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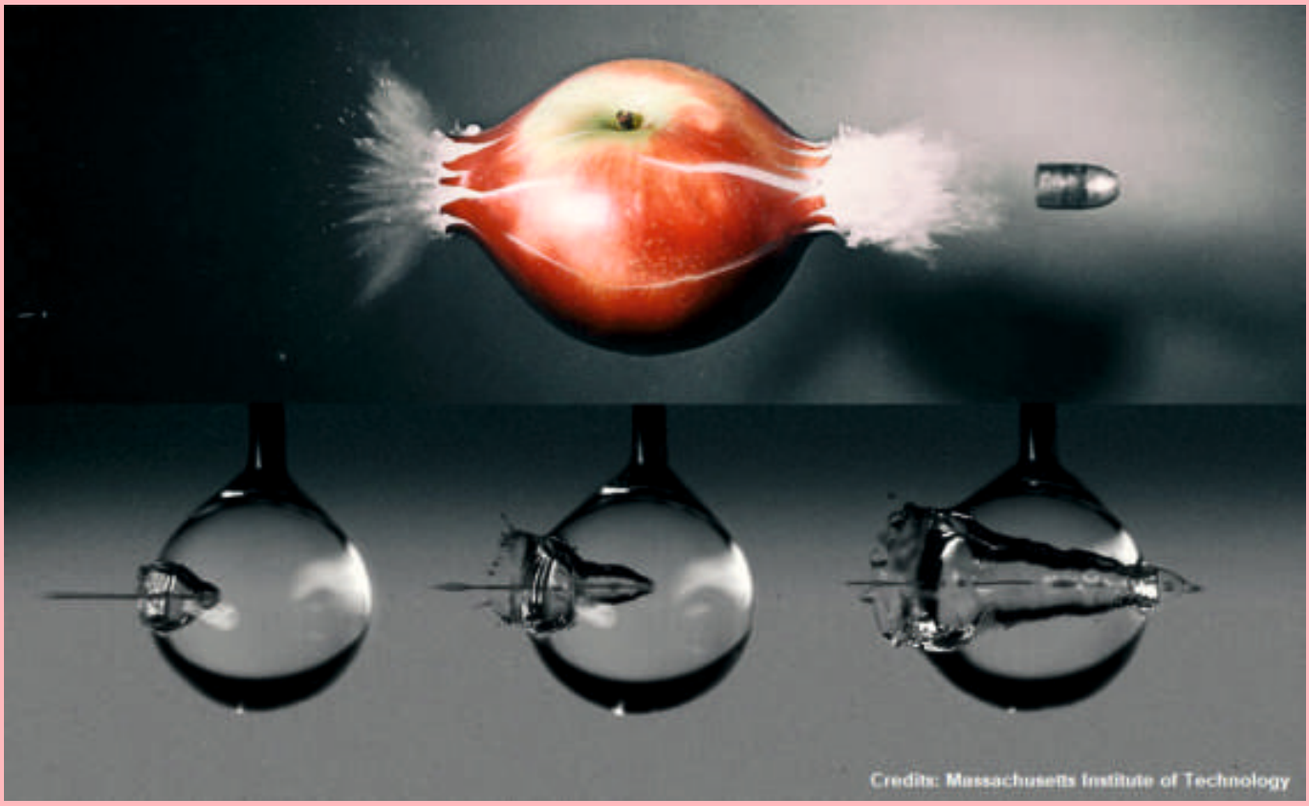

Squirting a jet of water through a drop of liquid may sound like idle fun, but if done precisely, and understood thoroughly, the splashy exercise could help scientists identify ways to inject fluids such as vaccines through skin without using needles. The study involves firing small jets of water through many kinds of droplets, hundreds of times over, using high-speed cameras to capture each watery impact. The team's videos are reminiscent of the famous strobe-light photographs of a bullet piercing an apple, pioneered by Massachusetts Institute of Technology's Harold "Doc" Edgerton. Edgerton's images captured sequential images of a bullet being shot through an apple, in explosive detail. The MIT team's new videos, of a water jet fired through a droplet, reveal surprisingly similar impact dynamics. As the droplets in their experiments are transparent, the researchers were also able to track what happens inside a droplet as a jet is fired through. Based on their experiments, the researchers developed a model that predicts how a fluid jet will impact a droplet of a certain viscosity and elasticity. As human skin is also a viscoelastic material, they say the model may be tuned to predict how fluids could be delivered through the skin without the use of needles.
(https://phys.org/news/2021-08-high-speed-camera-captures-jet-splashy.html)

The Story of Cosmology through Postal Stamps.... 02

OBSERVABLE UNIVERSE

BIRTH OF ASTRONOMY

The practice of looking to and tracking the heaven, stars, sun and moon has roots and parallel in many cultures. In epochs both ancient and contemporary humans have looked to the sky for verities of reasons-seeking wisdom, prophesy, better understanding the environment and time, for navigation for religious celebration and to achieve pragmatic goals such as optimal time for planting and harvesting the fields, ascertain suitable period of harvesting the crop.

This souvenir sheet, of 3 stamps depict well define pattern of starry sky. Sunset, planet and constellations, which are prime indicators of time and position in all civilizations and glorious part of our story of astronomy.

Position of sun and stars in the sky provide idea of optimal time for harvesting crop

Knowledge of star pattern greatly helped in navigatin during long journeyfor sailers and travellers and for celeberating an auspicious occassion

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A note for contributors of reports,...

Apart from articles, we also receive other contributions – reports of RC activities, webinars, anveshikas, proceedings of meetings, announcements and so on. These are received throughout the month and every sender wishes that his/her communication must find place in the next month's bulletin.

It is simply not possible. There has to be a **cut-off date.** We have fixed it as **22nd of the month.** A communication received by that date is most likely to find a place in the next issue. If not, it would have been held for some specific reason.

The Kanpur Post office have fixed 8th of a month as the date of dispatch for the IAPT Bulletin . We have to send the manuscript (after type setting) to the Kanpur press for printing by 30th/ 31st of every month.

The contributors are requested to kindly cooperate.

Editors

IAPT Annual Convention notice on page 341

Election notice for RCs on page 342

To our readers

For change of address and non-receipt of the Bulletin, please write (only) to:
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PHYSICS NEWS

First detection of light from behind a black hole

Fulfilling a prediction of Einstein's theory of General Relativity, researchers report the first-ever recordings of X-ray emissions from the far side of a black hole. Watching X-rays flung out into the universe by the supermassive black hole at the center of a galaxy 800 million light-years away, a Stanford University astrophysicist noticed an intriguing pattern. He observed a series of bright flares of X-rays and then later of different "colors" than the bright flares. According to theory, these luminous echoes were consistent with X-rays reflected from behind the black hole, but even a basic understanding of black hole tells that it is a strange place for light to come from. The strange discovery is the first direct observation of light from behind a black hole, a scenario that was predicted by Einstein's theory of general relativity but never confirmed, until now.

Read more at : https://www.sciencedaily.com/releases/2021/07/210728111256.htm
Original paper : Nature (2021). DOI: 10.1038/s41586-021-03667-0

Harvard-led physicists take big step in race to quantum computing

A team of physicists has developed a special type of quantum computer known as a programmable quantum simulator capable of operating with 256 quantum bits, or "qubits." The system marks a major step toward building large-scale quantum machines that could be used to shed light on a host of complex quantum processes and eventually help bring about real-world breakthroughs in material science, communication technologies, finance, and many other fields, overcoming research hurdles that are beyond the capabilities of even the fastest supercomputers today. Already, the simulator has allowed researchers to observe several exotic quantum states of matter that had never before been realized experimentally, and to perform a quantum phase transition study so precise that it serves as the textbook example of how magnetism works at the quantum level. These experiments provide powerful insights on the quantum physics underlying material properties and can help show scientists how to design new materials with exotic properties. This new system allows the atoms to be assembled in two-dimensional arrays of optical tweezers. This increases the achievable system size from 51 to 256 qubits. Using the tweezers, researchers can arrange the atoms in defect-free patterns and create programmable shapes like square, honeycomb, or triangular lattices to engineer different interactions between the qubits.

Read more at : https://www.eurekalert.org/news-releases/558162
Original paper : Nature (2021). DOI: 10.1038/s41586-021-03582-4

Accessing high-spins in an artificial atom

Researchers have devised a method for measuring the high-spin state of up to four electrons confined on a tiny gallium arsenide quantum dot. This research may lead to quantum computers that can process information by manipulating both electron charge and spin. Now, a team of researchers showed how to read out the spin state of multiple electrons confined to a tiny quantum dot fabricated from Gallium and Arsenic. The team took advantage of a phenomenon called the quantum Hall effect. When electrons are confined to two dimensions and subjected to a strong magnetic field, their states become quantized, so their energy levels can only take on certain specific values. To prevent disturbances from thermal fluctuations, the experiments were performed at extremely low temperatures, around 80 millikelvin.

Read more at : https://www.sciencedaily.com/releases/2021/08/210819102737.htm
Original paper : Physical Review Letters (2021). DOI: 10.1103/PhysRevLett.127.086802

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ARTICLE

Electronic Waste: A Global Challenge

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Abstract

The rapidly changing technology and short life span of the electronic gadgets are the main causes of the production of millions of tons of electronic waste (E-waste) across the world. It is the major global problem of 21st century. The e-waste refers to outdated non-biodegradable devices computer monitors, CPUs, VCRs, laptops, printers, mobile phones and chargers, refrigerators, CDs, CRTs, DVD players, cameras, PCBs, microwave ovens, air-conditioners, TV sets, washing machines, medical equipment and many more. The toxic and hazardous materials in the e-waste contain arsenic, lead, chromium, mercury, cadmium, barium, nickel etc. which possess serious threat not only to human health but also to the environment. These can damage the nervous system and circulatory system, can affect kidneys, heart, liver and can cause respiratory problems like bronchitis and lung cancer as well as skin diseases. Toxic chemicals are released into the air by open-air burning of e-waste, damaging the atmosphere. Most of the e-waste finds its place in the landfills and the toxic materials in it seeps into the groundwater, affecting both land and sea animals. This can also affect the health of the people living in the vicinity of the landfills. India is at the 3rd largest e-waste producer in the world after USA and China, as reported on world environment day 2018 generating 2.75 million tons of e-waste per annum. Proper management of e-waste is the biggest challenge due to lack of information and awareness about the proper guidelines for the disposal of e-waste and its recycling among the stakeholders. In India, the recycling of e-waste is normally done by unorganized sectors which is not a safe way. Out of the total e-waste generated, only 5% is recycled. Recycling is the only way we can reduce heap of e-waste. Useful materials such as glass, plastic and other components can often be extracted and reused. Besides these, new technologies are also coming up for the extraction of valuable metals such as copper, silver, gold etc. from the electronic scrap. The ideal e-waste management is given by three R's i.e. reduce, reuse and recycle. If we consider this e-waste as a resource, we will be able to reuse the material and help ourselves and the environment from getting polluted. Efforts are needed on global scale to tackle the e-waste challenge.

Introduction

Rapidly changing technology, innovations, and faster and busy life style of the present generation are responsible for generation of millions of e-waste. All the electrical and electronic equipment (EEE) and their parts that are at the end of their usual life, discarded by user due to change in technology, miniaturization, and replacement or stopped working and not repairable are considered to be e-waste or electronic waste including *all its components with consumable as well as non-consumables, which are part of the product when it was discarded.* Table 1 gives the e-waste generated under different categories (as European Union directives) along with respective % of total e-waste.

E-waste can also be classified on the basis of composition of its components into six categories-ferrous and nonferrous metals, plastics, glass, pollutants, and others. Ferrous metals constitute the largest portion of the WEEE materials, followed by plastics. The nonferrous metals including precious metals are at the third place. Thus, although, e-waste falls under the category of wastes, it is quite valuable if the useful and precious metals are recovered and sold. According to a recent UN report, 50 million tons of EEE is discarded

Table 1. E-waste generated under different categories along with respective % of total e-waste

S. No.	Category	Items	% of total e-waste [2]
1.	Large household appliances	washing machines, dryers, dishwashers, electric stoves, air conditioners , refrigerators etc.	49
2.	Small household appliances	toasters, food processor, mixer, hair dryer etc	7
3.	Information technology & tele-communications equipment	PCs, tablets, laptops, , printers, mobile phones, telephone etc.	16
4.	Consumer equipment	radios, TV sets, video cameras, VCR/DVD/CD/cassette players, musical instruments etc.	21
5.	Lighting equipment	fluorescent &discharge lamps	2.4
6.	Electrical and electronic tools	Drilling machine s, saw blades, , soldering irons, screw driver etc.	3.5
7.	Toys, and sporting goods	Battery operated trains/racing cars, video games, treadmills etc.	0.1
8.	Medical devices	Radiotherapy, cardiology & dialysis equipment etc	0.1
9.	Monitoring and control instruments	smoke detectors, heat regulators, thermostats , fire alarms etc.	0.2
10.	Automatic dispensers	for hot drinks, hot or cold bottles , soap, money etc.	0.2

every year globally which is worth 62.5 billion dollars and is growing exponentially [3].Improper handling of e-waste results in the substantial loss of valuable metals, such as gold, platinum, silver, copper and rare earth elements. It is estimated that the gold in the e-waste is nearly 100 times more than that in the same amount of gold ore.*lobal scale to tackle the e-waste challenge*

The US Environmental Protection Agency (EPA) estimates that only 15–20% of the e-waste is being recycled, remaining part into landfills and incinerators. Also, major portion of world's e-waste is recycled in developing nations informally without any safety precautions. The primitive methods used by the unorganized sector expose the people working with e waste to various toxic materials as found from the adverse effects on their health.

Harmful effects of e-waste

a) Health Hazards due to E-waste

E-waste consists of highly toxic substances harmful to human health as well as to the environment. Toxic materials found in e-waste include lead, cadmium, chromium (VI), arsenic, zinc, Nickel, antimony, lithium, barium and PVC etc. Table 2 presents various hazardous elements found in e-waste along with their harmful effects on human body [5, 6]. It is found that the brain, kidney, lungs, heart, liver, skin, eyes, circulatory and digestive systems are mainly affected by e-waste.

(b) *Environmental Degradation due to E-waste*

Although electronics has become an essential part of our daily life, it is found to be hazardous to the environment in addition to health of the people. The improper EEE products handling during their manufacturing, recycling and disposal can pollute the environment. Halogenated dioxins are produced during burning of e-waste for metal recovery from wires and cables. The dismantling activities of WEEE also produce fine particles of heavy metals and flame retardant materials which can enter into the soil or water through dry and wet depositions, which can leach into the ground causing soil and water pollution as well. Soil becomes toxic due to the deposition of substances such as mercury, cadmium, lead, arsenic, and polychlorinated biphenyls in landfills containing WEEE [7, 8].All the

Table 2. Hazardous elements in different components of e-waste along with their effects on health

E-waste hazardous element	Appliances/component of appliance containing hazardous element	Adverse Health effects
Lead	Button batteries, solders, resistors, PVCs, CRT, PCBs, LCD (old design)	Neurological disorders, convulsions, anemia, hypertension, infertility, affects kidney, mental retardation in children
Mercury	Button batteries, PCBs thermostats, sensors, relays, and switches, medical equipment, and mobile phones	Causes damage brain, insomnia, lung and respiratory disorders & skin irritation.
Cadmium	Button batteries, resistors, solders, PVCs	Affects kidneys, softens bones, Cancer
Hexavalent Chromium	Metal contacts in circuits	can damage liver, respiratory disorders, lung cancer, allergy
Arsenic	ICs, in transistors, diodes as dopant	Digestive disorder s, Cardiovascular & Skin diseases , diabetes, damage to circulatory, neural & renal systems
Zinc	Button batteries, resistors, ceramic capacitors	Digestive disorders
Nickel	Metal contacts, resistors, batteries, ceramic capacitors	chronic bronchitis, leading tolung cancer
Antimony	Brominated flame retarded (BFRs)plastics, PVCs, as dopant	Irritation in eyes & skin, heart & lung diseases, diarrhea, vomiting & ulcers.
Lithium	Batteries	Corrosive to eyes, skin & respiratory tract, shortness of breath, sore throat.
Barium	Ceramics, ceramic capacitors	Breathing problem, High BP , irregular heartbeats, stomach irritation, muscle weakness, variations in nerve reflexes, damages kidney & heart. swelling in brains & liver,
Beryllium	As beryllium oxide used thermal grease used in CPUs magnetrons, & power transistors, and gas lasers.	beryllium sensitization, chronic beryllium disease (CBD), and lung cancer
Polyvinyl chloride (PVC)	Electrical cables. (for insulation)	Skin burn and permanent respiratory damage, cancer

three phases of the environment i.e. soil, water and atmosphere, thus, get polluted due to electronic waste. To tackle this global issue, every country should have proper regulation including that of fixing responsibility of all stakeholders from the sale/purchase of the product up to the end of its life.

(c)Information Security threat due to improper e-waste disposal/ recycling

Proper recycling and disposal of electronic items are necessary for the environment and health, but it is essential for data security as well. Personal information can be easy extracted by anyone from one's electronic device. Moving of important documents to the recycle bin, by deleting it, is not enough as it can be recovered easily using the right hardware[8].

So, hard drives should be properly erased before disposing of a computer, otherwise sensitive information such as credit card numbers, personal financial information including account details etc. can be stolen by organized criminals. In order to completely and permanently wipeout the hard disc drive so that the data in it becomes unrecoverable, a hard drive wipe software is to be employed. Full Disk Overwriting can be done using software such as Gutmann algorithm, which is one of the safest data deletion techniques, but the disadvantage of it is that it is the most time-consuming. To have a reliable data deletion for a company, an ISO 27001certified software has to be used. ISO 27001 is the international standard for best practice for an information security management system.

EPA inspires the electronic recycling agencies also to be certified and accredited. Customers should go to certified electronics recyclers for their WEEE, as they follow strict environmental standards for maximization of reuse and recycling of e-waste, with minimal harm to human health and/or the environment.

Techniques for Disposal of E-Waste

Various methods are employed for the e-waste disposal. Some very common practices are landfilling, acid bath, and incineration, which are briefly described below [9]:

a) Landfilling

Landfilling is the most common practice for waste disposal in which any type of waste including municipal, industrial, electronic wastes are dumped into any open land sites. These release harmful and hazardous chemicals into the environment that have adverse effects on health of people living nearby. Now a days, therefore, specially designed layered landfill are dug and e-waste is buried in it and then is closed. It acts more likely as a storage tank for the WEEE. On the closed landfill, landscaping is done after applying five to six layered structures to grow shrubs and flowering plants. This not only decreases the ill effects of the pollutants released from e-waste but also the landfill is developed as a recreational site for the residents living there. [10]

(b) Incineration

Incineration of e-waste done in exclusively designed furnaces at high temperatures. This e-waste disposal method reduces the quantity of waste significantly and the energy recovered is also exploited separately. However, the disadvantage of the method is that harmful gases, cadmium, and mercury vapors are released into the environment.

(c) Acid Bath

In this technique, the electronic circuits are soaked into the corrosive solutions of sulphuric, hydrochloric or nitric acid so as to separate the metals from the circuit boards that settles at the bottom and can be recovered while the hazardous corrosive waste is disposed into the nearby water sources.

E-waste recycling techniques

The first step of electronic waste processing is dismantling the WEEE into its various constituents viz. metal frames, batteries, circuit boards, plastics, etc., that is usually done manually with simple equipment such as hammers, tongs, screwdrivers etc. The disadvantage of hand picking is that the labor may suffer from the adverse effects of the hazardous substances. It is to be noted that e-waste is mostly being recycled in developing or poor countries where the labor charges are the cheapest by unorganized sectors, who do not follow any health and safety measures.

The next step in recycling is shredding, for which the material is put into a mechanical separator. That does the grinding as well. This reduces significantly the amount of waste, thus, reducing the storage and transportation costs. The metal and plastic fractions of the e-waste

separated by the mechanical separator are then sold to smelters or plastics recyclers. Further, the shredded material is first passed over a magnetic drum to separate ferrous metals followed by an eddy current separator which attached to the end of a conveyor belt. Non-ferrous metals are thrown forward into a container, whereas the non-metals like glass and plastic just fall from the belt under gravity[11,12].

Refining is the final step of recycling that is generally employed to extract valuable metals such as Cu, Ag Au etc. using hydrometallurgical, electrometallurgical, bio-metallurgical processes and/or their combinations [13].

Advantages of e-Waste Recycling

Recycling of the EEE, which are either at the end of their life or just discarded, is the best solution to the exponentially increasing e-waste problem. A majority of the EEE devices are repairable and can be sold again. India is a good place for the companies to sell their second-hand mobile phone devices as millions of people are now tending to replace their cell phones by a second-hand smart phones as they cannot afford a new handset. The possibility of reuse of EEE, in turn, can conserve the natural resources on one hand and reduce e-waste on the other. This automatically can reduce air and water pollution caused by hazardous disposal. The recovery of various useful and precious metals and different materials puts the waste electronic gadgets into the category of resource, and thus conserving the natural resources of these metals as is evident from the United According to EPA, recycling one million mobile phones can yield 34 kg gold, 350kg silver, 16000kg copper, and 15kg palladium [14].

The reduction in e waste will conserve landfill space as well. The recycling of e-waste has been turned up into a profitable business opening a number of job opportunities. E-waste reusing and electronics take back policy can, further, cut down significantly the volume of waste generation as well as energy utilization in the product production. It is to be noted that 81% of the energy associated with a PC is consumed during production and only 19% when it is used.

The most recent example of recycling of e-waste is the Tokyo Olympic 2020 medals which are made out of 32kg gold, 3,500kg silver and 2,200kg bronze with 95 percent copper and 5 percent zinc from 78,985 tons of e-waste collected from the Japanese people between April 2017 and March 2019 [15]as declared by the organizing committee for the 2020 Olympic and Paralympic Games, Tokyo while presenting the designs for the medals.

United Nations Initiative in Tackling E-Waste

E-waste has become a global agenda during the last few years due to various health and environmental problems associated with it. The United Nations has taken initiative along with other bodies to tackle the problem [16]. It has been pointed out that the activities of the Department of Field Support (DFS) or the UN peace Keeping force use a large amount of EEE and hence large production of e-waste. Due to mobile nature of DFS the disposal of e-waste for them is a challenge. Similar is the case of Food & Agriculture Organization (FAO). It offers expertize in the application of EEE in agriculture production including mobile devices, drones, smart agriculture equipment and sensors etc. After the end of use in the field, the disposal of these EEE or E-waste is again challenging.

The entities like Global Environment Facility (GEF) which works on international cooperation of 183 countries together with institutions and civil societies and private sector, provided funds for e-waste management. International Telecommunication Union (ITU) can provide expertise to the developing countries on environmentally viable management of e-waste including effective take back system, manual dismantling and processing. ITU develops international standards, raises awareness on ICT, and provides innovative solutions to e-waste to reduce negative impacts of ICTs.

Interpol examined the movement of e-waste within and out of Europe through WEEE illegal trade project. Another entity International Labor Organization (ILO) related e-waste with labor employment, health and safety of labor at work. It also gave possibility of green jobs and worked towards eradicating child labor. ILO's recommendations help in tackling hazardous wastes, in formalizing recycling industry.

World Health Organization (WHO) takes care for the reduction of impact of WEEE on health of informal e-waste recyclers at local to global levels. World Intellectual Property Organization (WIPO) provides knowledge about patenting and innovation on e-waste recycling technologies whereas the United Nations Development Programme (UNDP) supports to

strengthen e-waste management capabilities.

E-Waste management regulations

Despite being top generator of e-waste, the United States does not have any national law for e-waste management, however, 25 of its states have their own e-waste regulations. The majority of the states follow the Producer Responsibility approach according to which it is the responsibility of the manufacturers to collect their discarded electronic products and to recycle these. Because the US has not signed any agreement on the Basel Convention of hazardous waste, United States is free to export its electronic waste to countries where the dismantling and recycling of e-waste are cheaper and those do not have strict environmental regulations. The European Union (EU), in contrast, has one of the toughest implementation of e-waste laws in the world. It bans the export of e-waste to developing countries and force the manufacturers to either recycle the waste themselves or raise fund for recycling [17].

China is the second largest e-waste producer with 6.1 million tons annually as well as recycling hub. Electronic waste imports began in the eastern coastal areas of China and enabled it to turn the waste as a resource. In Guiyu, Guangdong Province of China, 80% of the population of the town is involved in e-waste industry. This whole business, estimated to be worth 75 million US dollars, made Guiyu a wealthy town in ten years, but at the cost of environmental degradation and serious health problems to the residents. Children suffered from lead poisoning, the source of which may be lead ash from chip fragmentation. The gold on the circuit board is separated by highly corrosive acids; which is often discharged into rivers and other water bodies after it is used up. Realizing the adverse effects of waste disposal on the environment as well as on the people, Chinese government took an key step to ban the import of several types of waste, including plastics since 2018 [18] which has greatly influenced recycling industries all over the world. In US, companies, which were collecting the e-waste including plastic to transport it to China, got stuck with no immediate solutions. They had to start afresh seeking for new e-waste buyer country or dumping ground for e-waste and/or setting up recycling plants of their own.

(a) E-Waste Legislation in India

India being the third largest among the e-waste generators, is producing 2.5 million tons of e-waste annually. According to the Associated Chambers of Commerce and Industry of India (ASSOCHAM),the electronic waste is growing at the compound growth rate of 30% annually. As a growing economy, Indian government is very much concerned with the growth of e-waste in India and for the sustainable development. India got its first E-waste management rule in 2011 which became applicable from May 1, 2012 [19]. These Rules facilitate environmentally sound management of e-waste along with the recovery and/or reuse of useful materials from it, thereby reducing the amount of hazardous waste to be disposed. These regulations, thus, offer safe and environment friendly handling, transportation, storage and recycling of e-waste. The idea of Extended Producer Responsibility (EPR) was introduced in E-Waste (Management) Rules, 2016 according to which manufacturers are legally responsible for safe disposal of electronic items. Maintenance of records of the e-waste generated, handled and disposed are also necessary for assessment of accomplishment of target as well as future planning. Producers are now required to collect the WEEE through dealer, collection centers, buy-back or exchange schemes, etc. They have to provide e-mail address, toll-free/ helpline numbers to consumers through their websites and to create awareness through media, publications, advertisements etc. along with instructions for handling and disposal of the equipment after its use.State governments are held responsible for environmentally sound management of e-waste while ensuring that the rules are followed properly by various stakeholders. E-waste collection targets are also set for EPR-authorization. During first two years of implementation of rules, it is 30%, for 3rd & 4th years 40%, extending to 70% for the 7th year onward. The E-Waste Management Rules, 2016 have, further, been amended in 2018tochannelize the e-waste generated in the country towards authorized dismantlers and recyclers for formalizing e-waste recycling sector [20].

E-waste management through Circular Economy: A flourishing business

Circular Economy [21] is a regenerative economic system that works on 'take-make use- regenerate' model. It refers to designing of products with enhanced recoverability and recyclability, leading to resource

efficiency and aiding to recycling. Resource efficiency is the utilization of natural resources in a sustainable way with minimum impact on the environment. In addition to recovery of materials and metals from waste, recycling also saves energy, as much more energy is required in the production of metals from its naturally occurring sources, the ores. Circular economy, further ensures that a design centric approach be followed in production to have easier and cost effective dismantling and recycling for recovery of materials. These recovered metal/material can be used as raw materials and if the recycling cost is reduced, raw materials can be available at much lower cost. This, in turn, will also enhance the demand for secondary raw materials to have less production cost in the next cycle. A typical CRT television contains about 450g of copper, 227g of aluminum, and nearly 5.6g of gold. The amount of gold recovered from one ton of raw material from gold mine is only 5-6g whereas same amount of e-waste of discarded electronics yields 350g of gold. The overall cost of gold recovery from e-waste recycling including the cost of equipment and building along with charges for waste collection, labour, energy, material and transportation was found to be much less than that for gold recovery from its ore. [22].

E-Parisara Pvt. Ltd. is India's first scientific eco-friendly e-waste recycling government approved unit in Bengaluru having a recycling capacity of 3 tons e-waste/day. , now, India is having more than hundred registered e-waste recyclers, most of them are not engaged in it properly some are only storing the waste and that too in hazardous conditions [23].So, an e-waste awareness program has been started by the Ministry of Electronics and Information Technology (MeitY) to make peoplea ware about the hazardous effects of e-waste recycling by the unorganized sector, to inform them where they can deposit their e-wastes for recycling as well as the alternative methods of e-waste disposal. MeitY has also been involved in developing in expensive environmentally sound recycling technologies that is already at commercialization stage. E-waste recycling has huge opportunity in the country. India being deficient in precious mineral resources, the need of the hour is to have a strong and planned e-waste recovery management system that would create job opportunities for the people as well as wealth for the country.

Although establishing an e-waste recycling plant is a big investment and operating it also costs nearly 50 lakhs per month including labor, raw material, power etc. But if done properly, with proper registration etc., e-waste recycling is definitely profitable as can be realized from the progress made by Namo E-waste management, an NCR based company that started working in 2015, has its e-waste collection centers in 12 states and UTs that collect 70% of the e-waste generated in the country and earn a revenue worth 4.4 crore in 2016-17 [24].

Conclusion

The ideal e-waste management is given by three R's i.e. reduce, reuse and recycle. If we consider this e-waste as a resource, we will be able to reuse the material and help ourselves and the environment from getting polluted. Efforts are needed on global scale to tackle the e-waste challenge. Environment friendly approach should be followed just as International Telecommunication Union (ITU) in designing power adapters. This type of steps not only in reduces greenhouse gas emissions, but also increases energy efficiency. ITU has also standardized the eco-design of universal laptop chargers compatible with more devices, to reduce e-waste as well as power consumption in the production of separate chargers for each laptop. Similarly, efforts are on to use lead-free solder in circuit designing. Training and skill development for the informal sector workers should be organized to educate them about health hazards associated, safety measures to be taken while tackling the e-wastes and the good environmental friendly practices to be followed. To encourage and attract young entrepreneurs in the recycling business, government should provide funds for setting up e-waste recycling units as it is the major investment. Research in the field is also necessary for new improved technology for less e-waste generation with longer life of the electronic equipment with the possibility of upgradation.

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ARTICLE

Dimensional Analysis - Use of This Tool in Anticipating Physical Parameters

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Abstract

The word 'Dimension' here essentially signifies a measurable extent such as mass, length, time, etc. Dimensional Analysis forms a very significant part of the study of physics. Basically the students are taught that [M]. [L], [T] are the fundamental dimensions and the dimension of every other quantity can be derived from them. The other key factors which are highlighted are that every equation is dimensionally homogeneous. Dimension analysis helps us to understand the link between the units/dimension of physical quantity.

It gives very interesting results and helps to solve various unknown problems which would otherwise require a lot of experimental work. Through this article we shall cite quite a few examples to sensitize the students about some of the additional features of Dimensional Analysis.

Introduction

By the word 'Dimension' we essentially mean measurable quantities such as mass, length, time, etc. Dimensional analysis is a tool used in physics and engineering for deriving theoretical equations, checking empirical formulae, describing experiments, interpreting results from scale models and performing conversions between different systems of units [1]. Bridgman (1931) stated that, "The principal use of dimensional analysis is to deduce from a study of the dimensions of the variables in any physical system certain limitations on the form of any possible relationship between those variables[2]. It is mainly used to find the relations among physical quantities in complicated physical systems by their dimensions.

Dimensional Analysis studies the properties of observable quantities with dimensions and the properties of mathematical relationships that incorporate them [3]. This analysis is applied in the natural sciences; its principles (dimension, homogeneity, measurement and unity) are key factors in the formation of scientific thought since they are part of the basic principles of science. Compliance with the principles of Dimensional Analysis, and in particular the principle of dimensional homogeneity, is a basic prerequisite for proper mathematical modelling.

Many researchers have applied dimensional analysis as an analytical tool in various fields such as Geography [1], Biology [4, 5, 6], Economics [7, 8, 9] and other fields. A book by Don S.Lemons [10] covers the methods, history and formalization of the field, and provides physics and engineering applications through the mathematical methods of dimensional analysis.

An historical outline of dimension analysis is given by Huntley [11] who credits Newton with the discovery of the "principle of similitude" and Fourier with its development into present method. Several general treatments are available in the literature [2, 12, 13, 14, and 15]. Use of the special symbols M, L and T to denote the dimensions of mass, length, and time has become standard [16]. Physical dimensions refer to the measurement systems to characterize certain objects. Each physical dimension has several empirical scales of measurements and they are called "units". There are seven fundamental physical dimensions, namely mass M, length L, time T, temperature Θ, electric current

I(or charge Q), amount of substance, mole and luminous intensity I_v. The corresponding units defined by SI(international System of Units) are kilogram, metre, second, kelvin, ampere, mole and candela respectively. All other physical quantities are combinations of these fundamental quantities [17]. The general procedure of applying dimensional analysis is given by W.Shen [17] and others [18, 19].

The fundamental purpose of the present research article is to introduce the basic principles of Dimensional Analysis in the context of the real physical problems by citing a few examples to sensitize undergraduate students about the additional features of Dimensional Analysis.

Dimensional Analysis from Student's perspective: Misconceptions and Applications

Dimension Analysis forms a very significant part of the study of physics. The students are supposed to read this prior to them making inroads into cardinal areas of physics. Basically the students are taught that [M].[L],[T] are the fundamental dimensions and the dimension of every other quantity can be derived from them. The other key factors which are highlighted is that every equation is dimensionally homogeneous. The students are taught to derive equations such as

$$T = 2\pi\sqrt{\frac{l}{g}} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

for the time period of oscillation of a simple pendulum, by assuming that 'T' is a function of 'l' and 'g' by expressing

$$T = kl^a g^b \quad \ldots\ldots\ldots\ldots\ldots (2)$$

where k = A dimensionless constant and a, b are pure numbers.

We arrive at the result (Equation (1)) which is restricted to the extent that the value of the constant k cannot be fixed.

Students are exposed to similar exercises on introduction of ε_o and μ_o in connection with the electric and magnetic units and their links with [M], [L], [T]. While the above referred exercises are useful for the students, it has been felt that dimensional analysis has lot more to offer. As a matter of fact lot of physics, mathematical techniques can be made to evolve from Dimensional Analysis, like in Eq (1) we have used the product format. But have we pondered over the fact that quantities with different dimensions can be multiplied (e.g. mass x velocity = momentum), or one can be divided by the other (e.g. density = mass/volume), but they must not be added or subtracted!

Through this article we shall cite quite a few examples as mentioned earlier to sensitize the students about some of the additional features of Dimensional Analysis.

Let us start by narrating an incident.

It is about a student from Physics Honours background, while attempting a question on Maxwellian distribution of velocities, he could recollect the exponential factor as e^{-bu^2}, but he was confused about the value of 'b', that is whether it is $\frac{m}{2kT}$ or $\frac{2kT}{m}$. As he was feeling restless about it, a small help was offered and while doing so, it was explained to him that

$$e^x = 1 + \frac{x}{1!} + \frac{x^2}{2!} + \frac{x^3}{3!} + \cdots, -\infty < x < \infty \quad \ldots\ldots\ldots\ldots\ldots (3)$$

So if 'x' has a dimension, you have to add quantities having different dimensions which is absurd, so 'x' must be dimensionless. This was something which the student had not realised earlier. So he could immediately make out that 'bu^2' must be dimensionless. If $b = \frac{m}{2kT}$, then both the numerator and denominator of 'b' should have the dimensions of energy which would make 'b' dimensionless. A

student needs to imbibe this fact as a concept and should take every opportunity to verify this. Some illustrative cases are the discharge through an *R-C* circuit or an *L-R* circuit. The equations are-

$q = q_o e^{-t/CR}$…….. (4)

$i = i_o e^{-Rt/L}$…….. (5)

It can be verified that CR or $\frac{L}{R}$ has the dimension of time.

Now let us explore this further through the following example-

The constants appearing in the so called trial solution of a Linear Second Order Differential Equation.

Let us consider the good old second order differential equation of damped harmonic motion. The equation is

$m\acute{x} + \gamma\acute{x} + kx = 0$…….. (6),

where the symbols have their usual meanings. We rewrite the equation as

$\acute{x} + 2b\acute{x} + \omega^2 x = 0$…….. (7),

where$b = \frac{\gamma}{2m}$ and $\omega^2 = \frac{k}{m}$

Then we say that we assume a trial solution

$x = Ae^{\alpha t}$ ……..(8)

Where 'A' and 'α' are constants to be determined.

Firstly, why do we call it a 'Trial solution'? If Eqn (7) instead of being a second order differential equation had been of higher order then also we would have assumed

$$x = Ae^{\alpha t}$$

as done in Eq (8)

We observe in Eq (7) that$x, \acute{x}, \acute{x}$are linearly dependent. Had it been a *n*th order differential equation, all the derivatives (From the first to the *n*th order) would have been linearly dependent. Now, we know that the *n*th order derivative of the exponential function is itself for every '*n*'.So the solution of an equation of the type (7) is bound to be of exponential form and hence we assume

$$x = Ae^{\alpha t}$$

Now, we were looking for a solution where x is expressed as an exponential function of't'. But why do we need 'α'and 'A'? The prime reason is that 't' cannot appear alone in the power of 'e'. It has to appear with a multiplier 'α' which has the dimension of reciprocal of time, so that the overall power is dimensionless. Hence we need 'α'. Again, once we expand $e^{\alpha t}$, all the terms in the seriesare dimensionless. So the expression is dimensionless, whereas the left hand side has the dimension of x. So we have to insert the constant 'A' which has the dimension of $x$and thereby the two sides of the equation become dimensionally same. Thus the form of the so called trial solution of a second order differential equation which is very often used in physics has a strong link with dimensional analysis.

Solution of Differential Equation of S.H.M

The very well known second order differential equation of S.H.M (with symbols having their usual meanings) is as under:

$m\acute{x} + kx = 0$ .....(9)

We rewrite the above equation as

$$\acute{x} + \frac{k}{m}x = 0.$$

And we generally replace $\frac{k}{m}$ by ω^2.Do we tell our students why we replace $\frac{k}{m}$ by the square of a constant? Let us remember that at this stage we do not know the meaning of 'ω'; it would emerge from the solution after we make the mathematical analysis regarding the meaning of 'Phase' of S.H.M. To find an answer to above, let us examine the dimension of $\frac{k}{m}$

[k] = [Force per unit length] = $\frac{MLT^{-2}}{L} = MT^{-2}$

Thereafter, through the standard process of solution, we arrive at the result,

$x = asin(\omega t + \delta)$ ..... (10)

And by performing analysis using the concept of phase, we relate $'\omega'$ to the frequency $'\nu'$ or to the reciprocal of time period. Alternatively, we may introduce SHM by stating that it is that kind of motion for which $xvst$ curve is sinusoidal, i.e. either a sine curve or a cosine curve. The above definition also enables us to write the equation of SHM in the form of Eq (10),by falling back on dimensional analysis. As in the case of Eq (8) we should not have written just e^there also we cannot simply make 't' the argument of sine or cosine function. The power series (Mclaurin series) expansions of $sin\theta$ and $cos\theta$ in $'\theta'$is possible because the unit of $'\theta'$ is radian which is essentially dimensionless like the power of $'e'$. So 't' has to be multiplied by a quantity which has the dimension of reciprocal of 't'; hence 'ω'; then 'δ' appears as a dimensionless constant for introduction of generality in respect of origin of time , and 'a' appears as a multiplier as a quantity having dimension

of length to ensure dimensional homogeneity. Obtaining the physical meanings of a, ω and δ happens through usual analysis.

Velocity of light as the fundamental translation factor between space and time.

The most important outcome of the Special Theory of Relativity (STR) is perhaps that space, time and simultaneity are all relative but the velocity of light, 'c' is absolute. It turned out to be extremely crucial, because it opened the gateway for describing any event with a four dimensional framework of three space dimensions and one time dimension. It is essential because any event occurs at a point in space and at a given instant of time. But how to make space and time dimensionally congruent? For this, we need to consider the fact, that dimensionally length = time × velocity. Further, in real life we keep transforming lengths into time using examples, such as, the distance of the market place from my home is ten minutes' walk or two minutes' ride. Thus, we substitute a length by time, keeping in mind a velocity as a translational factor. Now, in order that this velocity is a fundamental translational factor, it should be such that it is independent of the frame of reference of the observer. Through the STR it got established that such a velocity is the 'velocity of light'. Then 'c' was considered to be the fundamental translation factor between space and time.

But as stated before, the need for having such a factor emerged from dimensional considerations. Before 'time' was recognised as the fourth dimension, the interval between two events was expressed (with symbols having usual meanings) as

$$\Delta S = \sqrt{x^2 + y^2 + z^2} \qquad \text{.....(11)}$$

But, special theory of relativity identified 'time' as the fourth dimension and the interval between two events at (0,0,0,0) and (x,y,z,t) is given by

$$\Delta S = \sqrt{(x^2 + y^2 + z^2 - c^2t^2)} \qquad \text{.....(12)}$$

It was required that the right hand side should have the dimension of length and 't' had to be multiplied with a 'velocity' to ensure dimensional homogeneity, and this was achieved through 'c' after the special theory established it to be independent of the frame of reference of the observer.

Dimension of 'h' or 'h bar'

'h' has the same dimension as that of action , i.e. (position) x (momentum). The said quantities are canonically conjugate. It is given by ML^2T^{-1}, which also happens to be the dimension of angular momentum. This must have been taken into consideration by Prof. Niels Bohr while making his path breaking postulate about the stationary orbits. In order to fix the orbits, by providing a condition, it was imperative that he took into account a physical quantity which is conserved. The electronic orbit in an atom is caused by a central force, and in case of such an orbit the angular momentum and total energy are conserved quantities. As a matter of fact they are the cardinal features of the postulates of Niels Bohr, and the first one is based on angular momentum.

Now, in order to express the condition for stationary orbit, angular momentum has to be equated with a quantity through which discreteness, which is departure from continuity, gets reflected. It is prudent that the order of separation between two consecutive orbits has to be extremely small so as to be perceptible in the atomic scale. Over and above it should have the dimension ML^2T^{-1}.

All the above conditions are fulfilled by h or $\hbar$ and we have the mathematical statement of the postulate (with symbols having usual meanings) as,

$$mvr = \frac{nh}{2\pi} \qquad \text{.....(13)}$$

Or $$mvr = n\hbar \qquad \text{.....(14)}$$

with n = 1,2,3,.....

Arriving at Schrödinger's formalism and subsequently Schrödinger's equation through a sort of conjecture

Let A and B be two Hermitian operators

Then,

$A^\dagger = A, \qquad B^\dagger = B$

The Commutator of A, B is given by

$$[A, B] = AB - BA \qquad \text{.....(15)}$$

So,

$[A, B]^\dagger = (AB)^\dagger - (BA)^\dagger$

$= B^\dagger A^\dagger - A^\dagger B^\dagger$

$= BA - AB$

$= -(AB - BA)$

Therefore,

$[A, B]^\dagger = -[A, B]$ .....(16)

Hence

$[A,B]$ is Skew –Hermitian

Now, position $\hat{x}$ and momentum $\hat{p}$ are dynamical variables, so they are Hermitian.

Hence,

$[\hat{x}, \hat{p}]$ is Skew Hermitian---- (a)

Now what value can be assigned to $[\hat{x}, \hat{p}]$?.

We observe that $[\hat{x}, \hat{p}] = \hat{x}\hat{p} - \hat{p}\hat{x}$, which has the dimension of action, ML^2T^{-1}----(b)

Now, Let us look at the classical analogue of $[\hat{x}, \hat{p}$, i.e. the value of Poisson Bracket of

x, p.

We have

$\{x, p\} = \frac{\partial x}{\partial x}\frac{\partial p}{\partial p} - \frac{\partial x}{\partial p}\frac{\partial p}{\partial x}$

$= 1.1 - 0.0$

$\{x, p\} = 1$ ..... (17),

which is a reflection of the basic feature of classical mechanics, that the position and momentum of a particle can be specified with exactitude simultaneously, which is why they are called canonically conjugate. In quantum mechanics this gets restricted by way of the Uncertainty Principle and the commutator $[\hat{x}, \hat{p}] \neq 1$, and since

$\Delta\hat{x}\,\Delta\hat{p} \sim \hbar$-----(c),

we may infer that $[\hat{x}, \hat{p}$ would be very small and related to $\hbar$.]

So, if we carefully analyze the requirements posed by (a), (b), (c), we find that '$i\hbar$' is a good choice for the value of $[\hat{x}, \hat{p}$.

Because

(1) $i^{\dagger} = -i$, so i serves the purpose of the commutator bracket being Skew Hermitian, thus meeting the requirement of (a).
(2) We have already seen that $i\hbar$ meets the requirement of (b)
(3) It also meets the requirements of (c), and so we assign the value $i\hbar$ to $[\hat{x}, \hat{p}$

$[\hat{x}, \hat{p} = i\hbar]$ .....(18)

Now, let us work out $[x, \frac{d}{dx}]\ \psi = (x\frac{d}{dx} - \frac{d}{dx}x)\psi$

$= (x\frac{d\psi}{dx} - \frac{d(x\psi)}{dx})$

$= x\frac{d\psi}{dx} - x\frac{d\psi}{dx} - \psi$

$= (-1)\ \psi$

$[x, \frac{d}{dx}]\ \psi = (-1)$ .....(19)

Therefore $[\hat{x}, -i\hbar\frac{d}{dx} = i\hbar$ .....(20)

Comparing (18) with (20) we have

$\hat{p} = -i\hbar\frac{d}{dx}$ .....(21)

Similarly, it can be shown that

$[\frac{d}{dp}, p] = 1$ ..... (22)

And, comparing again with Eq (18) , we have

$\hat{x} = i\hbar\frac{d}{dp}$ .....(23)

Thus, we arrive at co-ordinate and momentum representation of SchrÖdinger formalism respectively through Eq (21) and (23).

The above formalism, and in particular, the relation

$[\hat{x}, \hat{p} = i\hbar]$ .....(24)

is in consonance with the generalised connection between Classical Poisson Bracket and Quantum Commutator Bracket which are as under

$\{q_i, q_j\}_P = 0$; $\{p_i, p_j\}_P = 0$; $\{q_i, p_j\}_P = \delta_{ij}$

And,

$[q_i, q_j]_C = 0$; $[p_i, p_j]_C = 0$; $[q_i, p_j]_C = i\hbar\delta_{ij}$

where P and C are the symbols for Poisson and Commutator Brackets respectively. However, these are derived rigorously using the Heisenberg-Dirac equation of which the Schrödinger equation is an integral part. Our focus is on the role played by Dimensional Analysis in the whole treatment.

Conclusion

Through this article we have highlighted a different facet of Dimensional Analysis. We have used it *inter alia* to:

- justify the method of solving ordinary linear differential equations.

- provide justifications towards fixing some constants while solving the differential equation of S.H.M.
- apply the concept of dimensional homogeneity towards having a subtle role in establishing the velocity of light as a fundamental translational factor between length and time, and similarly for Neils Bohr arriving at his famous postulate of stationary orbits of electrons in an atom.
- arrive at the Schrödinger Formalism in Quantum Mechanics.

Thus we have seen that important features of Mathematics and Physics emerge out of Dimensional Analysis. We wish that this article will enable students to imbibe a new dimension to Dimensional Analysis.

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Determination of Mean Particle Size of Lycopodium Powder - An Experiment

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Abstract: This is a sequential to the paper on Babinet principle [1]. This paper gives brief theory and experimental procedure to determine the average particle size of tiny objects comparable with the wavelength of visible light so as to produce a diffraction pattern. This is a standard laboratory exercise in wave optics at undergraduate level, as the principle involved is very interesting [2-7]. In Tamil Nadu, some instruction manuals provide a wrong formula for this experiment! The formula given is the familiar formula for the diffraction at a plane transmission grating [11-15]. The Lycopodium powder are tiny opaque particles which can be considered as circular obstacles distributed randomly. The purpose of this paper is to point out the importance of the Airy formula for diffraction at a circular aperture. It involves Bessel function of order one in the distribution of amplitude/intensity. So the formula is entirely different and important and differs from that of a grating. It is suggested to use the correct formula and get the result. The importance of this formula lies in its application to the resolving power of optical instruments which have circular aperture including human eye. A list of classic books on optics which deal with topic is provided.

Introduction: Measurement of the mean diameter of tiny particles is of great interest, especially after the discovery of properties of nanoparticles. The size of Lycopodium particles, the blood sample, pollen grains is of the order of the wavelength of light and serve as the particles for this experiment. An inexpensive laser (pointer) can be used as the coherent beam or sodium vapor lamp.

The Airy's pattern: A random collection of (opaque) lycopodium particles produces the same diffraction pattern as the random collection of circular apertures of very small diameter comparable to the wavelength of light [1,2 and 3]. The Fraunhofer diffraction pattern due to a large number of random circular apertures is the well-known Air's pattern. The diffraction pattern of a circular aperture is the Airy's pattern [2,4,5,6,7 and 8]. The diffraction pattern of a random collection of N identical circular apertures is Airy pattern with N times the brightness due to one aperture. Thus, the Fraunhofer diffraction pattern due to lycopodium particles is also an Airy's pattern only (see Fig. 2 and 3). The normalized Fraunhofer diffraction amplitude due to a circular aperture of diameter d is given by

$$U(f_x, f_y) = U(\rho) = \left(\frac{2J_1(\pi \rho d)}{\pi \rho d} \right) \tag{1}$$

where $J_1(q)$ is the Bessel function of order 1 and argument q.

$$\rho = \sqrt{{f_x}^2 + {f_y}^2} = \frac{\sqrt{X^2 + Y^2}}{\lambda Z} = \frac{r}{\lambda Z}. \tag{2}$$

r is the radial distance from the centre of the Fraunhofer plane. The amplitude and intensity of Airy's pattern are shown in Fig. 3. Airy's disc extends up to the first diffraction minimum and then secondary maxima and minima are seen as circular bright and dark rings respectively. The widths of the secondary maxima and minima are not equal. The angular diameters of rings are **not proportional to** integer. The radii r_n of ***dark*** rings are given by [8,9].

$$\frac{1.22\,\lambda\,Z}{d}, \frac{2.233\lambda\,Z}{d}, \frac{3.238\lambda\,Z}{d}\ldots \tag{3}$$

and the radii of the centers of **bright** rings are given by

$$R_1 = \frac{1.635\lambda Z}{d}, R_2 = \frac{2.679\lambda Z}{d} \tag{4}$$

It is evident that the ***radii are not equi-spaced***. In a good darkroom, two or three dark rings can be seen clearly. The first dark ring is conspicuous as more than 90% of the intensity of the diffraction pattern is contained in the Airy's disk.

The diameter d of the circular aperture or equivalently average diameter of lycopodium particles is given by eq, (3),

$$d = 1.22\lambda\left(\frac{Z}{r_1}\right) = 2.233\lambda\left(\frac{Z}{r_2}\right) = 3.238\lambda\left(\frac{Z}{r_3}\right)\ldots \tag{5}$$

Z is the distance of the screen from the glass plate on which the lycopodium powder is strewn. r_n are the radii of the successive dark rings. The radius of the first dark ring is the radius of the Airy's disc. **Note d is not integral multiple of** $\frac{\lambda Z}{r_n}$. It is correctly given by eq. (5).

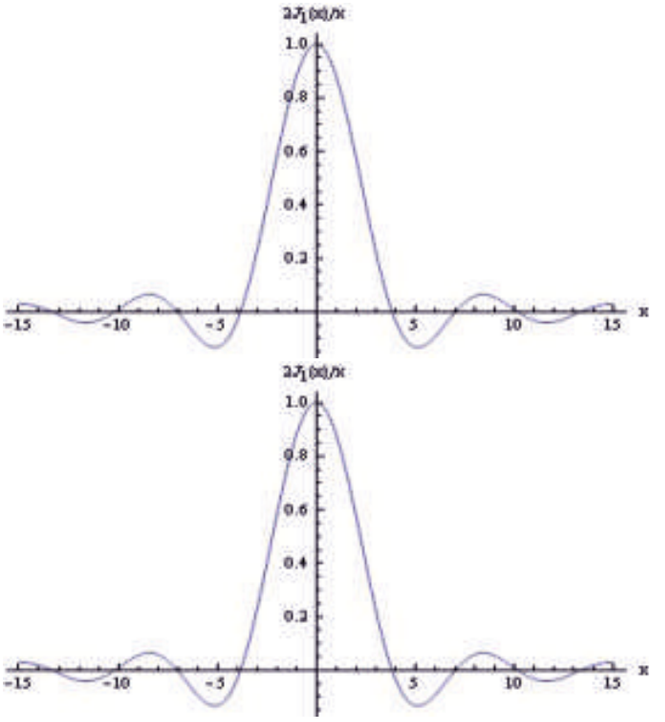

Figure. 1 Airy's function for amplitude

Radius	Order of Intensity
1.22π	I minimum
2.233π	II minimum
3.238π	III minimum

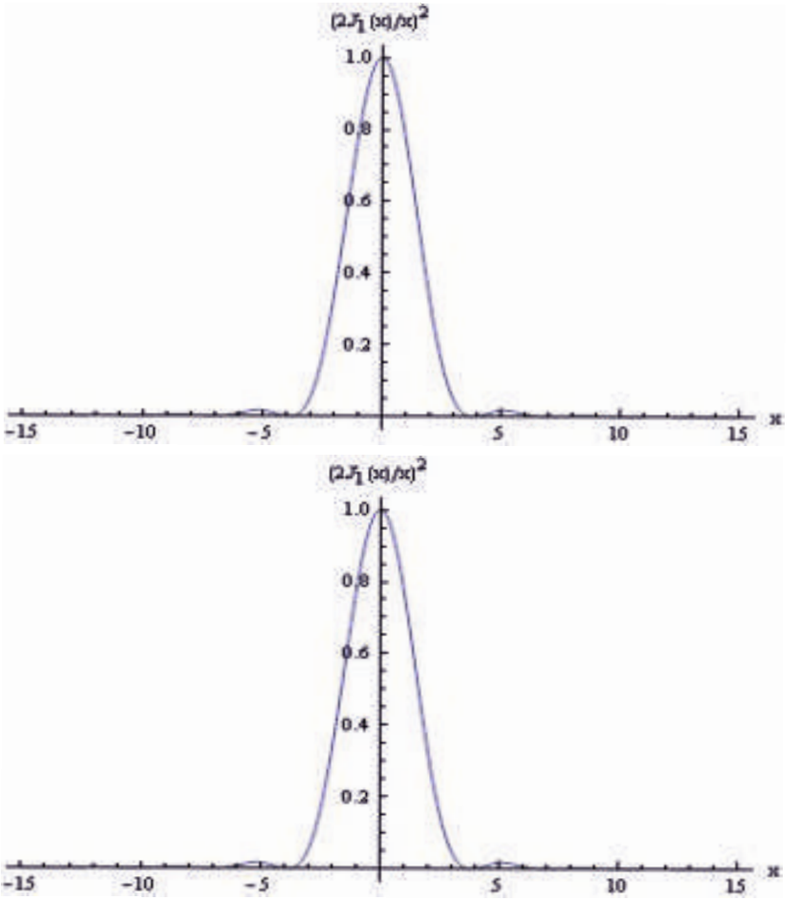

Figure. 2 Modulus square of Airy's function: Intensity Distribution

The Airy pattern plays a key role in resolution of optical instruments with imaging optics having circular symmetry. So, the factor **1.22, 2.233, 3.238, …** for the first, second, third etc dark rings are of paramount importance and ***cannot be ignored*** and should not be written as 1,2,3 etc. for the sake of simplicity [11-16]. The authors of these books/video have to take note of this conspicuous error in the practical manuals and correction is needed [17]. The beauty of Airy's formula of diffraction pattern of circular aperture lies in these non-integer values for the positions of minima (and maxima). They correspond to zeros of Bessel functions of order one: $J_1(q)$. Besides, many optical elements are circular in shape including the eye, telescope and microscope and Airy's formula plays a significant role in resolving power and the correct formula has to be provided. The sole objective of any book on science is to give correct information.

The following tabulation gives the result of an experiment with correct formula.

Serial No	Distance Z (in cm from the glass plate to screen	Order of Dark Rings (minima)	Diameter First/second order $2r_1/2\,r_2$ (cm)	Radius (cm) $r_1 \vee r_2$	K_1 $\frac{1.22Z}{r_1}$	K_2 $\frac{2.233Z}{r_2}$
1	46.6	1	2.1	1.05	54.14	53.36
		2	3-9	1.95		
2	28.2	1	1.3	0.65	52.92	54.75
		2	2.3	1.15		
3	35.1	1	1.4	0.7	61.17 deleted	50.56
		2	3.1	1.55		
4	39.9	1	1.9	0.95	51.24	52.4
		2	3.4	1.7		
5	52.2	1	2.4	1.2	53.07	58.28 deleted
		2	4.0	2.0		
6	50.0	1	2.3	1.15	53.05	55.82
		2	4.0	2.0		
7	61.5	1	5.2	2.6	51.74	52.81
		2	18.6	9.3		
8	68.4	1	3.2	1.6	52.15	56.56
		2	5.4	2.7		
9	25.0	1	1.30	0.65	46.92 deleted	55.82
		2	2.0	1.0		
	Mean values of $K_1 \wedge K_2$				52.61	54.0

$K = \frac{K_1+K_2}{2} = 53.31$ $\quad d = K\lambda = 53.31x690nm$ =36.8 μm.

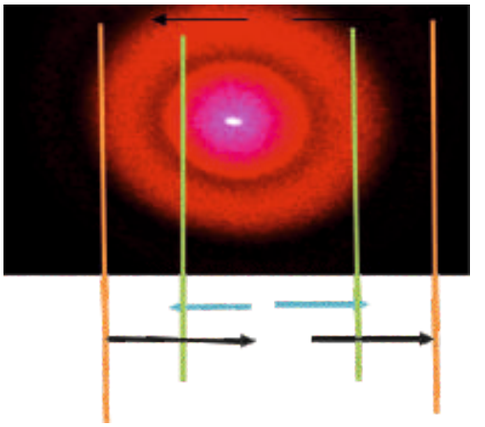

Fig. 3 Circular fringes formed by lycopodium particles on a screen placed at distances Z from the source. The diameters of the first and second minima are measured with a divider and a meter scale or with a graph sheet

SOME PRECAUTIONS, OBSERVATIONS AND COMMENTS: All optics experiments are conducted in dark rooms for excellent results. Usually a hand-torch is used by the students and instructors. All electrical connections should be well outside the reach of the students when they do the experiments. Special instructions are given on the laser power prior to the experiments involving laser like 'one should not directly see the laser light how small the power may be'. It is advised to wear goggles while using laser. There should be at least two persons in the laboratory so that in any emergency immediate action can be taken. An instruction sheet/hand-out on the experiment has to be provided to the student with adequate references to understand the theory and come prepared to do the experiment. At the end, each student submits a report on the experiment, which is a document of catalogue of difficulties faced, how they were overcome with data in tabulations and plots/graphs.

EXPERIMENTAL SET-UP: The following figure.4 shows the simple experimental set-up. A glass-plate strewn with lycopodium particles is kept vertically and at a distance Z, screen is kept vertically, a metric graph paper can be pasted to it or one can use divider and a metric ruler. The laser source is a semiconductor laser with a wavelength 690 nm. The transmission grating can be standardized (number of lines/m) with HeNe laser. Instead of lycopodium powder, blood sample can be used after it gets clotted on a glass substrate. The Airy pattern that is photographed is of a blood drop smeared on the microscope slide. See Fig. 3.

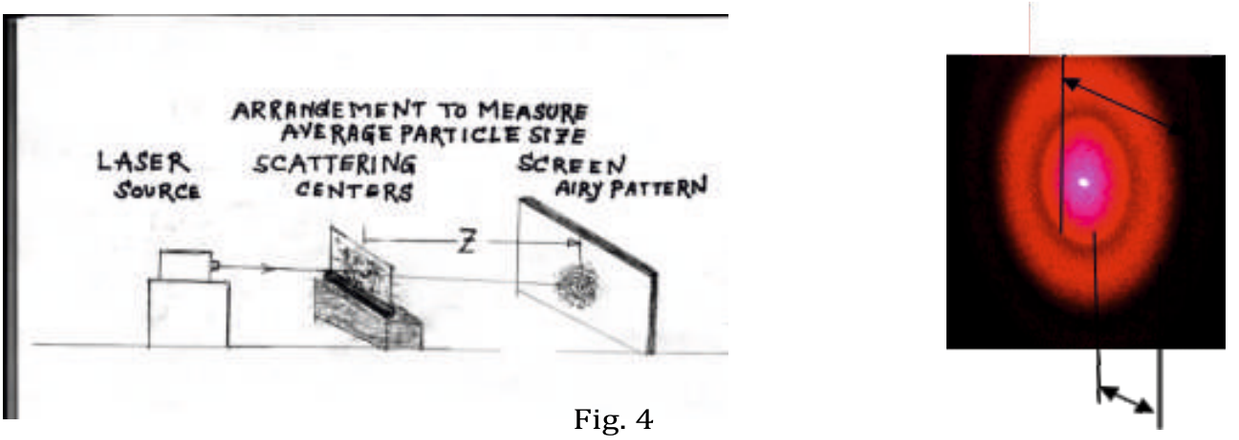

Fig. 4

ACKNOWLEDGEMENT:

The author acknowledges the encouragement of the Chairman, Vice Chairman of Vinayaka Missions University and the Principal of VMKV Engineering College.

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Online Lecture Series

(July 2021)

A series of Lectures on Topics of interest to School and college Physics Teachers was organised online by the RC-01 (Delhi & Haryana) during the pandemic. The lectures were delivered by eminent Physicists of the country. Each programme started at 11 am and consisted of one hour lecture followed by 30 minutes of Question & Answer session. The common features of all the events were that each event was started by Dr. Poonam Jain as moderator followed by an introduction about IAPT and its activities by Dr M S Bhandari, Secretary, (RC1). Thereafter the distinguished speaker was introduced by Prof V P Srivastava, President, (RC1). During 24th July programme, we had the honour of having Prof Ajoy K Ghatak, President, The National Academy of Sciences, India (NASI), as Chief Guest and he introduced the speaker, Prof. Amitava Raychaudhuri. Given the large number of questions and the time available for the Q & A session, the Q & A session was coordinated by Dr. Yogesh Kumar, EC member of RC1. Each event ended with a vote of thanks.

During 3rd July and 17th July events, the vote of thanks was proposed by Dr. Seema Vats, EC member of the IAPT. The 10th July event was graced by Prof J S Rajput, Former Chairman, NCTE and Former Director, NCERT, and the vote of thanks was proposed by Shri R K Tiwari, Vice President of the RC. During 24th July event, the vote of thanks was proposed by Dr. Poonam Jain, EC member of the RC.

Each programme was hosted via zoom platform. It was compeered by Dr. Poonam Jain and managed by Webinar team comprising Dr. Yogesh Kumar, Dr. Poonam Jain and Dr. S.K. Singhal, treasurer. The programme was live-streamed through YouTube and Facebook for participants who could not enter the zoom room. After the programme, video of each event was uploaded on YouTube for benefit of students and teachers to access it anytime after the event. As the event was conducted online, each programme was attended by teachers and students of School, Colleges, Universities/Institutions from all over India, with even some participants from abroad.

All the lectures can be accessed on YouTube under account,"iaptrc1"

Lecture 1

July 03, 2021 Venue : Zoom Platform
No. of Participants (Registered): 786

Topic: Revisiting the Laws of Thermodynamics

YouTube link:
http://www.youtube.com/watch?v=LFxuHT8A_YA

Speaker: Prof. Rajaram Nityananda ,Azim Premji University, Bengaluru (Former Director, National Centre for Radio Astrophysics, TIFR, Pune and TIFR Centre for Interdisciplinary Sciences, Hyderabad)

Prof. Rajaram Nityananda started his talk with an analogy that Thermodynamics deal with the nature in same way an accountant deals with the economy. While explaining the first law of Thermodynamics he said that the internal energy is not heat and it depends on temperature. In Thermodynamics we talk about work, and deal with average force and average displacement.. Giving another analogy he said that internal energy is like bank account balance, and work done and heat energy are like transactions. Then he explained the state function and path function by the analogy of climbing a mountain. He explained, in detail about the Reversible engine with the help of well-drawn diagrams and simulations. In a simple way, he further explained the zeroth law, temperature, thermal equilibrium, and entropy. And finally, he explained the Irreversible process in detail with the help of diagrams.

Lecture 2

July 10, 2021 Venue : Zoom Platform
No. of Participants (Registered): 740

Topic: Hidden Symmetry in Planetary Motion.

YouTube link:
https://youtu.be/nsdkDPZz1I4

Speaker: Prof. Venkataraman Balakrishnan
Adjunct Professor of Physics, IIT Madras

Professor Balakrishnan started with the Kepler's Laws. He gave the consequences of Angular Momentum Conservation stating that we have four constant of motions, one is total energy (Hamiltonian) and others are Cartesian coordinates L_1 L_2 L_3 of angular momentum. He explained Kepler's 2nd law, which is angular momentum conservation, therefore it is valid for every central force.

He then discussed Kepler's 3rd law which is specific to $1/r^2$ force and when it comes to solve the differential equation for the orbit which is most easily derived by realising that there exist another constant of motion and a vector called "Laplace-Runge-Lenz" vector. And in this we have three constant of motion A_1, A_2, A_3 along with the H, L_1, L_2, L_3. So in total we have 7 constants of motion. He explained the 6 phase of particle in which dynamics really occur and the point representing the state of particle in the phase chooses its own trajectory called as phase trajectory. He then explained the equation and shape of orbits with the help of Kepler's First law. After that he explained planetary motion in momentum variables which was somewhat different to know.

He said that the projections of 6-dimensional phase space onto position space and momentum space have simple curves and explained with a diagrammatical representation. He said that all the different orbital orientations are possible for given E&L value and explained this further with diagrammatic representation in a very lucid way.

He said "The Kepler's problem has a different hidden symmetry" and explained the Symmetry of a dynamic system and explained the difference between Classical mechanics and Quantum mechanics. Then he mentioned that there exists a deep connection between Symmetry, invariance and Conservations laws. For symmetry concern he preferred a Hamiltonian version of NOETHER'S THEOREM. He gave a quick overview of Hamiltonian dynamics. He said that 2n dimensional phase space of a Hamiltonian system has a very simple mathematical structure called a "symplectic structure". He explained Rotations from one orbit to another orbit of same E&L.

Lecture 3

July 17, 2021 Venue : Zoom Platform
No. of Participants (Registered): **510**

Topic: Scaling and power laws in the natural sciences and beyond
YouTube link:
http://www.youtube.com/watch?v=KP2oK8jotsI
Speaker: Prof. Venkatraman Balakrishnan
Adjunct Professor of Physics, IIT Madras

Prof. Balakrishnan started by recapitulating what we know about nature in terms of orders of the magnitude of the physical parameters. He quoted that "Nature's Canvas is vast beyond our imagination". The smallest length is Planck length and the smallest time is Planck time. He said that our bare senses could be extended by using the instruments like microscopes, Hubble telescope, etc. and the mathematics. He explained the Power Laws and its interdisciplinary applications. Then He described Gutenberg-Richter Law which is used to tell the number of earthquakes of given magnitude. He explained how simple concept of dimensional analysis can be used to describe many interdisciplinary phenomena. For example, G.I. Taylor estimated the energy of nuclear yield from newspaper picture by using the dimensional analysis and his result were very near the original one. He explained how scale invariance can yield dynamical information by applying it on Kepler's Law. Very lucidly Prof. Venkatraman explained why height that animal can jump is independent of its size. He described the scaling in thermodynamics. Extensivity and scaling are powerful properties in thermodynamics and statistical physics. He emphasized that the stability of matter is a consequence of Quantum mechanics. He described the scaling in meteorology and explained how the fact that perimeter is related to square root of area can be used to predict the sizes of clouds. In the last he concluded that the Scale invariance property is a very powerful tool for analysis and understanding of various phenomena and situations.

Lecture 4

July 24, 2021 Venue : Zoom Platform
No. of Participants (Registered): 594

Topic: THE MASS of SMALL THINGS

YouTube link:
http://www.youtube.com/watch?v=3IamfEzMQLA

Speaker: Prof. Amitava Raychaudhuri Professor Emeritus, Department of Physics, University of Calcutta (Former Palit Professor of Physics, University of Calcutta, and Former Director, Harish-Chandra Research Institute, Prayagraj (Allahabad))
Prof. Ajoy K Ghatak introduced Prof. Raychaudhuri. Prof. Ghatak said that it was a singular honour, privilege and pleasure to introduce the speaker of today's talk, Prof. Raychaudhuri. Prof. Ghatak said that, the clarity of his presentations, the rigor of his talk, the systematic way he proceeded in his lectures, the empathy he had for students, and his sense of fairness were noteworthy.

Dr. Amitava Raychaudhuri started the talk with the basic definition of mass. He then explained that mass of any particle or object exists due to interactions. After a brief explanation of the Standard Model and the elementary particles, he then explained the force mediators along with the reasons for the gluons and photons to be massless. He then talked about Peter Higgs' paper and mechanism..

After that, Dr Raychaudhuri took us into the world of Neutrinos where he moved on to talk about the properties and a series of Nobel winning physicists and in fact, chemists who performed experiments proving that the solar neutrinos change their type to Muon Neutrinos from Electron Neutrinos while travelling. Prof. Raychaudhuri, in the later part of the discussion also mentioned dark matter, dark energy, expansion and the composition of our universe.

At the end, he motivated us to pursue research by telling us about the loose ends like quantum gravity, neutrinos,

Poonam Jain (Sri Aurobindo College, DU)
Yogesh Kumar (Deshbandhu College, DU)

REPORT

Webinar on
Science: Fiction to Reality

Venue: Department of Physics, DAV College, Bathinda (Punjab)
Date: August 5, 2021 **Time:** 04:15 pm-05:30pm
Beneficiaries: 58 (School Teachers)
Resource Person: Dr Jaswinder Singh (EC member RC-2).
Anchor: Prof. Harpreet Kaur Brar
The department of Physics of DAV College Bathinda under DBT STAR College Scheme and in association with (RC-2) organized a webinar on "Science: Fiction to Reality" on 5th August. The resource person on the occasion was National Awardee Dr. Jaswinder Singh Shiksha Rattan (EC member, RC-2). He is also winner of Malti Gyan Peeth award as science educationist. He is well known personality in the region and also the innovator of one of its kind Science-Mathematics lab on wheels in his personal car – "Jaswins Science and mathematics lab on wheels". Dr. Gurpreet Singh, Head, Department of Physics Introduced the speaker.

The webinar was aimed at enhancing teaching skills of science teachers. The expert demonstrated various basic concepts in science with the help of objects from daily life. He emphasised on making science learning more interesting. The webinar was attended by 58 teachers of various educational institutions. Dr. Vikas Duggal proposed the vote of thanks.

Kulwinder Singh Mann
DAV College, Bathinda

NATIONAL GRADUATE PHYSICS EXAMINATION (NGPE-2022)

Conducted by

INDIAN ASSOCIATION OF PHYSICS TEACHERS

Registered Office : 206, Adarsh Complex, OPR 4, Awas Vikas-1, Keshavpuram, Kalyanpur, Kanpur - 208017
Web: www.indapt.org (Regd. No. K 1448)

Day, Date & Time of Examination SUNDAY, January 23, 2022
TIME : 10.00 AM to 1.00 PM

Last Date for Enrolment : 17th November 2021

Eligibility for Appearing in NGPE-2022 : Students of BSc I, II and III (Pass, Hons. or Integrated) are eligible. (Any one who has already passed B.Sc. is NOT eligible)

Exam Information :

Enrolment Fee - ₹ 150 (Rupees One Hundred & Fifty Only)
Language for NGPE - English, Hindi, Gujarati, Tamil, Telugu or any other language if 100 or more Students opt for it.

Format for NGPE :

Part A : 25 MCQs with any number of options (1, 2, 3 or all 4) may be correct. Credit is given only if all the correct options are marked (6 marks each; Total 150 marks)
Part B1 : 10 Short Answer (5 to 6 Lines) Questions (5 marks each; Total 50 marks)
Part B2 : Ten Problems (10 marks each ; Total 100 marks)

Unique Features of this Examination :

- Students can apply online on indapt.org as well as through centre.
- Fully voluntary examination in a stress free environment.
- Carry away the question paper both part A and part B.
- It provides Individual's own assessment at all India level.
- Same paper for all BSc I, II and III Year Students with separate national merit.
- Solutions in printed form are provided to Centre In-Charge for each participant.
- The only national level examination testing students in both theory & experiment.
- Previous Year (2021) Question Paper & Solution for every centre registered for NGPE - 2022.

CERTIFICATES AND AWARDS IN NGPE - 2022

(Cash Award will be released only if the candidate continues higher studies in Physics)

NGPE-2022 Awards

TOP 10% at Each Centre	:	Centre Topper Certificate
TOP 1% at State Level	:	State Topper Merit Certificate
TOP 1% at National Level	:	National Topper Merit Certificate + Book Prize
Top 5 Students in India	:	Merit Certificate + GOLD MEDAL + ₹ 20,000/- Cash Award

- Top 25 will be eligible for appearing in NGPE Part-C Examination - 2022 (an examination in experimental skill) for final selection for GOLD MEDAL and one time Scholarship (Max. 5 in Number) worth ₹ 20,000/- for pursuing higher studies in Physics. TA is paid and free lodging arranged.
- Top 25 will have eligibility for an interview for Admission in Post - B.Sc. Integrated Ph.D. Programme in Physical Sciences 2022 of S N BOSE NATIONAL CENTRE FOR BASIC SCIENCES, KOLKATA, (Only BSc III year students with more than 60% Marks)
  For more details must see website - http://bose.res.in/admission.htm or write email to admission@bose.res.in
- May get opportunity to attend one week EXPERIMENTAL PHYSICS WORKSHOP organized by IAPT AT KOLKATA (Regional Council - 15). TA is paid.
- Top 5 to 10 students of B.Sc. First year (of University 3Yr System) shall be eligible to participate in prestigious NATIONAL INITIATIVE FOR UNDERGRADUATE SCIENCE (NIUS) program of Homi Bhabha Center for Science Education, TIFR, Mumbai. (This is A Govt. of India, DAE Program organized at Mumbai).
- Top 20 students of B.Sc. I appearing in NGPE-2022 may get an opportunity for two weeks Academic Workshop on Basic Physics at IIT Guwahati (Preferably for those from University 3-yr B.Sc. System)
- Some more programmes for toppers may be declared later.

To obtain previous Ten Year Question Papers with complete solution deposit / transfer Rs. 150/- (One hundred fifty only) per set in IAPT account as per Bank details : Name of the account: Indian Association of Physics Teachers, Name of the bank : Central Bank of India, Branch : DBS College, Dehradun - 248 001, Account Number : 3750324900, IFSC Code : CBIN0283283. Then write a mail to iaptddn@gmail.com

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Quantum Physics Simulations Using Gnumeric Worksheets

Online Faculty Development Programme (FDP)

Jointly Organised by
Central University of Himachal Pradesh (CUHP) and
Regional Council-03(Chandigarh-HP)
(August 01-07, 2021)

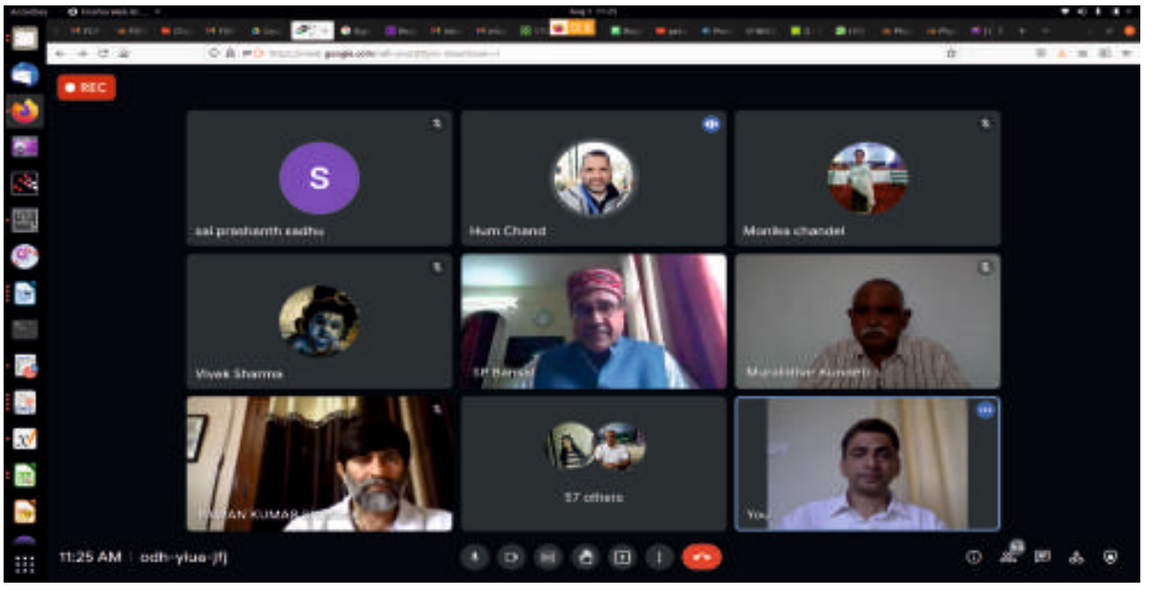
The IAPT-RC3 in association with Central University of Himachal Pradesh (CUHP) organised an online Faculty Development Program (FDP-2021) from August 01-07, 2021. The convenor, Prof. O.S.K.S. Sastri, Vice-president of IAPT-RC3 welcomed the participants and stated the main objectives of the FDP as

- To provide some new perspectives of Quantum Physics by eminent professors during the morning sessions from 11 am to 1 pm
- To introduce the UG faculty to perform simulations in quantum mechanics (QM) using Gnumeric, a free open source software. These are part of the afternoon session from 3 pm to 5 pm.

Prof S. P. Bansal, Hon Vice-Chancellor of CUHP graced the inaugural function of the FDP and emphasised the need to quickly adopt the new education policy (NEP) and the importance of introducing skill sets in students by giving them opportunities for multiple entry- multiple exit and academic bank credit systems so that they are industry ready.

The key-note address was delivered by Prof. R.C. Verma, Professor Emeritus, Patiala University. He gave the audience a two hour treat with an overview to Quantum physics by delving into need for quantum ideas, its postulates, degeneracy and its breaking in Hydrogen atom, importance of relativistic quantum mechanics and quantum field theory and finally deliberated on the epistemological interpretations.

In the afternoon session, Prof. O.S.K.S. Sastri gave a detailed presentation of the four stage process of simulation methodology for effectively engaging the students in computer simulation labs associated with quantum mechanics, statistical physics, molecular and nuclear physics. This was followed by a demonstration for solving time independent Schrödinger equation (TISE) for infinite square well potential using central divided difference (CDD) technique in Gnumeric, a free open source software, by Mrs. Sapna Verma of RKMV college, Shimla.



The following eminent speakers delivered insightful lectures as part of the FDP:

1. Prof P.K. Ahluwalia, retired professor from HPU (Shimla), spoke on nine different quantum mechanics formalisms from well known wave mechanics, ladder approach and matrix mechanics to more advanced path integral and Wigner distributions, along with their relevance and applications to various domains of physics.
2. Prof H.S. Mani, Chennai Mathematical Institute deliberated on the role of weak measurement in modern quantum physics by taking an example of spin-half system.
3. Prof C. Nagaraja Kumar, IAPT-RC3 President and Professor in Panjab University, presented insights into super symmetric quantum mechanics approach to iso-spectral rearrangement of information and its applications to a variety of non-linear physics problems.
4. Prof V. Balakrishnan from IIT Chennai discussed the particle in a box as a basic paradigm in quantum mechanics and stated that nanowires, quantum corals and quantum dots were good examples of such a system. Through the various 1D, 2D and 3D problems, he illustrated several aspects of QM such as stationary states, uncertainty relations, eigenvalues, eigenfunctions, orthonormality, completeness on the one hand and the role of boundary conditions, symmetry, dimensionality, compactness of the space, etc on the other.
5. Prof V. Muralidhar, retired from National Defence Academy, Pune took the participants on a journey into how to approach quantum mechanics from a classical point of view. He started with difficulties in various interpretations of quantum mechanics and introduced stochastic electrodynamics as classical electrodynamics coupled to electromagnetic zero-point field. Then he presented a quick introduction to geometric algebra and complex vector space, a mathematical formalism invented by him to explain how spin converts a classical harmonic oscillator into a quantum oscillator.
6. Prof. Peter Cameron, retired from National Brookhaven Laboratories, USA, in his presentation gave a new perspective with an introduction to quantum impedance model. He began with concept of photon impedance matching with electron impedance in Hydrogen atom and then introduced the idea of vacuum wavefunction in geometric algebra that leads to S-matrix of Dirac's QED. With many model outcomes such as origin of inertial mass, unstable particle spectrum in particle physics, gravitational mass, chiral anomaly, etc.

The afternoon sessions were devoted to introduction of various numerical methods by Prof. O.S.K.S. Sastri and the demonstrations in Gnumeric were done by members of PERSON (physics education research scholars online network), an initiative of IAPT-RC3. The following topics were covered during these sessions.

1. Dr. Sunil Bansal (PU, Chandigarh) -introduction to solving harmonic oscillator using Numerov matrix method (NMM),
2. Dr Pawan Kumar Sharma from Government College, Solan – solving harmonic oscillator problem using matrix methods with sine basis (MMS) in Gnumeric.
3. Dr. Vikram, G.G. S.D.College, Chandigarh - Solving Coulomb potential using both CDD and NMM.
4. Prof. O.S.K.S. Sastri - solve Morse potential using NMM and MMS.
5. Dr. K. Vijay Sai, Sri Sathya Sai Institute of Higher Learning outlined how to solve for neutron and proton single particle energies using Woods-Saxon potential by implementing NMM in Gnumeric.

A total number of 40 participants, from across the country, successfully completed the FDP.

OSKS Sastri
Convener

REPORT

Celebration of Einstein's Nobel Prize Centenary year

(June 27- July 16, 2021)

Samadhan IAPT Anveshika Pilibhit (UP)

Samadhan IAPT Anveshika Pilibhit organized online quiz on 13th of June and webinars were organized on 27th of June, 12th, 13th and 16th of July 2021 for the students of different schools. 1132 students and teachers participated in quiz, while a total of 232 students participated in webinars.

The event commenced with a song "cycle hai hamara jeevan, Einstein ka hai yeh kathan" followed by brief introduction of IAPT from Dr Sundar Singh, Secretary RC- 4. He apprised the audience about the activities undertaken by IAPT. Coordinator Mr Luxmikant Sharma gave a brief introduction about the webinar and said that we can draw inspiration from the life of the great Scientist, Einstein. Resource person Munender Pal Singh from Kendriya Vidyalaya, Pilibhit gave an interactive presentation regarding struggle of Einstein's life, from his childhood to obtaining the job of a clerk in patent office and how he used his spare time in publishing theories that changed the scenario of Physics.

Resource person, Mr Ajay Sharma from MB Inter College, Bareilly demonstrated production of charge by friction, conduction and induction and Photoelectric effect using ultraviolet light and electroscope. Participation of students and speed of answering, the interest and excitement was worth seeing. A number of secondary level teachers also participated in these activities.

Principals of host institutions proposed the vote of thanks to participants and resource persons and appreciated the efforts RC.

Sundar Singh

35th Annual IAPT Convention- 2020

ANNOUNCEMENT

35th Annual IAPT Convention- 2020

& National Seminar

Innovation in Physics Teaching and Research

Shri Vaishnav Vidyapeeth Vishwavidyalaya, Indore and Indian Association of Physics Teachers (IAPT), RC-09, Madhya Pradesh are jointly organizing 35th IAPT National Convention -2020 and National Seminar during **November 28-30, 2021** at Shri Vaishnav Vidyapeeth Vishwavidyalaya. Indore. The EC meeting will be on 28 Nov.2021.Details will be announced in time later on.

Uttam Sharma
Convener
Prof & Head, Department of Physics
SVVV, Indore, Mob. 9826212353

Election Notification

The Regional Councils (RCs) and Sub- Regional Councils (SRCs)

Nominations are hereby invited from the life members of IAPT for the RCs of their respective regions for the following posts for the term, January 01, 2022 to December 31, 2024.

President - 1

Vice–President - 1

Secretary - 1

Treasurer - 1

Members: 05

Please submit your nomination to reach the Returning Officer of your respective Region, so as to reach the RO, on or before October 15, 2021.

The Proforma for the nomination is the same as published on **page no. 298** of the August 2021 issue of the IAPT Bulletin, except for one change, viz., the relevant RC number is to be inserted in place of 'EC'. The Proforma is also available on our website ***www.indapt.org.***

Region- wise list of ROs along with their address, contact number and email are given below.

Regional Council (States)	**Name & Address of the Returning Officer**	**Communicated By**
RC-01 (Delhi,Haryana)	Shri R. S. Dass Mob. No.: 092503 97704 e-mail: rsgupta_248@yahoo.co.in Address: 49, Sector 4, Vaishali, Ghaziabad-201012	Dr. V.P.Srivastava President email: srivedp@gmail.com Mob: 098735 34750
RC-02 (Punjab, J&K and ladakh)	Prof. Deepak Chopra Head Department of Physics SCD Government College, Civil Lines, Ludhiana-141001 Mob.No. : 9814212059/8360226538 e-mail: deepakchopra67@gmail.com	Dr Rajeev Sharma Secretary email: rajeevsharma@pau.edu Mob: 9417579568
RC-03 (Chandigarh and Himachal Pradesh)	Prof A K Taneja Mob. No. 9878066672 e-mail: arvind_davc@yahoo.co.in Address # 672, Sector- 7, Panchkula, Haryana 134109	Prof. C N Kumar, President, Mob.9872644283 e-mail: cnkumar@pu.ac.in

RC-04 (Uttar Pradesh)	Dr. Anurag Saxena Mobile no. –9839940629 email id: anurag_knp123@yahoo.com Address: Deptt. Of Physics DAV College, Civil Lines, Kanpur – 208 001	Dr. Sundar Singh Secretary, *mob. 9411469145* *e-mail id ssg01bcb@gmail.com*
RC-5 (UttaraKhand)	Prof. B. P. Tyagi Mob: 9837123716, Email id: iaptddn@gmail.com Address: 23 AdarshVihar, Raipur Road, Dehradun – 248001	RO
RC-06 (Rajasthan)	Dr K C Swami. E-mail : kc_swami@yahoo.co.in	-------
RC-07 (Gujarat , Daman,Diu,DNH)	Dr. Kiritsinh B. Zankat Mobile no. - 9427615134 E-Mail:kbzankat@yahoo.com Address:- 4/4, G-1, Sector 20,B/H, Akshardham Temple, Gandhinagar-382020	Prof. Rajshree Jotania Secretary, *Mobile no. – 9427615134* *E-mail:* *rajshree_jotania@yahoo.co.in*
RC-08 (Maharashtra) (Members-02, remaining-03 from Sub-RC's, one each)	Prof. S.Y. Chougule Mobile no. - 9421218658 E- Mail id: - iaptelection21@gmail.com Address:- Red Villa, Sahyadri Colony, Road No.2 , Near Diamond Hall, Urun- Islampur, Tal- Walwa, Dist-Sangli,. Maharashtra 415409	Dr. Shinde Nitin S. Secretary, Mobile no : 9860438208 Email id: secretaryiapt08@gmail.com
SubRC-08B (Mumbai)	Prof.(Mrs.) Kalpana Sule L3131 Mobile no. - 9819720672 E- Mail id: - kalpanasule96@gmail.com Address:- 901, Surya Tower, N M Parekh Marg, Opposite Don Bosco High-school, King's Circle, Mumbai 400 019	Dr Atul Modi President, *mob. :* 7774030403 *e-Email id*atulmody@gmail com
SubRC-08C (Pune)	Dr. U. S. Kakade Mobile no. - 9011286723 E- Mail id: -uskakade@gmail.com Address: - Associate Professor, Department of Applied Science, Government College of Engineering, Awasari, Tal- Ambegoan, Dist- Pune-412 405	Dr. Sandip G. Kakade Secretary, mob. no:9561409730 email id: sgksp189@gmail.com

SubRC-08D (*Kolhapur, Sangli,Satara Ratnagiri and Sindhudurg,)*	Shri ShashikantBhimraoPatil mob. no. -9403156795 e-mail : -sbpatil62@gmail.com Address: Shivshakti, Savarkar Colony, Lane No. 1,Near DandekarHall, Vishrambag,Sangli-416415.	*Dr. Prashant P. Chikode, Secretary (M): 9422408462* *e-mail-* *prashantchikode@gmail.com*
RC-09 (Madhya Pradesh)	Professor S. B. Welankar Mobile No. –9827062492 E-Mail id: sbw62@rediffmail.com Address: -568 Dutt Nagar, CAT Road, Near Rajendra Nagar, Indore	Dr Uttam Sharma Secretary,Mob no.9826212353 E-mail Druttamsharma1971@gmail.com
RC-10 (Chhattisgarh)	Prof Umakant Srivastava ukscvru@rediffmail.com	---------
RC-11(Andhra Pradesh)	Dr.S.Sansi Raju- Mobile no.9440348636– E- Mail id:ssraju_lec@yahoo.com or ssr.lec.132@gmail.com Address:- flot no:g-7,Jewel Paradise apartment Sandipini Nagar,Yendada,Visakhapatnam 530045.	RO
RC-12 (Karnataka)	Dr Aravind H Dyama e-mail: aravinddyama@rediffmail.com	----------
SubRC-12A	Dr M K Raghavendra e-mail: maigurraghavendra@gmail.com	----------
RC-13 (Tamil Nadu, Puducherry)	Prof. G. Markandeyulu Mobile no. - 9444449764 E- Mail id: - mark@iitm.ac.in Address:-Dr. G. Markandeyulu Professor Department of Physics Indian Institute of Technology Madras Chennai – 600 036	N. Harish Kumar Secretary Mob. no: 9003224720 Email id: nhk@iitm.ac.in
RC-14 (Kerala and Lakshdweep)	----------	----------
RC-15 (WB,Sikkim,Andaman Nicobar islands	Dr.Mrinal Kanti Chakrabarti Email id :mkchakra@gmail.com Mobile : 9433826863, 9123847836 Address : 89 Garia Park, Kolkata 700084	RO

RC-16 (Odisha)	Prof Lambodar Prasad Singh e-mail: lambodar_uu@yahoo.co.in	----
RC-17 Assam and Arunachal Pradesh	-Shri Pranab Kumar Das Mobile no. –9864061308 E- Mail id: - dassone22@gmail.com Address: - House No. 06 Col. J. Ali Road C/o. Kamrup Footware Lakhtokia, Guwahati 781 001	Secretary, mobile no: 94350 41524 Email: dekamanab@yahoo.com /dekamanab2020@gmail.com
RC-18 (Tripura, Meghalaya, Mizoram, Manipur and Nagaland)	Shri Malay Bhaumik, L7822 Mobile No. : 9436186483. E – Mail id : mbhaumikblg54@gmail.com Address : Bishalgarh, Tripura.	ParimalMajumdar Secretary, RC – 18 Email id : majumdar2p@gmail.com Mobile no. : 9436454135.
RC-19 (Bihar)	Dr Rakesh Kumar Singh, Head ,Department of Nano -Technology, A K University,Patna Email: rakeshsinghpu@gmail.com	--------
RC-20 Jharkhand	Dr S N Tiwary, St. Xavier's College Ranchi e-mail: shreemantiwary@yahoo.com	----------
RC-21 Goa	Prof.E.S.Kannan Address: Dept.of Material Science , BITS Pilani,KKB Goa Campus, Zuarinagar Mobile No:8805758662 E- Mail id: -eskannan@goa.bits - pilani.ac.in	Prof. R.V. Pai President IAPT -Goa RC-21 Email: rvpai@unigoa.ac.in Mobile No.:9423887806
RC-22(Telengana)	Dr. R.L.N.SAI PRASAD Mobile no. – 9491151070 & 9493462458 E- Mail id: - rlnsaiprasad@gmail.com Address: - Prof. of Physics, NIT, Warangal – 506 004	Dr. V. Rajeshwar Rao President, RC-*22* *Email id:-* drvrr_kitss@rediffmail.com *Mobile no :- 9440555095*

Important dates for the elections to the Regional Councils

Sr. No.	Action	Last date
1.	The nomination to reach the RO of the RC by speed-post/personal – delivery/courier	October 15, 2021
2.	Scrutiny of nomination papers and intimation of valid nominations to the Candidates by the RO	October 22, 2021
3.	List of valid nominations along with recommendations by the outgoing Regional EC to be published in the IAPT Bulletin	November 2021 issue
4.	(a) Last date for the withdrawal of nomination; (b) proforma of the ballot paperto be published in the Bulletin	November 20, 2021 November issue
5.	The list of unopposed candidates, contesting candidates for the RC to be published by the RC-RO in the Bulletin	December 2021 issue
6.	Election, if required, to be conducted as per the bye laws of our Association, around	December 20, 2021
7.	**(a)** All the results to be declared on the website; **(b)** All the results of the Regional EC to be published in the Bulletin	by December end 2021; January 2022 issue

KN Joshipura
General Secretary

The Story of Cosmology through Postal Stamps.... 03

THE ANCIENT ASTRONOMY

THE MEGALITHIC AND NEOLITHIC AGE

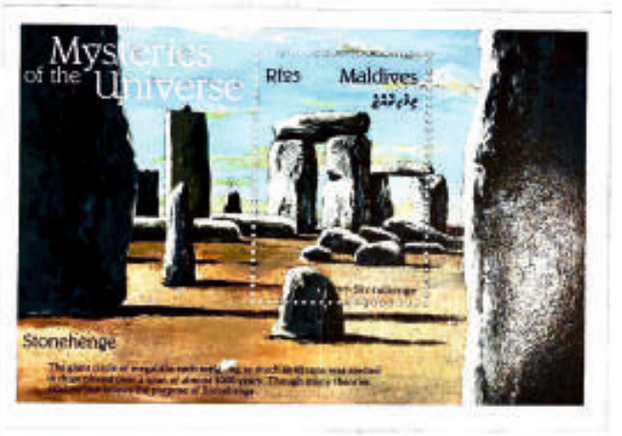
For the ancient civilization, the most striking aspect of the sky was movement of the Sun and Moon, eclipses, Starry sky and lightning. They tried to link their life with the rhythm of these celestial bodies and their appearance

Lightning

Solar eclipse

Amber disc of 3rd millennium BC. The incision is considered to be one of the first Neolithic representation of cosmos. The sequence of points represents solar calendar& four seasons

From the fourth millennium BC onward, megalithic monuments were designed and aligned to track the movement of sun and stars in different seasons to keep account of the time



Stonehenge*-(2300 BC-1300 BC)*
It is a giant stone circle erected in three phases over a span of 1000 years. Probably used for predicting movement of sun as indicator of specific season or time of year.

The megalithic structure of Callanish , Scotland,Ale's Stone in Sweden and Carnac in France , in each of these structure stones are so aligned in the direction of Sun rise and set locally ,on the day of summer Solastice

Callanish -scoctland

Ale's Stones-Sweden

Carrnac- France

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