GYAN-VIGYAN SARITA: शिक्षा

A non-remunerative, non-commercial and non-political initiative to Democratize Education as a Personal Social Responsibility (PSR)

2nd Monthly Supplement dt 1st March'17 of 2nd Quarterly e-Bulletin

Contents:

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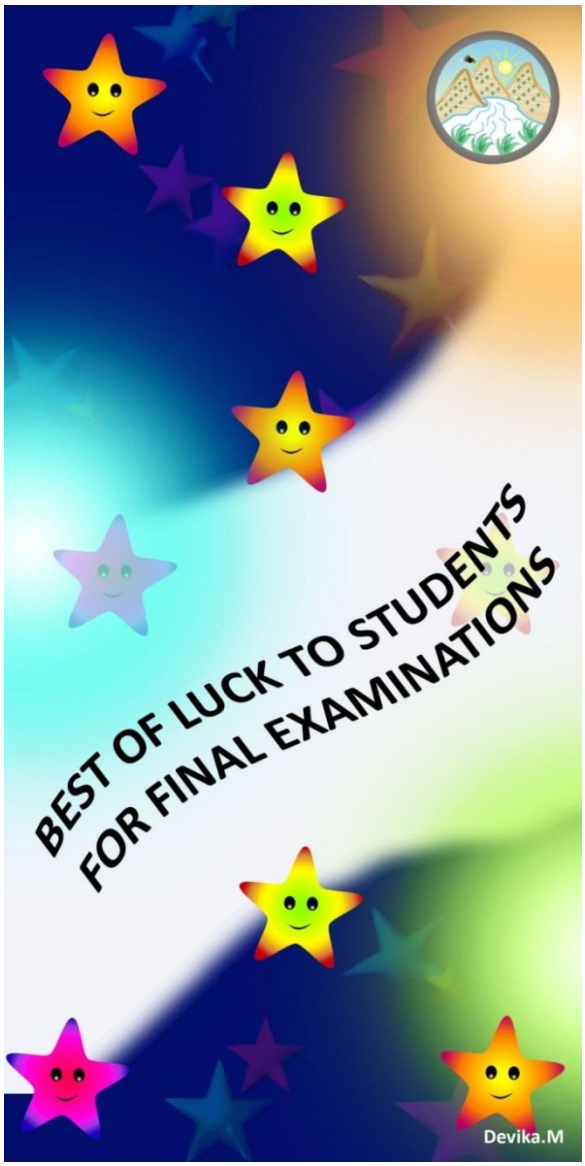

The man of knowledge must be able not only to love his enemies but also to hate his friends

- **Friedrich Nietzsche**

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Aim for the Best, but...

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

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संपादकीय

विकास के आधे-अधूरे सोच के शिकार : भारत के गांव

विश्व के सर्वाधिक जनसंख्या वाले देशों में भारत का दूसरा स्थान है। यहां विश्व की कुल आबादी का 17 प्रतिशत हिस्सा है। भारत में कुल बासित गांवों की संख्या 593731 है, जिनमें भारत की जनसंख्या का 72 प्रतिशत भाग निवास करता है।

मद्रास यूनिवर्सिटी में गिलबर्ट स्लेटर (Gilbert Slater) अर्थशास्त्र के एक प्रोफेसर थे। उन्होंने 1916 में कुछ दक्षिण भारतीय गांवों का सर्वे किया और एक पुस्तक प्रकाशित की, जिसका नाम था "Some South Indian Villages". उनकी पुस्तक के प्रकाशन के पचास वर्ष बीतने के बाद भी गांवों की स्थिति वैसी ही है, जैसी तब थी। कुछ भी नहीं बदला है। खेती का पुराना तरीका, गांवों से उत्पादों का बिक्री के लिये शहरों पर निर्भर रहना, शुरू में कौड़ी के दाम उत्पादों को किसानों द्वारा बेंचना और जरूरत पड़ने पर शहर से मंहगे भाव में खरीदना अभी भी कायम है।

संयुक्त राष्ट्र की एक रिपोर्ट के अनुसार भारत में कुपोषण के कारण मरनेवाले पांच साल से कम उम्र के बच्चों की संख्या प्रतिवर्ष दस लाख से ज्यादा है। 1947 में सामान्य जीवन 32 वर्ष का था। यह अब बढ़कर 65 वर्ष हो गया है, लेकिन गांवों में स्वास्थ्य सुविधायें लगभग शून्य हैं। अस्पताल कमरों में हैं, डाक्टर रजिस्टर में रहते हैं परंतु वास्तविकता में वे प्राइवेट क्लिनिक में पैसा कमाने में व्यस्त रहते हैं। दवायें आलमारी में रहती हैं और रजिस्टर में खत्म रहती हैं। स्कूल मकानों में हैं, पर वहां अच्छे अध्यापक नहीं हैं। अच्छे अध्यापक कोचिंगों और ट्यूशन केंद्रों में पैसा कमाते हैं। मजबूर होकर गांव का आदमी हर समय अपनी समस्याओं के समाधान के लिये शहर की ओर भागता है।

सरकारें जनता की भलाई के लिये कार्यक्रम बनाती हैं, पर जनता का उनसे भला नहीं हो पाता है क्योंकि जनता और सरकार की योजनाओं के बीच बेईमान राजनेता और लालची प्रशासनिक कर्मचारी भरे पड़े हैं जो सरकारी धन को अपनी सुख-सुविधाओं पर खर्च कर देते हैं।

14 फरवरी 2017 को, करीब दो दशकों से लंबित तमिलनाडु के पूर्व मुख्यमंत्री और अन्य नेताओं की आय से अधिक संपत्ति का मामला, सुप्रीमकोर्ट ने निपटाया। उनको दोषी पाकर, उनको जेल की सजा और आर्थिक जुर्माना किया। इससे पता चलता है कि हमारे जनप्रतिनिधि अत्यंत भ्रष्ट और लालची हैं। इनका ध्येय जनसेवा करना कम और धन-संग्रह करना ज्यादा है। इन सजाओं से न तो किसी को शर्म आयी, न पछतावा हुआ और न ही किसी ने कोई सबक सीखा।

महात्मा गांधी के अनुसार, जो गांव अन्न के उत्पादन का केंद्र होना चाहिये था, हर सुविधाओं से संपन्न होना चाहिये था, सामाजिक चेतना का केंद्र होना चाहिये था, पंचायती राज की भूमिका में अग्रणी होकर देश को राह दिखाने वाला होना चाहिये था, वह गांव आज पीने के पानी, स्वच्छ शौचालय और बिजली जैसी जरूरतों के लिये तरस रहा है। गांवों में औद्योगिक ईकाइयों का अभाव है। रोजगार के अवसर नहीं हैं। मजदूरी भी लगभग खत्म हैं।

गांव के लोगों ने वर्षों से चले आ रहे जाति-पांति के झगड़ों, महिलाओं पर अत्याचार, जमीन के आपसी विवाद, भाई-भाई के मनमुटाव, आदि से कोई सबक नहीं सीखा। इससे भी कोई सीख नहीं लिया कि जमीनों को बांटकर छोटी करने से वे उत्पादन की दृष्टि में बेकार हो जाती हैं, अंततः बिककर बड़ी जमीनों का हिस्सा बन जाती हैं और जमीन मालिक बेरोजगार हो जाता है।

सरकारें अपनी कुर्सी बचाने के लिये तात्कालिक लाभ के काम करती हैं जिससे गांवों का विकास नहीं हो पाता है। वे विकास की दीर्घकालिक योजनायें नहीं बनाती हैं। वे गांवों को कम और शहरों को ज्यादा सुविधायें देती हैं। गांव के बच्चों को लैपटाप बांटती हैं और शहर के लोगों को बिजली। वे भूल जाती हैं कि लैपटाप चलाने के लिये बिजली भी गांव में होनी चाहिये। इंटरनेट देती हैं पर स्पीड बेकार रहती है। विश्व के अन्य देशों की तुलना में भारत के गांवों का विकास बहुत धीमा है।

आजकल गांव एक नयी समस्या से जूझ रहे हैं और वह है: बढ़ती आत्महत्या की घटनायें। गांवों से पलायन करके युवा शहर जाते हैं। वहां शहरी सुविधाओं का उपभोग कर उसके अभ्यस्त हो जाते हैं। कुछ दिन बाद जब शहर से फिर गांव आते हैं तब वे मोबाइल, कम्पयूटर,

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टीवी, फार्म हाउस, विदेश यात्रा, आदि के सपने देखने में ही मस्त हो जाते हैं। सपने पूरे करने के लिये कर्ज लेते हैं। कर्ज चुकाने में असमर्थ रहने के बाद गलत कामों में लगते हैं और अंत में आत्महत्या कर लेते हैं।

आंकड़े बताते हैं कि करीब 90 लाख लोग प्रतिवर्ष गांवों से पलायन करते हैं। उत्तर प्रदेश, बिहार, मध्यप्रदेश, पंजाब, राजस्थान, उत्तराखंड, जम्मूकश्मीर और पश्चिम बंगाल ये आठ वे प्रदेश हैं जहां से सबसे अधिक पलायन होता है। दिल्ली, महाराष्ट्र और तमिलनाडु ये तीन वे प्रदेश हैं, जहां सबसे अधिक लोग पलायन करके पहुंचते हैं। भारत में पलायन के प्रमुख कारण हैं: खाने के लिये नहीं मिलना, भूखे रहना, भुखमरी का शिकार होना, और काम करने के लायक होते हुये भी काम नहीं पाना।

जनप्रतिनिधियों की सोच है कि यदि गरीबी, अशिक्षा, कमियां दूर हो गयीं तो लोग उन्हें पूछेंगे नहीं, उनकी राजनीति की चक्की बंद हो जायेगी, और कमाई का धंधा खत्म हो जायेगा। जनता जितनी कमी में रहेगी, नेतागिरी उतनी उंचाई पर रहेगी। हमारे राजनेताओं ने ऐसा व्यवहार करना शुरू कर दिया है जैसे तानाशाह हों। किसी ने हमें एक कहानी सुनायी जो यहां लिखना उचित रहेगा। एक दिन एक तानाशाह एक मुर्गे के साथ अपने अधीनस्थों के पास आया। उसने बिना बोले मुर्गे का पंख नोचा और जमीन पर तड़पता हुआ फेंक दिया। सभी देखनेवाले अचरज में थे कि यह कर क्या रहा है। थोड़ी देर में उसने जेब से कुछ दाने निकाले और उस मुर्गे की ओर फेंक दिया। मुर्गा दानों की तरफ घिसटते हुये आकर दाना चुनने लगा। अपनी पीड़ा भूलने लगा। फिर उसने कुछ और दाने फेंके, उसने फिर से उन्हें चुग लिया। अब उसने अपने अनुयायियों से कहा देखा इस मुर्गे को ! ठीक इसी प्रकार हमें जनता को रखना चाहिये। चाहें जितना अत्याचार करो, कुछ समय बाद उसे कुछ दे दो, वह अपना सब दुःख भूल जायेगी और तुम्हारी ओर फिर से चल पडेगी। इसे जितना तड़पाओगे, उतने अधिक दिन राज्य करोगे।

आजकल पंजाब, उत्तर प्रदेश, उत्तराखंड, मणिपुर, और गोवा में विधानसभाओं के चुनाव की सरगर्मी है। सफेद कपड़ों में नेता जनता के पास अपनी विकास की योजनायें लेकर पहुंच गये हैं। शोर मचा रहे हैं कि वे गांव की समस्याओं का हल निकालेंगे, पर वे यह नहीं बताते कि इन समस्याओं का हल आजादी के लगभग 69 वर्ष बाद भी क्यों नहीं निकला और यदि नहीं निकला तो जो लोग इसके जिम्मेदार थे, उनके विरूद्ध क्या कार्यवाही करेंगे?

गांवों के विकास के लिये जिम्मेदार, प्रशासक और राजनेता विकसित माहौल में बैठकर दयनीयता के बारे में विचार करते हैं। उनका काम ठीक वैसा ही होता है जैसे किसी ने रेगिस्तान खुद न देखा हो, और रेगिस्तान में पानी की व्यवस्था करने की तरकीब सुझा रहा हो। जो गांव देखा नहीं, वह गांव की समस्या को जानेगा कैसे? जो पानी में गिरा नहीं, वह तैरना सीखेगा कैसे? जो गाड़ी की सीट पर बैठा नहीं, वह गाड़ी चलाना सीखेगा कैसे? जो कभी बोला नहीं, वह बोलना सीखेगा कैसे? जो कभी लिखा नहीं, वह लिखना सीखेगा कैसे? जो कभी चला नहीं, वह चलना सीखेगा कैसे?

समस्याओं और उनके निदान के बारे में सोचना, खोज करने जैसा होता है। समस्यायें वैसी ही होती हैं, जैसी वे दीखती हैं। उनका हल वहीं मिलता है, जहां वे पैदा होती हैं। समस्यायें तुरंत हल ढूढती हैं, पर हमारे जन प्रतिनिधि इन समस्याओं के समाधान में इतने वर्ष बिता देते हैं कि या तो समस्यायें समाप्त हो जाती हैं या फिर उनसे प्रभावित व्यक्ति समाप्त हो जाते हैं।

हाल ही में, विकास करने का जज्बा, छत्तीसगढ़ के बस्तर जिले के पहाड़ी गांव बारूपाटा के लोगों ने दिखाया है। उन्हें स्कूल, अस्पताल, बाजार आदि के लिये 12 किमी दूर लोहाड़ी गुड़ा जाना पड़ता था। उन्होंने प्रशासन से कई बार मांग की कि उनके लिये कम लंबा रास्ता बनवाये। पर किसी ने उनकी नहीं सुनी। अंत में उब कर खुद ही पहाड़ी काटकर सड़क बनानी शुरू कर दी। आज वे चर्चा में हैं।

सच्चाई यह है कि शहर विकास करते हुये चमकते जा रहे हैं और गांव अंधेरे में डूबते हुये परछाइयां बनते जा रहे हैं। सरकार शहर में रहती है। सरकार के सभी अधिकारी शहर में रहते हैं। जनता के सभी प्रतिनिधि एम0एल0ए0 व एम0पी0 शहर में रहते हैं फिर विकास गांव का कैसे होगा? हम गांवों का विकास तब कर पायेंगे, जब हम गांव से ही विकास करने वाली योजनाओं को शुरू करेंगे। हम ऐसा तब कर पायेंगे, जब हम गांव की बात करना बंद करेंगे और गांव के लिये काम करना शुरू करेंगे। यदि हमारे पास गांवों का भविष्य देखने की योजना नहीं है तो यह सच मान लेना चाहिये कि विकास का भविष्य हमारे भूत की परछाई ही होगा।

आइये, हम ज्ञान विज्ञान सरिता परिवार से कुछ सीखें। इसने गांव के उन बच्चों को आगे बढ़ाने की तैयारी की है जिनके पास सुविधाओं की

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संख्या शून्य है। वे बच्चे कक्षा 9 से कक्षा 12 तक के विद्यार्थी हैं। इसके शिक्षक कई देशों में तथा अपने देश में कई भागों में हैं। वे इंटरनेट के माध्यम से सीधे बच्चों से उनकी बात सुनते हैं, उनकी समस्यायें सुनते हैं, और फिर उनको उनका भविष्य संवारने में अपना कीमती समय देते हैं। वे शिक्षा देने का कोई मूल्य नहीं लेते हैं। ये वह शिक्षक हैं जो किसी भी अच्छे स्कूल, अथवा कोचिंग संस्थान के शिक्षक से कई गुना अच्छे हैं और अपने विषय के जानकार हैं। विश्वास है ज्ञान विज्ञान सरिता परिवार का प्रयास व्यर्थ नहीं जायेगा क्योंकि उसकी शुरूआत एक सच्चे मन से है, और उद्देश्य एक सुविधाहीन को उसके दरवाजे पर ही उत्तम सुविधा देने की है। सफलता हमेशा अपनी अच्छाइयों को बढ़ाते रहने से मिलती है, न कि बुराइयों को कम करने की सोचने से। देर से ही सही, एक प्रयास तो करो।

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ABOUT US

This is an initiative, not an abrupt eruption, but driven by spirit of returning back to society with a spirit of Personal Social Responsibility (PSR) by a team of co-passionate persons who have survived many decades of rough weather conditions. It is not an organization, and it aims at Democratization of Education, in spiritual sense.
It works on non-remunerative, non-commercial and non-political manner. Its financial model is based on Zero-Fund-&-Zero-Asset, wherein participation is welcome from those who wish to contribute, with तन और मन. As and when the feel need of धन to supplement the initiative ownership of Funds and Assets is theirs, we are just user if it.

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 **Mentor's Manual** is being developed to support the cause.
- We are implementing this philosophy through **Online Mentoring**

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I never considered a difference of opinion in politics, in religion, in philosophy, as a cause for withdrawing from a friend

- **Thomas Jefferson**

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Coordinator's Views

OMS- AN INTROSPECTION

Online Mentoring Sessions (OMS) *is an outcome of continuous and consistent introspection of Chalk-N-Talk educational initiative for about Four years with a sense of* ***Personal Social Responsibility (PSR)*** *taken up after 2012 by a person, after his superannuation, in a non-remunerative, non-commercial and non-political manner. The initiative is focused to groom competence to compete among unprivileged children. Nevertheless, it is indiscriminative towards children from privileged families who are prime target of commercialization of education. Such children, when exposed to the selfless initiative of this kind are bound emerge as a citizen with a sensitivity towards their roles and responsibilities for unprivileged persons, eventually perpetuation of PSR.*

OMS has following few simple and unique features which are –

- Four co-passionate persons are collectively complementing to mentor Online the target children in mathematics, physics and chemistry, at personal level and not as an organization. One is a middle aged IT Professional and an alumnus IIT Kharagpur from Texas who mentors on weekends, Second persons is an alumnus from IIT Kanpur and a retired professor of Mathematics mentors on weekends. Third is a lady retired as Principal from Government School Haryana who Mentors Chemistry Thrice a day and Fourth person is a retired power sector engineer and an IIT Roorkee alumnus who mentors in mathematics and physics and also is a coordinator of this initiative.
- Mentoring is done past to 8th class passed students and is continued upto class 12th, until these students take competitive examination for selection in professional studies.
- Mentoring focuses on conceptual clarity, and neither at passing examination or securing marks. This along with the starting level is a considered decision keeping in view requirements specific to proficiency in mathematics, physics and chemistry for competitive success.
- Thus it does not conflict with the school curriculum. Accordingly, mentoring hours are aimed at outside school hours, unless insisted upon otherwise.
- It requires learning centers, where OMS sessions are held, to be facilitated by school, institution or local group/bodies which includes creation of infrastructure and its maintenance. This is essential because none of the target students can afford IT setup required to avail benefit of OMS.
- Facilitators are required to organize a subject-coordinator for each session of OMS to bridge learning gaps, if any, and ensure proper handling of IT setup. In process, these coordinators shall be benefited by capability transfer and enabling them to perpetuate the OMS like a chain reaction.
- It uses common purpose IT set up and internet facility on Google Hangouts platform which enables free connectivity upto Fifteen nodes. This is considered to be good enough for OMS and invoke group interaction among students spread across Thirteen learning centers; Two nodes are kept reserved for mentors and collaborators.
- With more passionate individuals volunteering to collectively complement in OMS, such autonomous systems, limiting to 15 nodes, can be created which have interdependence in sharing of experience, expertise and knowledge resource.

Opportunities in OMS: The inception and persuasion of OMS by a small set of co-passionate and dedicated elite persons with the spirit outlined above offers many opportunities as under –

1. **Connect passionate teachers and ambitious students:** In the prevalent commercially driven educational environment students that are targeted for grooming competence to compete, are complacent with their socio-economic-cultural constraints and rendered hopeless.
2. **Technological Solution:** In a situation where passionate and dedicated mentors are disconnected by geographical, health and other compulsions, Web-enabled Online Mentoring is an alternative to Chalk-N-Talk, confined in one room.
3. **Diversity:** Web-enabled Online Mentoring is an interactive environment where students' response of students is perceivable to the mentor, as much as students can raise questions and doubts to the mentor. Mentor, instead of teacher, tutor or a coach, is a considered expression and is in line with the philosophy of the initiative.
4. **Optimization:** In case of mentoring, Chalk-N-Talk is an undisputed upbeat. But, efforts of link the disconnection of passionate teacher and students Video Session (VS) suffers from Online interactive facility. Any efforts to embed interactive environment in VS is not new; but, this is quite expensive and is, therefore, prevalent only at commercial scale. These compulsions, for passionate and dedicated elite groups working selflessly, makes OMS is an optimal solution.
5. **Collectively Complementing:** Elite persons are driven by many compulsions to sustain the life that they are leading or have lead. In such a situation, despite a desire and preparedness to move out in discharge of PSR creates boundaries of expertise, time, location etc. Jig-Saw puzzle is not a childhood proposition but a real-life proposition. Accordingly, an effort to connect elite persons, who have capability to contribute, can create an environment where they collectively complement to create an optimistic

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environment for unprivileged person to aspire for coming out of pessimism and complacency.

6. **Experience to walk an extra mile:** Tends of increase in longevity with better health conditions is an opportunity for senior to make their time more purposeful and useful to those marginalized section of society. OMS environment offers an opportunity to work from place of their stay. Even, youngsters can deploy their passion for the larger good from their place of work or stay, as being done by a mentor from Texas.
7. **Transfer of capability:** OMS, being outside the school curriculum, neither renders commercial concentration of wealth nor clips job opportunity for aspiring teachers. Involvement of teachers as coordinators is helpful in enriching teaching resource through capability transfer from experienced and highly qualified passionate mentors.
8. **Model:** It is an open model which is scalable, replicable and upgradable without any kind of inhibitions to encompass as many elite persons as can be motivated.

Challenges in OMS: All that glitters is not gold and readers are advised not to get swayed away with all the fascinating opportunities. It is fraught with many challenges that are being encountered in pursuance, stabilization and scaling of OMS. These challenges, based on ground level experiences are being shared, to invite carefully considered participation,

- **Attendance:** Getting unprivileged children to study is toughest. Their socio-economic culture induces them to assist their parents in their work or vocation. Government has implemented many programmes of free lunch, scholarship, while individuals and social group extend their benevolence in distributing freebies. Despite, ground reality is that attendance in school and learning are compromised, and motivation to learn remains at its lowest ebb.
- **Availability of Teachers:** Migration of educated persons to cities is causing an acute shortage of teachers in rural and backward areas where density of unprivileged students is highest. As a result in such schools either teachers are not there, or they stay in nearby cities, which eventually reduces their availability at school.
- **Pride of Teaching Profession:** It is an unpleasant fact that drift of educated people towards more paying jobs is creating a vacuum of passionate teachers. And those in teaching are swayed towards coaching and tuitions to survive in glamour of prevalent commercialization. Eventually, teaching at school has reduced to proforma entry.
- **Learning of Mathematics and Physics:** These two subjects contribute in making thought process logical and responsive. Despite, phobia for these subjects percolate down and is rampant among first generation students. These subjects are closely interlinked and require correlating these subjects with the life of students, taking examples drawn from their environment. This requires passionate teachers to create a thrill of learning among students, and more particularly unprivileged ones. Without prejudice to other subjects, ability to perceive a problem and evolve its solution is enriched through these subjects, and this ability is of most avail in life as one grows, be it any walk of like.
- **Role of Coaching and Tuitions:** These are driven with commercial objectives, and competition among them is based on success in exams. This eventually drives students from means, i.e. conceptual clarity, to ends, i.e. success. Growing competition among coaching institutes, driven by parents aspiring to spend more a better fortune of their children, to invent shortcuts for better performance. It is appalling to notice that even domestic helps in cities, and in tehsil places vicious traps of coaching and tuition is so rampant, that performance of schools is a contribution of coaching and tuitions, involving either teachers at regular schools or those who could not even get into teaching jobs. There is a severe erosion in objective and value of education. There is a wrong perception; quality of education which is proportionate to the cost of it.
- **PSR Driven Mentoring:** This is driven by accomplished persons passionate and dedicated to return back to the society through imparting education with continuity, consistency and perseverance in a process to infuse conceptual clarity are received equally by affluent and unprivileged children. Children in affluent families see it as a matter of below dignity to receive painstaking free mentoring, while for children education from unprivileged children it is unsuitable for a quick result, come what may. Both the segments of society are unable to appreciate that there are no shortcuts in knowledge and excellence, one has to do self-carving. In such a scenario choice of selfless mentoring at a back seat. It is evident from the fact that even well qualified persons, who can mentor their child, find economics in engaging a tutor.
- **Availability of Coordinators:** In OMS, which is a sub-optimal choice specially due to non-availability of teachers, presence of Class-Subject coordinators during mentoring sessions at learning centers is extremely important to improve efficacy of OMS. But, in a commercially driven educational environment where teaching at school is a formality and induces students to join coaching/tuitions finding local teachers to act as coordinators after school hours is a million dollar question. Success of OMS requires a respectable incentive to coordinators, even when elite class engage with PSR.

  Further, coordinator has an important role to play is that of motivating marginalized students to pursue education with perseverance, which is difficult for a mentor who is remotely placed.
- **Scheduling OMS:** Difficulties of holding students during school hours, compounds problems of holding students and coordinators after school hours as envisaged in OMS. It is seen that scheduling OMS during school suffers severely due schooldays available in a session and multifarious activities.

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Moreover, school curriculum is designed to cater to average cross-section of students decided at state or national level. While, OMS is focused on motivating students and pursuing them to gain competence to compete. This requires, extending motivation such that none is deprived of it. And, those responsive to the motivation are impressed upon need of continuity of OMS irrespective of school hours, holidays and vacations. Such desirous students are included in OMS by learning center. It is big challenge and an opportunity for coordinators, facilitators and motivators. In this remotely placed mentor can at best extend his vision and do counseling to all concerned; success of OMS depends upon collective complementing of efforts.

- **Structuring of Batches:** At present there is a wide diversity among students of OMS and it is in terms of time of joining, hour of the day, medium of learning, and background. Ordering of batches is a solution in such diverse group of students. But, any kind of classification and/or ordering is possible only when group size is reasonable. Present challenge is to have students first and then structure batches. Sudden, absence at OMS, with only one learning center renders mentoring slots vacant, and when all diverse learning centers respond it becomes too pressing for passionate persons who are committed to mentor. This requires getting across learning centers to optimally utilize full capacity of nodes and start OMS in 1st week of April. This will not only resolve the diversity crisis, but also induce cross-motivation and competition through group dynamics among students at different learning centers. This is the fringe benefit of OMS.

  At Jhabua, a tribal place, where OMS was started in July'16, has after multiple trials has settled down at 25 students of Class 9th in mid of Jan'17. This has improved frequency of OMSs as much as its intensity where, students are raising their difficulties. This has been possible with the concern of district administration towards education and reciprocation to it by school administration. It is intended to be continued more vigorously for such a group of 25 students desirous of taking OMS sincerely and regularly.

  This initiative has been taken to couple of more such learning centers. But, it aborted prematurely in 2-3 months due to unpreparedness of the people, at the helm of affairs, to reciprocate to motivational needs of students and coordinators.
- **Technological Constraints:** The IT setup in use at OMS is a set of general purpose equipment. The challenge is of getting requisite bandwidth for seamless continuity in OMS. Tariff plans provided by ISPs have linking between data capacity (MB) and data speed (Mbps). Going for higher data capacity is assured with higher data speed and once despite tariff plans being unlimited, on exceeding data capacity data speed from Mbps slashes down to few kbps. At Jhabua, a tribal district in MP, district administration has permitted use of SWAN (State Wide Area Network) for OMS. Though issues of backbone network prevail, it has rendered higher internet data speed and availability. Looking forward, it is envisaged that with the growing and strengthening of communication network situation will improve.

Way Forward:

- Plan for start of OMS in April, beginning of academic session.
- Put in place necessary ground work to motivate students and coordinators to benefit from OMS, and complete it in Feb/March before end of academic session.
- Organize requisite IT Setup with whatever is available.
- Open the OMS model to elite group to collectively complement in mentoring, coordination, facilitation promotion without inhibitions, but to maintain spirit of the mission.
- Evolve incentives for coordinators to ensure continuity and consistency of their participation after school hours, holidays and vacations.
- Identify promising 2-3 students among the selected group to handle IT setup and communicate with the remote mentor in the event of non-availability of coordinator, and recognize their efforts.
- Connect learning centers to each mentor, based on his/her preparedness to handle multiple batches concurrently; progressively more learning centers can be added. Most of such persons are passionate for the cause, but may not have been regular teachers.

Summary: With ground level experience of opportunities, challenges and constraints during last five years it is relevant to get out of the paradox "***first egg or hen***" and start with whatever is available. In prevailing sadistic scenario "***something is better than nothing***", as long as it is with a sincere perception and with a spirit of selfless mission and vision to meet the challenges of OMS. This will help to pass on its merits and opportunities that it offers, to those who need it most. In addition it requires proper communication, consideration and understanding across all players in OMS; this will reduce variance of expectations and perceptions among them, a necessity for success in any mission. *This article is an effort to align all that.*

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Nearly all men can stand adversity, but if you want to test a man's character, give him power

\- **Abraham Lincoln**

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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) Mathematics, b) Physics , and c) Chemistry. 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 ***Permutations and Combinations*** in Mathematics, ***Waves and Motions –PartII*** containing to Sound Waves and Light Waves in Physics and ***Shapes of Orbitals*** in Chemistry.

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After all, the best part of a holiday is perhaps no so much to be resting yourself, as to see all other fellows busy working

- **Kenneth Grahame**

To have once been a criminal is no disgrace. To remain a criminal is the disgrace

- **Socrates**

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Invitation Article

Global Financial Architecture Needs New Approach

Madhu Bala Nath

The global financial architecture comprises of institutions like the United Nations, the International Monetary Fund and the World Bank, etc. The function of our global financial architecture is primarily to ensure that the global capital is employed to the best opportunity from people / institutions who have it to the people / institutions who need it. If someone asks: Has this architecture succeeded in generating and moving wealth in an equitable manner to promote sustained economic development? The answer to this remains mixed. Terms like, 'the crash of the Asian economy', 'the theory of the economic bubble', 'the concept of risk markets', 'the risk of cycles' all portray this mixed response.

The financial turmoil in East Asia in 1997-99 demonstrated the risks of global financial markets. Net capital flows to Indonesia, Korea, Malaysia, the Philippines and Thailand rocketed in the 1990s reaching $93 billion in 1996. As turmoil hit market after market these flows reversed overnight with an outflow of $12 billion in 1997.

What does this mean for sustainable economic development? The human impact of such vagaries of the market are severe and likely to persist long after economic recovery.

The impact on the lives of men and women relates to loss of jobs, fall in real wages, reduced access to health and education facilities, increased violence and crime, all culminating in a depletion of social capital.

Education and health budgets came under pressure: In Thailand with the collapse of the financial markets the budget of the Ministry of public health was reduced by 10% and the community and social services budget by 7.6%. In the Philippines the health expenditure declined by 10% as well. In Thailand one study estimates that nearly 100,000 students were not pursuing either primary or secondary education because of the crisis. In Korea enrolment registered small declines at primary and middle school levels. But drop-outs at the higher level increased by 36% in 1998.

Loss of jobs: During the east Asian crisis more than 13 million people lost work. A total of 435 Malaysian firms were declared bankrupt in the nine months from July 1997 to March 1998. Such bankruptcies are a loss of livelihood for owners and employees of small firms, which unlike large businesses and banks did not receive rescue packages. Unemployment that was virtually unknown for many years rose in all countries – by 0.3 million in Malaysia, 0.5 million in Thailand, 1 million in Indonesia and 1.5 million in Korea. Job losses hit women, the youth and uneducated and unskilled workers the hardest.

Social unrest, crime and violence followed: Argentina and Indonesia are recent examples. In Korea the hotline for women received escalating numbers of calls from women suffering domestic violence – seven times as many as in the previous year.

The depletion of human and social capital: The above deplete social capital which needs to be generated with care and support**.** Fiscal pressures on the state however put a resource squeeze on public spending on healthcare services. Furthermore the marketization of care has meant that cost minimizing standards are having a negative impact on the quality of health care. Above all people who need care the most cannot afford to pay for it as it is getting transformed from being an "entitlement" to a service that can be purchased.

Lessons Learnt: Learning from these situations, it is therefore clear that initiatives are promoted to make education and employable vocational skill development, accessible to large numbers of men and women so that they can withstand the onslaught of such volatilities. Investing in education and human resource development is in fact a survival strategy. There is a need for education to avail the benefits of the financial markets through new technology, the need for state subsidies to even purchase of a computer that is critical for participation and inclusion in development, the need to know English prevails in most of the websites. 80% of all websites are in English yet less than one in 10 people world-wide speak it.

Keeping the volatile nature of global wealth generation in view, it is becoming imperative to finance and support women and men to develop a portfolio of income earning activities including petty trade, services and artisan production to meet the increasing vulnerabilities. Reaching out through not just formal but also informal ways of teaching and learning is the need of the hour. The beginnings of this approach are encouraging. Projects like the sericulture *tussar* project for Bhil women in *Surguja* in Madhya Pradesh, the *Durry* making projects for Bhil tribals in Jobat in **Jhabua district**, the mulberry sericulture projects in *Jhadol* and Girwa blocks of Udaipur district in Rajasthan have proven that state governments are serious about human resource development.

I had the opportunity to work closely with the State Tribal Area Development Departments as the Regional Adviser working for the United Nations Development Fund for Women. As I look back into the eighties I see young men,

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project officers, field workers, extension officers who ensured with their commitment that the Bhils move up the vertical ladder of skill. I can see in the nineties young men and women from Astha the NGO that partnered the government in these initiatives, determined to make the empowerment of the Bhil women a reality so that they could frame their own destinies with enhanced incomes and reduced deprivations. Today I know that in the desolate lands of **Jhabua**, Surguja, Jhadol and Girwa, the silk and cotton fibres had launched a new life.

By the time the project period was over, the Bhil women had become alive to the issues that governed their lives. With the economic empowerment through the sale of silk cocoons in the markets, they gradually became pressure groups, questioning *Anganwadi* teachers who did not give adequate meals to the children. They demanded timely rations from the ration shops and fought misappropriation by the public distribution system. Social evils like wife swopping were questioned and discussed and the women in their *Mahila Mandals* lobbied with the village leaders to impose a fine on such practices.

The success of foreign development capital made into these initiatives by Japanese funding through the United Nations was studied by the World bank and a the critical elements of success were included in a multi-million dollar investment by the World Bank for promoting sericulture in seventeen states of India in the early nineties.

This left little doubt that educating people and moving their skills up the ladder have been strategies with a potential for attracting foreign direct investment. Foreign direct investment in India was insignificant in 1980 but rose to $1.2 billion in 1988 & $2.5 billion in 1994. It was Dr. Manmohan Singh and Mr. P.V Narasimha Rao, who brought foreign direct investment to India which subsequently generated more than a crore jobs. Today India has been providing incentives for research and development and working with foreign multinationals in high tech areas besides educating people and moving their skills up the ladder for attracting foreign direct investment. In 2015, India overtook China and the United States as the top destination for foreign direct investment. By 2015, India had attracted $31 billion in foreign direct investment compared to $ 28 billion by China.

But India is still not in a position that can make the Indians secure and safe from the ill effects of a sudden reversal of capital flows. Investment in human resource development is now a priority but the programs set up by the government like the National Skill Development Mission or programs that improve access to education like mid-day meals are still not robust enough to show lasting results.

Rethinking is going on in the minds of those who can make a difference. There lies a hope too for all who are envisioning the development from the perspective of those who have so far been left behind in this process.

Author is currently Country Representative and Country Director of Engender Health in India. She started her career in early Eighties as a Women Development Officer with the Swedish International Development Authority, (SIDA). Since then she has been associated with various international organization on the cause of women.
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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: शिक्षा,*** *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* ***20th of this month*** *to enable us to incorporate your contribution in next bulletin, subhashjoshi2107@gmail.com.*

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

- ***3rd Quarterlyy e-Bulletin Gyan-Vigyan Sarita: शिक्षा shall be brought out 1st April'17***
- ***And this cycle monthly supplement to Quarterly e-Bulletin Gyan-Vigyan Sarita: शिक्षा 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.

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MAKE A WISH, TAKE A CHANCE AND MAKE A CHANGE

Sandhya Tanwar

Make a wish and place it in your heart, now believe in it. All you have to do is to turn 'I Wish' into 'I Will'. Only we have the power to convert our wishes into reality. I read somewhere that 'God helps those who help themselves'.

Everybody is acquainted with the old tale of 'Aladdin and the Magic Lamp'. Where Jinn was rescued by Aladdin and in return, he used to fulfill his master's wishes. Unfortunately, in this practical world, there is no Jinn, who will make our wishes true. Dreams come from wishes and when they turn into reality, that moment is the happiest moment. We have to take charge of our happiness and only we have to work on achieving our dreams.

When we make a wish, we repeatedly start thinking about it. And when we do that, these wishes acts like a magnet and we automatically start building plans and dreaming about it. We start visualizing, as if it has already taken a shape of reality. And it feels like the Universe has started making conspiracy for getting it closer to you. One by one, day by day, we get start constructing new plans for attaining it.

This theory really works. I have experienced it many times. For instance, I always wanted to own a car and drive it like an expert. I never liked it when I have to request my family members/relatives to provide me with the pick and drop facility for urgent matters. I was always dependent on others for such matters and wanted to be independent. So, I made a wish, to own a car and drive it on my own. I started dreaming and visualizing about it. Today, I own a car and driving it nicely. This was almost impossible for me because of certain challenges, but despite of that, I didn't stop dreaming about it - that one day I will own it. I always had faith, belief in myself and a positive feeling that one day my wish will surely come true, sooner or later.

To share another experience, I have desired for learning at least one musical instrument i.e. Guitar.

It happened so that I found a music academy which was just at a distance of 10 minutes from my place. This academy is six years old and I never saw it, till the time I have desired for it, it was hidden from my sight all the time, even when I have crossed that path thousand number of times. Guitar is really tuff to learn, but I had just one wish in my mind that I have to play it like a rock star. So I started practicing it more and more. Today, I know how to play it (not like a rock star, but yes I can play it quite well now). I am still working on this dream. It was that positive feeling and desire that drove me to do what I have desired for.

Have you ever realized that if one wrong thing happened with us in the morning, sometimes, the whole day went on like that? One after another, everything goes wrong that day and at the end of the day, we sense like it was a very terrible day, just because it started like that. Have you ever given a thought as in why, just because one wrong thing happened at the beginning of the day has spoilt it in totality? There is a reason to it, because, your day was started with one tiny wrong thing and you gave the whole focus and energy to it. One negative thought attracted many other negative thoughts and the whole day turned into a bad one.

We have the power to get whatever we want. We just have to put our energy into it. Don't waste your energy into negative thinking, thinking about negative people, think only positive and these positive thoughts will act like a magnet for attracting your dream towards you. You will see that, sequentially, the Universe is pushing you closer to reach to your goal.

Isn't this theory amazing? This will work in all areas of your life, be it personal or professional. Make a wish, dream about it, believe in it, visualize it, be positive about it, take the chances and make it happen. There are so many people out there, who will say - You Can't. What you've got to do is to turn around and say 'Watch Me'. Wish it, dream it and do it. YOU ARE NEVER TOO OLD TO MAKE A NEW WISH OR TO DREAM A NEW DREAM.

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Contents

GROWING WITH CONCEPTS - Mathematics

PROBABILITY

Prof. SB DHAR

Measure of various phenomenon generates the theory of probability. If we do some experiment, then there are two possibilities: either *the result is known* or *the result is not known*. The experiment whose result is known is called **deterministic experiment**. All science experiments under the similar conditions may be named so. The experiment that does not produce the same result if performed under the same identical conditions is called the **random experiment**. The **theory of probability** starts from the random experiment.

Tossing of a fair coin having Head on one side and Tail on the other side may result in any one (i.e. head or tail), but the double headed coin i.e. having heads on both sides only will always result in Head. First one is deterministic while the other case is of the random experiment.

Note:

(a) Probability or the theory of probability is a branch of mathematics that deals with the measurement of the likelihood of an event or experiment to have a particular outcome quantitatively.

(b) Probability is based on the study of permutations and combinations as they are used to count the number of possible arrangements of a system.

(c) Probability of an event may be any real number between 0 and 1.

(d) In 1654, a gambler Chevalier de Mere approached the well-known French philosopher and mathematician Blaise Pascal (1623-1662 AD) for certain dice problems. Pascal took interest in it and discussed with famous French mathematician Pierre de Fermet (1601-1665 AD) and together they solved the problems.

Important Terms

Sample Space

It is the set of all possible outcomes of random experiment.

Examples:

(a) If a coin is tossed, the Sample space = {H,T}
(b) If Two coins are tossed the Sample space = {HH,HT,TH,TT}
(c) If a Dice is thrown, the Sample space = {1,2,3,4,5,6}
(d) If two dice are thrown, the Sample Space= {(1,1),1,2),.....(6,6)}
(e) If a dice of m faced is thrown n times, the Sample space = m^n.

Outcome:

It is the element of the sample space.

Equally likely outcomes

The outcomes that have the equal probability.

Trial

A random experiment repeated under identical conditions.

Simple event or Elementary event

Subset of sample space, Or each outcome of the random experiment, Or if an event can have only one sample point.

Occurrence of an event

An event E of the sample space S is said to have occurred if the outcome ω of the experiment is such that $\omega \in E$. and contrary to this if $\omega \notin E$, then the event E is said to not occur.

Types of Events

(a) Impossible event

The empty set, Or the event whose probability is 0, i.e, if P(E)=0 then E is an impossible event.

Example:

In toss of a coin coming up of neither head not tail is zero.

(b) Sure event

Happening of the whole sample space, Or whose probability is 1,

Example:

In tossing a coin, coming up of head or tail is sure.

(c) Compound event

A subset of the sample space is called compound event if it is disjoint union of single element subsets of the sample space.

Note:

Suppose there are n points in a sample space. So there will be n simple events. There will be 2^n subsets of these n elements. Then $2^n-(n+1)$ will be compound events excluding null set.

(d) Complementary event

The set A' or S-A. This event is also called "not event".

(e) Mutually exclusive events

A and B are mutually exclusively iff $A \cap B = \phi$ i.e, a null set.

(f) Exhaustive events

If $E_1 \cup E_2 \cup E_3 \cup ..... \cup E_n = S$ i.e. the sample space then all these are called exhaustive events.

(g) Odds in favour and Odds against

If an event can occur in m ways and cannot occur in n ways then **odds in favour** is given by m:n and **odds against** is given by n:m.

(h) The Probability of happening (odds in favour) is given by $\frac{m}{m+n}$

(i) The Probability of not happening (odds against) is given by $\frac{n}{m+n}$

Mathematical Definition

(a) For a finite sample space with equally likely outcomes, probability is defined as

$$P(Event) = \frac{number\ of\ elements\ in\ E}{number\ of\ elements\ in\ S}$$

(b) Probability of the event A or B:

$$P(AorB) = P(A \cup B)$$
$$= P(A) + P(B) - P(A \cap B)$$

(c) Probability of an event "not A":

$$P(notA) = 1 - P(A)$$

(d) Probability "not A" is denoted by $P(A')$ or $P(\overline{A})$ or $P(A^c)$

(c) $$P(A - B) = P(A \cap B^C)$$
$$= P(A) - P(A \cap B)$$

Conditional Probability

If E and F are two events associated with the same sample space of a random experiment, the conditional probability of the event E given that F has occurred, is represented by

$$P(E/F) = \frac{P(E \cap F)}{P(F)}, P(F) \neq 0$$

Properties of Conditional Probability

(i) If E and F be events of a sample space S of an experiment, then $P\left(\frac{S}{F}\right) = P\left(\frac{S}{E}\right) = 1$.

(ii) For P(F)≠o, $P\left(\frac{A \cup B}{F}\right) = P\left(\frac{A}{F}\right) + P\left(\frac{B}{F}\right) - P\left(\frac{A \cap B}{F}\right)$ where A and B are two events associated with S.

Multiplication Theorem on Probability

For Two events

If E and F are two events associated with a sample space S, then

(a) $P(E \cap F) = P(E).P\left(\frac{F}{E}\right)$, P(E)≠o

(b) $P(E \cap F) = P(F).P\left(\frac{E}{F}\right)$, P(F)≠o

For Three events

If *E, F, G* are three events of sample space, then

(a) $P(E \cap F \cap G) = P(E).P\left(\frac{F}{E}\right)P\left(\frac{G}{E \cap F}\right)$; P(F)≠o

Independent Events

Two events *E* and *F* are said to be independent if the probability of happening of one of them is not affected by the occurrence of the other.

$$P\left(\frac{E}{F}\right) = P(E), \text{ P(F)≠o}$$

$$P(E \cap F) = P(E).P(F)$$

Independent and Mutually Exclusive Events

(a) If E and F are independent events associated with a random experiment then $\overline{A}$ and B; A and $\overline{B}$; or $\overline{A}$ and $\overline{B}$ are also independent events.

(b) Independent events are always taken from different experiments, while mutually exclusive events are taken from a single experiment.

(c) Independent events can happen together while mutually exclusive events cannot happen together.

(d) Independent events are connected by the word "and " but mutually exclusive events arr connected by the word "or".

Total Probability

If $\{E_1, E_2, E_3, ... E_n\}$ be the partition of the sample space S, and A be any event associated with S, then

$$P(A)=\sum_{i=1}^{n}P(E_i)P\left(\frac{A}{E_i}\right)$$

Bayes' Theorem

If $E_1,E_2,E_3,...E_n$ are mutually exclusive and exhaustive events associated with a sample space, and A be any event of non-zero probability, then

$$P\left(\frac{E_i}{A}\right)=\frac{P(E_i).P\left(\frac{A}{E_i}\right)}{\sum_{i=1}^{n}P(E_i).P\left(\frac{A}{E_i}\right)}$$

Note:

$$P(A)+P(B)-1\le P(A\cap B)\le P(A)$$

Note

(a) Coin

A coin has a head side and a tail side. If an experiment consists of more than a coin, then coins are considered to be distinct if not otherwise stated.

(b) Dice

A die (cubical) has six faces marked 1, 2, 3, 4, 5, 6. We may have tetrahedral (having four faces 1, 2, 3, 4) or pentagonal (having five faces 1, 2, 3, 4, 5) die. Number of exhaustive cases of throwing *n* dice simultaneously (or throwing one dice *n* times)=6^n.

(c) Playing cards

A pack of playing cards contains 52 cards. There are 4 suits: *Spade, Heart, Diamond, Club*). Each has 13 cards. *Spade* and *Club* are of black colour cards and *Heart* and *Diamond* are of Red Colour, i.e. there are 26 Black cards and 26 Red cards. In 13 cards of each suit there are *Ace, 2,3,4,5,6,7,8,9,10, Jack, Queen, King*. ***Jack, Queen*** and ***King*** are called Face cards. *Ace, King, Queen* and *jack* are called honour cards.

Note:

Regarding mappings

Let A and B be two finite sets. If a mapping is to be selected randomly from A into B, then the

(a)Probability for being one-one function(mapping) = $\frac{{}^{B}P_{A}}{B^{A}}$

(b) Probability for being many-one function = $1-\frac{{}^{B}P_{A}}{B^{A}}$

(c)Probability for being a constant function = $\frac{n(B)}{B^{A}}$

(d) Probability for being one-one-onto function = $\frac{n(A)}{B^{A}}$; $n(B)=n(A)$

Probability for selecting squares on a Chess board

r squares are selected on a chess-board. The probability of them being along a diagonal= $\frac{4\left[{}^{7}C_r+{}^{6}C_r+.....+{}^{r}C_r\right]+{}^{8}C_r}{{}^{64}C_r}, 1\le r\le 7$

Probability for drawing shoes from cupboard

Let there be *n* pairs of Shoes. If *r* shoes are selected at random, then the

(a)Probability that there is no pair = $p=\frac{{}^{n}C_r.2^r}{{}^{2n}C_r}$

(b) Probability of being at least one pair = *1-p*.

Probability related to envelopes and letters

(a)Probability that all letters are in right envelopes= $\frac{1}{n!}$.

(b) Probability that all letters are not in right envelopes (or at least one is in wrong envelope)=$1-\frac{1}{n!}$.

(c)Probability that no letter is in right envelopes = p = $\frac{1}{2!}-\frac{1}{3!}+\frac{1}{4!}-....+(-)^n\frac{1}{n!}$.

(d) Probability that at least one letter is in right envelope = 1-p

(e)Probability that exactly *r* letters are in right envelopes

$$=\frac{1}{r!}\left(\frac{1}{2!}-\frac{1}{3!}+\frac{1}{4!}-....+(-)^{n-r}\frac{1}{(n-r)!}\right).$$

Measure of central tendency:

It gives an idea where data points are centered. It consists of Mean, Median and Mode.

Mean

It is denoted by $\bar{x}$. If the data are $x_1, x_2, x_3,... x_n$ then mean is denoted by

(i) $\bar{x}=\frac{x_1+x_2+x_3+.....+x_n}{n}=\frac{1}{n}\sum_{i=1}^{n}x_i$

(ii) $\bar{x}=\frac{f_1x_1+f_2x_2+f_3x_3+.....+f_3x_n}{f_1+f_2+.....+f_n}$;

$$=\frac{1}{N}\sum_{i=1}^{n}f_ix_i;$$

f_i is corresponding frequencies of x_i

(iii) $$\bar{x} = \frac{f_1 d_1 + f_2 d_2 + f_3 d_3 + ... + f_3 d_n}{f_1 + f_2 + ... + f_n}$$

$$= \frac{1}{N}\sum_{i=1}^{n} f_i d_i, d_i = x_i - a,$$

where a= assumed mean.

Median

It is the value of the middle term or terms when the data are arranged in increasing or decreasing order. It is denoted by

(a) M= $\left(\frac{n+1}{2}\right)th$ if the number of terms is odd.

(b) M=mean of $\left(\frac{n}{2}\right)th$ and $\left(\frac{n}{2}+1\right)th$ if the number of terms is even.

(c) For class interval data,

M= $L + \frac{\frac{N}{2} - F}{f} \times i$, where N= total number of frequency; F= cumulative frequency before median class; f= frequency of the median class; L= Lower limit of the median class; i=class interval of the median class.

Mode

It is the observation that occurs maximum number of times. It is denoted by

$$Mode = L + \frac{f - f_1}{2f - f_1 - f_2} \times i$$

where L= lower limit of Modal class, f= frequency of the modal class, f_1= frequency of the class preceding the modal class, f_2= frequency of the class following the modal class, i= class interval of the modal class.

Note: Mode = 3 Median – 2 Mean

Measure of Dispersion

Dispersion means scattered ness of data. It is measured on the basis of the measure of central tendency i.e, mean, mode or median. It is mainly of 4 types:

Range

It does not give any idea about the dispersion of data from a measure of central tendency as no central tendency is considered here.

Range = (Maximum value of the data)- (Minimum Value of the data)

Quartile deviation

$Q_1 = L + \frac{\frac{N}{4} - F}{f} \times i$

Mean Deviation

(a) Mean deviation about mean

$= \frac{sum\ of\ absolute\ deviations\ from\ mean}{number\ of\ observations}$

(b) Mean deviation (about assumed mean ***a***)

$= \frac{\sum_{i=1}^{n} |x_i - a|}{n}$

(c) Mean deviation in case of grouped data

$= \frac{\sum_{i=1}^{n} f_i |x_i - a|}{N}$ where

N = sum of all frequencies.

(d) Mean deviation (about mean $\bar{x}$)

$= \frac{\sum_{i=1}^{n} |x_i - \bar{x}|}{n}$

(e) In case of grouped data

$= \frac{\sum_{i=1}^{n} f_i |x_i - \bar{x}|}{N}$

(f) Mean deviation about median M

$= \frac{\sum_{i=1}^{n} |x_i - M|}{n}$

(g) Mean deviation (grouped data)

$= \frac{\sum_{i=1}^{n} f_i |x_i - M|}{N}$

Standard Deviation

$= \sigma = \sqrt{\frac{1}{n}\sum_{i=1}^{n} (x_i - \bar{x})^2}$

Standard deviation for frequency distribution

$$\sigma = \sqrt{\frac{1}{N}\sum_{i=1}^{n} f_i (x_i - \bar{x})^2}$$

A short-cut method to avoid calculation of mean $\bar{x}$ is used

$$\sigma = \sqrt{\frac{1}{N}\sum_{i=1}^{n} f_i x_i^{\,2} - \left(\frac{1}{N}\sum_{i=1}^{n} f_i x_i\right)^2}$$

Variance= (standard deviation)^2 =σ^2

If the series have equal means, then the series with lesser standard deviation is more consistent or less scattered.

Coefficient of variance= $\frac{\sigma}{Mean} \times 100$

Random Variable and its Probability distribution

A random variable is a real valued function whose domain is the sample space of a random experiment.

The probability distribution of a random variable X is the system of numbers.

X	X_1	X_2	X_3	..	X_n
$P(X)$	p_1	p_2	p_3	..	p_n

where $pi \neq 0$, $i=1,2,3,\ldots,n$ and $\sum_{i=1}^{n} p_i = 1$.

Mean and variance of a random variable

Mean = $\mu = E(X) = \sum_{i=1}^{n} p_i x_i$

Variance = $\sigma^2 = \sum_{i=1}^{n} p_i (x_i - \bar{x})^2$

Bernoulli Trials

Trials of a random experiment are called Bernoulli trails if they satisfy the following conditions:

(a) Number of trials are finite

(b) Trials are independent

(c) Each trial has only two outcomes: success and failure

(d) All trials have the same probability of success or failure

Binomial distribution

A random variable X is said to have a binomial distribution with parameters n and p if its probability distribution is given by

$$P(X = r) = {}^{n}C_r\, p^r q^{n-r}$$

where $q=1-p$ and $r=0,1,2,3,..n$

Solved Examples:

Ex. 1: An ordinary deck of cards contains 52 cards divided into four suits. If one card from the deck at random is picked up, then

(a) Find the sample space of the experiment.

(b) Find the event that the chosen card is a black face card.

Solution 1:

(a) The outcomes in the sample space S are 52 cards in the deck.

(b) Let E be the event that a black face card is chosen. The outcomes in E are Jack, Queen, King or spades or clubs.

Symbolically

E = {J, Q, K, of spades and clubs}, Or

E = {J♣, Q♣, K♣, J♠, Q♠, K♠}

Ex. 2: An experiment has four possible outcomes A, B, C and D, that are mutually

exclusive. Explain whether the following assignments of probabilities are permissible.

(a) P(A) = 0.12, P (B) = 0.63, P (C) = 0.45, P (D) = – 0.20

(b) P(A) =$\frac{9}{120}$, P (B) =$\frac{45}{120}$, P (C) =$\frac{27}{120}$, P (D) =$\frac{46}{120}$

Solution 2:

(a) Since P(D) = – 0.20, this is not possible as 0 ≤ P (A) ≤ 1 for any event A.

(b) P(S) = P (A ∪ B∪ C∪ D) =$\frac{9}{120} + \frac{45}{120} + \frac{27}{120} + \frac{46}{120} \neq 1$

This violates the condition that P (S) = 1.

Ex. 3: Three squares of chess board are selected at random. Find the probability of getting 2 squares of one colour and other of a different colour.

Solution 3:

In a chess board, there are 64 squares of which 32 are white and 32 are black. Since 2 of one colour and 1 of other can be

2W, 1B, or 1W, 2B,

The number of ways= ${}^{32}C_2 \times {}^{32}C_1 \times 2$ and also, the number of ways of choosing any 3 boxes is ${}^{64}C_3$.

Hence, the required probability

$$= \frac{{}^{32}C_2 \times {}^{32}C_1 \times 2}{{}^{64}C_3} = \frac{16}{21}$$

Ex. 4: A and B are two candidates seeking admission in a college. The probability that A is selected is 0.7 and the probability that exactly one of them is selected is 0.6. Find the probability that B is selected.

Solution 4:

Let p be the probability that B gets selected.

P (Exactly one of A, B is selected) = 0.6 (given)

P (A is selected, B is not selected; B is selected, A is not selected) = 0.6

$P(A \cap B') + P(A' \cap B) = 0.6$

$P(A)\,P(B') + P(A')\,P(B) = 0.6$

$\Rightarrow (0.7)(1-p) + (0.3)\,p = 0.6$ *Or* $p = 0.25$

Thus the probability that B gets selected is 0.25.

Ex. 5: 10% of the bulbs produced in a factory are of red colour and 2% are red

and defective. If one bulb is picked up at random, determine the probability of its being defective if it is red.

Solution 5:

Let A and B be the events that the bulb is red and defective, respectively.

$P(A) = \frac{10}{100}$, $P(A \cap B) = \frac{2}{100}$; $P(B \mid A) = P(A \cap B)/P(A)$

$$= \frac{\frac{2}{100}}{\frac{10}{100}} = \frac{2}{10} = \frac{1}{5}$$

Thus the probability of the picked up bulb of its being defective, if it is red, is1/5.

Ex. 6: Find the probability that in 10 throws of a fair die a score which is a

multiple of 3 will be obtained in at least 8 of the throws.

Solution 6:

Here success is a score which is a multiple of 3 i.e., 3 or 6.

Therefore, p (3 or 6) $= \frac{2}{6}$

The probability of r successes in 10 throws is given by

$$P(r) = {}^{10}C_r \left(\frac{4}{6}\right)^{10-r} \left(\frac{2}{6}\right)^{r}$$

P (at least 8 successes)

= P (8) + P (9) + P (10)

$$= {}^{10}C_8 \left(\frac{4}{6}\right)^{2} \left(\frac{2}{6}\right)^{8} + {}^{10}C_9 \left(\frac{4}{6}\right)^{1} \left(\frac{2}{6}\right)^{9} + {}^{10}C_{10} \left(\frac{2}{6}\right)^{10} = \frac{201}{3^{10}}.$$

Ex 7: A car manufacturing factory has two plants, X and Y. Plant X manufactures

70% of cars and plant Y manufactures 30%. 80% of the cars at plant X and 90% of the cars at plant Y are rated of standard quality. A car is chosen at random and is found to be of standard quality. What is the probability that it has come from plant X?

Solution

Let E be the event that the car is of standard quality. Let B1 and B2 be the

events that the car is manufactured in plants X and Y, respectively. Now

$P(B_1) = \frac{70}{100}$, $P(B_2) = \frac{30}{100}$

P (E | B_1) = Probability that a standard quality car is manufactured in plant $= \frac{80}{100}$

$P(E \mid B2) = \frac{90}{100}$

P (B1 | E) = Probability that a standard quality car has come from plant X

$$= \frac{P(B_1) \times P(E/B_1)}{P(B_1) \times P(E/B_1) + P(B_2) \times P(E/B_2)}$$

$$= \frac{\frac{70}{100} \times \frac{80}{100}}{\frac{70}{100} \times \frac{80}{100} + \frac{30}{100} \times \frac{90}{100}} = \frac{56}{83}.$$

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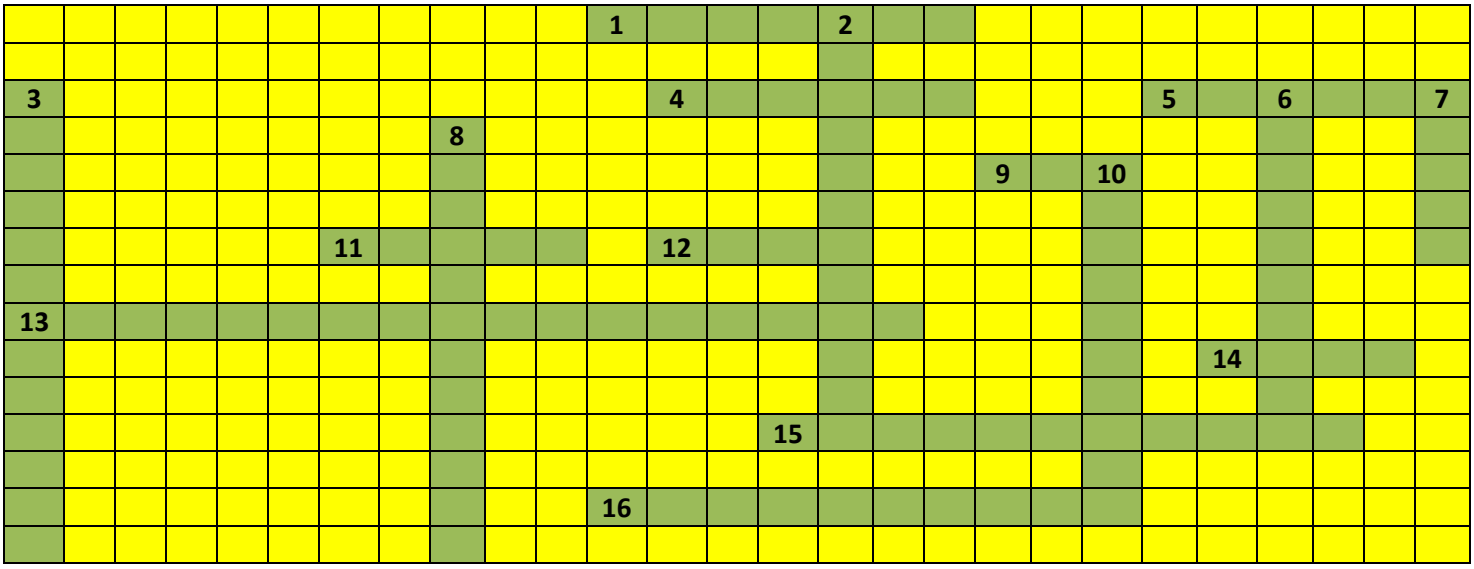
CROSSWORD PUZZLE March'17: PROBABILITY

Prof. SB. Dhar



Across

1 Result of an experiment
4 Experiment whose result is unpredictable
5 No of sample points when a dice and a coin are tossed together
9 Probability of drawing a black or a red card from a pack of 52 cards
11 Performing an experiment is called
12 Even chances probabilities are close to
13 Even face and odd face in a throw of a dice make together
14 Probabilities that very unlikely events have
15 Measure of likelihood of occurrence of an event
16 Events that make happening of an event

Down

2 Ratio of favourable outcomes to unfavourable outcomes
3 A name of event "not A"
6 Process to produce well defined results
7 Outcome of an experiment
8 Father of Probability
10 Name for the events of all possible outcomes of an experiment

—OO—

(Answer to this Crossword Puzzle shall be provided in 3rd Qarterly e-Bulletin No 2, Dt. 1st April'17)

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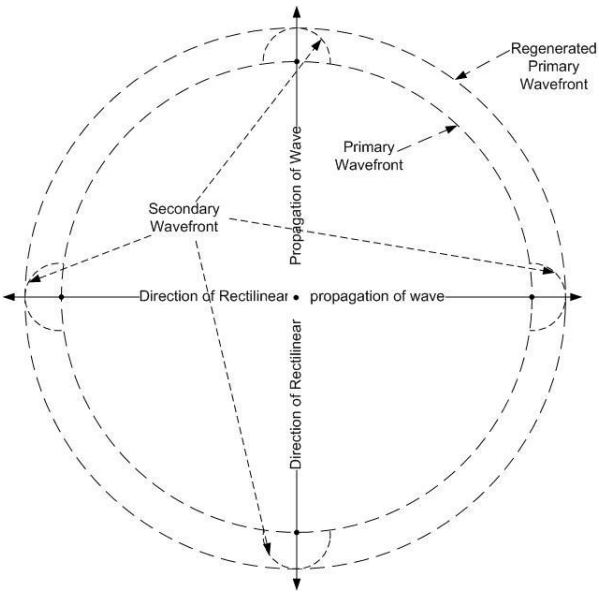
GROWING WITH CONCEPTS- Physics

Waves and Motion: Part-I

Dr. Subhash Kumar Joshi

Discovery of correlation between matter and energy has revolutionized understanding of nature. Waves form an indispensable coupling between matter and energy and define boundaries of classical mechanics vis-à-vis relativistic and quantum mechanics. This chapter is, accordingly, positioned in this manual after classical mechanics and heat where existence of waves was introduced. Starting with concept of waves, this chapter is intended to integrate SHM, with concepts of sound and light, which are manifestation of waves in different frequency domain. While elaborating the subject matter electro-magnetic nature of waves is left untouched; it would be incomprehensible without knowledge of electro-magnetism.

Propagation of sound and light through a medium was initially considered to be motion of particles from source to destination. It was **Christiaan Huygens** in 1678 who proposed that rectilinear propagation of light, which was substantiated by **Augustin-Jean Fresnel** in 1816 with his own theory to explain phenomenon of interference in light. The ***Huygens Wave Theory* (HWT)** is explained with a set of postulates that – **a)** light travels like wave propagation away from the source, **b)** the propagation is in the forms of a spherical wave-front in three dimensions, which travel with a uniform velocity in a homogenous medium, **c)** every point on the wave-front in the form of a wave- from acts like a source of light which perpetuates secondary wave-front, **d)** the secondary wave-front, **e)** Envelop of Secondary wave-fronts regenerates new wave-front, which perpetuates rectilinear propagation of the wave. The concept of wavefront can be best visualized by throwing a stone in the midst of a pond or lake and then observing waves propagating to its bank. The HWT successfully explains phenomenon of reflection and refraction, and those involving superposition viz. interference and diffraction. Generation of secondary wave-fronts, taking Four points on a primary wave-front, and a newly regenerated primary wave-front for onward perpetuation in the direction of propagation of wave is are shown in the figure. As we proceed into the journey, use of HWT shall be made while elaborating the above phenomenon.



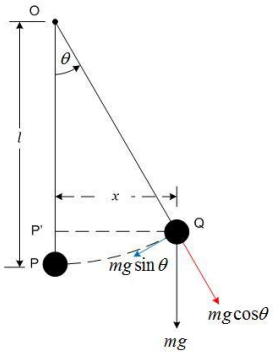
Simple Harmonic Motion (SHM): This is a simple extension of mechanics and very useful in analysis of waves. It would be no exaggeration to state that the SHM is fundamental and most natural motion. *Any periodic motion or vibration, which is also called oscillation can be explained with its constituent SHMs*, which was established by a mathematician ***Joseph Fourier*** *in 1807*, known as Fourier Analysis, which is a subject matter of higher studies, and hence its elaboration at this point is refrained.

The SHM is best explained with trace of a particle, along a diameter of a circle, which is performing a uniform circular motion. This, however, requires to be substantiated with a pendulum or vibration in a spring, real life visualizations, to appreciate SHM. Accordingly the three types of motions are analysed brought in the table below.

Before, we set on to analyse SHM, its basic premise is – **a)** force on a particle performing SHM is always directed towards its mean position, and **b)** force is always proportional to the displacement of particle from its mean position. With this premise oscillations of Pendulum and Spring shall be analysed. These physical observations are compared with the motion of trace of the particle, performing uniform circular motion i.e. constant angular velocity $\boldsymbol{\omega}$, along diameter of circle. It will be seen that all the three cases are in conformance with the premise of SHM. In respect of oscillation of pendulum and spring, certain assumptions are involved, while motion of trace of a particle performing circular motion, it

is an ideal representation of SHM. Accordingly, the latter one shall be extended to further analysis of SHM including time period ***T***. This definition of T shall be applied to the earlier two cases of SHM.

Oscillation of Pendulum



Length of Pendulum=l , and of Arc $PQ = l\theta$

When θ is small, or $x \ll l$,

$\sin\theta \rightarrow \theta = \frac{\text{Arc } PQ}{l} \cong \frac{P'Q}{l}$

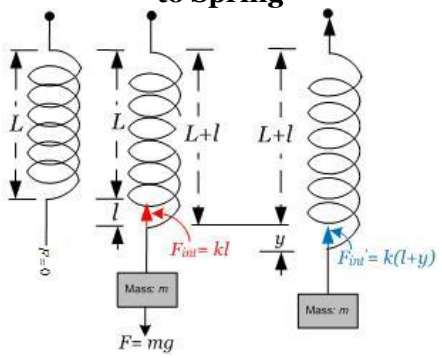
Force $\bar{F} = -mg\frac{P'Q}{l} = -mg\frac{x}{l}$

Acceleration of Mass $a = -\left(\frac{g}{l}\right)x; a \propto x$

This complies with both the premises of SHM

It involves ***assumption:*** θ is small

Oscillation of a Mass attached to Spring



For expansion (l) of spring: $kl = mg$;

Internal force on stretching of spring by additional length (y) : $F' = -(l+y)k$;

Net force : $F'' = F' + mg = ma$

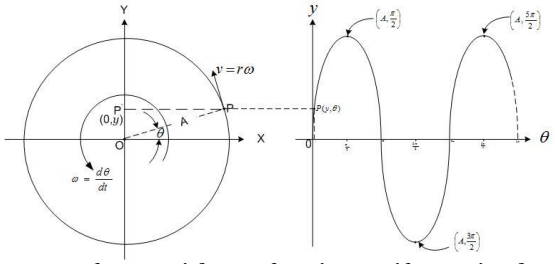
⇨ $ma = -(l+y)k + kl$

⇨ $ma = -ky;\ a = -\left(\frac{k}{m}\right)y;\ a \propto x$

This complies with both the premises of SHM

It involves ***assumption:*** *spring constant k remain uniform*

Motion of Trace of a Particle Performing Circular Motion



Trace of a particle performing uniform circular motion of radius ***A***, at ***ω*** rad/sec on y-axis is plotted along with the circular motion.

Displacement from Mean Position: $y = A\sin\theta$

Velocity of the trace: $v = \frac{dy}{dt} = \frac{d}{dt}(\text{A}\cdot\sin\theta)$

⇨ $A\cdot\frac{d}{d\theta}\sin\theta\cdot\frac{d\theta}{dr} = A\omega\cos\theta$

Acceleration of Particle: $a = \frac{dv}{dt} = \frac{d}{dt}(A\omega\cos\theta)$

⇨ $-A\omega^2\sin\theta = -\omega^2 y;\ a \propto y$

This complies with both the premises of SHM.

Since, here no assumption is involved, it is ideal representation of SHM.

This analysis is being extended to determine Time Period ***T*** *, and velocity of particle* ***v*** *at a particular displacement* ***y****, for circular motion and applied to oscillation of pendulum and spring*

Displacement of particle from mean position is since a ***Sine*** *function of angular displacenent θ, it is also called a* ***Sinusoidal Wave****.*

$$\omega = \sqrt{\frac{\left(\frac{g}{l}\right)x}{x}} = \sqrt{\frac{g}{l}};\ f = \frac{\omega}{2\pi}$$

$$T = \frac{1}{f} = \frac{2\pi}{\sqrt{\left(\frac{g}{l}\right)}} = 2\pi\sqrt{\frac{l}{g}}$$

$$\omega = \sqrt{\frac{\left(\frac{k}{m}\right)y}{y}} = \sqrt{\frac{k}{m}};\ f = \frac{\omega}{2\pi}$$

$$T = \frac{1}{f} = \frac{2\pi}{\sqrt{\left(\frac{k}{m}\right)}} = 2\pi\sqrt{\frac{m}{k}}$$

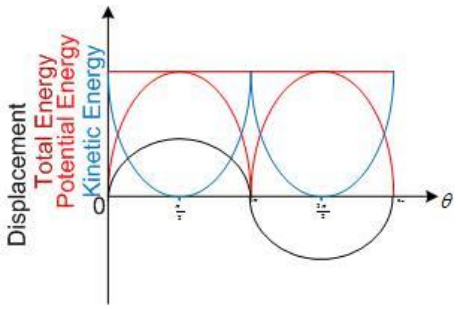
$$\omega = \frac{\text{Acceleration}}{\text{Displacement}} = \sqrt{\frac{a}{y}};\ \omega = 2\pi f = \frac{2\pi}{T}.$$

Here ***f*** - is frequency of oscillation (Cycles/Sec).

$$T = \frac{1}{f} = \frac{2\pi}{\omega}$$

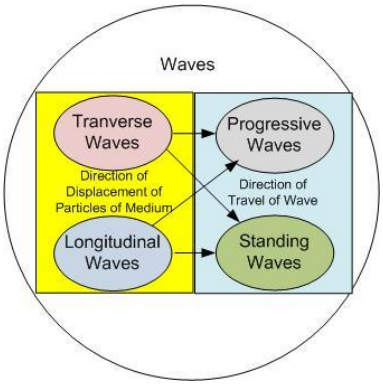
Composition of Energy of a particle performing SHM: Taking that particle is performing SHM in frictionless environment, where there is exchange of energy with external systems. In such a situation energy of particle shall comprise of *Potential Energy (PE)* and *Kinetic Energy (KE),* and the two together shall constitute *Total Energy (TE)* of the Particle.

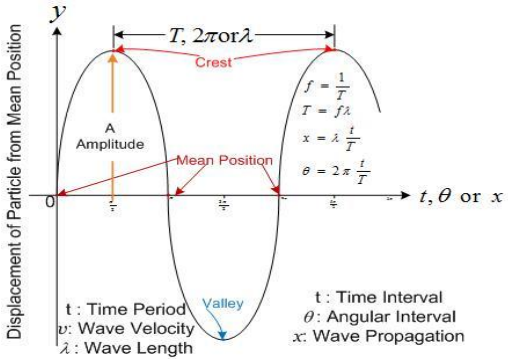
As per definition, $KE = \frac{1}{2}mv^2 = \frac{1}{2}m(A\omega\cos\theta)^2 = \frac{1}{2}mA^2\omega^2\cos^2\theta$, here $\boldsymbol{v}$ – is the instantaneous velocity of the particle of mass ***m,*** $PE = \int_0^y m\cdot a\cdot dy = \int_0^y m\cdot(A\omega^2\sin\theta)\cdot dy$, since $y = A\sin\theta$, hence $dy = A\cos\theta d\theta$. For convenience limits shall be managed at the last step. Accordingly, $PE = \int_0^y m\cdot(A\omega^2\sin\theta)\cdot(A\cos\theta d\theta) = mA^2\omega^2\int_0^y \sin\theta\cos\theta d\theta = \frac{mA^2\omega^2}{2}\int_0^y \sin 2\theta\, d\theta = \frac{mA^2\omega^2}{4}\int_0^\theta \sin u\, du\Big|_{u=2\theta;d\theta=\frac{du}{2}}$. It leads to $PE = \frac{mA^2\omega^2}{4}[-\cos u]_0^\theta = -\frac{mA^2\omega^2}{4}[\cos 2\theta - 1] = -\frac{mA^2\omega^2}{4}[(1-2\sin^2\theta)-1] = \frac{mA^2\omega^2}{2}\sin^2\theta$. Thus, $TE = PE + KE = \frac{mA^2\omega^2}{2}\sin^2\theta + \frac{mA^2\omega^2}{2}\cos^2\theta = \frac{mA^2\omega^2}{2} = \frac{1}{2}mv^2$; here, $v = A\omega$, which corresponds to tangential velocity of particle performing uniform circular motion, while in case of oscillation of simple pendulum and spring it is velocity of particle at mean position occurring at $\theta = n\pi$, where, n is an integer, PE is ZERO.



Oscillations are of various kinds: **a) *Free Oscillation***, where no external force is applied, trace of motion of planets, satellites electrons in their orbit **b) *Damped Oscillations***, whose depletes with passage of time, a swing left unattended, **c) *Forced Oscillations***, like swing or clock where regular at regular interval, extra energy is supplied to make up energy lost in each oscillation, **d) *Resonant Oscillations***, these occur in a system when its natural frequency is an integral multiple of an oscillation present in the environment. This finds extensive application in musical instruments. **e) *Coupled Oscillation***, occur in a system which communicates, exchanges, energy with an external system when it is set into oscillation. This principle is widely used in sound box, speakers.

Waves: Understanding of the SHM is the study of oscillation of a single particle, and is elemental in elaboration of wave, electromagnetic waves, involves medium to either for its existence or its propagation. Classification of waves, based on direction of motion of particles, is in two categories: **a) *Longitudinal Wave***, and **b) *Transverse Wave***. Further, consideration of propagation of wave creates another classification: **i) *Travelling Waves*** - in which every motion of particle perpetuates to the adjoining particle of the medium along the direction of propagation, **ii) *Standing waves*** – it is a result of interaction of forward and backward travelling wave, such that all particles of the medium at any point are in same phase, but their amplitude depends upon their position along the wave. While, each of these types of wave is characteristically different in respect of motion of particles of the medium of propagation, and shall be studied with its mathematical and graphical representation in the form of SHM. Elaboration of basic concepts of waves is considered a prerequisite to the understanding of phenomenon of Sound Waves and Light Waves. Accordingly, journey in the subject matter has been structured. Meanwhile, Parameters of wave, common among them, alongwith their mathematical correlation is summarized in the figure and are being defined, and shall find use all along..





Time period (*T*) : *It is the time taken to complete One Cycle.*

Frequency (*f or ν*) : *It is number of cycles in One Second, it is related to* $T = \frac{1}{f}$.

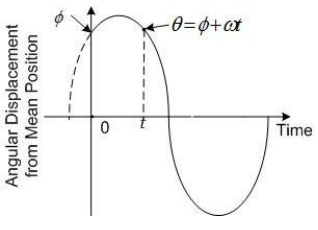
Crest : *It is the point on wave where displacement of particle from mean position is maximum.*

Valley : *It is point on wave where displacement of particle from mean position is minimum*

Wavelength (*λ*) : *It is distance covered by wave in one cycle. Most conveniently is is recorded as distance between two consecutive peaks, as shown in the figure.*

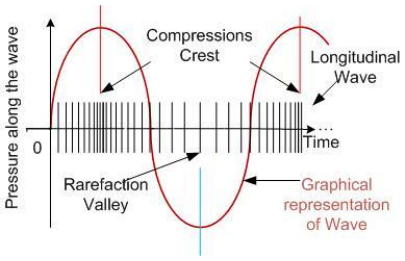
Velocity of wave (*υ*) : *It is distance covered by wave in One second, and* $v = \lambda f = \frac{\lambda}{T}$.

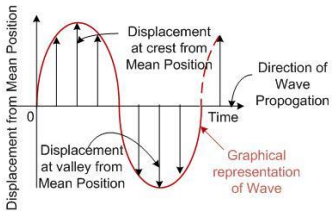
Phase (*θ*): *It is the angular displacement of a particle in a wave from its initial mean position, and* $\theta = \omega t$. *This repeats after every* 2π *angular displacement corresponding to T. In case a particle in a wave, initially displaced from its mean-position by an angle* ϕ, *is set into SHM then its phase after a lapse of time t is* $\theta = \emptyset + \omega t$ *and is shown in the figure.*



Basic concepts of waves are common to Sound wave and Light wave. Accordingly, these concepts are considered a prerequisite to the understanding of phenomenon of Sound Waves and Light Waves, and shall be elaborated before going into Sound and Light waves, to develop an integrated perspective of the two. Accordingly, journey in the subject matter has been structured and is in line with the approach of the Manual.

Longitudinal Wave: In a wave if *particles of medium oscillate, about their mean position, along the direction of wave then it is called longitudinal wave. These*

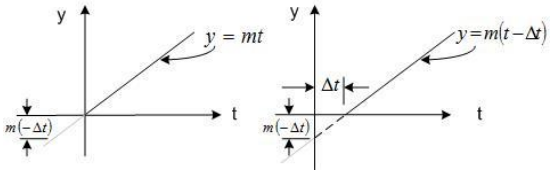


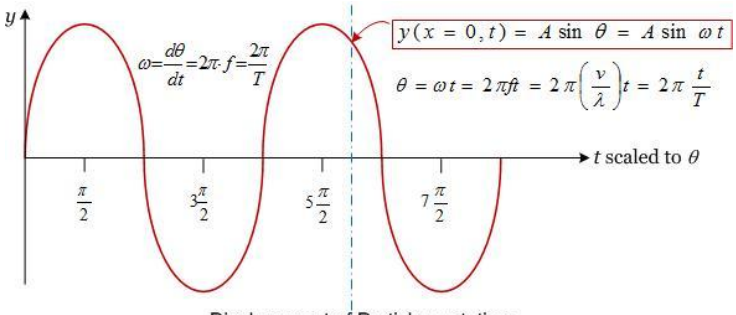


oscillating particles create compression ad rarefaction as shown in the figure. These waves are also represented as Sinusoidal Wave as shown in the figure. These waves are realized in rattling sound of doors and windows during a thunderstorm. Sound waves are basically Longitudinal Waves.

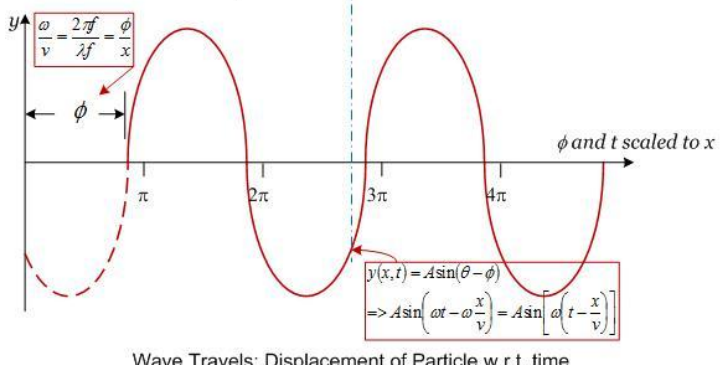
Transverse Wave: In *this type of wave particles of medium oscillate about their mean position, in a direction perpendicular to the direction of wave*. Waves generated in a water pond by dropping a stone are transverse waves. Likewise, all string-based musical instruments produce transverse waves; so are the Light waves.

Travelling Waves: The SHM elaboration considered oscillation of particles about its mean position and mathematically represented with a sinusoidal function. This is enough to explain the oscillation but in sufficient to represent oscillations that travel from one point to other, called waves, which carries or transfer energy from source to receiver or destination. This is elaborated with a simple straight line function $y = mt$. Here, ***y*** is the displacement of particle, from its initial position, at any instance ***t***, and ***m***, representing slope of line in graph is rate of change of displacement $m = \frac{dy}{dt}$. Let this straight line displacement is travelling, i.e. source is shifting through a displacement ***a***, such that $a = v \times \Delta t$. In this new situation displacement of the particle, at slope m, is identical to that having started from initial displacement $-\Delta t$. Accordingly, as per knowledge of Coordinate geometry displacement of particle at any instance is analogous to that at an instance $(t - \Delta t)$.

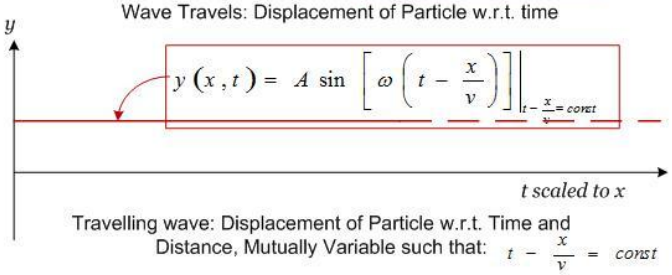




Displacement of Particle w.r.t. time



Wave Travels: Displacement of Particle w.r.t. time



Travelling wave: Displacement of Particle w.r.t. Time and Distance, Mutually Variable such that: $t - \frac{x}{v} = const$

This logic shall be extended to elaborate travelling SHM called ***travelling or progressive waves*** *expressed as* $y = f(x,t)$ and is elaborated in the figure. First graph shows displacement (y), from mean position $y = A\sin\theta$, here $\theta = \omega t = 2\pi ft = \frac{2\pi}{T}t$ at any instant of time. Next, the wave is taken to be moving along ***x*** axis through a distance x corresponding to a phase angle ϕ in time t. Accordingly, displacement of a particle, in accordance with the above example van be represented with a graph below where $y = A\sin\left[\omega t - \omega\frac{x}{v}\right] = A\sin\left[\omega\left(t - \frac{x}{v}\right)\right]$. Taking, variation in ***x*** and ***t*** such that $\left(t - \frac{x}{v}\right)$ remains constant, the displacement ***y*** shall also remain constant. This implies that with passage of time displacement is travelling forward, while particles of medium keep oscillating about their mean position. This is shown in the second graph. The third inference is about progressive displacement of a particle of medium from its mean position while both ***x*** and ***t*** are changing. It will be seen that when $\left(t - \frac{x}{v}\right)$ remains constant, displacement remains constant, that is with passage of time ***t***, displacement moves forward along ***x*** with velocity ***v***. This nature of travelling wave is shown in the third graph.

Fourth characteristic of travelling wave comes from its periodicity. At any point on the passage of a the displacement of particle of medium from mean position repeats at an interval $= \frac{2\pi}{\omega} = \frac{1}{f}$, here T - is called ***Time Period*** and it corresponds to angular displacement 2π to complete one oscillation, characteristic to sine function. Likewise, at any

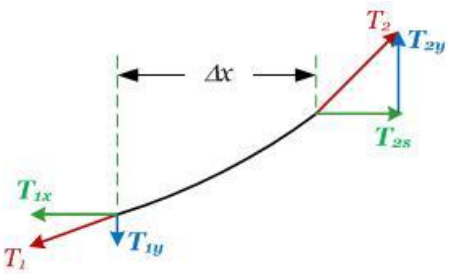
instance of time along the passage of time the displacement of particle from its mean position repeats at an interval of $\lambda = \frac{v}{f} = vT$, here λ - is called ***Wavelength***, i.e. distance covered in one Oscillation.

In a wave travelling forward i.e. along $\boldsymbol{x}$-axis –ve sign appears with $\frac{x}{v}$ and accordingly a general expression of a travelling/progressive wave is $y(x,t) = A\sin\left[\omega\left(t - \frac{x}{v}x\right)\right] = A\sin\left[\omega\left(t - \frac{x}{v}\right)\right]$. If the wave is travelling in a direction along $(-\boldsymbol{x})$ axis, automatically the equation shall take the form $y(x,t) = A\sin\left[\omega\left(t - \frac{(-x)}{v}x\right)\right] = A\sin\left[\omega\left(t + \frac{x}{v}\right)\right]$. Thus, progression of wave perpetuates with time. **This is general expression of a progressive wave** which represents displacement of a particle in the medium as a function of time and position from the source.

This expression is being extended to a differential equation of this time and position varying phenomenon known as Wave Equation. Accordingly, velocity of particles of medium performing SHM w.r.t. time and position are expressed as $v_y' = \frac{\partial}{\partial t}y(x,t) = \omega A\cos\left[\omega(t - \frac{x}{v})\right]$, and $v_y'' = \frac{\partial}{\partial x}y(x,t) = \frac{\omega}{v}A\cos\left[\omega(t - \frac{x}{v})\right]$, respectively. It is to be noted with a caution that that this velocity of the particle and the velocity of travelling wave (v). Taking it forward, acceleration of the particle w.r.t time and position is $a_y' = \frac{\partial^2}{\partial t^2}y(x,t) = -\omega^2 A\sin\left[\omega(t - \frac{x}{v})\right]$ and $a_y'' = \frac{\partial^2}{\partial x^2}y(x,t) = -\frac{\omega^2}{v^2}A\sin\left[\omega(t - \frac{x}{v})\right]$, respectively. This leads to $\frac{a_y'}{a_y''} = \frac{\frac{\partial^2}{\partial t^2}y(x,t)}{\frac{\partial^2}{\partial x^2}y(x,t)} = \frac{=-\omega^2 A\sin\left[\omega(t-\frac{x}{v})\right]}{-\frac{\omega^2}{v^2}A\sin\left[\omega(t-\frac{x}{v})\right]} = v^2$. It is to be noted with a caution that that this velocity of the particle and the velocity of travelling wave (v). It is most convenient to express a dynamic process as differential equation. Accordingly, $\boldsymbol{\frac{\partial^2}{\partial t^2}y(x,t) = v^2\left(\frac{\partial^2}{\partial x^2}y(x,t)\right)}$, and in its complementary form as $\boldsymbol{\frac{\partial^2}{\partial x^2}y(x,t) = \frac{1}{v^2}\left(\frac{\partial^2}{\partial t^2}y(x,t)\right)}$, called ***Wave Equation***. *Discovery of One Dimensional Wave Equation by* **Jean le Rond d'Alembert**, *in 1746, followed by* **Leonhard Euler** *Three Dimensional Wave Equation within a decade, was a great leap in discovery of physical systems and processes. Discovery of wave equation later helped to generalize transfer of energy through wave over a broad spectrum, right from mechanical vibrations to sound and electromagnetic radiation.* ***Here, analysis is confined to One Dimensional waves.***

Velocity of Wave: In this wave equation velocity of wave is a parameter which rationalizes acceleration of particles of medium w.r.t. time and position from the source. In strings based musical instruments transverse waves are established. While, in gases waves are where longitudinal. In both the cases, velocity of waves are governed by different phenomenon and are being elaborated separately.

Velocity of Wave in String: Strings are so made that their mass per unit length (μ) is uniform and is valid in normal state of rest. When string is set to transverse wave, along its length, non-uniform extension will take place and thus influence uniformity of μ . Looking at graphical representations of waves it might be perceived to be rigidity of a metal string keeps significant, but in reality it is quite small and for all practical purposes it is considered to be uniform. Now it needs to be explored as to how Tension (T) and μ play role in velocity of wave. Consider an element Δx having Tensions T_1 and T_2 at its Two ends, which goes in to decide shape of the waveform. Since, the wave propagation is transverse and hence displacement, velocity and accelerations of the particles of string along length shall not exist, Accordingly, T_{1x}=T_{2x} and it complies with Newton's Third Law of Motion. But, the nature of wave demanding transverse motion of particles of string will utilize difference in transverse components of tension such that $T_{2y} - T_{1y} = (\mu\cdot\Delta x)\frac{\partial^2 y}{\partial t^2}$, as per Newton's Second Law of Motion. Looking at the tensions over element Δx of the string, $T_{2y} - T_{1y} = T\left(\frac{T_{2y}}{T_{2x}} - \frac{T_{1y}}{T_{1x}}\right)\Big|_{T_{2x}=T_{1x}=T} = T\left(\frac{\left(\frac{\partial y}{\partial x}\Big|_{x\to x+x} - \frac{\partial y}{\partial x}\Big|_{x\to x}\right)}{\Delta x}\right)\Delta x = T\cdot\Delta x\frac{\partial^2 y}{\partial x^2}$.

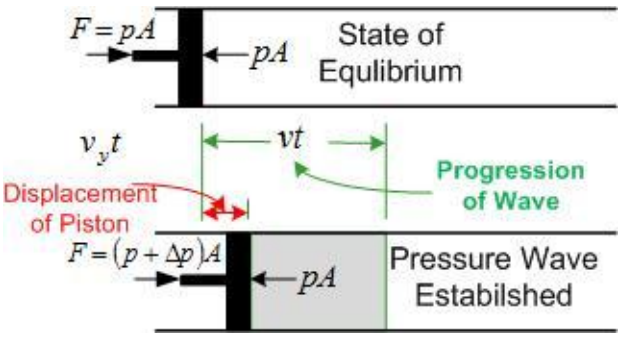


Comparing it with Wave Equation, which can be written as $\frac{\frac{\partial^2}{\partial t^2}y(x,t)}{\frac{\partial^2}{\partial x^2}y(x,t)} = v^2$, the equation evolved here for string lead to a similar form: $T_{2y} - T_{1y} = (\mu\cdot\Delta x)\frac{\partial^2 y}{\partial t^2} = (T\cdot\Delta x)\frac{\partial^2 y}{\partial x^2}$. It leads to $\frac{\mu\frac{\partial^2 y}{\partial t^2}}{T\frac{\partial^2 y}{\partial x^2}} = 1$, or $\frac{\partial^2 y}{\partial t^2} = \frac{T}{\mu}\frac{\partial^2 y}{\partial x^2}$. Comparing this equation with the wave

equation, velocity of wave in a string is: $v = \sqrt{\frac{T}{\mu}}$. This is also expressed as $v = \sqrt{\frac{Y}{\rho}}$ based on dimensional equality of $\sqrt{\frac{T}{\mu}} = \sqrt{\frac{Y}{\rho}}$.

Understanding of waves in strings, as seen in musical instruments, is with its ends fixed called ***Node***, which has no motion, be it transverse. Therefore, definition of wave where $v = \lambda f$. The number of Nodes between the fixed ends and length of wire (L) would decide pitch length and in turn frequency of wave. In case there are no nodes between the fixed ends, the length of wires it constitutes half pitch length $L = \frac{\lambda}{2}$. Accordingly, $v = 2L \cdot f = \sqrt{\frac{T}{\mu}}$,. It leads to natural frequency of vibration of string as $f = \frac{1}{2L}\sqrt{\frac{T}{\mu}}$.

Velocity of Wave in Fluids: Progression of wave in fluid is conceptualized in One Dimension in the figure, where travel of piston at velocity $\boldsymbol{v_y}$ in time $\boldsymbol{t}$ establishes longitudinal pressure wave in fluid which travels a distance vt, in corresponding time, such that velocity of wave is v. Beyond the distance of travel of wave, medium remains at equilibrium state. Considering, bulk elasticity of the medium (***B***), it leads to $B = \frac{\Delta p}{v_y t/_{vt}} = \frac{v\Delta p}{v_y}$. Accordingly, $\Delta p = B\frac{v_y}{v} => F = A\Delta p = B\frac{Av_y}{v}$, and per Newton's Second Law of Motion impulse $F = m\Delta v_y = \rho(Av)v_y$, thus a generalized expression comes to $F = B\frac{Av_y}{v} = \rho(Av)v_y$, or $\boldsymbol{v = \sqrt{\frac{B}{\rho}}}$.



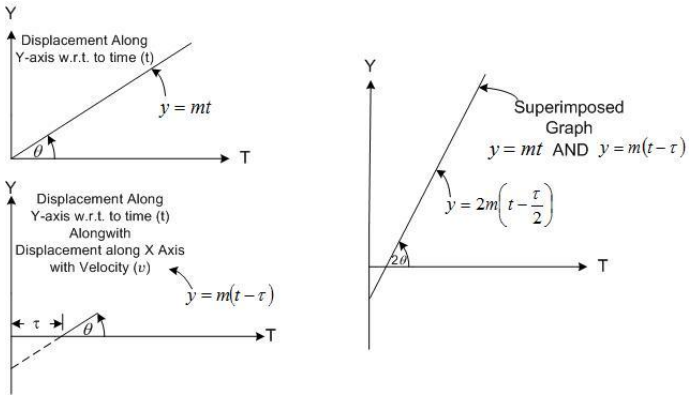
Velocity of Wave in Gas: Gases are highly compressible as compared to liquids**.** Therefore, *Newton* assumped that temperature of gas remains constant and accordingly used Boyle's Law pv = Const. to investigate velocity of wave in gases. Differentiating Boyle's Equation as : $p\partial v + V\partial p = 0$, or $B = -\frac{\partial p}{(\partial V/V)} = p$. Using this value of B, Newton redefined velocity of wave in gases as $= \sqrt{\frac{p}{\rho}}$ ***;*** this is known as ***Newton's Equation of Velocity of Wave in Gases.*** This equation is comparable to velocity of wave in strings.

In case of gases which are highly compressible, and the velocity of wave is quite high, the progression of pressure wave is an Adiabatic process where medium has no time to exchange heat with the environment, either during compression or rarefaction. Accordingly, in this case instead of Boyle's Law equation, and comply with $\boldsymbol{pV^{\gamma}}$ **= Constant** as per ***Poisson's Law***, covered in Heat and Thermodynamics. Thus Laplace, suggested a correction based on Poisson's Law whose logarithm is $\log p + \gamma \log V = Const.$ Differentiating this log-equation w.r.t. $\boldsymbol{t}$ leads to $\frac{1}{p}\frac{dp}{dt} + \frac{\gamma}{V}\frac{dV}{dt} = 0$, or $B = \frac{dp}{dV/V} = \gamma p$. Accordingly, the corrected equation $v = \sqrt{\frac{\gamma P}{\rho}}$ is known as Newton-Laplace Equation *of velocity in gases*.

Energy and Power in Wave: In wave represented by $y(x,t) = A\sin\left(\omega t - \frac{\omega}{v}x\right)$. In a string tension is always along the its length and hence $\frac{\partial y}{\partial x} = \frac{T_y}{T_x} = -A\omega\cos\left(\omega t - \frac{\omega}{v}x\right)$. Accordingly, $T_y = -TA\omega\cos\left(\omega t - \frac{\omega}{v}x\right)$, here $T_y = T$ which is uniform along length of string. Thus, instantaneous power $P(x,t) = T_y\frac{\partial y}{\partial t} = T\left[A\left(\frac{\omega}{v}\right)\cos\left(\omega t - \frac{\omega}{v}x\right)\right]\cdot\left[A\omega\cos\left(\omega t - \frac{\omega}{v}x\right)\right]$. It leads to $P(x,t) = \frac{TA^2\omega^2}{v}\cos^2\left(\omega t - \frac{\omega}{v}x\right) = \frac{TA^2\omega^2}{v}\left[\frac{1-\cos 2\left(\omega t - \frac{\omega}{v}x\right)}{2}\right]$. It comprises of Two Terms, One is a constant and it contains parameters characteristic to wave and independent of variables $\boldsymbol{x}$ and $\boldsymbol{t}$. And, the other term is a cosidal trigonometric function, which is time and place variant, averages to Zero over a cycle. Thus, average power of wave $\boldsymbol{P_{av}}$ is represented as

$= \frac{1}{2} \cdot \frac{TA^2\omega^2}{v} = \frac{1}{2} \cdot \frac{TvA^2\omega^2}{v^2} = \frac{1}{2} \cdot \boldsymbol{\mu v A^2 \omega^2}\Big|_{v=\sqrt{\frac{T}{\mu}}}$. This expression of average power is be represented in terms of frequency (ν) as $\boldsymbol{P = 2\pi^2 \mu v A^2 \nu^2}$.

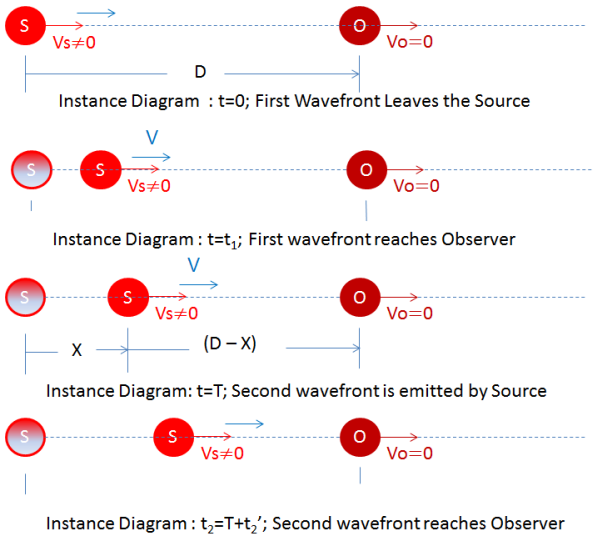
Principle of superimposition of Waves: A simple case of an object moving vertically with a constant velocity in an inertial frame of reference shown in the figure as (y, t) graph $y = mt$. In the graph below, another object moves vertically with the same constant velocity, but after a lapse of time τ. Like a wave, considering second function to be continuous, the (y, t) graph is plotted for $t > 0$. Summation of the two functions $y = mt + m(t - \tau) = 2m\left(t - \frac{\tau}{2}\right)$, in another (y, t) is synonymous to superimposition of two functions, and is easy to graph. But, in case of complex functions like wave functions, superimposition is best represented mathematically.



Accordingly, two wave functions $y_1 = A_1 \sin\left[\frac{2\pi}{\lambda}(vt - x)\right]$ and $y_2 = A_2 \sin\left[\frac{2\pi}{\lambda}(vt - x)\right]$ are considered to elaborate superimposition of waves. It could lead to multiple cases where in the Two wave functions with different – **a)** Amplitudes (A), **b)** Wave lengths (λ), **c)** velocity (v), and **d)** wave travel during initial phase shift. In most of the problems of wave superimposition that are encountered at this stage are for two waves with identical, Amplitude, velocity and frequency or wave length and accordingly simplistic mathematical analysis of waves travelling in opposite directions such as: $y = A \sin\frac{2\pi}{\lambda}(vt + x) + A \sin\frac{2\pi}{\lambda}(vt - x)$. Using trigonometric identities it reduces into $y = \left[A\sin\frac{2\pi}{\lambda}(vt + x) + \sin\frac{2\pi}{\lambda}(vt - x)\right] = 2A\cos\left(\frac{2\pi x}{\lambda}\right)\sin\left(\frac{2\pi vt}{\lambda}\right) = A_x \sin\left(\frac{2\pi vt}{\lambda}\right)$. Here, Amplitude of wave function at every point corresponding to $\left(\frac{2\pi x}{\lambda}\right)$, along the pitch is $A_x = 2A\cos\left(\frac{2\pi x}{\lambda}\right)$. And, displacement of each particle (y) from its mean position at any instant (t) is in same phase $y \propto \sin\left(\frac{2\pi vt}{\lambda}\right)$, where proportionality constant is A_x. This is a special case of ***Standing wave or Stationary wave*** and finds extensive application in *Sound Waves*. Further, *analysis of superimposition shall be dealt with as resonance of sound waves in strings and air column, while in reflection, refraction, interference and diffraction common to sound and light waves*, in Part II.

A generic analysis of periodic wave function was suggested by **Joseph Fourier**, in 1807, in the form of a series of sinusoidal functions : $A_x = \frac{A_0}{2} + \sum_{n=1}^{N} A_n \cdot \sin\left(\frac{2\pi nx}{T} + \varphi_n\right)$. Here, parameters of the waveform are, A_0 – is the bias from mean position of the periodic waveform, A_1- is the amplitude of the sinusoidal waveform of frequency as that of the periodic waveform; this is called fundamental frequency (f), A_n – is the amplitude of sinusoidal wave form of frequencies multiple of fundamental frequency (nf) and are called harmonics, n- is called the order of harmonic, and φ_n – is the phase shift from the initial in respect of each harmonic. Determination of these parameters of the frequencies constituting a non-sinusoidal periodic function was suggested by Fourier and is known as ***Fourier Analysis***; this is inverse of superposition of sinusoidal waveforms. Elaboration of Fourier Analysis is outside the scope of this document, nevertheless, *readers are welcome to raise their inquisitiveness through Contact Us*.

Doppler Effect in an Inertial Frame : Shrill of a train while arriving at platform and while leaving is different. Likewise, shrill of a horn of a Train being chased by a vehicle is different than that experienced on a platform. This is being analysed in three different cases; **a)** Source moving towards a stationary Observer, **b)** an Observer moving away from a stationary source, **c)** Both Source and Observer moving in one direction, with Observer ahead of Source. The results of the analysis in three cases have been generalized, at the end.



Case 1: Source moving towards a stationary Observer

Standard notations being used in the analysis, elaborated in figure, are as under-

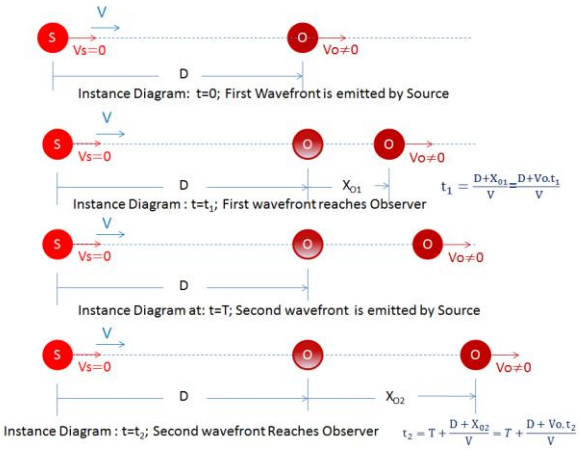
V- Velocity of Sound ; *Vs* – Velocity of Source ≠ 0; *Vo* – Velocity of Observer =0,
T – Time period of Sound ; *t* - an instance in the analysis,
t_1 – an instance when **First wave-front** emitted by source at *t*=0 reaches observer = $\frac{D}{V}$.
X – distance moved by Source during = $T \cdot Vs$, when Source emits **Second wave-front**
t_2'- is the time taken **Second wave-front** to reach the Observer = $\frac{D-X}{V}$
f- Frequency of Sound; f' – Apparent Frequency of Sound

Therefore, effective Time Period for the Observer-

$$T' = t_2 - t_1 = (T + t_2') - t_1 = \left(T + \frac{D-X}{V}\right) - \frac{D}{V} = \left(T + \frac{D - TVs}{V}\right) - \frac{D}{V} = T\left(1 - \frac{Vs}{V}\right)$$

Hence, apparent frequency : $\boldsymbol{f' = \frac{1}{T'} = \frac{1}{T\left(1-\frac{Vs}{V}\right)} = f \cdot \frac{V}{V-Vs}}$

Inference: *f* ' is equal to (*f*)x(Ratio of Velocity of sound w.r.t. Observer to Velocity of Sound w.r.t Source



Case 2: An Observer moving away from a stationary source:

Vs=0 and *Vo*≠ 0, and is elaborated in figure.

From the above-

$$t_1\left(1 - \frac{Vo}{V}\right) = \frac{D}{V}; t_1 = \frac{D}{V-Vo}; \text{ and } t_2\left(1 - \frac{Vo}{V}\right) = T + \frac{D}{V}; t_2 = \frac{TV+D}{V-Vo}$$

In this case Apparent Time Period for the Observer is –

$$t' = t_2 - t_1 = \frac{TV}{V-Vo}; \text{ or } f' = \frac{1}{t'} = \frac{1}{T}\left(\frac{V-Vo}{V}\right) = f\left(\frac{V-Vo}{V}\right)$$

Inference: f ' is equal to (f)x(Ratio of Velocity of sound w.r.t. Observer to Velocity of Sound w.r.t Source ***(Same as in case 1)***

Case 3: Both Source and Observer moving in one direction, with Observer ahead of Source

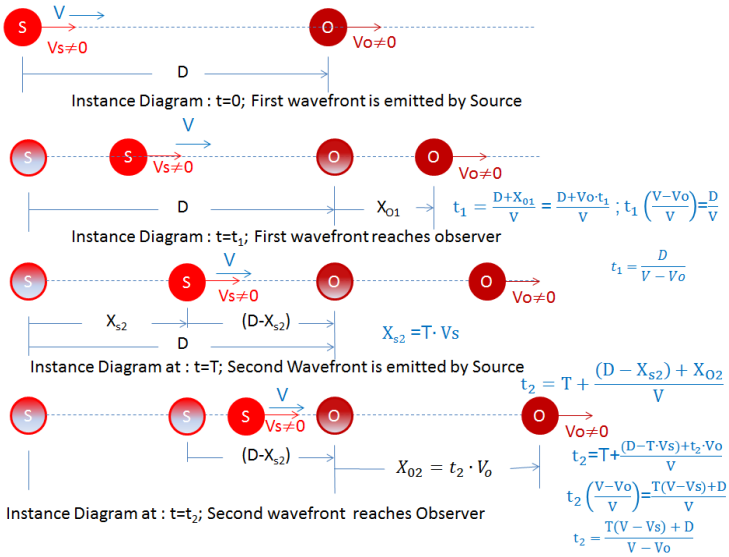
Figure below specifies each instance and specially t1 and t2 when First and Second Wave-front emitted by Source reach Observer, respectively alongwith relationships of related variables, as shown in the figure. Accordingly, apparent Time Period would be -

$$T' = t_2 - t_1 = \frac{T(V-Vs)+D}{(V-Vo)} - \frac{D}{(V-Vo)} = T\frac{(V-Vs)}{(V-Vo)}$$

Or, $f' = \frac{1}{T'} = \frac{1}{T} \cdot \left(\frac{V-Vo}{V-Vs}\right) = f.\left(\frac{V-Vo}{V-Vs}\right)$

Inference : *f* ' is equal to (*f*)x(Ratio of Velocity of sound w.r.t. Observer to Velocity of Sound w.r.t Source ***(Same as in case 1)***

General Inference on Doppler's Effect : *In case of source and/or observer moving, apparent frequency to the observer is natural frequency of source multiplied by ratio of relative velocity of sound w.r.t. Observer to*



the relative velocity of sound w.r.t. the Source. Manifestation of Doppler Effect in Light is change of Colour, called Doppler Shift and shall be elaborated in Part-II.

Summary: *Initially the concepts of waves discussed above are applicable in analysis of Sound Waves and Light Waves, with distinct boundary of frequencies. Accordingly, these concepts shall be used to elaborate commonalities in respect of various phenomena like reflection, refraction, interference, diffraction and polarization common to light and shall be included in Part II of this article, in 3rd Quarterly e-Bulletin due on 1st April'17. Light waves are a narrow part of electromagnetic waves, which is outside scope of this manual. Nevertheless, readers are welcome to raise their inquisitiveness through Contact Us.*

Examples have been drawn from real life experiences help to build visualization and an insight into the phenomenon occurring around. A deeper journey into the problem solving would 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, it is contemplated to come up with solutions of different type of questions as a dynamic exercise to catalyse the conceptual thought process.

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Author is Coordinator of this initiative **Gyan-Vigyan Sarita**, a non-organizational entity of co-passionate persons who are dedicated to the selfless mission through ***Online Mentoring Sessions*** *(OMS)* to unprivileged children. He had his career as a power engineer, and after superannuation he did his Ph.D, from IIT Roorkee; soonafter this in 2012, he took a plunge into mentoring unprivileged children with Sarthak Prayash an NGO. The endeavour continued in different forms. Currently the thrust area, at the behest of District Administration, is School of Excellence, in Jhabua, a tribal District in MP.

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SOLUTION TO THE PUZZLE-Feb'17: ON CALCULUS

Prof. S.B. Dhar

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GROWING WITH CONCEPTS - Chemistry

QUANTUM NUMBERS

Kumud Bala

An atom contains a large number of orbitals. These are distinguished from each other on the basis of their size, shape and orientation in space. These characteristics of an orbital are expressed in term of three numbers, called principal, azimuthal and magnetic quantum numbers. These numbers also follow form the solution of the Schrodiger wave equation. Further, to represent the spin (rotation) of the electron about its own axis, a fourth quantum number, called spin quantum number is introduced by Uhlenbeck and Goudsmit in 1925. ***Thus , Quantum numbers may be defined as a set of four numbers with the help of which we can get complete information about all the electron in an atom, i.e., location, energy, the type of orbital occupied, shape and orientation of that orbital, etc.***

These numbers are like the postal address of a man. To know about a particular person, Mr. X, we should know his country, his town, his lane and his house number. The four quantum numbers are briefly discussed below:

1. **Principal Quantum Number (n).** It is the most important quantum number since it tells the principal energy level or shell to which the electron belongs. It is denoted by the letter 'n' and can have any integral value except zero, i.e., n= 1,2,3,4 ... etc. The various principal energy shell are also designated by the letter, K, L, M, N, O, P ... etc. starting from the nucleus. This number helps to explain the main lines of the spectrum on the basis of the electronic jumps between these shells. The principal quantum number gives us the following information:
   (i) it gives the average distance of the electron from the nucleus. In other words, it largely determines the size of the electron cloud.
   (ii)it completely determines the energy of the electron in hydrogen atom and hydrogen like particles (which contain only one electron). For example, the energy of the electron in the nth shell of the hydrogen atom is given by $E_n = -2\pi^2me^4/n^2h^2$ where m is the mass, e is the charge of the electron and h is Planck's constant. However, in case of multi-electron atoms, it determines only the approximate energy of any electron.
   For the first principal shell (K), n = 1 which means that this energy shell is of lowest energy and lies closest to the nucleus. For the second principal shell (M), n = 2 and for the third principal shell (M), n =3 and so on. The energies of the various principal shells follow the sequence:
   K < L< M < N < O < P .... Or 1 < 2< 3< 4< 5 .....
   (iii) the maximum number of electrons present in any principal shell is given by $2n^2$ where n is the number of the principal shell.
2. **Azimuthal or angular momentum quantum number (l**). It is found that the spectra of the elements contain not only the main lines but there are many fine lines also present. To explain the presence of these fine lines, it was suggested that the electrons present in any main shell of a multi-electron atom do not have the same energy. This is because they move along different angular momentum. Thus, within the same principal shell, there are present a number of sub-shell or sub-levels of energy. As a result, the number of electronic jumps increases and so is the number of lines. Thus, this number helps to explain the fine lines of the spectrum.
   The azimuthal quantum number gives the following information:
   (i) The number of sub-shells present in the main shell.
   (ii)The angular momentum of the electron present in any sub-shell.
   (iii) The relative energies of the various sub-shell.
   (iv) The shape of the various sub-shells present within the same principal shell.

   This quantum number is denoted by the letter 'l'. For a given value of n, it can have any intergral value ranging from 0 to n-l. For example, for the 1st shell(K), n = 1, l can have only one value ,i.e., l= 0 ,for the 2nd shell (L), n=2, l can have two value, i.e., l= 0 and 1 ,for the 3rd shell (M), n=3, l can have three value, i.e., l = 0,1 and 2 , for the 4th shell (N), n=4, l can have four value, i.e., l = 0, 1 , 2, and 3.

   Each value of 'l' represents a different sub-shell. Depending upon the value of l, i.e., l= 0, 1, 2, and 3, the different sub-shell are designated as s, p, d, f respectively. These notations are the initial letter of

the words, sharp, principal, diffused and fundamental. To sum up :

Value of 'l'	0	1	2	3	4	5
Designation of sub-shell	s	p	d	f	g	h

(i) n = 1, l = 0 1s
(ii) n =2, l =0,1 2s 2p
(iii) n = 3, l = 0,1,2 3s 3p 3d
(iv) n = 4, l = 0, 1, 2, 3, 4s 4p 4d 4f

Thus, in general, the number of sub-shells present in any principal shell is equal to the number of the principal shell or the principal quantum number.

Further, the energies of the different sub-shells present within the same principal shell are found to be in order s<p<d<f i.e., an electron in the s-subshell has lower energy than that in the p-sub-shell of the same principal shell. Angular momentum of the electron in an orbital = $\sqrt{l(l+1)}$ h/2π

3. **Magnetic Quantum Number (m or m_l).** This quantum number is required to explain the fact that when the source producing the line spectrum is placed in a magnetic field, each spectral line splits up into a number of lines (Zeeman effect). This may be explained as follow:
An electron due to its orbital motion around the nucleus generates an electric field. This electric field in turn produces a magnetic field which can interact with the external magnetic field. Thus, under the influence of the external magnetic field, the electrons of a subshell can orient themselves in certain preferred region of space around the nucleus called orbitals. The magnetic quantum number determines the number of preferred orientation of the electrons present in a subshell. Since each orientation corresponds to an orbital, therefore the magnetic quantum number determines the number of orbitals present in any subshell. The magnetic quantum number is denoted by the letter 'm' and for a given value of l, it can have all the values ranging from –l to +l including zero, i.e., -l, -(l-1), -(l-2).... 0, 1....(l-2), (l-1), l . Thus, for every value of l,m has 2l+1 values. For example, (i) For l = 0 (s-sub-shell) , m can have only one value, i.e., m= 0. This means that s-sub-shell has only one orientation in space. In other words, s-sub-shell has only one orbital called s-orbital. (ii) For l = 1 (p-sub-shell), m can have three values, i.e., m = -1, 0, +1. This means that p-sub-shell has three orientations in space. In other words, a p-sub-shell has three orbital. Since these three orbital are oriented along x-axis, y-axis and z-axis, therefore, they are commonly referred to as p_x p_y and p_z. (iii) For l =2 (d-sub-shell), m can have five values, i.e., m = -2, -1, 0, +1 and +2. This implies that there are five different orientations of d-sub-shell in space. In other words, d-sub-shell has five d-orbitals. (iv) Similarly, when l=3 (f-sub-shell), m can have seven values, i.e., m = -3, -2, -1, 0, +1 +2, and +3. This implies that there are seven different orientations of the f-sub-shell. In other words, f-sub-shell has seven f-orbitals.

To sum up:

Sub-shell	s	p	d	f	g
No. of orbitals present	1	3	5	7	9

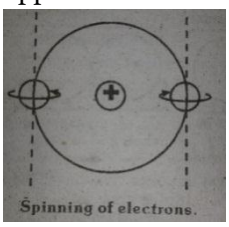
Values of m by latest conventions

Orbital	Value of m	Orbital	Value of m
p_z	m = 0	d_{z^2}	m = 0
p_x	m= +1	d_{xz}	m = +1
p_y	m = -1	d_{yz}	m = -1
		$d_{x^2-y^2}$	m = +2
		d_{xy}	m = -2

It may be pointed out that all the three p-orbitals of a particular principal shell have the same energy in the absence of a magnetic field. Similarly, all the five d-orbitals of a particular shell have same energy. These orbital of the same sub-shell having equal energy are called degenerate orbitals. However, in presence of an external magnetic field, this degeneracy is broken or split and the orbitals of the same sub-shell acquire slightly different energies. This causes the splitting of a given spectral line into many.

4. Spin quantum number (s). This number was introduced to account for the fact that the electron in an atom not only moves around the nucleus but also spin about its own axis (like the earth which not only revolves around the sun but also spin around its own axis). This number gives the information about the direction of spinning of the electron present in any orbital. It is represented by 's'. since the electron in an orbital can spin either in the clockwise direction or in the anti-clockwise direction, hence for a given value of m , s can have only two values, i.e., +1/2 and -1/2 or these are very often represent by two arrows pointing in the

opposite direction, i.e., ↑ and ↓ .



This quantum number helps to explain the magnectic properties of the substances. A spinning electron behaves like a micromagnet with a definite magnetic moment. If an orbital contains two electrons, the two magnetic moments oppose and cancel each other.

Thus ,it may be concluded that :

No. of sub-shells in nth shell = n

No. of orbital in a sub-shell = 2l+1

Maximum no. of electrons in a subshell =2(2l+1)

No.of orbitals in nth shell =n^2

Maximum no. of electrons in nth shell = $2n^2$

ASSIGNMENT

1. For a d- electron, the orbital angular momentum is :
   (a) $\sqrt{6}\hbar$ (b) $\sqrt{2}\hbar$ (c) $\hbar$ (d) $2\hbar$
2. The total number of orbitals in a shell having principal quantum number n is
   (a) 2n (b) n^2 (c) $2n^2$ (d) n+1
3. The maximum number of electrons in an orbit with l=2, n=3 is
   (a) 2 (b) 6 (c) 12 (d) 10
4. Not possible is
   (a) n=3 , l=0, m=0 (b) n=3, l=1, m=-1
   (c) n=2, l=0, m=-1 (d) n=2, l=1, m=0.
5. The orbitals for n=3, l=2 , m=+2
   (a) 1 (b) 2 (c) 3 (d) 4
6. The total number of orbitals for principal quantum number n=4, having l=3 is
   (a) 3 (b) 5 (c) 7 (d) 9
7. The number of 2p electrons having spin quantum number s = -1/2 are
   (a) 6 (b) 0 (c) 2 (d) 3
8. If n=3, l=0, m=0, then atomic number is
   (a) 12, 13 (b) 13, 14 (c) 10 , 11 (d) 11, 12

Answers : 1. (a) 2. (b) 3. (d) 4. (c) 5. (a) 6. (c) 7. (d) 8. (d)

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Answers to Science Quiz in 1st Supplementary dt 1st Feb'17 to 2nd Quarterly e-Bulletin

Kumud Bala

1. (c) 2. (d) 3. (a) 4. (d) 5. (d) 6. (c) 7. (d) 8. (d) 9. (b) 10. (c) 11. (a) 12. (d) 13. (c) 14. (c) 15. (a)

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SCIENCE QUIZ March'17

Kumud Bala

1. The mirror used in vehicles is
(a) convex (b) concave
(c) plane (d) none of these

2. The ray of light from denser to rarer medium
(a) deviates towards the normal
(b) deviates away from the normal
(c) goes undeviated
(d) reflected back

3. The apparent depth of a coin inside water tab decreases due to
(a) refraction of light
(b) reflection of light
(c) total internal reflection
(d) dispersion of light

4. The blood cells of the body that are called 'soldiers' are
(a) WBC (b) platelets
(c) RBC (d) all of these

5. The Tracheal system is found in
(a) insects (b) human
(c) fish (d) frog

6. The elimination of toxic nitrogenous waste and excess water in man is by
(a) excretion (b) circulation
(c) reproduction (d) pollution

7. Blood clotting is because of
(a) fibrin (b) thrombin
(c) thromboplastin (d) all of above

8. The shape of Bowman's capsule is like a
(a) glass (b) flask (c) spoon (d) cup

9. Lymph flows from
(a) tissue to heart (b) heart to tissue
(c) double circulation (d) all of these

10. In the reaction SO_2 (g) + $2H_2S$ (g) $\rightarrow$ 3S (s) + $2H_2O$ (l) SO_2 is acting as an
(a) acid (b) oxidizing agent
(c) reducing agent (d) base

11. The chemical formula of oleum is
(a) $H_2S_2O_7$ (b) H_2SO_5
(c) H_2SO_3 (d) SO_3

12. Haematite is an ore of
(a) aluminium (b) iron
(c) zinc (d) mercury

13. The pH of a solution is 4. When its pH changes to 2, then its H^+ ions concentration will
(a) decrease two times (b) increase two times
(c) increase 100 times (d) decrease 100 times

14. The number of atoms in a molecule of sulphur is
(a) 4 (b) 8 (c) 2 (d) 6

15. The comet is
(a) Halley (b) Mars (c) Venus (d) Moon

16. The tear gas is
(a) methyl isocyanide (b) sulphur dioxide
(c) chloropicrin (d) nitrous oxide

17. The type of radiation absorbed by CO_2 molecule in atmosphere are
(a) X-rays (b) Gamma- rays
(c) Infra-red rays (d) UV-rays

18. The layer of planet earth's atmosphere protects it from the harmful UV radiation of the Sun
(a) Stratosphere (b) Ozonosphere
(c) Troposphere (d) ionosphere

19. The wings of birds and insects are
(a) vestigial organs (b) homologous organs
(c) Paralogous organs (d) Analogous organs

20. The electronic configuration of an ion M^{+2} is 2, 8, 14. If its mass is 56. The number of neutrons in its nucleus is :
(a) 30 (b) 32 (c) 34 (d) 42

(Answers to this Science Quiz shall be provided in Third Quarterly e-Bulletin dt 1st April'17)

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Theme Song :

PREMISE: ***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 **E**ach **A**chieves **M**ore
(**TEAM**)

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