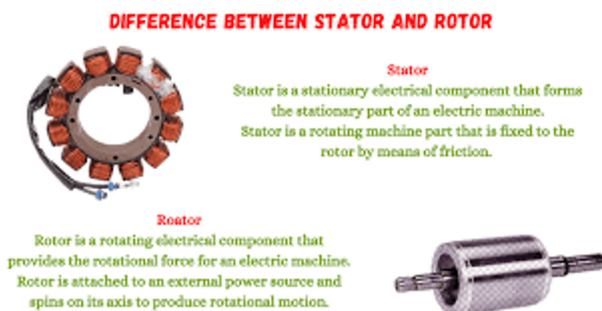
Above which particles become paramagnetic ie. **remain magnetic only under influence of magnetic field.**

99. What are Higgs boson particles? What is a large hadron collider experiment?
 interaction that gives mass to elementary particles is called the **Higgs mechanism** and the particle that mediates the interaction is called the **Higgs boson**.| photons and gluons do not interact with the Higgs field, which is why these particles do not have mass| Higgs mechanism doesn't result in anything resembling a force as it's a scalar field.| LHC is a nearly 17-mile-long circular tunnel that serves as a racetrack for smashing together particles of matter. The calculations also showed that the Higgs particle would be unstable, disintegrating into other particles in a minuscule fraction of a second.| In the 1980s, a possible solution was discovered, one that rings a loud Higgsian bell. If a region of space is uniformly suffused with a field whose particulate constituents are spinless, then Einstein's theory of gravity (the general theory of relativity) reveals that a powerful repulsive force can be generated—a bang, and a big one at that.| Particles interacted with the Higgs field just 10-12 seconds after the Big Bang. | Before this phase transition, all particles were massless. They travelled at the speed of light. | After the universe expanded and cooled, particles interacted with the Higgs field. This interaction gave them mass. |
 Leon Lederman referred to the Higgs as the "Goddamn Particle." The nickname was meant to poke fun at how difficult it was to detect the particle. It took nearly half a century and a multi-billion dollar particle accelerator to do it. | Applications include assessment of existence of new subatomic particles,

100. Tell me if transformers are machines. Where are transformers installed?
 Sir a machine needs to convert electrical energy into mechanical work| reason for transforming the voltage to a much higher level is that higher distribution voltages implies lower currents for the same power and therefore lower $i^2 \times R$ losses along the networked grid of cables. | Step up and step down transformer.

$$\frac{N_P}{N_S} = \frac{V_P}{V_S} = n = \text{Turns Ratio}$$

3 phase means 3 voltage at different phases= 3 different fields= superposition is rotating magnetic field (synchronous generator)



101. How do you define transistors to a normal person? Do you find transistors used in this room? Where was the transistor invented?
 Transistors are electronic material| a semiconductor device with three connections, capable of amplification in addition to rectification. | John bardeen, shockley invented it in 1947.

Faraday's first law" [quantity of reaction taking place in terms of mass of ions formed or discharged from an electrolyte is proportional to the amount of electric current passed.]]
 Transistor is a three terminal semiconductor device that regulates current or voltage flow and acts as a switch or gate for signals. | The electromotive force around a closed path is equal to the negative of the time rate of change of the magnetic flux enclosed by the path. (**faraday's law of induction**) | When the same quantity of electricity is passed through different electrolytes, the masses of different ions that are liberated at the electrodes are directly proportional to their chemical equivalent weights (**2nd law of Faraday**)

Difference between electricity and electronics: [Electrical deals with the flow of electrical power or charge, whereas electronics deals with the flow of electrons.]

https://www.tutorialspoint.com/basic_electronics/basic_electronics_transistors.htm

102. What is Moore's law? [Moore's perception that the **number of transistors on a microchip doubles every two years**, though the cost of computers is halved]

103. **What are Neutrinos? Do Neutrinos have mass and energy?**

Neutrinos are **subatomic fundamental particles, with no charge and little or zero mass** that interacts only **via the weak subatomic force and gravity**| Neutrinos were first **proposed by Swiss scientist Wolfgang Pauli**.| **Determination of neutrino masses** is one of the most important open problems in physics today| Neutrinos are **created by various radioactive decays; during a supernova, by cosmic rays striking atoms etc.**| **relativistic energy due to momenta**.| **Nuclei of cosmic rays collide with atmospheric molecules such as Nitrogen to give off pions and muons which further decay to produce neutrinos.**

104. **What is the objective of India based Neutrino Observatory?**

built underground, to **isolate the detector from cosmic rays and other background radiation**| a 1,300 meters (4,300 ft) deep cave under INO Peak near Theni, Tamil Nadu, India| **Objective:** (anticipated to provide a **precise measurement of neutrino mixing parameters**| **Study conservation laws**)| main magnetized iron calorimeter (ICAL) experiment will include the world's largest magnet| **Benefits:** (A way to **monitor nuclear proliferation for nuclear reactors**| A way to **'x-ray' the Earth to find cavities of mineral and oil deposits depending on matter passing and time travelled**.)| possible to **encode a message in neutrinos** using binary code for very **fast communication**| theorized that a certain type of **neutrino might come from decaying dark matter**.)| mountain consists of 1km of solid rock that **filters away most of the charged particles from the cosmic rays**| **endanger the biodiversity of the Western Ghats**.| **structural damage to the mountain to emission of hazardous chemicals**| improve **recognition as half of Nobel physics are from particle physics**.

105. **What are Gravitational waves? How Einstein was related to them? What is INO?**

Gravitational waves are **ripples in space-time created by the movement of mass**| They have been **detected from collision of two massive black holes**| Detected on 14th September 2015| **lasted for a fifth of a second**| Gravitational waves **interact only weakly** with matter. This is what makes them **difficult to detect**.| Two neutron stars **collides some 1300,000,000 years ago creating gravitational waves**, thus can **tell about history of universe**| will help us **understand nature of blackholes**| Einstein pictured these waves as **ripples in the fabric of space-time produced by massive, accelerating bodies, such as black holes orbiting each other**| Getting weaker as they move away from centre| Einstein **imagined gravity as a curve on space time surface**| when a mass making depression on this curve, **gravity is stronger more depression**| as mass making depression moves, **gravitational waves are generated**.| If length of interferometer changes, it means detection of **gravitational waves**.| can **tell information of source object**| **Neutron stars colliding or collapse into supernova**| **massive objects cause a distortion in space-time, which is felt as gravity**.| **Delay between gravitational wave and gamma ray emitted was very insignificant so it travels with speed of light.**

Black hole information paradox shows why standard model and gravity are not able to be coupled.| **Photoelectric effect (threshold existence irrespective of intensity)**|

Why cant string theory be theory of everything? [its quite high energy physics| cant be experimented]

What happened in big bang? [

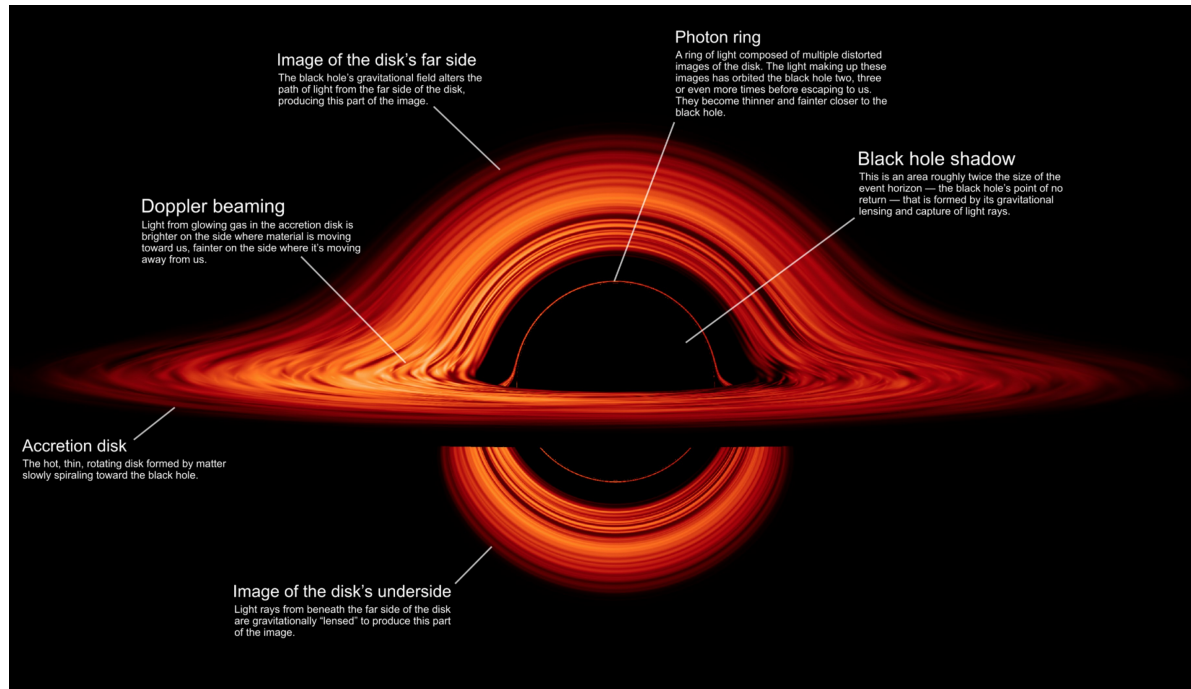
Laser Interferometer Gravitational-Wave Observatory (LIGO) [situated in Washington] is a **large-scale physics experiment and observatory** designed to detect **cosmic gravitational waves** and to develop gravitational-wave observations as an astronomical tool| **India is planning it and it was approved in 2016.**

Am I producing gravitational wave?: [wavelength is very large]

Black hole information paradox: [eulatory time evolution operator (

De-Broglie wavelength of large particle: [

Why is blackhole pic so? [cant take pic as light does not escape| matter surrounding blackhole revolve around gravity of blackhole| at 2.5 Radius from black hole, photon revolves around blackhole's gravity, below it light will be in black hole.]] light near us is redshift, down light is coming towards us| our projection of plane, plane of light incident is perpendicular.]



106. What is 5G technology? What are the challenges in implementing this technology?

5g is the next generation wireless cellular technology that will provide faster and more reliable communication with ultra-low latency. | 2-20 Gbps peak speed| higher radio frequency means higher data transfer however challenges import dependence, high upfront cost, tech. need, interference with radio altimeters, fibrization (at present only 30%, has to be doubled), tech standard (globally it is 3GPP while India has 5Gi)

Satellite internet provides at max 100 MBPS, high latency (600 ms compared to 20-50 ms for fibre), weather disruption and expensive. | VoLTE stands for voice over Long Term Evolution. Utilising IMS technology, it is a digital packet voice service that is delivered over IP via an LTE access network.

Radio altimeter operates in the frequency of 4.2-4.4 GHz, very close to the 5G network band planned in the US and it is feared that the 5G network will interfere with altimeter functioning. Radio altimeters are more accurate than barometric altimeters and have become more important and many times essential in aviation.

107. What is pi-meson? Who discovered it?

Boson | Yukawa reasoned that the electromagnetic force was infinite in range because the exchange particle was massless. He proposed that the short range strong force came about from the exchange of a massive particle which he called a meson.

108. What is magnetic levitation technology? (Levitation + repel to push via changing polarity of guideway through AC current)

Applications: Maglev Train, product display | If a small magnet is brought near a superconductor, it will be repelled because induced supercurrents will produce mirror images of each pole. If a

small permanent magnet is placed above a superconductor, it can be levitated by this repulsive force. | Like poles repel | **Requires rare earth elements and costly.** |

Can be levitated using lenz's law as **Moving rail would induce current in coils due to change in flux which then counteracts magnetic field of superconductor thus levitating rail** | Propulsion coils on the track are used to exert a force on the electromagnets in the train to make it move ahead. | **onboard superconducting magnets are attracted and pushed by the shifting field, propelling the Maglev vehicle.** | generate magnetic fields up to 10 times stronger than ordinary electromagnets, enough to suspend and propel a train. | **safety, less friction** |

109. How wide is the gender gap in STEM fields? What are the reasons behind it? Can you think of any measures to bridge it?

About 43 per cent of science, technology engineering and mathematics (STEM) graduates in India may be women, which is the highest in the world, but **women's share in STEM jobs in India is a mere 14 per cent.** | Reasons: (**Social issues** like **marriage** which is **considered incompatible with professional jobs** | **better work conditions** like sexual harassment prevention | **patriarchal attitudes in hiring** practices | **lack of recognition leading to lack of role models eg. 4 Nobel** in physics.) | **shift or transfer compromising their work.** |

Solutions: **Promote science education** in girls by organizing camps at school level | **promote safe workspace** | **promote recognition** of excellent woman scientists

Fun fact: Nobel Prize in Physics has been awarded **114 times to 216 Nobel Laureates** between 1901 and 2020. **John Bardeen is the only Nobel Laureate who has been awarded the Nobel Prize in Physics twice, in 1956 and 1972.** This means that a total of **215 individuals** have received the Nobel Prize in Physics.

Big bang entropy: [adiabatic] irreversible | entropy is relative quantity | entropy increased from very low (only one state was there) due to energy redistribution from singularity (dense mass)]

Black hole is area of spacetime fabric where gravity

110. What measures has the government taken to bridge the gender gap in sciences

Vigyan Jyoti Scheme (offers exposure for girl students from the rural background to help to plan their journey from school to a job of their choice in the field of science.) | **Gender Advancement for Transforming Institutions (GATI)** will develop a comprehensive Charter and a framework for assessing Gender Equality in STEM. | **Knowledge Involvement in Research Advancement through Nurturing (KIRAN) Scheme** is started by the Department of Science and Technology (DST) aimed to **bring gender parity in the Science & Technology sector** by inducting more women talent in the research & development domain. | **She-box are ensuring workplace safety**

111. Explain standard model in layman terms.

theory of fundamental particles and how they interact | have **three forces** except gravity | **5 sigma rule** | **12 fermions and 5 bosons** | **rules for six quarks, six leptons and gluons, photons, Z boson and W bosons, Higgs boson** | **Gluons, photons, Z&W bosons are exchange particles for quantum field theory.** | **Muons, one of leptons (larger than electron but very unstable (lasts fraction of a second)) g-factor of it showed deviation of value predicted at 2,** So experiment is known as Muon g-2 | **g-factor is measure of effect of muon's magnetic properties on it's surroundings as it is unstable** (a quantum mechanical factor in calculating magnetic moment associated with particle) | **current standard deviation is of 4.2 and it requires 5 standard deviation to claim discovery of unknown particle which caused alteration to g-factor.** | **wobbling is tilting of axis of spinning top.**

112. What is monte carlo simulation

rely on **repeated random sampling to obtain numerical results to then calculate average**

113. Dogra Hall @IITD

Structure is named "Dogra Hall" in the memory of Late **Prof. Dogra**, the first Director of IIT Delhi| Can be **supported at edges without having any columns in middle**| **Hyperbolic paraboloid**

114. Who invented Xray and how?

Roentgen (got nobel prize in 1901)

115. Quantum computing

Union Budget 2020-21 proposed to **spend ₹8,000 crore** (\$ 1.2 billion) on the newly launched **National Mission on Quantum Technologies and Applications (NMQTA)**| processors **can be a 1 and a 0 simultaneously**, a state called **quantum superposition** qubits. However on observing, it will collapse to become 0 or 1. This means **Qubit can store all possibilities of bits.** | China recently **demonstrated secure quantum communication links between terrestrial stations and satellites (secure communication)**| big boost to the **Genome India project** (genome is all the genetic matter in an organism. It is defined as "an organism's complete set of DNA, including all of its genes.)| **tracking protein behavior or even modelling new proteins** with the help of quantum computers could **be made easier and faster.** | **Internet-of-Things, machine learning, robotics, and artificial intelligence across sectors** will further help in laying the foundation of the **Knowledge economy.**|

- **Challenges:** On theoretical front lies the challenge of **creating the algorithms and applications for quantum computers**| **need of proper infra**| **skilled professionals**

In 2015, the National Supercomputing Mission was launched **to enhance the research capacities and capabilities in the country** by connecting them to form a Supercomputing grid, with **National Knowledge Network (NKN)** as the backbone.

- **QUEST – Quantum Enabled Science and Technology for 51 institutes by India**

1. **How is quantum computing achieved and how is it different from supercomputer:**
[quantum computing uses quantum entanglement| **superposition means it can do many operations simultaneously by taking possibilities of bits together in form of qubits.**]
2. **Meaning of god does not play dice?** [**Chaos and randomness are, therefore, not part of nature** ("God does not play dice").| **black-holes edge effects incorporate quantum effects**]
3. **What is Laminar flow?**
If **all particles passing through a particular point in fluid flow** have **same velocity**, then its laminar flow.
4. **How are physics and Indian philosophy related?**
Quantum physics eliminates the gap between the observer and the observed. The Upanishads say that the observer and the observed are the same things. Quantum mechanics **suggest collapse of the wave function implies that the reality we see exists only when we are there to observe.**
5. **Difference between Applied and Engineering Physics**
An applied physics student would **learn subjects covering broader areas (including High energy physics and superconductivity)**, whereas an **engineering physics student would go deeper into the subjects he learns.** But the distinction is very blurry in most cases.
6. **Why India lags in R&D in field like quantum physics-**
Lack of dedicated funding| **Research in silos** that too by few hundreds| **In developed countries, MNCs like google have taken lead unlike India.**
7. **Do you think teaching is still respectable job- no body wants to join**
Yes sir, it's a **thankless job**. Students still look up to teacher as **their role model**. However there are issues with regard to **pay, social security benefits especially in private schools, increasing recognition.**

8. **What is Engineering Physics (My major)? Is there something called Engineering Chemistry?**
Engineering physics involves **engineering things needed in cutting edge research which requires physical principles**. Its there on similar lines in chemistry **at IIT BHU**. | IIT Delhi started it in 2001.
122. **How do you determine that an electron is both a wave and a particle?**
It involved a **plate with two slits, with a screen behind it and an electron gun in the front**. A beam of electrons is passed through the slits, and is **observed by the screen placed behind it**. **Electron is particle as cathode ray tube turns wheel.**
123. **Tell me what is Schrodinger Wave Equation?**
Schrödinger equation gives the **evolution over time of a wave function**, **quantum-mechanical characterization of an isolated physical system**.
124. **Schrodinger cat**
a hypothetical **cat** may be considered **simultaneously both alive and dead as a result of being linked to a random subatomic event that may or may not occur**. **Bohr once remarked, in quantum world reality does not exist unless we observe it.**
125. **what are disruptive technologies? Can you name some negative disruptive technologies?**
These are technologies which **disrupts our way of life**. It can **include disruption in way of our purchasing mode, way of communication**. **Ecommerce, Social media. Negative disruptive technologies:** Bioweapons| plastic.
126. **Stephan hawking's work** (A famous physicist said that "Those who believe in destiny are the ones....")
"Brief Answers to the Big Questions" (God inflicting curse on disabled)| **A Brief history of time**| worked on **Fact that black holes would emit subatomic particles** until they eventually exploded.| **Hawking radiation using quantum effects near event horizon** (The 'event horizon' is the boundary defining the region of space around a black hole from which nothing (not even light) can escape)| worked in field of cosmology.
127. **Tell me the philosophy of Physics? How is it different from philosophy of chemistry?**
Study of change of chemical substances (**chemical reactions**) and **synthesis** lies at the heart of chemistry, and gives rise to concepts such as **organic functional groups** and rate laws for chemical reactions. (micro picture)
physics is involved with the fundamental principles of physical phenomena and the basic forces of nature, and also gives insight into the aspects of space and time. (macro picture)

With more uncertainty in physics, its now entering into realm of philosophy.
128. **What is the difference between Science and engineering?**
Science is the **study of the physical world**, while **Engineering** applies **scientific knowledge to design processes, structures or equipment**. **Engineering is the mind and effort** into making something; **technology** is the result of application of this mind and effort. **Engineering is more specific than technology. Engineering is a problem whereas technology is the solution.**
129. **Principles behind swimming**
By moving his or her arms through the water the swimmer creates a thrust force that propels the swimmer forward.
130. **Tell me about uncertainty principle**
Uncertainty principle postulates position and momenta can't be measured simultaneously.
131. **Which one is your favourite topic in physics? : Quantum mechanics**

132. **Tell me practical application(s) of quantum mechanics:** Quantum computing| Atomic clocks| nuclear fusion at stars.

133. **What is nano physics and its applications?**

- Enhanced role of surface atoms** with their unpaired spins and uncompensated bonds
- Quantum confinement** effects = discrete energy levels
- High surface to volume ratio**
- leads to nanoparticles being more chemically reactive.**

Applications:

Since the **dimensions of atoms and molecule are in nanometers**, this technology is called **nanotechnology**.

In 2013, India ranked **third in the number of papers published, behind only China and USA**. A team from IIT Madras has used **nanotechnology for arsenic decontamination of water**. Another team from IIT Delhi has come up with a water based self cleaning technology for use in textile industry. Importance for targeted drug delivery| **Smaller and portable Nano electronics**| Nanotechnology is **improving the efficiency of fuel production from raw petroleum materials through better catalysis**.| **Environment remediation**.| Nano mission| DST's **Sophisticated Analytical Instrument Facilities**

134. **What is neutron, neutron star and neutron bomb.**

a subatomic particle of about the same mass as a proton but without an electric charge, present in all atomic nuclei except those of ordinary hydrogen.| **Neutron stars are formed when a massive star runs out of fuel and collapses**. The very central region of the star – the core – collapses, making every **proton & electron** into a neutron. (**collapse occurs as after iron, sudden stoppage of energy generation causes the core to collapse and the outer layers of the star to fall onto the core.**) | The **neutron burst**, which is used as the primary destructive action of the warhead, is **able to penetrate enemy armor more effectively than a conventional warhead, thus making it more lethal** as a tactical weapon. A **low-yield thermonuclear weapon** designed to maximize lethal **neutron radiation** in the immediate vicinity of the blast while minimizing the physical power of the blast itself. The neutron release generated by a **nuclear fusion** reaction is intentionally allowed to escape the weapon, rather than being absorbed by its other components.

Fun facts: A star is a sphere of gas held together by its own gravity. | **Gravity constantly works to try and cause the star to collapse. The star's core, however is very hot which creates pressure within the gas**. This pressure counteracts the force of gravity, putting the star into what is called **hydrostatic equilibrium**.

When the **Sun runs out of hydrogen to fuse, the balance tips in the favor of gravity, and the star starts to collapse**. But **compacting a star causes it to heat up again** and it is able to fuse what little hydrogen remains in a shell wrapped around its core. **This burning shell of hydrogen expands the outer layers of the star**. When this happens, our Sun will become a **red giant**; it will be so big that Mercury will be completely swallowed!

Most neutron stars are observed as pulsars. Pulsars are rotating neutron stars observed to have pulses of radiation at very regular intervals that typically range from milliseconds to seconds. A pulsar (from *pulse* and *-ar* as in "**quasar**")^[1] is a highly magnetized rotating **compact star** (usually **neutron stars** but also **white dwarfs**) that emits beams of **electromagnetic radiation** out of its **magnetic poles**.

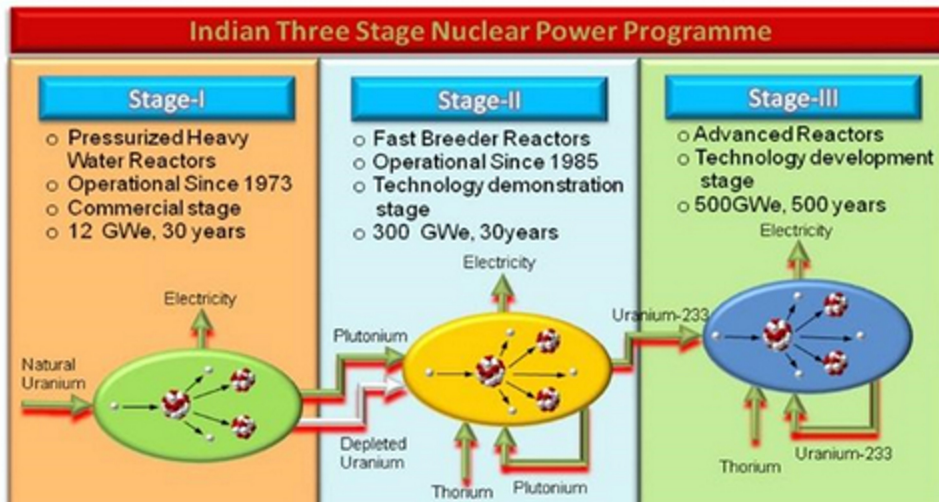
135. **Nano physics. We know that gold glitters but its nano particles don't..! Why?**

Gold glitters because of **sea of electrons moving through network of +vely charged ions**. These of sea of electrons **absorb incident light, their vibration cause emission of light** which we see as reflected light making it shiny. **Gold is not able to reflect bluest wavelentghs**. **Tin and Aluminium is able to reflect UV rays** unlike silver that's why used for roofing.

Gold does not react with oxygen that's why its considered good material to make things. **Nanoparticles using surface properties can be used as drug carrier while not reacting with other molecules**. Maybe it's because of the energy levels... **In a metal, they are pretty much continuous but in a nano particle, they are discrete**... So not all colors can be

reflected from a nano particle, only certain definite frequencies| Peacock color change

136. let me tell you we can't keep making small and smaller devices after a while. Tell me why?
Transistors lead to Gates which can add then multiply then do all arithmetic calculations. **A typical transistor is 14 nm (less than 8 times size of HIV virus) which enables transport of electron. At such level, electrons may pass using quantum tunneling** thus posing a physical limit.
137. **Why was stephan hawking so famous?** [With the **Oxford mathematician Roger Penrose**, he showed that if there was a Big Bang, it must have **started from an infinitely small point - a singularity**| **Black holes radiate energy known as Hawking radiation**, while gradually losing mass. This is **due to quantum effects near the edge of the black hole**, a region called the event horizon
138. What are wormholes?
139. **What is quantum tunnelling?**
quantum mechanical phenomenon where a wavefunction can propagate through a potential barrier.|
140. **Suppose we have two identical pieces one of a magnet and one iron but not magnetic. Size shape color every other thing is same. How will you find which one is magnet? You only have these two things that's it.**
Break both material| Place the end of bar A in the middle of bar B. If bar A sticks to bar B, then bar A is the magnet and bar B the unmagnetized iron bar. If bar A jumps to one of the ends of bar B, then bar B is the magnet.
141. **what is Fermat's principle?** : **Optical path** taken by a ray between two given points is the path that can be traversed in the **least time**.
140. **EPR Paradox: information flow speed can't be more than speed of light. Quantum entangled states affect each other instantaneously irrespective of distance between them. This leads to EPR paradox.** Einstein suggested local hidden variables. How it interacts is problematic. (einstein-podolsku-rosen paradox)
141. **Quantum entanglement:** States of particles are linked as such that information about one improves our knowledge of the other. Eg. **Photon breaks into positron and electron.**
142. **Quantum teleportation: creating an exact copy of a quantum state is impossible, no cloning theorem.**
143. **How did Indian nuclear program develop?**
India has 1-2% of uranium reserves compared to 25% thorium reserves.| **Thorium 232 is not fissile, so it needs to be transmuted into U-233**| So 3rd stage is needed to utilize thorium vast resources.
Apsara, 1st nuclear reactor in 1956| built by India with fuel supplied from UK|



<http://hyperphysics.phy-astr.gsu.edu/hbase/NucEne/fasbre.html>

3 stages:

A. **Pressurized heavy water reactor (PWR)** [natural uranium (0.7% U-235) + byproduct Plutonium-239]

B. **Fast breeder reactor (FBR)** (depleted uranium + input plutonium-239 leads to more Pu239) Besides a blanket of Th-232 around the FBR core also undergoes neutron capture reactions leading to the formation of U-233)

C. **Advanced heavy water reactor (AHR)** [self-sustaining series of thorium-232-uranium-233 fuelled reactors.] Thorium-232 + 1 neutron = Thorium-233 which decays quickly to Protactinium 233 which slowly decays into U-233.]

- The Prototype Fast Breeder Reactor (PFBR) is a 500 MWe fast breeder nuclear reactor presently being constructed at the Madras Atomic Power Station in Kalpakkam, India.
- The **Indira Gandhi Centre for Atomic Research (IGCAR)** is responsible for the design of this reactor.
- **As of 2007 the reactor was expected to begin functioning in 2010 but now it is expected to achieve first criticality in March-April 2016.**
- Construction is over and the owner/operator, **Bharatiya Nabhikiya Vidyut Nigam Limited (BHAVINI)**, is awaiting clearance from the Atomic Energy Regulatory Board (AERB).
- Total costs, originally estimated at 3500 crore are now estimated at 5,677 crore.
- The **Kalpakkam PFBR is using uranium-238 not thorium**, to breed new fissile material, in a sodium-cooled fast reactor design.
- The **surplus plutonium or uranium-233 for thorium reactors [U-238 transmutes into plutonium] from each fast reactor can be used to set up more such reactors and grow the nuclear capacity in tune with India's needs for power.**
- The fact that PFBR will be cooled by liquid sodium creates additional safety requirements to **isolate the coolant from the environment**, since sodium explodes if it comes into contact with water and burns when in contact with air.

Critical mass is mass needed to detonate a bomb| **Hydrogen bomb uses fission energy to fuse tritium with deuterium (tritium produced by neutron attacking Lithium in its hydride)**

144. **Tell me three laws of entropy:**

energy can neither be created nor destroyed; energy can only be transferred or changed from one form to another| **Entropy only increases for an isolated system** as it moves towards equilibrium ie. State of

maximum entropy| The **third law** of thermodynamics states that the **entropy of a system approaches a constant value as the temperature approaches absolute zero**

When all gas molecule occupy just half the room, this cannot be equilibrium since molecules can cross to the other side.| when everything gets maximum space, equilibrium occurs.

145. What has happened in CERN? Why is it important?

CERN's main function is to provide the [particle accelerators](#) and other infrastructure needed for high-energy physics research | **A boson with mass around 125 GeV/c² consistent with the long-sought Higgs boson in 2012.**

146. How is physics related to energy?

In [physics](#), **energy** is the [quantitative property](#) that must be [transferred](#) to an [object](#) in order to perform [work](#) on, or to [heat](#), the object.

147. Tell me some practical applications of General theory of relativity

GPS navigation| precision atomic clocks| predicting path of planet's orbit like mercury.

148. who gave the theory of evolution and what was the name of the book

On the Origin of Species by Charles Darwin in 1859.

149. What is Raman effect?

Raman effect is the [inelastic scattering](#) of [photons](#) by matter, meaning that there is both an exchange of energy and a change in the light's direction.| Raman also told **water molecules scattered light that's why color of ocean is blue.** | **rapidly characterize the chemical composition and structure of a sample, whether solid, liquid, gas, gel, slurry or powder.**| non invasive way.

150. How does dynamo work?: [Faraday's law of induction.| **As the bicycle moves, the wheel turns a magnet inside a coil. This induces enough electricity to run the bicycle's lights.]**

151. Use of physics knowledge in pandemic response: [Deploy diagnostics tool like one at IITD| mathematicalization of data| biophysics| problem solving approach| deployment of tech like nanosensors]

152. Three principles of electricity: [Ohm's law| Faraday's law| Maxwell's law| kirchoff's law]

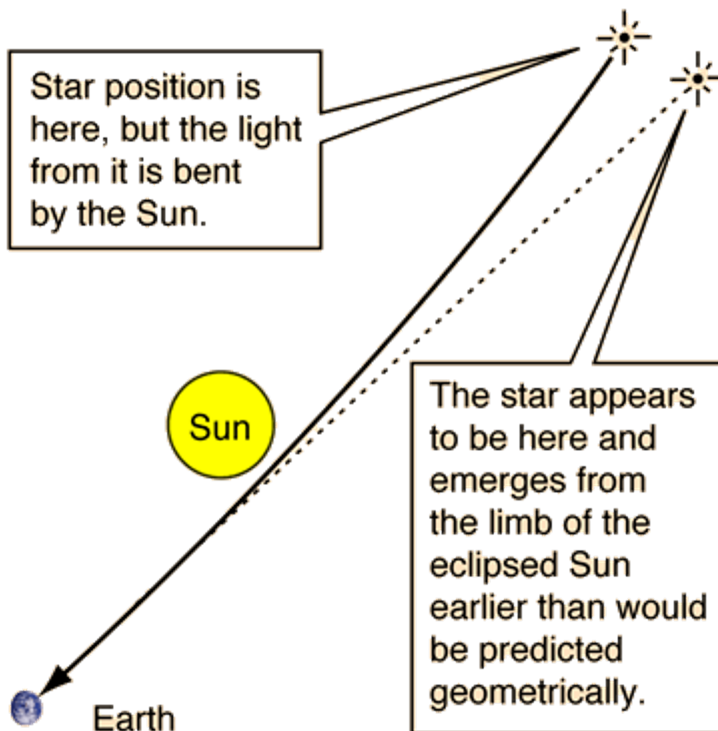
153. Why does light not need medium to travel?: []

154. Why does ball swing?: [primary motivation of **ball tampering** is to interfere with the aerodynamics of the ball to aid swing bowling.| **changing roughness on one side of ball changes swinging of ball**| ball tends to swing more severely than conventional swing and moves late in the delivery, making it more difficult for the batsman swinging away from sides.| on one side of ball, area is more thus velocity is lesser as per bernouli theorem]

155. How does a jet plane lift off?: [action-reaction and bernouli's theorem]

156. Why do clouds float? Why does particulate matter remains suspended in air? [Cloud droplets within this rising air are thus continually pushed upward at a greater rate than the rate at which gravity pulls them downward.| When any object falls through the air (or through water, for that matter), the aerodynamic drag force counters the force of gravity, and after a time/distance, the falling object reaches its *terminal velocity*.For the typical cloud droplet of 10 micrometers (it takes about 15 million cloud droplets to form the typical raindrop), its terminal velocity is around 0.3 cm/s or about. | An aerosol is a suspension of fine solid particles or liquid droplets in air or another gas]

157. **What is quantum supremacy?** [In [quantum computing](#), quantum supremacy or quantum advantage is the goal of **demonstrating that a programmable quantum device can solve a problem that no classical computer can solve** in any feasible amount of time (**irrespective of the usefulness** of the problem)]
158. **Refrigeration heat cycle:** [No, the room can't be cooled by leaving the door of an electric refrigerator open. **In fact the temperature of the room rises because the refrigerator extracts heat from the freezing chambers and rejects it to the surrounding air in the room.**]
159. **How does hyperloop work?** [**specialized pods are accelerated through a low-pressure tube** to achieve speeds **near the speed of sound**. | hypothetical benefits of the Hyperloop include immunity to weather, lack of crashes, rapid speed, low power requirements, and energy generation for its own operation | **One possible mechanism is magnetic levitation: using very large permanent magnets to suspend the pod above the bottom of the tube** | akin to the air bearings employed by an air hockey table: using a cushion of air to support pods, eliminating rolling resistance.]
160. **What is Saha ionization formula?** [Saha ionisation equation is an expression that relates the **ionisation state of a gas in thermal equilibrium to temperature and pressure.**]
161. **Tell difference between astronomy and astrology. Do you think astrology is a science?** [Astronomy is a science that studies everything outside of the earth's atmosphere, such as planets, stars, asteroids, galaxies; and the properties and relationships of those celestial bodies. **Astronomers base their studies on research and observation.** Astrology, on the other hand, is the belief that the positioning of the stars and planets affect the way events occur on earth. | Belief of position of stars and events on earth at moment seems far fetched but we can think of researching such aspect.]
162. **Why is uncertainty principle foundational principle of quantum mechanics?** [uncertainty principle says minimum uncertainty in measurement. | **uncertainty principle means we can't measure variables simultaneously in same state which is visible in spin states and elementary physics** | In his original proposal, Heisenberg predicted a **tradeoff between error and disturbance**. He suggested that when a gamma-ray microscope measures the position of an electron, the **measurement inevitably disturbs the electron's momentum.**]
163. **Implications of Wave particle duality in quantum mechanics (nature of physics)?** [**Particle acts as wave of probabilistic amplitude as electron shows interference pattern** | Explained black body spectrum and photoelectric effect | **wave like nature of particle enabled foundation of quantum mechanics**]
164. **what are consequences of uncertainty principle in layman terms?** [Uncertainty meant we cant measure two states simultaneously if they commute | now this was crucial to explain phenomena like quantization of spin in one direction when we observe two points in Stern Gerlach experiment, spin was crucial aspect to understand modern physics]
165. **Importance of polymers in energy physics?** [
166. **What is negative temperature?** [**energy flow cant happen from low to high temperature without external work** | How does laser burn up while concentrating it unlike other waves(explained by population inversion) | **infinite temperature is where probability of occupying all energy levels are same.** | **temperature hotter than infinitive temperature**]
167. **How did quantum mechanics revolutionize classical mechanics?** [explained subatomic phenomena]
168. **Tao of physics:**
169. **What are dimensions in layman terms:** [**a measurable extent of a particular kind, such as length, breadth, depth, or height.** | number of variables It would take to specify a point.]
170. **Big bang theory or God?** [Big
171. **Proof of General theory of relativity**



172. **Gravitational lensing:** [A **gravitational lens** is a distribution of matter (such as a [cluster of galaxies](#)) between a distant light source and an observer, that is capable of bending the light from the source as the light travels towards the observer]
173. **Reasons behind lightning:** [As ice crystals high within a thunderstorm cloud flow up and down in the turbulent air, they crash into each other. Small negatively charged particles called electrons are knocked off some ice and added to other ice as they crash past each other. This separates the positive (+) and negative (-) charges of the cloud. The top of the cloud becomes positively charged while the base of the cloud becomes negatively charged.] **Lightning happens when the negative charges (electrons) in the bottom of the cloud are attracted to the positive charges (protons) in the ground.**
accumulation of electric charges has to be great enough to overcome the insulating properties of air. When this happens, a stream of negative charges pours down towards a high point where positive charges have clustered due to the pull of the thunderhead.
174. **Importance of centre of gravity in sports:** [lower centre of gravity means less torque so short people are more successful in sports like weightlifting.] Gymnastics is another sport which requires so]
175. **John mitchell coined word "Event Horizon"** | Any object that approaches the horizon from the observer's side appears to slow down and never quite crosses the horizon. Due to [gravitational redshift](#), its **image reddens over time as the object moves away from the observer.**
176. **Why is second booster dose needed?** [first dose helps your body create an immune response, while the second dose is a booster that strengthens your immunity to the virus.]
177. **Black hole information paradox:** [Calculations suggest that physical information could permanently disappear in a [black hole](#), allowing many [physical states](#) to devolve into the same state. This is controversial because it violates a core precept of modern physics—that, *in principle*, the value of a [wave function](#) of a physical system at one point in time should determine its value at any other time.]

Why is the **second dose** of **COVID-19 vaccine** so **important?**



The **first dose** does not produce protective immunity, but **prepares the immune system to fight against COVID-19 infection.**

178.

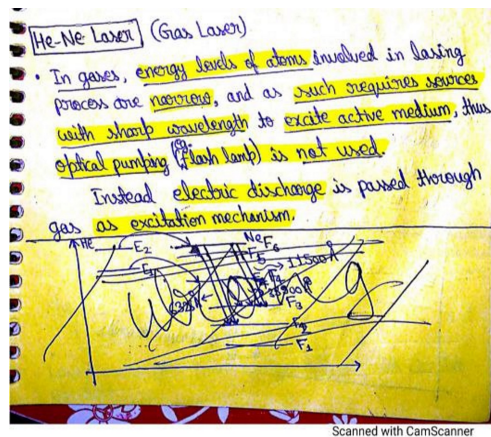


The **second dose** triggers the immune system to produce large number of antibodies and gives **cell-mediated immunity.**

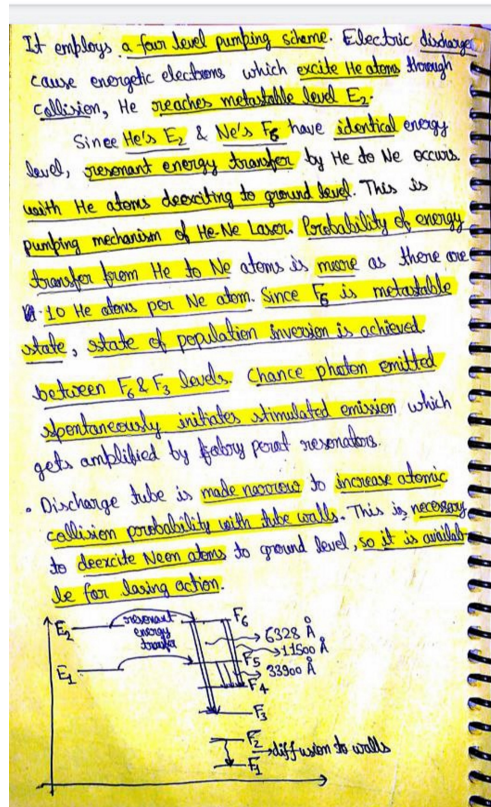
It also **stimulates the memory cells** so that the body remembers this infection for the **long term** and helps produce **antibodies** quickly in case of **reinfection.**

Therefore, **two doses of vaccine** are essential to get **maximum protection** from **COVID-19.**

Source: Dr. Randeep Guleria,
Director, AIIMS



179.



View on nuclear tech: [export potential, diversifying tech mix, electricity demand, development needs and huge development needs, advanced heavy water reactor target | waste, accident, effect on marine water discharge and initial capital cost]

Solar power: [overambitious | social cost and environmental cost | solar rooftop lesser and needs more MW plants] | [reliability and integration of ecosystem | import dependence on tech | e-waste | need development of storage system | battery and storage tech] | [first solar powered DEMU | giving space to solar panels like social barriers | subsidy on panels]

Biotech: []

IPR: []

How some of the Covid-19 vaccines compare

Company	Doses	Storage
RNA		
 Pfizer (BioNTech)		 -80 to -60°C (6 months) and 2 to 8°C (for up to 5 days)
 Moderna		 -25 to -15°C (6 months) and 2 to 8°C (for 30 days)
Viral vector		
 Oxford-AstraZeneca		 2 to 8°C (6 months)
 Sputnik V (Gamaleya)		 -18.5°C (liquid form) 2 to 8°C (dry form)
 Johnson & Johnson (Janssen)		 2 to 8°C (3 months)
Inactivated virus		
 CoronaVac (Sinovac)		 2 to 8°C
 Sinopharm		 2 to 8°C
 Covaxin (Bharat Biotech)		 2 to 8°C
Protein-based		
 Novavax		 2 to 8°C

Source: Wellcome Trust, BBC research



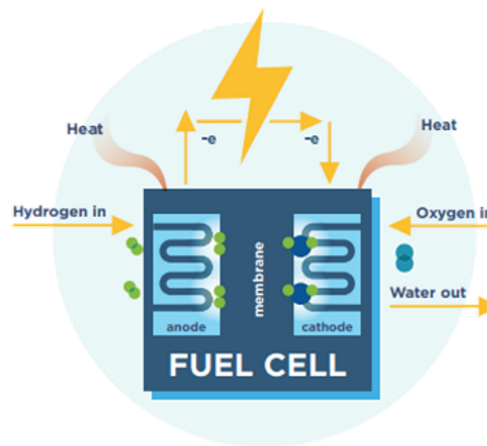
What is difference between nebulizer, ventillator and ECMO? [

- India will work out a policy to **institutionalise research and development on the next generation of battery technologies for electric vehicles**, like **metal-ion, metal air, hydrogen fuel cell**, etc, to replace lithium-ion batteries and **reduce India's dependence on other countries for its import within this decade**.

HOW FUEL CELLS WORK

A fuel cell is an electrochemical energy conversion device – it utilizes hydrogen and oxygen to generate electricity, heat, and water.

- 1 The hydrogen atoms enter at the anode.
- 2 The atoms are stripped of their electrons in the anode.
- 3 The positively charged protons pass through the membrane to the cathode and the negatively charged electrons are forced through a circuit, generating electricity.
- 4 After passing through the circuit, the electrons combine with the protons and oxygen from the air to generate the fuel cell's byproducts: water and heat.



- **Difference between Cosmology, Astrophysics and Astronomy:** [Cosmology studies universe as a whole (evolution) and its phenomena at largest scales unlike Astronomy/Astrophysics, which study individual objects. And then **Astronomy is primarily concerned with observing and measuring the relative positions and paths than giving explanations.** On the other hand, **Astrophysics and Cosmology try to explain the phenomenon observed.**]
- **What is String theory :** It proposes that the **fundamental constituents of the universe are one-dimensional “strings” rather than point-like particles.** What we **perceive as particles are actually vibrations in loops of string, each with its own characteristic frequency.** | 11 dimensions

Can it be theory of everything?: [

- **How does a gun work?** [All firearm uses the basic principles. First, the **trigger is pulled**, then causing a firing pin to strike the primer, the **primer fire up the gunpowder** and the **flaming powder generates pressure**, the **pressure pushes the bullet** down the barrel and out the muzzle.]
- **Defining feature of a coronavirus** is the **spike protein on its surface**. The spike protein initiates infection by **binding with a host protein, called ACE2 receptor**. Different species express ACE2 to different extents, and this plays a key role in determining how much a species is susceptible to coronavirus infection. | **Domestic cats and lions have more ACE2 receptors than other animals** | A respected research journal PLOS found that "**At very high risk are primates such as chimpanzee rhesus macaque. At high risk are species such as blue-eyed black lemur. Cats were found to have a medium risk, while dogs had a low risk.**"
- **Difference between DRDO and ISRO:** [ISRO works **under PMO** unlike DRDO which has to **rely on bureaucracy** | ISRO has had **better legacy of leadership** | **decentralized** leadership in terms of financial autonomy]
But DRDO had leadership of Kalam but it has been **uneven** , **funds autonomy has been lesser** and **bureaucratic control** (rules based focus rather than need based) | what to do: **increasing autonomy for funds disbursal**,
- **Einstein constant blunder:** [**cosmological constant** into his theory of general relativity to force the equations to **predict a stationary universe** | When it became clear that the universe wasn't actually static, but was expanding instead, Einstein abandoned the constant, calling it the ""biggest blunder" of his life. | **cosmological constant is the best fit for dark energy.**]
Why was Einstein skeptical of quantum effect: [World was deterministic | not imaginable as he considered philosophy of physics to be based on imagination | as he could not get answers and got answer God as answer.]
- **What is RTPCR test:** [Reverse transcription polymerase chain reaction | combining **reverse transcription**

of RNA into DNA and amplification of specific DNA targets using polymerase chain reaction to measure amount of RNA]] Transcription is the process of copying a segment of DNA into RNA. | disadvantages are the **financial cost compared to the antigen tests, the longer evaluation time (2-5 hours compared to 30 minutes of RADT), and need for highly professional staff for sample handling which is addressed by antigen test but its not accurate.**

- **What is antigen test:** [rapid antigen detection test (RADT)] test on **swabbed nasal samples** that detects antigens (foreign substances that induce an immune response in the body) | **higher chances of false negatives because antibodies used to detect antigen signals are often confused to react.**
- **What is surface tension and it's implications:** [cohesive] forces between liquid molecules are responsible for the phenomenon known as surface tension. | cohesive forces between molecules down into a liquid are **shared with all neighboring atoms.** Those **on the surface have no neighboring atoms above, and exhibit stronger attractive forces upon their nearest neighbors on the surface.** This **enhancement of the intermolecular attractive forces at the surface is called surface tension.** | Surface tension **decreases with temperature** | Hot water is a **better cleaning agent because the lower surface tension makes it a better "wetting agent" to get into pores and fissures rather than bridging them with surface tension.** Soaps and detergents further lower the surface tension. | adhesion is the force of attraction between the particles of different matter and cohesive force is the attraction between the particles of same matter. | **Surface tension is the tendency of liquid surfaces at rest to shrink into the minimum surface area possible.**

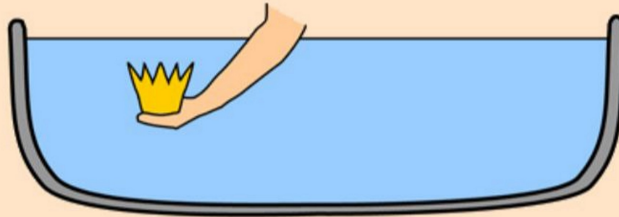
Surface Tension Examples	
Walking on water Small insects such as the water strider can walk on water because their weight is not enough to penetrate the surface.	Floating a needle If carefully placed on the surface, a small needle can be made to float on the surface of water even though it is several times as dense as water. If the surface is agitated to break up the surface tension, then needle will quickly sink.
Don't touch the tent! Common tent materials are somewhat rainproof in that the surface tension of water will bridge the pores in the finely woven material. But if you touch the tent material with your finger, you break the surface tension and the rain will drip through.	Soaps and detergents help the cleaning of clothes by lowering the surface tension of the water so that it more readily soaks into pores and soiled areas.
Clinical test for jaundice Normal urine has a surface tension of about 66 dynes/cm but if bile is present (a test for jaundice), it drops to about 55. In the Hay test, powdered sulfur is sprinkled on the urine surface. It will float on normal urine, but sink if the S.T. is lowered by the bile.	Washing with cold water The major reason for using hot water for washing is that its surface tension is lower and it is a better wetting agent. But if the detergent lowers the surface tension, the heating may be unnecessary.
Surface tension disinfectants Disinfectants are usually solutions of low surface tension. This allow them to spread out on the cell walls of bacteria and disrupt them. One such disinfectant, S.T.37, has a name which points to its low surface tension compared to the 72 dynes/cm for water.	Can you think of another?
HyperPhysics***** Mechanics ***** Fluids	
R Nave	
Go Back	

[Index](#)
[Fluid concepts](#)
[Surface tension](#)

- **How does thermometer work?** [thermometer measures temperature through a glass tube sealed with mercury that expands or contracts as the temperature rises or falls | **high boiling point and high coefficient of expansion despite being poorest conductor heat**]
- **What is buoyant force?** [Below example shows how buoyant force can be used to detect hollowness of gold crown by finding discrepancy in density]

Archimedes' Principle

Hmm! The crown seems lighter under water!



$$\text{Mass of object} - \text{Apparent mass when submerged} = \text{Density of water} \times \text{Volume of object}$$

$$\frac{440 \text{ grams}}{31 \text{ cm}^3} = 14.2 \text{ grams/cm}^3$$

Wait a minute! The density of solid gold is 19.3 gm/cm³!!

The buoyant force on a submerged object is equal to the weight of the liquid displaced by the object. For water, with a density of one gram per cubic centimeter, this provides a convenient way to determine the volume of an irregularly shaped object and then to determine its density.

- **Difference between wave and current:** [difference between a wave and a current (of water) was clearly understood; a **current is a motion of particles of water under gravity and fluidity while a wave results from the transmission of vibrations of water particles.**]
- **5 sigma rule:** [standard deviation can provide a yardstick: If a data point is a few standard deviations away from the model being tested, this is **strong evidence that the data point is not consistent with that model.** | deviation of 5 is considered a chance of existence of another particle]
- **Define biophysics:** [**science of the application of the laws of physics to biological phenomena.** | Indian origin Veki ramakrishna won nobel for biophysics in 2009 for studies of the structure and function of the Ribosome | minute particle consisting of RNA and associated proteins found in large numbers in the cytoplasm of living cells. They **bind messenger RNA and transfer RNA to synthesize polypeptides and proteins.**]
- **Why is biodiesel not garnering traction:** [2018 Biofuel Policy has the objective of **reaching 20% ethanol-blending and 5% biodiesel-blending by the year 2030.** | supply chain requires more time to be developed | considered less efficient]
- **Bose-einstein condensate:** [5th temperature | cooling to very low temperature | low temperature leads to bosons]
Linkage with universe: [
- **Reducing air pollution due to mobility in Delhi:** [decongest traffic | promote use of public transport like expanding metro and DTC buses | increase green cover]
- **Importance of ecological park:** [Conservation of biodiversity | tourism | support green cover to address issue of pollution]
- **What is supergravity?** [supersymmetry: **conjectured symmetry which pairs every fermion with a boson.**

For instance, the spin one photon would have a spin-1/2 partner called the "photino." |

Lagrangian of a theory to be locally invariant under supersymmetry transformations, one obtains a theory called supergravity. | requirement in supergravity of local supersymmetry implies the existence of a spin-3/2 particle called the gravitino. Then supersymmetry requires the existence of its spin-2 supersymmetric partner, the graviton, which is the quantum particle of gravity. | modern [field theory](#) that combines the principles of [supersymmetry](#) and [general relativity](#). |

Field theory usually refers to a construction of the dynamics of a field, i.e. a specification of how a field changes with time or with respect to other independent physical variables on which the field depends.

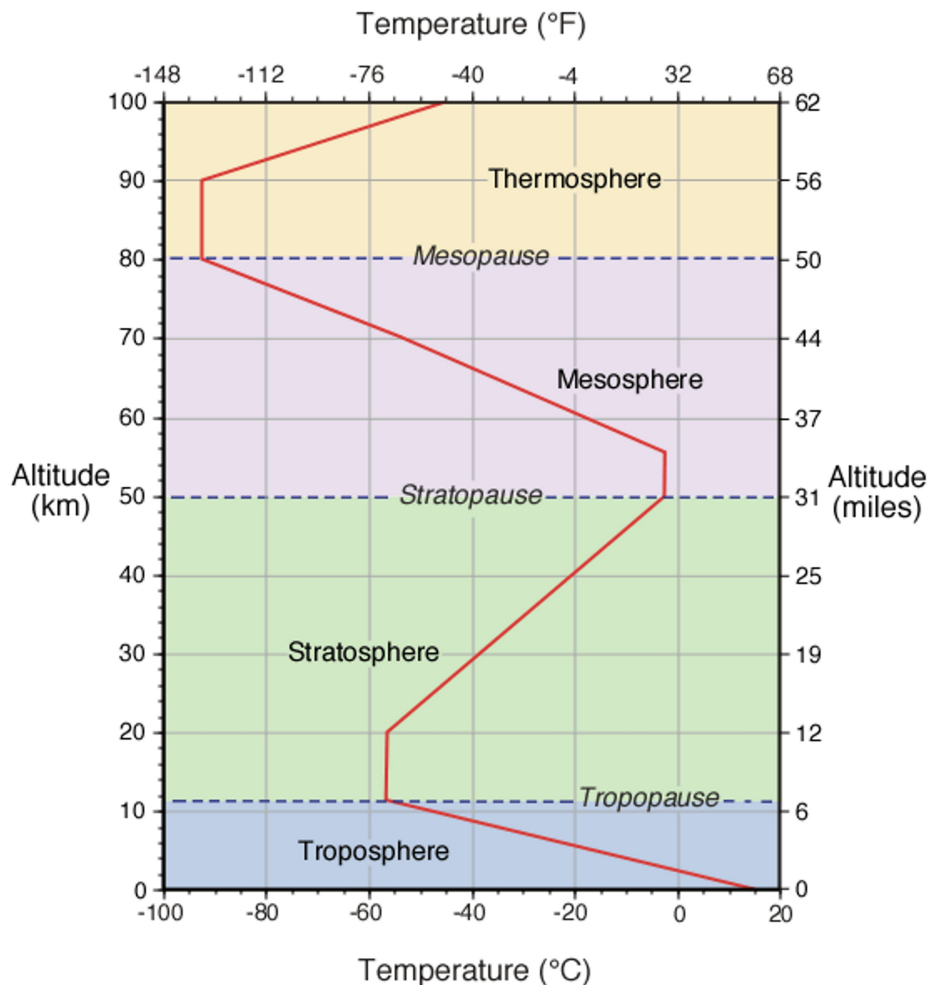
- **What are wormholes?** [proposing the existence of "bridges" through space-time. These bridges connect two different points in space-time, **theoretically creating a shortcut that could reduce travel time and distance**. The shortcuts came to be called **Einstein-Rosen bridges**, or wormholes.]

Hawking take on wormholes: [

What are hawking radiations? [

Why only minimum 3 satellites are needed for GPS to locate object? [

- **How does planet get energy to revolve around sun?** [Solar System was **formed from a rotating cloud of gas and dust which spun around a newly forming star, our Sun, at its center**. The planets all formed from this **spinning disk-shaped cloud**, and continued this rotating course around the Sun after they were formed. The **gravity of the Sun keeps the planets in their orbits**. They stay in their orbits because there is **no other force in the Solar System which can stop them**.]
- **Suborbital flight:** [main difference between orbital and suborbital flight is the speed at which a vehicle is traveling. **An orbital spacecraft must achieve what is known as orbital velocity, whereas a suborbital rocket flies at a speed below that**. | Richard Branson and Jeff Bezos recently boarded flight on Virgin and Blue origin flights for 11 minutes reaching upto altitude of 85 kms| Satellites need to reach that threshold speed of orbit velocity in order to orbit Earth. Such a satellite would be accelerating towards the Earth due to gravity, but its horizontal movement is fast enough to offset the downward motion so that it moves along a circular path. | they felt weightlessness (Microgravity is **the condition in which people or objects appear to be weightless**. The **effects of microgravity can be seen when astronauts and objects float in space** (If the object were a human being, he or she will not feel his weight since there is no upward force on him. Thus, **when an object is in free fall, it is weightless and this phenomenon is usually called the phenomenon of weightlessness**.)



- force of gravity, pulled this molten material inwards towards the planet's center into the shape of a sphere. Later, when the planets cooled, they stayed spherical. Planets are not perfectly spherical because they also spin. The **spinning force acts against gravity and causes many planets to bulge out more around their equators.** | Gravity supplies the necessary **centripetal force** to hold a satellite in orbit about the earth. The circular orbit is a special case since orbits are generally ellipses, or hyperbolas in the case of objects which are merely deflected by the planet's gravity but not captured. **Setting the gravity force from the universal law of gravity equal to the required centripetal force yields the description of the orbit.**
- Different type of space orbits** (synchronized with the Earth's rotation, but the orbit is tilted with respect to the plane of the equator in case of geosynchronous orbit being different from geostationary orbit | Sun synchronous orbits are like polar orbit where satellite passes over part of earth at same local time, used for satellites which require continuous solarlight at 700-800 km altitude (LEO) | Remote sensing (Remote sensing is the process of detecting and monitoring the physical characteristics of an area by measuring its reflected and emitted radiation at a distance (typically from satellite or aircraft). Special cameras collect remotely sensed images, which help researchers "sense" things about the Earth. Most of them are in polar sun-synchronous orbit) | Communication satellite (to relay TV, radio and phone signals) [why is radio wave used in communication? : [Radio waves have the ability to pass through the atmosphere, foliage, and most building materials, and by diffraction can bend around obstructions, and unlike other electromagnetic waves they tend to be scattered rather than absorbed by objects larger than their wavelength. It all stems from larger wavelength (1 mm with 300 GHz). | not cause damage if absorbed by the human body, and they can be reflected to change their direction.]]

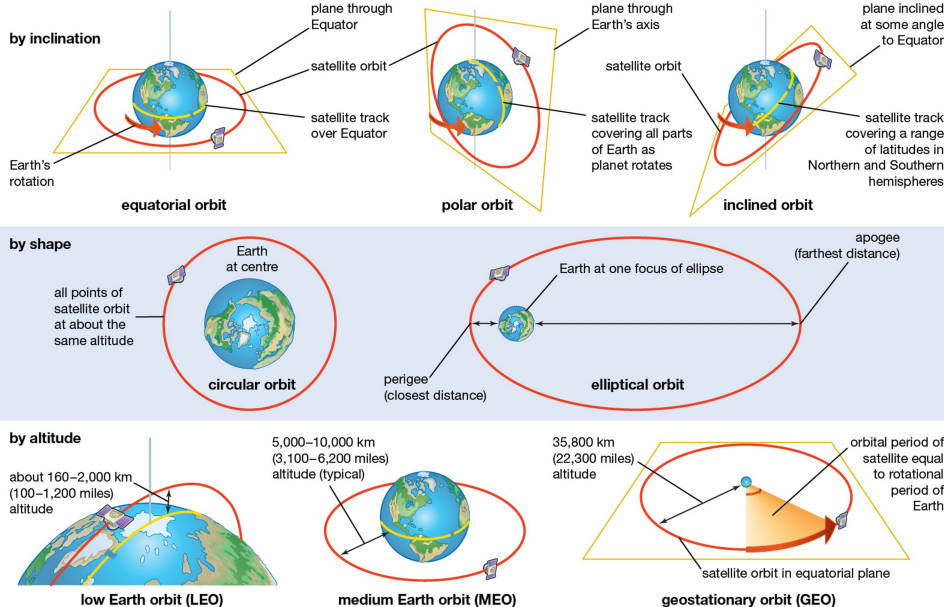
Achievements-

1. **PSLV C37- 104 satellites (to deliver earth observation satellites with upto 1750 kg to sun synchronous orbit| 4 stage with 2nd and 4th stage being liquid one)**
2. **GSLV MKIII- GTO 4000 kg. (3 stage: solid-liquid-cryogenics)**
 1. Indigenous upper cryogenic stage
 2. **CARE mission- experimental suborbital flight of LVM3. Crew Module injection to test reentry into atmosphere.**
 3. Solid Strap of motors and liquid booster (S200, L110)
3. **Reusable Launch vehicle- technology demonstrator.**
4. **Scramjet engine- TD. ABPS (air breathing) [**
In a ramjet, the combustion chamber - where the air is mixed with fuel and ignited - only works at subsonic speeds. So the intake slows the air down, releasing some of its energy as a shock wave, but this reduces fuel efficiency. The scramjet is an innovation on the ramjet in which the combustion chamber is specially designed to operate with supersonic airflow. Scramjet is simply an acronym for 'supersonic combustion' ramjet.]
5. **IRNSS- NAVIC**
 - Application- DM, Cartography, Mobile phone integration, Navigation, visual and voice navigation. | 7 satellites
6. Earth observation satellite **used as spying, environmental monitoring, cartography| considered eye in the sky.**

Why South pole for Chandrayan 2?

- **Least explored,**
- **scientific curiosity to study its craters which contains water ice** (detected by Chandrayaan-1).
- **Many crater bottom have never received sunlight. Thus little physical, chemical or geological change would have occurred since the creation of moon.** It also offers opportunity to **study fossils in the crater which are permanently dark and contains information of early solar system.**
- **Significance for future exploration, mining and colonization-** South contains water. **Mountain peaks with continuous sunlight exposure**

Types of Earth orbit



- GPS satellites fly in **medium Earth orbit (MEO)** at an altitude of approximately 20,200 km (12,550 miles). Each satellite circles the Earth twice a day.
- **No satellite broadband as yet** | planned by Amazon, Oneweb and SpaceX | Example like Starlink | Constellation of LEO satellites in hundreds to ensure high speed internet with low latency | affordability can be addressed by rationalising regulatory charges like defining levies to pure cost recovery basis. 5G has 1 ms latency | cost and maintenance quite high]
- **Benefits of starlink:** (Low latency as nearer to earth, address remote area connectivity of terrain and difficulty to setup infra, less prone to disasters) | **Challenges** (More needed as less coverage of area causing space debris, problem of mistaking light coming from reflection by satellites as one coming from spatial bodies (interference with space observation), light pollution (excessive anthropogenic lights, affecting sleep cycle= health , biodiversity issues like turtles getting hit on road who go out only in light)
- **Quantum information system:** [systems related to quantum computing, information exchange using quantum entanglement and algorithms of QuBit]

Tyndall effect: [Tyndall effect is light scattering by particles in a colloid or in a very fine suspension. | Flour suspended in water appears to be blue because only scattered light reaches the viewer and blue light is scattered by the flour particles more than red light.]

Quantum Cryptography: [Quantum cryptography is a method of encryption that uses the naturally occurring properties of quantum mechanics to secure and transmit data in a way that cannot be hacked. | Uses quantum superimposed states and entanglement | process of measuring a quantum system in general disturbs the system | By using quantum superpositions or quantum entanglement/synchronization and transmitting information in quantum states, a communication system can be implemented that detects eavesdropping (disturbing/trying theft) | in classical sense, crypted message can infiltrate by reading into code]

Quantum key distribution (QKD) is a secure communication method which implements a cryptographic protocol involving components of quantum mechanics. It enables two parties to produce a shared random secret key known only to them, which can then be used to encrypt and decrypt messages. | **How is quantum key distributed?** [space based satellite | photon exchange using free space |

Are we a pale blue dot in world, are not we insignificant?: [We are part of larger constellation of things. | Our time on earth is limited, we take **ourselves too seriously**. It's a **humbling and character building experience** (responsibility of being kind to each other) | we should **not attach ourselves to social expectations**, we should **focus on making our time worth**. | A dot is starting and ending point of everything]

Talk about Carl Sagan as a scientist: [study of potential life on other planets]

Doppler effect: [change in observed frequency due to relative motion of source and observer. | relative motion means distance travelled change=wavelength change]

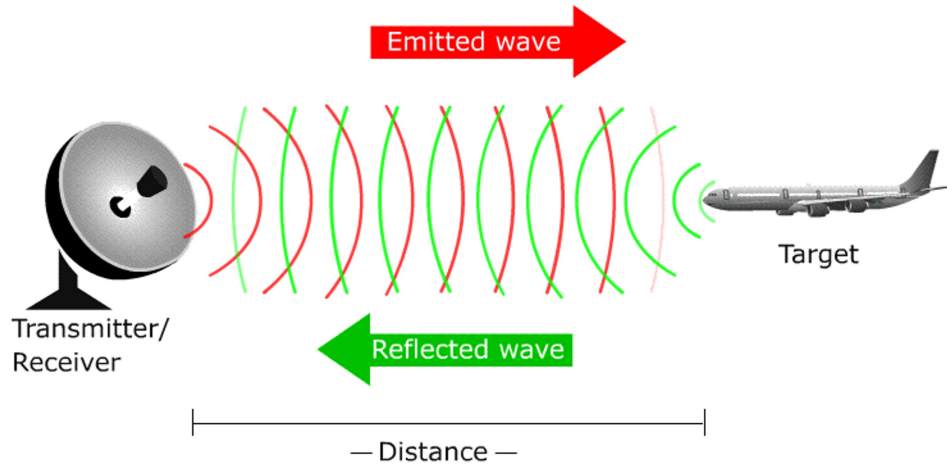
How does capillary action work? [when adhesion to walls is stronger than cohesive forces between liquid molecules | height achieved is limited by gravity and surface tension | **mercury does not show capillary action as it has higher cohesive forces showing capillary repulsion**].

Nobel prize in Physics for 2021: [Giorgio Parisi, Klaus Hasselmann, Syukuro Manabe | for the **physical modelling of Earth's climate, quantifying variability and reliably predicting global warming**" and the

other half to Giorgio Parisi "for the **discovery of the interplay of disorder and fluctuations in physical systems from atomic to planetary scales.**"

Doppler Radar: [specialized [radar](#) that uses the [Doppler effect](#) to produce velocity data about objects at a distance. It does this by bouncing a [microwave](#) signal off a desired target and analyzing how the object's motion has altered the frequency of the returned signal. | weather forecasting, astronomical data gathering.]

How does radar work? [Radar means **radio detecting and ranging**]



How does vacuum bomb work? [TOS1-A system of Russia (armored multiple rocket launcher)| **thermobaric** (using oxygen from air to create **high temperature explosion capable of vaporizing human bodies and long duration blast wave** | two stage process with first having aerosols made from carbon based fuels and second stage having **shock wave sucking oxygen from target creating a vacuum around target**)]

Aerosols are **suspended fine solid particles or liquid droplets.** |

- By choosing either the wave or the particle picture, the experimenter disturbs untouched nature. Such favoritism unleashes a limitation in what one can learn about nature "as it really is." This **limitation is expressed by Heisenberg's uncertainty relations**, which, for Bohr, were related to what he was now calling "complementarity." This shows how quantum mechanics was founded in heisenberg uncertainty principle.
- **Quantum limit:** [limitations of tradeoffs in measurement | tradeoff between error and disturbance | moment when measurements become uncertain | A **quantum limit** in physics is a limit on measurement accuracy at quantum scale]
- **Optional papers:** [
 - **Physics in administration:** [knowledge (quantum mech) and mindset (rational approach and objective mindset)]
 - **Gravity is so strong it warps space time fabric, it bends light and increased gravity will capture it.**]

What is importance of planck constant in QP? What if we remove h ?: [quantization of variables will be gone | energy levels are continuous as we enter realm of classical physics]

Practical applications of Raman effect?: [molecular analysis of chemicals | noninvasive |]

What

On a cold evening, metals are comparably more colder than wood, why so?

Why does a symmetric top keep spinning?

(Conservation of angular momentum, he looked less satisfied wanted more)

