GYAN VIGYAN SARITA:शिक्षा

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

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Special Issue: National Statistics Day. 29th June

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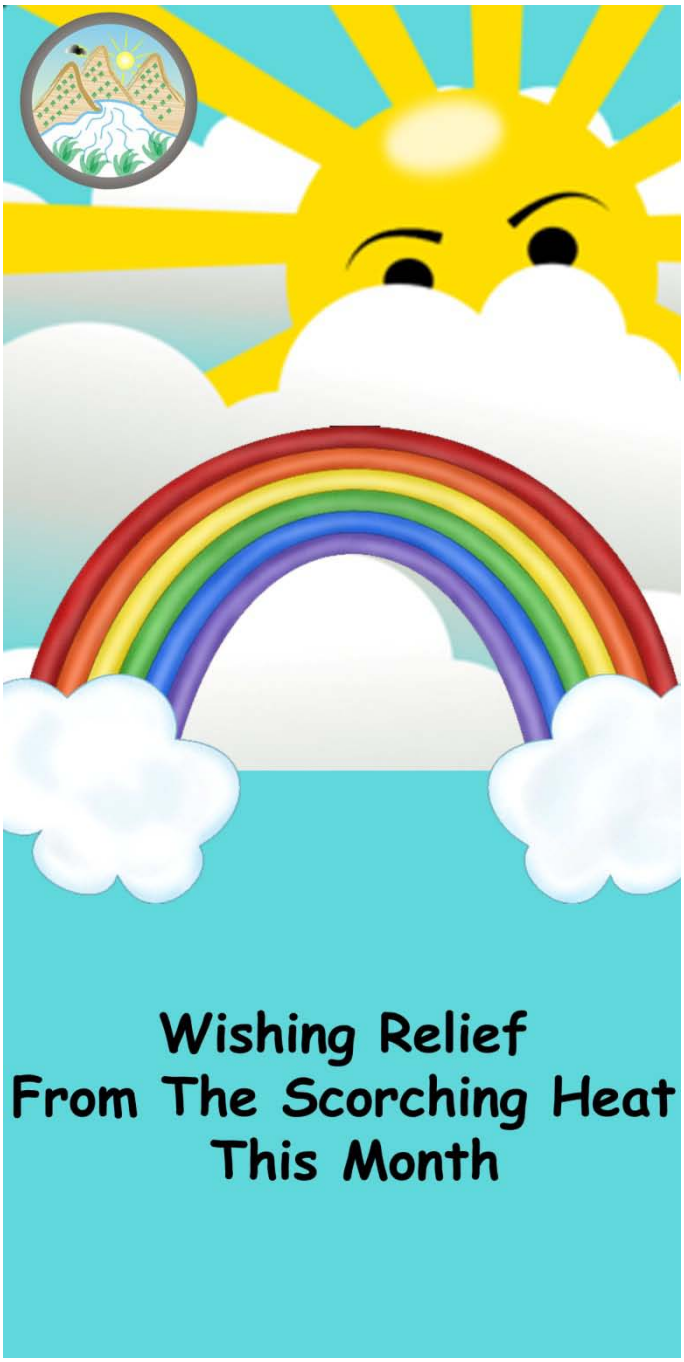

Aim at the Best, but...

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

Infrastructural Requirement for Centers in Interactive Online Mentoring Sessions (IOMS)

Learning Center (if asked for by Mentor)		Mentoring Center (if asked for by Mentor)	
Estimated Capital Cost (One Time)			
Particulars	**Cost (in Rs)**	**Particulars**	**Cost (in Rs)**
Desktop (without monitor)	20,000	Laptop	25,000
Projector	15,000	Projector	-
Web camera	10,000	Web camera	-
Mixer cum amplifier with Speaker and Wireless microphones	15,000	Headset with Microphone	3,000
Wireless Surface Writing device	15,000	Wireless Surface Writing device	15,000
Total	75,000		43,000
Estimated Recurring Cost			
Internet charges, based on estimated monthly data transfer which depends upon choice of cloud platform, and tariffs of ISP		Internet charges, based on estimated monthly data transfer which depends upon choice of cloud platform, and tariffs of ISP	
Cloud platform : a. Subscription whether it annual as in WebEx or One time with AMC like in as in UTP+. b. Cloud platform is a shared resource across Learning Centers benefitting from IOMS. c. The IOMS envisages session for more than one centre together, these charges may be shared across, or one centre bears total cost sequentially. It is purely in mutual agreement between Learning Centers. d. Benefit of sharing of charges of cloud platform can be optimized with offset of schedule of sessions of IOMS.		IOMS is since an initiative driven with Personal Social Responsibility (PSR) operating n Zero-Fund-&-Zero-Asset (ZFZA) basis, the Cloud Platform has to provided by Learning Centers benefitting from IOMS. Gyan Vigyan Sarita will be pleased to connect Learning Centers for collectively complementing the cost of Cloud Platform for arriving at a mutual agreement on financial sharing. So also IT Infrastructure with Dr Joshi has been in use and is working. But, at any stage if upgradation becomes essential, extended hand by learning centers is gratefully welcomed on ZFZA basis. The same is true for any other mentor joining IOMS	

Specification: These were practiced independently, based on ground level operating experience and need of optimizing the cost on the initiative. This is essential to utilize financial resources, considered scarce, for benefitting more number of students at more number of centers and mentoring centers.

These specifications have been updated by deriving motivation from **VIVEKDISHA, Belur Math**, which has been engaged in Online Teaching to about 22 Centers, since last 10 years. The only difference that IOMS has is in extensive use of Whiteboard.

Web Camera: Logitech HD 1080p, with a tripod or wall mounting

Projector: Portronics LED Projector Beem 100", 100 Limen, 130" Screen size, 800x480px resolution

Mixer-cum-Amplifier: Ahuja Make PA Mixer Amplifier Model DPA-370, 30 W Max/37W Max, with Two Cordless Mikes and Speakers. This device offers echoless input/output communication with base computer and Mikes and Speakers in the Class.

Cloud Platform: UTP+, by PeopleLink Unified Communications, Hyderabad with Six Users+Two Rooms. Its minimum bandwidth requirement is 256 mbps, with facilities to tune image resolution, frame rate, bitrate etc. seamless streaming of data Audio-video-whiteboard a necessity in IOMS. Without prejudice, any other platform that has been satisfactory tested for seamless data-transfer at or below 256 kbps is welcome.

Surface Writing Device: HUION make Model WH1409, it has wireless as well as wired communication with base computer.

UPS: An additional accessory, for uninterrupted continuity of session, based on power availability to be decided by Learning Center, **not included in above cost estimates.**

Furniture and Lighting: At Learning Center, as deemed fit by local administration of Learning Center, **not included in above cost estimates.**

संपादकीय

राष्ट्रीय सांख्यिकी दिवस (NATIONAL STATISTIC DAY)

विकास में योजना का बहुत महत्व होता है। किसी काम को सलीके से और समय पर करना ही योजना है। सही समय पर काम पूरा होने में आंकड़ों का बड़ा योगदान होता है। आंकड़े हमें बताते हैं कि हमें कहां, कितना, और कैसे काम करना है। वैज्ञानिकों का मानना है कि विचारों को अंकों में परिवर्तित कर ज्यादा उपयोगी बनाया जा सकता है।

सांख्यिकी अंकों का गणित है। यह अंकों के इर्द गिर्द ही रहती है। सांख्यिकी अंग्रेजी भाषा में Statistics कहलाती है जिसका मतलब होता है-आंकड़ों का संग्रह करना, उनका आवश्यकता के अनुसार वर्गीकरण करना और फिर उनसे नतीजे निकालना।

कार्ल पियर्सन (Karl Pearson) एक अंग्रेज गणितज्ञ थे। उन्होंने बायोमेट्रिका (Biometika) नामक एक जर्नल राज्यों से संबंधित आंकड़ों के संग्रह के लिये 1901 में स्थापित किया था। इस जर्नल ने ही महालनोबिस का भविष्य बदल दिया। वह लंदन से इस जर्नल को खरीद लाये और इसके आधार पर ही भारत में भारतीय सांख्यिकी संस्थान के माध्यम से संख्या (Sankhya) नामक जर्नल 1933 में शुरू किये।

सांख्यिकी का मूल स्वरूप राज्यों के विभिन्न तरह के आंकड़ों का सरकार द्वारा उपयोग करना था। इसे राजनीतिक अंकगणित (Political Arithmetic) भी कहा जाता था। सबसे पहले Statisik का प्रयोग Gottfried Achenwall ने 1749 में किया था।

संख्यिकी हमें सिखाती है कि कैसे हम अपने चारों ओर के सामाजिक, आर्थिक, और प्राकृतिक समस्याओं के कारणों का पता कर सकते हैं और कैसे हम उन समस्याओं को सुलझाने के लिये इसका उपयोग कर सकते हैं। समस्या कहां कहां है, कितने समय से है, कितनी है, और किस किस को है और कितनी गहराई तक है-यह सब जानने के लिये हमें हर जरूरी सूचना को एकत्र करना होता है। उन्हें समझने के लिये उनको कई कई हिस्सों में बांटना पड़ता है और तब हमें यह पता चलता है कि हमें अब करना क्या है। यह प्रारंभिक कार्य सर्वे भी कहलाता है।

29 जून का दिन भारतवर्ष में राष्ट्रीय सांख्यिकी दिवस के रूप में मनाया जाता है। यह क्रम वर्ष 2007 से शुरू हुआ है। यह दिन प्रशांतचंद्र महालनोबिस का जन्मदिन है। वर्ष 1893 में इसी दिन कोलकाता में उनका जन्म हुआ था। आर्थिक योजना और सांख्यिकी विकास के क्षेत्र में महालनोबिस के उल्लेखनीय योगदान के सम्मान में भारत सरकार ने उनके जन्मदिन को राष्ट्रीय सांख्यिकी दिवस घोषित किया है।

सांख्यिकी दिवस प्रत्येक वर्ष मनाया जाता है। इस दिन को मनाने का उद्देश्य यह होता है कि सामाजिक, आर्थिक नियोजन और नीति निर्धारण में प्रोफेसर महालनोबिस की भूमिका के बारे में आम जनता को बताया जाये, विशेषकर युवा पीढ़ी को जागरूक किया जाये और उन्हें प्रेरित किया जाये।

प्रोफेसर महालनोबिस ने 1931 में कोलकाता में भारतीय सांख्यिकी संस्थान INDIAN STATISTICAL INSTITUTE की स्थापना की थी, जिसकी आजकल देश में कई शाखायें हैं। महालनोबिस भारत सरकार के सांख्यिकीय सलाहकार रहे हैं। उनके सांख्यिकीय विभाग का सबसे बड़ा काम था कि वह देश की प्रगति के लिये उसकी राष्ट्रीय आय का अनुमान लगाये। स्वतंत्रता के बाद भारत में इस उद्देश्य की पूर्ति के लिये सबसे पहले 1949 में महालनोबिस की अध्यक्षता में एक राष्ट्रीय आय समिति बनी। उसी समय योजना आयोग का गठन किया गया और उनको इसका सदस्य

बनाया गया। महालनोबिस की योग्यता का अनुमान इस बात से लगाया जा सकता है कि भारत की दूसरी पंचवर्षीय योजना उनके ही माडल पर आधारित थी।

उनके दादा गुरूचरण ब्रहम समाज के अध्यक्ष एवं खजांची थे। उन्होंने समाज सुधार के अनेक कार्यो में सक्रिय योगदान किया था। इनके पिता भी एक शिक्षाविद थे। वह एडिनवर्ग यूनिवर्सिटी से फिजियोलाजी की पढाई किये थे। महालनोबिस की प्रारंभिक शिक्षा कोलकाता में हुयी और उच्च शिक्षा के लिये वह कैंब्रिज यूनिवर्सिटी में पढ़ने गये जहाँ महान गणितज्ञ रामानुजन से उनकी मुलाकात हुयी।

उन्होंने भारत में बेरोजगारी समाप्त करने के सरकार के प्रमुख उद्देश्य को पूरा करने के लिये योजनाएं बनायीं। सच कहा गया है कि जिसका बचपन विद्वानों के बीच गुजरा हो वह आगे चलकर एक महान व्यक्ति अवश्य बनता है। प्रशांत का बचपन भी विद्वानों और समाज सुधारकों के बीच गुजरा और उनकी प्रारंभिक शिक्षा उनके दादा द्वारा स्थापित ब्रहम व्वायज स्कूल में हुयी। प्रेसीडेंसी कालेज में जगदीशचंद्र बोस और शारदा प्रसन्न दास, प्रफुल्लचंद्र राय जैसे शिक्षकों ने उन्हें पढाया था। प्रसिद्ध वैज्ञानिक मेघनाद साहा उनसे एक कक्षा जूनियर थे और सुभाषचंद्र बोस दो कक्षा जूनियर थे।

महालनोबिस ने निश्चित संकल्पना के आधार पर सैंपल सर्वे की शुरूआत की थी जो आगे चलकर वर्तमान युग में बड़ी बड़ी नीतियों और योजनाओं का आधार बनी। 1945 में उनकी योग्यता को सम्मानित करते हुये लंदन की रायल सोसायटी ने उन्हें अपना फेलो नियुक्त किया। 1968 में उन्हें श्रीनिवासरामानुजन स्वर्ण पदक दिया गया। भारत सरकार की तरफ से 1968 में उनको पद्म विभूषण से नवाजा गया।

महालनोबिस को विज्ञान के क्षेत्र में व्यूरोक्रेटस यानि नौकरशाहों की दखलंदाजी पसंद नहीं थी। वे भारतीय सांख्यिकी संस्थान को एक स्वतंत्र संस्था के रूप में ही देखना चाहते थे। उनकी खोज महालनोबिस डिस्टेंस दो डाटा सेट के बीच की तुलना करता है। ग्राफिक्स आधारित विश्लेषण के जरिये उन्होंने अलग अलग तबकों के सामाजिक, आर्थिक हालात की तुलना की।

आज आवश्यकता है कि हम अपने देश के नौजवानों के लिये ऐसी योजनायें बनायें जो उन्हें उनकी पढ़ाई पूरी होते ही रोजगार दे । जितनी बेरोजगारी कम होगी, हमारा समाज उतना ही अधिक उन्नति करेगा और खुशहाल होगा। आइये, हम एक खुशहाल व्यक्ति, खुशहाल परिवार, खुशहाल समाज और फिर खुशहाल भारत की संकल्पना के साथ आज के सांख्यिकी दिवस को मनायें और इस संकल्पना को पूरा करने में हर तरह का योगदान करें। भारत में सांख्यिकी के जनक श्री प्रशांतचंद्र महालनोबिस को उनके जन्मदिन पर ज्ञानविज्ञानसरिता परिवार की तरफ से कोटि कोटि नमन ।

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The man who is pure, and who dares, does all things

- Swami Vivekananda

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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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 , c) Chemistry and d) English Gammar. 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 it is contemplated to come up representative problems from contemporary text books and Question papers from various competitive examinationsand a guide to theirsolutions in a structured manner, as a dynamic exercise to catalyse the conceptual thought process.

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An Appeal: Gyan Vigyan Sarita

A Non-organizational Initiative of a Small Set of Co-passionate Persons

Philosophy: Personal Social Responsibility (PSR)

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

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

Operation:

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

Involvement:

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

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

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

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

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

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

Coordinator's Views

Inspiration vis-à-vis Motivation

The whole world is relative and individuals or groups of people are differentiated either by their actions by thought process. Action are commensurate to measurement, but thought process which is not. Therefore, to gauge one's thought process it requires more of close observation and understanding of the person under consideration. Every out-performer strives hard to be so, and reasons attributed to this are inspiration and motivation of the person. Inspiration and motivation in common parlance are considered to be similar and are generally used interchangeably, but they are characteristically different. In this article effort is made to objectively discriminate the two notions for clarity of purpose. Happily, since couple of years inspirational stories in the field of education be it a teacher, student or a guardian are being filmed. This is an indicator of sensitivity prevalent in the society. This has reinforced the desire to add a link into dissemination on the subject.

Inspiration is mental stimulation which creates a necessity to act differently in a certain manner. This stimulus can be from the circumstances in which a person has lived or living. It could be over a wide range from survival instinct in adversities, In this journey, A person in whom a ray of hope or a solace could be visualized, while in pursuits of an ideal or a goal, is regarded as a role model. It has seen that some are inspired to into target a career in security services or police to help innocents from being tortured by criminals. Such persons might have had unpleasant experience of sufferings to one of their nearest dearest, in hands of some unlawful person(s). Some of such happenings are scripted, some are screened, while there are many which go unnoticed. Yet there are many persons of extraordinary grit and determination in every field. They are product of unusual situations in a positive mould, and this is called inspiration.

An inspired person aims at actions which yield result beyond personal gains and, therefore, risk taking is a process of reaching to destination. Risk taking ability of a person arises only when there is selflessness in motives. The moment personal interest creeps in, the whole thought process is translated into exploring trade off arithmetic, and its results dominate actions. In such self-centric situations opportunity cost, value of efforts and returns there upon becomes decisive. And one ends up in a paradox 'to be or not to be'..

There are many inspirational quotes available from all accomplished persons. Each of such persons at some point of time has spent sleepless nights, days with unfilled belly, walking and working in scorching heat of sun, shed-less rainy days and unclad nights in biting cold. Few of them never had luxury of having childhood fun. These persons, if go un-inspired would have turned into tyranny with full of revenge. If anything that prevented them from turning into ill-tolerant person is the inspiration that they derived during their upbringing in hardship. A person confronting unusual circumstances if has come up as an inspired person the people around, must have played an important role like a rudder, not letting him either sink or go directionless.

Inspiration can come at any time; not necessarily during infancy; it can come at an age of consciousness. Arousing of inspiration is a very complex psychological process and thus source of inspiration cannot be attributed to a single event or an individual. It is an effect consistent and perpetual impact of the circumstances which has created a strong conviction for a cause. This must have aroused an inner strength for the pursuit. This inner strength is sustained due to full bodily involvement and mental conviction. This inner strength attributes the phenomenal risk taking capability in the inspired person. Otherwise, it is quite normal for an uninspired person to either buckle or succumb to odds and take an easiest recourse.

Inspiration can be classified into active and passive inspiration. Active inspiration creates an urge to create or discover new things, applying new ideas, and taking mistakes in the process as stepping stones of forward pursuit. Scientists, leaders, reformers and passionate teachers are actively inspired persons. While followers are consume the success and ideas of the success of the person they are inspired with. Most of the monasteries are flock of passively inspired persons, called followers and disciples. The good

that they yield is the remnant influence of their ideal. And the evil that they produce are orthodoxy, irrational thinking and blind following. In an article '**Ideology vis-a-vis Purpose**' in this e-Bulletin dt 1st May'18, pp 7-10, these aspects were elaborated.

At times a wise review of the ideals is essential to adjudge objective relevance in contemporary scenario. Passive inspiration blocks wisdom to choose between right or wrong, and the followers are lost in the conventions, practices and/or traditions of their role model or inspiration. Such an inspiration at some point of time may lead fanaticism, a dangerous situation. It needs to be guarded against.

On the contrary motivation is the reason for a person to act in a particular way and relentlessly pursue a cause. But, motivation comes from external source in the form of either a reward or a fear. Reward could be unusual, or may be out of turn, while fear is of losing expected gains or benefits. If expected gains are to come in a normal course, as per *law of least potential- 'everybody in this universe tries to occupy position of least potential*' by natural choice persons would be waiting for their turn to be a receiver. And a corollary to reward is fear based on which concept of 'carrot and stick' was evolved in classical management. Off late many more methods of motivation have come in practice where fear of loss is camouflaged and projected as incentive. It is just sugar coating of a soar pill of fact of fear of forfeiture of an assured gain or being under the risk of a loss. In corporate world the salary package has two components one fixed and the other is 'performance linked incentive'. In marketing 'buy two to get three', like this every day one finds new and innovative motivational phrases or concepts.

The most common among all this is that source of motivation is external. The motivation is infused in person(s) to attain personal gain which is sometimes camouflaged or may be made transparent on sharing of interests. A person learns to live through motivation and incentives right from the stage of infancy in one form or the other. The motivator, based on urgency or need, uses different methods to infuse willingness or enthusiasm for betterment of his subjects. Thus sometimes motivator aims to make his job easier or for mutual interest.

Role of manager is to motivate his team spanning from those in family, peers, at work, stake holders, clients and prospective customers. A manager works within limits of motivation based on predetermined threshold of loss/gain.

Like inspiration, motivation is also of two types. *Intrinsic motivation* where instinct of pleasure, importance or desire is catalyzed to make person(s) to do certain things or act in specific manner. The other is *extrinsic motivation* by persons or compelled with '***fear or favour***' to do something. Motivator is calculative and strategic in degree and extent of motivation; it is purpose driven. Nevertheless, inspiration is boundless and continues to drive action until objective is achieved.

Gyan Vigyan Sarita(GVS) is a philosophy which is philosophy open to all to know, add, modify, alter, collaborate, facilitate, promote with full autonomy, or even take away, with a single expectation to do good to the society. It respects 'agree to disagree' approach. Genesis of the philosophy of GVS is in a sense of personal social responsibility (PSR) of a small group of Four persons who have converged to groom competence to compete among unprivileged children through education. This initiative is totally non-organizational, non-remunerative non-commercial and non-political. Its financial operations are on *Zero-Funds-and-Zero-Asset (ZFZA)* basis. The nature and methodology of its operations are quite discrete yet seriously committed to groom ability to think and apply among the target students. It started Six-years ago in Chalk-N-Talk mode, and since last Two years it is into a proven model '*Interactive Online Mentoring Session (IOMS)*'.

Journey of GVS has seen many ups and downs in last six years, and faced challenges of continuing to serve with तन और मन (Tan aur Man - bodily and mentally) without धन (Dhan – finances). This challenge is compounded seeing individuals, organizations, corporate and administration applauding the initiative in the beginning. But, going forward their withdrawal has been experienced with a non-transparency and non-communication. This creates obvious question –

(a) were they really inspired to allow this initiative? **(b)** if this initiative was considered to support purpose of their ideology, then reasons of their withdrawal? **(c)** if they have valid reasons to diverge, then why is non-transparency and non-communication from the persons who matter?

Purpose of this article is to incite elite readers, who can make a difference, and to consciously *shortlist persons and organizations*, who claim to be social reformers, *who are really inspired and open to collectively complement in social reform through education*. This task is so mammoth that none, howsoever mighty may be, can accomplish it alone. It is requested to consciously keep aside motivated persons from this initiative, it is not sustainable for them; they would back out when they find no room for their personal gratification or any gain. *Such motivated persons have created bad precedence in this initiative*. This is a bitter pill and has to be swallowed, if one wants to think and act GVS way; it is an open philosophy. GVS is open to any test or verification of its dedication, sincerity, honesty and meticulous methodology, within the constraints that we live with. We are committed to pursue it upto the extent we can. In this sequel next article in this column of this bulletin, due on 1st June'18, shall be on मैं अकेला? (Mai Akela – Am I Alone?).

Summary: *Inspiration is common in leaders, spiritual Gurus, passionate teachers and social reformers. Whereas, motivation is prevalent among followers, disciples, subordinates, employees and workers. Inspiration is proactive but, motivation is reactive. Inspired persons exercises care to the possible extent to ensure that no error or shortcoming in actions left out; he is aware of the consequence of any neglect; it is compounded loss and/or sufferings of the subjects of actions. But, motivated persons operates within assigned roles and responsibilities and while acting beyond their focus remains on expected reward.*

There are related attributes like passion, intuition and aspiration. Lower form of inspiration is passion, but the latter operates on zone of comfort. But, intuition is psychological reflection of context, experiences and emotional involvement in the actions. Aspiration is purely expectations on the persons involved. Motivator can capitalize upon passion, intuition and aspiration of subjects. But, inspired persons try to carve journey of their subjects for self-actualization. Social welfare has become a fashion for those who can afford the luxury, and it needs be carefully screened out in such initiatives arising out of imspiration.

We are sure that, from an atheist perspective, elite persons, with their sensitivity and sensibility in command, would not fail in making value addition to such initiatives, if there is any scope of correction or moderation. Thus make it roots to grow and sustain rough weather. And, from believers perspective, it is duty of the GOD to strengthen spirit of goodness to reach all its beloved children, lest none of them is left deprived of an opportunity to grow. It is HIS duty to ensure that credibility of such initiatives are first tested and then blessed with firm roots to bear storm of selfish motives.

Admiral Grace Murray Hopper, the first lady admiral US Navy was a self actualized person who practiced what she administered *"A ship in harbour is safe, but that is not what ships are built for. Go ahead! Take risks! There is no shame in saying sorry, if you went wrong."*

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जो व्यक्ति सीखना छोड़ देता है, वह अहंकार से भरता जाता है और जो सीखता रहता है, वह विनम्रता से भरता जाता है

पक्का दोस्त !

निरंजन धुलेकर

याद है मुझे , छोटा था निक्कर बुस्केट पहनने वाला । एक फल खाया तो माँ ने कहा 'जा उस जगह मिट्टी में ये गुठली दबा दे, तेरा दोस्त आ जाएगा मिलने तुझे !'.

दोस्त आया और बड़ा होने लगा मुझसे भी लंबा हो गया मेरे साथ पलते बढ़ते । फिर मुझसे मिलने उसके सैकड़ो दोस्त आने लगे उछलते ,कूदते ,उड़ते और रेंगते । कुछ वहीँ रहने लगे उसके साथ । मेरे अपने इस मोहल्ले में चहल पहल बढ़ गयी !

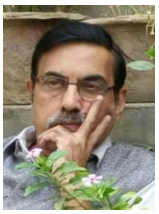
मैं फ़िर उड़ गया अपनी दुनिया मे ! सालों गुजर गए .. सुना , मेरा दोस्त अब बहुत बड़ा हो गया था फल आने लगे थे ,शाखें मोटी और मज़बूत हो गयी थीं !

मेरा अपना घर बन रहा था सुदूर शहर में ! उस दोस्त वाले घर मे भाई का परिवार ही बचा था । माँ थीं , तो मुझे दोस्त की सौगातें यानी फलों के टोकरे, भेजती थीं !

एक दिन एक ट्रक आ कर रूका मेरे नए घर के सामने, भाई ने बहुत प्यार से ढ़ेर सा सामान बनवा कर भेज दिया था घर मे सजाने को ..... मेज़, कुर्सियां, साइड टेबल, पलंग, डाइनिंग टेबल !

मुझे महसूस हुआ मेरे दोस्त की .... अस्थियाँ आयी थीं ।

अब मुझे जन्म भर दोस्त के श्राप की आग मे जलना होगा, खाते, पीते, जागते और सोते समय भी, शायद मेरी अपनी अस्थियों तक !



लेखक एक सेवानिवृत्त बैंक अधिकारी है | आपने गोविन्द वल्लभ पंत विश्वविद्यालय के कृषि विधा के स्नातक है, तत्पश्चात समाजशास्त्र में स्नातकोत्तर की उपाधि ग्रहण की | आपको माइक्रो -फिनान्सिंग क्षेत्र मैं वृहत अनुभव है | सामाजिक पर्यवेक्ष में चिन्तन एवं लेखन आपकी विशेष रूचि है |

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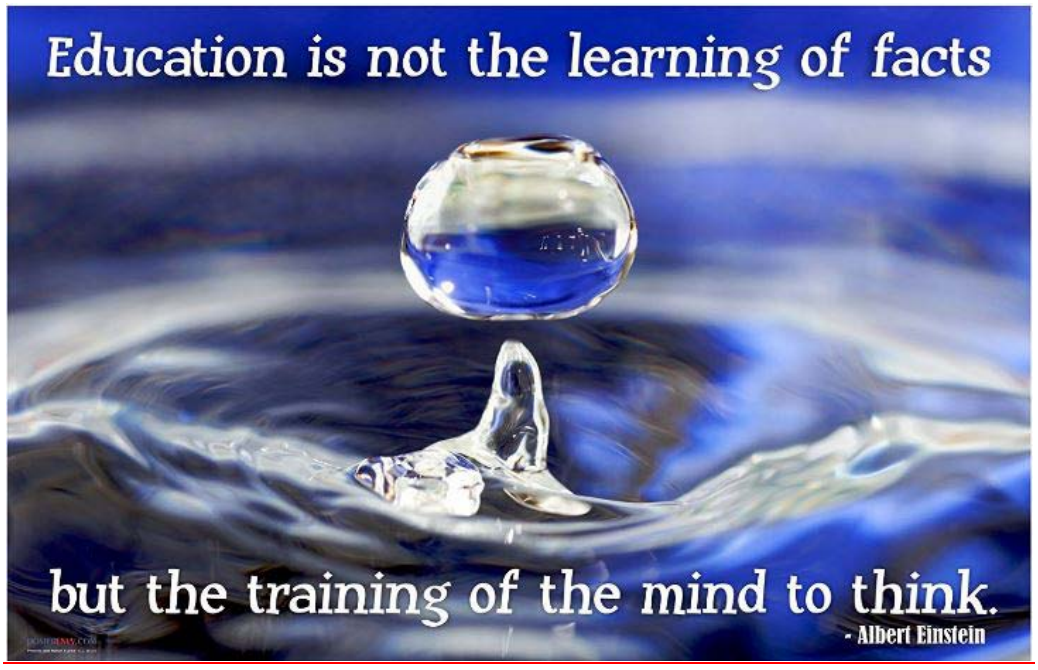

अंदाज ए बयां

अति बंद करो प्लीज!!

समीर लाल 'समीर'

हिन्दुस्तान की समस्या यह नहीं है कि हम क्या करते हैं? जो हम करते हैं वह मानव स्वभाव है , वो कोई समस्या नहीं.. सारी दुनिया वही करती है मगर समस्या यह है कि हम जो भी करते हैं अति में करते हैं. यही हमें औरों से अलग विशिष्ट पहचान देता है. विशिष्टता नामी और बदनामी दोनों की ही होती है.

ज्ञानी तो हर हिन्दुस्तानी होता ही है. हो न हो मगर मानता तो है ही. शायद ही कोई ऐसा हिन्दुस्तानी हो जिसे आप अपनी कैसी भी कठिन से कठिन समस्या या बीमारी बतायें और वो सलाह न दे. चाहे फ़िर आपको मात्र खरोच आई हो ,या पेट दर्द हो ,,कैंसर हुआ हो , एडस हो जाये, हर हिन्दुस्तानी के पास हर मर्ज की देशी विदेशी दवा का नुस्खा जेब में हाजिर मिलेगा. करेले से लेकर लहसुन, अर्जुन की छाल से लेकर इसबगोल की भूसी तक, मंत्र से केले में भस्म भर कर पीलिया के ईलाज तक , आरंडी के बीज से लेकर सौंफ के पानी से गठिया वात के ईलाज की , बुखार में बिना वजह जाने क्रोसिन से कॉम्बीफ्लेम तक और तो और एन्टीबायोटिक भी बिना खून के जांच के और मिर्चे और नीबू शहद विनेगर के घोल से हार्ट ब्लॉकेड खोलने का तरीका तक बताने को लोग हर क्षण तैयार बैठे हैं.

पीलिया का ईलाज तो मंत्र से ऐसा करते हैं कि हाथ धुलवा कर परात भर पानी में पूरा पीला पानी उतार देते हैं. गले में कंठा पहना कर उसे नाभी तक चार दिन में पहुँचा देना तो हर पीलिया जोगी और रोगी जानता है. गुप्त समस्याओं के चूरण और शिलाजीत की गोली देना तो लगता है कि भारतीयों के मौलिक अधिकार में से एक है.

आप समस्या बताने चलें और उसके पहले हर समस्या का उपाय और सलाह हाजिर. दिल्ली शिफ्ट होना होया फिर आपको विदेश जाना हो ,जन्म मृत्यु प्रमाणपत्र बनवाना हो या पासपोर्ट ,पान की दुकान पर अनजान सलाह देकर निकल जायेगा और आप सोचते रह जायेंगे कि यह बंदा कौन था ? सब के सब देवीय शक्ति लिए घूमते हैं चप्प्पल फटकाते गली गली. उनकी सलाह पर चलता तो सचिन कब का सौ शतक लगा चुका होता. अन्ना भ्रष्टाचार को जड़ से उखाड़ फेक चुके होते और भारत अमेरीका से ज्यादा विकसित राष्ट्र होता. मगर सलाह देते देते इतना अति कर गये कि लोगों ने उनकी सलाह ही सुनना बन्द कर दी. मगर वो सलाह देने से अब भी बाज नहीं आते.

कोई डॉक्टर का पता नहीं बताता और न ही डाईग्नोसिस सेंटर का. हड्डी में दर्द- पुत्तुर में जाकर अंडा मलवा लो. सांस भरती है , केरल जाकर जिन्दा मछली वाला ईलाज करा लो , कैंसर है- हिसार वाले बाबा जी की रोटी खा लो...पगला गये हो मतलब गधे से कम तो होगे नहीं..फलाने खेत की घास चर लो....न सुधार दिखे तो लोकसभा का चुनाव लड़ लो...सारे साथी एक जगह तो ईक्कठे हो लोगे कम से कम..हद है सलाहकारी की.

कहीं तो रुको...हर व्यवसाय के गुर जानने वाले अलग अलग विशेषज्ञ है, उन्हें मौका तो दो. मगर मौका देते तब हो जब बाकी सलाहकारी से निपट कर आखिरी दिनों मे पहुँचते हो. कोई राह बच नहीं रहती. अब विशेषज्ञ कोई भगवान तो है नहीं कि हर बिगड़ी स्थिति ठीक ही कर दे. जब शुरुवात थी तब मित्रों का साथ निभाते रहे और अंत में कोसने को विशेषज्ञ बचा.

सलाहकारी के क्षेत्र में अति- ज्ञान उपजाने में अति.

भारत के इंजिनियर विश्व को अपनी सेवायें देकर लुभाने क्या लगे कि उनकी ऐसी खेती शुरु हुई कि पान की दुकानों से ज्यादा इंजिनियरिंग कालेज खुल गये. बेटा नालायक निकल जाये तो उसे पहले एलएल बी करवाते थे और अब इंजिनियरिंग. बात डिमांड एंड सप्लाई की है जी.

निख्खटू से निख्खटू बेटा बेटी आज जब कुछ नहीं कर पा रहे तो इंजिनियर बन जा रहे हैं. ऐसे में वकील कौन बनेगा...चलो, वो कोई और बन जायेगा तो ठेकेदार कौन बनेगा.चलो, वो भी कोई न कोई बन जाये तो नेता कौन बनेगा...फिर तो कोई बचेगा ही नहीं . तब साईकिल और हाथी चुनाव चिन्ह का क्या दोष ? निकृष्ट मे से निकृष्ट्तम चुनना भी तो हम भारतीयों की ही पहचान है.

अति की सीमा देखनी हो तो टी वी पर भारतीय सि रियल की महिमा देखिये. जरा सी टीआर पी मिल भर जाये फिर तो मानो सिरियल ने अमरत्व प्राप्त कर लिया. उस सिरियल के हीरो हीरोईन वैसे के वैसे ही टमाटर बने रहेंगे और आप समय के साथ अपना सर धुनेंगे कि सिरियल देखते देखते बाल काले से सफेद हो गये , संख्या में भी आधे से अधिक विदा हो चुके और बच्चे स्कूल से कालेज में जा चुके मगर सिरियल है कि चले ही जा रहा है. ये तब तक नहीं मानते ज ब तक बढ़ी हुई टीआर पी घट कर शून्य न हो जाये. फिर वो चाहे प्रतिज्ञा हो या छोटी बहु...छोटी बहु कायदे से अब तक सास बन कर भी गुजर भी चुकी होती मगर अति की महिमा कि छोटी बहु अभी तक छोटी बहु ही है.

बुराई कितनी भी बुरी हो या चाहे गंधाती हो मगर हर बुराई में भी एक न एक अच्छाई तो होती ही है. कम से कम इसी बात का महत्व समझ कर ही पाकिस्तान से सिरियल समय पर खत्म करना सीख लें. अब उनके ही सिरियल 'धूप किनारे' की हिन्दी कॉपी 'कुछ तो लोग कहेंगे' को भी उसी राह पर ले चल पड़े हैं..देखना अति करके ही मानेंगे. अभी तो ऐसा ही लग रहा है.

वही हाल परिवारवाद का है राजनिति में-पांचवी पीढ़ी तैयार है जी हुजूरी करवाने को..तैयार क्या है-करवा ही रही है. छटवीं भी इस उ.प्र. विधानसभा में हल्की सी झलक दिखाई ही गई अपनी मम्मी के साथ मंच पर. कुछ अति तो इसमें भी है. इतनी विकल्पहीनता की दुहाई भी ठीक नहीं.

हम भारतीय जानते हैं दुर्गति की गति को धीमा करना..काश!! सीख पाते इसकी दिशा बदल कर बेहतरी के तरफ ले जाना.

होली आई. हर साल आती है. अब बधाई का सिलसिला ऐसा शुरु हुआ कि उसकी भी अति हो ली है इस होली पर. फेस बुक पर आये तो हर घंटे बधाई ही दिये जा रहे हैं. हर बार हमको टैग कर देते हैं. अब उस पर जो कमेंट आयें सारे हमारे ईमेल में. रंग तो एक बार नहा लो तो छूट जाये. छूटना ही होगा आखिर नकली रंग की भी तो अति है. मगर हम ईमेल साफ ही किये जा रहे हैं और टैग हैं कि खत्म ही नहीं हो रहे. मुबारकबाद में टैगिंग कैसी? वो तो हम यूँ भी ले लेंगे- अब टैग करके क्या साबित करना चाह रहे हो भाई.

एक सज्जन ने मुबारकबाद भेजी और सी सी में १२०० ईमेल एड्रेस...अब वे सारे जबाब देंगे और हम १२०० ईमेल की सफाई करने में जुटे नजर आयेंगे. मानो हमें होली खेलना ही नहीं है बस नगर निगम ने जमादार की नौकरी दी है कि चलो, ईमेल की सफाई करो.

बक्शो मित्र. माना तुम अच्छे कार्टून बना लेते हो , फोटोशॉप में काट छांट कर इसकी तस्वीर उसकी बना देते हो..तुकबंदी कर मुक्तक रच लेते हो , बधाई संदेश देने के नये आयाम गढ़ लेते हो मगर उन सब से उपर..यह

टैगिंग क्यूँ करते हो ? यह फेस बुक की सुविधा है या मेरी दुविधा.

ईमेल में सीसी के बाद ठीक नीचे बीसीसी भी है ,,वो तुम्हारी मोतियाबिंदी आँखें क्यूँ नहीं देख पाती ? कहीं तो तुम यह तो दिखाना नहीं चाह रहे कि तुम्हारी पहुँच कहाँ कहाँ तक है? पहुँच से होता क्या है ? मात्र तिहाड़ में बेहतर सुविधा और अच्छी सैल. रहोगे तो तिहाड़ में ही और कहलाओगे तो अपराधी ही.

अति बन्द करो,प्लीज!!

दो चार करोड खा जाओ- वादा है कि कोई हिदुस्तानी जो जुबां भी खोले..हम आदी हैं मान कर चलते हैं कि इतनी तो बनती है. मगर अब २००० करोड़ खा जाओगे एक खेल आयोजन में और सोचो कि सब चुप रह जायेंगे हमेशा की तरह- तो यह तो तुम्हारी ही बेवकूफी कहलाई. इतनी अति भी कैसे बर्दाश्त करें?

कलमाड़ी न बनो , कनुमोजी भी न बनो , तेलगी का फेस बुक से क्या लेना देना , २ जी को राजनिति में रहने दो , ईमेल को इससे दूर रखो....यहाँ तो अति न करो वैसी.

वरना एक दिन फेसबुक पर भी एक अन्ना जन्म लेगा...ईमेल पर बाबा रामदेव रामलीला करेंगे सलवार सूट पहन कर...प्रशासन अपनी चाल चलेगा और फिर...तुम कहोगे कि यह ठीक नहीं हुआ...

ऐसी नौबत ही क्यूँ लाते हो...पहले ही संभल जाओ!!!

लोकप्रिय चिट्ठाकार समीर लाल व्यवसाय से चार्टर्ड एकाउंटैंट हैं। आजकल वे कैनैडा में रहते हैं। उन्होंने कहानी लिखना पाँचवीं कक्षा में ही शुरु कर दिया था। आप कविता, गज़ल, व्यंग्य, कहानी, लघु कथा आदि अनेकों विधाओं में दखल रखते हैं| भारत के अलावा कनाडा और अमेरिका में मंच से कई बार अपनी प्रस्तुति कर चुके हैं। आपका ब्लॉग "उड़नतश्तरी" हिन्दी ब्लॉगजगत में एक लोकप्रिय नाम है। इन्हे अनेक सम्मानों से नवाजा जा चुका हैप्रकाशन : काव्य संग्रह - बिखरे मोती, उपन्यासिका - देख लूँ तो चलूँ, प्रकाशन में - कथा संग्रह: द साईड मिरर।

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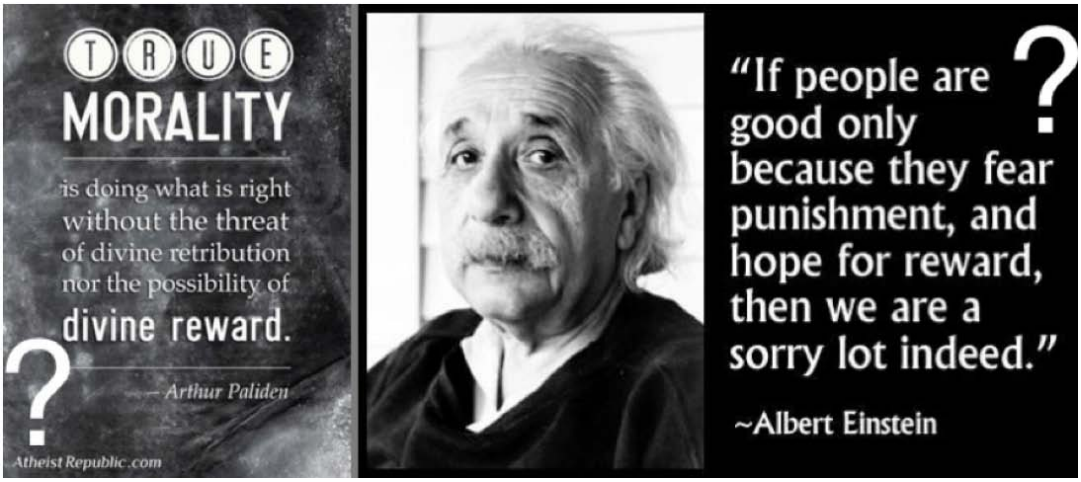

जीत तक ज़ारी जंग●●●●●

अज्ञात

बाज लगभग 70 वर्ष जीता है, परन्तु अपने जीवन के 40वें वर्ष में आते आते उसे एक महत्वपूर्ण निर्णय लेना पड़ता है।

उस अवस्था में उसके शरीर के तीन प्रमुख अंग निष्प्रभावी होने लगते हैं-

1. पंजे लम्बे और लचीले हो जाते है व शिकार पर पकड़ बनाने में अक्षम होने लगते हैं।
2. चोंच आगे की ओर मुड़ जाती है और भोजन निकालने में व्यवधान उत्पन्न करने लगती है।
3. पंख भारी हो जाते हैं, और सीने से चिपकने के कारण पूरे खुल नहीं पाते हैं, उड़ानें सीमित कर देते हैं।

भोजन ढूँढ़ना, भोजन पकड़ना और भोजन खाना..... तीनों प्रक्रियायें अपनी धार खोने लगती हैं। उसके पास **तीन ही विकल्प** बचते हैं,

(1) या तो देह त्याग दे,

(2) या अपनी प्रवृत्ति छोड़ गिद्ध की तरह त्यक्त भोजन पर निर्वाह करे...

(3) या फिर स्वयं को पुनर्स्थापित करे, आकाश के निर्द्वन्द्व एकाधिपति के रूप में।

जहाँ पहले दो विकल्प सरल और त्वरित हैं, वहीं तीसरा अत्यन्त पीड़ादायी और लम्बा। बाज पीड़ा चुनता है और स्वयं को पुनर्स्थापित करता है।

वह किसी ऊँचे पहाड़ पर जाता है, एकान्त में अपना घोंसला बनाता है, और तब प्रारम्भ करता है पूरी प्रक्रिया।

सबसे पहले वह अपनी चोंच चट्टान पर मार मार कर तोड़ देता है..!

अपनी चोंच तोड़ने से अधिक पीड़ादायक कुछ भी नहीं पक्षीराज के लिये। तब वह प्रतीक्षा करता है चोंच के पुनः उग आने की।

उसके बाद वह अपने पंजे भी उसी प्रकार तोड़ देता है और प्रतीक्षा करता है पंजों के पुनः उग आने की।

नये चोंच और पंजे आने के बाद, वह अपने भारी पंखों को एक एक कर नोंच कर निकालता है और प्रतीक्षा करता पंखों के पुनः उग आने की।

150 दिन की पीड़ा और प्रतीक्षा... और तब उसे मिलती है वही भव्य और ऊँची उड़ान, पहले जैसी नयी।

इस पुनर्स्थापना के बाद वह 30 साल और जीता है, ऊर्जा, सम्मान और गरिमा के साथ।

प्रकृति हमें सिखाने बैठी है – 'पंजे पकड़ के प्रतीक हैं, चोंच सक्रियता की और पंख कल्पना को स्थापित करते हैं।

इच्छा परिस्थितियों पर नियन्त्रण बनाये रखने की,सक्रियता स्वयं के अस्तित्व की गरिमा बनाये रखने की, कल्पना जीवन में कुछ नयापन बनाये रखने की।

इच्छा, सक्रियता और कल्पना... तीनों के तीनों निर्बल पड़ने लगते हैं.. हममें भी चालीस तक आते आते।

हमारा व्यक्तित्व ही ढीला पड़ने लगता है, अर्धजीवन में ही जीवन समाप्तप्राय सा लगने लगता है, उत्साह, आकांक्षा, ऊर्जा....अधोगामी हो जाते हैं।

हमारे पास भी कई विकल्प होते हैं - कुछ सरल और त्वरित., कुछ पीड़ादायी...!!

हमें भी अपने जीवन के विवशता भरे अतिलचीलेपन को त्याग कर नियन्त्रण दिखाना होगा - बाज के पंजों की तरह।

हमें भी आलस्य उत्पन्न करने वाली वक्र मानसिकता को त्याग कर ऊर्जस्वित सक्रियता दिखानी होगी - "बाज की चोंच की तरह", हमें भी भूतकाल में जकड़े अस्तित्व के भारीपन को त्याग कर कल्पना की उन्मुक्त उड़ाने भरनी होंगी - "बाज के पंखों की तरह।"

150 दिन न सही, तो एक माह ही बिताया जाये, स्वयं को पुनर्स्थापित करने में। जो शरीर और मन से चिपका हुआ है, उसे तोड़ने और नोंचने में पीड़ा तो होगी ही, पर तब उड़ानें भरने को तैयार होंगे, इस बार उड़ानें और ऊँची होंगी, अनुभवी होंगी, अनन्तगामी होंगी....!

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फुर्सत के पल

मृणालिनी घुळे

मिले हैं कुछ फुर्सत के पल

जाने न देना यूं निष्फल न
कुछ कलात्मक कार्य करो निश्चित
पाओगे सुनहरा कल।

सीखो अपनाओ कोई हुनर
होगी जीवन की सरल डगर
होगा जिससे हित जन जन का
प्रगति की राह आएगी नज़र।

कवियत्री एक सामाजिक चिंतक एवं विचारक हैं | आपकी कविताएँ वर्तमान पर्यवेक्ष्य में बुद्धि-जीवियों को उनके सामाजिक उत्तरदायित्व के प्रति उन्हें चिंतन के लिए प्रेरित करती हैं | आपकी लेखनी प्रादेशिक एवं राष्ट्रीय स्तर पर प्रकाशित है|

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नारी की आस ...

डॉ. संगीता पाहुजा

एक दिन ऐसा आएगा, फिर सब ठीक हो जायेगा
इसी सोच से हर दिन अपना मन मारती नारी

हर फर्ज निभाती नारी
घर- समाज सबके प्रति अपना फ़र्ज निभाती नारी
इक दिन ऐसा आएगा, सब ठीक हो जायेगा
इसी उम्मीद में अपना, सर्वस्व लुटाती नारी

सबकी ख़ुशी में अपना सुख ढूंडती नारी
फिर सोचती इक दिन ऐसा आयेगा
सब ठीक हो जायेगा, अपना सर्वस्व लुटाती नारी

बच्चो के बचपन,योवन को फलता देख
हर पल ख़ुशी खुशी अपना दर्द छुपाती
सब ठीक हो जायेगा,
इसी सोच में ,अपना सर्वस्व लुटाती नारी

सबको बढता देख प्रसन होती नारी
न जान पाई ,कब उम्र निकल गई सारी
यह सोचते की इक दिन ऐसा आयेगा
सब ठीक हो जायेगा, अपना सर्वस्व लुटाती नारी

कवियत्री आयुर्वेदिक चिकित्सक हैं | आपने B.A.M.S. की उपाधि M.D. University, रोहतक से प्राप्त की | आपके दिल्ली एवं नॉएडा में परामर्श केंद्र है | धार्मिक, नारी एवं समाज उत्थान कार्यों में आपकी विशेष रूचि है |

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ई-मेल - sangeeta.pahuja3@gmail.com

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Students' Section

My Experiences of Learning Online

Mohit Verma

I am a student of class 11th in Maths-Science stream. I have been studying since beginning i.e. last Ten years at Sunshine Society in its 'After The School Program'. There I had opportunity to learn and get motivated by Respected V.P Gupta Sir and other dedicated teachers, who were trying to bring children from unprivileged families int main stream of education. This initiative was started 10 years ago. This helped me to secure admission in Jawahar Navodaya Vidyalaya (JNV), -Dadti, U.P. in class 6th in academic session 2013-14 , through a competitive test. Since admission at JNV, which is a residential school my attending classes got restricted to vacations only. When I entered in class 9th, during summer vacations, I had an opportunity to attend motivational class organized by Sunshine Society, in coordination with Gyan Vigyan Sarita.

It was an addition to my learning experience. I had an opportunity to know maths and physics, its importance and usefulness in life and ability to think logically and scientifically. It created an interest in me to pursue my studies with these two subjects. In few months, the educational guidance was upgraded to Interactive Online Mentoring Sessions (IOMS). Sunshine society created necessary facilities to learn Online.

As a student of residential school it was not possible for me to attend classes regularly, and with start of academic session after summer vacations in July'16 I had to discontinue the Online Classes.

During vacations whenever I came home, I did enquire about the Online Sessions so that I could continue with learning. Unfortunately, it was seen that other students got discouraged with interruptions due to internet problems and other teething troubles in this IOMS initiative which was being made to motivate deprived students to bring them in main stream of education rather than just mugging subjects like maths and physics without understanding.

It is seen that all teachers both from Sunshine Society and Gyan Vigyan Sarita have lot of patience. Learning everything in maths and Physics with proper explanation, in a step-by-step manner, creates interest in the subject and feeling easy.

Now, I am in class 11th and able to appreciate the importance of maths and physics in better way and the kind and quality of guidance that was being offered through Online Classes. I approached Shri Gupta Sir and Sunshine Society, if Online Sessions could be arranged. Incidentally I was the only student and that too in class 11th who to take the benefit of Online Sessions in Maths and Physics. I was very happy that they organized sessions for me, during 4 to 6 pm from Monday to Friday, while other classes are held.

In Online session punctuality is attached highest importance. Passionate mentoring in online sessions helps to over understand subject clearly, remove doubts and thus fear goes off. Moreover, it is helpful for we students who cannot reach dedicated teachers and also these teachers being aged persons are able to avoid travelling in hot- and noon of the summer and vagaries of rainy days.

There is a saying 'Where there is will, there is a way". The IOMS was started with very little resources. But, determination of all concerned with this initiative has helped to make Online Mentoring a real life experience of learning from dedicated teachers, as if we are sitting in a class.

I sincerely wish I continue to get guidance of such dedicated initiative and more students come together to learn effectively and make their career.

Author is a student of Class 11th (PCM) in Jawahar Navodaya Vidyalaya, Dadri, UP. He comes from a very humble family in NOIDA. He is a good sports student. Apart from academics he participates regularly in extra-curricular activities.

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APPENDIX II-A: LIST OF STANDARD FORMULAE

Prof. SB DHAR

Mathematics for Class IX, X, XI and XII comprises of Algebra, Coordinate Geometry, Differential and Integral Calculus, Trigonometry, Mensuration (Solid Geometry) and Euclid's Plane Geometry. These are building blocks of pursuit in Matheamatics . So also, in mathematics terminology form its vocabulary and conveys whole concept nehind. Accordingly, terminology with its meaning are also important.

The list of important formulae for the use of students is quite long. So, in the coming Issues of the e-bulletin they will be listed continuously. Here is the First Part:

Identities

(1) $a^2 - b^2 = (a - b)(a + b)$
(2) $(a+b)^2 = a^2 + 2ab + b^2$
(3) $(a - b)^2 = a^2 - 2ab + b^2$
(4) $(a + b + c)^2 = a^2 + b^2 + c^2 + 2ab + 2ac + 2bc$
(5) $(a - b - c)^2 = a^2 + b^2 + c^2 - 2ab - 2ac + 2bc$
(6) $(a + b)^3 = a^3 + b^3 + 3ab(a + b)$
(7) $(a - b)^3 = a^3 - 3a^2b + 3ab^2 - b^3$
(8) $a^3 - b^3 = (a - b)(a^2 + ab + b^2)$
(9) $a^3 + b^3 = (a + b)(a^2 - ab + b^2)$
(10) $(a + b)^3 = a^3 + 3a^2b + 3ab^2 + b^3$
(11) **If n is a natural number**,
$a^n - b^n = (a - b)(a^{n-1} + a^{n-2}b + \ldots + b^{n-2}a + b^{n-1})$
(12) **If n is even**
$(n = 2k)$, $a^n + b^n = (a + b)(a^{n-1} - a^{n-2}b + \ldots + b^{n-2}a - b^{n-1})$
(13) **If n is odd**
$(n = 2k + 1)$, $a^n + b^n = (a + b)(a^{n-1} - a^{n-2}b + \ldots - b^{n-2}a + b^{n-1})$

Exponents

(1) $(a^m)x(a^n) = a^{m+n}$
(2) $(axb)^m = a^m x\, b^m$
(3) $(a^m)^n = a^{mn}$

Big Numbers

1 million = 1,000,000

1 billion = 1,000,000,000

1 trillion = 1 with 12 zeroes

1 quadrillion = 1 with 15 zeroes

1 quintillion = 1 with 18 zeroes

1 sextillion = 1 with 21 zeroes

1 googol = 1 with 100 zeroes

1 googolplex= 1 with a googol of zeroes

Small Numbers

0.1= tenth
0.01= hundredth

0.001= thousandth

0.0001=ten thousandth

0.00001= hundred thousandth

Roman Numerals

I=1

V=5 $\overline{V} = 5000$

X=10 $\overline{X} = 10{,}000$

L=50 $\overline{L} = 50{,}000$

C=100 $\overline{C} = 100{,}000$

D=500 $\overline{D} = 500{,}000$

M=1,000 $\overline{M} = 1{,}000{,}000$

British Units of Length

1 mile	= 8 Furlongs
1 Furlong	= 8 Yards
1 Yard	= 3 Feet
1 Foot	= 12 Inches
1 Inch	= 2.54 centimeters
16 km	=10 miles(approximately)

Number Systems

(i) Additive Identity: a + 0 = a
(j) Additive Inverse : a + (-a) = 0
(k) Associative of Addition :(a+b)+c=a+(b+c)
(l) Commutative of Addition: a + b = b + a
(m) Definition of Subtraction: a - b = a + (-b)

(n) Multiplicative Identity : $a \times 1 = a$

(o) Multiplicative Inverse: $a \times \left(\frac{1}{a}\right) = 1, a \neq 0$

(p) Multiplication times 0 : $a \times 0 = 0$

(q) Associative of Multiplication:
$(a \times b) \times c = a \times (b \times c)$

(r) Commutative of Multiplication: $a \times b = b \times a$

(s) Distributive Law: $a \times (b + c) = a \times b + a \times c$

(t) Definition of Division: $\frac{a}{b} = a\left(\frac{1}{b}\right)$

Logarithm

(1) If $x^y = z$, then $y = \log_x(z)$.
(2) $\log_x(1) = 0$
(3) $\log_x(x) = 1$
(4) $\log_x(m \times n) = \log_x(m) + \log_x(n)$
(5) $\log_x(m/n) = \log_x(m) - \log_x(n)$
(6) $\log_x(z^n) = n \log_x(z)$

(7) $$\log_m n = \frac{1}{\log_n m}$$

(8) $$\log_m n = \frac{\log_x n}{\log_x m}$$

Polygon

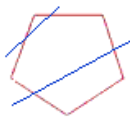
A closed plane figure made up of several line segments that are joined together. The sides do not cross each other. Exactly two sides meet at every vertex.

Types of Polygons Regular: Polygons whose all angles are equal and all sides are of the same length. Regular polygons are both equiangular and equilateral.

Equiangular: The polygons that have all angles equal.

Equilateral: The polygons that have all sides of the same length.

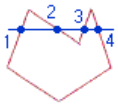
Example of Convex Polygon



Convex Polygon: The polygon in which a straight line drawn through it **crosses at most two sides**. Every interior angle is less than 180°.

Concave Polygon: The polygon in which a straight line drawn through it crosses **crosses more than two sides**. At least one interior angle is more than 180°.

Example of Concave Polygon



Formulae related to Polygons

N =Number of sides

S = Length from center to a corner

Area of a regular polygon = $\frac{1}{2} \times N \times \sin\left(\frac{360^0}{N}\right) S^2$

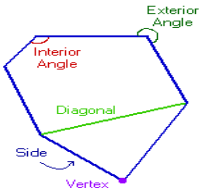
Sum of the interior angles of a polygon = (N - 2) x 180°

The **number of diagonals** in a polygon =

$$\frac{1}{2} \times N \times (N - 3)$$

The **number of triangles** (when all the diagonals from one vertex are drawn) in a polygon = (N - 2)

Parts of Polygon



Area Formulae

(1) Square = a^2
(2) Rectangle = ab
(3) Parallelogram = bh
(4) Trapezoid = $h/2 (b_1 + b_2)$
(5) Circle = $pi\ r^2$
(6) Ellipse = $pi\ r_1\ r_2$
(7) Triangle =1/2 base height
(8) Equilateral triangle = root3/4 a square Triangle given SAS (two sides and the opposite angle) = (1/2) a b sin C
(9) Triangle with sides (a,b,c) = $\sqrt{}$[s(s-a)(s-b)(s-c)] where s = (a+b+c)/2 (Heron's formula)
(10) Regular polygon = (1/2) n sin(360°/n) S^2 , where n = Number of sides and S = length from center to a corner

Binomial Theorem

(1) The number of terms in the expansion of $(x+y+z)^n = {}^{n+2}C_2 = \frac{(n+2)(n+1)}{2}$.

(2) Value of ${}^nC_r$ is defined as $\frac{n!}{r!.(n-r)!}$.

(3) The number of distinct terms in the expansion of $(a_1 + a_2 + \ldots\ldots + a_m)^n = {}^{n+m-1}C_{m-1}$.

(4) Coefficient of $a_1^{n_1} a_2^{n_2} \ldots\ldots a_m^{n_m}$ in the expansion of $(a_1 + a_2 + \ldots\ldots + a_m)^n$ is $\frac{n!}{n_1!\cdot n_2!\cdot n_3!\ \ldots\ldots n_m!}$.

(5) The rth term from the end in the expansion of $(x+a)^n$ is given by:
T_r (from end) = T_{n-r+2}(from beginning).

(6) ${}^nC_r = 0$ if $r < 0$

(7) ${}^nC_r = {}^nC_{n-r}$

(8) ${}^nC_x = {}^nC_y \Rightarrow x = y$ or $x + y = n$

(9) $\frac{{}^nC_r}{{}^nC_{r-1}} = \frac{n-r+1}{r}$.

(10) ${}^nC_r + {}^nC_{r-1} = {}^{(n+1)}C_r$.

(11) ${}^nC_r = \frac{n}{r}.{}^{(n-1)}C_{r-1}$.

(12) Pascal Law: ${}^nC_r + {}^nC_{r+1} = {}^{n+1}C_{r+1}$.

(13) Reciprocal Pascal Law: $\frac{1}{{}^{n+1}C_r} + \frac{1}{{}^{n+1}C_{r+1}} = \left(\frac{n+2}{n+1}\right).\frac{1}{{}^nC_r}$

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Complex Numbers

(1) If a and b are non negative then $\sqrt{a} \times \sqrt{b} = \sqrt{a \times b}$

(2) $\sqrt{-a} \times \sqrt{-b} \neq \sqrt{ab}$

(3) $|z_1 z_2| = |z_1| \,.\, |z_2|$

(4) $\left|\frac{z_1}{z_2}\right| = \left|\frac{z_1}{z_2}\right|$

(5) $\left|z_1 \pm z_2\right|^2 = \left|z_1\right|^2 + \left|z_2\right|^2 \pm \mathrm{Re}\left(z_1 \cdot z_2\right)$

(6) $\left|z_1 + z_2\right|^2 + \left|z_1 - z_2\right|^2 = 2\left(\left|z_1\right|^2 + \left|z_2\right|^2\right)$

(7) $\left|z_1 + z_2\right| \leq \left|z_1\right| + \left|z_2\right|$.

(8) arg (z) = 0 or $\pi \Rightarrow$ z is purely real.

(9) $\arg(z) = \pm\frac{\pi}{2} \Rightarrow$ z is purely imaginary.

(10) $\arg(\bar{z}) = -\arg(z) = \arg\left(\frac{1}{z}\right)$.

(11) $\arg\left(z - \bar{z}\right) = \pm\frac{\pi}{2}$

(12) $\arg(z) + \arg(\bar{z}) = 0$

(13) $\arg(z) + \arg(-\bar{z}) = \pi$

(14) $\arg(iz) = \arg(z) + \pi/2$

(15) $1+\omega^n+\omega^{2n} = 3$ or 0 according as n is a multiple of 3 or not.

(16) If $x = \cos\alpha + i\sin\alpha$, $y = \cos\beta + i\cos\beta$, $z = \cos\gamma + i\cos\gamma$, then $yz+zx+xy=0$, $x^2 + y^2 + z^2 = 0$, $x^3 + y^3 + z^3 = 3xyz$, $(1/x) + (1/y) + (1/z) = 0$

(17) $\omega^{3m}+\omega^{3n+1}+\omega^{3p+2}=0$ if m,n,p >0.

(18) $\overline{z_1 + z_2} = \bar{z}_1 + \bar{z}_2$

(19) $\overline{z_1 - z_2} = \bar{z}_1 - \bar{z}_2$

(20) $\overline{z_1 . z_2} = \bar{z}_1 . \bar{z}_2$

(21) $\left(\overline{z^n}\right) = \left(\bar{z}\right)^n$

(22) Mid-point of the line segment joining z_1 and z_2 is given by $\frac{z_1 + z_2}{2}$.

(23) The circumcentre z of the triangle with vertices $A(z_1)$, $B(z_2)$ and $C(z_3)$ is given by –

$$z = \frac{z_1(\sin 2A) + z_2(\sin 2B) + z_3(\sin 2C)}{\sin 2A + \sin 2B + \sin 2C} \text{ or}$$

$$z = \frac{\sum z_1 \bar{z}_1 (z_2 - z_3)}{\sum \bar{z}_1 (z_2 - z_3)}$$

(24) The orthocentre of the triangle ABC with vertices z_1, z_2 and z_3 is given by –

$$z=\frac{z_1(a.\sec A)+z_2(b.\sec B)+z_3(c.\sec C)}{a.\sec A+b.\sec B+c.\sec C}$$ or

$$z=\frac{z_1(\tan A)+z_2(\tan B)+z_3(\tan C)}{\tan A+\tan B+\tan C}$$ or

$$z=\frac{\sum z_1^{\,2}(\bar{z}_2-\bar{z}_3)+\sum|z_1|^2(z_2-z_3)}{\sum(z_1\bar{z}_2-z_2\bar{z}_1)}$$

(25) The Incentre of the triangle ABC with vertices A(z_1), B(z_2) and C(z_3) is given by -

$$z=\frac{az_1+bz_2+cz_3}{a+b+c}=\frac{|z_2-z_3|z_1+|z_3-z_1|z_2+|z_1-z_2|z_3}{|z_2-z_3|+|z_3-z_1|+|z_1-z_2|}$$

or $z=\dfrac{z_1(\sin A)+z_2(\sin B)+z_3(\sin C)}{\sin A+\sin B+\sin C}$

(26) If z_1, z_2, z_3 are the vertices of an equilateral triangle and z_0 is the circumcentre, then –

$$z_1^{\,2}+z_2^{\,2}+z_3^{\,2}=3z_0^{\,2}.$$

(27) If z_1, z_2, z_3 ,.....,z_n are the vertices of *n-sided* regular polygon and z_0 is the circumcentre, then –

$$z_1^{\,2}+z_2^{\,2}+z_3^{\,2}+....z_n^{\,2}=nz_0^{\,2}.$$

(28) If three points A(z_1), B(z_2), C(z_3) are the vertices of a triangle ABC then It is an equilateral if -

(a) $(z_1-z_2)^2+(z_2-z_3)^2+(z_3-z_1)^2=0$

(b) $z_1^{\,2}+z_2^{\,2}+z_3^{\,2}=z_1z_2+z_2z_3+z_3z_1$, or

(c) $\dfrac{1}{z_1-z_2}+\dfrac{1}{z_2-z_3}+\dfrac{1}{z_3-z_1}=0$, or

(d) $z_1^{\,2}+z_2^{\,2}-z_1z_2=0$ if one of the vertices of the triangle is at origin, say z_3=0

(29) If z_1, z_2, z_3 are vertices of an equilateral triangle, then $z_1^{\,2}+z_2^{\,2}+z_3^{\,2}=z_1z_2+z_2z_3+z_3z_1$

(30) Equation of the line joining z_1 & z_2 is $\begin{vmatrix} z & \bar{z} & 1\\ z_1 & \bar{z}_1 & 1\\ z_2 & \bar{z}_2 & 1\end{vmatrix}=0$

or,

(31) If three points z_1, z_2, z_3 collinear, then $\begin{vmatrix} z_1 & \bar{z}_1 & 1\\ z_2 & \bar{z}_2 & 1\\ z_3 & \bar{z}_3 & 1\end{vmatrix}=0$.

(32) Slope of the line is $-\dfrac{Re(a)}{I_m(a)}$

(33) Complex slope of the line passing through points z_1 and z_2 is given by $\left(\dfrac{z_1-z_2}{\bar{z}_1-\bar{z}_2}\right)$

(34) **Equation of Ellipse**

$$|z-z_1|+|z-z_2|=\lambda\ \&\ \lambda>|z_1-z_2|$$

(35) **Equation of hyperbola**

$$|z-z_1|+|z-z_2|=\lambda\ \&\ \lambda<|z_1-z_2|$$

(36) **Equation of circle**

$|z-z_0|=r$ where z_0 is the center and r is the radius.

or $z\bar{z}+a\bar{z}+\bar{a}z+b=0$

Centre (- a), radius $\sqrt{|a|^2-b}$ or

$|z-z_1|^2+|z-z_2|^2=k$ will represent a circle if $k\geq\frac{1}{2}|z_1-z_2|^2$.

(37) The equation of a circle on a line segment joining two points z_1 and z_2 as a diameter is given by $(z-z_1)(\bar{z}-\bar{z}_2)+(z-z_2)(\bar{z}-\bar{z}_1)=0$.

Some Important Loci

(1) The Locus of a point z satisfying $|z-z_1|=|z-z_2|$ is the perpendicular bisector of the line joining points z_1 and z_2.

(2) The locus of z satisfying the condition $|z-z_1|+|z-z_2|=|z_1-z_2|$ is the line segment joining z_1 and z_2.

(3) The locus fo z satisfying the condition $|z-z_1|-|z-z_2|=|z_1-z_2|$ is also a straight line joining z_1 and z_2 but z does not lie between z_1 and z_2.

(4) If $\arg\left(\dfrac{z-z_1}{z-z_2}\right)=0...or...\pi$ then the locus of z is a straight line passing through z_1 and z_2.

(5) The Locus of z such that $|z-z_1|+|z-z_2|=2a$ where 2a> $|z_1-z_2|$ is an Ellipse and its Foci will be at z_1 and z_2 and a is a real positive number.

(6) The Locus of z such that $|z-z_1|-|z-z_2|=2a$ where 2a< $|z_1-z_2|$ is a Hyperbola and its Foci will be at z_1 and z_2 and a is a real positive number.

(7) The locus of z satisfying $\left|\frac{z-z_1}{z-z_2}\right|$ = k (if k is not equal to 1) is a circle.

De Moivre's Theorem

(1) $(\cos\theta_1 + i\sin\theta_1)(\cos\theta_2 + i\sin\theta_2)....$
$(\cos\theta_n + i\sin\theta_n) = \cos(\theta_1+\theta_2+....+\theta_n)+$
$i\sin(\theta_1+\theta_2+....+\theta_n)$

(2) $(\cos\theta + i\sin\theta)^n = \cos n\theta + i\sin n\theta$

(3) $\frac{1}{\cos n\theta + i\sin n\theta} = \cos n\theta - i\sin n\theta$

Ratio

(1) Duplicate ratio of a : b is $a^2 : b^2$.
(2) Sub duplicate ratio of $a^2 : b^2$ is a : b .
(3) Triplicate ratio of a:b is $a^3 : b^3$.
(4) Ratio compounded of three ratios a:b , c:d, e:f is $\left(\frac{a}{b}\right).\left(\frac{c}{d}\right).\left(\frac{e}{f}\right)$.
(5) If a > b then $\left(\frac{a}{b}\right) > \left(\frac{a+x}{b+x}\right)$.
(6) If a < b then $\left(\frac{a}{b}\right) < \left(\frac{a+x}{b+x}\right)$.
(7) $\left(\frac{a}{b}\right)=\left(\frac{c}{d}\right)=\left(\frac{e}{f}\right)=\left(\frac{pa^n+qc^n+re^n}{pb^n+qd^n+rf^n}\right)^{\frac{1}{n}}$
(8) $\left(\frac{a}{b}\right)=\left(\frac{c}{d}\right)=\left(\frac{e}{f}\right)=\left(\frac{a+c+e}{b+d+f}\right)^{\frac{1}{n}}$
(9) If $\left(\frac{a_1}{b_1}\right),\left(\frac{a_2}{b_2}\right),\left(\frac{a_3}{b_3}\right),....$ are unequal fractions then $\left(\frac{a_1+a_2+a_3+..}{b_1+b_2+b_3+..}\right)$ lies between the largest and the least of them.

PROPORTION

(1) When the two ratios are equal, the four quantities composing them are called in proportion. It is represented as a:b :: c:d.
(2) The first and the last quantities a and d are called extremes while b and c are called means.
(3) Continued Proportion: If $\frac{a}{b}=\frac{b}{c}=\frac{c}{d}=...$ then a,b,c,d are called in continued proportion.
(4) Three quantities a, b, c are in continued proportion, then it is written as a:b :: b: c, here b is called mean proportion and c is called the third proportion to a and b.
(5) When a : b :: c:d then a/b = c/d or ad = bc.
(6) If a : b = c:d then b:a = d:c (this is called Invertendo).
(7) If a : b = c: d then a : c = b : d (this is called Alternendo).
(8) If a : b = c : d then (a+b): b = (c+d) : d (this is called componendo).
(9) If a : b = c : d then (a-b) : b = (c-d): d (this is called dividend).
(10) If a : b = c : d then (a+b) : (a-b) = (c+d): (c-d) (this is called componendo and dividendo).

SURDS

(1) Surds are defined as the quantities that are under radical signs and are not rational or any root of a number that cannot be exactly determined is called a surd.
(2) Surds are represented as $\sqrt[2]{a},\sqrt[3]{a},\sqrt[n]{a}$ where a is not a perfect square or perfect cube as the case may be.
(3) $\sqrt[2]{a}$ is commonly written as $\sqrt{a}$.
(4) Quantities under radical sign are called the radicand and n is called the index of the radical.
(5) Order of the surd is the number which indicates the root of the given arithmetical number.
(6) Conjugate of $a+\sqrt{b}$ is written as $a-\sqrt{b}$.
(7) For rationalising the Denominator the numerator and the denominator is multiplied by the conjugate of the Denominator.

Inequalities

(1) If x > y then y < x
(2) If x > y then –x < - y.
(3) The arithmetic mean is greater than Geometric mean i.e. $\frac{x+y}{2} > \sqrt{xy}$.
(4) If a,b,c are positive quantities then $(x^2+y^2+z^2) > (xy+yz+zx)$.
(5) If x > y, y> z then x > z.
(6) If x > y then x + k > y + k.
(7) If x < y then x – k < y – k.

(8) If $x > 0$, and $a > b > c$ then then $a^x > b^x$.
(9) If $a > 1$, $x>y>0$ then $a^x > b^y$.
(10) If $a > 1$, and $x > y$ then $\log_a x > \log_a y$.

Special Numbers

(1) **Prime numbers**: Prime number is a number that is not divisible by any number except unity and itself, ie there exist no prime factors of such numbers.
(2) Two numbers are called prime to each other if they are not divisible by a common factor except unity.
(3) If a number is divisor of a product of two numbers and one of them is a prime number, then it is certainly a factor of the other one.
(4) If a prime number is a divisor of b^n, then it will divide b.
(5) If a number is prime to two numbers, it will be prime to their product also.
(6) The prime number set is infinite ie prime numbers are infinite.
(7) If p is a prime number, the coefficient of every term in the expansion of $(x + y)^n$ is , except the first and the last, is divisible by p.
(8) If p is a prime number and N is prime to p , then $(N^{p-1} -1)$ is a multiple of p. (***Fermat's Theorem***).
(9) If p is a prime number, then $\{ 1 + (p-1)! \}$ is divisible by p. (***Wilson' Theorem***).
(10) Composite numbers are numbers that are divisible by other numbers.
(11) Prime Triplet: The set of three consecutive primes is called prime triplets. Ex. (3,5,7),(11,13,17),..
(12) Twin primes: The prime numbers differing by 2 are called twin primes. Ex. 3,5; 11,13;... etc
(13) Composite Numbers: A number which is not prime is called a composite number. Ex. 4, 12, 25,...
(14) Co-prime numbers or relatively prime numbers Two numbers are said to be co-primes if their HCF is 1. Ex. 4,9; 18,25; etc.
(15) Guass Theorem: If a,b c are three natural numbers such that c divides ab and c and a are relatively prime to each other, then c divides b. Ex. Let a=3, b=10, c=5. Here 5 and 3 are co=primes. ab=3.10 is divisible by 5. Note c also divides b.
(16) 0 is neither positive not negative.
(17) Negative of 0 is zero.
(18) **Perfect number**: A number for which the sum of all its factors is twice the number is called a perfect number. Ex. 6, 28, 496, ... Etc . Factors of 6 are 1,2,3,6. Sum of factors=1+2+3+6=12= 2.6. Note: if $2^k - 1$ is a prime number then $2^{k-1} (2^k -1)$ is a perfect number.
(19) **Armstrong Numbers**: A number for which the sum of the cubes of the digits is equal to the original number. Ex. $153= 1^3 + 5^3 + 3^3$
(20) **Palindrome numbers**: If the number and its reverse both are same, then it is called the Palindrom numbers. Ex. 121, 12345654321,...
(21) **Powerful Nubmers**: When base is equal to power and sums make the number. Ex. $3435=3^3 + 4^4 + 3^3 + 5^5$.
(22) **Fibonacci numbers**: Fibonacci numbers are those, term beginning with the third term formed by adding the preceeding two terms. Ex. 0,1,1,2,3,5,8,13,21,...
(23) **Remainder Theroem:** If a polynomial f(x) is divisible by (x-a) then the remainder is f(a), where a is a real number.
(24) **Factor Theorem:** If f(x) is a polynomial and a is a real number , then

(a) If f(a)=0 then (x-a) is a factor of f(x)

(b) If (x-a) is a factor of f(x) then f(a)=0

Divisibility Rules

(1) A number is divisible by 2 if it ends at unit place with either 0,2,4,6,or 8 only.
(2) A number is divisible by 3 if the sum of digits is divisible by 3.
(3) A number is divisible by 4 if the number formed with last 2 digits is divisible by 4.
(4) A number is divisible by 5 if it end with either 0 or 5.
(5) A number is divisible by 6 if it is divisible by 2 and 3.
(6) A number is divisible by 8 if the number formed by last 3 digits is divisible by 8.
(7) A number is divisible by 9 if the sum of the digits is divisible by 9.
(8) A number is divisible by 10 if it ends with 0.
(9) A number is divisible by 11 if the difference between the sums of alternate digits is divisible by 11.

Matrix

(1) Symmetric matrix: A square matrix is said to be a symmetric matrix if A'=A.

(2) Skew Symmetric matrix: A square matrix is said to be skew-symmetric if $A^{'} = -A$. Diagonal elements of a skew-symmetric matrix are zero.

(3) Every square matrix can be written as a sum of a symmetric and a skew-symmetric matrix. i.e.

$$A = \frac{1}{2}(A + A') + \frac{1}{2}(A - A')$$

(4) If A, B are symmetric matrices of same order then AB is also a symmetric matrix.

(5) B'AB is a symmetric or skew-symmetric as A is symmetric or skew-symmetric.

(6) All integral powers of a symmetric matrix are symmetric.

(7) Conjugate of a matrix: A conjugate of a matrix is a matrix formed with the conjugates of the corresponding elements of the original matrix. For example, If $A = \begin{pmatrix} a - ib & 3i \\ a & -4i \end{pmatrix}$ then $\overline{A} = \begin{pmatrix} a + ib & -3i \\ a & +4i \end{pmatrix}$

(8) Conjugate Transpose of a matrix: Is a matrix obtained by the transpose of the conjugate of the original matrix i.e? $\overline{A}' = \begin{pmatrix} a + ib & a \\ -3i & 4i \end{pmatrix}$. It is also denoted by A^{θ}.

(9) Hermitian matrix: If $A^{\theta} = A$, the matrix A is called a Hermitian matrix.

(10) Skew- Hermitian matrix: If $A^{\theta} = -A$, the matrix A is called a skew-Hermitian matrix. Note: Every square matrix is uniquely expressible as the sum of a Hermitian and a skew-Hermitian matrix.

(11) Orthogonal matrix: If $AA' = I$ then the matrix A is called an orthogonal matrix.

(12) Idempotent matrix: If $A^2 = A$, the matrix A is called an Idempotent matrix.

(13) Involuntary matrix: If $A^2 = I$ then the matrix A is called an involuntary matrix

(14) Nilpotent matrix: If $A^p = 0$ (but $A^{p-1} \neq 0$) then the square matrix A is called the Nilpotent matrix of nil potency p (or order p).The order of nilpotency is different from the order of the matrix A.

(15) Unitary matrix: If $A^{\theta}A = I$, the matrix A is called a Unitary matrix.

(16) Periodic matrix: If $A^{k+1} = A$then the matrix A is called the periodic matrix of period k.

Some Special Series

(1) $e^x = 1 + \frac{x}{1!} + \frac{x^2}{2!} + \frac{x^3}{3!} + \ldots\ldots .$

(2) $e^{-x} = 1 - \frac{x}{1!} + \frac{x^2}{2!} - \frac{x^3}{3!} + \ldots\ldots$

(3) $e^{cx} = 1 + \frac{cx}{1!} + \frac{(cx)^2}{2!} + \frac{(cx)^3}{3!} + \ldots\ldots .$

(4) $a^x = 1 + \frac{(\log_e a)x}{1!} + \frac{(\log_e a)^2 x^2}{2!} + \ldots\ldots .$

(5) $\log_e(1 + x) = x - \frac{1}{2}x^2 + \frac{1}{3}x^3 - \frac{1}{4}x^4 + \ldots$

(6) $\log_e(1 - x) = -x - \frac{1}{2}x^2 - \frac{1}{3}x^3 - \ldots\ldots$

Probability

(1) Probability of the event A or B: $P(AorB) = P(A) + P(B) - P(A \cap B)$,

(2) Probability of an event "not A": $P(notA) = 1 - P(A)$

(3) $P(A - B) = P\left(A \cap B^C\right) = P(A) - P(A \cap B)$

(4) If E and F are two events associated wit the same sample space of a random experiment, the conditional probability of the event E given tat F has occurred , i.e.

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

(5) **Bayes' Theorem**: $P(E_i/A)=\dfrac{P(E_i)P(A/E_i)}{\sum_{j=1}^{n}P(E_j)P(A/E_j)}$

where $\{E_1,E_2,....,E_n\}$ area partition of a sample space S and they are pair wise disjoint and make jointly sample space, A is an event with non-zero probability.

(6) Theorem of total probability:

$$P(A)=P(E_1)P(A/E_1)+P(E_2)P(A/E_2)+..+P(E_n)$$

where $\{E_1,E_2,....,E_n\}$ are a partition of a sample space and each has non-zero probability. A may be any event associated with S.

(7) Fundamental Inequality:

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

Arithmetic Progression (A.P)

(1) A sequence is called an Arithmetic Progression if $T_2-T_1=T_3-T_2=.....=T_{n+1}-T_n$ = constant

(2) The nth term of an AP, from beginning, is given by: $T_n=a+(n-1)d$, where a= first term and d= common difference of the AP.

(3) The nth term from the end is given by: $T_n'=l+(n-1)(-d)$ where *l* = last term and d is the common difference. Or, r^{th} term from the end is = $(n-r+1)^{th}$ term from the beginning = a + (r-1)d where a is the frst term and d is the common difference.

(4) The sum to n terms of the AP: $S_n=\dfrac{n}{2}\{2a+(n-1)d\}=\dfrac{n}{2}(a+l)$ where a= first term, d= common difference, *l*=last term or nth term, n= number of terms.

(5) A sequence is an AP if the nth term is a linear expression of n, i.e. $T_n=An+B$.

(6) A sequence is an AP if the sum to n terms is a quadratic expression of n, i.e. $S_n=An^2+Bn+C$.

(7) If a constant is added to or subtracted from all the terms of an AP, the resultant series remains in AP. Example: if $a_1, a_2, a_3,....a_n$ are in AP, and k is a constant then $a_1 \pm k$, $a_2 \pm k$, $a_3 \pm k$,.... $a_n \pm k$ will also be in AP.

(8) If all the terms of an AP are multiplied by or divided by a constant, the resultant series remains again in AP. Example: if $a_1, a_2, a_3,....a_n$ are in AP, and k is a constant then a_1 . k , a_2 . k, a_3. k,....a_n. k as well as a_1 / k , a_2/ k, a_3 /k,....a_n / k will also be in AP.

(9) If there are two APs and there corresponding terms are added or subtracted then the series formed by the new terms is again an AP with the new common difference of Sum of the two common differences or the difference of them as the case may be. But if the terms are multiplied together or divided by then they do not form an AP. Example: if $a_1, a_2, a_3,....a_n$ and $b_1, b_2, b_3,....b_n$ are two APs then a_1+b_1, a_2+b_2 , a_3+b_3,..., a_n+b_n and a_1-b_1, a_2-b_2 , a_3-b_3,..., a_n-b_n will also be in AP. But $a_1.b_1$, $a_2.b_2$, $a_3.b_3$,..., $a_n.b_n$ and a_1/b_1, a_2/b_2 , a_3/b_3,..., a_n/b_n will not be in AP.

(10) If pth term of an AP is q and the qth term is p then (p+q)th term is 0 and the nth term is (p+q-n).

(11) In an AP if $pT_p = qT_q$, then $T_{p+q}=0$.

(12) In an AP if S_p = q and S_q=p then Sp+q=-(p+q).

(13) If $S_p=S_q$ then $S_{p+q}=0$

(14) In a finite AP, the sum of equidistant terms from the beginning and the end is always constant and is equal to the sum of the first and the last term. Example: if $a_1, a_2, a_3,....a_n$ are in AP then if $a_1+a_n=a_2+a_{n-1}=a_3+a_{n-2}=.....=2a_1+(n-1)d$.

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

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

(17) 3 terms in AP are assumed to be a-d, a, a+d.

(18) 4 terms in AP are assumed to be a-3d, a-d, a+d, a+3d.

(19) If between a and b, n quantities $A_1,A_2,A_3,.....A_n$ are inserted and $a,A_1,A_2,A_3,.....A_n,b$ form an AP, then $A_1,A_2,A_3,.....A_n$ are called the Arithmetic Means.

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

$A_1 = a + \frac{b-a}{n+1}$ and

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

(20) If three different quantities a,b,c are there then they will be in AP if $\frac{a-b}{b-c} = \frac{a}{a}$.

Geometric Progression

(1) A sequence of non-zero numbers $T_1, T_2, T_3, ...T_n$ is called a geometric progression (GP) if – $\frac{T_2}{T_1} = \frac{T_3}{T_2} = \frac{T_4}{T_3} = ... = \frac{T_n}{T_{n-1}} = r$; r is called the common ratio.

(2) The nth term of a GP is given by $T_n = ar^{n-1}$ where a= first term and r=common ratio, n= number of terms.

(3) The sum to n terms of a GP is given by $S_n = \frac{a(r^n - 1)}{r-1}$.

(4) The sum to infinite number of terms in a GP is possible if common ratio r < 1 and is given by $S_\infty = \frac{a}{1-r}$.

(5) 3 terms of a GP are assumed to be $\frac{a}{r}, a, ar$.

(6) 4 terms of a GP are assumed to be $\frac{a}{r^3}, \frac{a}{r}, ar, ar^3$.

(7) If all the terms of a GP are multiplied or divided by the same non-zero constant , the series remains in GP.

(8) The reciprocals of the GP form again a GP.

(9) If each term of a GP is raised to the same power, the resulting sequence form GP.

(10) In a finite GP, the product of equidistant terms from the beginning and the end is always constant and is equal to the product of the first and the last term.

(11) Three non-zero terms a, b, c are in GP if $b^2 = ac$ and b lies between a and c.

(12) If between a and b, n quantities $G_1, G_2, G_3, ...G_n$ are inserted and $a, G_1, G_2, G_3, ...G_n, b$ form a GP, then $G_1, G_2, G_3, ...G_n$ are called the Geometric Means.

(13) If A and G are respectively the AM and GM, between a and b, then A>G.

(14) Equation $x^2 - 2Ax + G^2 = 0$ has a and b as its roots.

(15) No term of a G.P can be zero and so the common ratio cannot be zero.

(16) if two GPs are there and their corresponding term are multiplied or divided by each other then the new terms formed make again a GP.

(17) If the terms are added or subtracted then they do not form a GP.

(18) If $a_1, a_2, a_3, ..., a_n$ are in GP then $\log a_1, \log a_2, \log a_3, ..., \log a_n$ form an AP.

(19) If three different quantities a,b,c are there then they will be in GP if $\frac{a-b}{b-c} = \frac{a}{b}$.

Harmonic Progression

(1) A sequence $T_1, T_2, T_3, ...T_n$ of non-zero numbers is called a Harmonic Progression if the reciprocals form an Arithmetic Progression.

(2) No term of an HP can be zero.

(3) Harmonic Mean H between a and b is given by $H = \frac{2ab}{a+b}$.

(4) $A \geq G \geq H$.

(5) A, G, H are in GP.

(6) If A,G,H are of three given numbers a,b,c then a,b,c are the roots of equation $x^3 - 3Ax^2 + \frac{3G^3}{H}x - G^3 = 0$.

(7) There is no formula to calculate the sum to n terms of an HP.

(8) If three different quantities a,b,c are there then they will be in HP if $\frac{a-b}{b-c} = \frac{a}{c}$.

Important Expansions

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

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

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

(4) If nth term of a series T_n= $an^3 + bn^2 + cn + d$ then the Sum to n terms is given by $S_n=\sum T_n$
$=a\sum n^3+b\sum n^2+c\sum n+d\sum 1$

(5) $\sum n=1+2+3+.....+n=\frac{n(n+1)}{2}$.

(6) $\sum n^2=1^2+2^2+3^2+...+n^2=\frac{n(n+1)(2n+1)}{6}$

(7) $\sum n^3=1^3+2^3+3^3+...+n^{3^2}=\left(\frac{n(n+1)}{2}\right)$

(8) $\sum n^4=1^4+2^4+3^4+.....+n^4$
$=\frac{n(n+1)(2n+1)(3n^2+3n+1)}{30}$

(9) If Arithmetic Mean(A), A=(a+b)/2 , Geometric Mean(G), G^2=ab, and Harmonic Mean(H), H=2ab/(a+b) then G^2=AH.

(10) The sequence of numbers 1,1,2,3,5,8,... is called a Fibonacci's sequence. This is determined by the conditions: $F_n=F_{n-1}+F_{n-2}$, n≥ 2 and $F_1=1=F_2$

(11) a and b are given by $A\pm\sqrt{A^2-G^2}$.

(12) $\left(\frac{a_1+a_2+a_3+....+a_n}{n}\right)\geq\sqrt[n]{a_1.a_2.a_3....a_n}$
$\geq\frac{n}{\frac{1}{a_1}+\frac{1}{a_2}+\frac{1}{a_3}+....+\frac{1}{a_n}}$

Sets

(1) Union of sets A and B is given by $A\cup B=\{x:\in A$ or $x\in B\}$ and $x\notin(A\cup B)\Rightarrow x\notin A...and...x\notin B$.

(2) Intersection of sets A and B is given by
$A\cap B=\{x:\in A$ and $x\in B\}$ and
$x\notin(A\cap B)\Rightarrow x\notin A...or...x\notin B$.

(3) n(A∪ B) = n (A) + n (B) – n (A∩ B)

(4) Identity laws : A ∪ϕ = A. and A ∩ U= A .

(5) Commutative laws: A ∪ B= B ∪ A and A ∩ B= B ∩ A.

(6) Associative laws: A ∪ (B ∪ C)=(A ∪ B) ∪ C and A ∩ (B ∩ C)=(A ∩ B) ∩ C.

(7) Distributive laws: A ∪ (B ∩ C)=(A ∪ B) ∩(A ∪C) and A ∩ (B ∪ C) = (A ∩ B) ∪ (A ∩C) .

(8) De-morgan's laws: $(A\cup B)'=A'\cap B'$ and $(A\cap B)'=A'\cup B'$.

Function

A relation from set A to set B is called a function if every element of set A has one and only one image in set B. In other words, a function f is a relation from a non-empty set A to a non-empty set B such that the domain of f is A and no two distinct ordered pairs in f have the same first element. Or,

If a perpendicular dropped on the axis of X, cuts the curve at *one* point only, then the graph represents a function otherwise not.

(1) If n(A)=a and n(B)=b then ***total number of functions*** from A to B=b^a.

(2) Total ***number of one-one functions*** from A to B = ${}^bP_a$ if b ≥ a otherwise it is 0 where n(A)=a and n(B)=b.

(3) Total ***number of Onto functions***(surjections) from A to B= $\sum_{r=1}^{b}(-1)^{b-r}.{}^bC_r.r^a$

(4) The ***number of Onto functions*** defined from a finite set A containing *a* elements onto a finite set B containing 2 elements = 2^a-2.

(5) Total ***number of one-one onto*** (bijection) from A to B = a! or b! as the number of elements in A = number of elements in B.

(6) One-one function: (Injective) :A function f : X → Y is defined to be **one-one** (or **injective**) if for every x_1, x_2 ∈ X, f (x_1) = f (x_2) ⇒ x_1 = x_2. Otherwise, f is called many-one.

(7) Onto Function: (Surjective) :A function f : X → Y is said to be **onto** (or **surjective**) if for every y ∈ Y, there exists an element x in X such that f (x) = y.

(8) One-one onto: (Bijective) : A function f : X → Y is said to be **one-one** and **onto** (or **bijective**), if f is both one-one and onto. For an onto function rangeis equal to codomain.

(9) A one- one function defined from a finite set to itself is always onto but if the set is infinite then it is not the case.

(10) Linear polynomial functions (ax+b), x, e^x, log x are always one-one function.

(11) If (dy/dx) > 0 , or, (dy/dx) < 0, then y=f(x) is one-one, iff f is a continuous function.

(12) All even functions, modulus functions, periodic functions are always many-one functions.

(13) Square functions and Trigonometric functions are many-one functions in their domain.

(14) sin $\sqrt{x}$ and sin x^2 are not periodic as they cannot be expressed in f(x+T)=f(x).

(15) If f : A $\rightarrow$ B and g : B $\rightarrow$ C are two functions, then the **composition** of f and g, denoted by gof, is defined as the function **gof** : A $\rightarrow$ C given by gof (x) = g(f (x)), $\forall$ x $\in$ A. Composition of f and g is written as gof and not fog . gof is defined if the range of f $\subseteq$ domain of f and fog is defined if range of g $\subseteq$domain of f.

(16) A function f : X $\rightarrow$ Y is defined to be **invertible**, if there exists a function g : Y $\rightarrow$ X such that gof = I_X and fog = I_Y. The function g is called the inverse of f and is denoted by f^{-1}

(17) If f is invertible, then f must be one-one and onto and conversely, if f is one-one and onto, then f must be invertible. In general fog and gof are not equal, i.e. composition of functions is not commutative but it is associative. i.e. if f: X$\rightarrow$ Y, g: Y$\rightarrow$ Z, and h: Z $\rightarrow$S then h o (g o f)=(h o g) o f

(18) If either of the two f and g, one is an Identity function then, fog and gof are identity functions.

(19) If f: A $\rightarrow$B and g: B $\rightarrow$C are one-one and onto then gof : A$\rightarrow$ C is also one-one and onto. But if gof is one-one then only f is one-one g may or may not be one-one. If gof is onto then g is onto , f may or may not be onto.

(20) Given a finite set X, a function f : X $\rightarrow$ X is one-one (respectively onto) if and only if f is onto (respectively one-one). This is the characteristic property of a finite set. This is not true for infinite set.

(21) Let f : X $\rightarrow$ Y and g : Y $\rightarrow$ Z be two invertible functions. Then gof is also invertible with $(gof)^{-1} = f^{-1} o g^{-1}$.

A **binary operation** * on a set A is a function * : A × A $\rightarrow$ A. Notation: * (a, b) by a * b.

(1) Given a binary operation * : A × A $\rightarrow$ A, an element e $\in$ A, if it exists, is called **identity** for the operation *, if a * e = a = e * a, $\forall$ a $\in$ A. Identity element is unique.

(2) An element a $\in$ X is invertible for binary operation * : X × X $\rightarrow$ X, if there exists b $\in$ X such that a * b = e = b * a where, e is the identity for the binary operation *, then the element b is called **inverse of a** and is denoted by a^{-1}.

(3) An operation * on X is **commutative** if a * b = b * a $\forall$ a, b in X.

(4) An operation * on X is **associative** if (a * b) * c = a * (b * c) $\forall$ a, b, c in X.

(5) If the operation table is symmetric about the diagonal line then, the operation is commutative.

(6) Addition (+) and multiplication (.) on N , the set of natural numbers are binary operations. But subtraction (-) and division (÷) are not since (4,5)= 4-5 = -1 does not belong to N and (4÷5) also does not belong to N.

(7) Binary operations are functions.

(8) Number of binary operations on A = Number of functions from A x A to A = A^{AxA} , where A represents the Cardinal Number of the Set A. For example: if the cardinal number of A is 3 then the number of binary operations= 3^{3x3}= 3^9 .

Some specific functions

(1) A transcendental function is not expressible in a finite number of algebraic terms.

(2) Even functions are symmetrical about y-axis and odd functions are symmetrical about origin i.e. in opposite quadrants.

(3) f(x)=0 is the only function that is both even and odd.

(4) Any function can be expressed as a sum of an even and an odd function.

(5) Sum of even and odd function is neither even nor odd.

(6) Sum of even functions is always even and Difference of two odd functions is also an even function always.

Equation

(1) Every equation has a root real or imaginary.

(2) The number of roots of an equation is equal to its degree and not more than in any case.

(3) Equations with real coefficients may have imaginary roots but they occur in pair i.e. a+ib and a-ib are present together.

(4) Equations with rational coefficients may have surds roots but they occur in pair i.e. (a$\sqrt{b}$) and (a - $\sqrt{b}$) are always together.

(5) Equations with all positive coefficients has no positive root ie $x^3 + ax^2 + x + b=0$ will have no positive root.

(6) Equations having coefficients of all even powers of x as (-) and of all odd powers (+) will have no negative root i.e. $x^5 – a x^4 + b x^3 - c x^2 + dx -1=0$ will have no negative root.

(7) Equations containing only even powers and all coefficients having same sign will have no real root ie $x^6 + a x^4 + b x^2 + c =0$ will have no real root.

(8) Equations containing only odd powers and all coefficients having same sign will have no real root except x =0, i.e. $x^5 + a x^3 + b x =0$ will have no real root except x =0.

(9) An equation of odd degree has at least one real root whose sign is opposite to its last term.

(10) An equation of even degree will have at least two real roots one negative and one positive whose last term is negative.

(11) The maximum number of positive roots in an equation is equal to the change of sign of the coefficients of f(x) and the maximum number of negative roots is equal to the change of sign in f(-x). this is called the Descarte's Rule of sign.

(12) Descarte's Rule of sign gives the maximum number of positive or negative real roots. It does not give the exact number of positive or negative real roots of f(x)=0.

(13) In an equation f(x) if for values a and b , f(a) and f(b) have different signs, then a root must exist between a and b.

(14) f(a) and f(b) containing same signs has either no root or an even number of roots of f(x) between a and b.

(15) f(a) and f(b) containing different signs has an odd number of roots of f(x) between a and b.

(16) If an equation has r equal roots, its first derivative f'(x) will have (r-1) equal roots.

(17) To find an equation whose roots are enhanced by m, replace x by x-m.

(18) To find an equation whose roots are diminished by m, replace x by x + m.

(19) $ax^2 + bx + c = 0$ is positive or greater than 0 for all values of $x \in R$ iff a>0, D<0.

(20) $ax^2 + bx + c = 0$ is negative or less than 0 for all values of $x \in R$ iff a<0, D<0.

(21) Curve represented by the Quadratic expression cuts x-axis at two points iff D>0.

(22) Curve represented by the Quadratic expression touches x-axis if D=0.

(23) Curve represented by the Quadratic expression will not intersect x-axis if D<0.

(24) Curve represented by the Quadratic expression will be completely above x-axis if a >0.

(25) Curve represented by the Quadratic expression will be completely below the x-axis if a<0.

(26) If the roots of the equation represented by $ax^2 + bx + c = 0$ are real α and β, and for a real k they are such that $\alpha < k < \beta$, then D>0, af(k)<0.

(27) If k_1 , k_2 are such that $k_1 < \alpha$, $\beta < k_2$, then $D \geq 0$, $af(k_1) > 0$, $af(k_2) > 0$, $k_1 < -(b/2a) < k_2$.

(28) If $k < \alpha$, β or $k > \alpha$, β; then $D \geq 0$, af(k) >0.

(29) If one of the roots lies in the interval (k_1, k_2) then $f(k_1)f(k_2)<0$.

(30) If a-b+c=0 then one root is -1 and the other root is (– c/a).

(31) If $ax^2 + bx + c = 0$ and a+b+c =0 then one root is always 1 and the other is (c / a).

(32) If all the terms are with positive coefficients and no odd powers are there, it will have complex roots.

(33) Every odd degree equation has at least one real root.

(34) If $x^3 + ax + b=0$ has only real roots, then $4a^3 + 27 b^2 \leq 0$

(35) α is a repeated root iff $f(\alpha)=0$ and $f'(\alpha)=0$.

(36) If $(x-\alpha)^k$ divides f(x) then $(x-\alpha)^{k-1}$ divides f'(x).

(37) If both roots are positive, then $\alpha+\beta>0$ and $\alpha\beta>0$.

(38) If both roots are negative, then $\alpha+\beta<0$ and $\alpha\beta>0$.

(39) If both roots are greater than k, then D≥0, (-b/2a) > k, a f(k) >0.

(40) If both roots are less than k then D≥0, (- b/2a)< k, a f(k)>0.

Statistics

(1) Measure of central tendency: It gives an idea where data points are centred. It consists of

Mean : it is denoted by $\bar{x}$. If the data are $x_1, x_2, x_3, \ldots x_n$ 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) $$\bar{x} = \frac{f_1x_1 + f_2x_2 + f_3x_3 + ... + f_3x_n}{f_1 + f_2 + ... + f_n} = \frac{1}{N}\sum_{i=1}^{n} f_ix_i$$

(iii) $$\bar{x} = \frac{f_1d_1 + f_2d_2 + f_3d_3 + ... + f_3d_n}{f_1 + f_2 + ... + f_n}$$

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

where a= assumed mean.

Median : It is the value of the middle term/ terms when the data are arranged into increasing or decreasing order. It is denoted by

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

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

(iii) 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.

It is also given by **Mode = 3 Median – 2 Mean**

2. **Measure of Dispersion**: Dispersion means scatterness of data. It is measured on the basis of the measure of central tendency ie mean, mode or median. It of mainly of 4 types:

(i) **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. It is calculated by

Maximum value of the data - Minimum Value of the data

(ii) **Quartile deviation** $Q_1 = L + \frac{\frac{N}{4} - F}{f} \times i$

(iii) Mean deviation

(about mean assumed mean a) = $\frac{\sum_{i=1}^{n}|x_i - a|}{n}$

Mean deviation in case of grouped data = $\frac{\sum_{i=1}^{n} f_i|x_i - a|}{N}$ where N= sum of all frequencies.

Mean deviation (about mean $\bar{x}$)= $\frac{\sum_{i=1}^{n}|x_i - \bar{x}|}{n}$

In case of grouped data= $\frac{\sum_{i=1}^{n} f_i|x_i - \bar{x}|}{N}$

Mean deviation about median M= $\frac{\sum_{i=1}^{n}|x_i - M|}{n}$

In case of grouped data= $\frac{\sum_{i=1}^{n} f_i|x_i - M|}{N}$

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

In case of frequency distribution, $\sigma = \sqrt{\frac{1}{N}\sum_{i=1}^{n} f_i\left(x_i - \bar{x}\right)^2}$

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

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

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

Probability related to letters and Envelops

(1) Probability of inserting all the n letters in right envelops = $\frac{1}{n!}$.

(2) Probability of inserting atleast one letter in wrong envelop = $1-\frac{1}{n!}$.

(3) Probability of inserting all the n letters in wrong envelops p= $1-\frac{1}{1!}+\frac{1}{2!}-\frac{1}{3!}+....+\frac{(-1)^n}{n!}$.

(4) Probability of keeping at least one letter in right envelope = 1-p.

Probability related to shoes and cupboard

(1) Probability of selecting k shoes at random out of n pairs of shoes, when no pair is selected is p= $\frac{{}^nC_k.2^k}{{}^{2n}C_k}$.

(2) Probability of getting at least one pair is = 1-p.

Probability related to Squares on the chess board

Probability of selecting r squares from a chess board when they lie on a diagonal is = $\frac{4\left({}^7C_r+{}^6C_r+.....+{}^rC_r\right)+{}^8C_r}{{}^{64}C_r}, 1\le r\le 7$.

Probability related to Functions from A to B.

(1) Probability of selecting a one-one function = $\frac{{}^BP_A}{B^A}$

(2) Probability of selecting a many one function = $1-\frac{{}^BP_A}{B^A}$

(3) Probability of selecting a one-one-onto function= $\frac{B}{B^A}$

(4) Probability of selecting a constant function = $\frac{B!}{B^A}$

Probability related to a Pack of Playing Cards

(1) A pack has 4 suits.
(2) Each suit has 13 cards.
(3) Suits are Spades, Clubs, Hearts and Diamonds.
(4) Spades and Clubs are of Black colour and Hearts and Diamonds are of Red colour.
(5) Each suit has Ace, King, Queen, Jack, 10, 9, 8, 7, 6, 5, 4, 3, 2 cards.
(6) Cards K,Q,J are called Face Cards.
(7) Cards A,K,Q,J are called Honour Cards.
(8) Cards 10,J,Q are called Knave cards.

Dr S.B. Dhar, is **Editor of this Quartrerly e-Bulletin**. He is an eminent mentor, analyst and connoisseur of Mathematics from IIT for preparing aspirants of Competitive Examinations for Services & Admissions to different streams of study at Undergraduate and Graduate levels using formal methods of teaching shared with technological aids to keep learning at par with escalating standards of scholars and learners. He has authored numerous books of excellence.
e-Mail ID: maths.iitk@gmail.com

—00—

Answers to Science Quiz : May'18

Kumud Bala

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

—00—

ANSWER: CROSSWORD PUZZLE May'18: MATHEMATICAL SYMBOLS

Prof. S.B. Dhar

												1I	N	T	E	G	R	A	L	2P	A	R	T							
		3C																		R										
		O							4A	P	5P	R	O	X	I	M	A	T	I	O	N			6E			7S				
8L	I	N	E						B		A									D				M			U				
		G							S		R									U				P			P			9P	
	10P	R	O	P	O	R	T	I	O	N	A	L	I	T	Y					C				T			E			L	
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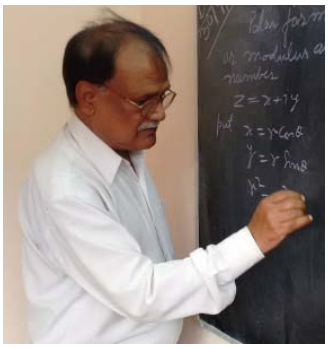
हमारापंचवर्षीयप्रवास

Start: June-2012



April-2015

June-2016.....

पारम्परिक शैक्षणिक मार्दर्शन से प्रारम्भ कर आज हम तकनीकी-विकास के सहारे मूलभूत प्रासंगिकता को आगे बढ़ने में संलग्न हैं...

यह प्रयास अपने सामाजिक कर्त्तव्य के प्रति सहजविनीत आग्रह है; कृपया इस पर विचार करें.

. 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 target students a feel that you care for them, and they are anxiously awaiting to get benefitted by your contributions. We request you to please feel free to send your creation, by* ***20th of each 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-

- ***With the start of Second year of operation, we have reached to 7th Quarterly e-Bulletin Gyan-Vigyan Sarita: शिक्षा. We shall brought out its Secondt Supplement on 1st June'18.***
- ***Theme of the 8th Quarterly e-Bulletin dt 1st July'18 is National Doctors' Day celebrated on 1st July to to honour legendary physician Bidhan Chandra Roy commemorate his birth anniversary.***
- ***And this cycle of monthly supplement sandwitching consecutive Quarterly e-Bulletin Gyan-Vigyan Sarita: शिक्षा is aimed to continue endlessly***

We believe that this monthly supplements to 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 and/or experiences.

—00—

बुद्ध ने कहा है.....!

जीवन नदी जैसा है, यहां प्रतिपल सब बह रहा है।

ऐसा ही जीवन का प्रवाह है

जो आये उसे अंगीकार करो

जो जाये उसे अलविदा करो

कुछ पकड़ के मत रखो

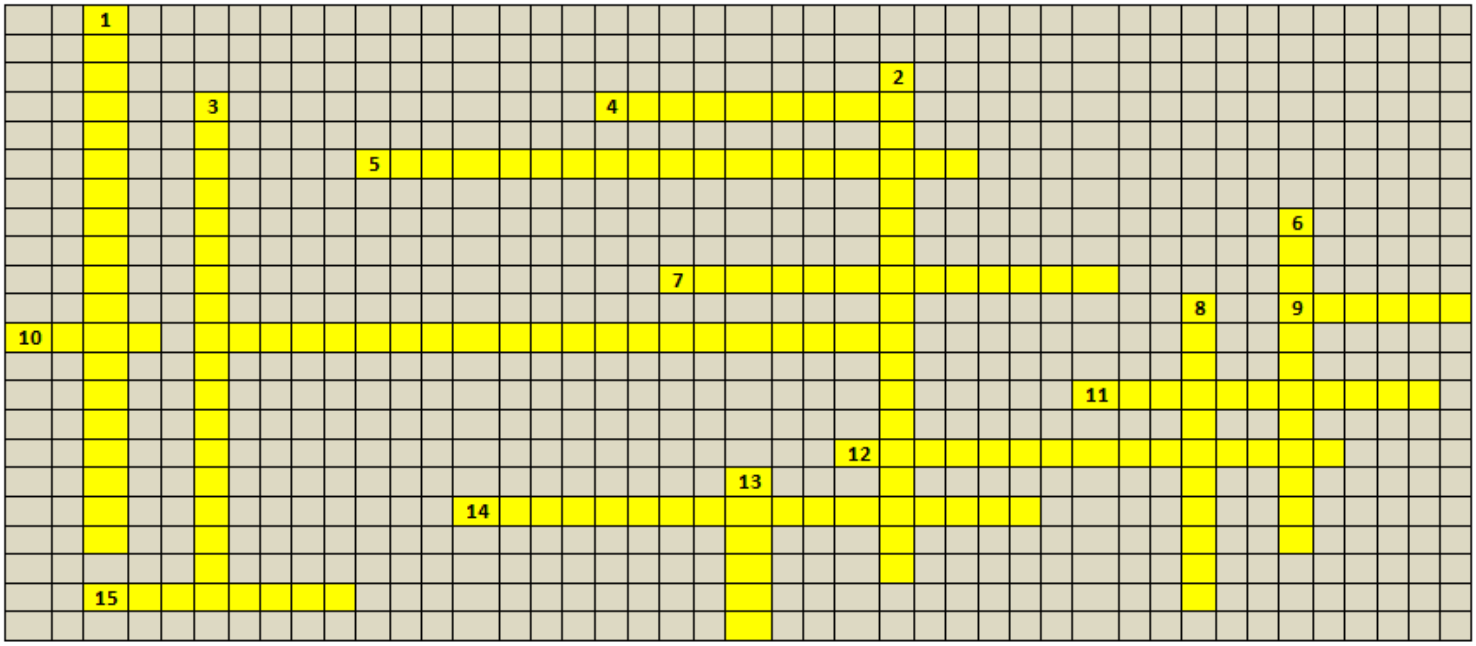
ऐसा आदमी कभी दुखी नहीं होता।

- ओशो

—00—

CROSSWORD PUZZLE: Prof. PRASHANT CHANDRA MAHALANOBIS

Prof. SB Dhar



ACROSS

4 University of London where Mahalanobis studied

5 Two class junior student

7 Govt of India's Award to Mahalanobis

9 A teacher of Mahalanobis at Presidency College

10 Institute established by Mahalanobis

11 An organization established by Grand father of PC

12 Name of Mahalanobis

14 College where he studied at Calcutta

15 Place where Mahalanobis was born

DOWN

1 A Discovery of Mahalanobis

2 Plan where Mahalanobis model was used

3 Medal given to Mahalanobis

6 Name of a survey

8 One year junior student to Mahalanobis

13 A teacher of Mahalanobis at Presidency college

—00—

Growing with Concepts : Physics

Practicing Problem Solving- Physics

Growing with concepts has two parts, First is assimilation of concepts and Second is practicing concepts in problem solving. Second part is essential in carving proficiency in use of concepts, the essence of learning. Therefore, First Part of concepts through a series of articles in this column has been completed and integrated in Mentor's Manual, as a free web-resource.

The Second Part has been started in May'18 issue of the e-Bulletin. This would cover sequentially topic-wise typical questions in the form of a question paper. Since, such set of questions as of now shall be made available at monthly frequency, it may be difficult for students, aspiring to make best of it to wait for next month. Therefore, answers to each question are provided in the respective e-Bulletin, for verification. In case any student is unable to arrive at correct answer illustration of the problems is available in the same bulletin at a different place, with an advise not to jump on it in first attempt.

These questions are drawn from various sources viz. text books, study materials, examinations, and moderation has been made to the possible extent. This shall continue until we are able to automate extracting a set of questions, in the form of a question paper, where question are available on topic wise, level-wise, type-wise or mixed for intensive practice. All these effort are and shall be available as free web-resource.

It is advised that before starting with questions, concepts of the topic are so understood that it is possible to revise them without book or copy, i.e. revise mentally. It is assured that this capacity of mental revision is achievable with little practice, and then it keeps growing in intensity and complexity. *All that it requires is faith in enormous capacity of self and ability to think*. Albert Einstein had said – "*Education is not the learning of facts, but training of mind to think*"

Accordingly, some steps are to be followed while attempting question - **1)** Read question to see what is given. If it is nor clear read carefully the problem statement. **2)** Read question to understand what asked. This is the objective of problem and must be clear before attempting solution, else read it again. **3-a)** Never start attempting solutions intuitively, visualize the problem statements and for clarity, if required, draw a diagram, formulate basic equations also called mathematical model. **3)** Solution of problem - **3-b)** Choose equations most appropriate for solving the problem in hand, else a wrong starting point may divert attention leading to more calculations or a lengthy solution. **3-c)** Never be in hurry of calculation at each step, most of the calculations are simplified by cancellation. Generally in physics attempt is to test conceptual clarity. **3-d)** Never forget to write answer using principles of significant digits. **4)** Last but not the least – **4-a)** Check solution to verify whether it is conforming to step (2) above. **4-b)** Check solution to ensure given variables are placed correctly in solution and there is no calculation error.

General practice is to remember formulae of each chapter first, before solving problems. This may lead to error in application of concepts in the event of any twist in problem. Once practice is started with basic equations, automatically both concepts and related formulae become intuitive. This helps in – **a)** visualization of problems with clarity, **b)** evolving solution in minimum number of steps as suggested in step (3) above, **c)** better understanding with accuracy and speed, the parameter of excellence, intelligence and success, and **d)** acting as a safeguard from risk of unreliable efforts on mugging formulae first.

Keeping this in view, efforts have been made to provide illustration to the answers from basics, to the extent possible. Students with sound basics might find the details in illustrations to be redundant, nevertheless this initiative of Gyan Vigyan Sarita is targeted to mentor those unprivileged students who are neither connected through IOMS nor able to obtain suitable guidance which can groom competence among them to create a space for them in this competitive world. The effort would be successful only if such target students are able to use it for application of concepts with clarity, accuracy and speed, and in process leading them to undertake many steps as mental analysis, a necessity for success in competitive examinations.

Any input on typographical error in question, answers and illustration or to diversify the scope of this resource material is gratefully welcomed; it is in the spirit of Personal Social Responsibility (PSR) the core of this initiative. Readers are welcome to make suggestions for value addition through **CONTACT US**.

Going forward these questions shall be organized by clustering each type of questions for intra-level practice by students. It is our endeavour to automate the practice tests. This will require students to register, free-of-cost, to avail facility of practice tests, self-evaluation and refer to detailed Illustrations in case of any doubt or difficulty.

"Mind has enormous capacity, ability and speed to think, all that it requires is, to shake it off from a dormant state, and use it. It is achievable through a gradual process of self-carving, without any short-cut."

—00—

Code: Phy/KINX/O/001

Physics Objective Questions: Kinematics – Typical

{Each question is tagged with Level and Type SC (Single Choice) or MC Multiple Choice)}

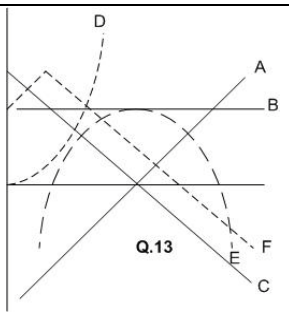
No of Question: 61] **[Time Allotted: 3 Hours**

(All questions are compulsory)

Q-1	A plane travels 200 km on a straight line making an angle 30^0 east of due north How far north the plane travels from its starting point? (a) 200 km (b) $100\sqrt{3}$ km (c) 100 km (d) 150 km
Q-2	A vehicle travels 30 km due north and then takes a turn to Left travels 40 km before stopping. Find (i) total distance travelled and (ii) total displacement (a) (i) 70 km (ii) 50km Due $\left(\frac{\pi}{2}+\tan^{-1}\left(\frac{4}{3}\right)\right)^0$ West of North (b) (i) 70 km (ii) 50km Due $\left(\tan^{-1}\left(\frac{4}{3}\right)\right)^0$ West of North (c) (i) 70 km (ii) 50km Due $\left(\pi-\tan^{-1}\left(\frac{4}{3}\right)\right)^0$ West of North (d) (i) 50 km (ii) 70km Due $\left(\frac{\pi}{2}+\tan^{-1}\left(\frac{4}{3}\right)\right)^0$ West of North
Q-3	Displacement of a particle in three consecutive steps is $\vec{d}_1 = 3.5\hat{\imath} + 4\hat{\jmath}$, $\vec{d}_2 = -4.5\hat{\imath}$ and $\vec{d}_3 = -4.5\hat{\jmath}$. What is net displacement after third step (a) $1\hat{\imath} + 0.5\hat{\jmath}$ (b) $1\hat{\imath} - 0\hat{\jmath}$ (c) $-1\hat{\imath} - 0.5\hat{\jmath}$ (d) $0\hat{\imath} - 0.5\hat{\jmath}$
Q-4	Position of a particle on a line is represented by expression $x = At + Bt^2 - Ct^3$, here A, B and C are constants having values $2\ ms^{-1}$, $3\ ms^{-2}$ and $1\ ms^{-3}$ and t is time. Position, velocity and acceleration of particle at $t = 5$sec of particle are – (a) (i) 40 m (ii) $43\ ms^{-1}$ (iii) $24\ ms^{-2}$ (b) (i) 40 m (ii) $43\ ms^{-1}$ (iii) $-24\ ms^{-2}$ (c) (i) 40 m (ii) $43\ ms^{-1}$ (iii) $-24\ ms^{-2}$ (d) (i) -40 m (ii) $-43\ ms^{-1}$ (iii) $-24\ ms^{-2}$
Q-5	A ball is thrown vertically upward with a velocity $30\ ms^{-1}$. At what time ball would be at 25 m, while descending. (a)5 sec (b) 6 sec (c) 1 Sec (d) 4 sec

Q-6	Position of a particle on X-Y plane is represented by expression $x = A + Bt + Ct^2 - Dt^3$, here A, B, C and D are constants having values 5m, $2\ ms^{-1}$, $3\ ms^{-2}$ and $1\ ms^{-3}$. Average velocity and acceleration particle between $t = 0$sec and $t = 3$sec are – (a) (i) $15\ ms^{-1}$ (ii) $-3\ ms^{-2}$ (b) (i) $-15\ ms^{-1}$ (ii) $-3\ ms^{-2}$ (c) (i) $-15\ ms^{-1}$ (ii) $3\ ms^{-2}$ (d) (i) $15\ ms^{-1}$ (ii) $3\ ms^{-2}$
Q-7	An object is moving with a velocity $\vec{v}(t) = v_y(t)\hat{j} + v_z(t)\hat{k}$,where $v_z(t) = 0$. From this can it be concluded that acceleration $\vec{a}(t)$ (a) Will have no components that are identically zero (b) May have components that are identically zero, (c) Will have only Z component that is identically zero **(d)** Will have an identically zero z component and may be identically zero component in x or y direction**.**
Q-8	An object is moving in x-y plane with position defined as $\overrightarrow{r_P}(t) = x(t)\hat{\imath} + y(t)\hat{\jmath}$. Reference point O is at $\overrightarrow{r_O}(t) = 0$. The object is definitely moving towards O when- (a) $v_x > 0$ and $v_y > 0$ (b) $v_x < 0$ and $v_y < 0$ (c) $x \cdot v_x + y \cdot v_y < 0$ (d) $x \cdot v_x + y \cdot v_y > 0$
Q-9	An object is moving with a velocity $\vec{v}(t) = v_y(t)\hat{j} + v_z(t)\hat{k}$,where $v_z(t) = 0$. From this can it be concluded that position $\vec{r}(t)$ - (a) Will have no components that are identically zero (b) May have components that are identically zero, (c) Will have only Z component that is identically zero (d) Will have an identically zero z component and may be identically zero component in x or y direction.
Q-10	An object is launched straight up into the air from the ground with an initial vertical velocity of 30 ms^{-1}. The object rises to a highest point approximately 30 m above the ground in 3 secs; it then falls back to ground in another 3 secs immediately at a velocity of 30 ms^{-1}. Then Average speed $(\overline{s})$ and average velocity $(\overline{v})$ are a. $\overline{s} = 10\ ms^{-1}$ and $\overline{v} = 5\ ms^{-1}$ b. $\overline{s} = 10\ ms^{-1}$ and $\overline{v} = 0\ ms^{-1}$ c . $\overline{s} = 0\ ms^{-1}$ and $\overline{v} = 0\ ms^{-1}$ d. $\overline{s} = 0\ ms^{-1}$ and $\overline{v} = 10\ ms^{-1}$
Q-11	An object is moving along X-axis with position as a function of time $x = x(t)$, such that at $x = 0$ is point O. The object is definitely moving towards O when – (a) $\frac{dx}{dt} < 0$ (b) $\frac{dx}{dt} > 0$ (c) $\boldsymbol{\frac{dx^2}{dt} < 0}$ (d) $\frac{dx^2}{dt} > 0$
Q-12	An object starts from rest at $x = 0$ when $t = 0$. The object moves in x direction with +ve velocity. The instantaneous velocity and average velocity are related by – (a) $\frac{dx}{dt} < \frac{x}{t}$ (b) $\frac{dx}{dt} = \frac{x}{t}$ (c) $\frac{dx}{dt} > \frac{x}{t}$ (d) $\frac{dx}{dt} (> \text{OR} = \text{OR} <) \frac{x}{t}$

Q-13 Figure shows few graphs with unlabelled axes. Match: i) which graph would best represent velocity as a function of time for an object moving constant speed? ii) Which graph best represents velocity as a function of time for acceleration given by $a = 3t$? iii) Which graph best represents distance as function of time for a constant negative acceleration iv) Which graph best represents velocity as a function of time if Graph E shows distance as a function of time? Match each case to the graph(s) in the following table.



Case	Graph
(i)	A
(ii)	B
(iii)	C
(iv)	D
	E
	F

Q-14 An object is moving in x direction with velocity $v_x(t)$ and $\frac{dv_x}{dt}$ is non-zero constant. With $v_x = 0$ when $t = 0$, then for $t > 0$ the quantity $v_x \cdot \frac{dv_x}{dt}$ is –

(a) Negative (b) Zero (c) Positive (d) Cannot be determined from given information

Q-15 A statement "A freely falling object traverses a distance in each second greater than that traversed till beginning of the second" Comment that the statement is –

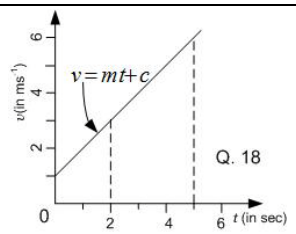
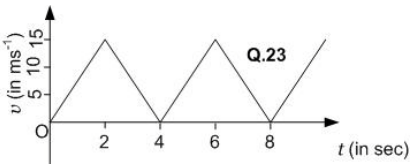
(a) Always true
(b) Only true for sufficiently short time
(c) True for sufficiently long time
(d) Never true

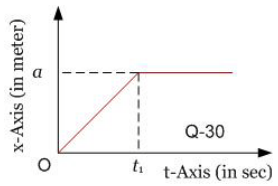
Q-16 An object is tossed vertically into the air with an initial velocity of 8 ms^{-1}. Using the sign convention (+)ve for upward, how does the vertical component of acceleration a (after it is tossed) varies during the flight of the object?

(a) On the way up $a_y > 0$, On the way down $a_y > 0$
(b) On the way up $a_y < 0$, On the way down $a_y > 0$
(c) On the way up $a_y > 0$, On the way down $a_y < 0$
(d) On the way up $a_y < 0$, On the way down $a_y < 0$

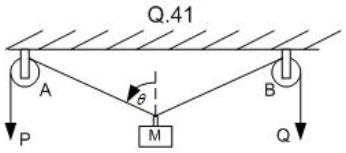
Q-17 A boy jumps off a high diving board above a swimming pool. Halfway between the board and the water he tosses a ball upward. Ignoring air friction, the instant after the ball leaves his hands the vertical component of acceleration of the ball is-

(a) (+)ve, but then decreases through Zero to $(-)9.8ms^{-2}$
(b) Zer0, but then decreases through Zero to $(-)9.8ms^{-2}$
(c) In between Zero and $(-)9.8ms^{-2}$, but then decreases to $(-)9.8ms^{-2}$
(d) $(-)9.8ms^{-2}$

Q-18	Speed-vrs-time graph of motion of a particle is shown in the figure, find distance traversed by the article during $2 \leq t \leq 5$ - (a) 13 m (b) 14 m (c) 15 m (d) 10 m 
Q-19	A particle starts with initial velocity 5 ms^{-1} along x direction with a uniform acceleration 0.75 ms^{-2}. Find, Distance travelled in between $3 \leq t \leq 5$ seconds. (a) 16 m (b) 10 m (c) 20 m (d) 5 m
Q-20	A ball is thrown up at a speed of 15 ms^{-1} . Find maximum height reached by ball is approximated to - (a) 120 m (b) 100 m (c) 110 m (d) 90 m
Q-21	A nut-bolt is thrown with a velocity 2 ms^{-1} ms from a stand of 1.5 m height at an angle of 45^0 . How far, from the building, it would reach on the ground- (a) 2 m (b) 1 m (c) $\sqrt{2}$ m (d) $\frac{1}{\sqrt{2}}$ m
Q-22	A man is walking on road at a uniform speed of 4 kmph while it is raining vertically at 3 kmph The speed of rain drops experienced by the man is – (a) 7 kmph (b) 1 kmph (c) 5 kmph (d) None of these
Q-23	Q. Graph shows velocity of a ball w.r.t. time. Then – (i) distance travelled by the particle during $0 \leq t \leq 4$ sec, (ii) change of acceleration of particle at point $t = 6$sec is - (a) (i) 30 m (ii) -15 ms^{-3} (b) (i) 30 m (ii) 15 ms^{-3} (c) (i) -30 m (ii) -15 ms^{-3} (d) (i) 15 m (ii) 30 ms^{-4} 
Q-24	A plane flying at an altitude of 125 m at a horizontal velocity of 150 kmph drops relief packet at mid-noon. The material will reach the ground at a distance w.r.t. shadow of plane on the ground at the time of drop - (a) 200 m (b) 220 m (c) 210 m (d) 230 m
Q-25	A car is moving with velocity a kmph along a straight road towards a huge wall at a distance D km and takes a sharp turn to the left on reaching the wall. An insect starts flying from wall towards the car, when it is at a Distance D from it, at a uniform velocity b kmph, such that $b > a$. After reaching the wind-pane of the car, it abruptly, without loosing time, turn back and starts flying towards the wall. Likewise, after reaching wall, it again abruptly turn back and continues to fly till it reaches the wall. Then (i) distance covered by insect is km, and(ii) number of trips made by the fly are – (a) (i) ∞ km (ii) 1000 (b) (i) $2D$ km (ii) 1000 (c) (i) D km (ii) 1000 (d) (i) $D\left(\frac{b}{a}\right)$ km (ii) ∞

Q-26	A particle is projected horizontally with a speed u from from the top of plane inclined at an angle θ with the horizontal. Distance along the plane where the particle will strike it is – (a) $\frac{2u^2}{g}$ (b) $\frac{2u^2}{g}\tan\theta$ (c) $\frac{2u^2}{g}\sin\theta$ (d) $\frac{2u^2}{g}\sec\theta$
Q-27	A bullet is fired horizontally at an object which starts making a free fall from the height of gun.. The bullet will – (a) Hit the object, irrespective of its horizontal velocity (b) Hit the object, irrespective of its distance from the gun (c) Hitting object is independent of its distance from the gun and velocity of the bullet (d) Hitting object dependents of its distance from the gun and velocity of the bullet
Q-28	Four particles A,B,C and D are placed at vertices of a square of side ABCD. A is tracking particle B with a uniform speed v, likewise particle B towards C, particle C towards D and D towards A with uniform speed v. All particles start at same instant $t = 0$ sec. They shall converge, after start, at a time – (a) $\sqrt{\frac{a}{v}}$ sec (b) $\frac{a}{2v}$ sec **(c)** $\mathbf{2}\frac{a}{v}$ sec (d) $\frac{a}{v}$ sec
Q-29	A is going due north at a speed of 50 kmph. It makes a 90^0 without change of speed. The change of speed at the instance is - (a) 50 kmph towards west (b) 70 kmph towards south-west (c) 70 kmph towards north-west (d) Zero
Q-30	Displacement of a particle is shown in the $x-t$ graph. Which of the following statement is true – (a) The particle is continuously moving along X-direction. (b) The particle is at rest (c) Velocity of the particle increases upto time t_1 and then becomes constant (d) The particle moves with constant velocity during $0 \le t \le t_1$ and then stops. 
Q-31	A particle has a velocity u towards east at $t = 0$ sec. Its acceleration is towards west and is constant. Let x_A and x_B be the magnitude of displacements in its first 10 secs and next 10 secs, then – (a) $x_A < x_B$ (b) $x_A = x_B$ (c) $x_A > x_B$ (d) Information is incomplete to relate x_A and x_B
Q-32	Q. A person is travelling on a straight line moves with a uniform velocity v_1 for some time and with uniform velocity v_2 for next equal time. The average velocity v is – (a) $\boldsymbol{v = \frac{v_1+v_2}{2}}$ (b) $v = \sqrt{v_1 v_2}$ (c) $\frac{2}{v} = \frac{1}{v_1} + \frac{1}{v_2}$ (d) $\frac{1}{v} = \frac{1}{v_1} + \frac{1}{v_2}$

Q-33	A person is travelling on a straight line moves with a uniform velocity v_1 for a distance x and with uniform velocity v_2 for next equal distance. The average velocity $\bar{v}$ is – (a) $\bar{v} = \frac{v_1+v_2}{2}$ (b) $\bar{v} = \sqrt{v_1 v_2}$ (c) $\frac{2}{\bar{v}} = \frac{1}{v_1} + \frac{1}{v_2}$ (d) $\frac{1}{\bar{v}} = \frac{1}{v_1} + \frac{1}{v_2}$
Q-34	A with stone is released from an elevator going up an acceleration a. The acceleration of stone after it is released is – (a) a upward (b) $(g-a)$ upward (c) $(g-a)$ downward (d) g downward
Q-35	A person standing near the edge of the top of a building throws two ball A and B. The ball A is thrown vertically upward and ball A is thrown vertically downward with same speed. The ball A hits the ground with a speed v_A , and ball A hits the ground with a speed v_B . Then – (a) $v_A > v_B$ (b) $v_A < v_B$ (c) $v_A = v_B$ (d) v_A and v_B would depend upon height of building, which is unknown
Q-36	In projectile motion velocity – (a) is always perpendicular to the acceleration (b) is never perpendicular to the acceleration (c) is perpendicular to the motion at one instant only (d) is perpendicular to the motion at two instants.
Q-37	Two bullets are fired simultaneously, horizontally and with different speeds from the same place. Which bullet would hit the ground first – (a) the faster one (b) the slower one (c) both simultaneously (d) bullet of heavier mass
Q-38	Range of a projectile fired at an angle 15^0 with the horizontal is 50 m. If keeping the speed to be same it is fired at an angle 45^0 the range would be – (a) 25 m (b) 37 m (c) 50 m (d) 100 m
Q-39	Two projectiles A and B are projected with an angle of projection 15^0 and 45^0, respectively. The range of projectiles will be – (a) $R_A < R_A$ (b) $R_A = R_B$ (c) $R_A > R_B$ (d) Information given is incomplete to decide relation between R_A and R_B
Q-40	A river is flowing from west to east at a speed of 5 metres per minute. A man on the south bank of the river, capable of swimming at 10 metres per minute in still water, wants to swim across the river in the shortest time. He should swim in direction - (a) Due north (b) 30^0 east of north (c) 30^0 north of west (d) 60^0 east of north

Q-41	In the arrangement shown in the figure, the ends P and Q of an inextensible string m0ve downwards with uniform speed u. Pulleys A and B are fixed. The mass M moves upwards with a speed –  (a) $2u\cos\theta$ (b) $\frac{u}{\cos\theta}$ (c) $\frac{2u}{\cos\theta}$ (d) $u\cos\theta$
Q-42	Consider motion of the tip of the minute hand of a clock in One hour – (a) The displacement is zero. (b) The distance covered is Zero (c) Average speed is Zero (d) Average velocity is Zero
Q-43	Motion of a particle moves along X-axis is expressed as $x = u(t-2s) + a(t-2s)^2$ - (a) Initial velocity of the particle is u (b) Acceleration of particle is a (c) Acceleration of the particle is $2a$ (d) At $t = 2$ sec particle is at origin
Q-44	Pick the correct statements (a) Average speed of a particle in a given time is never less than the magnitude of average velocity. (b) It is possible to have a situation in which $\left\lvert\frac{d\vec{v}}{dt}\right\rvert \neq 0$ but $\frac{d}{dt}\lvert\vec{v}\rvert = 0$ (c) The average velocity of a particle is zero in a time interval. It is possible that instantaneous velocity is never zero in the interval (d) The average velocity of a particle moving on a straight line is zero on a time interval. It is possible that instantaneous velocity is never zero in the interval (infinite accelerations are not allowed)
Q-45	An object may have – (a) Varying speed without having varying velocity (b) Varying velocity without having varying speed (c) Nonzero acceleration without having varying velocity (d) Nonzero acceleration without having varying speed
Q-46	Mark the correct statement for a particle moving on a straight line – (a) f the velocity and acceleration have opposite sign the object is slowing down (b) If the position and velocity have opposite sign, the particle is moving towards the origin (c) If velocity is zero at an instant, the acceleration should also be zero at that instant (d) If the velocity is zero for a time interval, the acceleration is zero at any instant within the time interval

Q-47 The velocity of a particle is zero at $t = 0$ -

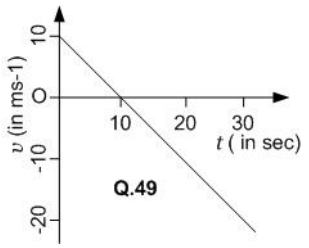
(a) Acceleration at time $t = 0$ must be zero
(b) Acceleration at time $t = 0$ may be zero
(c) If acceleration is zero from $t = 0$ to $t = 10$ sec, the speed is also zero in this interval
(d) If speed is zero from $t = 0$ to $t = 10$ sec, the acceleration also zero in this interval

Q-48 Mark the correct statements –

(a) Magnitude of velocity of a particle is equal to its speed
(b) Magnitude of average velocity in an interval is equal to its average speed in that interval
(c) It is possible to have a situation in which speed of a particle is always zero, but average speed is not zero.
(d) It is possible to have a situation in which speed of a particle is never zero, but average speed is zero.

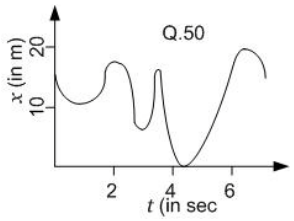
Q-49 Q. Velocity-time graph for a particle moving on a straight line is shown in figure. Mark correct statements -

a. The particle has a constant acceleration
b. The particle has never turned around
c. The particle has zero displacement
d. Average speed of the particle in interval 0 to 10 sec is same as average speed of particle in interval 10 to 20 sec.



Q-50 Position of a particle moving on X-axis is shown as a function of time in the figure.-

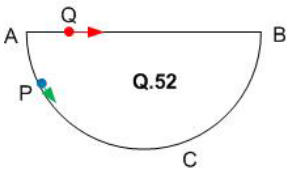
(a) The particle comes to rest 6 times
(b) Maximum speed is at $t = 6$ sec
(c) Velocity remains positive for $t = 0$ sec to $t = 6$ sec
(d) Average velocity for the total period shown in figure is negative



Q-51 Acceleration of a particle as seen from Two frames of reference S_1 and S_2 have equal magnitude 4 ms^{-2} -

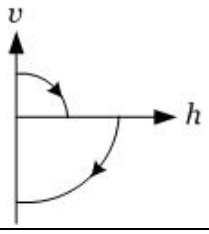
(a) The frames must be at rest with respect to each other
(b) The frames may be moving with respect to each other, but neither is accelerated with respect to each other
(c) The acceleration of S_2 with respect to S_1 may be either zero or 8 ms^{-2}
(d) The acceleration of S_2 with respect to S_1 may be anywhere between zero and 8 ms^{-2}

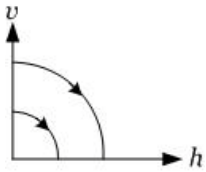
Q-52 A particle passes through a frictionless hemispherical bowl. It passes the point A at $t = 0$. At this instant of time the horizontal component of velocity is v. A bead Q of the same mass as P is ejected from A at $t = 0$ along the horizontal frictionless string AB with speed v. Let t_p and t_q be the time taken by P and Q to reach point B. Then –

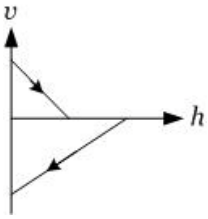


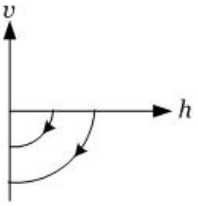
(a) $t_p < t_q$ (b) $t_p = t_q$ (c) $t_p > t_q$ (d) $\frac{t_p}{t_q} = \frac{\text{Length of arc ACB}}{\text{Length of chord AB}}$

Q-53 A ball is dropped vertically from height h above the ground. It hits the ground and bounces up vertically to a height $\frac{h}{2}$. Neglecting subsequent motion and air resistance, velocity v varies with height h above the ground as –

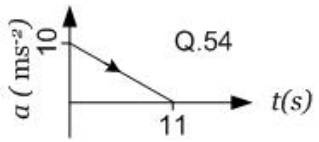
(a) 

(b) 

(c) 

(d) 

Q-54 A particle starts from rest. Its acceleration (a) vrs time (t) is shown in graph. The maximum speed of particle will be –

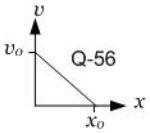


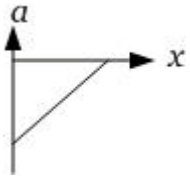
(a) 110 ms^{-1} (b) 55 ms^{-1} (c) 550 ms^{-1} (d) 660 ms^{-1}

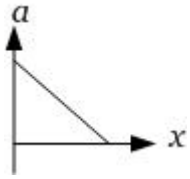
Q-55 A block slides down a frictionless plane starting from rest. Let s_n be the distance travelled in n^{th} sec . Then $\frac{s_n}{s_{n+1}}$ will be –

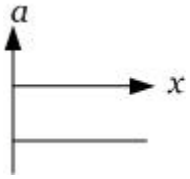
(a) $\frac{2n-1}{2n}$ (b) $\frac{2n+1}{2n-1}$ (c) $\frac{2n-1}{2n+1}$ (d) $\frac{2n}{2n+1}$

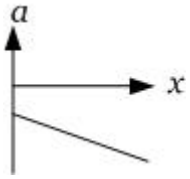
Q-56 The graph shows the variation of velocity with displacement, Which one of the options correctly represent variation of acceleration with displacement.



(a) 

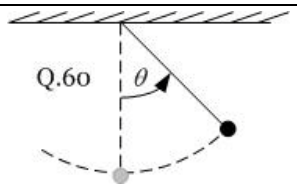
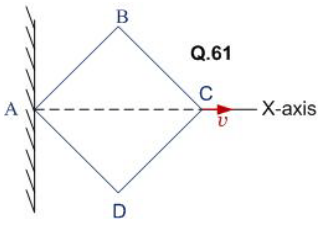
(b) 

(c) 

(d) 

Q-57 Moving magnitude of displacement of a particle moving in a circle of radius a with constant angular speed ω varies with time t as –

(a) $2a \sin \omega t$ (b) $2a \sin \frac{\omega t}{2}$ (c) $2a \cos \omega t$ (d) $2a \cos \frac{\omega t}{2}$

Q-58	A smooth square platform ABCD is moving towards right with uniform velocity v. At what angle θ must a a particle be projected from A with a speed u so that it strikes the point B - (a) $\sin^{-1}\left(\frac{u}{v}\right)$ (b) $\cos^{-1}\left(\frac{v}{u}\right)$ (c) $\cos^{-1}\left(\frac{u}{v}\right)$ (d) $\sin^{-1}\left(\frac{v}{u}\right)$
Q-59	Two stones are thrown up from edge of a cliff with initial speeds v and $2v$. The relative position of the second stone with respect to the first varies with time till both stones strike the ground as – (a) Linearly (b) First linearly and then parabolically (c) Para bolically (d) First parabolically and then linearly
Q-60	A pendulum of length 1 m is released from an angle 60^0 from its mean position. The rate of change of speed of the bob at $\theta = 30^0$ is $\left(g = 10\text{ms}^{-2}\right)$ - (a) $5\sqrt{3}\,\text{ms}^{-2}$ (b) $5\ \text{ms}^{-2}$ (c) $10\ \text{ms}^{-2}$ (d) $2.5\ \text{ms}^{-2}$ 
Q-61	Fours rods of equal length (l) have been hinged to form a rhombus. Vertex A is fixed to a rigid support, vertex C is being moved along X-axis with a constant velocity $v\ \text{ms}^{-1}$ as shown in the figure. The rate at which vertex B is approaching X-axis at a moment when rhombus is in shape of a square is – (a) $\frac{v}{4}$ (b) $\frac{v}{3}$ (c) $\frac{v}{2}$ (d) $\frac{v}{\sqrt{2}}$ 

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Growing with Concepts: English Grammar

Unit-2: Object (Direct)

S. Swarnalatha

Inbility to contribute in this column due unavoidable reasons is regretted

Author is a teacher at Ramakrishna Mission School at Vishakhapattanam. She has volunteered to contribute a column Growing With Concepts – English Grammar. Sushri **Sarswathi Tenneti Madam**, A vetron senior teacher and mentor in English Language has kindly consented to make value addition for enriching this column.

E-mail ID: Swarnalathasingampalli@gmail.com

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Phy/UDM/O/001

Answers: KINEMATICS – OBJECTIVE Questions

1	2	3	4	5	6	7	8	9	10
b	a	c	d	a	a	b,c & d	c	a & b	b
Lvl. I	Lvl. I	Lvl. I	Lvl. I	Lvl. I	Lvl. I	Lvl. II	Lvl. II	Lvl. II	Lvl. I
11	12	13	14	15	16	17	18	19	20
c	d	**	c	b	d	d	b	a	c
Lvl. II	Lvl. II	Lvl. II	Lvl. II	Lvl. II	Lvl. II	Lvl. II	Lvl. I	Lvl. I	Lvl. I
21	22	23	24	25	26	27	28	29	30
b	c	a	c	d	c	d	d	b	d
Lvl. I	Lvl.	Lvl. II	Lvl. I	Lvl. III	Lvl. II	Lvl. I	Lvl. I	Lvl. I	Lvl. I
31	32	33	34	35	36	37	38	39	40
d	a	c	d	c	c	c	d	d	a
Lvl. I	Lvl. I	Lvl. I	Lvl. I	Lvl. I	Lvl. I	Lvl. I	Lvl. I	Lvl. III	Lvl. I
41	42	43	44	45	46	47	48	49	50
b	a & d	c & d	a,b & c	b & d	a,b & d	b,c & d	a	a & d	a
Lvl. II	Lvl. I	Lvl. II	Lvl. I	Lvl. I	Lvl. I	Lvl. I	Lvl. I	Lvl. I	Lvl. III
51	52	53	54	55	56	57	58	59	60
b & d	a	a	b	c	a	b	b	b	b
Lvl. II	Lvl. II	Lvl. II	Lvl. II	Lvl. I	Lvl. I	Lvl. I	Lvl. II	Lvl. I	Lvl. III
61	** Note: Answer to Q-13: is here due to space limitation - Case (i) - Graph A & C; Case (ii) – Graph D; Case (iii) – Graph E; Case (iv) – Graph C								
c									
Lvl. I	Lvl. II								

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If no one heeds your call, then march on alone.....

- Ravindranath Tagore

Growing with Concepts: Chemistry

HYDROGEN BONDING

Kumud Bala

A hydrogen bond is a partially electrostatic attraction between a hydrogen (H) which is bound to a more electronegative atom such as nitrogen (N), oxygen (O), or fluorine (F), and another adjacent atom bearing a lone pair of electrons. For example, in hydrogen fluoride (HF), hydrogen atom forms a weak bond with fluorine atom of the neighboring molecule, while remaining bonded to its fluorine atom. This may be shown as H-F..... H-F ..... H-F ..... Hydrogen atom acts as a bridge between two atoms, holding one atom by a covalent bond and the other by a hydrogen bond. The hydrogen bond is represented by dotted line (.....) while the covalent bond is represented by solid line (–). As a result of hydrogen bonding, HF exists as a cluster of hydrogen fluoride molecules and is represented as $(HF)_n$. Thus, the attractive force which binds hydrogen atom of one molecule with electronegative atom (F,O or N) of another molecule is known as hydrogen bond or hydrogen bonding.

Cause of formation of hydrogen bonding:- When hydrogen is bonded to strongly electronegative element A (F,O or N), the electron pair shared between two atoms lies far away from the hydrogen atom. As a result, hydrogen atom becomes highly electropositive with respect to the other atom A. Since, the electrons are displaced towards A, it acquires partial negative charge (δ–) while hydrogen atom gets partial positive charge (δ+). The bond H–A becomes polar and may be represented as $H^{\delta+}–A^{\delta-}$. The electrostatic force of attraction between positively charged hydrogen atom of one molecule and negatively charged atom of neighboring molecule results in the formation of hydrogen bond.

$$.....H^{\delta+}–A^{\delta-}.....H^{\delta+}–A^{\delta-}.....H^{\delta+}–A^{\delta-}.....$$

Conditions for hydrogen bonding:- (i) The molecule must contain a highly electronegative atom linked to H-atoms. The higher the electro negativity more is the polarization of the molecule. (ii) The size of the electronegative atom should be small. The smaller the size, the greater is the electrostatic attraction. Thus only F, O or N atoms can form hydrogen bonds, as these atoms are small in size and have high electro negativities. For example, NH_3 shows hydrogen bonding while HCl does not, although both N and Cl have the same electro negativity (3.0). Hydrogen bonds are not formed by Cl– atom because of its bigger size than nitrogen.

Strength of hydrogen bond:- Hydrogen bond is much weaker than a covalent bond. The strength of hydrogen bond ranges from 10-40 $kJmol^{-1}$ while that of a normal covalent bond is of the order of 400$kJmol^{-1}$. It may also be noted that the bond length of a hydrogen bond is larger than that of a covalent bond. For example, in case of H-F molecule, the covalent bond between H and F is 109pm, while the bond length of hydrogen bond between F and H is 155pm. The dissociation energies of the H-bond depends upon the attraction of the shared pair of electrons and hence on the electro negativity of the atom. The bond energies in case of three elements are as follows:

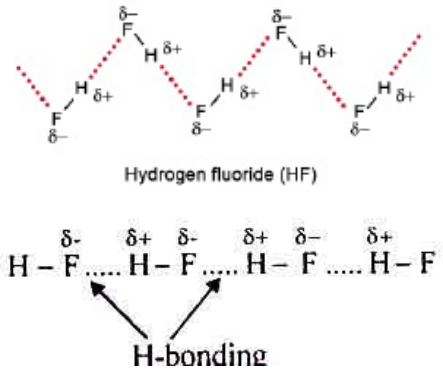
H.....F bond dissociation energy is = 41.8$kJmol^{-1}$, H.....O bond dissociation energy is = 29.3$kJmol^{-1}$, H....N bond dissociation energy is = 12.6$kJmol^{-1}$.

Types of hydrogen bonding: Hydrogen bonds can be classified into two types ; (i) Intermolecular hydrogen bonds (ii) Intramolecular hydrogen bonds.

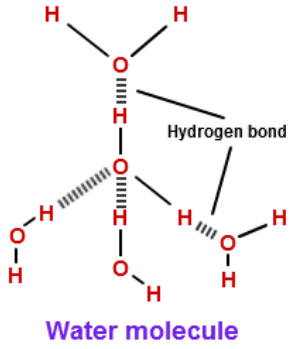
(i) Intermolecular hydrogen bond:- This bond is formed between two different molecules of the same or different substances. For example,

1. Hydrogen bond between molecules of hydrogen fluoride: In the solid state, HF

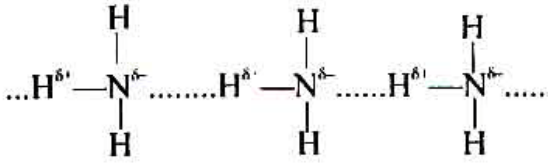
consists of long zig-zag chains of molecules associated together through hydrogen bonds. HF molecules are represented as $(HF)_n$. In the liquid or gaseous state, these become linear.



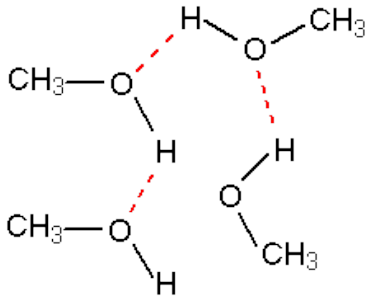
2. H_2O molecule: Water molecule contains highly electronegative oxygen atom linked to hydrogen atom. Thus, oxygen atom attracts the shared pair of electrons more and this end of the molecule becomes negative whereas the H-atom becomes positive. The negative end of the molecule attracts the positive end of the other. As a result, hydrogen bonding takes place. Each oxygen is tetrahedrally surrounded by four hydrogen atoms, two by covalent bonds and two by hydrogen bonds.

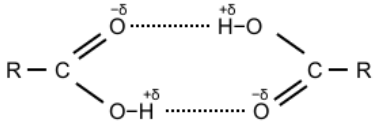


3. Ammonia:- Ammonia molecule has an electronegative nitrogen atom bonded to three hydrogen atoms. Due to difference in electro negativity between nitrogen and hydrogen, each hydrogen atom acquires positive charge. Thus, in the molecule, there is one negative site and three positive sites so that the molecules of ammonia associate through hydrogen bonding to form long chains.

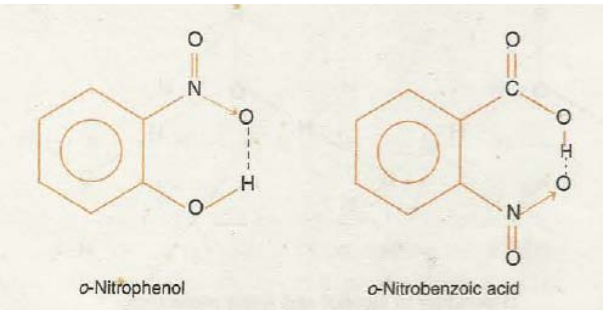


4. Alcohols (ROH)- These molecules contain the highly electronegative oxygen atom linked to H-atom and form associated molecules. In carboxylic acid, the H-bonding is limited to association of two molecules only.



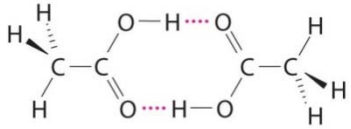


(ii) Intra molecular hydrogen bond: Intra molecular hydrogen bond is formed between the hydrogen atom and the highly electronegative atom (F, O or N) present in the same molecules. Intra molecular hydrogen bond results in the cyclization of the molecules and prevents their association. For example,



Effects or consequences of hydrogen bonding:- Hydrogen bond helps in explaining the abnormal physical properties in several cases. Some of the properties affected by H-bond are given below:

1) Dissociation:- In aqueous solution, hydrogen fluoride dissociates and gives the difluoride ion (HF_2^-) instead of fluoride ion (F^{-1}). This is due to H-bonding in HF. This explains the existence of KHF_2. On the other hand, the molecule of HCl, HBr and HI do not have H-bonding because Cl, Br and I are not so highly electronegative. This explains the non-existence of compounds like $KHCl_2$, $KHBr_2$ and KHI_2.
2) Association:- Due to intermolecular hydrogen bonding two or more molecules of a compound exist as associated molecules. For example, carboxylic acids (RCOOH) exist as dimers even in the vapour state because of the hydrogen bonding. The molecular masses of such compounds are found to be double than those calculated from their simple formulae. Molecular mass of acetic acid is found to be 120 and increase in size also.


Hydrogen bonding in acetic acid

3) Higher melting and boiling points:- The compounds having hydrogen bonding show abnormally high melting and boiling points. For example, H_2O, HF and NH_3 containing hydrogen bonds have higher melting and boiling points due to the fact that some extra energy is needed to break these bonds. A few examples are given below:

(a) The unusually high boiling point of HF in among the halogen acids is due to the existence of hydrogen bonding in HF.

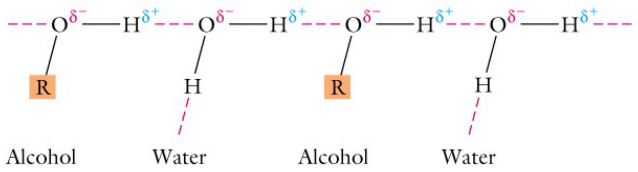
HALOGEN ACID	BOILING POINTS
HF	292.4K
HCl	189.4K
HBr	206.0K
HI	237.0K

(b) H_2O is a liquid whereas H_2S, H_2Se and H_2Te all are gases at ordinary temperature. The reason for this is that in case of water, hydrogen bonding causes association of the H_2O molecules with the result that the boiling point of water is more than that of the other compounds. There is no such hydrogen bonding in H_2S, H_2Se and H_2Te.

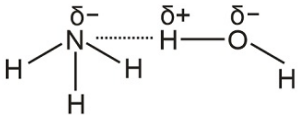
(c) NH_3 has higher boiling point than PH_3. This is again because there is hydrogen bonding in NH_3 but not PH_3 .

(d) Water boils at higher temperature than HF. It is probably due to the fact that water forms two H-bonds as compared to one in HF.

4) Solubility:- Hydrogen bonding also influence the solubility of one substance in another. For example, alcohol is highly soluble in water due to hydrogen bonding with water molecules.



Similarly, ammonia (NH_3) is soluble in water because of hydrogen bonding.

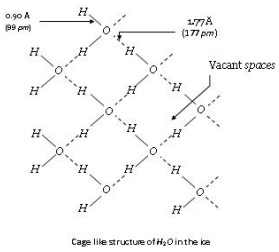


Intermolecular hydorgen bonding between water and ammonia molecules

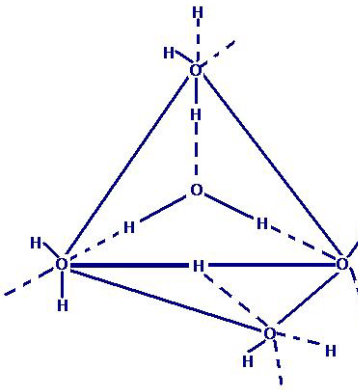
5) Volatility: The compounds involving hydrogen bonding between different molecules such as NH_3, H_2O and HF have higher boiling points. Therefore, they are less volatile as compared to the other corresponding members of their groups. For example, in group 17, the enthalpies of vaporizations decrease in the order HCl < HBr < HI < HF. Similarly in groups 15 and 16 the trends are: $H_2S < H_2Se < H_2Te < H_2O$ and $PH_3 < AsH_3 < SbH_3 < NH_3$.

6) Viscosity and surface tension:- The substances which contain hydrogen bonding exist as associated molecules. So their flow becomes comparatively difficult. In other words, they have higher viscosity and high surface tension.

7) Explanation of lower density of ice than water: In case of solid ice, the hydrogen bonding gives rise to a cage like structure of water molecules. As a matter of fact, each water molecule is linked tetrahedrally to four other water molecules as shown in figure.



Cage like structure of H_2O in the ice



Obviously, the molecules are not as closely packed as they are in the liquid state. But there are vacant spaces present in the crystal structure. This gives rise to an open cage like structure for ice having a larger volume for the given mass of water. Consequently, the density of ice is less than water. That is why ice floats on water. When ice melts this cage like structure collapses and the molecules come closer to each other. Thus, for the same mass, the volume of water decreases.

Note that each oxygen atom is linked to four H-atoms, two by covalent bonds and two by H-bonds. Each water molecule is linked to four water molecules tetrahedrally by H-bonds.

8) Explanation of maximum density of water at 4°(273K): At 273K, there is sufficient hydrogen bonding present in the water molecules (or ice).Thus, the open cage like structure exists which has larger volume and thus, makes the density low. On heating, the hydrogen bonds start collapsing and thus the molecules start coming close together resulting in the decrease of volume and hence increase of density. This goes on up to 277K. After 277K, the increase in volume due to expansion of liquid water becomes much more than the decrease in volume due to breaking of H-bonds. Thus, after 277K, there is net increase of volume on heating which means decrease in density. Hence, density of water is maximum 277K.

ASSIGNMENT

1. Hydrogen bond is strongest in
(a) S-H.....O (b) O-H.....S
(c) F-H.....F (d) F-H....O

2. The pair likely to form strongest hydrogen bonding is
(a) H_2O_2 and H_2O
(b) HCOOH and CH_3COOH
(c) CH_3COOH and CH_3COOCH_3
(d) SiH_4 and $SiCl_4$

3. Intra molecular hydrogen bond exists in:
(a) ortho nitrophenol (b) ethyl alcohol
(c) water (d) diethyl ether

4. Ammonia has higher boiling point than expected because:
(a) it forms NH_4OH with water
(b) its density decrease on freezing
(c) it has strong intermolecular covalent bonds
(d) it has strong intermolecular hydrogen bonds

5. Methanol and ethanol are miscible in water due to:
(a) covalent character
(b) Hydrogen bonding character
(c) ionic bonding character
(d) tendency to form coordinate bonds

6. Which of the following has maximum density?
(a) water at 25°C (b) ice at –4°C
(c) water at 4°C (d) ice at 0°C

7. When two ice cubes are pressed over each other, they unite to form one cube. Which of the forces are responsible to hold them together?
(a) Hydrogen bond formation
(b) Vander Waal's forces
(c) covalent bonds
(d) dipole interactions.

8. Among H_2O, H_2S, H_2Se and H_2Te, which one has the highest boiling point? :
(a) H_2O because of hydrogen bonding
(b) H_2Te because of higher molecular weight
(c) H_2S because of hydrogen bonding
(d) H_2Se because of lower molecular weight

9. The energy of hydrogen bond is of the order of
(a) 4kJ mol^{-1} (b) 40kJ mol^{-1}
(c) 400kJ mol^{-1} (d) 4000kJmol^{-1}
.

10. The maximum number of hydrogen bonds that a water molecule can form is:
(a) 1 (b) 2 (c) 3 (d) 4

11. Which one of the following molecules will form a linear polymeric structure due to hydrogen bonding:
(a) HCl (b) HF (c) H_2O (d)NH_3

ANSWERS: 1. (c) 2. (b) 3. (a) 4. (d) 5. (b) 6. (c) 7. (a) 8. (a) 9. (b) 10. (d) 11. (b)

Author is M.Sc. (Chem.), M.Ed. and Advanced Diploma in German Language (Gold Medallist). She retired as a Principal, Govt. School Haryana, has 3-1/2 years' experience in teaching Chemistry and distance teaching through lectures on Radio and Videos. She has volunteered to complement mentoring of students for Chemistry through Online Web-enabled Classes of this initiative.
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—00—

SCIENCE QUIZ-June'18

Kumud Bala

1. In India, on which among the following dates 'National Statistic Day' is celebrated?
(a) 29 June (b) 1 June (c) 28 June (d) 15 June

2. Who was the first Indian statistician to receive world recognition?
(a) Prasanta Chandra Mahalanobis
(b) C.R.Rao
(c) Jayanta Kumar Ghosh
(d) Kantilal Mardia

3. What is the theme of the 2017 National Statistics Day?
(a) Human empowerment
(b) Agriculture and farmer's welfare
(c) Administrative statistics
(d) Trees and their calculative lives

4. In which year, govt. of India had designated 29 June as the 'National Statistics Day' to celebrate the birth anniversary of Prof. P.C. Mahalanobis, a renowned and eminent statistician?
(a) In 2006 (b) In 2007 (c) In 2005 (d) In 2010

5. What is the main idea behind celebrating this day?

(a) To create awareness among people in socio-economic planning and policy formulation
(b) Anthropometry
(c) To link between statistics and genetics
(d) Statistical science

6. Who was the founder of Indian Statistics Institute?
(a) Prof. P.C. Mamalanobis
(b) Debabrata Basu
(c) C.R. Rao
(d) Jayanta Kumar Ghosh

7. When was Indian statistical Institute founded by Prof. P. C. Mahalanobis in Kolkata?
(a) 17 December, 1931
(b) 17 December, 1959
(c) 17 January, 1932
(d) 17 November, 1931

8. Who has proposed the establishment of an International Day of Yoga to promote international peace and cooperation?
(a) Narendra Modi (b) Amit Shah
(c) Pranav Mukherji (d) Baba Ramdeva

9. When was the first International Day of Yoga celebrated worldwide?
(a) 21 June, 2015 (b) 21 June, 2014
(c) 21 June, 2016 (d) 21 June 2013

10. How many participants have participated in India's capital, New Delhi to lead to a new Guinness Record for the largest yoga lesson?
(a) 40,000 (b) 36,000
(c) 37,000 (d) 20,000

11. Where was the resolution of celebrating International Yoga Day passed?
(a) World health organization
(b) UN, General Assembly
(c) India, Parliament
(d) None of the above

12. Who had introduced yoga first time to the western world in a religion conference Chicago, America?
(a) Swami Vivekananda
(b) Narendra Modi
(c) Maharishi Patanjali
(d) Baba Ramadeva

13. Celebration of International Yoga Day in India is done by which ministry?
(a) Ministry of Ayush
(b) Ministry of Civil Aviation
(c) Ministry of Communication
(d) Ministry of Human Resource and development.

14. What is the theme of International Yoga Day 2017?
(a) Connect the youth (b) Yoga for mind
(c) Yoga for health (d) Yoga for soul.

15. What do you understand by the term Doga?
(a) Doga is a not a form of yoga
(b) Doga is a kind of yoga by using dogs as props
(c) Doga is related with dogs
(d) All the above options are wrong.

16. In 2017, which city host PM Narendra Modi's International Yoga Day celebration?
(a) New Delhi (b) Chandigarh
(c) Lucknow, UP (d) Allahabad, UP

17. Which Veda mentions about the elements of yoga?
(a) Athar Veda (b) Rig Veda
(c) Sam Veda (d) Yajur Veda

18. Who is known as father of yoga?
(a) Patanjali (b) Shiva
(c) Brahma (d) Adiyogi

19. How many countries have supported the yoga day proposal?
(a) 50 (b) 100
(c) 150 (d) more than 170.

20. Why 21 June is chosen for celebrating International Yoga Day?
(a) 21 June is the day to pay homage to the Sadgurus.
(b) This is also Day of the Summer Solstice.
(c) From yoga's perspective, this time is the transition period, i.e., a better time for meditation.
(d) This date in the Northern Hemisphere is also the longest day of the year band it has special significance in many parts of the world
(e) All the given options are correct

(Answers to this Science Quiz May'18 shall be provided in 7th Quarterly e-Bulletin dt. 1st July'18)

—00—

Education is one of the great things of life. Education is an attempt to touch the evil at its source, and reform the wrong ways of living as well as one's outlook towards life.

- Plato

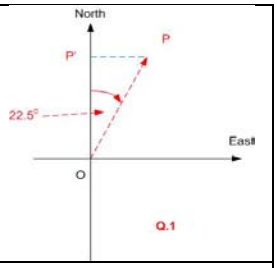
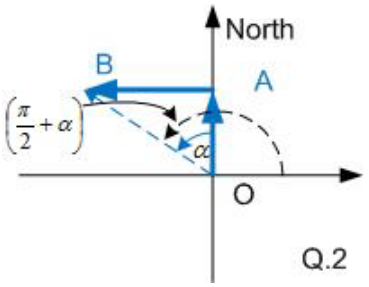
Tell me and I'll forget. Show me, and I may not remember. Involve me, and I will understand

- Native American Saying

Code: Phy/KINX/O/001

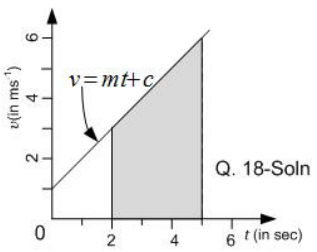
Illustration of Answers Objective Questions – Kinematics

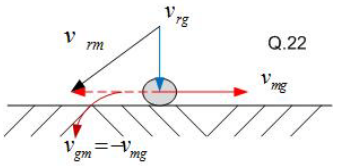
Note: ***Students are advised to refer to Question while consulting the illustration of answer mot matching to those listed. This shall avoid repetition of question.***

Q-1	Distance travelled due north is $OP' = OP\cos 30 = 200\frac{\sqrt{3}}{2} = 100\sqrt{3}$, **Answer is Option (b)** 
Q-2	Given that $OA = 30$km, $AB = 40$km. Therefore, Distance travelled is $OA + AB = (30 + 40)$ km $= 70$ km. But displacement is $OB = \sqrt{(OA)^2 + (AB)^2} = \sqrt{30^2 + 40^2} = 50$ km and Angle $\alpha = \tan^{-1}\left(\frac{AB}{OA}\right) = \tan^{-1}\left(\frac{40}{30}\right) = \tan^{-1}\left(\frac{4}{3}\right)$. Since angle is measured in anti-clockwise direction at an angle $= \left(\frac{\pi}{2} + = \tan^{-1}\left(\frac{4}{3}\right)\right)$. **Answer is Option (a).** 
Q-3	Total Displacement $\vec{d} = (3.5\hat{\imath} + 4\hat{\jmath}) + (-4.5\hat{\imath}) + (-4.5\hat{\jmath}) = (3.5 - 4.5)\hat{\imath} + (4 - 4.5)\hat{\jmath} = -1\hat{\imath} - 0.5\hat{\jmath}$. **Answer is Option (c).**
Q-4	From the given function $x = f(t)$ Position, velocity and acceleration is determined successively - (i) Position of particle at $t = 5$sec is obtained by substituting value of constants and t. Therefore, $x = 2\cdot 5 + 3\cdot 5^2 - 1\cdot 5^3 = 10 + 75 - 125 = -40$m. (ii) Velocity of the particle at $t = 5$sec is $v = \frac{d}{dt}(2\cdot t + 3\cdot t^2 - 1\cdot t^3)\Big\|_{t=5} = 2 + 6\cdot t - 3\cdot t^2|_{t=5}$ $\rightarrow 2 + 6\cdot 5 - 3\cdot 5^2 = 2 + 30 - 75 = -43\text{ms}^{-1}$ (iii) Acceleration $t = 5$sec is $a = \frac{d}{dt}v\Big\|_{t=5} = \frac{d}{dt}(2 + 6\cdot t - 3\cdot t^2)\Big\|_{t=5} = (6 - 6\cdot t)|_{t=5} = 6 - 6\cdot 5$ $= -24\text{ms}^{-2}$ **Answer is matching with answer in option (d)**
Q-5	Since, u is upward and g is downward, hence, we have equation $h = ut - \frac{1}{2}gt^2$. Further, both u is integer, while h is in given in accuracy of First decimal and hence $g = 10$, taken to be of lowest accuracy operand i.e. integer with Two SDs. Accordingly, $25 = 30\cdot t - \frac{1}{2}\cdot 10\cdot t^2$. This is a equation of form $5\cdot t^2 - 30\cdot t + 25 = 0 \rightarrow t^2 - 6\cdot t + 5 = 0 \rightarrow (t-1)(t-5) = 0$. Thus possible values of time are $= 1$ sec $t = 5$ sec. Since, time taken to reach maximum height according to equation $v = u - gt \rightarrow 0 = 30 - 10.t \rightarrow t = 3$ sec and accordingly it will taken another 3 sec to descend to ground, thus total time of flight is 6 sec. Therefore, time $(t)$for ball to be at height 25 m while descending shall be any where $3 < t < 6$, i.e. $t = 5$ sec. **Answer is Option (a)**
Q-6	(i) Position of particle at $t = 0$sec is obtained by substituting value of constants and $t = 0$ in the given expression. Therefore, $x|_{t=0} = 6 + 2\cdot 5 + 3\cdot 5^2 - 1\cdot 5^3 = 6 + 10 + 75 - 125 = -34$m. And $x|_{t=3} = 6 + 2\cdot 3 + 3\cdot 3^2 - 1\cdot 3^3 = 6 + 6 + 27 - 27 = 12$m Therefore, average velocity of the particle is $\bar{v} = \frac{\Delta x}{\Delta t} = \frac{x|_{t=3} - x|_{t=0}}{3-0} = \frac{12-(-34)}{3} = \frac{46}{3} = 15.\dot{3} =$ **15 ms^{-1}**

	(i) Velocity of particle at $t = 0$sec is $v\|_{t=0} = \frac{dx}{dt}\Big\|_{t-0} = (2 + 3\cdot 2t - 1\cdot 3t^2)\Big\|_{t=0} = 2\text{m.s}^{-1}$ and velocity of particle at $t = 3$sec is $v\|_{t=0} = (2 + 3\cdot 2t - 1\cdot 3t^2)\|_{t=3} = (2 + 6\cdot 3 - 3\cdot 9)\text{m.s}^{-1}$. It comes to $-7\,\text{m.s}^{-1}$. Therefore, average acceleration of the particle is $\bar{a} = \frac{\Delta v}{\Delta t} = \frac{v\|_{t=3} - v\|_{t=0}}{3-0} = \frac{-7-2}{3} = \frac{-9}{3} = -3\,\mathbf{ms^{-2}}$ **Answer is Option (a)**
Q-7	Each option shall have to be analyzed- (a) Is not possible since given that $v_z(t) = 0$ and hence, at least one component $a_z(t) = \frac{d}{dt}v_z(t) = 0$. **False** (b) Since, $a_z(t) = \frac{d}{dt}v_z(t) = 0$, but whether $a_x(t) = 0$ or $a_y(t) = 0$ would depend upon information of $v_x(t)$ and $v_y(t)$, which may or may not be Zero. Hence, may have more than one component of acceleration Zero. **True** (c) By definition and illustration at (a) above $a_z(t) = 0$. **True** (d) This is possible by illustration at (b) above. **True** **Hence Answer is (b), (c) and (d)** ***Note:*** *Language of the question needs to be checked to ensure expected answer is singular or plural, or any other nuance.*
Q-8	In such a problem each case has to be analyzed as under- (b) When $v_x > 0$, the object if at $x > 0$. would be moving away from O, and if at $x < 0$ then towards O. Same is true for $v_y > 0$. Thus direction of moving of object is dependent on its position which is nor defined and hence cannot be definitely stated. (b) When $v_x < 0$, the object if at $x > 0$. would be moving towards from O, and if at $x < 0$ then away O. Same is true for $v_y < 0$. Thus direction of moving of object is dependent on its position which is nor defined and hence cannot be definitely stated. (c) It leads to Four cases (i) If $x > 0$ and $v_x < 0$, then both $x\cdot v_x < 0$, the object would be moving towards O along X axis. The same is true for $x < 0$ and $v_x > 0$. (ii) If $y > 0$ and $v_y < 0$, then both $y\cdot v_y < 0$, the object would be moving towards O along Y axis. The same is true for $y < 0$ and $v_y > 0$. (iii) If both $x\cdot v_x < 0$ and $y\cdot v_y < 0$, then object is moving towards O along both X and Y axes (iv) If either of $x\cdot v_x > 0$ or $y\cdot v_y > 0$ then along object is moving along corresponding axis away from O, but definitely towards O on the other axis (d) It also leads to Four cases (i) If $x > 0$ and $v_x > 0$, or If $x < 0$ and $v_x < 0$, In either case $x\cdot v_x > 0$ and the object, along X axis, would be moving away from O (ii) If $y > 0$ and $v_y > 0$, then both $y\cdot v_y > 0$, the object, along Y axis, would be moving away from O. (iii) If both $x\cdot v_x > 0$ and $y\cdot v_y > 0$, then object is moving away from O along both X and Y axes (v) If either of $x\cdot v_x < 0$ but $y\cdot v_y > 0$ then is moving along O only along X-axis and if $x\cdot v_x > 0$ but $y\cdot v_y < 0$ the object would be moving along O only Y-axis. **The with certainty it is only case (c) when object would be moving towards O, i.e, Option (c).**
Q-9	Each option is being analyzed separately - (a) Since, $v_z(t) = \frac{d}{dt}r_z(t) \rightarrow \int v_z(t)dt = r_z(t) + C \rightarrow 0 = r_z(t) + C$ or $r_z(t) = C_z$ which may be zero if $C_z = 0$ or may not be zero if $C_z \neq 0$. Thus, it is per sure that at least one component $r_z(t)$ and may or may not be identically zero. Since, there is uncertainty in this answer, hence it is **True.** (b) Since, from (a) above, $r_z(t)$ may be identically zero only when $C_z = 0$. Likewise value of components $r_x(t) = 0$ and $r_y(t) = 0$ would depend upon information of $v_x(t)$ and $v_y(t)$, which

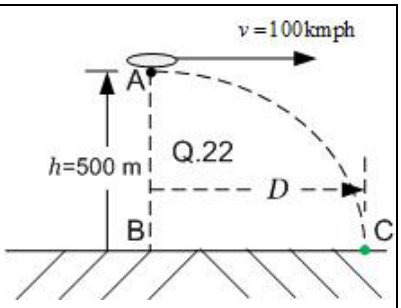
	may or may not be Zero. Hence, may have more than one component of acceleration Zero. **True** (c) By definition and illustration at (a) above uncertainty for $r_z(t)$ to be zero depends upon value of C_z and hence it is **False** *(d)* This is not possible by illustration of uncertainty at (c) above. **False** **Answer is Option (a) and (b)**
Q-10	Average speed $\bar{s} = \frac{\text{Total Distance}}{\text{Total Time}} = \frac{30+30}{3+3} = \mathbf{10\ ms^{-1}}$, since distance is scalar it is +ve and added. Average velocity $\bar{v} = \frac{\bar{y}_f - \bar{y}_i}{t_f - t_i} = \frac{0-0}{6-0} = \mathbf{0\ ms^{-1}}$. Since ball starts from ground and returns to ground hence $\bar{y}_f = \bar{y}_i = 0$, while $t_i = 0$ sec and $t_f = 3+3 = 6$ sec. **Thus answer is Option(b)**
Q-11	In this problem taking each option and verify which of them do not satify given condition (a) $\frac{dx}{dt} < 0$, if point is at $x > 0$, then it is moving towards O, but as soon as it crosses O it will start moving away from O, Hence this is not valid (b) $\frac{dx}{dt} > 0$, if point is at $x < 0$, then it is moving towards O, but as soon as it crosses O it will start moving away from O, Hence this is not valid (c) $\frac{dx^2}{dt} < 0$, in this case irrespective of $0 < x < 0, x^2 > 0$ and $\frac{dx^2}{dt} = 2x \cdot \frac{dx}{dt}$. It leads to Two cases – a. If $x > 0$ and point is moving towards O as given, then $\frac{dx}{dt} < 0$ and hence $x \cdot \frac{dx}{dt} < 0$ b. If $x < 0$ and point is moving towards O as given, then $\frac{dx}{dt} > 0$ and hence $x \cdot \frac{dx}{dt} < 0$ **Thus in either situation i.e. at $0 < x < 0$ the particle is moving towards O.** (d) $\frac{dx^2}{dt} > 0$, in this case irrespective of $0 < x < 0, x^2 > 0$ and $\frac{dx^2}{dt} = 2x \cdot \frac{dx}{dt}$. It leads to Two cases – a. If $x > 0$ and point is moving towards O as given, then $\frac{dx}{dt} < 0$ and hence $x \cdot \frac{dx}{dt} < 0$ b. If $x < 0$ and point is moving towards O as given, then $\frac{dx}{dt} > 0$ and hence $x \cdot \frac{dx}{dt} < 0$ Since, in either situation i.e. at $0 < x < 0$ when the particle is moving towards O, $\frac{dx^2}{dt} = 2x\frac{dx}{dt} \not> 0$. Hence this case is not valid. **Answer is Option (c).**
Q-12	Problem states only $x(t) > 0$ and nothing more and hence we have to consider $x = kt^n$ with various possibilities as under - a. $n = 0$, then $\frac{dx}{dt} = 0$, this is not valid since given that $\frac{dx}{dt} > 0$ and x>0 b. $1 > n > 0$, then $\frac{dx}{dt} = nkt^{n-1}$, and $\frac{x}{t} = \frac{kt^n}{t} = kt^{n-1}$s, it leads to $\frac{dx}{dt} < \frac{x}{t}$. c. $n = 1$ then $\frac{dx}{dt} = k$, and $\frac{x}{t} = \frac{kt}{t} = k$, it leads to $\frac{dx}{dt} = \frac{x}{t}$. d. $n > 1$ then $\frac{dx}{dt} = nkt^{n-1}$, and $\frac{x}{t} = \frac{kt^n}{t} = kt^{n-1}$, it leads to $\frac{dx}{dt} > \frac{x}{t}$. **Thus possible cases satisfying given conditions are $\frac{dx}{dt} (> \text{OR} = \text{OR} <) \frac{x}{t}$, i.e. Option (d)**
Q-13	In each case eventually it is leads to variation of x w.r.t. t. and accordingly abscissa is identified with t and ordinate is identified with x. Thus, each case is being analyzed separately as under - Case (i): Constant speed $s = \frac{dx}{dt}$, since object is moving x cannot be constant with varying time in $x-t$ graph. Since, no other information is given about the path of moving particle, it shall be constant velocity along (+)ve X-axis **[Graph A]**, (-)ve X-axis **[Graph C]**. Thus graph A and C match with this case. Case (ii): Given that $a = \frac{d^2x}{dt^2} = 3t \rightarrow \frac{dx}{dt} = \frac{3}{2}t^2 + C_1 \rightarrow x = \frac{3}{6}t^3 + C_1 t + C_2$. This is cubic equation and for all (+)ve values of t displacement will continue to rise till infinity. Thus best representative **graph is D.**

	Case (iii): This case is similar to displacement particle thrown vertically upward, with acceleration due to gravitation (g) acting in (-)ve direction with respect to initial velocity represented by equation $x = ut - \frac{1}{2}gt^2$. It will lead to a parabolic curve and is best represented by **graph E**. Case (iv): Given graph E represents $x - t$ curve, then for $v - t$ curve $\frac{d}{dt}x = \frac{d}{dt}\left(ut - \frac{1}{2}gt^2\right)$. It leads to $v = u - gt$, this is equation of a line with point of inflection at $t = \frac{u}{g}$. The **graph C**, best represents this case. **In Answer Matching of graph is consolidated.**
Q-14	Acceleration $a = \frac{dv_x}{dt} = C \neq 0$, given that C is constant. Since object is moving in x direction for $t > 0$. It leads to two cases – Case 1: If $C > 0$, then $v_x(t) > 0|_{t>0}$ hence $\boldsymbol{v_x \cdot \frac{dv_x}{dt} > 0}$ **i.e. +ve**. Case 2: If $C < 0$, then $v_x(t) = 0 + C \cdot t = C \cdot t < 0|_{t>0}$. Since, object is moving in x direction hence necessarily $v_x(t) > 0$, therefore $\frac{dv_x}{dt} \not< 0$ or C$\not<$ 0. Thus this case is not valid with giver criteria. **Answer is Option (c).**
Q-15	This is a case of free fall under gravity. In this case total distance traversed during fall in $t = n$ sec is $s_n = 0 \cdot n + \frac{1}{2}g \cdot n^2 = \frac{g}{2} \cdot n^2$, and total distance traversed during fall in $(n+1)$ sec is $s_{n+1} = 0 \cdot n + \frac{1}{2}g \cdot (n+1)^2 = \frac{g}{2} \cdot (n+1)^2$. Thus, distance traversed in last $(n+1)^{th}$ sec is $\Delta s_{n+1} = s_{n+1} - s_n = \frac{g}{2}((n+1)^2 - n^2) = \frac{g}{2}(2n+1)$. Thus for $n = 1, \Delta s_{n+1} = \frac{g}{2} \cdot 3$ and $s_n = \frac{g}{2} \cdot 1$, thus $\Delta s_{n+1} > s_n$. For $n = 2, \Delta s_{n+1} = \frac{g}{2} \cdot 5$ and $s_n = \frac{g}{2} \cdot 4$, thus $\Delta s_{n+1} > s_n$. For r $n = 3, \Delta s_{n+1} = \frac{g}{2} \cdot 7$ and $s_n = \frac{g}{2} \cdot 9$, thus $\Delta s_{n+1} < s_n$. Thus point of inflection of the relationship occurs between 2 sec and 3 sec. **Hence, answer shall be Option (b)**
Q-16	Given the sign convention that (+)ve is upward and hence, all the variable pointing upward shall be (+)ve $(x, v$ and $a) > 0$. Likewise, variables pointing downward shall be (-)ve $(x, v$ and $a) < 0$. In the instant problem magnitude of a_y is in question w.r.t. sign convention which is (-)ve irrespective of direction of travel be it upward or downward. Thus On the way up $a_y < 0$, On the way down $a_y < 0$. **Answer is option (d)**
Q-17	This is a case of absolute acceleration and this is due gravity. Since, the ball is projected upward, i.e. in (=)ve direction, the acceleration due to gravity shall be downward i.e. $(-)9.8ms^{-2}$. **Hence, answer is Option (d)**
Q-18	Motion of a particle in straight line can be expressed on $v - t$ graph as $v = mt + c$. In this case $c = 1$. The intercept on v-axis. Slope of line $m = \frac{v_5 - v_2}{5-2} = \frac{6-3}{5-2} = \frac{3}{3} = 1$. Distance (s) traversed by the particle is $= \int_2^5 v dt = \int_2^5 (t+1)dt = \left[\frac{t^2}{2} + t\right]_2^5 = \left[\left(\frac{5^2}{2} + 5\right) - \left(\frac{2^2}{2} + 2\right)\right] = \left[\left(\frac{5^2}{2} + 5\right) - \left(\frac{2^2}{2} + 2\right)\right]$., and is shown in gray colour in the graph. This resolves into $s = \left[\frac{1}{2}(25-4) + 3\right] = [10.5 + 3] = 13.5 \approx 14$ m. Here, principle of rounding of digits is applied while reporting final result. **Hence, answer is Option (b).** 
Q-19	Equation of motion gives $v|_t = u + at$, therefore, $v|_3 = 5 + 0.75 \times 3 = 7.25$ and at a later time $v|_5 = 5 + 0.75 \times 5 = 8.75$. Therefore, distance travelled can be found by formula $v^2 = u^2 + 2as \rightarrow s = \frac{v^2 - u^2}{2a} = \frac{(8.75)^2 - (7.25)^2}{2 \times 0.75} = \frac{(8.75 - 7.25)(8.75 + 7.25)}{1.5} = \frac{1.5 \times 16}{1.5} = 16$ m. **Hence, answer is Option (a).**

Q-20	Given that $u = 15\ \text{ms}^{-1}$, and at maximum height final velocity is $v = 0\ \text{ms}^{-1}$. Therefore, $h = \frac{v^2 - u^2}{2(-g)} = \frac{0-15^2}{2(-10)}$. Since, given data is for Two SDs, and hence $g = 10\ ms^{-2}$, i.e. with Two SDs. Accordingly, $h = \frac{225}{20} = 112.5 \approx 110$ m. **Hence, answer is Option (c).**
Q-21	Initial velocity of nut-bolt in vertical direction is $u_v = 2\sin 45^0 = \sqrt{2}$, and in horizontal direction is $u_h = 2\cos 45^0 = \frac{2}{\sqrt{2}} = \sqrt{2}$. The object is experiencing an acceleration $g = -10\ \text{ms}^{-2}$. This value of g is taken based on SDs of the given data with a (-)ve sign. The object reaches ground at a height -10m, the $(-)$ve sign is assigned to depth below the point of projection. Therefore, to determine distance of fall from stand there are several ways. Here it is decided to determine vertical velocity of the nut-bolt when it touches ground, and it would be ${v_v}^2 = {u_v}^2 + 2(-g)(-h) = 2 + 2 \times 10 \times 1.5 = 32 \rightarrow v_v = \pm 4\sqrt{2}$ m. Since, while touching ground vertical velocity is downward and hence it will be $v_v = -4\sqrt{2}$. Thus time taken by the object to touch ground will be $v_v = u_v + (-g)t \rightarrow -4\sqrt{2} = \sqrt{2} - 10 \times t$. It leads to $-5\sqrt{2} = -10 \times t \rightarrow t = \frac{5\sqrt{2}}{10} = \frac{1}{\sqrt{2}}$ sec. Since, travel of object in horizontal is free of acceleration i.e. $a_h = 0\ \text{ms}^{-2}$, therefore, total horizontal distance travelled is $s = u_h \times t = \sqrt{2} \times \frac{1}{\sqrt{2}} = 1$m. Hence answer is **option (b).** ***Note:*** *It is not essential to spend time in remembering formulae for various cases. Any problem can be solved by starting with basic equations. Normally such problems involve quantities causing minimum calculations. With practice, all associated problems become intuitive and it becomes possible to handle any twist in problem.*
Q-22	In this velocities of man and rain drops are given with respect to ground. And speed of rain drops w.r.t. man is to be determined, i.e. its magnitude. Therefore, $\vec{v}_{rm} = \vec{v}_{rg} + \vec{v}_{gm} = \vec{v}_{rg} - \vec{v}_{mg}$. Thus $v_{rm} = \lvert v_{rm} \rvert = \sqrt{{v_{rm}}^2 + {v_{mg}}^2 + 2v_{rm} \cdot v_{mg} \cdot \cos\theta}$, here $\theta = 90^0$ i.e. angle between direction of rain drop w.r.t ground and direction of man w.r.t. ground. This leads to $v_{rm} = \sqrt{{v_{rm}}^2 + {v_{mg}}^2} = \sqrt{4^2 + 3^2} = \sqrt{25} = 5$. Since $\sqrt{25}$ is a surd, therefore, its value is (+)ve. **Answer is Option (c).** 
Q-23	Slope of $v - t$ graph, which are line segments in zones $0 \le t \le 2$, $4 \le t \le 6$, is $m = \frac{15}{2}\text{ms}^{-2}$ and in zones $2 \le t \le 4$, $6 \le t \le 8$, is $m = -\frac{15}{2}\text{ms}^{-2}$. This slope $m = \frac{dv}{dt}$, and is nothing but acceleration of the ball along the cutve. Therefore, equation of line segments shall be $v - v_1 = m(t - t_1) \rightarrow v = m(t - t_1) + v_1$ with corresponding values if the variables. Distance covered by ball during $0 \le t \le 4$ is $s = \int_0^4 v dt = \int_0^2 v dt + \int_2^4 v dt$. This is equal to area under of $v - t$ graph i.e. of triangle $0 \le t \le 4$ sec $= \frac{1}{2} \times 4 \times 15 =$ 30m. And change of acceleration at $t = 6$ sec is $= a_{6+} - a_{6-} = m_{6+} - m_{6-} = \left(-\frac{15}{2}\right) - \frac{15}{2} = -15\ \text{ms}^{-2}$. **Answer is Option (a)** ***Note:*** *Here integration can be avoided by replacing it with area of corresponding triangles represented by the graph. While applying mathematics in physics, using appropriate mathematical formulation helps to gain speed, which is crucial in examinations.*

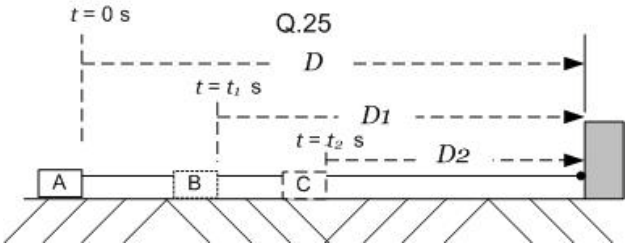
Q-24

Velocity of plane in SI is $v = \frac{150\times1000}{60\times60} = 41.7\,\text{ms}^{-1}$. Shadow of plane on the ground is at B, vertically below the plane. Time taken by packet to reach ground $h = u\cdot t + \frac{1}{2}gt^2 = \frac{g}{2}t^2$, since at the time of drop vertical velocity of packet is Zero, while acceleration die to gravity $g = 5\text{ms}^{-2}$ velocity. In this case both h and g vertically downward are taken to be (+)ve. Therefore, $t = \sqrt{\frac{2h}{g}} = \sqrt{\frac{2\times125}{10}} = 5$ sec, Therefore, distance of fall of packet shall be $D = vt = 41.7\times5$ m. It works out to $D = 208.5$ m = 210 m. This is in conformance with the principles of SDs. **Answer is Option (c)**



Q-25

Part (i) –Velocity of car w.r.t. ground is a kmph. And velocity of insect while flying from wall towards car is $(-b)$ kmph, and while flying from car towards wall is b kmph. Since insect continues to fly, without stop at b kmph, till car take a sharp turn at the wall. Hence, time of fly of insect (T) is equal to time taken by car to cover a distance to reach the wall. Thus, $T = \frac{D}{a}$ hrs, and distance covered by fly is $= b\times\frac{D}{a}$ km $= \boldsymbol{D\left(\frac{b}{a}\right)}$**km**.

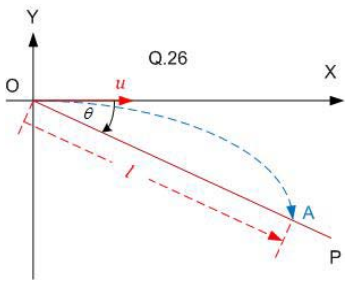


Part (ii) – When both are flying towards each other in opposite direction, and they meet after time t' then $a\times t_1 + b\times t_1 = D \rightarrow t_1 = \frac{D}{a+b}$ hrs and car reaches position B at a distance from the wall $D_1 = D - a\times t_1 \rightarrow D - a\left(\frac{D}{a+b}\right) = \frac{bD}{a+b}$. Then, insect starts flying back towards wall with a speed b kmph and takes time $t_2 = \left(\frac{bD}{a+b}\right)\times\frac{1}{b} = \left(\frac{D}{a+b}\right)$ hrs, and car reaches at position C having travelled another distance $a\times t_2$ km. Thus car at position C is away from the wall $D_2 = D_1 - a\times\left(\frac{D}{a+b}\right) = \frac{bD}{a+b} - \frac{aD}{a+b} = \left(\frac{b-a}{b+a}\right)D$.

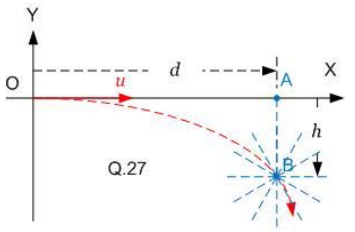
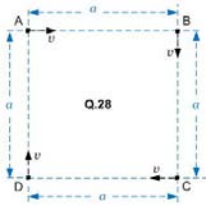
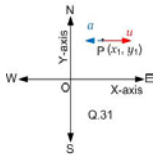
It is seen that at start of first trip distance between car and wall is D km, at start of 2nd trip it is $\left(\frac{b-a}{b+a}\right)D$ and it keep on reducing by a factor $\left(\frac{b-a}{b+a}\right)$ in every successive trip till it reduces to ZERO. It becomes a convergent geometric series Dr^n such that $Dr^n \rightarrow 0|_{r<1 \text{ and } n\rightarrow\infty}$. In this case $b > a$ both are of (+)ve magnitude and hence $r = \frac{b-a}{b+a} < 1$. Thus the only necessary condition for distance between car and insect reducing to ZERO is $n \rightarrow \infty$, i.e. **it will take infinite trips. Thus answer is Option (d)**

Q-26

Slope of line $m = \tan(-\theta) - \tan\theta$. Hence equation of line OP is $y = -\tan\theta\cdot x$. Travel of particle along X-axis shall be $x = ut$, since there is no acceleration along it. But travel of particle along Y-axis shall be $y = 0\cdot + \frac{1}{2}(-g)\cdot t^2$. Therefore, trajectory of particle in X-Y plane can be defined by eliminating t in equations of x and y as $y = -\frac{g}{2}\cdot\left(\frac{x}{u}\right)^2$. Thus coordinates of A can be determined by point of intersection of the trajectory and the line, using their equations respectively. Thus, $y = -\tan\theta\cdot x = -\frac{g}{2}\cdot\left(\frac{x}{u}\right)^2 \rightarrow x = \frac{2\tan\theta u^2}{g}$. Therefore, corresponding value of $y = -\tan\theta\left(\frac{2\tan\theta u^2}{g}\right) = -\frac{2\tan^2\theta}{g}\cdot u^2$. Thus length of span over inclined plane $l = \sqrt{(x-0)^2 + (y-0)^2} = \sqrt{\left(\frac{2u^2\tan\theta}{g}\right)^2 + \left(-\frac{2\tan^2\theta}{g}\cdot u^2\right)^2} = \frac{2u^2\tan\theta}{g}\sqrt{1+\tan^2\theta} = \frac{2u^2\tan\theta}{g}\sec\theta$. It resolves into, $l = \frac{2u^2}{g}\tan\theta\cdot\sec\theta = \frac{2u^2}{g}\sin\theta$. Answer is **Option (c).**

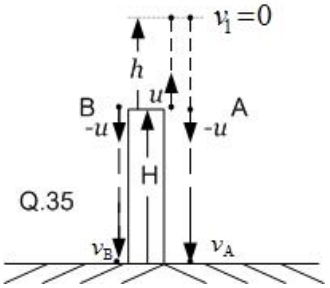


Note: Solution of problem becomes simple using Coordinate Geometry, i.e. equation of line, curve and point of intersection,

Q-27	Let object start a free fall at the instance bullet is fired at it horizontally. Since initial horizontal velocity of bullet and object $u = 0$ ms^{-1}, both are experiencing an acceleration due to gravity. Let in time t the bullet hits the object, during which free fall of the object is $h = 0 \cdot t + \frac{1}{2} g \cdot t^2 \rightarrow t = \sqrt{\frac{2h}{g}}$. The Bullet will also descend through same height h . For the bullet to be able to hit the object, necessary condition is $= \frac{d}{u}$, since the bullet is not experiencing any acceleration in horizontal direction. Thus equating $t = \frac{d}{u} = \sqrt{\frac{2h}{g}} \rightarrow d = u \cdot \sqrt{\frac{2h}{g}}$, a necessary condition for the ball to hit the bullet. **Answer is Option (d)** 
Q-28	This is a problem of type pursuit where particle A is pursuing B and the sequence continues till the converge. Speed of approach of particles A and B separated at a distance a is sum of components of speed of respective particles along the line of separation at any instant. Initially it is $v_a = \lvert(v + v\cos 90^0)\rvert = v$. Accordingly, time of convergence $t = \frac{a}{v}$ sec. **Answer is Option (d)** 
Q-29	Speed of car before change of speed at the instance t is $v_{t^-} = 50\hat{j}$ and speed after turn is $v_{t^+} = -50\hat{\imath}$. Therefore, net change of speed at the instance is $\Delta v = v_{t^+} - (v_{t^-}) = -50\hat{\imath} - 50\hat{\jmath} = 50 \times \sqrt{2}\angle 225^0$. It calculates to 70 kmph and graphically in direction south-west. **Answer is Option (b)**
Q-30	Rate of change of distance from initial position during $0 \le t \le t_1$ is $\frac{dx}{dt} = \frac{\Delta x}{\Delta t} = \frac{a}{t_1}$ is constant as graph is a straight line. And during $t > t_1$ the graph is parallel to t-axis and the equation of graph for that portion is $x = a$, i.e. the particle stops. Hence, **Answer is Option (d)**
Q-31	Let position of the particle at time $t_0 = 0$ sec be A (x_A, y_A) . Initial velocity u is parallel to X-axis, and acceleration (let it be $-a$) acting parallel to X-axis, but it is retarding i.e, in opposite direction indicated by (-)ve sign. Therefore, it is only X-coordinates of point would change with time. Since, acceleration is acting against velocity, therefore, for any position of particle B at $t > 0$ the X-coordinates $x_B < x_A$.  What is asked is to compare magnitude displacement in first 10 Sec $(x_A)$and next 10 sec (x_B). Here, value of X-coordinate at first 10th sec i.e. $t_1 = t_0 + \Delta t = 0 + 10 = 10$ secs (x_2) is $x_2 = x_1 - (ut_1 - at_1{}^2) = x_1 = 0 - 10u + 100a = 100a - 10u$. And value of X-coordinate in next $\Delta t = 10$ secs i.e. $(t_2 = t_1 + \Delta t = 10 + 10 = 20)$ (x_2) is $x_2 = x_0 - (ut_2 - at_2{}^2)$. This resolves to $x_3 = 0 - 20u + 400a = 400a - 20u$. Thus, magnitude of displacement in $\lvert x_A\rvert = \lvert x_2 - x_1\rvert = \lvert 100a - 10u - x_1\rvert$ and $\lvert x_B\rvert = \lvert x_3 - x_1\rvert = \lvert 400a - 20u - x_1\rvert$ Thus magnitude of displacement, with respect to x_1 (the reference point) would depend upon value of u and a, which are not known, and it would not be possible to compare $\lvert x_A\rvert$ and $\lvert x_B\rvert$. It implies information is incomplete to answer question. **Answer is Option (d)**
Q-32	Let the time of two travels be t and hence distance travelled at velocity v_1 will be $x_1 = v_1 t$, and distance travelled at velocity v_2 will be $x_2 = v_2 t$. Accordingly, average velocity $\bar{v} = \frac{\Delta x}{\Delta t} = \frac{x_1 + x_2}{t + t} = \frac{v_1 t + v_2 t}{2t} = \frac{v_1 + v_2}{2}$. **Hence, answer is Option (a).**
Q-33	Let the distance of two travels be x and hence time of travel with velocity v_1 will be $t_1 = \frac{x}{v_1}$, and another time of travel with at velocity v_2 will be $t_2 = \frac{x}{v_2}$. Accordingly, average velocity $\bar{v} = \frac{\Delta x}{\Delta t} = \frac{x + x}{t_1 + t_2} = \frac{2}{\frac{1}{v_1} + \frac{1}{v_2}}$. This can be transformed into $\frac{2}{\bar{v}} = \frac{1}{v_1} + \frac{1}{v_2}$. **Hence, answer is Option (c).**

Q-34 The moment stone is released from elevator, it velocity (v) is same as that of the escalator at the time of release. But, after that it makes a free fall with initial velocity (v), but the only acceleration acting on it that due to gravity i.e. g downward. **Hence answer is Option (d)**

Q-35 The ball A and B are thrown with velocity $(+)u$ m/sec and $(-)u$ m/sec, upward and downward, respectively. All upward and downward directions are (+ve) and (-)ve respectively. The ball A rises to height $h = \frac{u^2}{2g}$, and when it descends to the pint of throw, same as that of ball B, it acquires velocity $(-)u$ m/sec. Now the velocity of both the balls at height $-h$ from the initial point, when it reaches the ground, would be $v^2 = u^2 + 2(-g)(-H) = u^2 + 2gH$. Therefore velocity of ball at ground would be, $u = \sqrt{v^2 + 2gH}$. Since, velocity of ball$(= -u)$, depth of travel $(= -H)$ and acceleration $(= -g)$ are all in same direction for both balls and hence $\boldsymbol{v_A = v_B}$. **Answer is Option(c).**



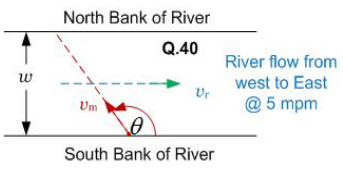
Q-36 In projectile motion velocity $\vec{v} = v_x\hat{\imath} + v_y\hat{\jmath}$ is always tangential to its trajectory. Therefore, direction of velocity of projectile, an angle (α) with horizontal, is such that $\tan\alpha = \frac{v_y}{v_x}$. Therefore, acceleration (g) to be perpendicular to $\vec{v}$, necessary condition is $\tan\alpha = \frac{v_y}{v_x} = 0 \rightarrow v_y = 0$.
And acceleration is due to gravity $(\vec{a} = -g\hat{\jmath})$ which is always directed vertically downward towards. At highest point in the trajectory of the projectile $v_y = 0$, while, $v_x = V\cos\theta$ remains constant. At all other point on the trajectory $v_x \neq 0$. Thus, it is only the highest point of the projectile where its velocity $\vec{v} = v_x\hat{\imath}$ while the acceleration $\vec{a} = -g\hat{\jmath}$ where $\vec{v}$ and $\vec{a}$ are mutually perpendicular.
Hence answer is Option (c).

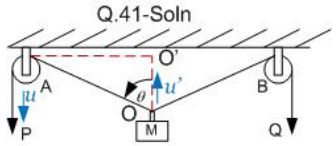
Q-37 Since both the bullets are fired horizontally, simultaneously and from same place, their initial vertical velocities are ZERO, and they have to traverse same height to hit the ground. Therefore, the time would be from $h = 0\cdot t + \frac{1}{2}gt^2 \rightarrow t = \sqrt{\frac{2h}{g}}$, would be same. **Hence, answer is Option (c).**

Q-38 Let u is the velocity of the projectile fired at an angle $\theta = 15^0$, has a range 50 m. Then vertical velocity is $u_y = u\sin\theta$. Therefore, time of flight would be $-u\sin\theta = u\sin\theta - gt \rightarrow t = \frac{2u\sin\theta}{g}$. Accordingly, range of projectile would be $R = u_x\cdot t = u\cos\theta\cdot\frac{2u\theta}{g} = \frac{u^2\sin 2\theta}{g} = \left|\frac{u^2}{g}\cdot\frac{1}{2}\right|_{2\theta=30^0} = 50 \rightarrow u^2 = 100g$. Now keeping u to be same when it is fired at an angle $\theta' = 45^0$ thus, new range would be $R' = \left|\frac{u^2\sin 2\theta'}{g}\right|_{\theta'=45^0} = \frac{u^2}{g} = \frac{1}{g}\cdot 100g = 100$ m. **Answer is Option (d).**

Q-39 It has been seen in the Illustration that range of a projectile is $R = \frac{u^2\sin 2\theta}{g}$. Accordingly, for projectile A and B, their ranges would be $R_A = \frac{{u_A}^2\sin 2\theta}{g}$ and $R_B = \frac{{u_B}^2\sin 2\theta}{g}$. Despite angle of projection known, the other variable in range is u_A and u_B, which are unknown. Hence, ranges of Two projectiles cannot be compared. **Answer is Option (d).**

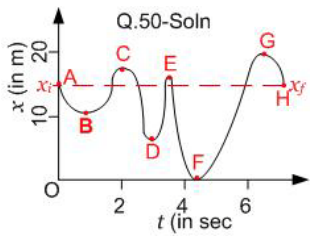
Q-40 The stipulations of the problem are shown in the figure. To cross the river at a given speed v_m its component across the river $(v_m\sin\theta)$ is decisive and time taken by it would be $t = \frac{w}{v_m\sin\theta}$. For minimum possible time either $\frac{dt}{d\theta} = 0$, or component of velocity across the river should be maximum i.e. $\frac{d}{d\theta}(v_m\sin\theta) = 0$. The later case is mathematically simple since v_m is a given constant. Therefore, for



	$\frac{d}{d\theta}\sin\theta = \cos\theta = 0$, the condition is the $\theta = \pm\frac{\pi}{2}$. $\theta \neq -\frac{\pi}{2}$, since it amount to traversing against North bank on land. Hence, $\theta = \frac{\pi}{2}$, i.e. northward. **Answer is Option (a).**
Q-41	Given that end P is moving with a velocity $u = -\frac{dy}{dt}$, here y is vertical descend of point P. Let at any point of time length of string AO be l and makes an angle θ with the vertical and $\frac{dy}{dt} = \frac{dl}{dt} = -u$. Now in triangle AOO', $l^2 = (AO')^2 + (OO')^2$. Since, pulleys are fixed and hence AO' is constant, on differentiating the Pythagorean identity $2l\frac{dl}{dt} = 2(OO')\frac{d}{dt}(OO') = 2l(-u) = 2l\cos\theta\,.\,u'$. It simplifies into $u' = -\frac{u}{\cos\theta}$. Since u is downwards, hence (-)ve sign signifies Point O ,oving upwards. Since Point O is fixed to mass rigidly and its velocity is that of mass M. **Hence, answer is Option (b)** 
Q-42	Each option is being analyzed since it is of type multiple choice. (i) Since tip of the minute hand of a clock reaches back to the same position after one hour. Hence, its displacement $\Delta s = 0$ in one hour. **Option (a) is correct.** (ii) Distance covered is $\Delta x = 2\pi l$, here l is the length of minute hand hence $\Delta x = 2\pi l \neq 0$ (iii) Speed of the tip $\frac{\Delta x}{60\times60} \neq 0$, since numerator $\Delta x \neq 0$ (iv) Average velocity of tip $\bar{v} = \frac{\Delta s}{60\times60} = 0$, since $\Delta s = 0$ **Option (d) is correct.** **Answer- Options (a) and (d) are correct**
Q-43	Each option is being analyzed since it is of type multiple choice. (i) $u_0 = \frac{dx}{dt} = \frac{d}{dt}u(t-2) + a(t-2)^2 = u + 2a(t-2) = u - 2a|_{t=0} \neq u)$. Hence this option is **incorrect** (ii) Acceleration of the particle is $\frac{d}{dt}\left(\frac{dx}{dt}\right) = \frac{d}{dt}\left(u + 2a(t-2)\right) = 2a \neq a$. Hence this option is **incorrect** (iii) During verification of option (b) at (ii) above it is found that $\frac{d}{dt}\left(\frac{dx}{dt}\right) = 2a$. **This option is correct** (iv) $x = u(t-2) + a(t-2)^2 = u(2-2) + a(2-2)^2|_{t=2} = 0$ I,e, particle is at origin, **Option (d) is correct.** **Answer-Options (c) and (d) are correct**
Q-44	Each option is being analyzed since it is of type multiple choice. (i) Shortest distance between two points A and B is the length of the line joining them. If a particle is travelling only in one direction along the line then average speed $= \frac{\Delta x}{\Delta t}$ and so also

	average velocity $\|\vec{v}\| = \frac{\Delta\|\vec{x}\|}{\Delta t}$. The moment particle travels either to-or-fro or deviates from straight line before it reaches from A to B, average speed $> \|\vec{v}\|$. **The Option (a) is correct** (ii) At highest point in trajectory of projectile, $\|\vec{v}\|_{0_+} = \|\vec{v}\|_{0_-}$ this makes $\frac{d}{dt}\|\vec{v}\| = 0$, but acceleration $a = g = \left\|\frac{d\vec{v}}{dt}\right\| \neq 0$. **Thus Option (b) is also correct** (iii) Given that $\bar{v} = \frac{\vec{v}_2 - \vec{v}_1}{t_2 - t_1} = 0$, it does not warrantee that $\vec{v}_t \neq 0\|_{t_1 < t < t_2}$. **Hence Option (c) is also correct.** (iv) This case is different from (c) since motion is restricted on a straight line, which is not the case in case (c). In this case it is given that $\bar{v} = \frac{\vec{v}_2 - \vec{v}_1}{t_2 - t_1} = 0$ and that infinite acceleration are not allowed i.e. $\Delta t \neq 0$ it means as $\Delta t \to 0$, $\Delta x - 0$, this leads to an indeterminate quantity which is not possible and hence Option (d) is incorrect. Statement "infinite acceleration are not allowed" makes this case different from case (c). **Answers is Options (a), (b) and (c).**
Q-45	Each option is being analyzed since it is of type multiple choice. (i) Instantaneous speed is $= \frac{\Delta x}{\Delta t}\Big\|_{\Delta x \to 0}$ while instantaneous velocity is $= \frac{\Delta \vec{x}}{\Delta t}\Big\|_{\Delta x \to 0}$. Thus in limits $\Delta x = \Delta\vec{x}$, hence it is not possible for instantaneous velocity and speed. Moreover, unless question states average speed and velocity it is to be treated as instantaneous velocity and speed. **Thus this option is incorrect.** (ii) In case of circular motion velocity at every instant is changing due to direction of displacement, but speed (distance covered) remains constant**. Hence Option (b) is correct** (iii) For $\vec{a} = \frac{\Delta\vec{v}}{\Delta t} \neq 0$, it is essential that $\Delta\vec{v} \neq 0$**. Hence Option (c) is not correct.** (iv) Since (b) is possible and hence $\vec{a} = \frac{\Delta\vec{v}}{\Delta t} \neq 0$ while speed is constant. Example is circular motion. **Hence Option (d) is correct** **Answer is Options (b) and (d)**

Q-46	Each option is being analyzed since it is of type multiple choice. (i) We have $v = u + at$, and sign of a and v are different then, object will initially slow down and but after velocity v becomes zero then it starts increasing. Here, use of is in the question is to be noted in question ".... object is slowing down....", it talk of present perfect tense, which is possible. **This option is correct.** (ii) We have $s = ut + \frac{1}{2}at^2$. If u is (+)ve and a is (-)ve, at that instant magnitude of velocity would tend to reduce. So also is true for u is (-)ve and a is (+)ve. **Hence this option is correct at that instance.** (iii) In motion of a particle, point of inflection, where velocity passes through zero while changing direction. This happen since acceleration is non zero. Therefore, $a \neq 0$. **Hence, this option is incorrect.** (iv) If velocity is zero during $t_1 \leq t \leq t_2$, hence during this interval $\Delta v = 0$, therefore acceleration $a = \frac{\Delta v}{\Delta t} = 0$, numerator being zero. **Hence, this option is correct.** **Answer is options (a), (b), and (d)**
Q-47	Each option is being analyzed since it is of type multiple choices. **(i)** For acceleration at $t = 0$, it is essential that $\Delta v = v_{0+} - v_0 = 0$. Given that $v_0 = 0$, but there is no information on value of v_{0+}, this option cannot be assertively stated to b correct. **Thus this option is incorrect.** (ii) Considering analysis at (i) above, $a_{t=0}$ may be zero if $v_{0+} = 0$. **Thus this option is correct.** (iii) **If acceleration is Zero during $0 \leq t \leq 10$**, then as per $v = 0_+ + 0 \cdot t = 0$ during the interval, thus there would be no displacement hence speed shall also remain zero. **Thus this option is correct.** (iv) This condition is corollary of case analyzed at (iii) above hence true. **Thus this option is correct.** **Answer is options (b), (c) and (d)**
Q-48	Each option is being analyzed since it is of type multiple choices. (i) Unless specifically indicated velocity and speed are treated as instantaneous. Hence this statement is correct in limits $\Delta t \to 0$. **This option is correct.** (ii) Average velocity is $\frac{\Delta \vec{x}}{\Delta t}$ over an interval $\Delta t \neq 0$. It can be equal to average speed if-and-only-if despite different terminal points terminal $\lvert\Delta \vec{x}\rvert$ is equal to distance. This since cannot be guaranteed based on given information. **Hence this option is incorrect** (iii) If speed of a particle is zero, hence it is not moving, hence there cannot be any displacement and velocity has to be zero. **Hence this option is incorrect** (iv) If speed of particle is never zero, hence it will definitely cover a distance during a given

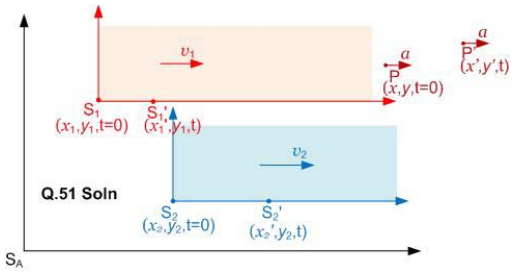
	interval. Hence average speed during the interval cannot be zero, since distance is a scalar. **Hence this option is incorrect** **Answer – Only option (a)**
Q-49	Each option is being analyzed since it is of type multiple choices. (i) The graph is a straight line and its equation would work out to $y - y_1 = \left(\frac{0-10}{10-0}\right)(x - x_1)$. Taking $(x_1, y_1) \equiv (0,10)$, the equation becomes $y = -1t + 0 + 10 = -1t + 10$, here slope of the line $\frac{dy}{dt} = m = -1$ and this same as acceleration. Thus $a = -1$ is a constant. **This option is correct** (ii) Since slope is uni-directional and the velocity is changing from (+) ve to (-)ve at t=10 sec, this is the point when particle is turning around. **Hence this option is incorrect.** (iii) Since displacement is $s = \int_{t_1}^{t_2} y dt = \int_{t_1}^{t_2} (-1t + 10) dt = \left[-\frac{t^2}{2} + 10t\right]_{t_1}^{t_2}$ This cannot be equal to zero either (a) $t_1 = t_2$ Or (b) graph is upro 20 sec only this is due to (-) slope with initial velocity (+ve). Since the graph is over a range $t = 0$ to $t = 30$. **Hence, this option is incorrect** (iv) Average speed of particle $0 \le t \le 10$ is $= \frac{0-10}{10-0} = -1$ and likewise Average speed of particle $10 \le t \le 210$ is $= \frac{-10-0}{20-10} = -1$. Both are same. **Hence this option is correct.** **Options (a) and (d) are correct.**
Q-50	Each option is being analyzed since it is of type multiple choices. For convenience of analysis Eight points A, B, C, D, E, F, G and H have been marked in red. (i) Points B, C, D, E, F and G are **only six points** where x-t curve has points of inflection where slope is where slope is zero and hence particles comes to rest. **This Option is correct.**  (ii) Maximum speed is at that point when $\frac{dx}{dt}$ is large, and by inspection of graph it is in section between E and F. Graph at $t = 6$ sec is outside the identified zone of maximum speed. **Hence this option is incorrect.** (iii) Since slope in sections of the graph AB, ED and EF are (-)ve, **hence this option is incorrect.** (iv) Since position (x_f) of the particle at the end of the graph (Point H) is equal to initial value (x_i) at the starting point A, $\bar{v} = \frac{x_f - x_t}{t-0} = \frac{0}{t} = 0$. i.e. it is not negative. **Hence this option is incorrect.** **Answer Option (a) is correct.**

Q-51

Each option is being analyzed since it is of type multiple choices.

(i) It is to be noted that only magnitudes of acceleration from Two frames of reference are given, while acceleration is a vector. Moreover, their initial velocities are not known. Hence, it cannot be said with certainty that the Two frames at rest with respect to each other. **Hence, this option is incorrect.**

(ii) For this case a figure is conceptualized where frames S_1 and S_2 are shown w.r.t to an absolute frame S_A. Frame S_1 with its origin has coordinates $(x_1, y_1, t = 0)$ w,r.t. S_A is shown. Likewise, frame S_2 with its origin has coordinates $(x_2, y_2, t = 0)$ w,r.t. S_A is shown. For simplification, both the frames are taken to be moving parallel to X-Axis of S_A, with velocities v_1 and v_2 respectively and are not accelerating as stipulated for this case.. Therefore, new position of the origins of two frames after a time t would be $x_1' = x_1 + v_1 \cdot t$ and $x_2' = x_2 + v_1 \cdot t$, respectively. Particle P (x,y) at t=0 is having an acceleration a parallel to X-axis w.r.t. S_1 and S_2, and reaches at position P' after a time t. Therefore, for new position w.r.t. S_A, $x' = x + at^2$, here another simplification is initial velocity of particle P is Zero. Therefore displacement of particle w.r.t. S_1 and S_2 would be $\Delta x_1 = x' - x_1'$ and $\Delta x_2 = x' - x_2'$, respectively. Substituting values, $\Delta x_1 = (x + at^2) - (x_1 + v_1 \cdot t)$ and $\Delta x_1 = (x + at^2) - (x_2 + v_1 \cdot t)$, respectively. Thus acceleration of particle w.r.t. S_1 and S_2, where x, x_1, x_2, v_1 and v_1 are constants, it would be –



I. Acceleration w.r.t. S_1 is $a_{p1} = \frac{d^2}{dt^2}\Delta x_1 = \frac{d}{dt}\left(\frac{d}{dt}\left((x + at^2) - (x_1 + v_1 \cdot t)\right)\right) = \frac{d}{dt}(2at - v_1) = 2a$,

II. Acceleration w.r.t. S_2 is $a_{p2} = \frac{d^2}{dt^2}\Delta x_2 = \frac{d}{dt}\left(\frac{d}{dt}\left((x + at^2) - (x_2 + v_1 \cdot t)\right)\right) = \frac{d}{dt}(2at - v_2) = 2a$

Therefore, acceleration of frame S_1 with respect to particle would be $a_{1p} = -a_{p1} = -2a$. Thus acceleration of frame S_1 w.r.t. S_2 would be $a_{12p} = a_{1p} + a_{p2} = -2a + 2a = 0$

For particle to be experiencing an acceleration, in the instant case, with respect to S_1 and S_2 it is not necessary for the frames to be accelerated w.r.t. each other, while they may be moving with a constant velocity. In such a situation acceleration of particle would be same w.r.t. both the frames, as much as neither of the frame is accelerated w.r.t. each other. **Hence, this option is correct.**

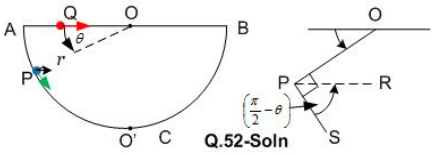
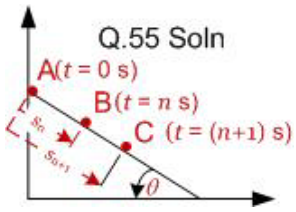
(iii) $|\vec{a}|$ of S_2 with respect to S_1 $|\vec{a}| = |\vec{a}_{s2} - \vec{a}_{s2}| = \sqrt{{a_{s2}}^2 + {a_{s1}}^2 + 2a_{s1} \cdot a_{s2} \cdot \cos\theta}$ would depend upon angle θ between them which can $0 \le \theta \le 180^0$. Given that $a_{s2} = a_{s2} = 4\ \text{ms}^{-2}$, $a = 0$ when $\theta = 180^0$ and $a = 2 \times 4\ \text{ms}^{-2} = 8\text{ms}^{-2}$ and therefore $0 \le a \le 8\text{ms}^{-2}$. Since θ is not known, hence $a = 0$ or $a = 8\ \text{ms}^{-2}$ can not stated with certainity. **Hence, this option is incorrect**

(iv) $|\vec{a}|$ of S_2 with respect to S_1 $|\vec{a}| = |\vec{a}_{s2} - \vec{a}_{s2}| = \sqrt{{a_{s2}}^2 + {a_{s1}}^2 + 2a_{s1} \cdot a_{s2} \cdot \cos\theta}$ would depend upon angle θ between them which can $0 \le \theta \le 180^0$. Given that $a_{s2} = a_{s2} = 4\ \text{ms}^{-2}$, $a = 0$ when $\theta = 180^0$ and $a = 2 \times 4\ \text{ms}^{-2} = 8\text{ms}^{-2}$ and therefore $0 \le a \le 8\text{ms}^{-2}$. **This option is correct.**

Answer is options (b) and (d)

Q-52

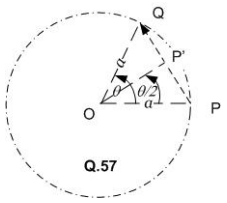
It is to be noted carefully *that both P and Q pass off point A at* $t = 0$, ***with same horizontal velocity*** v, over frictionless bowl and string respectively. As Q slides its velocity increases ipto point

	O' right below center of the bowl O, and then while traversing u pward its velpcity decreases. The increase in velocity of P, while sloding down increases its horizontal velocity v and on reaching back to B at height of A, it comes back t0 v. Thus all along traversing semicircular arc ACB it horizontal velocity $v_h > v$ and hence time taken by P to reach B would be $t_p < t_q$. **Answer is Option (a)** 
Q-53	Velocity of ball dropped from ground from a height h, will have initial velocity $u = 0$ and hence velocity at any height would be $v = \sqrt{2gh}$ downward (-ve) But, after bounce if it goes to height $\frac{h}{2}$ then it initial velocity at bounce shall be $v' = \sqrt{2g\frac{h}{2}} = \sqrt{gh}$, upward (+ve). Thus, considering sign conventions possible options are (a) and (c). Since, $v - h$ graph is not a straight line therefore Option (c) is ruled out. Further, $v - h$ relation is quadratic, with higher (-)ve v for higher h and for bounce since velocity is lower and hence lower height but (+)ve. These, stipulations are there in option (a). **Answer is Option (a)**
Q-54	Given that $u = 0$ and $a = -\frac{10}{11}t + 10$. Since, acceleration is +ve in given time zone maximum velocity the area under the curve i.e. $v_{max} = \int_{t\_0}^{t\_11} a \cdot dt$ since $a = \frac{dv}{dt}$ Thus $v_{max} = \int_{t\_0}^{t\_11} \left(-\frac{10}{11}t + 10\right) \cdot dt$. Oy resolves into $v_{max} = \left[-\frac{10}{11} \cdot \frac{t^2}{2} + 10t\right]_0^{11} = -5 \times 11 + 10 \times 11 = 55$ ms^{-1}. **Answer is Option (b)**
Q-55	Acceleration due to gravity g ms^{-2} is vertically downward. Since block starts, from rest, sliding down, hence acceleration along the plane would be $g \sin\theta$. Hence, $x_{n\_1} = 0 \cdot n + \frac{1}{2} \cdot g \sin\theta \cdot (n-1)^2 = \frac{g \sin\theta}{2}(n-1)^2$; $x_n = \frac{g \sin\theta}{2}n^2$, and $x_{n+1} = \frac{g \sin\theta}{2}(n+1)^2$. Hence, $s_n = x_n - x_{n\_1} = \frac{g \sin\theta}{2}(n^2 - (n-1)^2) = \frac{g \sin\theta}{2} \cdot (2n-1)$. And $s_{n+1} = x_{n+1} - x_n = \frac{g \sin\theta}{2}((n+1)^2 - n^2) = \frac{g \sin\theta}{2} \cdot (2n+1)$. Thus $\frac{s_n}{s_{n+1}} = \frac{\frac{g \sin\theta}{2} \cdot (2n-1)}{\frac{g \sin\theta}{2} \cdot (2n+1)} = \frac{(2n-1)}{(2n+1)}$. **Thus answer is option (c)** 

Q-56

Equation of graph on v-x plane is $v = \frac{dv}{dx}.x + v_0 = \left(\frac{-v_0}{x_0}\right).x + v_0$. Further, manipulating $\frac{dv}{dx} = \frac{dv/dt}{dx/dt} = \frac{a}{v} \rightarrow v = -\left(\frac{x_0}{v_0}\right).a$. Thus, equation of the given graph transforms into $\left(\frac{x_0}{v_0}\right).a = \left(\frac{-v_0}{x_0}\right).\boldsymbol{x + v_0}$. It is simplified into $a = \left(\frac{-v_0}{x_0}\right)^2 x - \boldsymbol{v_0}\left(\frac{x_0}{v_0}\right) = \left(\frac{v_0}{x_0}\right)^2 x - \boldsymbol{v_0}\left(\frac{x_0}{v_0}\right)$. This equation has (+)ve slope and (-)ve interecept on on ordinate. **Thus answer is option (a)**

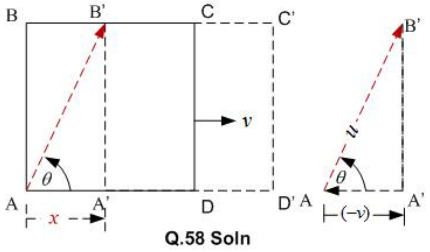
Q-57



Given that a particle (P) is moving in circular paty of radius a with an angular speed ω. Therefore angle traversed in time t would be $\theta = \omega t$, and reach a point Q. Therefore, magnitude of displacement in time t would length of chord PQ. Since OPQ is an isosceles triangle with OP = OQ = a, hence PQ = 2PP'=$2(a\,\text{sns}\frac{\theta}{2}) = 2a\sin\frac{\omega t}{2}$.

Hence **answer is Option (b)**

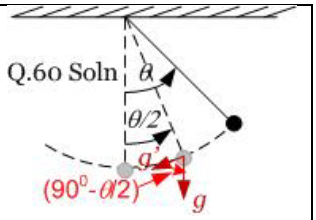
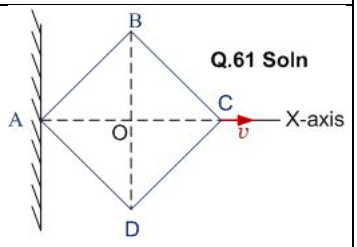
Q-58



Let the square frame be ABCD at time $t = 0$ and is moving with a velocity v. After a time the frames would be displaced to position A'B'C'D' such that displacement of vertex shall be $x = vt$. The particle after projected from point A with a speed u at an angle α so as to hit the vertex B. Relative velocity of particle w.r.t. frame should be such that its its horizontal component should lead to cancellation of relative velocity of frame, i.e. $u\cos\theta - v = 0 \rightarrow \cos\theta = \frac{v}{u} \rightarrow \theta = \cos^{-1}\left(\frac{v}{u}\right)$. **Answer is Option (b).**

Q-59

Let stone A be projected with velocity $v_a \angle_{\theta_a}$ and stone B be projected with velocity $v_b \angle_{\theta_b}$. Therefore, vertically upward velocities of the two stones shall be $v_a \sin\theta_a$ and $v_b \sin\theta_b$ respectively and their time of flights shall be $T_a = \frac{2v_a \sin\theta_a}{g}$ and $T_b = \frac{2v_b \sin\theta_b}{g}$. Let, $T_a > T_b$ then during $0 \leq t \leq T_b$ the relative velocity of stone A w.r.t shall be $\vec{v}_{ab} = \vec{v}_a - \vec{v}_b$ and during this period relative acceleration would be zero because both are under acceleration $\vec{g}$ vertically downward. Therefore, during $0 \leq t \leq T_b$ relative position of stone A w.r.t. B shall be varying linearly with time. But, at T_b stone B becomes stationary, while, stone A will continue to perform projectile motion, with it ne velocity and height at that instant. Since projectile motion is parabolic. **Hence, Answer is Option (b)**

Q-60	Given that bob is released from rest at an angle $\theta = 60^0$. At this position it experiencing an acceleration $g = 10\ m_s{}^{-2}$ vertically downward, which remains constant in magnitude and direction. But, since pendulum is fixed to ceiling and hence its tangential acceleration at given angle $\theta = 30^0$ would be $= g\cos\left(90^0 - \theta/_2\right) = g\cos 60^0 = \frac{g}{2} = 5\ \mathrm{ms}^{-2}$.  **Thus answer is Option (b).**
Q-61	Since, vertex A is fixed and C is moving toward right with a velocity $v\ \mathrm{ms}^{-1}$ and point O is mid point of AC and hence rate of displacement of point O, by principle of proportionality, would be $\frac{d}{dt}(\mathrm{AO}) = \frac{v}{2}\mathrm{ms}^{-1}$. When rhombus is in shape of square in triangle AOB which is a right angle isosceles triangle ABO, side AB and vertex A are fixed and BO =AO. Further, $\mathrm{AB}^2 = \mathrm{AO}^2 + \mathrm{BO}^2$. Differentiating the equation w.r.t. t it would be $0 = 2\mathrm{AO}\frac{d}{dt}(\mathrm{AO}) + 2\mathrm{BO}\frac{d}{dt}(\mathrm{AO}) \rightarrow \frac{d}{dt}(\mathrm{AO}) = -\frac{d}{dt}(\mathrm{AO})$. ence, if velocity of A is (+v) along X-axis, velocity of B is (-)ve i.e. along Y axis towards X-axis $\frac{v}{2}\mathrm{ms}^{-1}$.  **Thus answer is Option (c)**

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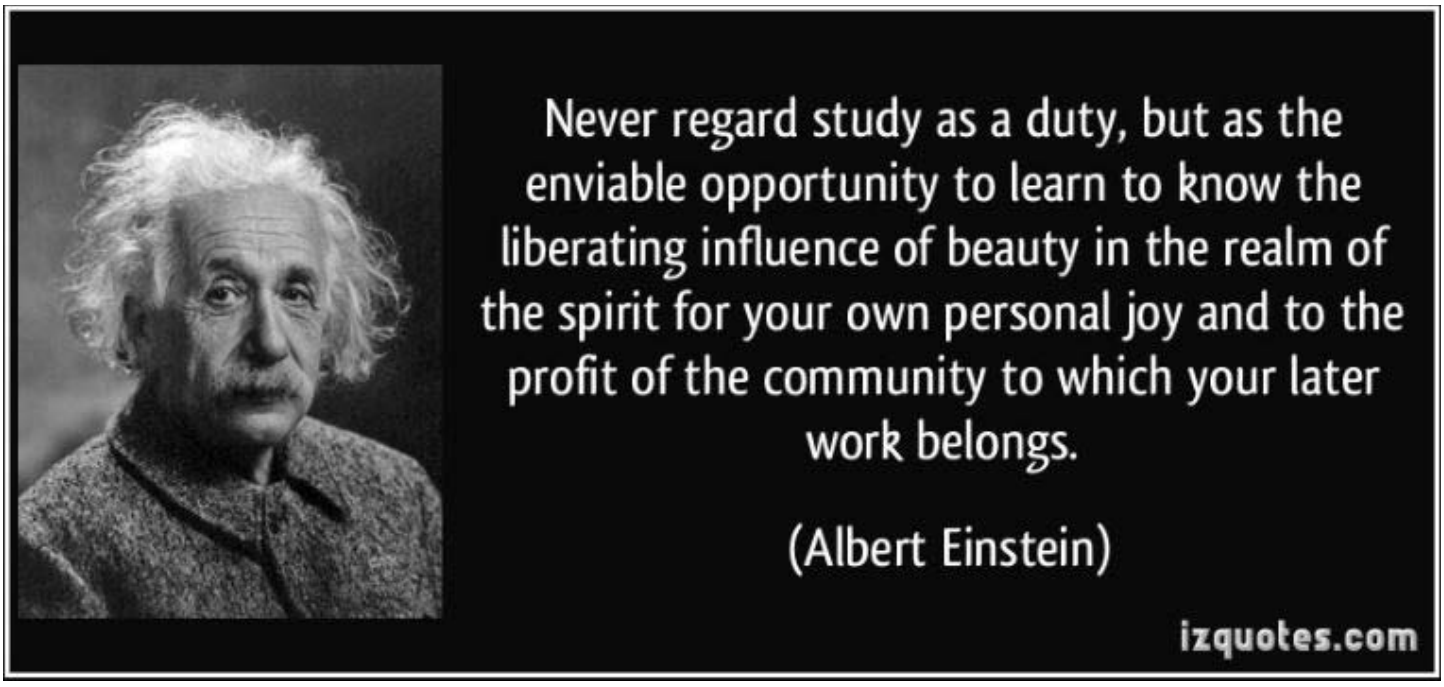

Theme Song :

PREMISE: ***We are pleased to adopt a song*** **" इतनीशक्तिहमेंदेनादाता....."** ***from a old Hindi Movie Do Aankhen Barah Haath दोआँखेंबारहहाथ 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 ofcompassionate 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 होना

हम चले नेक रस्ते पे हम से, भूलकर भी कोई भूल होना ||

दूर अज्ञान के हो अंधेरे, तू हमें ज्ञान की रोशनी दे

हर बुराई से बचते रहें हम, जितनी भी दे भली ज़िन्दगी दे

बैर होना किसी का किसी से, भावना मन में बदले की होना ||

इतनी शक्ति हमें देना दाता, मन का विश्वास कमजोर होना

हम चले नेक रस्ते पे हम से, भूलकर भी कोई भूल होना ||

हमना सोचें हमें क्या मिला है, हम ये सोचे किया क्या है अर्पण

फूल खुशियों के बाँटे सभी को, सबका 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 होना

हम चले नेक रस्ते पे हम से, भूलकर भी कोई भूल होना ||

Together **E**ach **A**chieves **M**ore
(**TEAM**)

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