GYAN-VIGYAN SARITA: शिक्षा

A non-remunerative, non-commercial and non-political initiative to Democratize Education as a Personal Social Responsibility (PSR) 1st Supplementary Bulletin dt 1st May'17 of 3rd Quarterly e-Bulletin

Contents:

- Editorial
- Coordinator's Views
- Conceptual Frame work: Online Mentoring
- Learning Difficulties
- Circles of Influence and Concerns
- > Teaching Water Conservation and Management
- Manipur Inititative Children with Disability
- Fun of Learning
- Learning with my Mentors
- Growing with Concepts:
 - Mathematics : Sequence and Series
 - Physics: Waves and Motions: Part-III
 - Chemistry: Chemical Thermodynamics
- > Quizzes:
 - <u>Crossword Puzzle</u>
 - <u>Solution to Crossword Puzzle- April'17</u> - <u>Science Quiz</u>
 - Answer to Science Quiz April'17
- <u>Invitation for Articles</u>
- An Appeal
- Theme Song

Editor-**शिक्षा** e-Bulletin: **Dr SB Dhar**

Coordinator-ज्ञान-विज्ञानसरिता: Dr Subhash Joshi

Graphics Designer: Devika Mathur

Disclaimer: Views expressed in this bulletin are author's view and ज्ञान-विज्ञान सरिता, Publishers of this bulletin, are not responsible for its correctness or validity.

Rights of Publication

Core Committee of ज्ञान-विज्ञान सरिता reserves right of moderation or publication of a contributions in the e-Bulletin

Address:

#2487, Betina, Mahagun Moderne, Sector-78, NOIDA, Uttar Pradesh, PIN: 201309,, (INDIA).

e-Bulletin – <u>Eco-friendly</u>: It is a considered decision to make this communiqué an e-Bulletin, and thus save paper. May please like to share it but <u>please do not print it</u>, unless it is a must.

Our Website: <u>http://gyanvigyansarita.in/</u> E-mail: <u>subhashjoshi2107@gmail.com</u>

other's Day_ **Education** Mother Of Wellness



Devika.M



... start, without loosing time, with whatever is available.

संपादकीय



विकास : लगातार प्रयास का नतीजा

सभी छात्र-छात्रायें नयी कक्षाओं में आने को हैं। उत्सुकता नये वातावरण की प्रतीक्षा कर रही है। नयी किताबें, नये मित्र, नयी कक्षायें, नयी पाठ्यवस्तु, नया लक्ष्य, और नये मौके सबमें अधीरता पैदा कर रहे हैं। यहां तक की यात्रा, लंबी विकास-यात्रा का एक अंग रही है। ऐसी ही छोटी-छोटी विकास-यात्राओं से जिंदगी संवरती है, और बाद में संकलित होकर व्यक्ति की सफल विकास-यात्रा बनती है।

विकास का अर्थ है : आगे बढ़ना। आगे बढ़ना तभी संभव होता है, जब एक नियम के तहत काम किया जाता है। नियम में होकर काम करना वैज्ञानिक सोच कहलाती है। वैज्ञानिक सोच एक गणितीय नियम है। उसमें एक निरंतरता होती है, समता होती है, मनमानीपन के लिये जगह नहीं रहती है, सोच में जिज्ञासा करना आदत बन जाती है, और उस जिज्ञासा की शांति हेतु तरीके ढूंढ़ने के लिये लगातार प्रयास करना आ जाता है।

हर उन्नति में पुराने को छोड़कर, आगे बढ़ना नियम होता है। बिना पुराने नियमों पर चले, नये नियम नहीं बनते हैं। नया नियम, पुराने नियम में केवल उनकी कमियां दूर करना भर होता है। किसी सीढ़ी पर चढ़ना तभी संभव होता है जब सबसे नीची पायदान मजबूती से आधार को पकड़े रहती है। एक पांव आगे बढ़ाने के लिये दूसरे पांव को मजबूती से रखे रहना पड़ता है। जिस प्रकार प्रेम, स्नेह, और श्रद्धा जैसे मानवीय गुण मनुष्य में अपने आप पाये जाते हैं और उन्हें सीखना नहीं पड़ता है, ठीक उसी प्रकार जिज्ञासा को शांत करने के तरीके तलाश करना भी सिखाना नहीं पड़ता है।

विकास बैठकर नहीं होता है, बल्कि कुछ करने से होता है। विकास चलते हुये, रास्ते में आने वाले अवरोधों को दूर करते जाने से होता है। पहिये की खोज, दिन और रात का ज्ञान, बीमारियों से लडाई, जड़ी-बूटी की खोज, लिवर-पुली का आम जीवन में उपयोग, तीर-धनुष से आधुनिक हथियार तक का आविष्कार, दूरबीन से टेलिस्कोप तक जाना, कलम-दवात-कागज से कम्प्यूटर-प्रिंटर तक आना, अथवा आनुवंशिकता सिद्धांत से भविष्य बता देना, आदि लगातार प्रयास के नतीजे हैं।

विकास, अध्ययन और आकलन पर आधारित होता है। आकलन, प्रयासों की ऐतिहासिक विरासत होती है। हमें हमेशा विरासत को संजोकर रखना चाहिये। प्रश्न पूछने की कला, ज्ञान बढ़ाने की आधार शिला है। नये प्रश्नों को पूछना ही, नयी संभावनाओं को तलाश करना है। नयी संभावनायें, नये दृष्टिकोण से आती हैं। नया दृष्टिकोण, हमारे अंदर की रचनात्मकता से पैदा होता है। रचनात्मक होने का साधारण नियम है कि अगर हमारे सिद्धांत में हमारे तर्क सही नहीं बैठ रहे हैं, तब हमें अपने तर्को को बदल देना चाहिये। बदलाव की आदत, जीवन-पद्धति का अंग बनने पर रचनाशक्ति पैदा करती है। विकास, यथार्थ होता है। भ्रम की स्थिति से आगे बढ़ जाना समझ की ओर जाना है। हम सब जानते हैं कि पदार्थ के बिना गति नहीं होती है और गति के बिना पदार्थ नहीं होता है। गति स्वंय एक अंतर्विरोध है। ठीक यही प्रक्रिया विकास के क्षेत्र में लागू होती है। जब हम ज्ञात और अज्ञात की बातें करते हैं, तब हम पाते हैं कि आज का अज्ञात, समय के साथ कल का ज्ञात बन जाता है लेकिन तब तक एक नया अज्ञात आ चुका होता है। अज्ञात की खोज, अज्ञात संभावनाओं को सोचने से होती है। सोचने से दिमाग का विकास होता है और दिमाग की खूबी है कि वह कभी भी अपनी विकसित अवस्था से पीछे नहीं सिकुड़ता है, बल्कि और आगे ही फैलता जाता है।

सोचना, दिमाग की आदत है। सोचने से दूसरों की विचारधारा को समझा जाता है। आइंसटीन, कोपरनिकस, गैलीलियो, ब्रूनो, आदि ने अपनी खोजों को अपने समकालीन वैज्ञानिकों के साथ अनेक बहसों के माध्यम से आगे बढ़ाया और परिणाम हुआ कि वे सबके सब, ज्ञात की सीमा को लांघ गये। डार्विन की खोजी यात्रायें, गैलीलियो का अपने जीवन के एक बड़े हिस्से को आसमान ताकते हुये बिता देना, यूरेका-यूरेका कहते सड़क पर आर्कमिडिज का दौड़ जाना, इसी सीमा को लांघना था।

आंखें बंद कर लेने से न दुनिया खत्म होती है और न ही समस्यायें हल होती हैं। प्रतिभायें यदि विचारधाराओं से प्रेरित नहीं हो पाती हैं तब वे अराजक दिशाओं में भटकने लगती हैं और विकास से उनका कोई लेना-देना नहीं रह जाता है। अतः आज की आवश्यकता है कि हम प्रतिभाओं के लिये अवसर तलाशें, और उनका उपयोग समाज और देश के विकास में करें।

विकास की भारतीय सोच, विश्व की प्राचीनतम परंपरागत सोचों में से एक है। भारतीय मनीषियों की सोच प्रारंभ से ही वैज्ञानिक तथ्यों पर आधारित रही है। हमारे यहां विज्ञान का अध्ययन ईसा से करीब 3000 वर्ष पूर्व शुरू हुआ। हड़प्पा और मोहनजोदड़ो की खुदायी से प्राप्त सिंधु घाटी के प्रमाणों ने यह सत्य प्रमाणित कर दिया है कि माप-तौल का उन्हें ज्ञान था, और परिवहन के लिये बैलगाड़ी का प्रयोग होता था। वैदिक काल के ग्रंथों में मानव-शरीर के सूक्ष्म अंगों के बारे में जानकारी को पढ़कर ऐसा विश्वास करना आसान हो जाता है कि उस समय शव-विच्छेदन-प्रक्रिया की जानकारी थी। गणित और ज्योतिष में तो हमें महारथ हासिल ही थी। इसी काल के एक ऋषि मेधतिथि थे। उन्हें 10¹² तक की बड़ी संख्याओं का ज्ञान था। वे अपनी गणनाओं में 10 और उसके गुणकों का उपयोग करते थे।

आइये, अपने प्रतिभा संपन्न अतीत के छाये में हम सब और आगे बढ़ें, *ज्ञान विज्ञान सरिता* के माध्यम से विकास का रास्ता दिखाने वाले बनें, और इस रास्ते पर चलते-चलते अपने चारों ओर के लोगों का भविष्य संवारें।

-00-

All that I am or ever hope to be, I owe to my angel Mother. – Abraham Lincoln

An Appeal: Gyan Vigyan Sarita A non-organizational initiative of a small set of Co-passionate Persons

Philosophy: Personal Social Responsibility (PSR)

Objective: Groom competence to Compete among unprivileged children from 9th-12th in Maths and Physics, leading to IIT-JEE.

Financial Model: *Zero-&-Fund-Zero-Asset* (*ZFZA*). It calls for promoters and facilitators to provide infrastructure for use to the extent they feel it is neither abused nor there is a breach of trust. And, reimbursement of operational expenses to the participators

Operation:

- a. **Mode:** Online since July'16, using Google Hangouts, a free we-conferencing S/w, with connectivity upto 15 nodes.
- b. **Participation:** Voluntary and Nonremunerative, Non-Commercial and Non-Political

Involvement:

- a. As Promoter
 - i. Initiate a Learning Center,
 - ii. Sponsor a Mentor who is willing to join on certain terms,
- iii. sponsor cost of operation and up-gradation of infrastructure to voluntary mentors,
- iv. Sponsor Website.
- b. As Facilitator
 - i. Provide space and infrastructure for **Online Mentoring Sessions (OMS)**, which is generally available, with a marginal add-on,
 - ii. Garner support of elite persons to act as coordinators at a Learning Centre.
- c. As Participator -
- i. As a Mentor,
- ii. As Coordinator,
- iii. As Editor and or contributor of thought provoking articles for e-Bulletin, which are relevant to the initiative, and make it more purposeful and reachable to the target audience.
- iv. As author of Chapters for Mentors' Manual, being uploaded as a Free Web Resource,

- v. Anything else that you feel can add value to the mission and make it more purposeful.
- vi. Anything else that you consider to make this initiative to become more effective.

Background: The initiative had its offing in May'12, when its coordinator, a power engineer by profession, soonafter submission of Ph.D. Thesis in April'12, at IIT Roorkee, at the age of 61 years, decided to mentor unprivileged students.

SARTHAK PRAYASH, a Ghaziabad based NGO, warmly accepted the proposition and created a facility to mentor students from 8+ to prepare in mathematics and physics and prepare them for engineering entrance tests. They warmly reciprocated and created a class room.

Experience in this selfless social work were used to navigate across without losing focus. He was associated with SUBODH FOUNDATION from Sept'15 to Sept'16 during which he published a monthly e-Bulletin **SUBODH-पत्रिका** to create visibility across persons who could make a difference.

In Sept'16, post transition, the mission has been continued as a non-organizational entity Gyan Vigyan Sarita, with a set of Four persons, including retired Prof. SB Dhar, Alumnus-IIT Kanpur, a middle aged Shri Shailendra Parolkar, Alumnus-IIT Kharagpur, settled at Texas, US and Smt. Kumud Bala, Retired Principal, Govt. School Haryana. Earlier, they were complementing the OMS. While, the initiative survived transition. website: a http://gyanvigyansarita.in has been launched. It contains under its Menu: Publication>e-Bulletins, and >Mentors' Manual. You may like to read them.

Actions Requested: May please like to ponder upon this initiative. Queries, *if any, are heartily welcome*. We would welcome your collective complementing in any of the areas listed at **Involvement**, above, to make the mission more purposeful and reachable to target children.

. -00-

Page **5** of 50 1st Supplement dt. 1st May'17 to 3rd Quarterly e-Bulletin: Gyan- Vigyan Sarita: शिक्षा



Coordinator's Views

EDUCATION : MOTHER OF WELLNESS

Mother is a person which cares her child till he reaches a stage of self-supporting in his environment to live with, yet her care for the child does not end till her last breadth. Every person howsoever accomplished or humble may be, would subscribe to these views; unless events were not against him to deprive Mother's time.

In certain part of India, specially Maharashtra, GOD, Saints, Guru and those who take care of wellbeing of others are called "मावली" a connotation prevalent for MOTHER. It is an extremely selfless, pious and indiscriminative character independent of gender. One would hardly find a mother un-perturbed with any child in pain or trouble. Mother, is most wonderful creation of GOD. On Mother's Day falling on 14th May, during this month, it was considered to be apt to contextually introspect our mission - Democratize Education with special emphasis on unprivileged children.

Every child, be it a prince or beggar, general or soldier, elite or criminal has a mother. It is relevant to recall a quote of Tenneva Jordan - A mother is a person who seeing there are only four pieces of pie for five people, promptly announces she never did care for pie.

Having a mother or being a mother is natural to one's existence. But, education is not; it is a systematic process of catalyzing learning, transforming into a persons who while living for self is able to look beyond, analyze, decide and able to perform. This performance is a matter of role entailed upon one's position and place. It is pertinent to remember that no role is exclusive; each is complex, integrated and interdependent. This makes education different from a self-centered commodity. Educational transformation in an individual creates an insight into individual accountability to ensure that results reap, rather than just remain demanding. This accountability, towards larger good, is inclusive of maximum benefit, minimum harm or damage, and sustainable growth. Relating education to passing of an examination, securing high percentage of marks, getting admission, job, package, and powerful position are extremely narrow perspective on education and are characteristics to a person who is highly selfish and unable to think beyond.

Education is like growing a generation, and in this context quote of Confucius is relevant- "*If you think in terms of a year, plant a seed; if in terms of ten years, plant trees; if in terms of 100 years, teach the people.*" It is important to appreciate that education is a dynamic process, it depends upon, awareness, preknowledge, relevance, and yet, it is elemental. The elementary nature of education provides basic instinct to look beyond in a logical and consequential manner. If education is unable to open up the thought process from the confinement of rules, traditions, methods, dogmas, hatred and cruelty, then certainly it is suffering from aberrations and needs an urgent action of revamping.

In this journey in last five years we have experienced people with varied approach, motives and take away. Nevertheless, it is exciting to cite a news flash from Shri Anurag Choudhary, CEO, Zila Parishad, Jhabua that 55 tribal students from Government Coaching have cracked IIT-JEE, results of which were declared less than an hour ago. Shri Anurag Choudhary, a young dynamic IAS, is an alumnus from IIT Kanpur and is making special efforts to promote and groom students from the Tribal Belt to be able to compete at highest level. Honestly, we have no contribution in success of the initiative and the students. This endeavour is supported and encouraged by Shri Ashish Saxena, IAS, District Magistrate whom we have approached to collectively complement and intensify the efforts through Online Mentoring of unprivileged children. This news flash came to us when this column was being written, and it creates an optimism that there are people who think alike, and it is also vouched based on articles received for this e-Bulletin. All that it requires is to exercise patience to come across such persons who can collectively make a difference.

Education is, and has to be indiscriminative, objective and selfless. It must empower a person to judge between right and wrong, desirable and essential, necessary and compulsory. There is difference between learning, knowledge and education, which are more often confused than not. There are certain natural instincts which are not to be taught. Every person by birth is inquisitive but, innovator, discoverers, path breakers, trend setters and reformers are few. Law of Inertia states that everybody tries to occupy position of least potential, and with all inquisitiveness this law is also applicable to human behavior. There could be differences in learning of students, knowledge and education. Ashlesha, in her article has cited *Learning Deficiencies* and *remedial measures* and there are quite a large number of cases which deserve special attention. Yet, really the number is small in proportion, and, therefore, it would amount to natural injustice, if they are deprioritized simply on a count. But, there are a large number of students who reel under their socio-economic-cultural constraints. Such children, despite governments efforts and claims, remain outside sphere of influence of passionate and dedicated teachers who could incite in them a dream, an urge and a need to work hard to accomplish it. As a result these children continue to suffer from lack of ability to sustain the kind of continuity, consistency and opportunities which could change their fortunes. **Dr. Bheem Rao Ambedkar** whose journey of life and accomplishments are exemplary had said "*We may forgo material benefits of civilization, but we cannot forgo our right & opportunity to reap the benefits of the highest education to the fullest extent.*" This is the objective of Democratization of Education, eradication of educational inequality, which is rampant.

Children of accomplished persons study in most coveted schools. They get specialized coaching and tuitions from most celebrity teachers. Despite, success rate and ROI of these students in competitive examinations like JEE, is found to be very low. Nevertheless, a highly commercial environment prevalent in education renders opportunities to learn, grow and perpetuate in them a commercial culture which has entailed them this fortune. This is nothing but drifting of education from a process of reforms to a commodity available at cost for those who can afford.

Swami Avdheshanand Giri, in one of his recent spiritual discourses mentioned about Gurukul system prevalent in ancient India, where students were not required to pay any kind of charges for learning. These gurukul were maintained by state and were open to all join and learn. Despite, discrimination by Guru Dronacharya gave birth to vengeance leading to Mahabharata, and it turned out to be self-destructive.

Agrima, a young accomplished lady, with her illustrious career has taken it as passion to associate with initiatives on education for children, youth as well as adults from underprivileged backgrounds. She, instead of perpetuating her fortune travels around in tough conditions to witness their condition, analyze their concerns and consolidate them in writing, as an independent social policy researcher. Her observations and experience are aimed at to arouse sensitivity among elite, who can make a difference. In a recent article she reproduces a sticker outside the school's braille room handicapped children –"My attitude is based on how you treat me".

Socio-economic thinkers have to review various policies of protectionism and equalization of opportunities in democracy. This philosophical discourse should not be merely a talk of either frustrated mind or of a person with belly full. It has to come out of political appeasement and self gratification, and must drive towards development, which is a derivative of internal competence. It requires accomplished persons to collectively complement efforts towards social integration. It is a big cultural reform which in ancient India various Rishis did it. In medieval history Chankya played that role. And in modern history Swami Vivekananda, Rabindranath Tagore, Mahatma Gandhi and many others influenced political leadership.

Motherhood and education has carried human civilization over generations from predator stage in a gradual manner to present stage of development, peace and harmony. It is, therefore, incumbent upon elite to pro-act for sustaining the process before disparity and discontentment reaches a point of inflexion which could drive the anarchy and discontentment back to predevelopment stage.

The democratization of education, to groom competence to compete in a democracy is a real challenge that leadership shall have to shoulder. Without this message transform, reform and perform would remain a mirage. Making the message a reality is a tough call which needs to shed populist measures and motivate persons out of inertia of complacence. It does not have any short-cuts. It requires each believer to practice it collectively to complement efforts, while competing. Articles contributed by various authors reaffirms the faith that there are many like-minded thinkers and players, and success of the endeavor demands on each one to look beyond personal motives and gratification, to maintain transparency and integrity. It is the essence of coexistence and group dynamics, practiced and advocated by Gyan Vigyan Sarita, a non-organizational initiative driven with a sense of Personal Social Responsibility; it works on non-remunerative, non-commercial and nonpolitical basis. It is open to all to add, modify or take away for the larger good of deprived persons.

Ever since a plunge was made in this initiative it has been growing into an increasing obsession not for selfsatisfaction but a painion of disparity in opportunities of grooming competence. Accordingly, in this column ground level experiences are disseminated with a hope that elite audience, who can make a difference, would think on the issues and suggest if there is any better, effective and more selfless way to Democratize Education. We believe that some of the readers would consider the contents and come forward to collectively complement to make this cause, under whatever banner, more purposeful for those who need it most. *It would help us all to leave a legacy of leading a life with a higher sense of responsibility in the form of eternal motherhood through education to all for a sustainable wellness.*

LEARNING DIFFICULTIES: AN ENIGMA

Ashlesha Deshpande

"In this life we cannot do great things. We can only do small things with great love" - Mother Teresa

Do we know what is common amongst the personalities: Albert Einstein, Agatha Christie, Tom Cruise, Bill Gates, and Walt Disney? The plain answer is: All are methodical in their respective fields.

A good counselor also adopts this methodical approach in accepting a child for counselling through the following information:

- (a) Does the child puzzle you?
- (b) Is the standard of the child's work erratic?
- (c) Does the child spell the same word in a variety of ways?
- (d) Does the child have difficulty in copying matters from the blackboard?
- (e) Does the child use spoonerism, e.g. Park Cark?
- (f) Does the child surprise you by the amount of efforts put into the work?
- (g) Is the child clumsy in some respects, but very good in others, e.g. in manipulating things?

Once the child is identified with these difficulties, an Educational psychologist or a Special Educator is required to find out the abilities in the areas of reading, writing, spelling and arithmetic. The knowledge of the child's family background is also needed to learn any serious emotional disturbances etc.

In some schools, the following tests are conducted for the child's grade-age proficiency:

- (a) Indian Child Intelligence Test (ICIT): (9 Subjects)
- (b) Seguin Form Board Test.
- (c) Informal Assessments of Basic Skills.
- (d) Draw-A-Man Test Methods.

A child is said to be experiencing Learning Disability if its performance is below 2 grade levels. For example, if a child who is in 4th Grade is only able to read and write at 2nd Grade level or even less, he could be having LD. If the child is good in arithmetic but not in languages or if the child is good in languages and is poor in computing the numbers, it could be a case of Specific Learning Disability.

A counselor must keep in mind that this information should be used for remedial measures required for the child, and not to demoralize the child or the parents. School Counselor should offer counseling to the parents to make them understand that their child despite the difficulties can still be able to come up in life in one or the other area of skills. Even academics can be improved to a great extent by one-to-one remedial teaching, depending on the degree of disability. Sooner the problem is identified, earlier the remedial measures could start for better outcome.

Parents' acceptance of the issue is the most important factor in proceeding further to seek help for the child to overcome the difficulties. Teachers at school should reduce the burden of home-work for these students so that extra time is available for the learning needs of the child.

It has been learnt that many parents realize that their child is having severe problems when the child reaches the higher level of schooling, the syllabus increases, teacher pressure increases and the child starts gaining self-consciousness. It results in growing depression and mounting frustration in the child which make him aggressive. Counselling helps the child in realizing his strengths, identifying the weaknesses, and providing the ways to overcome these weaknesses.

The Dyslexia or Learning Disability problem was well pictured in the movie **Taare Zameen Par** by the director and actor Aamir Khan. It was a sensitive portrayal and treatment of the subject that caught the heart strings of the movie goers.

It would be important for all parents and teachers that they should first help the child for building his emotional health good by teaching the Life skills, like, communication, decision making, inter personal relationship, emotional management etc., and then give required attention to the academic health.

Let us be prepared for recognizing the child's hidden potentials, encouraging him to build on these potentials, acknowledging his behavior, appreciating his every achievement, correcting his undesirable behavior with love, and being ever friendly with him whether it is a victory or a failure.



Author, settled at Chennai, has an illustrious international career right from childhood. M.Sc.(Psychology), PG Diploma in Education Administration and has done many Specialized courses Despite she has chosen a humble profession to carry her passion of remedying Learning Disabilities (LD), a critical concern of most in this competitive world. At the age of 13 years she represented India in **Jyvaskyla Congress, at, Finland** later in many international athletics events till her 21 Yrs age. She was as an **Indian Railway Traffic Services**. (IRTS), selected through UPSC-Civil Services and first women to be conferred with "**Sword of Honour**" at Maharashtra Police Academy, Nasik (Maharashtra) . She has conducted several workshops, awareness and orientation programs regarding children development and education. She strongly believe in hard work, sincerity and dedication; professional honesty and integrity should be the hallmark when on duty. She has kindly consented to complement this initiative with articles for this e-Bulletin.

E-mail ID: ashlesha.consultant@gmail.com

-00-

OUR MENTORING PHILOSOPHY: Mentoring is not teaching, neither tuition nor coaching. It is an activity driven by passion, and commerce has no place in it. In this effort is to caution students that -

- This place is not where they will be taught how to score marks and get higher ranks, but to conceptualize and visualize subject matter in their real life so that it becomes intuitive.
- This place is not to aim at solutions but inculcate competence to analyze a problem and evolve solution.
- This place does not extend selective and personalized attention, rather an opportunity to become a part of which is focused on learning and problem solving ability collectively.
- This place provides an opportunity to find students above and below one's own level of learning. Thus students develop not in isolation but learn from better ones and associate in problem solving to those who need help. This group dynamics while create a team spirit, an essential attribute of personality, while one learns more by teaching others.
- This place has strategically chosen Online Mentoring, so that those who are unprivileged can gather at one point and those who can facilitate learning of such students by creating, necessary IT setup. Aseperate <u>Mentor's Manual</u> is being developed to support the cause.
- We are implementing this philosophy through **<u>Online Mentoring</u>**

-00-

I think my mother...made it clear that you have to live life by your own terms and you have to not worry about what other people think and you have to have the courage to do the unexpected.

– Caroline Kennedy

Live as if you were to die tomorrow. Learn as if you were to live forever.

– Mahatma Gandhi

Circle of Influence and Circle of Concern - for Students

Amit Gupta

"Circle of Influence and Circle of Concern" is a concept commonly taught in corporate training programmes. This concept has found widespread acceptance in the corporate world due to its effectiveness.

However, looking at the pressures students face, it was thought prudent to explain this concept to students as well, since the concept basically applies to human nature and the environment in which we function.

Some of the common thought patterns students carry could be listed as :

- 1. If my Maths teacher would have been as effective as Physics Teacher, I would be scoring 5% more marks in mathematics.
- 2. If the Principle of my school was more lenient, I could have got more time to study at home and could have got admitted in a better college.
- 3. If my home was near the school, I would have scored much better.
- 4. If my father was more educated, I could have scored much better.

Basically, these thought patterns affect student's studies in the following way:

- 1. These thoughts create negative energy frames in our mind, and hence the absorption and grasping ratio of our mind gets reduced.
- 2. These thoughts keep boggling us, and hence our concentration gets affected. Even while studying, these thoughts either disrupt us in between, or by occupying itself in the subconscious mind, a free flow to the mind is restricted.

However, these are very common thought patterns, and strictly speaking, the concerns expressed therein may be true. So, how do we tackle them ?

In order to have a free and unrestricted flow of studies to the mind, the very simple concept of "Circle of Influence and Circle of Concern" has found to be very useful.

The Concept states that all those concerns we can do something about fall in the Circle of Influence, and the concerns we cannot do anything about fall in the Circle of Concern.



Weather, The examination system (Unit tests/ board exams), Previous year results, The teachers etc. lies in the Circle of concern. Because the student does not have any control on the same.

However, systematic studies, concentration, rising early etc. fall in the circle of influence, over which the student has full control.

The student is advised that he focuses simply on the areas that fall in the circle of influence, forgetting what lies in the circle of concern.

Notice the double sided arrows in the above figure.

It has been found that if one works in the circle of influence, the arrows work towards expanding the circle of influence, whereas if one concentrates/ thinks more on the elements that fall in the circle of concern, the arrows diminish the circle of influence. Thus, as you start focusing only on the areas which you can work upon, gradually nature opens up more possibilities for you, and at times surprisingly finding solutions to items that lie in your circle of concern.

Thus we advise students if any thought disturbs them, just put it either in the circle of influence or circle of concern. If it is in the circle of concern, simply forget it. If it lies in the circle of influence, start working on it. So No thoughts, No imaginations, either work or forget.

This principle is advocated by many management gurus, and has well proved its effectiveness in the corporate world. When people with high management responsibilities have benefited from it, then why not the students ?



The author is an electrical engineer, Batch'1991 having varied experience in the field of electrical and instrumentation maintenance, sales and business development of value added services and executing maintenance contracts. Currently he is working in a MNC at Gurgaon. This experience has developed in him an insight of dynamics of human resource. He has a strong passion to disseminate his hard learning at work and in journey of life to students, descending generation, as well, so that they are more equipped to use their urge and energy in an easier way to deal with the various behavioral aspects encountered in the personal, student life and professional life. **E-mail ID:** <u>amitgpt2000@gmail.com</u>

-00-

INVITATION FOR CONTRIBUTION OF ARTICLES

Your contribution in the form of an article, story poem or a narration of real life experience is of immense value to our students, the target audience, and elite readers of this Quarterly monthly e-Bulletin **Gyan-Vigyan Sarita:** \Re and thus create a visibility of the concerns of this initiative. It gives them a feel that you care for them, and they are anxiously awaiting to read your contributions. We request you to please feel free to send your creation, by <u>20th of this month</u> to enable us to incorporate your contribution in next bulletin, <u>subhashjoshi2107@gmail.com</u>.

We will be pleased have your association in taking forward path our plans as under-

- 2nd Supplementary e- Bulletin of 3rd Quarterly e-Bulletin <u>Gyan-Vigyan Sarita: शिक्षा</u> shall be brought out 1st June'17. It shall be dedicated to Indian Statistical Day to commemorate Birth Day of great Indian Statistician Late Shri Prasanta Chandra Mahalanobis; 29th June'1893 – 28th June'1872).
- And this cycle monthly supplement to Quarterly e-Bulletin <u>Gyan-Vigyan Sarita: 剤細</u> aimed to continue endlessly

We believe that this quarterly periodicity of e-Bulletins shall make it possible for our esteemed contributors to make contribution rich in content, diversity and based on their ground level work.

-00-

The doctors told me I would never walk again. My mother told me I would. I believed my mother. – Wilma Rudolph

Teaching About Water Conservation and Management?

Aarti Sharma

According to Indian scriptures water is one of the five elements of nature (Panchbhoot) necessary for survival. It is one of the basic natural resources that we derive from Mother Earth. It's impossible to imagine world without water as there would be nothing to drink and nothing to consume. Other creatures, such as plants, animals, birds and ocean life would die in the absence of water.

Despite the significance of this indispensable resource, water reserves in almost all regions of the world are fast depleting due to excessive overdrawing without replenishing, salt water contamination as well as pollution leading to severe paucity of water. Rapid population growth and an increasing consumption of water have further aggravated the problem Nations facing water scarcity have to face challenges like drought, depletion of water resources and climate change.

Need for Teaching About Water Conservation and Management: Water conservation means using our water wisely and caring for it properly. Children can make a very important difference towards water conservation as due to lack of awareness they constitute a critical mass for wasting, mismanaging and misusing water. Their inability to conceive the disastrous impact future on generations. environment, agriculture, and human and animal life often leads them to wasting water. Even in countries suffering from severe shortage of water, children display careless attitude towards this issue. It is, therefore, important to teach children to treat water resources with respect and to conserve and reuse water whenever possible. Children should be educated on the wise and sustainable use of water to ensure that they do not waste this precious resource.

Inducing Techniques: As water equals life, affirmative reinforcement should be used while making children and adults learn about water conservation. Being major water wasters they should be made to realize that millions of people die from thirst or drinking contaminated water in different parts of the world. Sometimes they have to be evacuated due to non-availability of water .Such facts do have a poignant impact on the psyche of the students and stimulates them to develop positive attitudes towards water conservation and sustainable

use of water. They should be made to feel proud about their actions and positive attitude. Water saving should be turned into a game for kids and they should be suitably rewarded for making water conscious decisions. March 22 being the World Water day – children should be made to take pledge on this day to save water in every possible way.

Parents, Schools and Media – Harbingers of Change: Parents, schools, media organs, nongovernmental organizations and the entire society should jointly and severally share the responsibility to carry out urgent adaptation in the children's attitudes towards appreciating the importance of water conservation as education and the media are the most active and powerful tools organs in bringing about an positive change in children towards water protection.

In many developed countries, such as the US, education on water conservation is an important component of school curricula. Teaching materials, conservation kits and teachers guides are made available in all school districts. A system of monitoring the impact of such education on children's attitudes and behavior are set in place in almost all schools. Besides, education on water conservation is also provided for the whole community.

Illustrative Guide to Judicious Water Management: According to the World Water Development Report 2017 as water demand is increasing across the globe, the quantity of waste water produced as a result of various human activities is also growing. In addition, climate change is threatening water reserves. Hence, children should be encouraged by parents and schools alike in preparing water management plans which they can carry to their adulthood. Some important examples in water management are mentioned below-

- 1. Remind children to tightly turn off <u>faucets</u> and avoid leaving the water running as they brush their teeth or washing the hands while they lather. This small action goes a long way to saving water at the <u>sink</u>.
- 2. Avoid recreational water toys that require constant flow of water.

- 3. By shortening the shower by a minute or two or by turning off tap while lathering the hair , gallons of water per month can be saved .
- 4. Encourage the use of water used for washing and rinsing clothes to flush the toilets and clean the floors. Alternately, encourage usage of a dual flush toilet that has two flush options – half flush for liquid waste and full flush for solid waste.
- 5. Collect the water used for rinsing fruits and vegetables and use it for watering plants.
- 6. Reuse leftover water from cooked or steamed food to start a nutritious soup.
- 7. Use drip irrigation for shrubs and trees to apply water directly to the roots where it is needed.
- 8. Use a rain barrel to harvest rain water for watering plants and landscapes.
- 9. Encourage checking and repairing of water leakages, drips, and other sources of water wastage.

- 10. Use mops, brooms, or a bucket to wash and rinse. Don't use hoses to clean hard surface areas.
- 11. Sensitize about Use water efficient products to minimize water wastage.
- 12. Domestic wastewater is a valuable source of water and should be actively rechanneled wherever possible for further domestic use.

Conclusion : Since each of us depends on water for life, it is our responsibility to learn more about water <u>conservation</u> and how we can help keep our water pure and safe for generations to come. The enjoyment of having pure, clean water must also be equally backed by efforts to save water so that we may continue to enjoy these benefits in future.

Teaching children about the importance of water and the need for Conservation at an early age can be undoubtedly a challenge, but it's an important lesson for the sake of our family and the survival of our future generations. Conserving water is imperative as water equals life. This education can come from the schools, parents and media alike and can play an important role in promoting social responsibility for water use among children.



Author is Senior Audit Officer working with the office of Comptroller & Auditor General of India. She is a regular writer on issues of diverse nature having impact on education, health, environment, and social psychology and dynamics. **E-mail ID:** aartiissaro4@gmail.com

-00-

Children must be taught how to think, not what to think.

– Margaret Mead

The mind once enlightened cannot again become dark.

– Thomas Paine

It does not matter how slowly you go as long as you do not stop.

- Confucius

The Manipur Initiative: Education and Freedom at a School for Children with Disability

Agrima Bhasin

With imagination and heart, this school shows how to make the participation of children with disabilities not an exception but the rule.

"My attitude is based on how you treat me," reads a sticker outside the school's braille room. Inside, Pau, the braille instructor, and his student, Elizabeth, both visually impaired, are spelling numbers. Elizabeth reads aloud, "One Zero - Ten; Two Zero - Sixty!" Pau adjusts the braille card and asks her to try again. At this, teachers next door break into affectionate laughter, aware that Elizabeth, who occasionally teases Pau, would soon give the right answer.

Across the airy corridor, in the physiotherapy room, Tina, a five-year-old with cerebral palsy, is working on her balance. "Give me a high five, Tina," smiles Angie, the physiotherapist. Tina delights at the clap of their palms, while balancing herself on her knees. It is a weekly session that Tina refuses to miss, even if unwell.

In other classrooms, Tina's friends are spelling alphabets into a wooden mud-tray or learning nursery rhymes in sign language. Outdoors, a group of children have encircled their favourite teacher, Thang. They hug him, tug at his shirt and giggle naughtily as he jokes with them.

Elizabeth, Tina and their friends are students at The Malsawm Initiative, a school for children with disabilities in the tribal district of Churachandpur, 60 km south of Manipur's capital city, Imphal. The school brings together children with various categories of disabilities — be it autism, cerebral palsy, Hydrocephalus, Down's syndrome, hearing, visual and locomotor impairments.

For the current batch of 30 children, aged five to 14, who until a few years ago were leading an overprotected and isolated life at home, the school is a space with a promise of freedom — to learn, think, play, make mistakes and not be judged. It combines education and therapeutic care (physiotherapy, speech therapy and mobility training) such that the children can develop their cognitive, communication, social and daily living skills

Dondouching and Pauzagin Tonsing founded the school in 2011, after a six-year-long struggle to find a school where their son Malsawm could study. A handsome boy with a sharp ear for music, Malsawm lost his eyesight in 2005 to Optic Nerve Atrophy, a condition that impairs the optic nerve. "We thought if our son goes to school, he would start learning the basics and his social skills would improve. But he was not learning anything — the special schools in the town had more holidays than working days and the teachers at the private school he attended were clueless but too polite to kick him out," says Malsawm's mother, Dondouching, who actually feels sorry for the teachers. "He needed time and thought, but the teachers were only baby-sitting him; they wanted to help but could not."

Dejected, the couple pulled Malsawm out of school, enrolled themselves for a distance-learning Bachelor of Education (B.Ed.) programme and began meeting other parents. "At first the parents were reluctant and ashamed to meet us since talking about disability was a taboo here," says Pauzagin, founder of the Churachandpurbased Centre for Community Initiative (the parent organisation that set up the school). Pauzagin discovered that most parents and caregivers had been living with a sense of guilt, having internalised the social stigma associated with birthing or raising a child with disability.

This changed with frequent meetings, where parents shed their discomfort and formed a group to advocate for the rights of persons with disabilities. This was before an educationist known for his love of playgrounds for children, offered the couple a portion of his school's land for free. In response, the couple and parents of fourteen other children, pooled in their faith and imagination to set up The Malsawm Initiative (which initially was a oneroom thatch and bamboo structure, and today, is a yellow and red building amidst a green thicket on a low-lying hill slope).

In the life of the school, the parents or caregivers of children with disabilities have always played a pivotal role. Once, when a landslide blocked roads around the school, parents and teachers formed a human chain and cleared the rubble. Dondouching explains, "Children spend the maximum time with their families. So we expect the caregivers to be fully involved. We also encourage siblings to volunteer at the school so that they can observe and learn from the teachers."

At the same time, and in the absence of any state support for disability-specific education, rehabilitation or information services, the staff at the school is sensitive to the caregivers' personal circumstances. This is especially so in a class-disparate situation, where the demands of everyday survival impinge on the time of some caregivers.

"The parents of several children at the school are daily wage earners — small shopkeepers or farmers who labour all day on the *jhum* (shifting agriculture) hill slopes; others are single parents or aged grandparents. Many of them express a sense of helplessness and frustration and might even feel depressed. This often explains their behaviour, which can be neglectful, overprotective and even abusive towards the child," explains Dondouching.

To overcome some of the above barriers with empathy and non-judgement, the 14-member staff of the school (including special educators, assistant teachers and UN Volunteers) provides after-school support services like counselling, therapy and home-visits in cases of severe disabilities or single parent households. And during school hours, they love and care for the students like they would for their own child or sibling.

This is evident not only from their classroom interactions but also from the spirited welcome that the teachers (ready with broad smiles, wheelchairs and trendy highfives) extend to the arriving students each morning and from the hours they pour into creating teaching and learning games and materials that line the bright yellow walls and shelves of the school.

The teachers also maintain a meticulous diary for every child's monthly development. "He can identify different shapes and colours; can write and vocalise alphabets A-Z and can tie shoe laces on his own," reads an entry. These diaries fuel the end-of-month meetings where parents and teachers jointly review the child's learning. At one such meeting, as he waited for his turn to meet the speech therapist, J.J., a parent and a secondary school history teacher, spoke of his five-year-old son, Hratha, who dropped out of regular school. "He would keep running out of school, so they said they could not handle him." At Malsawm, too, Hratha kept running out for the first three months. But the teachers also ran after him. And here, Hratha has discovered a love for gadgets and YouTube.

"Hratha has a photographic memory and grasps information in seconds. Then he is bored," explains Dondouching. "He is not intellectually disabled," she says, explaining that the exclusion of 'autism' from the list of disabilities included in the Persons with Disability Act (1995) means that children like Hratha did not get a disability certificate or were categorised by the district authorities as 'mentally retarded' or learning disabled. This has since been changed in April 2016, but is yet to be implemented.

The couple believes that advocacy is critical in the face of little to no awareness and empathy among district officials, church leaders and the larger community, including their own friends and relatives. "Most people just feel pity; they say "so sorry" and then feel grateful for being able-bodied, says Dondouching.

The teachers want Churachandpur to become the first disabled-friendly district in the Northeast. For this, the able-bodied must be willing to connect as equals. Pauzagin says with a grin, "We even organised a Gangnam-style dance competition to raise awareness," and adds, shrugging, "Otherwise no one would have come."

This article is reproduced from the first published in The Hindu (Sunday Magazine) on 12 November 2016. Original article can be accessed at: <u>http://www.thehindu.com/features/magazine/The-Manipur-initiative-Education-and-freedom-at-a-school-for-children-with-disability/article16443835.ece</u>



Author is an alumna of Oxford University and Lady Shri Ram College. She is an independent policy researcher who writes on social justice and human rights issues.

E-mail ID: agrimabhasin1267@gmail.com

I did then what I knew how to do. Now that I know better, I do better.

-00-

– Maya Angelou

FUN LEARNING FOR TINY TOTS

It is a known fact that a child learns from his/her mother's womb itself. Abhimanyu's example is so wellknown. Modern science too explains that a child, younger than 5 years, has a rapid growth of his brain and major synaptic connections take place in his brain at this tiny age and he is able to grasp knowledge and information very quickly. Therefore, these days, mothers attend pre-natal sessions and children are sent to toddler programs, play groups, nursery, kindergarten, and primary school and so on and so forth. Pre-school and primary school teaching are more challenging than high school teaching and, therefore, require lots of creative thinking.

Every child is unique and has his/her own aptitude and ways to learn, understand, analyze, and process the information received or experience gained. For imparting education to a child, one should aim at the whole-child approach involving such policies, practices, and relationships which ensure that each child is healthy and safe besides remaining engaged, supported, and challenged suitably. Concept of Multiple Intelligence (also known as 8MIs by Howard Gardner) is very useful in making the process of learning a fun rather than torture or tiresome.

Good schools or quality education systems must be available to all children from all walks of society, i.e., including specially-abled and also those who cannot afford to pay school fees. Provision of monetary support in the forms of scholarships and nutritional meals should be made for the bright children who, otherwise, may not go to school for want of adequate financial support.

The aim of any school (for tiny tots) should be to provide the children with quality education and analytical capabilities along with encouragement to explore so that they develop inquisitiveness and remain so even after they have grown so that ultimately they may make a positive impact on the society.

Sunita Bharti Asawa

Following are some of the concepts and methods, one may follow to make school a place of fun learning:

Potter's job requires him to have all the patience in the world. He moulds the clay when it is soft and one wrong touch of the potter changes the shape. It is the same with schooling system where teacher is like a potter and the child is clay.

Teachers or facilitators must fulfill basic requirements of education in addition to a major requirement of having strong passion to handle tiny tots. Young mothers having proper education fit very well into these eligibility criteria.

The school infrastructure must be designed and executed so as to take all necessary care to safeguard the safety and security of the child besides providing environment which is conducive for providing quality education. The school must have well-ventilated classrooms having smart white boards, a big playground to meet the physical needs of the students, a computer laboratory, an activity room, Montessoricum-library room, and safe toilets.

The students must be connected with many on-going environmental and social issues like banning the usage of plastic, saving water and electricity, not wasting food, helping the deprived children, joys of giving (making kids to share their toys and clothes with the children who were underprivileged) etc.

Aanganwadis are government run pre-primary schools. They also provide pre-natal support to the underprivileged women in the society. They provide food and clothes and medical facility to pregnant women. The Aaganwadi schools provide food and education to the underprivileged children for free. But, in spite of all the efforts of the Government and other NGOs, the dropout rate seems to be increasing after class 5th or 6th as the children are forced to work for their livelihood. Therefore, the efforts to educate the children, especially the underprivileged ones, are further needed by the Governments, NGOs, Industrialists, business persons, and even philanthropists. The encouragement of initiative of adopting villages by the corporate world for this purpose will be a right act in this direction.



Author is **Ex. Administrative Manager, Kidzee School, Jamnagar.** After completing her MBA, she worked as Research Assistant in KPMG for a Project in Visakhapatnam. Later she was an Executive (Customer Care), Sterling Resorts for a year, Career Counselor with Excel Academy, and (4) member of management of Kidzee and MLZS School handling operations of a school for a period of 4 yrs. She has also done a diploma course in Textile designing and is a qualified Yoga instructor. E-mail ID: sunita tosh10@hotmail.com

-00-

GROWING WITH CONCEPTS

Concepts of an expert are not like a static foundation of a huge structure; rather it is like blood flowing in a vibrant mind.

During growing into an expert, each one must have used best of the books available on subject and received guidance of best of the teachers. Authors might have had limitations to take every concept thread bare from first principle and so also must be the constraint of teacher while mentoring a class with a diversity of inquisitiveness and focus. As a result, there are instances when on a certain concept a discomfort remains. The only remedy is to live with the conceptual problem and continue to visualize it thread bare till it goes to bottom of heart and that is an **ingenious illustration**.

In this column an effort is being made to take one topic on Mathematics, Physics and Chemistry in each e-Bulletin and provide its illustration from First Principle. We invite all experts in these subjects to please mail us their ingenious illustrations and it would be our pleasure to include it in the column.

We hope this repository of ingenious illustrations, built over a period of time, would be helpful to ignite minds of children, particularly to aspiring unprivileged students, that we target in this initiative, and in general to all, as a free educational web resource.

This e-Bulletin covers – a) <u>Mathematics</u>, b) <u>Physics</u>, and c) <u>Chemistry</u>. This is just a beginning in this direction. These articles are not replacement of text books and reference books. These books provide a large number of solved examples, problems and objective questions, necessary to make the concepts intuitive, a journey of educational enlightenment.

Looking forward, these articles are being integrated into Mentors' Manual. After completion of series of such articles on Physics, representative problems from contemporary text books and Question papers from various competitive examinations, it is contemplated to come up with solutions of different type of questions as a dynamic exercise to catalyse the conceptual thought process.

• This column in next Supplementary e-Bulletin due on 1st April'17 shall contain *Quadratic Equations and Complex Numbers* in *Mathematics, Current Electricity and Magnetism – Part-I* in Physics and *Chemical Thermodynamics* shall be continued in Chemistry.

-00-

Learning With My Mentors

Rohit

[Foreword by Coordinator Gyan Vigyan Sarita]

[This is a narration of journey of a student who has been associated with us since Dec'2012, while studying in class 8th. His mother is a house maid in Vasundhara, Ghaziabad District, while his father is an unskilled labour. He stays at LIG colony, Arthala Industrial Estate. The mother got awakened with educational awareness in different houses where she worked, and as a result was always in lookout for persons who could guide her only child study better. During, Nov'12 this initiative, which planted by Sarthak Prayash, an NGO, was operating in chalk-n-talk mode. With passage of time, it has undergone many operational changes, and now it is operating Online Mentoring Session, at behest of Gyan Vigyan Sarita, a selfless non-organizational initiative of a few passionate persons. The student, economically weak but in General Category, despite facing IIT-JEE Main-2017 and PET-UPTU'17, continues his association with the initiative and guides his junior colleague. Original text of the student has been edited only for the purpose of publication, without affecting original content.]

My journey of proper education began while I was



studying in Class 8th. I came across Sarthak Prayash, which had started its SAMARTH programme to help unprivileged children to study better, further and make them able to make a choice of career. Here, I got an opportunity to study. My teachers never provided direct solution to my problems. They firstly

explained necessary concepts involved in the problems and then made me to think to reach the solution by myself. This became practice in the problems of Physics and Mathematics. This practice was to prepare students of Class 9th and 10th for higher classes. At the same time, our course of 9th and 10th was also explained with guidance to solve our study related problems.

We were explained to revise the topics and problems discussed in class Twice; Once on paper and second time mentally, without book or notes in front of us. But, students usually missed to revise the subjects on same day and this was the reason, that as time passed subject faded in memory and I could not get marks as compared to what was explained at the center. Now I realize that, I was one of those who did not take instructions seriously, which could have helped me to score better.

After 10th Class, I continued learning with the sir, which was moved from center to his home, then Subodh Foundation and latest is Gyan Vigyan Sarita, where Four experienced persons continue to teach us free of cost. I had no choice because my parents could not afford me either tuition or coaching. In class 11th and 12th I tried to solve my difficulties which I had left unsolved together with fresh learning. But, with the increase in pressure of course, I really could not maintain speed. As a result, gap in learning and problem solving continued to widen. Shailendra Sir, Dhar Sir and Kumud Madam were also very kind to repetitively explain and revise concepts Three-Four times. But, due to my inability to revise, I developed fear for asking my doubts afresh.

When in May'16, Mentoring Sessions were fully shifted to Online, problems of internet connectivity used to affect continuity in class and gap continued to widen.

Further, we were not going prepared by reading chapter to be taught, before the class. Now I realize, any extra effort to revise and go prepared in class is essential to improve understanding of subject, raise questions in case of doubts and create a habit of self-study, for which there is no substitute.

I know that my conditions do not permit me to take a drop to re-prepare for IIT-JEE or PET. But, I am sharing my experience with other students and that what my mentors time and again emphasized upon us that **there is no short-cut to knowledge and excellence**. Therefore, I request them to please take advice of my mentors seriously and put them into practice. This will help them to increase their mental capacity to understand and apply the instructions accurately and speedily. I am continuing my association with the initiative, now Gyan Vigyan Sarita, with a hope that it will be useful to my other friends and help them to put their trust on mentors, and a bitter truth that please do not escape from hard work and self-study; it will compound the learning and self-confidence.

With this I am my continuing my journey into education

GROWING WITH CONCEPTS – Mathematic

SEQUENCES & SERIES

Prof. S.B. Dhar

A sequence is defined as the arrangement of numbers in which each term is related to its predecessor by a Uniform Law. There are evidences that Babylonians some 400 years ago, were knowing Arithmetic and Geometric Progressions. Indian

There are mainly four types of sequences in the 10+2 syllabus.

- (a) Arithmetic Sequence
- (b) Geometric Sequence
- (c) Harmonic Sequence, and
- (d) Arithmetico Geometric Sequence

Problems are asked generally to find out nth term of the sequence, identification of sequence, sum of finite number of terms, or infinite number of terms. Sometime typical problems are set to test learning of the various concepts of sequences, used in Theory of Equations, Probability, Trigonometry, Coordinate Geometry, and Calculus too.

Sequence

A sequence is a function whose domain is the set of Natural Number, i.e., $f:N \rightarrow X$ given by $f(n)=x_n$ for all $n \in N$.

A sequence whose Range is a subset of Real number is called a real sequence.

Series

If $a_1, a_2, a_3, ..., a_n$ is a sequence then the expression $a_1+a_2+a_3+...+a_n$ is called a series.

Series can be finite if the number of terms is countable and infinite if the terms are uncountable.

Progression

The sequence whose terms follow the certain pattern are called progressions i.e., if there exists a formula for writing the nth term of the sequence then it becomes a progression. All sequences do not form a progression. mathematician *Aryabhata* (470AD) was the first to give formula for the sum of squares and cubes of natural numbers. In 598 AD, *Brahmgupta*; in 850AD, *Mahavira*; and in 1114-1185AD, *Bhaskar* also worked on these squares and cubes.

Terms of a progression are connected either by + or - sign as the case may be.

Example:

If some sequence $\langle a_n \rangle = (-1)^n$ is expressed then it consists of only two terms $\{-1,1\}$.

Facts related to A.P.

- 1. $T_1+T_2+T_3+....T_n$ is called in an Arithmetic Progression if $T_2-T_1=T_3-T_2=...=T_n-T_{n-1}=$ constant. This constant is called the Common Difference.
- 2. The nth term of an AP , from beginning, is given by:

 $T_n = a + (n-1)d$, where a = first term, and d= common difference.

3. The nth term from the end is given by:

 $T'_n = l + (n-1)(-d)$, where l = last term, and d is the common difference.

Or, r^{th} term from the end = $(n-r+1)^{th}$ term from the beginning = a + (r-1)d where *a* is the first term and *d* is the common difference.

4. The sum to n terms of the AP :

 $S_n = \frac{n}{2} \{ 2a + (n-1)d \} = \frac{n}{2}(a+l)$ where a = first term, d= common difference, l = last term or nth term, n= number of terms.

5. A sequence is said to be an AP if the nth term is a linear expression of n, i.e.

 $T_n = An + B$

6. A sequence is an AP if the sum to n terms is a quadratic expression of n, i.e.

 $S_n = An^2 + Bn + C$

7. If a constant is added to or subtracted from all the terms of an AP, the resultant series remains in AP.

Example:

If $a_1, a_2, a_3,...,a_n$ are in AP, and k is a constant then $a_1 \pm k$, $a_2 \pm k$, $a_3 \pm k$,.... $a_n \pm k$ will also be in AP.

8. If all the terms of an AP are multiplied or divided by a constant, the resultant series remains again in AP.

Example:

If $a_1, a_2, a_3,...,a_n$ are in AP, and k is a constant then ka_1 , ka_2 , ka_3 ,...., ka_n as well as $\frac{a_1}{k}, \frac{a_2}{k}, \frac{a_3}{k}, ..., \frac{a_n}{k}$ will also be in AP.

9. If there are two APs and there corresponding terms are added or subtracted then the series formed by the new terms is again an AP with the new common difference of Sum of the two common differences or the difference of them as the case may be. But if the terms are multiplied together or divided by, then they do not form an AP.

Example:

If $a_1, a_2, a_3,...,a_n$ and $b_1, b_2, b_3,...,b_n$ are two APs then $a_1 + b_1, a_2 + b_2, a_3 + b_3,..., a_n + b_n$ and $a_1 - b_1, a_2 - b_2, a_3 - b_3,..., a_n - b_n$ will also be in AP. But $a_1, b_1, a_2 b_2, a_3 b_3,..., a_n b_n$ and $\frac{a_1}{b_1}, \frac{a_2}{b_2}, \frac{a_3}{b_3}, ..., \frac{a_n}{b_n}$ will not be in AP.

10. If pth term of an AP is q and the qth term is p then (p+q)th term is o and the nth term is (p+q-n).

- 11. In an AP if $pT_p = qT_q$, then $T_{p+q}=0$.
- 12. In an AP if $S_p = q$ and $S_q=p$ then $S_{p+q}= -(p+q)$.
- 13. If $S_p=S_q$ then $S_{p+q}=0$
- 14. In a finite AP, the sum of equidistant terms from the beginning and the end is always constant and is equal to the sum of the first and the last term.

Example:

If $a_1, a_2, a_3,...,a_n$ are in AP then $a_1 + a_n = a_2 + a_{n-1} = a_3 + a_{n-2} = ... = 2a_1 + (n-1)d$.

15. Three terms *a*, *b*, *c* are said to be in AP if 2b = a+c and *b* lies between *a* and *c*.

16.
$$T_r = \frac{T_{r-k} + T_{r+k}}{2}, 0 \le k \le n - r$$
.

- 17. 3 terms in AP are assumed to be a-d, a, a+d.
- 18. 4 terms in AP are assumed to be *a*-3*d*, *a*-*d*, *a*+*d*, *a*+3*d*.
- 19. If between a and b, n quantities $A_1, A_2, A_3, \dots, A_n$ are inserted and $a, A_1, A_2, A_3, \dots, A_n, b$ form an AP, then $A_1, A_2, A_3, \dots, A_n$ are called the Arithmetic Means.

20.
$$A_1 + A_2 + A_3 + \dots + A_n = \frac{n}{2}(a+b)$$

21.
$$A_1 = a + \frac{b-a}{n+1}$$
 and $A_2 = a + 2\left(\frac{b-a}{n+1}\right)$ and so on.

22. If three different quantities *a,b,c* will be in AP

$$if \frac{a-b}{b-c} = \frac{a}{a}$$

Facts relating to GP

1. Non-zero numbers $T_1, T_2, T_3, \dots, T_n$ are called to be in a geometric sequence if $\frac{T_2}{T_1} = \frac{T_3}{T_2} = \frac{T_4}{T_3} = \dots = \frac{T_n}{T_{n-1}} = r; \text{ r is called the common ratio.}$

- 2. The nth term of a GP is given by T_n = arⁿ⁻¹ where a= first term and r = common ratio, n = number of terms.
- 3. The sum to n terms of a GP is given by $S_n = \frac{a(r^n - 1)}{r - 1}.$
- 4. The sum to infinite number of terms in a GP is possible if common ratio r < 1 and

is given by $S_{\infty} = \frac{a}{1-r}$.

- 5. 3 terms of a GP are assumed to be $\frac{a}{r}$, *a*, *ar*.
- 6. 4 terms of a GP are assumed to be $\frac{a}{r^3}, \frac{a}{r}, ar, ar^3$.
- 7. If all the terms of a GP are multiplied or divided by the same non-zero constant, the series remains in GP.
- 8. The reciprocals of the GP form again a GP.
- 9. If each term of a GP is raised to the same power, the resulting sequence form GP.
- 10. In a finite GP, the product of equidistant terms from the beginning and the end is always constant and is equal to the product of the first and the last term.
- 11. Three non-zero terms *a*, *b*, *c* are in GP if $b^2 = ac$ and *b* lies between *a* and *c*.
- 12. If between a and b, n quantities $G_1, G_2, G_3, \dots, G_n$ are inserted and $a, G_1, G_2, G_3, \dots, G_n, b$ form a GP, then $G_1, G_2, G_3, \dots, G_n$ are called the Geometric Means.

- **13**. If A and G are respectively the AM and GM, between *a* and *b*, then A>G.
- 14. Equation $x^2 2Ax + G^2 = 0$ has *a* and *b* as its roots.
- 15. No term of a G.P can be zero and so the common ratio cannot be zero.
- 16. If two GPs are there and their corresponding term are multiplied or divided by each other, then the new terms formed make again a GP.
- 17. If the terms are added or subtracted then they do not form a GP.
- 18. If $a_1, a_2, a_3, \dots, a_n$ are in GP then $loga_1$, $loga_2$, $loga_3, \dots, loga_n$ form an AP.
- 19. Three different non-zero quantities *a,b,c* are in GP if $\frac{a-b}{b-c} = \frac{a}{b}$.

Facts related to HP

- 1. $T_1, T_2, T_3, \dots, T_n$ of non-zero numbers is said to be in Harmonic Sequence if the reciprocals form an Arithmetic Sequence.
- 2. No term of an HP can be zero.
- 3. Harmonic Mean H between a and b is given by 2ab

$$H = \frac{2ab}{a+b}.$$

- 4. $A \ge G \ge H$.
- 5. A, G, H are in GP.
- 6. If *A*,*G*,*H* are of three given numbers *a*,*b*,*c* then *a*,*b*,*c* are the roots of equation $x^{3} - 3Ax^{2} + \frac{3G^{3}}{H}x - G^{3} = 0$.
- 7. There is no formula to calculate the sum to n terms of an HP.

8. Three different non-zero quantities *a,b,c* are in

HP if
$$\frac{a-b}{b-c} = \frac{a}{c}$$
.

Important Sums:

(a)
$$\sum \frac{1}{n^2} = \frac{1}{1^2} + \frac{1}{2^2} + \frac{1}{3^2} + \dots \infty = \frac{\pi^2}{6}$$

(b) $\sum \frac{1}{(2n-1)^2} = \frac{1}{1^2} + \frac{1}{3^2} + \frac{1}{5^2} + \dots \infty$
 $= \frac{\pi^2}{8}$

(c)
$$\sum (-1)^{n-1} \frac{1}{n^2} = 1 - \frac{1}{2^2} + \frac{1}{3^2} - \frac{1}{4^2} + \dots \infty = \frac{\pi^2}{12}$$

(d) If nth term of a series $T_n = an^3 + bn^2 + cn + d$ then the Sum to *n* terms is given by $S_n = \sum T_n$

$$=a\sum n^{3}+b\sum n^{2}+c\sum n+d\sum 1$$

(e)
$$\sum n = 1 + 2 + \dots + n = \frac{n(n+1)}{2}$$

(f) $\sum n^2 = 1^2 + 2^2 + \dots + n^2$

$$=\frac{n(n+1)(2n+1)}{6}$$

(g) $\sum n^3 = 1^3 + 2^3 + \dots + n^3$

$$= \left(\frac{n(n+1)}{2}\right)^2$$

(h)
$$\sum n^4 = 1^4 + 2^4 + \dots + n^4 =$$

 $\frac{n(n+1)(2n+1)(3n^2 + 3n - 1)}{30}$

- (i) If Arithmetic Mean(A), $A = \frac{a+b}{2}$, Geometric Mean(G), $G^2=ab$, and Harmonic Mean(H), $H = \frac{2ab}{a+b}$, then G²=AH
- (j) The sequence of numbers 1, 1, 2, 3, 5, 8, ... is called a Fibonacci's sequence. This is determined by the conditions: $F_n=F_{n-1} + F_{n-2}$, $n \ge 2$ and $F_1=1=F_2$
- (k) a and b are given by $A \pm \sqrt{A^2 G^2}$.

(1)
$$\left(\frac{a_1 + a_2 + a_3 + \dots + a_n}{n}\right) \ge \sqrt[n]{a_1 \cdot a_2 \cdot a_3 \cdot \dots \cdot a_n} \ge \frac{n}{\frac{1}{a_1} + \frac{1}{a_2} + \frac{1}{a_3} + \dots + \frac{1}{a_n}}$$

Some Examples:

1. For any three positive real numbers *a,b*, and *c*, $9(25a^2 + b^2) + 25(c^2 - 3ac) = 15b(3a + c)$, then find the relation between *a,b*, and *c*.

Solution:

 $9(25a^{2}+b^{2})+25(c^{2}-3ac)-15b(3a+c)=0$ $\Rightarrow 225a^{2}+9b^{2}+25c^{2}-45ab-15bc-75ac=0$ i.e., $\frac{1}{2} [(15a-3b)^{2} + (3b-5c)^{2} + (5c-15a)^{2}]=0$ $\Rightarrow (15a-3b)=0, 3b-5c=0, 5c-15a=0$ $\Rightarrow 15a=3b, 3b=5c, 5c=15a$ $\Rightarrow 15a=3b=5c$ $\Rightarrow \frac{a}{1} = \frac{b}{5} = \frac{c}{3} = k \text{ (say)}$ $\Rightarrow a=k,b=5k,c=3k$ $\Rightarrow a,c, b \text{ are in AP}$

2. Let *a,b,* $c \in \mathbb{R}$. If $f(x) = ax^2 + bx + c$ is such that a+b+c=3 and f(x+y) = f(x) + f(y) + xy, $\forall x, y \in \mathbb{R}$. then find the value of $\sum_{n=1}^{10} f(n)$.

Solution:

Given $f(x) = ax^2 + bx + c$ (i) Putting x=1, f(1)=a+b+c=3 (given) Put, x=1, y=1 in (i) f(2)=f(1)+f(1)+1=2(3)+1=7 put, x=1,y=2 in (i) f(3)=f(1)+f(2)+2=3+7+2=12 Similarly, f(4)=18.. Hence,

$$\sum_{n=1}^{10} f(n) = f(1) + f(2) + f(3) + \dots \text{ to terms}$$

S_n=3+7+12+18+.... Make a series whose sum can be deduced using method of difference. S_n=3 + 7 + 12 + 18 + + T_n(ii) S_n= 3 + 7 + 12 + 18 + + T_n(iii) Subtract (iii) from (ii) 0=3+4+5+....-T_n ∴ T_n= 3+4+5+....to n terms = $\frac{n}{2}{2\times3+(n-1)\times1} = \frac{n(n+5)}{2}$ S_n= $\sum T_n = \frac{1}{2}\sum (n^2 + 5n)$ = $\frac{1}{2}(\sum n^2 + 5\sum n) = \frac{n(n+1)(n+8)}{6}$

3. The Fibonacci sequence is defined by $a_1 = a_2 = 1$ and $a_n = a_{n-1} + a_{n-2}$, n>2. Find $\frac{a_{n+1}}{a_n}$ for n=5.

Solution:

Given $a_1=1$, $a_2=1$ Putting n=3, $a_3=a_2+a_1=2$ Putting n=4, $a_4=a_3+a_2=3$ Putting n=5, $a_5=a_4+a_3=5$ Putting n=6, $a_6=a_5+a_4=8$

Putting, n=10, S₁₀=330

$$\left(\frac{a_{n+1}}{a_n}\right)_{n=5} = \frac{a_6}{a_5} = \frac{8}{5}$$

4. In an AP if mth term is *n* and the n^{th} term is *m*, where $m \neq n$, find the p^{th} term.

Solution:

Let the AP be *a*, a+d, a+2d,.... Then $T_m: a+(m-1)d=n$ (i) $T_n: a+(n-1)d=m$ (ii) From (i)-(ii) $(m-n)d=-(m-n)\Rightarrow d=-1$ $\Rightarrow a=n-(m-1)(-1)=n+m-1$ $\therefore T_p=a+(p-1)d=n+m-1+(p-1)(-1)=n+m-1-p+1=n+m-p$

5. In an AP, if p^{th} term is $\frac{1}{q}$ and q^{th} term is $\frac{1}{p}$, prove that the sum of first pq terms is $\frac{1}{2}(pq+1)$ where $p \neq q$.

Solution:

Let the AP be a, a+d, a+2d,... $T_p: a+(p-1)d = \frac{1}{q}(i)$ $T_q: a+(q-1)d = \frac{1}{p}(ii)$ From (i)-(ii) $(p-q)d = \frac{1}{q} - \frac{1}{p} = \frac{(p-q)}{pq} \Rightarrow d = \frac{1}{pq}$ $\Rightarrow a = \frac{1}{q} - \frac{(p-1)}{pq} = \frac{p-p+1}{pq} = \frac{1}{pq} n$ $\therefore S_{pq} = \frac{pq}{2} \{2a+(pq-1)d\} = \frac{pq+1}{2}$

6. The sums of n terms of two arithmetic progressions are in the ratio 5n+4 : 9n+6. Find the ratio of their 18^{th} terms.

Solution:

Let the two APs be

 $a_1, a_1+d_1, a_1+2d_1, \dots$ And $a_2, a_2+d_2, a_2+2d_2, \dots$ Given that

$$\frac{S'_n}{S''_n} = \frac{\frac{n}{2} \{2a_1 + (n-1)d_1\}}{\frac{n}{2} \{2a_2 + (n-1)d_2\}} = \frac{\{2a_1 + (n-1)d_1\}}{\{2a_2 + (n-1)d_2\}} = \frac{\left\{a_1 + \frac{n-1}{2}d_1\right\}}{\left\{a_2 + \frac{n-1}{2}d_2\right\}} = \frac{5n+4}{9n+6}$$

To find the ratio of 18th terms, $a_1 + \frac{n-1}{2}d_1$ should look like $a_1 + 17d_1$. It means $\frac{n-1}{2} = 17$, or n=35.

Therefore

$$\frac{\left\{a_1 + \frac{n-1}{2}d_1\right\}}{\left\{a_2 + \frac{n-1}{2}d_2\right\}} =$$

$$\left(\frac{5n+4}{9n+6}\right)_{n=35} = \frac{5\times35+4}{9\times35+6} = \frac{179}{321}$$

7. The sum of first three terms of a GP is
$$\frac{13}{12}$$
 and their product is -1. Find the common ratio and the terms.

Solution:

Let the three terms of a GP be $\frac{a}{r}$, a, ar.

Given
$$a^3 = -1 \Rightarrow a = -1$$

Also, $\frac{a}{r} + a + ar = \frac{13}{12}$
 $\Rightarrow -\frac{1}{r} - 1 - r = \frac{13}{12}$
 $\Rightarrow 12r^2 + 25r + 12 = 0$
 $\Rightarrow (4r+3)(3r+4) = 0$
 $\Rightarrow r = -\frac{3}{4} \text{ or } -\frac{4}{3}$
Hence the terms are $\frac{4}{3}, -1, \frac{3}{4}$

8. If AM and GM of two positive numbers *a* and *b* are 10 and 8 respectively, then find the numbers.

Solution:

Given that $\frac{a+b}{2} = 10$ and $\sqrt{ab} = 8$ $\Rightarrow a+b=20$, and ab=64Using $(a-b)^2 = (a+b)^2 - 4ab$ $\Rightarrow (a-b)^2 = 400 - 256 = 144$ $\Rightarrow a-b=12$ Solving a-b=12 and a+b=20, a=16 and b=4

9. The sum of two numbers is 6 times their geometric means, show that the numbers are in the ratio $(3+2\sqrt{2}):(3-2\sqrt{2})$

Solution:

Let the numbers be *a* and *b*. Given that

$$a+b=6\sqrt{ab}$$
$$\Rightarrow \frac{a+b}{\sqrt{ab}} = \frac{6}{1}$$

On using componendo and dividendo

$$\frac{a+b+2\sqrt{ab}}{a+b-2\sqrt{ab}} = \frac{6+2}{6-2} = \frac{2}{1}$$
$$\Rightarrow \frac{(\sqrt{a}+\sqrt{b})^2}{(\sqrt{a}-\sqrt{b})^2} = \frac{2}{1}$$

On taking square roots

$$\frac{\sqrt{a} + \sqrt{b}}{\sqrt{a} - \sqrt{b}} = \frac{\sqrt{2}}{1}$$

Using componendo and dividend

$$\frac{2\sqrt{a}}{2\sqrt{b}} = \frac{\sqrt{2}+1}{\sqrt{2}-1}$$
$$\Rightarrow \frac{\sqrt{a}}{\sqrt{b}} = \frac{\sqrt{2}+1}{\sqrt{2}-1}$$

On squaring both sides

$$\frac{a}{b} = \frac{3+2\sqrt{2}}{3-2\sqrt{2}}$$

10. Find the sum of the following series up o n

terms:
$$\frac{1^3}{1} + \frac{1^3 + 2^3}{1+3} + \frac{1^3 + 2^3 + 3^3}{1+3+5} + \dots$$

Solution:

The nth term of the series is

$$T_n = \frac{1^3 + 2^3 + 3^3 + \dots + n^3}{1 + 3 + 5 + \dots (2n - 1)} = \frac{\sum n}{n^2}$$

$$= \frac{\left(\frac{n(n+1)}{2}\right)^2}{n^2} = \frac{(n+1)^2}{4}$$

$$\Rightarrow S_n = \sum T_n = \frac{1}{4} \left(\sum n^2 + 2\sum n + \sum 1\right)$$

$$= \frac{1}{4} \left(\frac{n(n+1)(2n+1)}{6} + \frac{2n(n+1)}{2} + \frac{n}{1}\right)$$

$$= \frac{n}{24} \left((n+1)(2n+1) + 6(n+1) + 6\right)$$

$$= \frac{n}{24} \left(2n^2 + 9n + 13\right)$$



Dr S.B. Dhar, is **Editor of this Quartrerly e-Bulletin**. He is an eminent mentor, analyst and connoisseur of Mathematics from IIT for preparing aspirants of Competitive Examinations for Services & Admissions to different streams of study at Undergraduate and Graduate levels using formal methods of teaching shared with technological aids to keep learning at par with escalating standards of scholars and learners. He has authored numerous books – Handbook of Mathematics for IIT JEE, A Textbook on Engineering Mathematics, Reasoning Ability, Lateral Wisdom, Progress in Mathematics (series for Beginner to Class VIII), Target PSA (series for class VI to class XII) and many more. **e-Mail ID:** maths.iitk@gmail.com

THE TIMES OF INDIA, NEW DELHI* TIMES NATION 15

-00-

55 students from MP's tribal zone clear JEE Main IAS Officer Gives Wings To Jhabua Kids' Dreams

Ankur.Sirothia @timesgroup.com

Bhopal: Call them the Miracle 55. These many students from MP's Jhabua — a tribal zone with a literacy rate of just 63.5% — have cleared the IIT-JEE Main this year.

Most of them belong to small villages and had to walk several kilometres to reach their government-run schools. Access to a professional coaching institute was not even a dream, it was plain impossible. But thanks to a young IAS officer, Anurag Chaudhary the CEO of Jhabua zilla panchayat, impossible isn't a word these kids like to use now. 'The challenge was that Jhabua has a high illitera-

Most of these students belong to small villages of MP's Jhabua district and had to walk several kilometres to reach their government-run schools

cy rate and even those who study hardly opt for mathematics despite being bright students," he said.

Chaudhary roped in the best government schoolteachers of physics, chemistry and mathematics and they took classes for the students after school hours and on holidays. It worked like a charm. Mohit Kutsena, one of those who has cleared IT-JEE this time, travelled 12km a day, sometimes on foot, to reach his school but says he did not mind it "because there were people willing to put their faith in me". "Coaching after school hours helped me a lot, particularly in chemistry I want to be a computer engineer. The support I got here will help merealise my dreams." he said.

Expenses for this mission were met by pooling in funds received under different government schemes. Those who cleared the Mains will now be sent to Indore to prepare for IIT-JEE Advanced. The government will take care of education expenses.

CROSSWORD PUZZLE MAY'17: MATHEMATICS

Prof. SB. Dhar



Across

2 A harmonic series term cannot be

3 Statement that appears to contradict itself

8 Series in *x,y,z* with relation *2logy=logx+logz*

10 Proposition that is neither proved nor disproved

11 Series whose n^{th} term is of type an+b

13 Sum divided by counts is called

14 Number set defining domain of sequence function

15 Formula applied to the results again and again



1 Name of ratio
$$\frac{a}{b} = \frac{a+b}{a}$$

4 Step by step procedure for operation

5 Name of series 0,1,1,2,3,5,8,...

6 Method to find the sum of 1+3+6+10+15+ ..

7 Rule from Please Excuse My Dear Aunt Sally

9 Number used to measure the size of the set

12 Infinite series of reciprocals of exponents

-00-

(Answer to this Crossword Puzzle shall be provided in Supplementary e-Bulletin Dt. 1st June'17) **GROWING WITH CONCEPTS- Physics**

Waves and Motion: Part-III - OPTICS

Dr. Subhash Kumar Joshi

Light Waves : Initial experience of human being with light comes from observation with eyes, the organ which provides vision. Inability to see, unless a person is blind or sleeping, is perceived as absence of light. This vision has grown into discrimination of an object with its shadow and image. Shadow is the shape created by an object by intercepting light in its passage, while image is creation of a replica of an object. This formation of shadow created inquisitiveness on nature of light propagation. *Newton*, one of the greatest exponent of science, in 1704 in his book Opticks, *mistakenly considered light to be made up of tiny particles called Corpuscules* and analysed its reflection and refraction with his basic laws of motion known as *Corpuscular Theory*. Despite, Huygens' Waves Theory, which was propounded in 1678, the Newton Theory, in the form of *Ray Optics*, maintained its influence over community and continued unquestioned until 1801, when *Thomas Young* demonstrated interference of light which contradicts Newton's theory of light. This effect dominance of Newton was against the basic philosophy of scientific exploration and advancement. This land mark experiment changed the course of discovery of nature of light leading *Electromagnetic Theory (EMT) of Light* propounded by *Maxwell* in 1860, which has not yet contradicted any of the experimental observations in general and in particular contents of this manual. Nevertheless, inquisitive students are welcome for knowing more about EMT through <u>Contact Us</u>.

Simplest experiment that light travels in a straight line is using three non-transparent black screen, Two of



them towards the light source, in this case a candle, have a pin-hole. When the middle screen is aligned to the light incident on the screen from candle, the light passes through it and creates a bright spot on third complete black screen. But, when

alignment

of the middle screen is slightly disturbed, the light instead of passing through the pin-hole in it creates a bright spot on the screen, indicating interception of light by it. In the process, the bright spot earlier appearing on third screen disappears, confirming the interception of rectilinear propagation of light ray by middle screen.



Another celestial phenomenon, more prominently observed and cited in mythology and pre-recoded history, is **Solar and Lunar Eclipse** and goes well with the Newton's Theory of light. **Solar Eclipse** (सूर्य ग्रहण)



occurs when view of Sun is obstructed by Moon as shown in the figure. This can happen only during No-moon Nights (अमावस्या). Degree and duration of eclipse depends on relative orbital Motion of moon w.r.t Earth in context of **Spherical Geometry**. This happen iff motion of Moon's shadow is intercepted

by Earth's Surface. This shadow has Two parts. One is *Umbra*, *complete shadow of Moon* which is in shape of conical frustum such that cross-section of Moon, designated by CD, intercepting Sun Light form is base of frustum, while surface of earth intercepting the conical shadow, identified by PQ, is the top of frustum and is identified with points CDQP. The other is *Penumbra*, *partial-shadow* of Moon Earth designated by CPR and DQS. Eventually, shape of the Penumbra is again conical frustum surface of the Earth, identified by RPQS, as

its base and surface of Moon, identified by CD, as its top. In this conical volume of **penumbra**, shadow is uniformly graded all around from edge CPQS to CRSD leading complete darkness to brightness. The formation of the shadow, its occurrence and visibility, is only during Day of No-Moon.

Lunar Eclipse (चंद्र ग्रहण) occurs during Full Moon Nights (पूर्णिमा) when shadow of Earth is intercepted

by the surface of Moon as shown in the figure. This occurs when Moon passes through shadow of the Earth. Like Solar Eclipse, degree and duration of eclipse depends on same parameter, but with a difference of only relative position of Earth and Moon. In this also darkness of Penumbra gradually diminishes all around



from CDP to CDSR. The formation of the shadow, its occurrence and visibility, is only during Nights of Full-Moon.

Since, wave nature of light is proved beyond doubt, reflection and refraction phenomenon of light is being elaborated in the same perspective. Accordingly, explanation of Reflection of Light goes in line with Reflection of Sound elaborated earlier. Refraction of light is explained with Huygens Wave Theory. This requires correlating the concept with the velocity of light is different for each transparent medium and so is the velocity of wave front. Taking a parallel beam of light AB-CD travelling in air at a velocity v_a intercepts surface of transparent water at BD. In water velocity of light is v_w . This change of velocity would be applicable to rays BE and DF forming edge of the beam such that wavefront, characteristically, remains perpendicular to the



direction of propagation. This requires that time (t) taken by ray CP to travel a distance PD, in air, must be equal to time taken by ray AB to travel a distance BQ, in water. In Δ BPD, $BD = PD \sin i$; likewise in Δ BPD, $BD = BQ \sin r$. Further, $PD = v_a t$ and $BQ = v_w t$. Using these equalities, $= v_a t \sin i = v_w t \sin r$. It leads to $\frac{\sin i}{\sin r} = \frac{v_w}{v_a}$, and this ratio is characteristic to two mediums through which light is travelling and is called **Refractive Index** of the Two mediums designated as $_{a}\mu_w = \frac{1}{w\mu_a} = \frac{\sin i}{\sin r}$. These, observations are experimentally verifiable and have

been summarized into *Laws of Refraction of Light* as – **a)** Incident Light, Refracted Light and Normal to the surface at the point of incidence are in the same plane, **b)** Ratio of sine of angle of incidence (sin *i*) and angle of refraction (sin *r*) is directionally constant for the two medium and is called Refractive Index, **c)** Refractive Index from air to water is $_{a}\mu_{w} = \frac{v_{w}}{v_{a}}$, and **d)** Directional Refractive Index is reciprocal to each other i.e. $_{a}\mu_{w} = \frac{1}{_{w}\mu_{a}}$. This Reflection and Refraction phenomenon are most easily and widely observed and have found many applications in real life. Elaboration of these experiences and applications are in conformance

with basics of Geometry and hence it is called Geometrical Optics.

Reflection From a Plain Mirror: This is the beginning of Geometrical Optics at which concept of image is

introduced. A point object O is placed in front of mirror is emitting light in all directions. Reflection of Two divergent rays OA and OB incident on the mirror are considered. As per *Laws of Reflection* these rays after reflection further diverge along AC and BD, respectively. These reflected rays to the observer appear to be coming from O', and this is called image of O. In this ray geometry, Δ OAB and Δ O'AB, side AB is common and are congruent by ASA theorem. Accordingly, perpendicular distance of object O in front of mirror shall be equal to O'M, the distance of image behind the mirror.



Every physical object can be considered to be comprising of points and for simplicity Trays emanating from top and bottom points of the Object AB, are considered for image formation, Formation of image of a point

requires the reflected rays to converge, while in this case reflected rays CE and DF are diverging. These divergent-reflected rays when projected backwards, shown by dotted lines appear to be emerging from A', making it an apparent image of A. Likewise, image of bottom B of the object is B'. Geometrically Δ ADC and Δ A'DC with a common side CD are congruent by ASA theorem. Accordingly, A' is behind the mirror is placed symmetrically placed w.r. t. A. Likewise, image B' is mirror image of bottom B. This is true for every point of Object AB of the object in its mirror image A'B'. The image A'B' apparently radiating light is called **Virtual Image**, which characteristically can be



experienced but not taken on a screen. This leads to two types of images **Real Image**, *which are formed by convergence of light and hence can be taken on a screen*. While *Virtual Image* is the one which *is experienced by apparent emergence of light but cannot be taken on screen*.

This elaboration of formation of image by plain mirror, can be extended to determine *minimum height and width of mirror to be half of the actual height and width of object*; it requires application of simple geometrical symmetry. Nevertheless, inquisitive reader can reach us for proof of this statement through *Contact Us.*

Reflection from Spherical Mirrors: Spherical mirrors have geometrical symmetry across its diameter and



accordingly cross-section of mirrors are shown to classify **Convex Mirror** whose outer surface is <u>a reflecting surface</u>, while **Concave mirrors** have inner surface is reflecting.

Reflecting Surface

Reflection from spherical surface adds new dimension to image formation for which geometry of the mirror is being defined. Reflection of a parallel beam of light by a concave surface is taken as a base case to define the geometry. Later, it would be used for analysing formation of images for both kinds of mirrors, with different positions of objects.

Case I – **Concave Mirror-Object at Infinity:** *Rays emanating from an object at a distance much larger than radius* (\mathbf{r}) of a concave mirror *PC*, can be approximated to be parallel to principal axis of the mirror whose centre of curvature is C, and point P where principal axis intercepts surface of the mirror is called Pole. Parallel rays MN and RS, making an angle $\boldsymbol{\theta}$ with the radial at the point of interception by the mirror. After reflection, these rays shall make an angle $\boldsymbol{\phi}$ with the radial such



that $\theta = \emptyset$, and converge at point F, called **Focal Point** and distance PF as **Focal Length**(f). Further, using property of triangle exterior angle $\beta = \theta + \emptyset = 2\theta$, being sum two opposite-interior angles. Further, length of arc PN on the surface of mirror $\operatorname{len}(\widehat{PN}) = r\theta$, angles are expressed in radians. And , also $\operatorname{len}(\widehat{PN}) \cong f\beta$; *this approximation is valid, as long as beam is narrow*. Accordingly, $\operatorname{len}(\widehat{PN}) \cong f\beta = r\theta$, or $f2\theta = r\theta$, it leads to an important conclusion $f = \frac{r}{2}$. Thus, a narrow parallel beam, approximated to be coming from an object an infinity, converges at point called **Focal point**. **Case II – Concave Mirror-Object Beyond Centre**: In this case object MU is placed on *principal axis*. Two rays are considered to be emanating from top of Object such that MN, parallel to principal axis, and this



ray after reflection pass through focal point F. Another ray MR is passing through Centre, is since along the radial will be normal to the point of incidence and hence after reflection it would return along the same path. These, two reflected rays since intersect at S, it would form top of the **real image** of the object. As regards, image of bottom, ray along principal axis, being normal to the surface of mirror at the point of incidence P, which is the pole of mirror, V vertically below the image of top of the object. Taking, size of object

MN<<*f*, geometry of rays can be approximated to Δ PNF $\approx \Delta$ VSF, accordingly, $\frac{PN}{PF} = \frac{VS}{FV}$, or $\frac{PN}{VS} = \frac{PF}{FV}$. This is true for absolute values (unsigned) of corresponding lengths, and shall be carried through in elaborations to follow. Likewise, in Δ MUC $\approx \Delta$ VSC. $\frac{MU}{VS} = \frac{UC}{VC}$. With the approximation cited above PN \approx MU, and it would lead to $\frac{PF}{FV} = \frac{UC}{VC}$, this proportionality, can be transformed to axial distances indicated in the figure and accordingly, it would lead to $\frac{f}{v-f} = \frac{u-r}{r-v}$. Applying componendo to this ratio-proportion it takes a form $\frac{v}{v-f} = \frac{u-v}{2f-v}$. Making cross-multiplication, $2fv - v^2 = uv - v^2 - fu + fv$, and it simplifies to fv + fu = uv. Dividing this expression by uv, it becomes, $\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$; here, all terms are +ve, are w.r.t. Pole as reference on Principal axis. Further, image is real-inverted.

Case III –Concave Mirror –Concave Mirror - Object Between Focus and Centre: Conceptually, this case is also a corollary of the Case II and position of image can be obtained by interchanging position of object with image, and reversing directions of rays. Alternatively, same logic of rays, for top of object, one parallel to principal axis and other taken in a direction which is apparently emerging from centre and returning along it, being perpendicular to the point of incidence on the mirror. The alternative ray diagram analysis is also shown, on the right of the corollary ray diagram. Both the analysis are correct, and is matter of convenience for the reader.



Applying, geometrical analysis, as done in Case II, to similar triangles Δ PNF and Δ MUF, and Δ SVC and Δ MUC, it leads to $\frac{PF}{UF} = \frac{VC}{UC} \rightarrow \frac{f}{u-f} = \frac{v-r}{r-u} \rightarrow \frac{u}{u-f} = \frac{v-u}{2f-u} \rightarrow 2fu - u^2 = uv - u^2 - fv + fu \rightarrow fu + fv = uv$. Dividing the last expression with uvf, it transforms into $\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$. In this expression all terms are +ve, and *are w.r.t Pole as reference on Principal axis. Further, image is real-inverted*.

Case IV – Concave Mirror - Object At Focus Centre: This case is corollary of case 1, where a point object will have image at infinity, and is obtained by just reversing the directions of rays.

Case V – Concave Mirror -Object Between Pole and Focus: In this case rays MN and MR, from top of the object, are seen to be diverging after reflection and appear to emanating from S, which obtained by



projecting the divergent rays in opposite direction. Geometrical analysis of similar Δ PNF and Δ SVF leads to $\frac{SV}{NP} = \frac{v+f}{f}$, while in similar Δ MUC and Δ SVC leads to $\frac{SV}{MU} = \frac{r+v}{r-u}$. Since, MU \approx NP, $\frac{v+f}{f} = \frac{r+v}{r-u} \rightarrow \frac{v+f}{f} = \frac{2f+v}{2f-u} \rightarrow \frac{v}{f} = \frac{u+v}{2f-u}$. It leads to $2vf - uv = uf + vf \rightarrow vf - uf = uv$. Dividing the last expression with uvf, it transforms into

 $\frac{1}{u} - \frac{1}{v} = \frac{1}{f}$. In this expression only $\frac{1}{v}$ occurs with (-)ve sign, while all distances are along principal axis *w.r.t Pole* as reference. It is to be noted that VS is on the left of the reference point, while all other terms are on right of the reference. Accordingly, taking **v** to be (-**)ve**, the expression transforms into $\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$, general form and it also conforms with convention of number line. In addition in this case, the image is virtual and erect.

Case VI - Convex Mirror - Object at Infinity: Analysis, in case of convex mirror, is on the same lines as

done in concave mirror, except the change of geometry. A beam of light parallel to principal axis, makes an angle α with the radial at the point of incidence and is reflected through an angle $\beta=\alpha$ with the radial, as shown in the figure. In Δ FBC, $\theta=\alpha+\beta=2\alpha$. This leads to r=2f. In convex mirror, the reflected rays are divergent, and hence focal point (F) is behind the mirror, which in a direction opposite to that of the reflected ray.



Case VII – Convex Mirror – Near Pole: In this also follows analysis same pattern. In similar Δ PNF and Δ SVF, $\frac{NP}{SV} \approx \frac{PF}{VF} = \frac{f}{f-v}$. This approximation is again due arc PN, considered to be a straight line. Likewise, in similar Δ MOC and Δ SVC, $\frac{MO}{SV} = \frac{u+r}{r-v} = \frac{u+2f}{2f-v}$. Since, $MO \approx NP$, the two proportions are consolidated into $\frac{f}{f-v} = \frac{u+2f}{2f-v}$; applying dividend to this t $\frac{v}{f-v} = \frac{u+v}{2f-v}$. It leads to a form of relation with *uvf*, form it takes is $\frac{1}{u} - \frac{1}{v} = -\frac{1}{f}$. Since, both v and f are behind mirror, i.e. against the direction of propagation of reflected rays, their signed values shall be –ve. These signed values of parameters lead to the relation into its generic form $\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$.

Important Inferences: These observations in mirrors are summarized into *Five inferences* – **a**) *image of an object, in case of plane mirror is symmetrically placed behind it.* In this elaboration, the only assumption that mirror, the reflecting surface, is considered to be of negligible thickness. This is not true for glass mirrors, generally seen, but is true for glossy film or metal surface. **b**) *determination of image of a point requires convergence of at least Two rays.* **c**) *actual convergence of rays causes a real image, while apparent convergence for a divergent rays produce virtual image*, and **d**) *Sign Convention* where all distances measured along the direction of rays are (+)ve and those against direction of the rays are (-)ve., **e**) Direction of Image where- Real images are inverted, while virtual images are erect, and **f**) Accuracy of position of image wherein the relationship $\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$, is a fair approximation, when size of object (both height, and or width) is much smaller than **r**.

Parabolic Mirrors: It must have experienced that image of Sun, which is at an extremely large distance than radius of mirror (\mathbf{r}) of a concave mirror, shall cause parallel rays (beam of light) incident on concave mirror, is not a point, rather it a bright spot with highest intensity at the centre, and getting blurred towards outer periphery. The reason being width of beam is comparable to \mathbf{r} . This, is a violation of assumption, leading to r = 2f, made at the beginning of image formation in spherical mirror. Parabolic Mirrors have a property that a parallel beam converges to its focal point. Concept of Parabola which was elaborated in Chapter-II, Foundation Mathematics, as an integral part of Conic-sections. This property of parabolic reflector is derived here under in an effort to inculcate integration of mathematics and physics.

The parabolic shape of reflector is expressed as $y^2 = 8x|_{a=2}$, of light parallel to principal axis hence, Focus of

parabola is defined as (2,0). Taking a ray PQ incident on reflector at Q (x_i, y_i) , At point Q, Slope of tangent $m_t = \tan \theta_t = \frac{dy}{dx} = \frac{4}{y_1}\Big|_{y=y_1}$, accordingly slope of normal QN at point Q, a point under consideration, is $m_n = -\frac{1}{m_t} = -\frac{y_1}{4}$. Accordingly, angle of incidence of ray PQ at point Q, $\tan \alpha_i = \tan(\theta_i - \theta_n) = \frac{m_i - m_n}{1 + m_i m_n} = \frac{0 + \frac{y_1}{4}}{1 + 0 \cdot \frac{y_1}{4}} = \frac{y_1}{4}$. Since, $\therefore \tan \alpha_r = \tan(\theta_n - \theta_r) = \frac{m_n - m_r}{1 + m_r m_n} \rightarrow \frac{y_1}{4} = \frac{-\frac{y_1}{4} - m_r}{1 - m_r \cdot \frac{y_1}{4}}$. It leads to: $m_r \cdot \left[1 - \left(\frac{y_1}{4}\right)^2\right] = -\frac{y_1}{2} \rightarrow m_r = \frac{-\frac{y_1}{2}}{\left[\left(\frac{y_1}{4}\right)^2 - 1\right]} = -\frac{8y_1}{[y_1^2 - 16]}$. Since, it

is reflected ray, equation of reflected ray in a direction opposite to it, its slope, for determining the equation of ray is $y - y_1 = m_r(x - x_1)$. Accordingly, intersection of reflected ray with principal axis would be $0 - y_1 =$



 $\frac{8y_1}{[y_1^2-16]}(x-x_1) \rightarrow y_1^2 - 16 = 8(x-x_1)8x_1$. It leads to $8x_1 + 16 = 8x - 8x_1 \rightarrow x = 2$. In the given profile of parabola a = 2 a beam parallel to principal axis, converges at its Focus Point (2,0). Further, this **conclusion** is valid for any beam parallel to Principal Axis, parabolic reflectors are the ideal beam concentrator.

Lateral Magnification: It is defined as a **ratio of height of image to height of object**. Since, the height measured above principal axis is (+)ve, for erect images the Linear Magnification (*m*) shall be +ve, where for inverted images, it will be (-)ve. In all the images analysed, above, $m = -\frac{MO}{SV}$. A close examination of geometry of images, together with the sign convention, shows that $m = \frac{MO}{SV} = -\frac{u}{v}$ and it takes care of which ever ratio is taken. Accordingly, for final value of *m* for erect images is (+/-) ve, based on image is erect/inverted, while for inverted images it is (-)ve. Typical, two cases of real and virtual images which are inverted and erect respectively are reproduced for a ready reference.



Refraction: It is a widely observed phenomenon, and is experienced in apparent depth of a pond shorter than real, straight wood dipped in apparently bent at surface its surface. Sun after setting apparently larger than normal size, mirage, objects appearing wavy during noon of Summer, and many more are left to be listed by readers through their observations. The basic principle behind all this is refraction and only representative cases shall be elaborated here, and reader to analyse the rest of them using these basic principles. Nevertheless, inquisitive readers are welcome to raise query, in case of any difficulty through <u>*Contact Us.*</u>

Basic concept of refraction was elaborated soon after Lunar Eclipse, at the beginning. Qualitatively, apparent bending of a

straight stick dipped in water is due to rays emanating from each point on dipped stick having varying angle of incidence; larger the angle of incidence, more is the angle of refraction, and eventually rays from the dipped portion of the stick apparently coming from a point above the actual position, so does the stick appears to be bent at surface of immersion. Precisely, this is the reason why does water appears shallow.

This elaboration shall be taken farther into quantitative analysis of refraction and its various effects. A beginning is made with an apparent shifting of an object seen



through a glass slab. Velocity of Light in vacuum is $3.0x10^8$ m/sec and nearly same as that in the air, while in water it is $P = \frac{2.0x10^8 \text{ m/sec. Accordingly,}}{a\mu_g = \frac{v_g}{v_a} \text{ and } g\mu_a = \frac{v_a}{v_a} = \frac{1}{a^{\mu_g}}}$



Here, v_a is the velocity of light in air, v_g is the velocity of light in glass, $_{a}\mu_{g}$ is the refractive index of light from air to glass and $_{g}\mu_{a}$ is refractive index of light from glass to air. It is seen that when light travels from lighter medium to denser medium, following law of refractive index, it bends towards normal at the

point of incidence . The refracted ray while travelling from denser medium to lighter medium would depart from normal. The extent of shift is a geometrical deduction and is left for reader for self- study. *Effective refractive index of cascaded the parallel mediums is product of refractive indices of the interfacing mediums and emerging light is parallel to the incident light if the parallel mediums are immersed in same medium, which is air in the instant case.*

This inference, gives rise to Two cases of automatic consequence. **One** when light passes from denser to lighter medium, how long angle of refraction would continue to increase. **Second**, is when light passes through an intervening medium having non-parallel but plain surfaces.

Taking the **First case**, as shown in figure AB is interface, below which is a denser medium and above it is lighter medium. A ray DP incident on point P is normal to the interface passes through un-deviated since angle of incidence is Zero, and is in conformance with the Law of Refraction. As the angle of incidence increases for rays FP, KP and MP deviates from normal in increasing order along PL, PG and PN, respectively; it is as per

the Law of Refraction. It is seen that ray MP after refraction passes along PN making an angle 90° with the normal and is along the interface. Any further, increase in angle of incidence as shown for ray RP will get reflected at the point of incidence and travel along PS and is called **Total Reflection**. Thus law of refraction is valid in this case until refracted ray is along PN the interface, and angle of incidence corresponding to this ray MP is called **Critical Angle**. Reflection of light from a hot surface of the earth during noon of gives a feel that there is water ahead. This happens because of heating of earth's



surface air gets heated and in turn lighter. Instead, density of air above, i.e. at the level of object and the

observer, being away from the earth's surface, is relatively denser. This forms an ideal case for total reflection for objects at a distance. As the object and observer move closer, the angle of incidence reduces below critical angle and total reflection stops. This phenomenon of total of reflection on roads is called *Mirage*.

The Second Case when surface of a denser medium are not parallel. A typical quadrilateral cross-section of a



glass bar with its lateral four edges are parallel is shown in the figure. The edges are not visible made to be for simplicity of figure. A ray PQ enters the glass bar at point Q on its side AB, and after refraction it deviates towards normal inside denser medium along QR. This ray at point R on the side CD deviates away from the normal along RS. Eventually, the ray PQ undergoes a deviation through an angle δ called **Angle of Deviation**, towards the base of the denser medium. Since, none of the faces are parallel, base of the medium is decided by

the side towards smaller of the two supplementary angles formed by the incident ray. In the instant case these angles are \angle PQA and \angle PQB, out of which \angle PQA is smaller and hence AD is the base. *Thus, based on angle of incidence any of the other two sides can become base of prism*. Cross-section ABCD is idealized into a Trapezium BCDE with sides DE||BC and sides CD=BE. This is a section of an isosceles \triangle DEF and is an idealized **Prism**, a 3-D geometry, which has extensive application in Optics.

An ideal Prism ABC is shown with an incident ray PQ on its side AC at an angle of incidence i_1 , and after

refraction through a medium of refractive index $_{1}\mu_{2}$ has an angle of refraction r_{1} along QR. This ray make an angle of incidence i_{2} on side AB, and again undergoes refraction $(_{2}\mu_{1} = \frac{1}{_{1}\mu_{2}})$ making angle r_{1} with the normal at Point R on the side. Since opposite \angle MQA = \angle MQA = $\frac{\pi}{2}$, and sum-up to 180°, therefore, \angle QMA + \angle QMR = $\pi \rightarrow \alpha + \angle$ QMR = $\pi \rightarrow \angle$ QMR = $\pi - \alpha$. Further, in \triangle MQR, $r_{1} + i_{2} + (\pi - \alpha) = \pi$. It leads to $\alpha = r_{1} + i_{2}$, and $\delta = (i_{1} - r_{1}) + (r_{2} - i_{2}) = (i_{1} + r_{2}) - \alpha$.



It, raises a natural inquisitiveness as to is there any correspondence

between angles δ , i_1 , r_2 and α . Differentiating w.r.t. $\delta = (i_1 + r_2) - \alpha$, w.r.t. i_1 and equating it ZERO for a minimum deviation, $0 = 1 + \frac{dr_2}{di_1} - 0$, since **Angle of Prism** (α), is constant for a prism. Therefore, $\frac{dr_2}{di_1} = -1$. Since, in refraction, all ratios are trigonometric sine functions, for $\sin i_1 = \sin r_2$, differentiating, w.r.t. i_1 , $\cos i_1 = \cos r_2 \frac{dr_2}{di_1}$, or $\cos i_1 = -\cos r_2$, eventually, magnitudes of angles $i_1 = r_2$. Since, $_1\mu_2 = \frac{\sin i_1}{\sin r_1}$, and $_2\mu_1 = \frac{\sin i_2}{\sin r_2} = \frac{1}{_1\mu_2}$, therefore, $\frac{\sin i_1}{\sin r_1} = \frac{\sin r_2}{\sin i_2}$ it leads to, $r_1 = i_2$, this can happen when geometrically QR is parallel to the base of Prism, *a case for Minimum Deviation*, alternatively ray is traversing symmetrically through the prism. Accordingly, angle of incidence is represented as: $i = i_1 = r_2$ and angle of refraction of incident ray as: $r = r_1 = i_2$. Thus, mathematically, *a condition for Minimum Deviation* through $\delta_m = 2i - \alpha$, and $r = \frac{\alpha}{2}$. This leads to **Refractive Index of material of Prism** $\mu = \frac{\sin i}{\sin r} = \frac{\sin \frac{\alpha + \delta_m}{2}}{\sin \frac{\alpha}{2}}$, and in case of a small angle of prism (α), $\mu = \frac{\frac{\alpha + \delta_m}{\frac{\alpha}{2}}}{\frac{\alpha}{2}}$, or $\delta_m = (\mu - 1)\alpha$.

Dispersion of Light : Rainbow has been observed since immemorial times as a celestial miracle. It was only with the prism, as shown in the figure, that it was realized that visible white light is a composition of seven

The Visible Light Spectrum			
Color	Wavelength (nm)	Frequency	
Red	620 - 750	400-484THz	
Orange	590 - 620	484-508 THz	
Yellow	570 - 590	508-526 THz	
Green	495 - 570	526-606 THz	
Blue	450 - 495	606-668 THz	
Violet	380 - 450	668-789 THz	

colours, called a spectrum with frequencies and in turn wavelength, gradually varying from 620 nm to 380 nm causing a visual effect of

Red colour to Violet. As elaborated in heat, every object at any temperature emits a complete spectrum of light and prominence of depends frequency upon a temperature of object. Rays of wavelength above 740 nm are called infrared rays and below 380 nm are



called ultra violet rays. Dispersion of light into a spectrum is reversible and



white light can be reconstructed, by passing it through a similar prism, placed inverted as shown in the figure. The reason for dispersion of light is that refractive index of light depends upon its wavelength. Light rays have different velocities in different medium, but with the change of medium frequency of a ray of light remains unaltered. As a result it is the wavelength a **composite light** (mix of multiple frequencies) that changes with medium and causes deviation of rays, having different wavelength at different

angles during refraction at non-parallel surfaces. A ray of light with single frequency is called **monochromatic light**. Readers inquisitive tp know more about dependence of Refractive Index on wavelength are welcome to write us through <u>*Contact Us*</u>

Inferences on Prism: a) Prism is a special case of a transparent medium having non-parallel surfaces, **b)** an incident rays after refraction through prism deviates towards its base, **c)** minimum angle of deviation through prism is a function of the Angle of Prism and refractive index of the medium w.r.t. the medium in which it is placed **d)** angle of deviation through a prism varies with the frequency of light rays.

Refraction Through Spherical Surfaces: *Every transparent curved surface can be split into small elements frustum of prisms with each element having different Angle of Prism.* Likewise, spherical surfaces, which are most commonly used, are simple to analyse due to uniformity in its radius of curvature. The analysis of refraction through spherical surfaces is being done using a Two rays, One parallel to principal axis and the other, along the radial. This is on the lines of reflection from spherical surfaces, to maintain a consistency of logic.

Case 1 – Convex Surface and Object at Infinity: In case of convex surface, a narrow beam of rays parallel principal is taken. The ray along principal axis being radial would pass through un-deviated along the principal



axis. The ray MN parallel to principal axis makes an angle i_1 with normal at the point of incidence N, after refraction takes a path along NF and intersects the principal axis at F. So is the case with another ray RS. Refractive index (RI) of medium being μ , the relation for a narrow beam shall be $\mu = \frac{\sin i}{\sin r} \approx \frac{\alpha}{\beta}$, or $\alpha \approx \mu\beta$. In Δ NCF, \angle NCP= a, and $a = \beta + \angle$ NFC. It leads to \angle NFC= α - β . Further, for a narrow beam arc



Case 2 - Convex Surface and Object in Lighter Medium: This case is an extension of Case 1, and would require



radial an a parallel ray to determine position of image. It is important to remember that, in this case irrespective of the radius of the curved surface, length of the medium is sufficiently long to have the image inside it. A situation of image formation, when,

rays surpass the medium for formation of image shall be elaborated little later. Accordingly, as per geometrical symmetry, $\frac{MO}{SV} = \frac{u+r}{v-r}$, and $\frac{NP}{SV} = \frac{f}{v-f}$. It leads to: $\frac{u+r}{v-r} = \frac{f}{v-f} \rightarrow uv + rv = (v+u)\frac{\mu}{\mu-1}r$. In this

 $(\mu - 1)(uv + rv) = (v + u)\mu r \rightarrow \mu uv + \mu rv - uv - rv = \mu vr + \mu ur \rightarrow (\mu - 1)uv = rv + \mu ur$ Dividing this equation by uvr, it transforms into $\frac{(\mu - 1)}{r} = \frac{1}{u} + \frac{\mu}{v}$. If μ_1 is RI of ambient medium w.r.t vacuum and μ_2 is RI of the medium having Convex surface, the RI of the medium w.r.t. ambient $\mu_2 = \mu_1 \cdot \mu$, hence $\mu = \frac{\mu_2}{\mu_1}$. Substituting value of μ , the relationship between u, v, and r transforms into: $\frac{(\mu_2 - \mu_1)}{r} = \frac{\mu_1}{u} + \frac{\mu_2}{v}$. Either of the Two relationships between u, v, and r can be used based on availability of RI, absolute $(\mu_1 \text{ and } \mu_2)$ or relative μ

Case 3 – Concave Surface and Object at Infinity: A typical case of Concave surface of glass having RI µ

is shown in the figure. Incident ray MN, parallel to the Principal axis, after refraction makes an angle β with normal at the point of incidence. In view of this in Δ FCN, \angle FNC= β and \angle NFC = $\alpha - \beta$. Further, for a narrow beam $\mu = \frac{\sin \alpha}{\sin \beta} = \frac{\alpha}{\beta}$, moreover length of arc NP= $f \angle$ NFC $\rightarrow (\alpha - \beta)f$, and NP $\approx \alpha r$. Thus, with a fair approximation for a narrow beam is $(\alpha - \beta)f \approx \alpha r$. Accordingly,



consolidating two approximations, $(\mu - 1)\beta f \approx \mu\beta r \rightarrow f = \frac{\mu}{\mu-1}r$. This is of the same form as that derived for convex surface. In this, since both r and f are in direction opposite to the direction of ray, hence as per sign conventions will have –ve values. But, the expression remains unaltered since sign convention affects both sides uniformly.

Case 4 - Concave Surface and Object Between Focal Point and Centre Medium: Extending the analysis to



image formation by rays MN, parallel to principal axis, which after refraction deviates along NL, as if it is emerging from focal point F. The other ray MQ, through C along radial, goes un-deviated. Intersection of rays NL and QK, creates a virtual image SV. Utilizing property of similar Δ MOC and Δ SVC and Δ NPF and Δ SVF, we have $\frac{MO}{SV} = \frac{OC}{VC} = \frac{u-r}{v-r}$, and $\frac{NP}{SV} = \frac{PF}{VF} = \frac{f}{f-v}$. Since, MO=NP, it leads to $\frac{u-r}{v-r} = \frac{f}{f-v} \rightarrow vr - uv =$ (v-u)f. T his gets transformed using relationship between μ , r, and f into $: vr - uv = (v-u)\frac{\mu}{\mu-1}r \rightarrow (1-\mu)uv = vr - \mu ur$. Dividing

this *by uvr*, it becomes $\frac{1-\mu}{r} = \frac{1}{u} - \frac{\mu ur}{v}$. Substituting, $\mu = \frac{\mu_2}{\mu_1}$, on the lines done for convex mirror, *the relationship takes a form* $\frac{\mu_2-\mu_1}{r} = \frac{\mu_1}{u} - \frac{\mu_2}{v}$. Using the sign convention both *v* and *r* are in direction opposite to that of ray shall be –ve while *u* being in the direction of ray shall remain +ve.

Thus, in accordance with the sign convention it takes a **generic form** $\frac{\mu_1 - \mu_2}{r} = \frac{\mu_1}{u}$; it is identical to the relationship derived for convex surface. *This is an example of beauty of algebra, which has a capability of generalizing conclusion of specific cases. Use of this generic relationship shall be made to determine position of image in a lens having Two curved surfaces.*

Case 5 – **Lenses:** Lenses are made of two curved surfaces in various formations as shown in the figure. Generic lenses using concave and convex curved surfaces are shown in the figure. Using the generic relationship between u, v and r formation of image for convex lens most commonly used is being elaborated.



A convex lend of absolute RI μ_2 , is placed in a medium having absolute RI μ_1 . The left boundary of radius R₁, of the lens, is



shown with red line, and the hypothetical spherical medium is extended on the right side encompassing within it image V_1 . This image V_1 , serves as an object for another convex lens of radius side R2 shown on right shown in blue colour forming an image V. This hypothetical spherical surface is shown extended on the left side with dotted blue lines. Analysis

of image formation by the convex lens is decomposed into two separate surfaces as shown in separate figures, one with red boundary and other with blue boundary as shown in the composite figure. formed by the Two surfaces is being analysed separately.

The ray UQ from the object incident on the spherical surface of radius R1, is deflected along QV₁. Since $\mu_2 > \mu_1$ the ray inside medium of RI μ_2 will get deflected along QR₁. Another ray UP1 along radial will travel un-deflected and a real image V' shall be formed inside a virtual medium of RI μ_2 . Now directly using generic relationship derived for a convex spherical surface position of





Now extending analysis to spherical surface having radius R_2 , a virtual medium of RI μ_2 and outside it another virtual medium of RI μ_1 , the image at V1, would serve as a virtual object. This virtual object and medium is helpful in analysis and gives results which are experimentally verifiable. The ray V1S from virtual object gets deflected, at the point of incidence away from the normal and travels along ST. It is a ray from a virtual object creates a virtual image V together with ray V₁P₂, which is eventually a real image. In this case virtual object is in denser medium the position of image V shall be determined

with $\frac{(\mu_1 - \mu_2)}{r_2} = \frac{\mu_2}{\nu'} + \frac{\mu_1}{\nu}$. Combining these two case into a Convex Lens, it leads to $(\mu_2 - \mu_1) \left(\frac{1}{r_1} - \frac{1}{r_2}\right) = \frac{\mu_1}{u} - \frac{\mu_1}{\nu}$, alternatively it can be written as $(\mu - 1) \left(\frac{1}{r_1} - \frac{1}{r_2}\right) = \frac{1}{u} - \frac{1}{\nu}$. This is an approximation of the position of image since r_1 and r_2 are measured from poles P_1 and P_2 of respective spherical surfaces, while the relation assumes the Two poles to be coincident. Thus the approximate relationship is valid for **Thin Lenses** only.

Taking, the object to be at a large distance from the lens i.e. $u \to \infty$, the image as per logic used to arrive at this point would be at **Focal Point of the Lens**, i.e. v = f. Accordingly, focal length of the lens $\frac{\mu_1}{f} = (\mu_2 - \mu_1) \left(\frac{1}{r_2} - \frac{1}{r_1}\right)$. This formula in a form $\frac{1}{f} = (\mu - 1) \left(\frac{1}{r_1} - \frac{1}{r_2}\right)$ is known as **Lens Makers formula**. Combining the Lens Makers Formula with the relationship for a lens $\frac{1}{f} = (\mu - 1) \left(\frac{1}{r_1} - \frac{1}{r_2}\right) = \frac{1}{f} = \frac{1}{u} - \frac{1}{v}$. This equality in the form $\frac{1}{f} = \frac{1}{u} - \frac{1}{v}$ is known as **Lens Formulation or a Characteristic Equation of Lens**. This lens formula finds extensive application in **Composite Lenses** used in **Optical Instruments**.



Magnification Power of Lenses: A simplified diagram of a image formed by a convex spherical surface is shown in

the figure. As per relationship already proved $\frac{\mu_2}{v} + \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{r} \rightarrow r = \frac{(\mu_2 - \mu_1)uv}{\mu_2 u + \mu_1 v}$. Further, from the geometry of image formation, Lateral or transverse Magnification **Factor** $m = -\frac{SV}{UO} = -\frac{v-r}{u+r}$. Substituting value of r from the above, $m = -\frac{v-\frac{(\mu_2-\mu_1)uv}{\mu_2u+\mu_1v}}{u+\frac{(\mu_2-\mu_1)uv}{\mu_2u+\mu_1v}} = -\frac{\mu_1v^2+\mu_1uv}{\mu_2u^2+\mu_1vu+\mu_2uv-\mu_1uv}$. It resolves into $m = -\frac{\mu_1v^2+\mu_1uv}{\mu_2u^2+\mu_2uv} = -\frac{\mu_1v}{\mu_2u}$. In this -ve sign indicates that the image is inverted, and signed values of u and v, would correctly signify the nature of image erect or



inverted. This is identical to that in spherical mirrors. But, the **Power of Lens** is $P = \frac{1}{r}$.

Application of Optics: These principles have found extensive application in enhancing visibility and it starts



with human body. Eye is an optical organ, an excellent natural sense of vision. Primarily it has a lens which creates image of the object being observed on the retina, as shown in the conceptual diagram, while bio-technical details are skipped, deliberately. It has capability to adjust its focal length and the overall eve structure adjusts aperture, exposer to, depending upon intensity of light. Communication of the image on retina to

brain and its processing is all a biological intelligence which continues to be matter of investigation and its replication as artificial intelligence; it is outside the subject matter of the Manual. The vision human eve is affected either by age or otherwise and is corrected by external lenses and is a kind of **Optical Instrument**.

Size of an object perceived by eye is based on the extent of retina is sensitized, and mathematically it is an



angle that the image on retina forms. In the figure Two objects of same size AB and CD are shown, the latter being closer to the eye, and their images A'B' and C'D' form angles θ_1 and θ_2 , respectively; this angle is called **Visual Angle**. Since, $\theta_2 > \theta_1$, the eye perceives CD bigger than AB. Taking another object EF of smaller size, whose rays coincide with rays from AB forms, its image E'F' has the

same visual angle as that of A'B'; apparently the eve perceives the two objects to be of the same sizes. If an object invisible to a normal eye could be due to two reasons -a) Object being far away from the observer, or b) the size of object being too small. Eventually in both the cases visual angle formed by objects are too small to sensitize retina. Optical Instruments, basically manipulate visual angle of object to a desired value to create visibility of objects which are otherwise invisible, shall be discussed little later.

An eye perceives an object only if its image is formed on retina conforming to characteristic equation of a convex lens $\frac{1}{u_o} + \frac{1}{v_o} = \frac{1}{f}$. In case of an object at infinity $u_o \to \infty$, it leads to $\frac{1}{u_o} \to 0$, and $\frac{1}{v_o} = \frac{1}{f_{max}}$, or $v_o = f_{max}$, and it depends upon the shape of the eye. Further, as object moves closer, the eye adjusts its focal length (f) so as to form its image on the retina. Minimum distance for a clear visibility for a normal eye is $u_{0-min} = 25$ cm, and it is called **Near Point**, and its distance from pole of lens is expressed as **D**. Accordingly, minimum focal length of a normal eye shall be $\frac{1}{25} + \frac{1}{f_{max}} = \frac{1}{f_{min}}$. This is reason that blinking of eyes, which within the maximum time of persistence of image (1/50sec) does not obstructs vision, until eyes are closed.

Broadly, there are Four types of Visual Problems- a)Far-Sightedness or Hypermetropia, b) Short-Sightedness or Myopia, c) Presbyopia and d) Astigmatism. Each of these are being elaborated separately.

Short-Sightedness: In this image is formed before the retina, as a result retina perceives a blurred image. Geometrically it would require reducing angle of rays coming from object, in turn deflecting them upwards. This is achieved through a concave lens, an inverted elemental frustum of prisms in its upper-half, while



prisms in lower-half. Correct choice of lens helps to create a corrected image on the retina, as shown in the figure.

Far-Sightedness: In this image is formed behind the retina, while retina intercepts the rays causing



unfocussed image leading to perceiving a blurred image. Geometrically it would require reducing angle of rays coming from object, in turn deflecting them upwards. This is achieved through a convex



lens, which is conceptually an erect elemental frustum of prisms in its upper-half, while inverted elemental prisms in lower-half. Correct choice of lens helps to create a corrected image on the retina, as shown in the figure.

Presbyopia: It is a vision problem involving both Short-Sightedness and Far-Sightedness for which remedy lied in bifocal lens. Latest technology supports progressive lenses which have gradual change of focal length, adjusted to movement of eyeball, and objects at different length can be viewed without movement of neck.

Astigmatism: This problem is related *change in spherical shape of the retina causing different curvature along different planes.* This affects vision in different directions. This is remedied with **cylindrical lenses** having different curvature corresponding to the need of correction.

Simple Magnifying Lens: Simple Magnifier: At times a simple magnifier is required to view extremely small components as might have been seen with repairers of watch and electronic devices, who uses a simple



convex lens. This is explained in figure with two objects AB and GH, of same size; the object AB uses all rays in direction of their propagation to form image and have all u, v and f values +ve, as per sign convention. But, as the object GH is placed between F1 and P a virtual image is formed by extending rays in a direction, opposite to that of their propagation. In this focal point F₁ is important in determining position of the image, while the Other focal point F₂ towards objects decides formation of image, as clearly visible from the ray diagram.

Accordingly, while u and f_1 are +ve, there is -ve value of v. Magnification of an object is $m = \frac{h'}{h} = \frac{D}{u}$, while as per characteristic formula of lens $\frac{1}{u} + \frac{1}{-v} = \frac{1}{f} \rightarrow \frac{1}{u} = \frac{1}{D} + \frac{1}{f}$. It leads to $m = D\left(\frac{1}{D} + \frac{1}{f}\right) = 1 + \frac{D}{f} \approx \frac{D}{f}\Big|_{D\gg f}$. Further, $\theta_i \approx \frac{h'}{D}$, and visual angle of the object seen without magnifier, otherwise at Near Point, is $\theta_o \approx \frac{h}{D}$. Thus, **Angular Magnification** $m = \frac{\theta_i}{\theta_o} = \frac{h'/D}{h/D} = \frac{h'}{h}$, is same as derived above. Generally value of m for a Simple Magnifier is <9, and is insufficient for view in minute objects, particles or organism. This has led to development of *Compound Microscope*.

Compound Microscope: This is a manipulation of visual angle using more than one lens, called composite lenses and hence it is called *Compound Microscope*. It comprises of Two Convex lenses One facing the object is called **Object Piece** and other used for viewing is called **Eye Piece**. Positions of the two lenses with

respect to object are so manipulated that real-magnified image of object is formed by Object Piece between the Two lenses and Eye Piece acts Simple Magnifier to create virtual image beyond Object Piece but at a Near Point (distance D) from eye piece. Aperture of Object piece is smaller than eye piece. *Magnification by Object Piece*



 $m_0 = \frac{v_0}{u_0}, \quad \text{accordingly}, \quad \frac{1}{u_o} + \frac{1}{v_o} = \frac{1}{f_o} \rightarrow \frac{v_o}{u_o} + 1 = \frac{v_o}{f_o} \rightarrow -m_o + 1 = \frac{v_o}{f_o} \rightarrow m_o = 1 - \frac{v_o}{f_o}.$ While Magnification of Eye Piece $m_e = \frac{v_e}{u_e} = \frac{D}{u_e} = \frac{D}{u_e}$ $\frac{D}{L-v_o} = 1 + \frac{D}{f_e}$. Overall Magnification Compound Microscope $m = m_0 m_e$. It thus leads $m = \left(1 - \frac{v_o}{f_o}\right) \left(1 + \frac{D}{f_e}\right).$ In Compound to Microscope $1 - \frac{v_o}{f_o} \rightarrow -\frac{L}{f_o}$, and this approximation is valid for Two reasons – **a**) $\frac{v_o}{f_o}$ and, b) image formed by Object piece is very Thus close to eye piece. Overall Magnification Microscope of $m \approx$

 $-\frac{L}{f_0}\left(1+\frac{D}{f_e}\right)$. *Microscope has provision to adjust its length (L) to create a clear vision*. This formulation of Magnification is parametric in nature and hence order of magnification can be determined using values of the parameters.

Telescope: An instrument is used to observe object at a far distance otherwise either invisible or visible without clarity is called Telescope. This Two device also has Two convex lenses, one is called Object Piece, facing towards Object and has longer focal length (f_0) with larger aperture which allows more rays to be capture to enhance intensity of the real image of the distant object created by it. The other lens has a shorter focal length (f_e) and acts like a *simple magnifier* that creates a virtual image if the object. The object being far emits parallel ray making a small angle θ_o and is practically same as that on the eye, with the principal axis of the Telescope, such that $\tan \theta_o = \frac{A'B'}{f_o} \approx \theta_o$. Thus magnification by *Eye Piece* is $\tan \theta_e = \frac{A''B''}{A'B'} = \frac{A'B'}{-f_e} \approx -\theta_e$.



magnification by *Eye Piece* is $\tan \theta_e = \frac{1}{A'B'} = \frac{1}{-f_e} \approx -\theta_e$. Thus in this case since position and size of object cannot be estimate magnification **Angular Magnification**, as defined in Simple Magnifier, is being considered. It is a ratio of angle subtended by image on the eye $(-\theta_e)$ to the angle subtended by object on the eye (θ_o) . Accordingly,

 $m = \frac{\theta_e}{-\theta_o} = \frac{(A'B'/f_e)}{-(A'B'/f_o)} = -\frac{f_o}{f_e}$. In case, the image formed by Object Piece is at Focal Point of Eye Piece, the image

though magnified would create problems of clarity of vision. In view of this Eye Piece is so positioned that it acts like a Simple Magnifiers and image is created at Near

Point distance D and it shall have $\frac{1}{u_e} - \frac{1}{D} = \frac{1}{f_e} \rightarrow \frac{1}{u_e} = \frac{1}{f_e} + \frac{1}{D} \rightarrow u_e = \frac{Df_e}{D+f_e}$ and $\theta_e \approx \frac{A'B'}{u_e}$. It, further, leads to $\theta_e \approx A'B' \left(\frac{D+f_e}{Df_e}\right)$, and $m = \frac{A'B' \left(\frac{D+f_e}{Df_e}\right)}{-\left(\frac{A'B'}{f_0}\right)} = -\frac{f_o}{f_e} \left(1 + \frac{f_e}{D}\right)$. Thus, all these parameters being fixed, length of Telescope shall also be fixed at $L = f_0 + u_e \rightarrow f_0 + \frac{Df_e}{D+f_e}$.

plane

Optical

а

with

monochromatic light when passed through

Cosposcular Theory, known as Newton's

Rings and gave qualitative explanations as shown in the extact of his publication. Later, in 1801, *Thomas Young* was the first Scientist

Phemnomena

He explained these rings with

this

Planoconvex Lens, and reflected by

demonstrated

mirror.

who

Interference

These are generic optical instruments, where Angle of Vision is manipulated by proper choice of lenses, their focal length and position. There are many variants of these optical instrument evolved by different scientists and inventors to meet specific needs of discoveries and are available in references coted at the end. Nevertheless, readers are welcome to raise their specific inquisitiveness through *Contact Us*

Special Phenomenon: Newton had observed formation of alternate bright and dark rings by

PROP. XII.

Every ray of Light in its paffage through any refrafing furface is put into a certain transient conftitution or flate, which in the progress of the ray returns at equal intervals, and disposes the ray at every return to be easily transmitted through the next refracting surface, and between the returns to be easily reflected by it. M

landmark **Double Slit Experiment.** This was explained mathematically with the use of wave equation and could corroborate interference through thin film and Newton's Ring which will be elaborated after Young's Experiment. Net effect of wave at any point is resultant of the waves incident and is nothing but superimposition of the wave. Wave function [$e = E \sin(kx - \omega t)$.], having a magnitude and phase angle at any point at any instant of time, and therefore **interference** can be analyzed by taking each ray as a vector or simply superimposition of wave-function. Going ahead with two rays from **Coherent sources**, whose light rays same magnitude and phase angle at any instant are considered and is visulaized through waves created in a still water pond by two sticks of equal length cyclically dipped and taken out at same frequency for equal depth, maintaining unform distance and phase between them . Patterns of waves generated with varrying distance (d) between two sticks and constructive interference caused by them is conceptualized with - **a**) distance is equal to wavelength ($d = \lambda$), **b**) Twice the wave length ($d = 2\lambda$) and **c**) distance ($2\lambda < d < 3\lambda$). It is seen



that as distance between increases, number of constructive coherence depited by intersection of wavefronts increase.

Wave is nothing but a cyclic disturbance that perpetuates. In string the disturbance is in the form of transverese displacement of medium in along a line, in water waves it is similar to that of string but along a plane, sound wave causes longitudinal displacement in space, while light waves cause disturbance, in three dimensional space like that of sound wave, but this diturbance is of electrical and magnetic field and given a name Electro-magnetic wave, mathematically defined by Maxwell, as cited in the beginning.

Light is a progressive wave, electrical disturbance caused at a point at distance x from the source at any point of time t is $e = E \sin(kx - \omega t)$. Moreover, every point on wavefronts from a light source, behaves like a

secondary light source. Therefore, at any point beyond, light from each of the two sources may have different phase value and net effect would of the incident light wave, secondary waves of the same source, expressed as $e' = E \sin(kx_1 - \omega t + \varphi_1) + E \sin(kx_2 - \omega t + \varphi_2)$. Since, the primary source is same each of the component shall have same frequency and amplitude, but, the net effect could be:- a) Constructive Interference where each component is constructive being in same phase producing bright spot, b) Destructive Interference – where each component is destrutive being out of phase, or c) Resultant- where each component is neither constructive nor destructive, i.e. phase diffrence $0^0 < \emptyset < 180^0$, and accordingly, intensity of brightness of the resultant light wave varies between bightest to darkest and was demonstrated by Thomas Young in 1801 with a landmark Double Slit Experiment, to demonstrate Optical Interfence is shown in the figure. Two coherent sources A and B are created through Two narrow slots. Light from these sources travel a disnace x_1 and x_2 , to reach a point P₁ on the screen, while for point P on screen placed symmetrically w.r.t. the Two sources, are equidistant by geometrical symmetry. Thus net electrical



disturbance at any point, say P1, as per trigonometric $P_{1} \quad \text{identity } \left(\sin A + \sin B = 2 \sin \frac{A+B}{2} \cdot \cos \frac{A-B}{2} \right) \text{ would be}$ $y \quad e' = 2E \sin \left(k \frac{x_{1}+x_{2}}{2} - \omega t + \frac{\varphi_{1}+\varphi_{2}}{2} \right) \cdot \cos \left(\frac{x_{2}-x_{1}}{2} + \frac{\varphi_{2}-\varphi_{1}}{2} \right).$ Since, sources are coherent $\varphi_2 = \varphi_1$. Accordingly, the net electric field at the point shall be $e' = 2E \sin\left(k \frac{x_1 + x_2}{2} - \omega t + \varphi\right) \cdot \cos\left(k \cdot \frac{x_2 - x_1}{2}\right)$. Here , $\frac{x_1+x_2}{2} = x_1 + \frac{\Delta x}{2}$, while, $x_2 - x_1 = \Delta x$. Thus, the net field has one sinusoidal component proportional to $\sin\left(k\left(x_1+\frac{\Delta x}{2}\right)-\omega t+\varphi\right)$, with the other component is proportional to $\cos\left(k \cdot \frac{\Delta x}{2}\right)$. Thus, geometrically, $x_1^2 = D^2 + \left(y - \frac{d}{2}\right)^2$, and $x_2^2 = D^2 + \left(y + \frac{d}{2}\right)^2$, or $\Delta x = \frac{yd}{x_2 + x_1}$.

Thus, $\Delta x \to \frac{yd}{D}\Big|_{D \gg d \text{ and hence } x_2 + x_1 \to D}$. Accordingly, if $\Delta x = \frac{yd}{p} = n\lambda$, it is case of constructive interference since $k \cdot \Delta x = \frac{2\pi}{\lambda} \cdot n\lambda = 2\pi n$. And if $\Delta x = (2n+1) \cdot \frac{\lambda}{\lambda} \to k \cdot \Delta x =$ $\frac{2\pi}{\lambda} \cdot (2n+1)\frac{\lambda}{2} = (2n+1)\pi$, it is a case of destructive interference. Sets of Bright to dark strips, in varying degree are called Fringes. In both the cases of



constructive/destructive interference n is an odd number. Further, distance between bright strip and n^{th} Bright Strip on either side is caused by Constructive Interference shall be $y_n = \frac{n\lambda D}{d}$. Thus distance between Two consecutive bright fringes shall be $y = y_n - y_{n-1} = \frac{\lambda D}{d}$, and this is called Fringe Width. Essential conditions of Interference are -a) The sources of the waves must be **coherent**, which means they emit identical waves with a constant phase difference, **b**) The waves should be *monochromatic* - they should be of a single wavelength.

There are special cases of Intereference viz. Thin Film Interference, Newton's Ring, as much as Diffraction, which occurs in presence of One wide Source, instead of narrow slit. Diffraction is seen as interefetence caused by multiple sources of light. Likewise, Polarization and scattering of light are also of importance. These special Phenomenon, together with Optical Abberation shall be included in the chapter which shall be integerated, within a week, in Mentors' Manual as a part of Publications as Free Web-resource on our website.

Summary: As journey into Physics advances there is a increasing order of integration of Mathematics into Physics. It was with this ability James Clerk Maxwell which made it possible to use his ingenuity to relate various experimental observation of electricity, magnetism and electromagnetism into an integrated set of mathematical equations, known as Electro Magnetic Field Theory. Likewise, Albert Einstein could question classical mechanics to evolve Theory of Relativity, which was proved experimentally later. This **beauty of integration of mathematics and physics needs to be appreciated and to be cultivated** to discover many more secrets of nature. And every scientist who has contributed in discovery of nature had proficiency in integration of mathematics into observation and visualization of physical world.

Sign convention used in this is consistent and so is the practice in reference books. Reader, while getting across different books must take care to carefully note the sign convention.

In Part-I concepts of waves and in Part- II Sound Waves were elaborated. This theory has been extended to Light Waves and its applications in this Part-III of the series.Nevertheless, readers are welcome to raise their inquisitiveness, beyond the contents, through <u>Contact Us</u>.

Examples, during elaborations, have been drawn from real life experiences help to build visualization and an insight into the phenomenon occurring around. Solving of problems, is an integral part of a deeper journey to make integration and application of concepts intuitive. This is absolutely true for any real life situations, which requires multi-disciplinary knowledge, in skill for evolving solution. Thus, problem solving process is more a conditioning of the thought process, rather than just learning the subject. Practice with wide range of problems is the only pre-requisite to develop proficiency and speed of problem solving, and making formulations more intuitive rather than a burden on memory, as much as overall personality of a person. References cited below provide an excellent repository of problems. Readers are welcome to pose their difficulties to solve any-problem from anywhere, but only after two attempts to solve. It is our endeavour to stand by upcoming student in their journey to become a scientist, engineer and professional, whatever they choose to be.

Looking forward, these articles are being integrated into Mentors' Manual. After completion of series of such articles on Physics, representative problems from contemporary text books and Question papers from various competitive examinations shall be drawn and supported with necessary guidance to evolve solutions as a dynamic exercise which is contemplated to accelerate the conceptual thought process.

References:

- 1. NCERT; PHYSICS, Text Book for Class XI (Part I and II), and Exemplar Problems.
- 2. भौतिक शास्त्र, कक्षा ११, मध्य प्रदेश पाठ्यपुस्तक निगम, 2016
- 3. S.L.Loney; The Elements of Statistics and Dynamics: Part 1 Statics and Part 2 Dynamics.
- 4. H.C. Verma; Concepts of Physics, (Vol 1 & 2).
- 3. Resnick, Halliday, Resnick and Krane; Physics (Vol I and II).
- 4. Sears & Zemansky; University Physics with Modern Physics.
- 5. I.E. Irodov; Problems in General Physics



Author is Coordinator of this initiative Gyan-Vigyan Sarita, a non-organizational entity of copassionate persons who are dedicated to the selfless mission through *Online Mentoring Session (OMS)* to unprivileged children.

e-Mail ID: subhashjoshi2107@gmail.com

-00-

SOLUTION TO THE PUZZLE-April'17: ON ELECTION

Prof. S.B. Dhar



-00-

The most rewarding things you do in life are often the ones that look like they cannot be done.

- Arnold Palmer

A dream does not become reality through magic; it takes sweat, determination and hard work.

- Colin Powell

GROWING WITH CONCEPTS - Chemistry

CHEMICAL THERMODYNAMICS

Kumud Bala

Thermodynamics is a Greek word which means flow of heat (thermo=heat, dynamics =flow) in physical changes and chemical reactions.

Definition

"The branch of science which deals with energy changes in physical and chemical processes is called chemical thermodynamics".

In fact, in chemical reactions bonds in the reactant molecules are to cleave which need certain energy. At the same time, bonds in the products are to be formed. There is release of certain amount of energy. Since, two values of the energies are not normally the same, there is an energy change in chemical reactions responsible for thermodynamics.

Importance of thermodynamics

- 1. It helps us to predict whether any given chemical reaction can occur under the given set of conditions, or not.
- 2. It helps in predicting the extent of reaction before the equilibrium is attained.
- 3. It helps to deduce some important laws like Law of chemical equilibrium, Distribution law etc.

The limitation of thermodynamics

- 1. It helps to predict the feasibility of a process but does not tell anything about the rate at which it takes place.
- 2. It deals only with the initial and final states of a system but does not tell anything about the mechanism of the process (i.e., the path followed by the process).
- 3. It deals with properties like temperature, pressure, etc. of the matter in bulk (macroscopic properties) but does not tell anything about the individual atoms and molecules (microscopic properties).

Some basic terms and concepts

System

A specified part of the universe which is under observation is called a system.

Surroundings

The remaining portion of the universe which is not a part of the system is called surroundings. For example – If we carry a chemical reaction in a glass tube. Glass tube is a system, rest of the universe represent the surrounding. The glass wall of the tube is the boundary between system and surrounding. Thus, system and



the surrounding together constitute the universe, i.e.,

Universe = System + Surrounding.

Types of thermodynamics systems



1. Open system: A system is said to be an open system if it can exchange both

system in it can exchange both matter and energy with the surroundings. For example-Boiling water without a lid heat escape into the air. At the same steam (which is matter) also escapes into the air. Animal and plants are open systems from the thermodynamics point of view.



2. Closed system: If a system can exchange only energy with the surroundings but not matter, it



is called a closed system. For example- Boiling water is placed in a closed metallic vessel. It allows heat to be transferred from the stove to the water. Heat is also

transferred to the surrounding. Steam is not allowed to escape.

3. Isolated system: If a system can neither exchange matter nor energy with the surroundings, it is called an isolated system. For example-Water is placed in a vessel which is closed as well as insulated. A thermo flask is an isolated system.



State of a system and state variable

The state of a system means the conditions of the system which is described in terms of certain observable or measurable properties such as temperature (T) , pressure (P) and volume (V) etc. of the system. If any of these properties of the system changes, the system is said to be in different state, i.e., the state of the system changes. That is why these properties of a system are called state variables. A process is said to occur when the state of the system changes. The first and the last state of a system are called the initial state and the final state respectively.

State function

A state function is a property of the system whose value depends only upon the state of the system and is independent of the path or manner by which the state is reached. State functions are pressure, temperature, volume, internal energy, entropy and enthalpy etc. For example – A person standing on the roof of a five storied building has a fixed value of potential energy, irrespective of the fact whether he reached there by stairs or by a lift. Thus, the potential energy of the person is a state function. On the other hand, the work done by the legs of the person to reach the same height is not same in two cases, i.e., whether he went by lift or by stairs. Hence, work is not a state function. Instead, it is sometime called a 'path function'.

Macroscopic properties of the system

Thermodynamics does not deal with the properties of the individual atoms and molecules but deals with the matter in bulk. The properties of the system which arise from the bulk behavior of the matter are macroscopic properties. For examplecalled pressure, volume, temperature, surface tension, viscosity, density, melting point, and boiling point. The macroscopic properties can be classified into two types:

- **1.** Extensive properties
- **2.** Intensive properties

Extensive properties

The properties of the system whose value depends upon the amount of the substance present in the system are called extensive properties. For examplemass, volume, surface area, energy, enthalpy, entropy and free energy.

Intensive properties

These are those properties which depend only upon the nature of the substance and are independent of the amount of the substance present in the system. For example- temperature, pressure, surface tension, viscosity, density, freezing point, boiling point and specific heat. Extensive properties may become intensive properties by specifying unit amount of the substance concerned. Thus, mass and volume are extensive properties but density and specific volume (i.e., mass per unit volume and volume per unit mass respectively) are intensive properties of the substance or the system. Further. extensive properties are additive but intensive properties are not.

Thermodynamic processes

A thermodynamic process is said to occur when the system changes from one state (initial state) to another (final state). The different processes met within the study of chemical thermodynamics are as follows:

- 1. Isothermal process: When a process is carried out in such a manner that the temperature remains constant throughout the process, it is called an isothermal process. Obviously, when such a process occurs, heat can flow from the system to the surrounding and vice versa in order to keep the temperature of the system constant.
- 2. Adiabatic process: When a process is carried out in such a manner that no heat can flow from the system to the surrounding or vice versa, i.e., the system is completely insulated from the surrounding, it is called an adiabatic process. In such a process, temperature of the system always changes.
- 3. Isochoric process: It is a process during which the volume of the system remains constant.
- 4. Isobaric process: It is a process during which the pressure of the system is kept constant.

Reversible process

In order to understand a reversible process, imagine a gas confined, within a cylinder provided with a frictionless piston upon which is piled some very fine sand.

Suppose the pressure exerted by the gas on the

equal piston is to the combined pressure exerted by the weight of the piston, the pile of sand and the atmospheric pressure. Thus under these conditions, the piston does not move at all and a state of equilibrium is said to exist. Now, if one particle of sand is removed,



the gas will expand very slightly but the equilibrium will be restored almost immediately. Such a change is called an infinitesimal change. If the particle of sand is replaced, the gas will return to its original volume. By the continued removal of the particles of sand the gas can be allowed to undergo a finite expansion but each step in this expansion is an infinitesimal one and can be reversed by an infinitesimal change in the external conditions. At all times, the equilibrium is restored immediately. Thus, the necessary condition for reversible compression is P_{external} = P_{internal} + dp and for reversible expansion is $P_{\text{external}} = P_{\text{internal}} - dp$. Hence, in general, we can write, for reversible process, $P_{external} = P_{internal} \pm dp$. A process carried out in the above manner is called a reversible process and may be define as "a process which is carried out infinitesimally slowly so that all changes occurring in the direct process can be exactly reverse and the system remains almost in a state of equilibrium with the surrounding at every stage of the process."

Irreversible process

An irreversible process is define as that process which is not carried out infinitesimally slowly (instead, it is carried out rapidly) so that the successive steps of the direct process cannot be replaced and any change in the external conditions disturbs the equilibrium.

Cyclic process

A process in which the system undergoes a series of changes and ultimately returns to its original state is called a cyclic process. There is no change in energy in a cyclic process.

Internal energy

Every substance possesses a fixed quantity of energy which depends upon its chemical nature and its state of existence, known as internal energy (U). Internal energy is made up of (i) kinetic energy (ii) potential energy of the constituent particles (atoms, ions, molecules). The kinetic energy is due to the motion of all particles, in the form of translational energy, rotational energy, vibrational energy, electronic energy, nuclear energy of constituent atoms. Potential energy of the molecules is due to molecular interaction, chemical bond energy due to existence of bonds between atoms within the molecules etc. The sum of these different forms of energies associated with molecules is called its internal energy. It is usually represented by the symbol 'U' or 'E'. Thus, U or $E = E_e + E_n + E_c + E_p + E_k + E_v$

Change of internal energy

Absolute value of internal energy of a substance cannot be calculated because it is not possible to determine the exact values for the constituent energies. It can be measured, when a system changes from initial state (U₁) to the final state (U₂). The difference between the internal energies of the two states considered as change of internal energy. $\Delta U = U_2 - U_1$

Similarly, in a chemical reaction, if U_R is the internal energy of the reactants and U_P is the internal energy of the products, then change of internal energy would be $\Delta U=U_p-U_R$

The internal energy of a system changes when (i) heat passes in or out of the system (ii) work is done on or by the system (iii) matter enters or leaves the system.

Conclusion

The internal energy depends upon the quantity of the substance contained in the system. Hence, it is an extensive property.

Internal energy is a state function. It depends upon the initial and final state and is independent of the path. For example, one mole of CO_2 at 300K and 1 atmospheric pressure will always have the same internal energy irrespective of the fact that it has been brought to these conditions from 500K and 5 atmospheric pressure or from 1000K and 10 atmospheric pressure. The internal energy of ideal gases is a function of temperature only. Hence, in isothermal processes, as the temperature remains constant, there is no change in internal energy. $\Delta E =$

Sign of \Delta U - ΔU is negative if energy is evolved, ΔU is positive if energy is absorbed.

The units of energy are ergs (in CGS system) or joules (in SI units). 1joule = 10^{7} ergs.



Heat – heat is a form of energy exchanged between the system and the surrounding because of the difference of temperature between them. It is expressed as 'q'.

Sign of q – when heat absorbed by the system from the surroundings is taken to be positive. When heat released by the system to the surroundings is taken to be negative.

Units of q –it is measured in terms of calories. "A calorie is defined as the quantity of heat required to raise the temperature of one gram of water through 1° C.

In SI system, it is measured in joules. 1 calorie = 4.184 joules, 1 joules = .2390 calories.

Heat is not a state function, because its values do not depend merely on the initial and final states but depend upon the path followed.

Work- work is said to have been done whenever the point of application of a force is displace in the direction of force. W=F x dl

F =magnitude of the force, dl =the displacement in the direction of the force

Two main type of work used in thermodynamics are (i) Electrical work (ii) Mechanical work

Electrical work

This type of work is involved in case of reactions involving ions. Force is the E.M.F and the displacement is the quantity of electricity flowing through the circuit. Hence, electrical work done = E.M.F x quantity of electricity.

Mechanical work or pressure

Volume work- this type of work is involved in systems consisting of gases. It is the work done when the gas expands or contracts against the external pressure (atmospheric pressure). It is a kind of mechanical work. The expression for such a work may be derived as: Consider a gas enclosed in a cylinder fitted with a frictionless piston.

Suppose, area of cross –section of cylinder = a sq. cm

Pressure on the piston = P (which is slightly less than internal pressure of the gas so that gas can expand). Distance through which gas expands = dl cm

Then as pressure is force per unit area, force (f) acting on the piston will be $f=P \ge a$

 \therefore work done by the gas (i.e., the system) = force x distance =f x dl = P x a x dl but ax dl = dV, a small increase in the volume of the gas. Hence, the small

amount of work (δw) done by the gas can be written as δw = P x dV if the gas expands from initial volume V₁ to the final volume V₂, then the total work done (w) will be

$$w = \int_{V_1}^{V_2} P.dV$$

If the gas expands against constant external pressure (irreversible expansion), the result may be written as

$$w = P \int_{V_1}^{V_2} dV = P (V_2 - V_1) = P. \Delta V$$

where $\Delta V = (V_2 - V_1)$ is the total change in volume of the gas.

w= -P. ΔV (for expansion, work is done by the system).

If the external pressure (P) is slightly more than the pressure of the gas, gas will be contract i.e., the work will be done by the surrounding on the system $V_2 < V_1$, w= P. ΔV

Sign of w- according to SI conventions, w is taken as taken as negative if work is done by the system, i.e., for work of expansion. $V_2 > V_1$ so that (V_2-V_1) is positive and hence w is negative and it is taken as positive if work is done on the system, i.e., for compression, $V_2 < V_1$ so that V_2-V_1 is negative and negative multiplied by negative will be positive.

Units of w – SI units of work are joules or ergs. 1 joules= 10^7 ergs, I joules= $1Nm = 1Kgm^2s^{-2}$

Work done in isothermal reversible expansion of an ideal gas: The small amount of work done, δw , when the gas expands through a small volume, dV, against the external pressure, P_{ext} is given by δw = -P_{ext} dV .However, for reversible expansion

 $P_{ext} = P_{int} - dp$ $\therefore \delta w = -(P_{int} - dp)dV = -P_{int} dV (dp x dV)$ is negligible) \therefore Total work done when the gas expands from initial volume V_1 to final volume V_2 ,

will be w=
$$-\int_{V_1}^{V_2} P_{\text{int}} dV$$

For an ideal gas, PV = nRT, i.e., $P_{int} = \frac{nRT}{v}$ hence, w=

$$-\int_{V_1}^{V_2} \frac{nRT}{V} dV$$

For isothermal expansion, T= constant so that, w= -

$$nRT \int_{V_1}^{V_2} \frac{1}{V} dV = nRT \ln \frac{V_2}{V_1} = w = 2.303 nRT \log \frac{V_2}{V_1}$$

Assignment

1. Which of the following is not an intensive property?

(a) entropy	(b) pressure		
(c) temperature	(d)	molar	
volume			

2. If temperature remains constant during the process, it is called an -

(a) Isothermal process
 (b) adiabatic process
 (c) isobaric process
 (d) isochoric process

- 3. In thermodynamics, a process is called reversible when
 - (a) surrounding and system change into each other
 - (b) there is no boundary between system and surrounding
 - (c) the surrounding are always in equilibrium with the system
 - (d) the system changes into surroundings spontaneously.
- 4. Which of the following statements is false?

- (a) work is a state function
- (b) temperature is a state function
- (c) change in the state is completely defined when the initial and final states are specified(d) work employee at the last fill
- (d) work appears at the boundary of the system.
- 5. An isolated system is that system in which
 - (a) there is no exchange of energy with the surroundings
 - (b) there is exchange of mass and energy with the surroundings
 - (c) there is no exchange of mass and energy with the surroundings
 - (d) there is exchange of mass with surroundings.
- 6. If there is no exchange of heat between the system and the surrounding during the process. It is called
 - (a) adiabatic process (b) isobaric process
 - (c) isothermal process (d) irreversible process.
- 7. Which of the following is not a state function
- (a) heat(b) internal energy(c) enthalpy(d) entropy

Answers to Assignment

(e).⁷ (e).³ (c).² (e).⁴ (c).² (e).¹

-0-



Author is M.Sc. (Chem.), M.Ed. and Advanced Diploma in German Language (Gold Medallist). She retired as a Principal, Govt. School Haryana, has 3-1/2 years' experience in teaching Chemistry and distance teaching through lectures on Radio and Videos. She has volunteered to complement mentoring of students for Chemistry through Online Web-enabled Classes of this initiative.

e-Mail ID: kumud.bala@yahoo.com

-00-

Education is the ability to listen to almost anything without losing your temper or your self-confidence.

– Robert Frost

The hand that rocks the cradle, is the hand that rules the world.

-W. R. Wallace

Page 49 of 50 1st Supplement Dt 1st May'17 to 3rd Quarterly e-Bulletin: Gyan- Vigyan Sarita: शिक्षा http://www.gyanvigyansarita.in/

SCIENCE QUIZ May'17

Kumud Bala

- 1. A student determines the focal length of a device 'X' by focusing the image of a distant object on a screen placed on the same side as the object. The device 'X' is a :
 - (a) concave lens (b) convex lens
 - (d) convex mirror (c) concave mirror
- **2.** Raisin absorbs water by (a) exosmosis

(c) plasmolysis

- (b) endosmosis (d) diffusion
- **3.** Not a type of reproduction, is
 - (a) fragmentation (b) vegetative propagation
 - (c) budding (d)
 - regeneration change
- 4. That smells like vinegar, is
 - (a) acetic acid (b) hydrochloric acid
 - (d) sodium hydroxide (c) lime water
- 5. When sodium hydrogen carbonate powder is added to acetic acid, a gas evolves. The statements which is not true for this gas, is
 - (a) it turns lime water milky
 - (b) it extinguishes a burning splinter
 - (c) it turns red litmus blue
 - (d) it is a colourless and odourless gas
- **6.** The solutions of blue colour
 - (a) solution of copper sulphate
 - (b) solution of ferrous sulphate
 - (c) solution of zinc sulphate
 - (d) solution of aluminium sulphate
- 7. During budding in yeast, the parent cell is divided by the process:
 - (a) cytoplasm and nucleus divides at same time
 - (b) the nucleus first divides then cytoplasm

(c) the cytoplasm first divides then nucleus	
(d) the cytoplasm and nucleus don't divide	

- 8. The scientist who discovered safety lamp for the safety of miners
- (a) Sir Humphrey Davy (b) Archimedes (c) Niels Bohr (d) Newton **9.** The fullerenes are
 - (a) C60
 - (b) C70 (c) C90 (d) all of these
- 10. Our ancestors imagined some figures in star groups and gave them specific names.
 - (a) constellation (b) seven stars
 - (c) small seven stars (d) figure stars
- **11.** The term vaccine was introduced by
 - (a) Charles Darwin (b) Edward Jenner
 - (c) Alexander Fleming (d) Robert Hooke
- **12.** Constituents of cell membrane is/are:
 - (a) phosphate proteins (b) Amino acids
 - (c) phosphor-lipid proteins (d) cellulose
- **13.** Primary building blocks of a DNA molecules are:
 - (a) nitrogenous bases, phosphate and ribose macromolecules
 - (b) nitrogenous bases, phosphate and deoxyribose macromolecules
 - (c) phosphorous bases, nitrogen and ribose macromolecules
 - (d) none of these
- 14. To bring down ice temperature to -9°C, we use (a) potassium nitrate (b) potassium nitride
 - (c) potassium chlorate (d) ammonium nitrate
- 15. The photosynthetic symbiont of a lichen is
 - (b) moss (a) legumes
 - (c) green algae (d) cyano bacteria

(Answers to this Science Quiz shall be provided in Supplementary e-Bulletin dt 1st June'17)

-00-

Answers to Science Quiz in April'17

Kumud Bala

8. (b) 9. (a) 10. (c) 11. (a) ANSWERS: 1. (b) 2. (a) 3. (c) 4. (a) 5. (c) 6. (a) 7. (c) 12. (b) 15. (a) 16. (b) 17. (c) 13. (b) 14. (a) 18. (b)

-00-

Page 50 of 50 1st Supplement Dt 1st May'17 to 3rd Quarterly e-Bulletin: Gyan- Vigyan Sarita: शिक्षा http://www.gyanvigyansarita.in/

Theme Song :

<u>PREMISE:</u> We are pleased to adopt a song " इतनी शक्ति हमें देना दाता....." from a old Hindi Movie Do

Aankhen Barah Haath दो आँखें बारह हाथ of year 1957, directed by The Late V. Shantaram. The lyrics are by Shri Bharat Vyas, singer Melody Queen Sushri Lata Mangeshkar, and Music Direction by Vasant Desai. It has become a widely accepted inspirational song and/or prayer in many educational institutions and socially inspired initiatives engaged in mentoring of unprivileged children. This newly formed non-organizational initiative, being selflessly operated by a small set of compassionate persons, finds its philosophy in tune with the song and conveys its gratitude to all he eminent persons who brought out the song in a manner that it has attained an epitome of popularity. While working its mission and passion, the group invites one and all to collectively complement in grooming competence to compete among unprivileged children. The song/prayer goes as under -

इतनी शक्ति हमें देना दाता, मन का विश्वास कमजोर हो ना हम चले नेक रस्ते पे हमसे, भूलकर भी कोई भूल हो ना ॥

दूर अज्ञान के हो अंधेरे, तू हमें ज्ञान की रोशनी दे हर बुराई से बचते रहें हम, जितनी भी दे भली ज़िन्दगी दे बैर हो ना किसी का किसी से, भावना मन में बदले की हो ना ||

इतनी शक्ति हमें देना दाता, मन का विश्वास कमजोर हो ना हम चले नेक रस्ते पे हमसे, भूलकर भी कोई भूल हो ना ॥

हम ना सोचें हमें क्या मिला है, हम ये सोचे किया क्या है अर्पण फूल खुशियों के बाँटे सभी को, सब का जीवन ही बन जाए मधुबन अपनी करुणा का जल तू बहा के, कर दे पावन हर एक मन का कोना ||

इतनी शक्ति हमें देना दाता, मन का विश्वास कमजोर हो ना हम चले नेक रस्ते पे हमसे, भूलकर भी कोई भूल हो ना ॥



Together Each Achieves More (TEAM)

Every end, so also end of this e-Bulletin, is a pause for a review, before re-continuing of a journey far beyond ...



