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## Letter of  A Father to the Teacher of His Son…

*This is the famous letter supposedly written by great American president Abraham Lincoln to his son's teacher. There are different versions available at different places and some even claim it's not correct. Irrespective of its authenticity, this letter is a great read.*

*"My son starts school today.*
*It is all going to be strange and new to him for a while and I wish you would treat him gently.*
*It is an adventure that might take him across continents. All adventures that probably include wars, tragedy and sorrow.*
*To live this life will require faith, love and courage.*

*So dear Teacher, will you please take him by his hand and teach him things he will have to know, teaching him – but gently, if you can.*
*Teach him that for every enemy, there is a friend.*
*He will have to know that all men are not just, that all men are not true.*
*But teach him also that for every scoundrel there is a hero, that for every crooked politician, there is a dedicated leader.*

*Teach him if you can that 10 cents earned is of far more value than a dollar found. In school, teacher, it is far more honorable to fail than to cheat.*
*Teach him to learn how to gracefully lose, and enjoy winning when he does win.*

*Teach him to be gentle with people, tough with tough people. Steer him away from envy if you can and teach him the secret of quiet laughter.*
*Teach him if you can – how to laugh when he is sad, teach him there is no shame in tears.*
*Teach him there can be glory in failure and despair in success. Teach him to scoff at cynics.*
*Teach him if you can the wonders of books, but also give time to ponder the extreme mystery of birds in the sky, bees in the sun and flowers on a green hill.*
*Teach him to have faith in his own ideas, even if every one tell him they are wrong.*

*Try to give my son the strength not to follow the crowd when everyone else is doing it.*
*Teach him to listen to every one, but teach him also to filters all that he hears on a screen of truth and take only the good that comes through.*

*Teach him to sell his talents and brains to the highest bidder but never to put a price tag on his heart and soul.*
*Let him have the courage to be impatient, let him have the patient to be brave.*
*Teach him to have sublime faith in himself, because then he will always have sublime faith in mankind, in God.*

*This is the order, teacher but see what best you can do. He is such a nice little boy and he is my son."*

**—00—**

**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 : <br> a. Subscription whether it annual as in WebEx or One time with AMC like in as in UTP+. <br> b. Cloud platform is a shared resource across Learning Centers benefitting from IOMS. <br> 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. <br> 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. <br><br> 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. <br><br> 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 Beam 100", 100 Lumen, 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:** A-VIEW (Amrita Virtual E-Learning World) developed by Amrita University in association with IIT Bombay, an MHRD, GOI sponsored project.. Problems with Whiteboard functionality of A-VIEW are being circumvented with OneNote app of MS Office for IOMS. This has many features of minimizing bandwidth requirements.

**Surface Writing Device:** HUION make Model WH1409, or Wacom Intuos with  wireless device makes it suitable for  communication with base computer in class like environment.

**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.**

<u>संपादकीय</u>

# उज्ज्वल भविष्य की ओर निहारता समृद्धिशाली अतीत : श्रद्धांजलि

विलक्षण नेतृत्व-प्रतिभा के धनी, संगठन कार्यों में दक्ष, सबको साथ लेकर चलने के महारथी, अदृश्य भविष्य को वर्तमान में साफ-साफ देखने वाले, अद्भुत भाषण-शैली के जनक, प्रखर वक्ता, स्नेहिल व्यक्तित्व से भरपूर, राजसत्ता को धर्मसत्ता के अधीन रखने के हिमायती, भारतीय जनसंघ, भारतीय जनता पार्टी के संस्थापक, राष्ट्रीय भावना के प्रचारक, राष्ट्रधर्म, पांचजन्य, वीर अर्जुन, दैनिक स्वदेश आदि समाचार पत्रों व पत्रिकाओं के सफल संपादक, विश्व के ताकतवर पश्चिमी देशों के विरोध के बावजूद पोखरण में परमाणु परीक्षण कराने में अडिग रहनेवाले जननायक, देशहित में पाकिस्तान से एकतरफा शांति-स्थापना का प्रयास करने वाले, भारत के चार प्रमुख नगरों दिल्ली , चेन्नई, मुम्बई और कोलकाता को स्वर्णिम चतुर्भुज योजना के तहत सड़क मार्गों से जोड़ने की शुरूआत करनेवाले, संयुक्त राष्ट्र - महासभा में पहली बार हिंदी में बोलनेवाले, भारतरत्न पूर्व प्रधानमंत्री श्री अटलबिहारी बाजपेयी के निधन पर ज्ञान विज्ञान सरिता परिवार उनकी ही एक कविता यहां उद्धृत कर अपनी श्रद्धांजलि अर्पित कर रहा है।

बाधाएं आती हैं, आएं
घिरें प्रलय की, घोर घटाएं,
पावों के, नीचे अंगारे,
सिर पर बरसें, यदि ज्वालाएं,
निज हाथों में, हंसते-हंसते,
आग लगाकर, जलना होगा,
कदम मिलाकर चलना होगा।

उजियारे में, अंधकार में,
कल कहार में, बीच धार में,
घोर घृणा में, पूत प्यार में,
क्षणिक जीत में, दीर्घ हार में,
जीवन के, शत-शत आकर्षक,
अरमानो को, ढलना होगा,
कदम मिलाकर, चलना होगा।

सम्मुख फैला, अगर ध्येय पथ,
प्रगति चिरंतन, कैसा इति अब,
सुस्मित हर्षित, कैसा श्रम श्लथ,
असफलता सफल, समान मनोरथ,
सब कुछ देकर, कुछ न मांगते,
पावस बनकर, ढलना होगा,
कदम मिलाकर, चलना होगा।

कुछ कांटों से, सज्जित जीवन,
प्रखर प्यार से, वंचित यौवन,
नीरवता से, मुखरित मधुबन,
परहित अर्पित, अपना तन-मन,
जीवन को, शत-शत आहुति में,
जलना होगा, गलना होगा,
कदम मिलाकर, चलना होगा।

ईश्वर अटल जी की आत्मा को शांति प्रदान करे व भारत को पुनः ऐसा राजपुरूष दे, जो उनके बताये आदर्शों पर चले और उनके सपने को पूरा करे। उनका सपना था-ऐसा भारत जो भूख, भय, निरक्षरता, और अभाव से मुक्त हो। ज्ञानविज्ञानसरिता परिवार की तरफ से शत-शत नमन।

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*Coordinator's Views*

## To Be Or Not To Be….?

*A famous phrase "To Be or Not to be" coined by Shakespeare about five centuries ago in a soliloquy of prince Hamlet is considered relevant in present times. We have seen transformation of an era when teaching was a most coveted profession of scholars, to the last option for many to use the opportunities available and for a few first option in an environment of commercialized education. This paradox leads to a dilemma -'to be or not to be a teacher' and is being introspected in the month of September, when country celebrates Teachers' Day to commemorate birthday of Dr. Sarvepalli Radhakrishnan an Indian philosopher and statesman who was the first Vice President of India and the second President of India.*

Every thoughtful person often lands into a dilemma when confronted with a situation to make a choice. This true since there is nothing absolutely right or wrong. Each act or phase is clubbed with its merits and demerits. It is only ability of a person to handle demerits and optimize merits of any act or situation. It is this ability which plays a crucial role in leaning of the decision maker towards one of the available options. Thus one grows and learns to live in this paradox. Nevertheless 'to be or not to be a teacher' invokes a case study involving professional, moral, emotional, educational and socio-economic perspectives.

Once a middle-aged teacher was sitting in a get-together with his classmates who had attained a respectable height in their respective fields. Each of them was boasting his contributions to the society as he grew and sarcastically belittling the teacher being a liability on the socio-economic system. The teacher carrying a humble outfit kept bearing all tall dispositions of his classmates who used to borrow his notes. At last the gathering asked the teacher about his contributions; he had no comparable claim. Yet he raised a simple quarry about their children and asked - were they teaching them and checking their homework? Each of them responded inability to spend their valuable time with their children and instead they had arranged one of the best home tutors on a handsome tuition fee. In response, the teacher recalled their student hood and their teachers who always welcomed them with their difficulties at anytime, be it within or outside their school. He respectfully remembered his teachers as his role model and that he was trying to carry forward the torch. He politely submitted that he was trying to compensate inabilities of his classmates, who are too occupied in their professional life, and unable to look after studies even of their own off-springs. The gathering turned into a pin-drop silence.

After a brief pause teacher continued saying that parents are natural teachers. But, they are distancing themselves from their beloved children and handing them over to commercial teachers. And in this commercial society where each of them was racing for growth, belongings and area of influence, why should teacher alone abide by ethical, moral and academic values? Is there any instance when an accomplished student of a dedicated teacher or his parents volunteered in matrimonial alliance with children of an able teacher? In one of the most populous country, our India, there are stray instances where rich heritage of gurukul is respected. Merely by felicitating a teacher on Teachers' Day or Guru Poornima, society does not get absolved of its responsibility of welfare of teachers; in absence of this such ceremonies a reduce to a structured and emotional exploitation of teachers.

It requires to review the basic meaning of education - Is it assimilating information? Is it only about passing examination with good marks? Getting top position? Getting admission in reputed institute? Getting good placement with fat salary packet, perks and power? And so on. Or, is it about ability to observe? Because no teacher can do finger holding till last breadth. Is it ability to think and analyze how and why of their observation? Because no teacher can provide thumb rule, a key, to solve problems to be encountered in real life. Is it ability to evolve solution and option? Because every real life problem is unique and does not have a readymade solution. Is it ability to select best option? Because every solution has bright and gray side and therefore choice of option is based on one's ability to handle risks and optimize strengths in a manner which is feasible, adaptable, economical, sustainable and supports coexistence. Is it skill to implement and demonstrate feasibility of the option? Because, thoughts and ideas are abstract and reality is what can be implemented.

The teacher continued saying that we have come far off from predator age. We claim ourselves to be a civilized society. Disparity among people, if any, may not be always because of their own faults, it could be due to perennial or extraneous reasons. This places elite persons on a plane of higher responsibility such that the society grows in harmony to coexist in monolithic manner. In this pursuit teacher has a big role to play and society especially elite section have to ensure that teacher is respected and facilitated in discharge of his role. Treating teachers as unproductive mass to fit into any kind of non-academic activity is like using carbon content of diamond as a fuel. At the same time teachers must rise and reciprocate befitting to the role and responsibilities of quality education bestowed upon them. This is again paradoxical.

He further stated that this requires a collective review of our position and the role that we play in correcting aberration in socio-education system. It is far different

from creating numbers; rather it is about enhancing intrinsic values of every individual through education.

The teacher also narrated that when one walks towards a source of light his shadow follows him, and every other person can observe it. But, when one turns back towards source of light his pursuit to chases shadow is like a mirage and never accomplished; and he distances from source of light; light represents knowledge, capability, wisdom, power and all kind of positive traits, while shadow represents absence of light and in turn negativity. Materialistic gains as long as sustainable and coexistent are welcoming. But, generally they get focussed in personal accomplishments with a selfish motive giving rise to negativity.

The humble person, a teacher, gave a big message and command to the gathering of accomplished persons.

The obsession of accomplishment and belongings is such that it does not let one to selflessly look beyond and with a sense of Personal Social Responsibility (PSR). Despite, residual educational values, if observed scantily, are because of some inspired individuals who have passionately chosen to be a teacher, and not out of compulsions of survival as a last resort. Such passionate teachers gauge their success in accomplishment of their pupils. Such a teacher during his performance places a high demand on his dependents whose needs might be met partially, or at times remain unmet. It is the real collective sacrifice of the teacher's family. Pain of such a situation can be only visualized but is difficult to described. There is a saying that '*behind every successful man there is a lady'*. But, with due respect towards the lady behind the man, it is equally important to recognize that '*behind every successful person there is a great teacher'*, because the lady must have had an able teacher.

Those who choose teaching under compulsion keep boasting that their sacrifices, and remain in hunt for a reward. In the process they miss the opportunity of creating successful persons. Such teachers tend to become instrumental in reducing education into a commercial commodity. This kind of socio-economic order that is emerging might create a magnificent structure; but it would be quite fragile and unable to withstand slightest tremor. This is due to absence of reinforcement of bondages that are nurtured in true education.

After seven decades of independence message of Shri Ram Nath Kovind, President of India on of Republic Day'2018 to turn education from rote-learning to thought provoking is a pointer for all of us to introspect. Likewise, Prime Minister during his speech on Independence Day'2018 had to talk tough against social crimes and specially crime against women in an era where we are aiming at becoming global growth engine. On the contrary society is engaging invaluable time of top judiciary to legalize moral, family and social erosions on adultery, gay relationship; criminal cases of atrocities on innocent, destitute women and children, and some inhuman practices in different religion and sects. Seeing this happening, shatters my faith of being descendents of a Indian culture, which is claimed to be most civilized and progressive. This roll-down has to be stopped, rather it must be reversed if we really love our children and wish to pass on to them a legacy to feel proud of.

Real need is of growth coupled with stability whose important virtues are on human respect, all being treated equals. The equality has to exists in opportunities of growth and building competence to all without discrimination of gender, caste, colour, creed, geographical, region and religion. Nevertheless, perpetuation of opportunities needs to be linked to performance of every individual. Inequality in performance, if any, should regulate the role that one is called upon to play. This inequality at performance is without prejudice to objectivity of sustained stability and coexistence, a need of a sound socio-economic order.

It is important to remember that gains made out of legacy are long lasting only if they are grown with sincere efforts. There are always more potential persons on the watch to grab others belongings and opportunities. This creates an inevitable sense of insecurity and subconsciously turn into atrocities from either side. It is a matter of choice for every individual to ether live in a sense of insecurity and possessiveness, or to stretch out for a reform of socio-economic with PSR to create a society with a stable growth.

This kind of growth is possible only in truly civilized society whose firm roots are held by its educational values and system. Adhesive strength of the education system, to hold the roots firmly, is derived from passionate, committed and dedicated teachers who have decided to be there out of inspiration and pursuing it without expectations society; what society meets them.

Society cannot and should not evade these questions. Let elite section of society, which is capable of making a difference, come forward, meditate and introspect to answers and share the collective wisdom to the youth of society to decide **to be a teacher, or a trader of information and opportunities.** Let them not to be on the watch for aspirant s and highest bidders . Any further widening or bridging of educational disparity would depend upon choices and actions that we elite persons make. Let us not be a part of predicament of our beloved descendents when they are called upon their history and pass a judgement on the choices that we made and life that we lived; or indulge in falsification of the facts.

**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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## 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 8ᵗʰ Quarterly e-Bulletin Gyan-Vigyan Sarita:** शिक्षा **.**
  ➢ **Theme of the 3ʳᵈ Annual and 9ᵗʰ Quarterly e-Bulletin dt 2ⁿᵈ October'18 is Educational Perspective.**
  ➢ **And this cycle of monthly supplement sandwitching consecutive Quarterly e-Bulletin Gyan-Vigyan Sarita:** शिक्षा **is aimed to continue endlessly**

**We believe that this Annual Issue of with monthly supplements to quarterly periodicity of e-Bulletins shall make it possible for our esteemed contributors to make it rich in content, diversity and based on their ground level work and/or experiences.**

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# 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 Promote**r –
   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.in*has been launched. It contains under its**Menu:  Publication>e-Bulletins,** and>**Mentors' Manual.** You may like to read them.*

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

अंदाज ए बयां

## शहर के मुँह में भी जुबान होती है....

समीर लाल 'समीर'

सुन कर अजीब सा लग सकता है मगर हर शहर के मुँह में एक जुबान होती है और उस जुबान की अपनी एक अलग ही जुबान होती है.

आपका शहर दरअसल वो शहर होता है जो आपके बचपन से जवानी तक के सफर का और अक्सर उसके बाद तक का भी चश्मदीद गवाह होता है या यूँ कहें कि वो शहर जिस शहर में आपके व्यक्तित्व की मौजूदा आलीशान इमारत जिन मुख्य स्तंभों पर आधारित है, वो स्थापित हो.

भले ही वहाँ आपने जन्म न लिया हो , भले ही वहाँ आपके माता पिता सदा किराये के मकान में रहते आये हो और आप भी किराये के मकान में रहते रह गये हों..मगर बचपन से खेलते पढ़ते घूमते बड़े होते होते न जाने कब वो शहर आपमें समा जाता है. उसकी सड़के, गलियाँ, बाग बगीचे सब आपके मानस पर रच बस जाते हैं.

मुझ जैसा जबलपुर शहर का प्राणी जो आज बरसों से कनाडा में आ बसा है मगर फिर भी जब कभी कनाडा के विश्व विख्यात नियाग्रा फाल्स के सामने खड़ा होता है तो उसे उसमें जबलपुर का नर्मदा नदी का धुँआधार जलप्रपात नजर आता है और मेरी पत्नी जो मिर्जापुर की है , उसे उसी नियाग्रा फाल्स में विन्धम का झरना. एक ही वक्त में एक ही चीज दो अलग अलग प्राणियों की आँखों को दो अलग अलग आलम दे – ये सिर्फ जहन में बसे एक शहर की औकात है.

अपना शहर और अपने शहर का जहन मे बसना समझना हो तो हालात तो यूँ हैं कि श्रीवास्तव जी जो सन १९६५ में लखनऊ से कनाडा में आ बसे थे सपरिवार और फकत चार पाँच साल में भारत जाना आना होता रहा था जिनका मात्र दो या तीन हफ्तों के लिए, वो अभी जब पिछले माह एक लम्बी बीमारी के बाद गुजरे तो उनके अंतिम संस्कार के दौरान लोगों को कहते सुना कि भाई साहब का बहुत मन था कि अंतिम सांस वो लखनऊ में ही लेते मगर मन का मांगा कब पूरा होता है. तब लगा कि ये होता है अपना शहर जो मरने के बाद भी आपके नाम के साथ गुथा रहता है.

आपके शहर के मुँह में जो जुबान होती है वो जरा सा फिसली और समझो कि हुआ आपका बंटाधार. फिर भले आप शहर में हों या उसे छोड़ कर कहीं और जा बसे हों मगर वो शहर आपको छोड़ने को तैयार नहीं..वो तो आपके भीतर रच बस चुका होता है और साथ साथ चलता रहता है और फिर जो आपको उस शहर से होने की पहचान देती है, वो होती है उस शहर के मुँह में बसी जुबान की

अपनी एक अलग जुबान. कुछ ज्ञानी उसे उस शहर की भाषा या महाज्ञानी उसे उस शहर की बोली भी कहते हैं.

चाहे आप अपना शहर छोड़ कर दिल्ली , बम्बई या बैंगलोर आ बसें या सात समुन्दर पार अमेरीका , कनाडा आ बसें तो भी. जब कभी बात निकलेगी तो पूछने वालों का पहला प्रश्न ही यह होगा कि आप कहाँ से हैं?

तब आप जैसे ही बताते हो कि आप जबलपुर से हैं और वो पूछने वाला भी अगर आपके शहर का ही हुआ तो अति प्रसन्न भाव से बतायेगा कि 'गजब हो गओ महाराज!! हम भी जबलईपुर से हैं'. ये जबलपुर का जबलपुर वाले का जबलपुर वाले के सामने जबलईपुर निकल जाना एकदम स्वभाविक प्रक्रिया है , इसके लिए सामने वाले को न तो कुछ सोचना होता है और न ही कोई प्रयास करना होता है. यह एकदम सहज हो जाने वाली घटना है और आप जान जाते हो कि ये तो अपने शहर का सर्टिफाईड बंदा है. ये होती है उस शहर के मुँह में होने वाली जुबान की अपनी एक अलग जुबान. उस शहर की बोली.

तब बात आगे बढ़ती है और वो पूछता है कि काये , जबलपुर में कहाँ से? और आप जैसे ही उसे अपना मोहल्ला बताते हो , हालांकि अब उस मोहल्ले में आपका कुछ भी नहीं मगर वो मोहल्ला फिर भी हमेशा आपका ही रहता है , तुरंत वो कहता है कि अरे!! वहीं तो वो शर्मा जी रहते थे स्टेट बैंक वाले जिनकी लड़की का ड्राईवर के साथ चक्कर था. ये जो एकाएक बेवजह शर्मा जी और उनकी लड़की की भद्द उतार दी गई.. वो होती है उस शहर के मुँह में रहने वाली जुबान.

ये इसी शहर के मुँह में रहने वाली जुबान की मेहरबानी है कि अच्छा अच्छा बोले तो आप अच्छे और पोल खोल दे तो आप बुरे. वैसे सच जानो तो दर्ज तो आपके शहर की मुँह की जुबान पर आपके बारे सब कुछ है ही..इतना कुछ कि जो करम आपने उस शहर में न कर , सेफ रहने के लिहाज से किसी और शहर में किये हों उसे तक वो अपने सीने से लगाये बैठी रहती है और न जाने कब, एकाएक लपलपा के बोल दे और फिर आप देखिये कि क्या तमाशा खड़ा होता है..

कभी अपने शहर के मुँह की जुबान से , अपनी पैदाईश से लेकर घटना दर घटना मय सबूत के पूरी जन्म कुण्डली , जिसे शायद आपको खुद भी याद करने के लिए दिमाग पर जोर डालना पड़े , सुनना हो तो एक काम करियेगा..बस!! एक बार एक बड़ा चुनाव लड़ लिजियेगा किसी जानी मानी पार्टी की टिकट पर..फिर

सुनियेगा..मन लगा कर कि क्या क्या गुल खिलाये थे आपने मियाँ..अपने ही शहर की मुँह की जुबान से...उसी की जुबान में.. और तब आप भी मान जायेंगे..कि

'हर शहर के मुँह में एक जुबान होती है'

बस!! डर इतना सा है कि इस बदलती दुनिया में कहीं स्मार्ट सिटी का कल्चर शहर को बेजुबान न बना दे!! मुंबई बहुत नहीं तो थोड़ा स्ट्रीट स्मार्ट तो है ही और वो इसका काफी हद तक प्रमाण भी देता रहा है अन्य शहरों की तुलना में.

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।

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# GROWING WITH CONCEPTS

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

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

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

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

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

*Looking forward, these articles are being integrated into Mentors' Manual. After completion of series of such articles on Physics 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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*Ayurveda : Healthy Life*

# RITUCHARYA

**Dr. Sangeeta Pahuja**

The word Ritucharya is derived from two words- Ritu means Season PLUS Charya means Routine.

According to Ayurveda Ritucharya plays an important role in one's life to stay healthy. By following the Ritucharya guidelines of Ayurveda we can keep ourselves away from diseases.

A year has been divided into two periods according to the position of Sun. These two periods are called

Aadan kaal -(Uttarayan--Aagney--agni guna pradhan or Northern Solistice)

Visarg kaal -(Dakshinayan--Saumya--sheet guna Pradhan or Southern Solistice)

Aadan kaal includes 3seasons – (a) Shishir (Magha,Phaga) or late Winter, (b) Vasant (Chaitra,Vaisakh)orAutumn, and (c) Grishm (Jyeshtha, Aashad) or Summer

Visarg Kaal includes 3seasons – (a) Varsha (shravan, Bhadrapad) or Rainy season, (b) Sharad (Ashwin, Kartika) orAutumn, and (c) Hemant (Margsheesh, Pausha) orWinter

Ayurveda  provided guidance about diet and lifestyle in different seasons to stay healthy. By following the same one can stay healthy.

HOW TO STAY HEALTHY IN VARSHA RITU (Rainy season)

**VARHA RITU** (15th July-15th September) has Vata prakop (raised vata), pitta sanchay and Amal Ras (sour) pradhan. That's why leads to problems like weak metabolism, low physical stamina, Indigestion, joint pain, skin diseases, blood Disorders and bacterial and viral infections. As this season is Vata Pradhan, so old age persons should take special care.

Favourable diet and Lifestyle

Consume Vata Pacifying food

Sour, salty and sweet (madhur, Amal,lavan) Ghee and milk Gourd, parval, bitter gourd, torai, ginger, cumin methi garlic, green gram, honey mango lemon,  jamun, Haritaki, saindhav lavan etc.

Drink fersh and filtered or boiled water.

Avoid following food items

Potato and other tubers, Rice, cabbage,  cauliflower, spicy, heavy and stale food, areated drinks, fish , mutton, curd,  leafy vegetables, chilled water etc.

Lifestyle

Avoid  day time sleeping, and night time awakening. Don't stay empty stomach for long time.

## HOW TO STAY HEAITHY IN SHARAD RITU (Autumn)

Autumn season (15th september to 15th November) has Pitta prakop (Aggravated Pitta) and lavan(salt) Ras pradhan and person has the medium metabolic strength.

During Autumn weather has many changes,even interference between Summer and winter.Therefore in the Autumn the temperature of day time and night may be eratic and have large fluctuations. Therefore, this season leads to many problems like Eye infections, Skin infections, Allergic asthma, Gastroduodenal ulcers and increased risk of heart disorders.

**Favourable diet and lifestyle**

**Diet**

Follow Pitta Pacifying diet madhur,tikt, kashay (Sweet, Bitter and Astringent) food items are Pitta Pacifying.

Barley, wheat,moong Dal, sugar candy(shakkar), honey, patol, Amla, Jaggery, Grapes, milk, meat of dry land animals, pineapple, raisins,apple, avocado, beans, tofu, cow milk, cow ghee, Triphla Churna, Cardamom, Dalchini, Sweet fennel etc.

**Lifestyle**

Moderate exercise

Wear flower Garland of this season

Apply paste of sandal on body

Eat after short intervals.

**Unfavourable diet and Lifestyle**

**Diet**

Avoid oily, spicy,heavy,sour food items like curd, flesh of Aquatic animals.

**Lifestyle**

Avoid sun exposure

Heavy exercise

Don't stay hungry for long hours

Avoid overeating

Avoid day sleeping

Avoid Eastern wind

## HOW TO STAY HEALTHY IN HEMANT RITU (Early Winter)

**Hemant Ritu** (15ᵗʰ November-15ᵗʰ January) is Madhur Ras pradhan. Metabolic strength is strong in this season. So we can have heavy and oily food items to satisfy the metabolic fire (Jatharagni).

In this season due to cold vata gets absorbed in our body and detoriate the Dhatus and leads to some problems like cold.cough,dry skin problems like psoriasis, Airthritis,viral fever etc.

FAVOURABLE diet and lifestyle

Madhur-Amal-Lavan (Sweet-Sour-Salty) Ras pradhan food items are good to consume in this season to satisfy the metabolic fire and to pacify vata.

Wheat,Besan, whole wheat bread, milk products, sugarcane and sugary products, corn, hot milk, Jaggery, Ghee, Mishri, Amla, Lemon, spinach, leafy greens, clarified butter, Brussels, sprouts, Kiwi, guava, Grapefruit, Jamun, Pomegranate, flesh of Aquatic animals, Coconut, Raisins, curd, cheese, Kheer and herbs like mint, ginger, garlic, coriander, fennel, chamomile are good to consume ,as they are helpful to remove the toxins from the body .

FAVOURABLE LIFESTYLE

Do head massage with oil at least twice a week

Body massage with oil

Sesame oil infused with Bala herb help to prevent skin problems

Sunbathing

Stay in warm and cozy places.

Wear warm clothes.

Do exercise.Yoga and Pranayam

UNFAVOURABLE DIETAND Lifestyle

Avoid dry, cold and light food items in excess.

Areated drinks

Avoid pungent Bitter and Astringent (Katu-tikt-kashay) food items.

UNFAVOURABLE LIFESTYLE

Avoid luxury and leisure

Avoid day sleeping

Do not stay empty stomach for long time.

Avoid suppression of natural urges.

HOW TO STAY HEALTHY IN WINTER SEASON

**SHISHIR RITU** (15th January- 15th March)

Shishir Ritu is Tikta Ras (Bitter) pradhan. Kapha sanchay (accumulation) during the winter season is due to cold and damp caused by winds, clouds and rain.

Metabolic strength is strong in this season, so we can consume heavy and oily food items during this season in comparison of other seasons.

Due to cold in winter season vata gets absorbed in our body and detoriate the Dhatus and can lead to some problems like joints pain and Respiratory infections.

Favourable diet and lifestyle

Sweet-Sour-Salty (Madhur-Amal-Lavan) food items are good to consume.

Wheat, Besan, milk and milk products, sugarcane products, Jaggery, til, Dates, cow ghee, maize, urad Dal are good to eat. Seasonal fruits and vegetable juices,moong Dal kichdi, ginger, garlic are also good to consume.

Fruits like Apple, guava, grapes, Kiwi, pomegranate and citrus fruits have antioxidants and phytonutrients and have anti viral, antifungal properties ,so good to consume for the prevention of seasonal problems like cold, flu, asthma, bronchitis etc.

Herbs like ginger, garlic, clove, cinnamon are good to add in your daily diet for prevention of Respiratory infections.

Consume ginger and garlic with rock salt 15minutes before meals.It will increase the appetite and will reduce cough also.

Consume 1/2tsf Haritaki churna at bed time if someone has Habitual constipation.It also improve digestion.

Consume lukeworm water with lemon juice to strengthen the metabolic system.

Drink concoction (kadha) of ginger, clove, tulsi, cinnamon, mulethi (licorice) in the morning to prevent respiratory infections.

☐

Consume fibrous food, green vegetables, sprouted grains,nuts on regular basis.

☐

Drink gourd(lauki) juice empty stomach, you can add Tulsi and mint leaves for additional benefits.

☐

Til should be consumed to balance the disequalibrium of Vata Dosha.

Favourable life style

☐

Wear woolen clothes and cover your head and ear while going outside.

☐

Opt for active lifestyle

☐

Drink lukeworm water

☐

Do regular exercise

☐

UNFAVOURABLE DIET AND LIFESTYLE

☐

Avoid Bitter, pungent and Astringent ( Katu-tikt-kashay)food items.

☐

Avoid day time sleeping

☐

Avoid suppression of natural urges

☐

Don't stay empty stomach for long hours.

☐

Avoid luxurious and seddantary lifestyle.

☐

People suffering from hypertension and cardiac problems should avoid. Early morning and late evening walk.

☐

Avoid heaters in closed room because it reduces moisture and causes throat irritation.

☐

**Vasant- Ritu** (15ᵗʰ March-15ᵗʰ  May).

☐ ☐

Vasant-Ritu is called as Sandhikal of winter and summer in Ayurveda. So diet and lifestyle changes are required to cope up with the fluctuating temperature and to balance the Tridoshas to stay healthy.

This month has raised kapha Dosha (kapha prakop), kashay ras pradhan (astringent) by nature. That's why our body has average metabolism in this season.which leads to Respiratory infections and metabolic disorders.

So we have to follow some dietary and lifestyle changes to cope up with the season's nature to stay healthy without any medication.

Preferable foods

To pacify kapha consume, Barley, Wheat, Dalia, Chickpeas, old sali rice, maize, masoor, arhar, Radish, Gourd, carrot Bathua, chaulai, parval, mustard leaves, Methi, Spinach, Coriander, Ginger, Turmeric, cucumber, water melon, Panna (Raw mango drink)etc.

Take Haritaki churna 3gm in the morning empty stomach will help to pacify kapha.

Boiled water with saunth is good to balance Kahpa.

Take fresh neem leaves with black pepper to prevent skin allergies.

Consume Katu-Tikt-Kashay (bitter-pungent-astringant) food items to pacify kapha.

Foods to avoid

Heavy, Sour, Salty, Hot spices, sugarcane, onion, Potato, Buffalo milk, Dry foods(like biscuits, rice cakes etc. which leads to dehydration), undercooked vegetables.

Lifestyle

Avoid might time awakening (should sleep by 10 pm) 6-7 hour sleep is must. Avoid day time sleeping

Do exercise regularly (preferably in the early morning ).It reduces the accumulated kapha.

Massage and hot water bath help to balance Kapha.

## GRISHM RITU (15ᵗʰ May-15ᵗʰ July)

This month has vata sanchaya(mild increase)and Katu(pungent)Ras pradhan in nature.That's why leads to headache, giddiness etc. And over exposure to heat increased Pitta which leads to Gastrointestinal problems like acid reflux, diarrhoea, dysentery, vomiting, skin rash, acne and emotional mood swings like frustration, anger, impatience etc.

So,we have to follow some dietary and lifestyle changes to cope up with the season's nature to stay healthy without any medication.

Preferable foods

We need to balance Pitta in summer regardless our constitution.Our digestive fire(Jathargni)is naturally low during hot weather and we often experience decrease in appetite.So we should take care of this change by eating in moderation. Drink plenty of water throughout the day as it helps in flushing out the toxic matter from the body.Include ample of fruits and vegetables in your diet to beat the summer heat i.e.. watermelon slices, cucumber salads, Coconut water, barley water,sweet lassi,sweet cherries, sweet berries, egg whites, most grains, organic milk, soft cheese, bitter gourd, pumpkin, leafy greens, sprouts, asparagus, chaulai, sehjan, potato, mint, pomegranate, Grewia asiatica (phalsa), etc.

Consume herbal tea instead of carbonated drinks like mint tea which provides amazing relaxation and stamina. Barley water(Saktu) is another good choice to beat the heat.

Do not consume stale or leftover food as they contain harmful bacteria. Avoid tea, coffee, carbonated drinks because they will make you more dehydrated.

## Foods to avoid

Oily, spicy and sour foods like garlic sauces, marinated olives, Alcohol etc.

## Lifestyle

Wear loose and cotton clothes,drink water before going outside.Drink water after short intervals in case of night awakening to balance vata and kapha.Do swimming, relaxing in shades have cooling and calming effects.

*Know Ayurveda, Follow Ayurveda and Stay Healthy.*

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TRUE MORALITY is doing what is right without the threat of divine retribution nor the possibility of divine reward.
— Arthur Paliden
AtheistRepublic.com
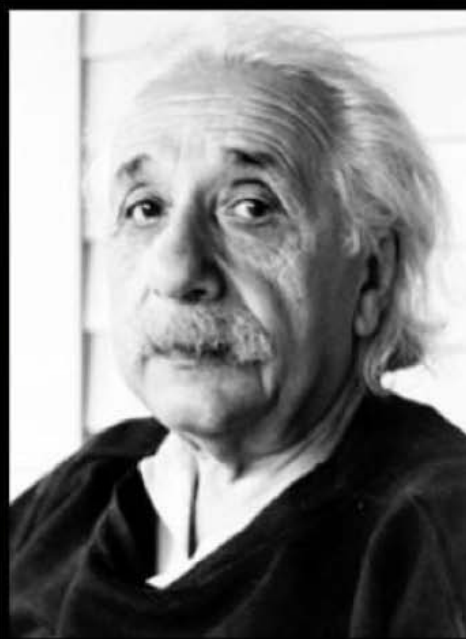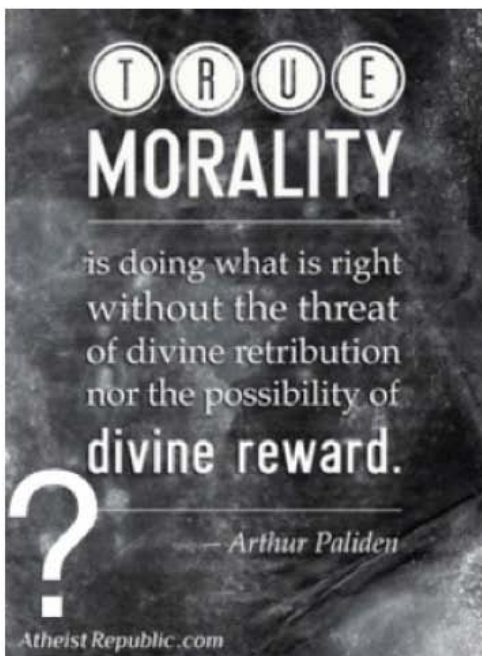
"If people are good only because they fear punishment, and hope for reward, then we are a sorry lot indeed."
~Albert Einstein

## शिक्षक –

मृणालिनी घुळे

शतदल सी हैं कलाएं जिसमें

शिक्षक है वह फूल कमल का।

सद्विवेक देता छात्रों को

सिंचन करता नयी फसल का।

शिक्षक ही है धुरा देश की

कुंभकार होता है शिक्षक।

कच्ची मिट्टी से है बनाता

चित्रकार हो या हो चिकित्सक।

वही परखता गुण छात्रों के

गढ़ता वही पंडित, वैज्ञानिक।

सादा जीवन उच्च विचार की

साक्षात् मूरत होता शिक्षक।

## मोह -

डॉ. संगीता पाहुजा

हर कोई है जानता,जन्म-मरण का यह सिलसिला

फिर भी बंधा है यह मानव मायाजाल के मोह में ।

कभी रिश्तो के मोह में,कभी भौतिक वस्तुओं

और सांसारिक सुखो के मोह में ।

हर सुख-दुःख का कारण है यह मोह ,हर कोई है जानता

इसी मोह ने बांधा सबको आवागमन के चक्र में ।

निकल न पाया कोई भी इस मायाजाल के चक्र से

कभी इसके,कभी उसके लिए कहकर फंसता मायाजाल चक्र में ।

इस मोह से मुक्त होकर मानव कभी सोचता

 तो न फंसता इस आवागमन के चक्र में ।

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 |

E-mail: mrinalinighule46@gmail.com
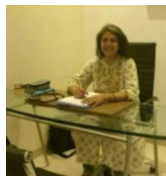
कवियत्री आयुर्वेदिक चिकित्सक हैं | आपने B.A.M.S. की उपाधि M.D. University, रोहतक से प्राप्त की | आपके दिल्ली एवं नॉएडा में परामर्श केंद्र है | धार्मिक, नारी एवं समाज उत्थान कार्यों में आपकी विशेष रूचि है|
संपर्क: मो. क्र.- 9953967901,

E-mail: sangeeta.pahuja3@gmail.com

—oo—

# You Start Dying Slowly…. :  आप धीरे-धीरे मरने लगते हैं….

**Pablo Neruda,**
**A Nobel Laurate for Literature in 1971, (Reproduced)**

**You start dying slowly...**

if you do not travel,

if you do not read,

If you do not listen to the sounds of life,

If you do not appreciate yourself.

**You start dying slowly...**

When you kill your self-esteem;

When you do not let others help you.

**You start dying slowly...**

If you become a slave of your habits,

Walking everyday on the same paths…

If you do not change your routine,

If you do not wear different colors

Or you do not speak to those you don't know.

**You start dying slowly...**

If you avoid to feel passion

And their turbulent emotions;

Those which make your eyes glisten

And your heart beat fast.

**You start dying slowly...**

If you do not change your life when you are not satisfied with your job, or with your love,

If you do not risk what is safe for the uncertain,

If you do not go after a dream,

If you do not allow yourself,

At least once in your lifetime,

To run away from sensible advice…

**आप धीरे-धीरे मरने लगते हैं**, अगर आप:

- करते नहीं कोई यात्रा,

- पढ़ते नहीं कोई किताब,

- सुनते नहीं जीवन की ध्वनियाँ

- करते नहीं किसी की तारीफ़।

**आप धीरे-धीरे मरने लगते हैं**, जब आप:

- मार डालते हैं अपना स्वाभिमान,

- नहीं करने देते मदद अपनी और न ही करते हैं मदद दूसरों की।

**आप धीरे-धीरे मरने लगते हैं**, अगर आप:*

- बन जाते हैं गुलाम अपनी आदतों के,

- चलते हैं रोज़ उन्हीं रोज़ वाले रास्तों पे,

- नहीं बदलते हैं अपना दैनिक नियम व्यवहार,

- नहीं पहनते हैं अलग-अलग रंग, या

- आप नहीं बात करते उनसे जो हैं अजनबी अनजान।

**आप धीरे-धीरे मरने लगते हैं**, अगर आप:*

- नहीं महसूस करना चाहते आवेगों को,

- और उनसे जुड़ी अशांत भावनाओं को,

- वे जिनसे नम होती हों आपकी आँखें,

- और करती हों तेज़ आपकी धड़कनों को।

**आप धीरे-धीरे मरने लगते हैं**, अगर आप:*

- नहीं बदल सकते हों अपनी ज़िन्दगी को, जब हों आप असंतुष्ट अपने काम और परिणाम से,

- अगर आप अनिश्चित के लिए नहीं छोड़ सकते हों निश्चित को

- अगर आप नहीं करते हों पीछा किसी स्वप्न का

- अगर आप नहीं देते हों इजाज़त खुद को

- अपने जीवन में कम से कम एक बार,

  - किसी समझदार सलाह से दूर भाग जाने की.।

**तब आप धीरे-धीरे मरने  लगते हैं**..!!*

*Students's Section*

# TEACHERS' DAY

**Riya Choudhary**

### *"A Mother gives birth to a child, A Teacher gives Life"*

As most accurately said by Harry Truman, "If you can read this, thank a teacher." A teacher is someone who acts like a ray of light, hope and blessing to escape the dark side of life and see the rainbow. When life seems to be a dark tunnel, a teacher shows the path to light. No finite number of words can ever explain the meaning, role and impact of a teacher in our lives. A teacher is a personification of 'Inspiration' and 'Guidance'. They play a significant role in shaping the future of children in particular, and shaping the future of the nation in general. Their contribution to the nation and our lives is too big to measure.

Here comes on the way, the day to celebrate 'those', who are equivalent to God- YES!! Teachers' Day. On Teachers' Day, we celebrate Teachers, their lessons, good memories, happy times, the punishments and everything. We remember our favorites and even the ones we always got in trouble with. Teachers' Day celebration is a way to show gratitude towards one of the greatest pillars in our lives and honour them for their indispensable role in society, nurturing lives, creating a better tomorrow.

**5ᵗʰ September – The Big Day:** In India, Teacher's Day is celebrated every year on September 5, to mark the birth anniversary of a great teacher Dr. Sarvepalli Radhakrishnan, who was a prominent believer of education and was a well known diplomat, scholar, the President of India and above all a TEACHER. It is said that when he became the President of India, his students and friends urged him to celebrate his birthday. Known for his humble and modest nature, he said, "Instead of celebrating my birthday, it would be a proud privilege if September 5 is observed as Teachers Day." Since then, from 1962, his birthday has been observed as "Teachers' Day" in the country.

**5th October – World Teacher's Day:** Since 1994, even UNESCO observes World Teacher's Day on 5ᵗʰ October, "a day devoted to appreciating, assessing and improving the educators of the world."

This day is celebrated to acknowledge the contributions made by mentors, gurus and teachers, who play a pivotal role in our lives.

**Teachers' Day Celebrations :** The celebration starts with a prayer, followed by lightning of lamp. Special cultural programs are conducted; celebratory songs and hymns are sung. Teachers are awarded for their efforts. Fun games are played. In some schools and colleges, higher class students take the role of a teacher for the day and special lunch is arranged for the teachers.

All the social media platforms are flooded with greetings and tributes to teachers. Some students and learners offer hand-made cards and presents to their teachers while others present bouquets.

**Role of Teacher:** A teacher is the most impactful person in our lives. They help us to differentiate the good and the bad. We are taught, not only the academic lessons but also the lessons of life. They inculcate the values in us and develop a culture within us. A good teacher always inspires and motivates us to be a better version of ourselves. Being a teacher is a selfless job and not everyone has the patience, love and knowledge to be a teacher. Every teacher has so much to offer, but it depends on us how much we take! A teacher can help us to win any battle, and no matter how much and whatever we do, we can never return the favor of our teachers on us.

*As they say, "It takes a big heart to shape little minds", celebrating Teachers' Day is just a way of thanking and showing love to all those who have been a part of the student's learning, development and have contributed in making them human.*

### HAPPY TEACHER'S DAY TO EVERY TEACHER AROUND!

Author is a student of B.Com (final) Taxation group in St. Aloysius College, Jabalpur. She is a part of College Assembly, regularly as a host/ motivator.

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Education is a social process.
Education is growth.
Education is not a preparation for life;
education is life itself.

- John Dewey

www.DreamThisDay.com

## हमारा पंचवर्षीय प्रवास



**Start: June-2012**



**April-2015**



**June-2016........**

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

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

*GROWING WITH CONCEPTS - Mathematics*

# LET'S DO SOME PROBLEMS IN MATHEMATICS

## Prof. SB Dhar

We learnt Chapter-wise Concepts in the past issues of this e-bulletin. We also discussed the Important Formulae of different branches of Mathematics. We are now starting from this issue a new segment of **Chapter-wise Multiple Choice Questions** for the readers with hinted solution.

This article deals with problems from the section **Sequences and Series** of **Algebra**. It may be assumed that these problems will be useful for the students who are either studying in 10+2 (Intermediate) Classes or aspiring for the prestigious Entrance Examination - JEE (Main) or IIT- Advanced.

Everyone has his or her own approach towards the solution of any problem according to his or her understanding of the concepts and self made some thumb-rules. Hence, the complete solutions are not being written here except the hints with concepts, so that the readers may enjoy their way of doing the problems. Someone has rightly said: eafty fey tk;sxh HkVdrs gh lgh] xqejkg rks oks gSa tks ?kj ls fudys gh ugha . So, go on attempting the questions. In case, some reader is unable to do the question(s) and is interested in detailed solution, he or she may request separately through mail or WhatsApp. He/she is being assured to get the required solution in no time.

1. **Let $\alpha$, $\beta$ be the roots of the equation $Ax^2-4x+1=0$; $\gamma$, $\delta$ be the roots of the equation $Bx^2-6x+1=0$. If $\alpha$, $\gamma$, $\beta$, $\delta$ are in Harmonic Progression, then the value of B-A is -**

   **(a)5        (b)6        (c)7        (d)8**

   *Hint: (a)*

   (a) Use the relation between sum of the roots' and product of the roots' relation with their coefficients for both the given equations.

   (b) For equation (i) $\alpha + \beta = \frac{4}{A}$; $\alpha.\beta = \frac{1}{A}$

   (c) For equation (ii) $\gamma + \delta = \frac{6}{B}$; $\gamma.\delta = \frac{1}{B}$

   (d) Since $\alpha$, $\gamma$, $\beta$, $\delta$ are in HP. Hence, $\frac{1}{\alpha}, \frac{1}{\gamma}, \frac{1}{\beta}, \frac{1}{\delta}$ will be in A.P.

   (e) Apply the conditions and evaluate: $\alpha = 1, \beta = \frac{1}{3}, \gamma = \frac{1}{2}, \delta = \frac{1}{4}$, A=3, B=8, and B-A=5.

2. **The condition that the roots of the equation $x^3-px^2+qx-r=0$ may be in AP is -**

   **(a)** $2p^2q + 27r = 9q^2$

   **(b)** $2p^2q - 27r = 9q^2$

   **(c)** $2p^2q + 27r + 9q^2 = 0$

   **(d) None of these**

   *Hint: (a)*

   (a)Let the roots be *a-d, a , a+d*

   (b) Use relations between coefficients and sum of roots, sum of product of two roots and product of all roots.

   (c) Evaluate: $a = \frac{p}{3}, a^2 - d^2 = \frac{3r}{p}, 2a^2 + \frac{3r}{p} = q$

   (d)Simplify: $2\left(\frac{p}{3}\right)^2 + 3\frac{r}{q} = q$

3. **Solution of the equation:** $\frac{x-1}{x} + \frac{x-2}{x} + \frac{x-3}{x} + \cdots + \frac{1}{x} = 3$, is –

(a)5        (b)6        (c)7        (d)8

*Hint: (c)*

(a) Rewrite the given expression as $\frac{1+2+3+\cdots+(x-3)+(x-2)+(x-1)}{x} = 3$

(b) Use the sum to n terms formula of AP and find x=7

4. **The least value of n (n$\in$ N) for which the sum of the series 1+3+32+33+...upto n terms exceeds 9000 is –**

(a)10              (b)9
(c)8              (d)None of these

*Hint: (b)*

(a) Use the formula for the sum to n terms of GP: $S_n = \frac{a(r^n-1)}{(r-1)}, r \neq 1, r > 1$

(b) Use inequality: $S_n > 9000$ and evaluate n=9

5. **The sum of the series to n terms:** $(x+y)+(x^2+xy+y^2)+(x^3+x^2y+xy^2+y^3)+....$ **is –**

(a) $\frac{1}{x-y}\left[\frac{x^2(1-x^n)}{1-x} - \frac{y^2(1-yx^n)}{1-y}\right]$

(b) $\frac{1}{x-y}\left[\frac{x^2(1-x^n)}{1-x} + \frac{y^2(1-yx^n)}{1-y}\right]$

(c) $\frac{1}{x+y}\left[\frac{x^2(1-x^n)}{1+x} - \frac{y^2(1-yx^n)}{1+y}\right]$

(d)None of these

*Hint: (a)*

(a) Rewrite the terms as: $(x+y) = \frac{x^2-y^2}{x-y}$, $(x^2+xy+y^2) = \frac{x^3-y^3}{x-y}$, $(x^{n-1}+x^{n-2}y+\cdots.+y^{n-1}) = \frac{x^n-y^n}{x-y}$

(b) The sum becomes: $\frac{1}{(x-y)}[(x^2-y^2)+(x^3-y^3)+\cdots.+(x^n-y^n)]$

(c) The sum is $\frac{1}{x-y}\left[\frac{x^2(1-x^n)}{1-x} - \frac{y^2(1-yx^n)}{1-y}\right]$

6. **If   x>0,   y>0,   z>0   then   (x+y)(y+z)(z+x)   is**

(a)$\leq$8xyz          (b)$\geq$3xyz
(c)$\leq$3xyz          (d)$\geq$ 8xyz.

*Hint: (d)*

(a) Use Inequality: AM $\geq$ GM

(b) $\frac{x+y}{2} \geq \sqrt{xy}, \frac{y+z}{2} \geq \sqrt{yz}, \frac{x+z}{2} \geq \sqrt{xz}$

(c) Multiply all together to get the required answer.

7. **In any triangle ABC, tanA+tanB+tanC is-**

(a)$\geq$3              (b)$\leq\sqrt{3}$
(c)$\leq 3\sqrt{3}$          (d)$\geq 3\sqrt{3}$

*Hint: (d)*

(a) For any triangle ABC, tanA+tanB+tanC= tanA tanB tanC as A+B+C=180⁰

(b) Use AM $\geq$GM Inequality: $\frac{tanA+tanB+tanC}{3} \geq \sqrt[3]{tanA.tanB.tanC}$

(c) Raise both sides to power 3 : $(tanA+tanB+tanC)^3 \geq 27(tanA.tanB.tanC)$
Or, $(tanA+tanB+tanC)^3 \geq 27(tanA+tanB+tanC)$

(d) Simplify to get the required result putting A=B=C

8. **If $a+b+c=3$ and $a,b,c$ are all positive quantities then**
(a) $a^2 b^2 c^2 \leq \frac{3^{10}2^4}{7^7}$
(b) $a^3 b^3 c^3 \geq \frac{3^{10}2^4}{7^7}$
(c) $a^2 b^3 c^2 \geq \frac{3^{10}2^4}{7^7}$
(d) $a^2 b^3 c^2 \leq \frac{3^{10}2^4}{7^7}$

*Hint: (d)*

(a) To bring $a^2$, divide $a$ into 2 parts $\frac{a}{2} + \frac{a}{2}$, to bring $b^3$, divide $b$ into 3 parts $\frac{b}{3} + \frac{b}{3} + \frac{b}{3}$ and for $c^2$, divide c into 2 parts $\frac{c}{2} + \frac{c}{2}$ and write a+b+c=3= $\frac{a}{2} + \frac{a}{2} + \frac{b}{3} + \frac{b}{3} + \frac{b}{3} + \frac{c}{2} + \frac{c}{2}$

(b) Use AM $\geq$GM

(c) $\dfrac{\frac{a}{2}+\frac{a}{2}+\frac{b}{3}+\frac{b}{3}+\frac{b}{3}+\frac{c}{2}+\frac{c}{2}}{7} \geq \sqrt[7]{\dfrac{a}{2}\cdot\dfrac{a}{2}\cdot\dfrac{b}{3}\cdot\dfrac{b}{3}\cdot\dfrac{b}{3}\cdot\dfrac{c}{2}\cdot\dfrac{c}{2}}$

(d) Simplify to get reach the result.

9. **Value of** $\displaystyle\sum_{i=1}^{n}\sum_{j=1}^{i}\sum_{k=1}^{j}1$ **, when n is 9, is –**

(a)165        (b)156        (c)265        (d)256

Hint: (a)

$$\sum_{i=1}^{n}\sum_{j=1}^{i}\sum_{k=1}^{j}1 = \sum_{i=1}^{n}\sum_{j=1}^{i}(j) = \sum_{i=1}^{n}\frac{i(i+1)}{2} = \frac{1}{2}\left(\sum n^2 + \sum n\right)$$

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

10. **If *a,b,c* are in HP, then the value of** $\dfrac{b+a}{b-a} + \dfrac{b+c}{b-c}$ **is –**

(a) 0        (b )1        (c) 2        (d)3

Hint: (c)

(a) Use the fact tht if *a,b,c* are in HP, then $\dfrac{1}{a}, \dfrac{1}{b}, \dfrac{1}{c}$ will be in AP.

(b) Rewrite the expression as

$$\frac{b+a}{b-a} + \frac{b+c}{b-c} = \frac{\frac{1}{a}+\frac{1}{b}}{\frac{1}{a}-\frac{1}{b}} + \frac{\frac{1}{c}+\frac{1}{b}}{\frac{1}{c}-\frac{1}{b}}$$

(c) assume $\dfrac{1}{b}-\dfrac{1}{a} = \dfrac{1}{c}-\dfrac{1}{b} = d$ , common difference

(d) simplify to get the value of the expression as 2.

11. **If *a,b,c* are positive real numbers representing the sides of a triangle, then –**

(a) $1 < \dfrac{a^2+b^2+c^2}{ab+bc+ca} < 2$

(b) $3 < \dfrac{a^2+b^2+c^2}{ab+bc+ca} < 4$

(c) $0 < \dfrac{a^2+b^2+c^2}{ab+bc+ca} < 1$

**(d) None of these**

Hint: (a), (b)

(a) Use Inequality: AM ≥ GM : $a^2 + b^2 \geq 2ab$, $b^2 + c^2 \geq 2bc,\ c^2 + a^2 \geq 2ca$

(b) On adding all together: $a^2 + b^2 + c^2 \geq ab + bc + ca$ or $ab + bc + ca \leq a^2 + b^2 + c^2$

(c) Use $\dfrac{b^2+c^2-a^2}{2bc} = \cos A \Rightarrow b^2 + c^2 - a^2 \leq 2bc$ ,as -1 ≤ cosA ≤ 1

(d) Use cos B and cos C and add all together to get $b^2 + c^2 + a^2 \leq 2bc + 2ca + 2ab$

(e) On joining Inequalities (b) and (d) get: $ab + bc + ca \leq a^2 + b^2 + c^2 \leq 2(ab + bc + ca)$

(f) Add 2ab+2bc+2ca to the extreme sides to get $3(ab + bc + ca) \leq a^2 + b^2 + c^2 \leq 4(ab + bc + ca)$

12. **Sum of the series** $\dfrac{1}{2^2-1} + \dfrac{1}{4^2-1} + \dfrac{1}{6^2-1} + \ldots\ldots + \dfrac{1}{20^2-1}$ **is –**

(a) $\dfrac{10}{21}$        (b) $\dfrac{1}{21}$

(c) $\dfrac{1}{2}$        (d)None of these

Hint: (a)

(a) Rewrite the expression as

$$\frac{1}{1\times3} + \frac{1}{3\times5} + \frac{1}{5\times7} + \ldots\ldots + \frac{1}{19\times21} =$$

$$\frac{1}{2}\left\{\left(\frac{1}{1}-\frac{1}{3}\right)+\left(\frac{1}{3}-\frac{1}{5}\right)+\left(\frac{1}{5}-\frac{1}{7}\right)+\ldots+\left(\frac{1}{19}-\frac{1}{21}\right)\right\} =$$

$$\frac{1}{2}\left\{\left(\frac{1}{1}-\frac{1}{21}\right)\right\} = \frac{10}{21}$$

13. **If *a,b,c,d* are four distinct quantities in HP then –**

(a)a+d>b+c        (b)ad>bc

(c)a+d=b+c        (d)ad=bc

*Hint: (a), (b)*

(a) *a,b,c,d* are in HP
(b) use concept AM>HM
(c) $\dfrac{a+c}{2} > b$ , $\dfrac{b+d}{2} > c \Rightarrow a+c > 2b$ , $b+d > 2c$
(d) on adding the two inequalities $a+c+b+d > 2b+2c \Rightarrow a+d > b+c$
(e) use GM>HM
(f) $\sqrt{ac} > b, \sqrt{bd} > c \Rightarrow \sqrt{abcd} > bc \Rightarrow ad > bc$ on squaring both sides

**14. If** $\dfrac{2n+1}{2n-1} + 3\left(\dfrac{2n+1}{2n-1}\right)^2 + 5\left(\dfrac{2n+1}{2n-1}\right)^3 + \ldots\ldots$ **to n terms**
**= 36, then n is**
(a) 4                   (b)5
(c)6                   (d)None of these

*Hint:(a)*

(a) Assume $x = \dfrac{2n+1}{2n-1}$
(b) Let $S_n = x + 3x^2 + 5x^3 + \ldots\ldots + (2n-1)x^n$
(c) Use method of difference
(d) $xS_n = x^2 + 3x^3 + 5x^4 + \ldots\ldots + (2n-1)x^{n+1}$
(e) subtract (d) from (b) shifting terms of b to one term right to get
$$(1-x)S_n = x + 2x^2\left\{\dfrac{1-x^{n-1}}{1-x}\right\} - (2n-1)x^{n+1}$$
$$\Rightarrow S_n = \dfrac{x}{1-x} + 2x^2\left\{\dfrac{1-x^{n-1}}{(1-x)^2}\right\} - (2n-1)\dfrac{x^{n+1}}{1-x} \Rightarrow$$
$$S_n = \dfrac{x+x^2}{(1-x)^2} \Rightarrow \dfrac{x+x^2}{(1-x)^2} = 36 \Rightarrow x = \dfrac{9}{7} \text{ or } \dfrac{4}{5} \Rightarrow n=4$$
or $\dfrac{9}{2}$ hence n=4

**15. If a, b, c, d are in GP, then (b-c)²+(c-a)²+(d-b)² is**
(a)(a-d)²                   (b) (a+d)²
(c) a=2d                   (d) None of these

Hint:

(a) a,b,c,d are in GP $\Rightarrow$ b²=ac, c²=bd, bc=ad
(b) The given expression on expansion is b²-2bc+c²+c²-2ac+a²+d²-2db+b²= (2b²-2ac)+(2c²-2bd)+(a²-2bc+d²)=0+0+(a²-2ad+d²)=(a-d)²

**16. The sum of the every pair of the first n natural numbers is**
(a) $\dfrac{n(n+1)(3n+2)(n-1)}{24}$
(b) $\dfrac{n(n+1)(n-1)(3n-2)}{24}$
(c) $\dfrac{n(n+1)(2n+1)}{12}$
(d)None of these

Hint: (a)

(a) We have to find out the value of (1.2+1.3+…+2.3+2.4+…3.4+3.5+…)
(b) Use Identity: $(1+2+3+…+n)^2 = (1^2+2^2+3^2+…+n^2) + 2(1.2+2.3+…)$ $\Rightarrow$
$$\left(\sum n\right)^2 = \sum n^2 + 2P \Rightarrow$$
$$P = \dfrac{\left(\sum n\right)^2 - \sum n^2}{2} =$$
$$\dfrac{1}{2}\left\{\left(\dfrac{n(n+1)}{2}\right)^2 - \left(\dfrac{n(n+1)(2n+1)}{6}\right)\right\} =$$
$$\dfrac{n(n+1)(n-1)(3n+2)}{24}$$

**17. The sum** $1(1)! + 2(2)! + 3(3)! + \cdots\ldots$ **upto n terms is**
(a)$(n+1)! - 1$       (b)(n)!
(c)n-1                   (d)None of these

*Hint: (a)*

(a) Write the $n^{th}$ term $T_n = n\,(n)! = \{(n+1) - 1\}\,(n)! = (n+1)(n)! - (n)!$
(b) Put n=1, n=2, and so on and add all the terms to get $S_n = (n+1)! - (1)!$

18. **Let X be the set consisting of the first 2018 terms of the AP 1, 6, 11, ….. and Y be the set consisting of the first 2018 terms of the AP 9, 16, 23,…. The number of elements in X∩Y is**
    **(a)3746**              **(b)3748**
    **(c)3749**              **(d)None of these**

    *Hint: (b)*

    (a) $X=\{1,6,11,......,10086\}$ and $Y=\{9,16,23,.....,14128\}$ Note that common differernce of the first is 5 and the common difference of the second is 7, so the common differrnce of the common terms series will be 5×7=35
    (b) $X∩Y=\{16,51,86,.....\}$
    (c) X has lesser number of terms than that of Y, so let m = n(X∩Y) or        16+(m-1)35 ≤ 10086 ⇒ m = 288
    (d) Use n(X∪Y) = n(X)+n(Y)-n(X∩Y)        ⇒ n(X∪Y) = 3748

19. **Let n be a positive integer and x(x+1)+(x+1)(x+2)+….+{x+(n-1)}(x+n)=10n has two consecutive integral solution then n is**
    **(a) 9        (b)10        (c)11        (d)12**

    *Hint: (c)*

    (a) The $n^{th}$ term of the LHS of the expression=$T_n$= $x^2+(2n-1)x+(n^2-n)$

(b) Write:
    $10n=\sum_{n=1}^{n}\{x^2 + (2n-1)x + (x^2-1)\}$
    $=x^2 \sum 1 + x \sum(2n-1) + \sum(n^2-1)$
    $3x^2+3nx+(n^2-31)=0$
(c) Assume the consecutive integral roots be α and α+1
    ⇒α+(α+1)=-n and α(α+1)=$\frac{n^2-31}{3}$
(d) On eliminating α from the two equations, we get $n^2-121=0$ ⇒n=11

20. **If a,b,c are positive rational numbers and 9(25a²+b²)+25(c²-3ac)=15b(3a+c),then**
    **(a)b,c,a are in AP**
    **(b)a,b,c are in AP**
    **(c)a,b,c are in GP**
    **(d)b,c,a are in GP**

    *Hint: (a)*

    Rewrite the given expression as -

    $(15a-3b)^2+(3b-5c)^2+(5c-15a)^2=0$.

    All the three quantities are positive as they are square. We know that some of the positive quantities is never zero except all are separately zero. Hence, 15a=3b=5c ⇒$\frac{a}{1} = \frac{b}{5} = \frac{c}{3}$ or we can say that $\frac{1}{1},\frac{1}{3},\frac{1}{5}$ are in HP or 1,3,5 are in AP i.e., a,c,b are in AP.

## Question of the week

*In a circle, the base and the height of a right angled triangle are 6 and 8 units respectively. Evaluate the height of the right angled triangle with the same area but base 2 units.*

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**e-Mail ID:** maths.iitk@gmail.com

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# Answers to Science Quiz  : Aug'18

**Kumud Bala**

| 1.  (c) | 2.  (b) | 3.  (a) | 4.  (a) | 5.  (a) | 6.  (a) | 7.  (c) | 8.  (c) | 9.  (dc | 10. (a) |
|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| 11.  (c) | 12.  (c) | 13.  (c) | 14.  (b) | 15.  (d) | 16.  (c) | 17.  (c) | 18.  (a) | 19.  (b) | 20. (c) |
| 21. (a) | 22. (a) | 23. (b) | 24. (b) | 25. (c) | 26. (b) | 27. (a) | 28. (c) | 29. (a) | 30. (a) |

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## ANSWER: CROSSWORD PUZZLE Aug'18: India's Fight For Freedom

**Prof. S.B. Dhar**

| | | | | | | | | | 1M | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 2C | H | A | N | D | R | A | G | U | P | 3T | A | | | | | |
| | 4F | | | | | | | | | G | | R | | | | | | | | |
| | A | | | | | | | | | H | | Y | | | | 5A | | | | |
| | H | | | | 6V | | 7B | | | A | | S | | | | L | | | | |
| 8V | I | J | A | Y | N | A | G | A | R | | O | | L | 9T | W | O | T | O | T | H | R | E | E |
| | E | | | | | S | | | | M | | E | | W | | | | X | | |
| | N | | 10M | | | C | | | | B | | M | | I | | 11M | | | A | |
| | | 12B | A | T | T | 13L | E | O | F | P | A | N | I | P | A | T | | E | | 14D | I | N | E | I | L | A | H | I |
| | | | H | | | O | | | | Y | | I | | R | | E | | | A | | D |
| | | | A | | | R | | | | T | | R | | D | | R | | | L | | E |
| | | | T | | | D | | | | H | | 15S | E | L | E | U | C | U | S | | A | | R |
| | | | M | | | C | | | | A | | | | S | | T | | | I | |
| | | | A | | | U | | | | N | | | | T | | | | | L | |
| | | | G | | | R | | | | E | | | | I | | | | | A | |
| | | | A | | | Z | | | | | | | | N | | | | | M | |
| | | | N | | | O | | | | | | | | Y | | | | | A | |
| | | | D | | | N | | | | | | | | | | | | | |
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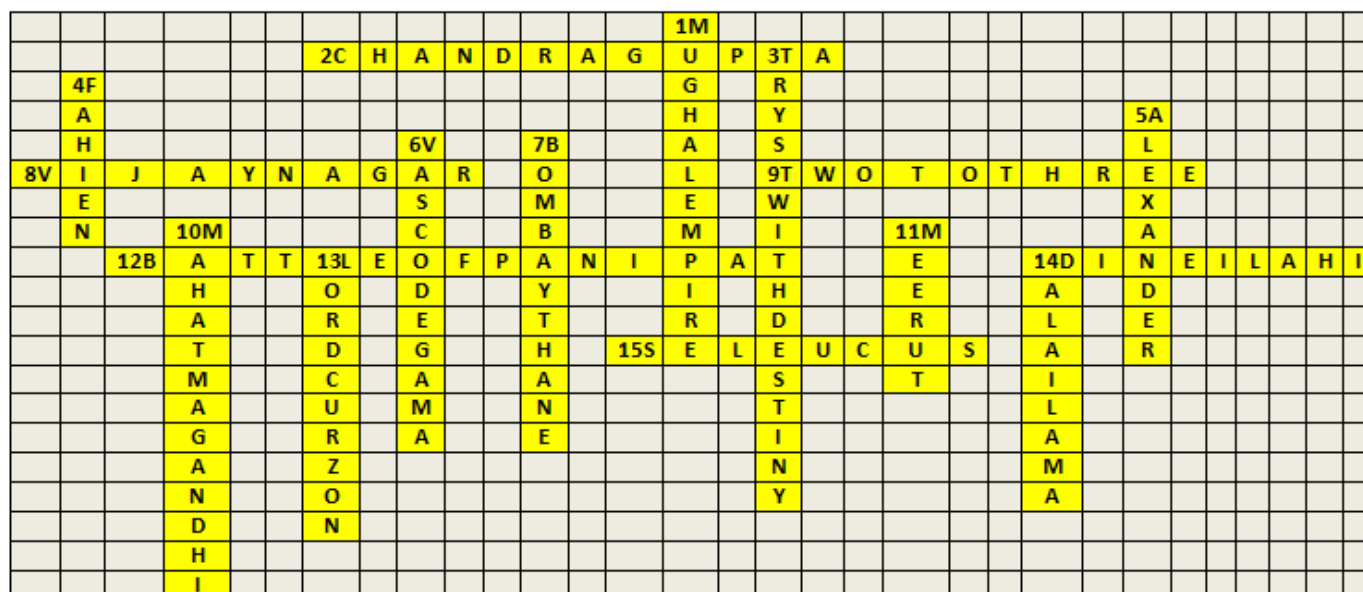
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*I have been impressed with the urgency of doing.*

*Knowing is not enough; we must apply.*

*Being willing is not enough; we must do.*

- *Leonardo da Vinci*

# CROSSWORD PUZZLE September'18: Enginners' Day

**Prof. SB Dhar**
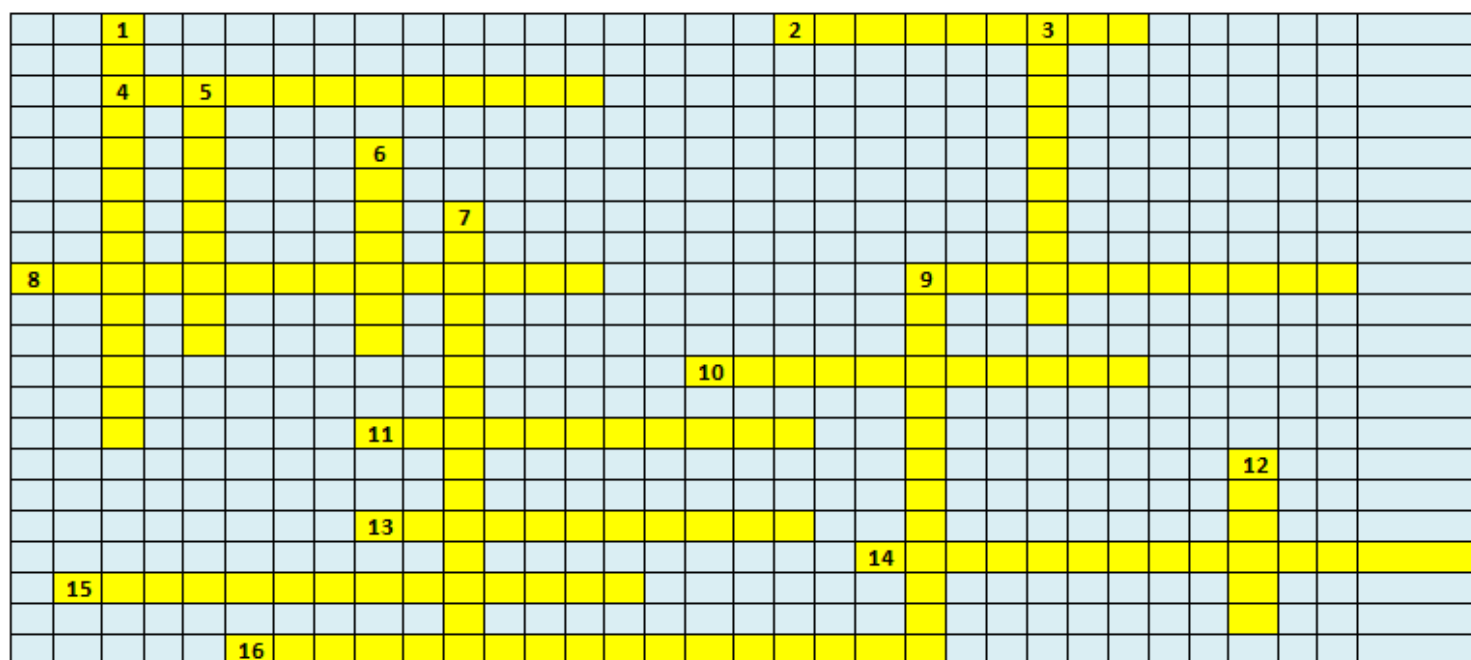
**ACROSS**

2. Engineers fill the gap between Science, Technology & ....

4. In the name of M Visvesvaraya, M stands for .....

8. Engineers possess .......

9. MV is recognized as ....

10. MV's most notable work is ......

11. Automatic flood gates were first installed at Reservoir...

13. Nation's highest award MV got .....

14. Engineers are by nature....

15. Engineers transform Theories into .....

16. Dam made by MV in Karnataka ....

**DOWN**

1. MV designed successfully .....

3. Block System relates to......

5. Sir MV was born in ......

6. Engineers' day in India is celebrated in September on....

7. As a chief engineer MV got constructed......

9. Engineers' Day is a tribute to.....

12. India  creates approximately Engineers in Lakhs.....

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*Growing with Concepts : Physics*

*Code: Phy/MRB-1/O/001*

# Solving Problems Involving – Mechanics of Rigid Bodies

*Mechanics elaborated in earlier sections was considering point objects, of infinitesimal size, and is therefore also called Particle Mechanics. This is a theoretical simplification of reality where objects have a shape with mass distributed across it.  There are objects in which, distance of each particle with respect to rest of the particles constituting the object remains fixed either in motion or under application of force. Such objects are called **rigid bodies** and involve integration of the effect of motion or force on each of the particle constituting the object. This has lead to evolution of **Mechanics of Rigid Bodies (MRB)**.  This concept of fixed relative distance in rigid bodies is again a theoretical consideration. But, there are materials and objects which under motion or application of force experience very small change in relative distance between the particles constituting the mass. Such objects, for all practical purposes  are fit for study and analysis on the principles of MRB which has evolved concepts mainly Centre of Mass (CM), Centre of Gravity (CG) and Moment of Inertia (MI).  These concepts go a long way in analysis of various phenomenon that are experienced around,  and inventions of tools and appliances that have made life easy.*

In our endeavour to groom competence to compete through Interactive Online Mentoring Sessions (IOMS) we are supplementing it with Mentors' Manual progressively in our monthly e-Bulletin and posting them on the web in Publication Section. Problem solving, after understanding of concepts, is an essential requirement for gaining proficiency. In this section, objective questions in Concepts of Physics, Volume-I, by H.C. Verma are considered excellent collection involving whirling around basic concepts being addressed. Illustrations have been framed to help students not connected to us through IOMS, or otherwise, in developing clarity of concepts and their application in problem solving. This is aimed at laying a foundation necessary for competence to solve question encountered in IIT-JEE, which involve integration of concepts and have a history of never asked before.

Answering objective questions, large in number with much shorter time, if not found easy, are generally attempted by students either by guess or imperfect intuition. Nevertheless, these objective questions unless handled analytically, choice of answer goes wrong and it costs heavily in terms of negative marks.

Answering maximum number of objective questions  correctly requires refined intuition, backed by rapid analysis involving dissection of the problem, not encountered anytime before, then apply related concept to each section and lastly integrate the analysis into a solution by negating options, out of the provided ones, not valid. It is practice with clarity of concepts, patience and perseverance that is needed to develop an ability to analyze complex problems mentally and offer extempore solution. This ability is regarded as high and refined the intuitive power. This endeavour is to groom competence in students through systematic-analysis, without resorting to shortcuts, in their formative stage. This bound to lead speed of analytical visualization tending to be speed on imagination. In this connection Albert Einstein, who is known for his extraordinary ability of thought experiments, his quote "*I have perspired more than inspired*" is highly inspiring.

Another, important method of developing high intuitive skill is *group dynamics*, where students discuss, problems and solutions attempted individually, in groups and try to clarify concepts. Only in case of disagreement they consult their mentor. It not only enhances collective wisdom but also helps to evolve individual ability and group synergy; both the traits are important attribute of a good  personality. This group dynamics is being integrated in learning and mentoring methodology of IOMS.

Possibility of inadvertent typographical errors is not ruled out. We would gratefully welcome suggestions for value addition and corrections, if needed.

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*Code: Phy/MRB-I/O/001*

# Mechanics of Rigid Bodies : Objective Questions (Typical)

**No of Questions: 62**                                   **Time Allotted: 3 Hours**

## All questions are compulsory

| | |
|---|---|
| Q-01 | Consider the following Two equations given here - **(A)** $\vec{R}_{cm} = \dfrac{1}{M}\sum_i m_i \vec{r}_i$, and **(B)** $\vec{a}_{cm} = \dfrac{\vec{F}}{M}$, then in a non-inertial frame -<br><br>**(a)** both are correct     **(b)** both are wrong     **(c)** A is correct but B is wrong     **(c)** B is correct but A is wrong |
| Q-02 | Consider the following two statements  -<br>   (A) Linear momentum of system remains constant<br>   (B) Center of mass of system remains constant<br>Then –<br>   (a) A implies B, and B implies A<br>   (b) A does not imply B, B does not imply A<br>   (c) A implies B, but B does not imply A<br>   (d) B implies A but A does not imply B |
| Q-03 | Consider the following Two statements –<br>   (A) Linear momentum of system of particles is Zero.<br>   (B) Kinetic energy of system of particles  is Zero<br>Then,<br>   (a) A implies B, and B implies A<br>   (b) A does not imply B, B does not imply A<br>   (c) A implies B, but B does not imply A<br>   (d) B implies A but A does not imply B |
| Q-04 | Consider the following Two statements –<br>   (A) Linear momentum of system of a particle is independent of the frame of reference.<br>   (B) Kinetic energy of system of  a particle  is independent of frame of reference<br>Then,<br>   (a) Both A and B are true<br>   (b) A is true but B is false<br>   (c) A is false but B is true<br>   (d) Both A and B are false |
| Q-05 | All particles of a body are situated at a distance $R$ from the origin. The distance of centre of mass of the body from the origin is –<br>   **(a)** $= R$     **(b)** $\leq R$     **(c)** $> R$     **(d)** $\geq R$ |

| Q-06 | A circular plate of diameter d is kept in a contact with a square plate of edge d as shown in the figure. The density of the material and thickness of both the plates is uniformly same. The centre of mass of the composite system will be – <br> **(a)** Inside the circular plate <br> **(b)** Inside the square plate <br> **(c)** At the point of contact <br> **(d)** Outside the system |
|------|---|
| Q-07 | Consider a system of two identical particles. One of the particle is at rest and the other has an acceleration a. The centre of mass of the system has an acceleration – <br><br> **(a)** Zero    **(b)** $\frac{1}{2}\vec{a}$    **(c)** $\vec{a}$    **(d)** $2\vec{a}$ |
| Q-08 | Internal forces in a system can change – <br> **(a)** Linear momentum but not the kinetic energy of the system <br> **(b)** Kinetic energy of the system but not its linear momentum <br> **(c)** Linear momentum as well as kinetic energy <br> **(d)** Neither the linear momentum nor the kinetic energy |
| Q-09 | A bullet hits a block kept at rest on a smooth horizintal surface and gets embedded into it. Which of the following does not change? <br> **(a)** Linear momentum of the block <br> **(b)** Kinetic energy of the block <br> **(c)** Gravitational potential energy of the block <br> **(d)** Temperature of the block |
| Q-10 | A uniform sphere is placed on a smooth horizontal surface and a horizontal force $F$ is applied on it at a distance $h$ above the surfce. The acceleration of the centre is – <br> **(a)** Maximum when $h = 0$ <br> **(b)** Maximum when $h = R$ <br> **(c)** Maximum when $h = 2R$ <br> **(d)** Independent of Maximum when $h$ |
| Q-11 | A body falling vertically downward under gravity breaks into two pieces of unequal masses. The centre of mass of the two parts taken together shift horizontally towards - <br> **(a)** Heavier piece <br> **(b)** Lighter piece <br> **(c)** Does not shift horizontally <br> **(d)** Depends on the vertical velocity at the time of breaking. |
| Q-12 | A body at rest break into two pieces of unequal masses. The parts will move – <br> **(a)** In the same direction <br> **(b)** Along different lines <br> **(c)** In opposite directions with equal speed <br> **(d)** In opposite directions with unequal speed |

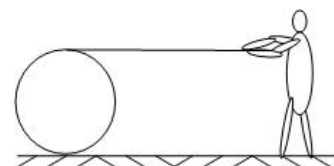| | |
|---|---|
| Q-13 | A heavy ring of mass $m$ is clamped on the periphery of a light circular disc. A small particle having equal mass is clamped at the centre of the disc. The system is rotated in such a way that the centre moves in a circle of radius $r$ with a unform speed $v$. We can conclude that an external force – <br><br> **(a)** $\dfrac{mv^2}{r}$ must be acting on the central particle      **(b)** $\dfrac{2mv^2}{r}$ must be acting on the central particle <br><br> **(c)** $\dfrac{2mv^2}{r}$ must be acting on the system      **(d)** $\dfrac{2mv^2}{r}$ must be acting on the ring. |
| Q-14 | A nucleus moving with veocity $\vec{v}$ emits an α-particle. Let the velocities of the α-particle and the remainibg nuleus be $\vec{v}_1$ and $\vec{v}_2$ and their masses $m_1$ and $m_2$. Then – <br><br> **(a)** $\vec{v}$, $\vec{v}_1$ and $\vec{v}_2$ must be parallel to each other <br> **(b)** None of the two of $\vec{v}$, $\vec{v}_1$ and $\vec{v}_2$ should be parallel to each other <br> **(c)** $\vec{v}_1 + \vec{v}_2$ must be parallel to $\vec{v}$ <br> **(d)** $m_1\vec{v}_1 + m_2\vec{v}_2$ must be parallel to $\vec{v}$ |
| Q-15 | The centre of mass of a system of particles is at the origin. It follows that – <br> (a) The number of particles to the right of origin is equal to the number of particles to the left <br> (b) The total mass of particles to the right of the origin is same as the total mass to the left of the origin <br> (c) The number off pariciles on X-axis should be equal to number of particesn on Y-axis <br> (d) If there is a particle on (+)ve X-axs, there must be at least one particle on the (-)ve X-axis. |
| Q-16 | A body has its centre of mass at the origin. The coordinates of the particles – <br> (a) May be all positive <br> (b) May be all negative <br> (c) May be all non-negative <br> (d) May be positive for some particles and negative for others |
| Q-17 | In which of the following cases the centre of mass of a rod o a unifoem cross-section, is certainly not at its centre – <br> (a) The density continuously increases from left to right <br> (b) The density continuously decreases from left to right <br> (c) The density decreases from left to centre and then increases <br> (d) The density increases from left to centre and then decreases |
| Q-18 | If the external forces acting on a system have a zero resultant, the centre of mass – <br> (a) Must not move      (b) Must not accelerate <br> (c) May move      (d) May accelerate |

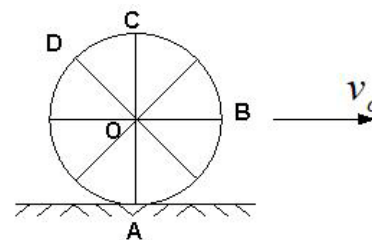| Q-19 | A non-zero external force acts on a system of particles. The velocity and the acceleration of the centre of mass are found to be $v_0$ and $a_0$ at an instant $t$. It is possible that – <br><br> (a) $v_0 = 0$, $a_0 = 0$    (b) $v_0 = 0$, $a_0 \neq 0$    (c) $v_0 \neq 0$, $a_0 = 0$    (d) $v_0 \neq 0$, $a_0 \neq 0$ |
|---|---|
| Q-20 | Two balls are simultaneously thrown in air. The acceleration of centre of mass of the two balls while in air – <br><br> (a) Depends on the direction of motion of the balls <br> (b) Depends on the masses of the two balls <br> (c) Depends on the speed of the two balls <br> (d) Is equal to $g$ |
| Q-21 | A block moving in air breaks in two parts separate parts. Then – <br> (a) The total momentum must be conserved <br> (b) The total kinetic energy must be conserved <br> (c) Total monentum must change <br> (d) Total kinetic energy must change |
| Q-22 | Let $\vec{A}$ be a unit vector along the axis of rotation of a purely rotating body and $\vec{B}$ be a unit vector along the velocity of a particle $P$ of the body away from the axis. The value of $\vec{A} \cdot \vec{B}$ is – <br><br> (a) 1    (b) -1    (c) 0    (d) None of these |
| Q-23 | A body is uniformly rotating about an axis fixed in an internal frame of reference. Let $\vec{A}$ be a unit vector along the axis of rotation and $\vec{B}$ be a unit vector along the resultant force on a particle $P$ of the body away from the axis. The value of $\vec{A} \cdot \vec{B}$ is – <br> (a) 1    (b) -1    (c) 0    (d) None of these |
| Q-24 | A particle moves with a constant velocity parallel to the X-axis. Its angular momentum with respect to origin is – <br> (a) Zero    (b) Remains constant    (c) Goes on increasing    (d) Goes on decreasing |
| Q-25 | A body is in pure rotation. The linear speed $v$ of a particle, the distance $r$ of the particle from the axis and the angular velocity $\omega$, such that $\omega = \dfrac{v}{r}$. Thus – <br><br> (a) $\omega \propto \dfrac{1}{r}$    (b) $\omega \propto r$    (c) $\omega = 0$    (d) $\omega$ is independent of $r$ |
| Q-26 | Figure shows a small wheel fixed coaxially on a bigger wheel of double of its radius. The system rotates about a common axis. The strings supporting masses A and B do not slip on the wheels. If $x$ and $y$ are distances travelled by masses A and B in the same intrval, then – <br> (a) $x = 2y$    (b) $x = y$    (c) $y = 2x$   (d) None of these |

| Q-27 | A body is rotating uniformly about a vertical axis fixed in an inertial frame. The resultant force on a particle of the body not on the axis is – |
|---|---|
|  | (a) Vertical  (b) Horizontal and skew with the axis  (c) Horizontal and intersecting the axis  (d) None of these |
| Q-28 | A body is rotating non-uniformly about a vertical axis in an inertial frame. The resultant force on a particle of the body not on the axis is – |
|  | (a) Vertical  (b) Horizontal and skew with the axis  (c) Horizontal and intersecting the axis  (d) None of these |
| Q-29 | Let a force $\vec{F}$ is acting on a particle which has position vector $\vec{r}$. Let $\vec{\Gamma}$ be the torque of this force about the origin, then – |
|  | (a) $\vec{r}\cdot\vec{\Gamma}=0$ and $\vec{F}\cdot\vec{\Gamma}=0$    (b) $\vec{r}\cdot\vec{\Gamma}=0$ and $\vec{F}\cdot\vec{\Gamma}\neq 0$ |
|  | (c) $\vec{r}\cdot\vec{\Gamma}\neq 0$ and $\vec{F}\cdot\vec{\Gamma}=0$    (d) $\vec{r}\cdot\vec{\Gamma}\neq 0$ and $\vec{F}\cdot\vec{\Gamma}\neq 0$ |
| Q-30 | One end of a uniform rod of mass $m$ and length $l$ is clamped. The rod lies on a smooth horizontal surface and rotates on it about the clamped end at a uniform angular velocity $\omega$. The force exerted by the clamp on the rod has a horizontal component – |
|  | (a) $m\omega^2 l$    (b) Zero    (c) $mg$    (d) $\dfrac{1}{2}m\omega^2 l$ |
| Q-31 | A uniform rod is kept of length $l$ is kept vertically on a horizotal smooth surface at a point O. It it is rotated slightly and released, it will fall down on the horizontal surface. The lower end will remain – |
|  | (a) At O    (b) At a distance less than $\dfrac{l}{2}$ from O |
|  | (c) At a distance less than $\dfrac{l}{2}$ from O    (d) At a distance larger than $\dfrac{l}{2}$ from O |
| Q-32 | A circular disc P of radius $r$ is made up of of iron plate of uniform thickness $t$ and another circular disc Q of radius $4r$ is made up of iron plate of thickness $\dfrac{t}{4}$. The relation between moment of inertial $I_P$ and $I_Q$ is - |
|  | (a) $I_P > I_Q$    (b) $I_P = I_Q$    (c) $I_P < I_Q$    (d) Depends upon actual values of $t$ and $r$. |
| Q-33 | Equal torques act on the Two circular discs A and B having radius $r$ and uniform thickness $t$ and another circular of radius $4r$ is made upof iron plate of thickness $\dfrac{t}{4}$, are made up of same material. At some instant linear speed of a point on rim of A and B are $v_A$ and $v_B$, respectively. Then, |
|  | (a) $v_A > v_B$    (b) $v_A = v_B$   (c) $v_A < v_B$    (d) Depends on actual magnitude of torque |

| Q-34 | A closed cylindrical tube containing some water (not filling the entire tube) lies in a horizontal plane. If the tube is rotated about a perpendicular bisector, the moment of inertia of water about the axis – |
|---|---|
| | (a) Increases |
| | (b) Decreases |
| | (c) Remains constant |
| | (d) Increases if the rotation is clockwise and decreases if it is is anti-clockwise |

| Q-35 | The moment of inertia of a uniform semicircular wire of mass $M$ and radius $r$ about a line perpendicular to the plane of wire through the centre is – |
|---|---|
| | (a) $Mr^2$      (b) $\dfrac{1}{2}Mr^2$      (c) $\dfrac{1}{4}Mr^2$    (d) $\dfrac{2}{5}Mr^2$ |

| Q-36 | If $I_1$ and $I_2$ are the moment of inertia of two bodies of identical geometry. The first is made of Aluminium and second is of iron.  Then – |
|---|---|
| | (a) $I_1 < I_2$          (b)   $I_1 = I_2$ |
| | (c)  $I_1 > I_2$          (d) Relation between $I_1$  and $I_2$ depends upon actual shape of the bodies. A |

| Q-37 | A body having its centre of mass at the origin has three of its particles at $(a,0,0)$, $(0,a,0)$ and $(0,0,a)$. The moments of inertia of the system of masses about X-axis and Y-axis are $0.20$ kg. m² . Then the moment of inertia about Z-axis is – |
|---|---|
| | (a)  $0.20$ kg. m²        (b)   $0.40$ kg. m² |
| | (c)  $0.10$ kg. m²        (d)  Cannot be deduced with the given information |

| Q-38 | A cubical block of mass $m$ and edge $a$ slides down a rough inclined plane at an inclination $\theta$ with a uniform velocity. The torque of the normal force on the block about its centre has a magnitude – |
|---|---|
| | (a) Zero    (b) $mga$    (c) $mga\sin\theta$    (d) $\dfrac{1}{2}mga\cos\theta$ |

| Q-39 | A thin circular ring of mass $M$ and radius $r$ is rotating about its axis with an angular speed $\omega$. Two particles of mass $m$ each are attached to to the ring at diametrically opposite point. The angular speed of the ring will become – |
|---|---|
| | (a)  $\dfrac{\omega M}{M+m}$    (b)  $\dfrac{\omega M}{M+2m}$    (c)  $\dfrac{\omega(M-2m)}{M+2m}$    (d)  $\dfrac{\omega(M+2m)}{M}$ |

| Q-40 | A person sitting firmly over a rotating stool has his arms stretched. If he folds his arms, his angular momentum about axis of rotation would – |
|---|---|
| | (a) Increase    (b) Decrease    (c) Remain unchanged    (d) Doubles |

| Q-41 | Centre of a wheel rolling on a plane surface move with a speed $v_0$. A particle on the rim of the wheel at the same level as the centre will be moving at speed - |
|---|---|
| | (a) Zero        (b) $v_0$      (c) $\sqrt{2}v_0$      (d) $2v_0$ |

| | |
|---|---|
| Q-42 | A wheel of radius $20$ cm is pushed to move it on a rough horizontal surface. It is found to move through a distance of $60$ cm on the road during the time its completes one revolution about the centre, Assume that the linear and angular acceleration is uniform. The frictional force acting on the wheel by the surface is –<br>(a) Along the velocity of the wheel<br>(b) Opposite to the velocity of the wheel<br>(c) Perpendicular to the velocity of the wheel<br>(d) Zero |
| Q-43 | The angular velocity of the engine ( and hence of the wheel) of a scooter is proportional to the petrol input per second. The scooter is moving on a frictionless road with unform velocity. If petrol input is increased by 10%, the linear velocity of scooter is increased by –<br>(a) 50%    (b) 10%    (c) 20%    (d) 0% |
| Q-44 | A solid sphere, a hollow sphere and a disc, all having same mass and radius, are placed at the top of a smooth incline and released. Least time will be taken in reaching the bottom by –<br>(a) The sold sphere     (b) The hollow sphere     (c) The disc       (d) All will take same time |
| Q-45 | A solid sphere, a hollow sphere and a disc, all having same mass and radius, are placed at the top of a incline plane and released. Frictional coefficients between the objects and the incline are same and not sufficient to allow pure rolling. Least time will be taken in reaching the bottom by –<br>(a) The sold sphere     (b) The hollow sphere     (c) The disc       (d) All will take same time |
| Q-46 | A solid sphere, a hollow sphere and a disc, all having same mass and radius, are placed at the top of a smooth incline and released. Frictional coefficients between the objects and the incline are same and not sufficient to allow pure rolling. Smallest kinetic energy at the bottom of the incline will be achieved by –<br>(a) The sold sphere      (b) The hollow sphere<br>(c) The disc              (d) All achience the same kinetic energy |
| Q-47 | A string of negligible thickness is wraped several times around a cylinder kept on a rough horizontal surface. A man standing at a distance $l$ from the cylinder holds one end of the string and pulls the cylinder towards him as shown in the figure. There is no slipping anywhere. The length of the string passed through the hand of the man while the cylinder reaches his hands is –<br>(a) $l$      (b) $2l$      (c) $3l$      (d) $4l$ |
| Q-48 | Axis of rotation of a purely rotating body –<br>(a) Must pass through the centre of mass<br>(b) May pass through the centre of mass<br>(c) Must pass through a particle of the body<br>(d) May pass through a particle of the body |
| Q-49 | Consider following two equtions : (A) $L = I\omega$    (B) $\dfrac{dL}{dt} = \Gamma$ , then in noninertial frame –<br><br>(a) Both A and B are true       (b)  A is true but B is false<br>(c)  B is true but A is false      (d)  Both A and B are false |

| | |
|---|---|
| Q-50 | A particle moves on a straight line with a uniform velocity. Its angular momentum is <br>    (a) Always zero <br>    (b) Zero about a point on the straight line <br>    (c) Not zero about a point away from the straight line <br>    (d) Remains constant about any given point |
| Q-51 | If there is no external force acting on a rigid body, which of the following quantities must remain constant ? <br>    (a) Angular momentum    (b) Linear momentum <br>    (c) Kinetic energy           (d) Moment of inertia |
| Q-52 | Let $I_A$ and $I_B$ be moment of inertia of a body about two axes A and B respectively. The axis A passes through the centre of mass of the body but B does not. Then – <br>    (a) $I_A < I_B$ <br>    (b) If $I_A < I_B$, the axes are parallel <br>    (c) If axes are parallel, $I_A < I_B$ <br>    (d) If axes are not parallel then $I_A \geq I_B$ |
| Q-53 | A sphere is rotating about a diameter. Then- <br>    (a) The particles on the surface of the sphere do not have any linear acceleration <br>    (b) The particles on the diameter do not have any linear acceleration <br>    (c) Different particles on the surface have different angular speed <br>    (d) All particles on the surface have same linear speed. |
| Q-54 | The density of a rod gradually decreases from one end to the other. It is pivoted at an end so that it can move about a vertical axis passing through the pivot. A horizontal force F is applied on the free end in a diretion perpendicular to the rod. The quantities that do not depend on which end of the rod is pivoted are – <br>    (a) Angular acceleration <br>    (b) Angular velocity when rod completes one revolution <br>    (c) Angular momentum when rod completes one rotation <br>    (d) Torque of the applied force |
| Q-55 | Consider a wheel of a bicycle rolling on a level road at a linear velocity $\vec{v}_0$ as shown in the figure . Then- <br>    (a) Speed of particle A is zero <br>    (b) Speed of particles B, C and D are all equal to $v_0$ <br>    (c) Speed of C is $2v_0$ <br>    (d) Speed of B is greater than the speed of O <br>  |
| Q-56 | Two uniform solid spheres having unequal masses and unequal radii are released from rest from the same height on a rough inclined plane. If sphere rolls without slipping, then – <br>    (a) The heavier sphere reaches the bottom first <br>    (b) The bigger sphere reaches the bottom first <br>    (c) The two two sphere reach the bottom together <br>    (d) The information given is insufficient to answer which sphere will reach the bottom first. |

| Q-57 | A hollow sphere and a solid sphere having same mass and same radii are rolled down a rough inclined plane. Then –<br>(a) The hollow sphere reaches the bottom first<br>(b) The solid sphere reaches the bottom with greater speed<br>(c) The solid sphere reaches the bottom with greater kinetic energy<br>(d) The two spheres will reach the bottom with same linear momentum |
|------|---|
| Q-58 | A sphere cannot roll on a –<br>(a) Smooth horizontal surface<br>(b) Smooth inclined surface<br>(c) Rough horizontal surface<br>(d) Rough inclined surface |
| Q-59 | In rear-wheel drive cars, the engine rotates the rear wheels and the front wheels rotate only because the car moves. If such a car accelerates on a horizontal road, the friction –<br>(a) On the rear wheel is in forward direction<br>(b) On the front wheel is in backward direction<br>(c) On the rear wheel has a larger magnitude than the friction on the front wheel<br>(d) On the car is in the backward direction |
| Q-60 | A sphere can roll on a surface inclined at an angle $\theta$ if the frictional coefficient is more than $\dfrac{2}{7} g \tan\theta$.<br><br>Suppose the coefficient of friction is $\dfrac{1}{7} g \tan\theta$. If sphere is released from rest on the incline then –<br><br>(a) It will stay at rest<br>(b) It will make pure translational motion<br>(c) It will translate and rotate about the centre<br>(d) The anglar moentum of the sphere aboiut its centre will remain constant |
| Q-61 | A sphere is rolled on a rough horizontal surface. It gradually slows down and stops. The force of friction tries to –<br>(a) Decrease the linear velocity<br>(b) Increase the angular velocity<br>(c) Increase the linear momentum<br>(d) Decrease the angular momentum |
| Q-62 | As shown in the figure, a smooth plane inclined at an angle $\theta$ is fixed in a car. The car is having an acceleration $a = g \tan\theta$ on a horizontal road. If the sphere is set in pure rolling on the incline then-<br>(a) It will continue pure rolling<br>(b) It will slip down the plane<br>(c) Its linear velocity will increase<br>(d) Its linear velocty will slowly decrease |

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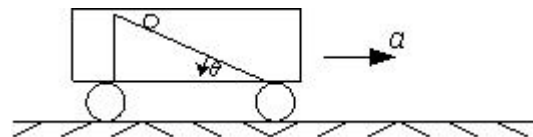
*Growing with Concepts:  Chemistry*

# STATES OF MATTER

<div align="right">

Kumud Bala

</div>

Matter exists in three different physical states, namely solid, liquid and gaseous states. Comparison of the characteristics of a solid, a liquid and a gas is given below.

| | | | |
|---|---|---|---|
| 1 | Solids have both a shape and a definite volume. | Liquids do not have shapes but have definite volumes. | Gases have neither definite shapes nor definite volumes. |
| 2 | Molecules of a solid possess least energy. | Molecules of a liquid have energies more than those of solids. | Gas molecules are most energetic. |
| 3 | The positions of molecules in the crystal lattice are fixed and hence solids do not have translatory or rotatory motion but only possess vibratory motion. | Molecules of a liquid have greater freedom of movement. They have some translatory and rotatory motion in addition to the vibratory motion. | Molecules of a gas have large rotatory, vibratory and translatory motions. |
| 4 | Solids possess least compressibility and thermal expansion. | Liquids have slightly higher compressibility and thermal expansion than those of solids. | Gases possess high compressibility and thermal expansion. |
| 5 | Molecules are closely packed (intermolecular distance are of the order of $10^{-8}$ cm). | Molecules are less closely packed (intermolecular distance are greater than in solid but less than in gases). | Molecules are sufficiently apart from one another (intermolecular distance are of the order of $10^{-7} - 10^{-5}$ cm). |
| 6 | Intermolecular forces of attraction are the strongest. | Intermolecular forces of attraction are weaker than those in solids. | Intermolecular forces of attraction are almost negligible. |
| 7 | The density of solids is high. For example, iron, silver, common salt. | The density of liquids is lower than that of solids but it is much higher than that of gases. For example, water, alcohol, milk and oil. | Gases generally have low densities. For example, air, $CO_2$, oxygen, hydrogen. |

It may be noted that a given substance may also exist simultaneously in all the three states under certain specific conditions of temperature and pressure. For example, water exists in all the three phases simultaneously i.e., ice, water and water vapour at $0.01^{°}$C and 4.58 mm of Hg pressure. "The temperature at which all the three phases of same substance exist simultaneously is called triple point".

**Intermolecular forces:-**  The forces of attraction and repulsion between interacting particles( atoms and molecules) are called intermolecular forces. Such forces exist in all the states of matter and are responsible for

many structural features and physical properties of matter. It may be noted that this term does not include the electrostatic forces that exist between the two oppositely charged ions and the forces that hold atoms of a molecule together i.e., covalent bonds. Intermolecular forces are weak forces. The existence of weak attractive intermolecular forces was first proposed by the Dutch scientist Johannes Vander Waals, who studied the effect of these molecular forces on the behavior of real gases. In his honour, these forces are called Vander Waals forces. Such forces come into existence due to the interplay of the positive and negative charges between the neighboring atoms of non-polar molecules when they are very close to each other. Intermolecular forces arise due to the following types of interactions:-

1. Dispersion forces or London forces – Atoms(He, Ne) and non-polar molecules($H_2$, $Cl_2$, $O_2$, $CH_4$) are electrically symmetrical and have no dipole moment because their electronic charge cloud is symmetrically distributed. But the intermolecular forces may exist even in these non-polar atoms such as noble gases or non-polar molecules. This is because the noble gases and non-polar molecules can be liquefied suggesting that there must be some intermolecular attraction. In other words, a dipole may develop momentarily even in such atoms or molecules. In order to understand the origin of these forces, let us consider two noble gas atoms A and B very close to each other. Each atom is uncharged because its electronic charge cloud is symmetrically distributed around the nucleus.
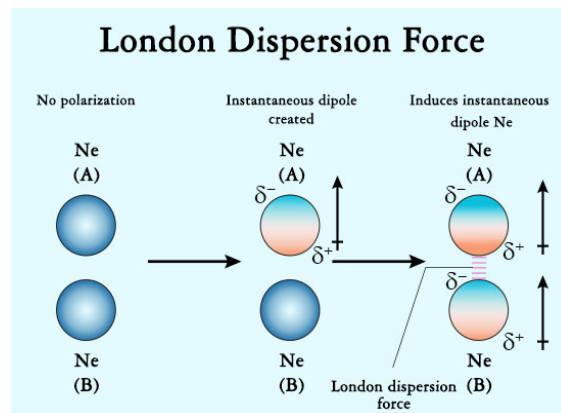


However, due to the motion of the electrons, we can imagine that for a fraction of time, the electronic charge distribution in one of the atoms say 'A' becomes unsymmetrical, i.e., charge cloud is more on one side than the other. During this very short period, the unsymmetrical centers of positive and negative charges do not coincide. As a result of this instantaneous distribution of electrons in the atom, a small temporary dipole known as instantaneous dipole is created. This instantaneous or transient dipole distorts the electron distribution in the neighboring atom 'B' and induces dipole known as instantaneous induced dipole. The temporary dipoles of atoms 'A' and 'B' attract each other. These attractive forces are also called instantaneous dipole and instantaneous induced dipole forces. Similarly, temporary dipoles are induced in non-polar molecules also. These forces of attraction were first studied by the German physicist Fritz London and therefore, these are known as London forces. These are also called dispersion forces. These forces are always attractive and the interaction energy due to these forces is proportional to the sixth power of the distance between two interacting particles (i.e., $\frac{1}{r6}$ where 'r' is distance between two particles. These are significant only at a short distance of about 500pm. These forces are responsible for the condensation of noble gases and other gases such as $H_2$, $Cl_2$, $CH_4$ etc. which has no residual bonding capacity. In all such cases, the solid and liquids are formed through these interactions. However, these forces are very weak in nature. The strength of the forces depends upon: (i) size of the molecule (ii) number of electrons present in the molecule and (iii) molecular structure.

(i) Size of the molecule:- larger or more complex are the molecules, greater is the magnitude of London forces. This is obviously due to the fact that the large electron clouds are easily distorted. Since larger molecular size amounts to larger molecular mass, it is often suggested that the magnitude of London forces increases with increasing molecular mass. For example, for the hydrides of group 14, as we move down the

group, the size of the molecules increases. Hence, the magnitude of London forces increases and so do their boiling point, e.g.,

| | | |
|---|---|---|
| $CH_4$ | < $SiH_4$ | < $GeH_4$ |
| Methane (112K) | Silane (161K) | Germane (183K) |
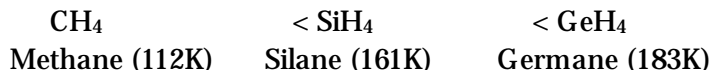
(ii) Similarly, for noble gases, as we move down the group, the size of the atom increases, i.e., size of the electron cloud increases which gets more and more easily distorted. As a result, London forces increase and the boiling points of noble gases increase from helium to radon.

| | He | Ne | Ar | Kr | Xe | Rn |
|---|---|---|---|---|---|---|
| b.pt.(K) | 4.2 | 27.2 | 87.3 | 121 | 165 | 211 |

(iii) Geometry of the molecules:- The shape of the molecules has a significant effect on the magnitude of London forces. For example, n-pentane and neo-pentane have the same molecular formula $C_5H_{12}$. However, their boiling points are different. The boiling point of n-pentane is about 27° higher than that of neo-pentane. The difference in boiling points is because of different shapes of the molecules; n-pentane has zigzag chain whereas neo-pentane is nearly spherical.



neopentane        n-pentane

B.pt= 9.5°C        B.pt= 36.2°C
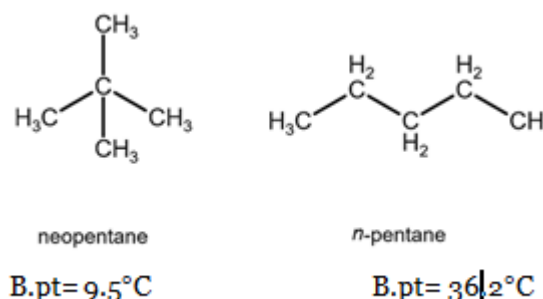
The overall attraction between molecules is greater in case of n-pentane because there are more sites of interaction; the molecules are able to come in contact with the entire length of the molecule. In case of neo-pentane, there is less contact and hence less force of attraction.

2. Dipole–dipole (Keesom) forces:- These forces of attraction occur among the polar molecules. The reason for the origin of these forces is quite obvious. Polar molecules have permanent dipoles. The positive pole of one molecule is thus attracted by the negative pole of the other molecule. For example, HCl, in which chlorine being more electronegative acquires a slight negative charge whereas the hydrogen end becomes slightly positively charged. The partial charges are always less than unit electronic charge ($1.6 \times 10^{-19}C$). The dipole- dipole interactions then take place

**Dipole-dipole**

· forces of attraction between oppositely charged ends of polar molecules.
· the strength of the dipole-dipole force is dependent on the polarity of the molecule



among the HCl molecules. The magnitude of dipole-dipole force in different
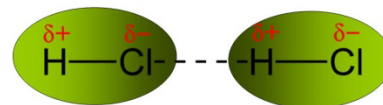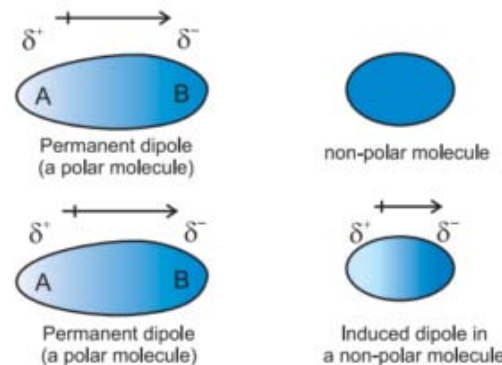


Dipole-Dipole Interactions

polar molecules can be predicted on the basis of the polarity of the molecules, which in turn depends upon the electro negativities of the atoms present in the molecule and the geometry of the molecule (in case of polyatomic molecules). The polarities of the molecules are usually expressed in terms of dipole moments of the molecules.
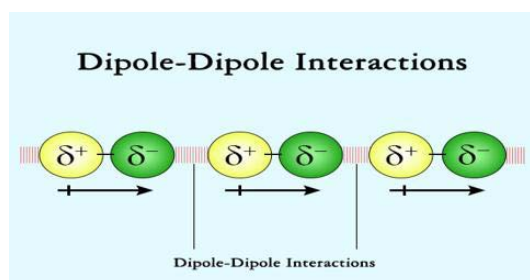
For example, dipole moment of $PH_3$ and $H_2S$ are 0.55D and 1.10D respectively, i.e., dipole moment of $H_2S$ is double than that of $PH_3$. Thus, though both have nearly same molecular mass, the m.pt. ( –134°C)  and b.pt. ( –86°C)  of $H_2S$ higher than those of $PH_3$ i.e. –86°C and –61°C, respectively .

The existence of these forces was studied by Keesom in 1912. Hence, these forces are called Keesom forces and the effect is called orientation effect.

3.  Dipole- induced dipole interaction:- A non-polar molecule may be polarized by the presence of a polar molecule (dipole) near it, thereby making it an induced dipole. The interactions between them are called dipole-induced dipole interactions. This is because the electron cloud of the non-polar atom or molecule gets deformed due to the electric field of the polar molecule. This cause a shift in the centre of gravity of the negative charge relative to the nuclear charge and results in the formation of an induced dipole moment. As the size of the atom or molecule increases, the influence of the electric dipole on it also increases. For example, noble gases get polarized in the presence of polar molecules.

The interaction energy is also proportional to $\frac{1}{r6}$ and depends upon the dipole moment of the polar molecule and polarizability of the non-polar atom or molecule. Molecules or atoms of larger size have more tendencies to get polarized. The existence of these forces was studied by Debye in 1920 and this effect is called Induction effect.

4.  Ion-dipole interaction:- This is the attraction between an ion (cation or anion) and a polar molecule. For example, when NaCl is dissolved in water, the polar water molecules are attracted towards $Na^+$ ion as well as $Cl_–$ ion (process called hydration of ions). The strength of this interaction depends upon the charge and size of the ion and the magnitude dipole moment and size of polar molecule. Due to greater charge density on the cation, this interaction is usually stronger with the cation than with anion having the same charge but bigger size. Further, $CCl_4$, being non-polar, cannot interact with $Na^+$ and $Cl^-$ ions. Hence, NaCl is insoluble in $CCl_4$.
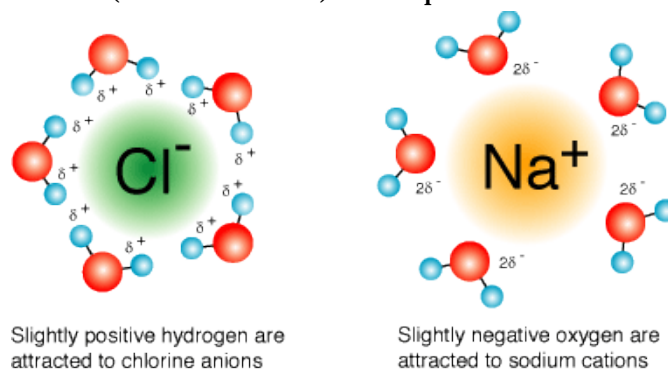
It may be noted that ion-dipole forces are not Van der Waals forces.

## Assignment

1. Triple point of water is-
   (a) 273K    (b) 373K    (c) 203K    (d) 193K

2. The interaction energy of London force is inversely proportional to sixth power of the distance between two interacting particles but their magnitude depends upon:
   (a) Charge of interacting particles
   (b) Mass of interacting particles
   (c) Polarizability of interacting particles
   (d) Strength of permanent dipoles in the particles.

3. Dipole –induced dipole interactions are present in which of the following pairs?
   (a) HCl and He atoms    (b) $SiF_4$ and He atoms
   (c) $H_2O$ and alcohol    (d) $Cl_2$ and $CCl_4$.

4. Dipole –dipole forces act between the molecules possessing permanent dipole. Ends of dipoles possess 'partial charges'. The partial charge is:
   (a) More than unit electronic charge
   (b) Equal to unit electronic charge
   (c) Less than unit electronic charge
   (d) Double the unit electronic charge.

5. Which intermolecular forces are present in HCl molecules in liquid HCl?
   (a) Dispersion forces
   (b) Ion- dipole interaction
   (c) Dipole- induced dipole
   (d) Dipole- dipole interaction.

6. Dispersion forces are present in which of the following molecules.
   (a) $Cl_2$ and $CBr_4$
   (b) Water molecules
   (c) He and a polar molecules
   (d) HCl molecules in liquid HCl

7. n-Pentane , iso-pentane and neo- pentane have same molecular formula, but their boiling points are different. The difference in boiling points is because of:
   (a) Shapes of the molecules
   (b) Number of electrons present in the molecule
   (c) Size of the molecule
   (d) London forces.

**ANSWERS**

1. (a)    2. (c)    3. (a)    4. (c)    5. (d)    6. (a)    7. (a)

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*Code: Phy/MRB-I/O/001*

# Mechanics of Rigid Bodies : Answer Sheet of Objective Questions (Typical)

| Q-01 | Q-02 | Q-03 | Q-04 | Q-05 | Q-06 | Q-07 | Q-08 | Q-09 | Q-10 |
|------|------|------|------|------|------|------|------|------|------|
| c | d | d | d | b | b | b | b | c | d |

| Q-11 | Q-12 | Q-13 | Q-14 | Q-15 | Q-16 | Q-17 | Q-18 | Q-19 | Q-20 |
|------|------|------|------|------|------|------|------|------|------|
| c | d | c | d | None | c, d | a, b | b, c | b, d | d |

| Q-21 | Q-22 | Q-23 | Q-24 | Q-25 | Q-26 | Q-27 | Q-28 | Q-29 | Q-30 |
|------|------|------|------|------|------|------|------|------|------|
| a, d | c | c | b | d | c | c | b | a | d |

| Q-31 | Q-32 | Q-33 | Q-34 | Q-35 | Q-36 | Q-37 | Q-38 | Q-39 | Q-40 |
|------|------|------|------|------|------|------|------|------|------|
| c | c | a | a | a | a | d | a | b | c |

| Q-41 | Q-42 | Q-43 | Q-44 | Q-45 | Q-46 | Q-47 | Q-48 | Q-49 | Q-50 |
|------|------|------|------|------|------|------|------|------|------|
| c | a | d | d | d | d | b | b, d | b | b, c, d |

| Q-51 | Q-52 | Q-53 | Q-54 | Q-55 | Q-56 | Q-57 | Q-58 | Q-59 | Q-60 |
|------|------|------|------|------|------|------|------|------|------|
| a, b, c, d | c | b | d | a, c, d | c | b | b | a, b, c | b |

| Q-61 | Q-62 |
|------|------|
| a, d | a |

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# SCIENCE QUIZ - September'2018

**Kumud Bala**

1. Since when India is celebrating teacher's day?
   (a) 1962   (b) 1972   (c) 1982   (d) 1975

2. How was teacher's day originated?
   (a) Birthday of Jawaharlal Nehru
   (b) Birthday of Indira Gandhi
   (c) Birthday of Dr. Sarvapalli Radhakrishnan
   (d) None of the above

3. Who said ; 'teaching is not a profession, but a way of life'?
   (a) Dr. Radhkrishnan     (b) Swami Vivekananda
   (c) Gulzarilal Nanda     (d) Narendra Modi.

4. In which year Dr. Radhkrishnan became president of India?
   (a) 1952     (b) 1962     (c) 1972     (d) 1982

5. On which date in India Teachers' day is celebrated?
   (a) 14 November     (b) 5 October
   (c) 5 September     (d) 5 December

6. Who was the teacher of lord Krishna?
   (a) Dronacharya     (b) Sandipani Muni
   (c) Rishi Visishtha     (d) Garga Muni

7. Which of the following statement(s) about Dr. Radhkrishnan is/are correct.
   (i) He became the first Vice President of India, (ii) he was elected to the constituent assembly of India, (iii) he was awarded with Bharat Ratna in 1954, (iv) he had received the peace prize of the German Book Trade in 1961.
   (a) Both (i) and (ii) are correct
   (b) both (iii) and (iv) are correct
   (c) (i) , (ii) and (iii) are correct
   (d) All the four are correct

8. For how many terms was Sarvapalli Radhkrishnan Vice president of India?
    (a) one     (b) two     (c) three   (d) four

9. On which day is the world teacher's day celebrated?
   (a) 5ᵗʰ October          (b) 5ᵗʰ March
   (c) 5ᵗʰ September       (d) 5ᵗʰ August

10. Who inaugurated 'World Teacher's Day'? (a) UN
    (b) UNESCO    (c) Red Cross     (d) SAARC

11. What was the theme for the world teacher's day in 2006?
    (a) Opening doors to better world
    (b) Teachers expanding horizons
    (c) QQuality teachers for quality education
    (d) Teachers, a force for quality.

12. What is the main function of Ozone in upper atmosphere?
    (a) It gives protection against the electromagnetic radiation emitted by the Sun.
    (b) It provides protection against infra-red light emitted by the Sun.
    (c) It shields earth from X-rays radiation from the Sun.
     (d) it shields earth from harmful ultraviolet rays of the Sun.

13. In what SI unit is power of lenses rated?
    (a) Meter   (b) Ampere   (c) Dioptre   (d) Kelvin

14. To trace the path of ray of light through the triangular glass prism, a student observes that the emergent ray has:
    (a) Bent away from the base of the prism
    (b) Bbent towards the base of the prism
    (c) moved parallel to the direction of incident ray
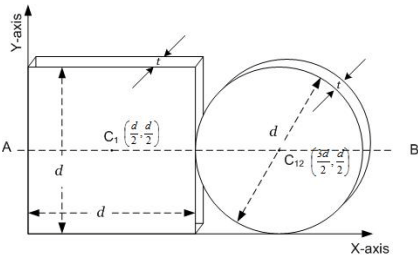    (d) gone perpendicular to incident ray.

15. Reaction of Calcium oxide (CaO) with water is regarded as exothermic. A student mixes these two products in a test tube and touches its side surface. Which of the following statement correctly describes the student's observation?
    (a) the test tube becomes cold due to release of heat energy
    (b) the test tube becomes hot due to release of heat energy
    (c) the test tube becomes hot due to absorption of heat energy
    (d) the test tube becomes cold due to absorption of heat energy.

16. Which one is a double displacement reaction?
    (a) $BaCl_2 + Na_2SO_4 \rightarrow BaSO_4 + 2NaCl$
    (b) $CaO + H_2O \rightarrow Ca(OH)_2$
    (c) $2Pb(NO_3) \rightarrow 2PbO + 4NO_2 + O_2$
    (d) $Zn + 2AgNO_3 \rightarrow Zn(NO_3) + 2Ag$

17. The metal with lowest density is:

    (a) Sodium    (b) Potassium
    (c) Lithium    (d) Cesium

18. Purification of silicon for use in semiconductors is carried out by:
    (a) Heating under vacuum    (b) Froth flotation
    (c) Liquation    (d) Zone refining

19. Identify the correct order of reactivity among the following:
    (a) $Cu < Fe < Zn < Al < Na$
    (b) $Fe < Zn < Cu < Na < Al$
    (c) $Zn < Cu < Fe < Al < Na$
    (d) $Cu < Zn < Al < Na < Fe$

20. In the thermite process, the reducing agent used is:
    (a) calcium    (b) sodium

21. (c) coke    (d) aluminium powder

22. Which of the following are the ingredients of gun metal?
    (a) Iron, Tin    (b) Copper, Tin
    (c) Iron, Brass, Tin    (d) Iron, Zinc, Titanium

23. Insulin is:
    (a) Harmone    (b) Enzyme    (c) Gland    (d) Food

24. The longest cell is:
    (a) Gamete    (b) Bone cell
    (c) Nerve cell    (d) Muscle cell

25. Hormones in human are secreted by specialized glands called:
    (a) Liver    (b) Endocrine
    (c) Pancreas    (d) All of these

26. Olfactory receptors detect:
    (a) Smell    (b) Light    (c) Sound    (d) Taste

27. Voluntary movements in vertebrates are coordinated by:
    (a) Cerebellum    (b) Cerebrum
    (c) Thyroid    (d) Pituitary

28. Cerebral hemisphere is the centre of:
    (a) Thinking    (b) Will power
    (c) Reasoning    (d) All of these

29. Ventricles of the central nervous system are full of :
    (a) Spinal fluid    (b) Cerebrospinal fluid
    (c) Cranial fluid    (d) Pericardial fluid

*(Answers to this Science Quiz Sept'18 shall be provided in*
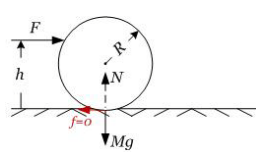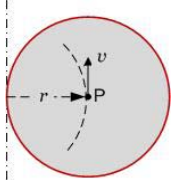*3rd Annual Issue, 9ᵗʰ Quarterly e-Bulletin dt. 2ⁿᵈ Oct'18.*
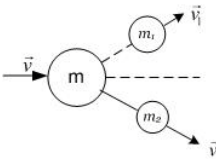
*Code: **Phy/MRB-I/O/001***

# Mechanics of Rigid Bodies : <u>Illustrations of Answers</u> to Objective Questions (Typical)

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| I-01 | Determination of position vector centre of mass $\left(\vec{R}_{cm}\right)$ is based on $\vec{R}_{cm} = \frac{1}{\sum_i m_i}\sum_i m_i \vec{r}_i = \frac{1}{M}\sum_i m_i \vec{r}_i$, here acceleration of frame has no implication, and hence (A) is correct. As regards acceleration in a inertial frame as per NSLM $\vec{a}_{cm} = \frac{\vec{F}}{M}$, but when mass $M$ is in an non-inertial frame having an acceleration $\vec{a}_f$ force experienced by it would be $\vec{F} = \left(\vec{a}_{cm} - \vec{a}_f\right)M$ and hence (B) is wrong; this can be better explained with experiencing weight in a lift accelerating during ascend and during descend. Accordingly, out of the given **options (c) is the answer.** |
| I-02 | Statement (A) implies that $\vec{P} = \sum_i m_i \vec{v}_i = $ Constant. On integrationg it leads to - $\int \vec{P}dt = \sum_i \int m_i \vec{v}_i dt$, which is mathematically $\int \vec{P}dt = \sum_i \left( m_i \int \vec{v}_i dt - \int \left(\frac{d}{dt}m_i \times \int \vec{v}_i dt\right)dt\right)$. By conservation of mass $\frac{d}{dt}m_i = 0$ and hence second term will disappear and it would lead to $\int \vec{P}dt = \sum_i m_i \left(\vec{r}_i + \vec{C}_i\right) = \sum_i m_i \vec{r}_i + \sum_i m_i \vec{C}_i = M\vec{R} + \vec{C}$. In this with (A) LHS is linearly increasing with time and so also in RHS for each of the constituent mass First terms would continue to increase linearly i.e. vector $\vec{R}$ of COM is not fixed. But, the second term is fixed bias created by initial condition. This implies that centre of mass is not fixed *i.e. while A implies B does not.* <br><br> Statement (B) implies that $\vec{R} = \frac{\sum_i m_i \vec{r}_i}{\sum_i m_i} \rightarrow M\vec{R} = \sum_i m_i \vec{r}_i$. Differentiating it, $\frac{d}{dt}M\vec{R} = \sum_i \left(m_i \frac{d}{dt}\vec{r}_i + \vec{r}_i \frac{d}{dt}m_i\right)$. Since by conservation of mass second term of RHS is Zero and both the terms of derivative ob LHS are constant, it leads to $0 = \sum_i m_i \vec{v}_i = \sum_i \vec{p}_i$. This is possible if either $\vec{v}_i$ for all constituent masses are Zero or resultant of all $\vec{p}_i$ is constant at Zero. Thus, *(B) implies (A). Thus conclusions of analysis of both the premises lead to answer (d).* |
| I-03 | Statement (A) implies that $\vec{P} = \sum_i m_i \vec{v}_i = 0$ i.e. either $\vec{v}_i$ for all constituent masses are Zero or resultant of all $\vec{p}_i$ is constant at Zero. In case resultant of all velocities is $\sum_i \vec{v}_i = 0$ then kinetic energy cannot be zero since it involves square of the magnitudes of velocity (scalar quantity). Thus, while *(A) implies (B) does not*. <br><br> As regards statement (B) it implies that $KE = \sum_i \left(\frac{1}{2}m_i v_i^2\right) = \frac{1}{2}\sum_i m_i v_i^2 = 0$ is possible when velocity of all particles is zero. Thus, while *(B) implies (A) does not*. |

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| | ***Thus conclusions of analysis of both the premises lead to answer (d).*** |
| Q-04 | Q-04, HCV-I,Obj-SCQ,pp.157 |
| | Consider the following Two statements – <br>   (C) Linear momentum of system of a particle is independent of the frame of reference. <br>   (D) Kinetic energy of system of  a particle  is independent of frame of reference <br> Then, <br>     (e)  Both A and B are true <br>     (f)  A is true but B is false <br>     (g)  A is false but B is true <br>     (h)  Both A and B are false |
| I-04 | Statement (A) implies that $\vec{P}_R = \sum_i m_i \vec{v}_{i\_R}$ and $\vec{v}_{i\_R} = \vec{v}_{i\_S} + \vec{v}_{R,S}$ here $\vec{P}_R$ is linear momentum in FOR R; $\vec{v}_{i\_R}$ is velocity of particle in FOR R; $\vec{v}_{i\_S}$ is velocity of particle in FOR S and $\vec{v}_{R,S}$ is velocity of FOR R w.r.t. S. Thus addend $\vec{v}_{R,S}$ will create a dependence of linear momentum on FOR. Hence, **premise A is false**. <br><br> Likewise, in statement B,  $KE_p = \frac{1}{2}\sum_i m_i v_{i\_R}{}^2$ and component $\vec{v}_{R,S}$ in KE makes it dependent on FOR, and hence **premise B is false**. <br> ***Thus conclusions of analysis of both the premises lead to answer (d).*** |
| I-05 | Since, $\vec{R} = \dfrac{\sum_i m_i \vec{r}_i}{\sum_i m_i}$, given that $|\vec{r}_i| = R$, but distribution of mass of particles in the system is not given. <br><br> Hence, if all $\vec{r}$ are coincident then by principles of vector addition $\dfrac{\left|\sum_i \vec{r}_i\right|}{n} = R$, here number of vectors is $n$. And if any of the vector is divergent then $\dfrac{\left|\sum_i \vec{r}_i\right|}{n} < R$. Combining both the cases **answer is (b)** |
| I-06 | The masses are arranged as shown in the figure. With material density $\rho$ mass of square plate shall be $M_1 = \rho(d^2 t)$ with its COM at $C_1\left(\dfrac{d}{2}, \dfrac{d}{2}\right)$ and for circular plate shall be $M_2 = \rho\left(\dfrac{\pi d^2}{4} t\right)$ with its COM at $C_1\left(\dfrac{3d}{2}, \dfrac{d}{2}\right)$. Hence, coordinates of combined COM shall be  <br><br> $\overline{Y} = \dfrac{d}{2}$, since each of objects is symmetrical about line AB passing through C₁ and C₂ and parallel to X-Axis. Whereas, along X-axis is, <br><br> $\overline{X} = \dfrac{M_1\left(\dfrac{d}{2}\right) + M_2\left(\dfrac{3d}{2}\right)}{M_1 + M_2} = \dfrac{\rho d^2 t\left(\dfrac{d}{2} + \dfrac{\pi}{4}\cdot\dfrac{3d}{2}\right)}{\rho d^2 t\left(1 + \dfrac{\pi}{4}\right)} = \dfrac{\dfrac{d}{2}\left(\dfrac{3\pi + 4}{4}\right)}{\dfrac{\pi + 4}{4}} = \dfrac{d}{2}\left(\dfrac{3\pi + 4}{\pi + 4}\right) = \dfrac{d}{2}\cdot\dfrac{13.42}{7.14} < d$. Thus, COM |

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| | of compound mass it shall be inside square plate. Hence, **answer shall be (b)** |
| I-07 | Let at time $t = 0$, two identical particles A and B of mass $m$ are at position vectors $\vec{r}_{a\_0}$ and $\vec{r}_{b\_0}$ along X-axis for simplification; particles are taken to be at rest at the initial instance both. Therefore centre of mass shall be initially at $\vec{R}_0 = \dfrac{m\vec{r}_{a\_0} + m\vec{r}_{b\_0}}{2m} = \dfrac{1}{2}\left(\vec{r}_{a\_0} + \vec{r}_{b\_0}\right)$. Particle A remains at rest i.e. $\vec{r}_{a\_0} = \vec{r}_{a\_t}$, while the particle B has an acceleration $\vec{a}$. Therefore, position vector of particle at any instant $t$ would be $\vec{r}_{b\_t} = \vec{r}_{b\_0} + \left(0 \times t + \dfrac{1}{2}\vec{a}t^2\right)$. Therefore COM of the two masses shall be at $\vec{R}_t = \dfrac{m\vec{r}_{a\_t} + m\vec{r}_{b\_t}}{2m} = \dfrac{1}{2}\left(\vec{r}_{a\_0} + \vec{r}_{b\_0} + \dfrac{1}{2}\vec{a}t^2\right) = \vec{R}_0 + \dfrac{1}{2}\left(\dfrac{1}{2}\vec{a}\right)t^2$. Thus, as per Second equation of kinematics, acceleration of COM is $\dfrac{1}{2}\vec{a}$, and hence **answer (b).** |
| I-08 | Internal forces in a system are always in pairs i.e. equal and opposite. In this question two physical quantities linar momentum $\left(\vec{P} = \sum_i m_i v_i\right)$ and kinetic energy $\left(KE = \dfrac{1}{2}\sum_i m_i v_i{}^2\right)$ are compared in different context. Taking derivative of linear momentum $\dfrac{d}{dt}\vec{P} = \sum_i m_i \dfrac{d}{dt}v_i = \sum_i m_i a_i \rightarrow \Delta\vec{P} = \vec{F}_{ext}\Delta t$. Thus in accordance with NSLM they are is the external forces which changes linear momentum. But, taking derivative of kinetic energy $\dfrac{d}{dt}KE = \dfrac{1}{2}\sum_i m_i \dfrac{d}{dt}\left(v_i{}^2\right) = \dfrac{1}{2}\sum_i m_i(2v_i)a_i$. It leads to $\Delta KE = \left(\sum_i m_i v_i a_i\right)\Delta t$, thus change in kinetic energy in a time $\Delta t$ is due acceleration and its consequent effect on velocity of constituent masses. These are used to analyse given options - <br>• From the above analysis **option (a) is incorrect** internal forces are stated to change linear momentum. <br>• Option (b) is correct in respect of linear momentum. As regards KE, internal forces when affect $a_i$ of constituent particles, change in $v_i$ affects the kinetic energy as well and is in accordance with basic definition. Hence, ***both the cases in option (b) are correct***. <br>• From the logic invalidating option (a) ***the option (c) is incorrect***. <br>• Since internal forces change kinetic energy of the system as in option (b) and hence taking both P and KE invariant in ***option (d) is incorrect.*** <br>Accordingly ***answer is option (b)*** |
| I-09 | Let $m$ and $v$ are mass and velocity of the bullet and $M$ and $V = 0$ are mass and velocity of block. After bullets gets embedded then as per principle of Conservation of Monentum $mv + M \times 0 = (M + m)v_f \rightarrow v_f = \dfrac{mv}{M + m}$, here $v_f$ is the final velocity. With this analysis of each option is – <br>• Moment of block post embedding of bullet changes from Zero to $M\left(\dfrac{mv}{M + m}\right)$, ***hence option (a) is incorrect***. |

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| | • Kinetic energy of the block post embedding changes from Zero to $\frac{1}{2}M\left(\frac{mv}{M+m}\right)^2$, **hence option (b) is incorrect**. <br> • Since block is placed on a horizontal surface hence its height $(h)$ above ground remains unchanged post embedding and hence its gravitational, potential energy $(=Mgh)$, $M$ and $g$ remaining constant, it remains unchanged, **hence option (c) is correct**. <br> • Embedding of bullet in block is causing a plastic deformation and which shall internal energy of the block and hence its temperature and **hence option (d) is incorrect** <br> The above analysis leads to **as answer option (b)** |
| I-10 | Since, horizontal surface is smooth and $\mu=0 \rightarrow f=\mu(Mg)=0$. In absence of friction, there wuld be only lipping of sphere, without angular rotation. Therefore, force $F$ will only cause translational motion of sphere and as per NSLM, centre of sphere would accelerate horizontally at $a=\dfrac{F}{M}$, in which there is no dependence on height $(h)$) of application of $F$. This rules out option (a), (b and (c), and goes in favour of otion (d). Hence, **answer is (d).** |
| I-11 | Let an object of mass $M$ falling vertically has a velocity of fall $U$ breaks into two unequal masses $m_1$ and $m_2$ at height $h$ above ground. Only vertical gravitational acceleration causing a force $Mg$ on the object, and $m_1 g$ and $m_2 g$ on split masses is acting. Since, there is only vertical force acting on the split masses COM would move downward along $\vec{g}$. As regards horizontal displacement there is no force in this direction acting either on the object or split masses, therefore, as per NFLM there woild be no horizontal displacement of COM. Therefore, **answer is (c)** |
| I-12 | Let an object of mass $M$ is at rest and hence its momentum $P=0$. Since, no external force is defined causing breaking of the object in two equal masses $m_1$ and $m_2$ and start travelling with velocities $\vec{v}_1$ and $\vec{v}_2$ respectively. Then, as per NFLM $P=m_1\vec{v}_1+m_2\vec{v}_2=0 \rightarrow \dfrac{m_1}{m_2}=(-)\dfrac{\vec{v}_2}{\vec{v}_1}$. From this equation following inferences can be drawn – <br> • Since $m_1$ and $m_2$ are unequal scalar quantities and hence, by ratio-proportion, magnitudes $v_1$ and $v_2$ of vectors $\vec{v}_1$ **and $\vec{v}_2$ shall also be unequal**. <br> • In ration proportion LHS is scalar and therefore for equality of proportion $\dfrac{\vec{v}_2}{\vec{v}_1}$ shall have to be scalar. This is possible only when $\vec{v}_1$ **and $\vec{v}_2$  are colinear**. <br> • In the derived equation (-)ve sign on RHS indicates that direction of $\vec{v}_1$ vector is opposite to the $\vec{v}_2$. <br> The above inferences satisfy option (d), and **answer is (d).** |
| I-13 | COM of a ring is at its centre and hence shall be at point P, located at distance $r$ from axis of rotation as shown in the figure. The ring is filled with light disc and hence its mass is considered negligible. Another particle pass is placed at centre of the disc. Thus mass concentrated at point P is $2m$. When the system is rotated in a circular parth of radius $r$ at velocity velocity $v$, trajectory of the mass $2m$ shall pass through P. This is a |

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| | case of circuar motion and hence an external force equal to centripetal force $2m\left(\dfrac{v^2}{r}\right)$ shall have to be applied on the sysem to maintain the rotation. Accordingly, **answer is (c).** |
| I-14 | Momentum of nucleus before emission is $\vec{P} = m\vec{v}$, and emiision of α-particle momentii of α-particle and the remainibg nuleus shall be $\vec{p}_1 = m_1\vec{v}_1$ and $\vec{p}_2 = m_2\vec{v}_2$, resectively. As per principle of conservation of momentum (PCM) $\vec{P} = \vec{p}_1 + \vec{p}_2 \rightarrow m\vec{v} = m_1\vec{v}_1 + m_2\vec{v}_2 \rightarrow \vec{v} = \dfrac{1}{m}(m_1\vec{v}_1 + m_2\vec{v}_2)$. Since, $m_1 \neq m_2$ and so also $\vec{v}_1 \neq \vec{v}_2$  only condition thuat satisfies PCM is the equation  is $\vec{v}_1$ is parallel to $m_1\vec{v}_1 + m_2\vec{v}_2$. Hence, **answer is (d).** |
| I-15 | Vector of COM is $\vec{R} = \dfrac{\sum_i m_i\vec{r}_i}{\sum_i m_i}$. For COM t0 be at origin $\vec{R} = 0 = R$. This proposition is being analysed for each of the given options to verify if  it satisfies $\vec{R} = 0$ <br><br>• Since numerator is scalar multiles of vector $\vec{r}_i$ and therefore requirement is $\sum_i m_i\vec{r}_i = 0$ and not the count but as stipluated **at (a) , hence this option is not correct.** <br><br>• Again going by definition of $\vec{R}$ it is not the equal masses on either side of the origin, but $\sum_i m_i\vec{r}_i = 0$, and therefore, **option (b) is not correct**. <br><br>• Going by analysis of option (a) and (b), this option too does not lead to $\sum_i m_i\vec{r}_i = 0$, and **option (c) is not correct.** <br><br>• Option (d) takes all particles on X-axis and it is similar to otion (a). Hence, **option (d) is also not correct**. <br>Thus none of the options are correct. <br>*[N.B.: In MCQ questions, it might happen options are so twisted that none of them apply to the given condition, and may lead to none of the options.]* |
| I-16 | Vector of COM is $\vec{R} = \dfrac{\sum_i m_i\vec{r}_i}{\sum_i m_i}$. For COM t0 be at origin $\vec{R} = 0 = R$. This proposition is being analysed for each of the given options to verify if  it satisfies $\vec{R} = 0$ . In light of this each of the option needs to be verified- <br><br>• When coordinates of all particles are (+)ve, they for $\vec{R}$ shall be (+) and COM shall not be at origin, hence **option (a) is not correct**. <br><br>• When coordinates of all particles are (-)ve, they for $\vec{R}$ shall be (-) and COM shall not be at origin, hence **option (b) is not correct**. <br><br>• Inlight (a & b) above vector of COM can be written as <br><br>$\vec{R} = \dfrac{\sum_i m_i\vec{r}_i}{\sum_i m_i} = \dfrac{\sum_{i=1}^{j} m_i\vec{r}_i + \sum_{i=j+1}^{k} m_i\vec{r}_i + \sum_{i=k+1}^{l} m_i\vec{r}_i + \sum_{i=l+1}^{m} m_i\vec{r}_i}{\sum_{i=1}^{k} m_i}$ where, $\sum_{i=1}^{j} m_i\vec{r}_i$, $\sum_{i=j+1}^{k} m_i\vec{r}_i$, $\sum_{i=k+1}^{l} m_i\vec{r}_i$ and |

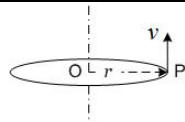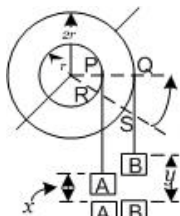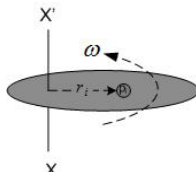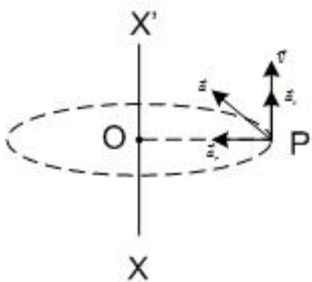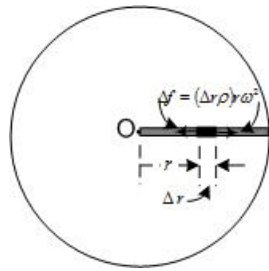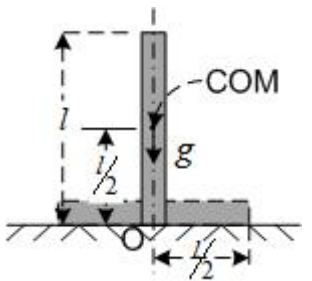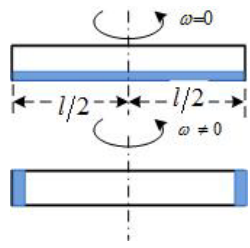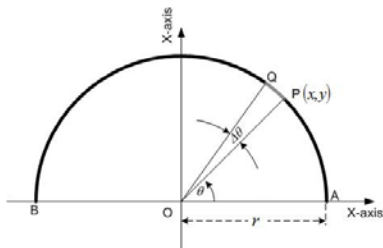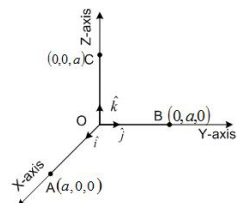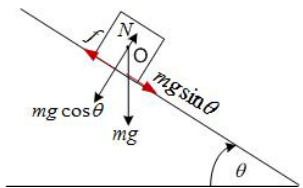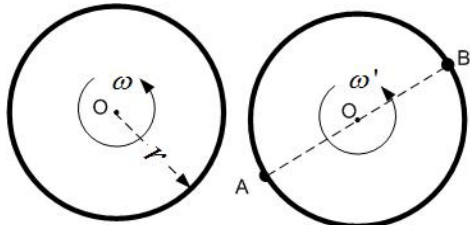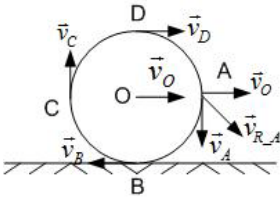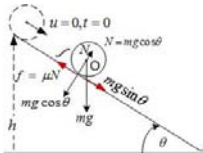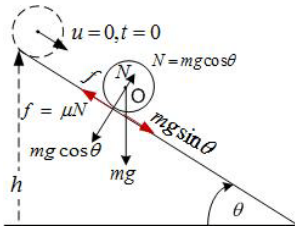| | |
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| | $\sum_{i=l+1}^{m} m_i \vec{r}_i$ correspond to particles in 1st, 2nd, 3rd and 4th quadrant.<br><br>▪ Non-negative coordinates mean positive coordinates, but preceeding it with **<u>may be</u>** implies it is not necessary. This makes *option (c) correct*.<br>▪ Option (c) when put in other words with some (+) and others (-)ve and that makes *option (d) correct*<br><br>Accordingly, ***answer is option (c) and (d).*** |
| I-17 | ***N.B.:*** *This question can be easily answered by symmetry of the mass distribution, which plays an important role in analysis. Nevertheless, to train the thought process the each of four options are being analysed.*<br><br>• **Option (a):** gradient of density $k_a = \dfrac{\rho_2 - \rho_1}{L}$. Therefore, centre of mass shall be at<br><br>$$\overline{L} = \frac{\int_0^L l(\rho_0 + k_a l)dl}{\int_0^L (\rho_0 + k_a l)dl} = \frac{\int_0^L (\rho_0 l + k_a l^2)dl}{\left[\rho_0 l + \dfrac{k_a l^2}{2}\right]_0^L} = \frac{\left[\rho_0 \dfrac{l^2}{2} + k_a \dfrac{l^3}{3}\right]_0^L}{(2\rho_o + k_a L)\dfrac{L}{2}} = \frac{(3\rho_0 + 2k_a L)\dfrac{L^2}{6}}{(2\rho_o + k_a L)\dfrac{L}{2}}.$$ It<br><br>leads to $\overline{L} = \left(\dfrac{3\rho_0 + 2k_a L}{2\rho_o + k_a L}\right)\dfrac{L}{3} \neq \dfrac{L}{2}$. Thus, COM shall lie between such that<br><br>$0 < \overline{L} < \dfrac{L}{2}$, i.e. COM is not at the centre, hence, ***option (a) is correct.***<br><br>• **Option (b):** gradient of density $k_b = \dfrac{\rho_1 - \rho_2}{L} = (-)k_a$. This is mirror image of option (a) and hence COM shall be $\dfrac{L}{2} < \overline{L} < \dfrac{L}{2}$, hence, ***option (b) is correct.***<br><br>• **Option (c):** gradient of density in section $0 \le l \le \dfrac{L}{2}$ is $k_c = \dfrac{\rho_1 - \rho_2}{\dfrac{L}{2}} = (-)2\dfrac{\rho_2 - \rho_1}{L} = (-)2k_a$, and in<br><br>section $\dfrac{L}{2} \le l \le L$, gradient is $k_c' = \dfrac{\rho_2 - \rho_1}{\dfrac{L}{2}} = 2\dfrac{\rho_2 - \rho_1}{L} = 2k_a$. Accordingly,<br><br>$$\overline{L} = \frac{\int_0^{L/2} l(\rho_0 - 2k_a l)dl + \int_{L/2}^L l(\rho_0 + 2k_a l)dl}{\int_0^{L/2} (\rho_0 - 2k_a l)dl + \int_{L/2}^L (\rho_0 + 2k_a l)dl}.$$ It leads to<br><br>$$\overline{L} = \frac{\rho_0 \int_0^L l\,dl - 2k_a\left(\int_0^{L/2} l^2 dl - \int_{L/2}^L l^2 dl\right)}{\rho_0 \int_0^L dl - 2k_a\left(\int_0^{L/2} l\,dl - \int_{L/2}^L l\,dl\right)} = \frac{\rho_0 \dfrac{L^2}{2} - \dfrac{2k_a}{3}\left(\dfrac{L^3}{8} - \left(L^3 - \dfrac{L^3}{8}\right)\right)}{\rho_0 L - \dfrac{2k_a}{2}\left(\dfrac{L^2}{4} - \left(L^2 - \dfrac{L^2}{4}\right)\right)} = \frac{1}{2}\frac{\left(\rho_0 + k_a \dfrac{L}{2}\right)L}{\left(\rho_0 + k_a \dfrac{L}{2}\right)} = \frac{L}{2}$$, i.e. COM |
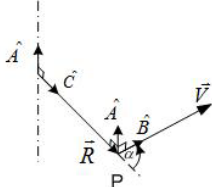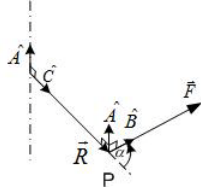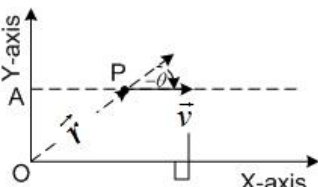
is at $\dfrac{L}{2}$, hence, *option (c) is incorrect.*

- **Option (d):** Mathematical formulation in this case shall be same as at option (c) except that in section $0 \le l \le \dfrac{L}{2}$ is $k_d = \dfrac{\rho_2 - \rho_1}{\dfrac{L}{2}} = 2\dfrac{\rho_2 - \rho_1}{L} = 2k_a$, and in section $\dfrac{L}{2} \le l \le L$,

$k_d' = \dfrac{\rho_1 - \rho_2}{\dfrac{L}{2}} = (-)2\dfrac{\rho_2 - \rho_1}{L} = (-)2k_a$. This is left for reader to determine $\overline{L}$ on the lines of option

(c) and it will be seen that $\overline{L} = \dfrac{L}{2}$, i.e. COM is at the centre of the rod and *hence option (d) is incorrect*.
**Answer is options (a) and (b).**
*N.B.: Here a twist has been given in question by stating COM is not in the centre and needs to be carefully noted*

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| I-18 | NFLM stipulates that a body in uniform motion or state of rest continues to be so unless resultant of external forces $R = \sum_i \vec{F}_{ext\_i} = 0$ and as per NSLM $\sum_i \vec{F}_{ext\_i} = m\vec{a} \rightarrow \sum_i \vec{F}_{ext\_i} \rightarrow \vec{a} = 0\big|_{m \ne 0}$. Thus analysis of given options – <br> • It is not necessary as per NFLM for body to be in a state of rest, hence *option (a) is not correct.* <br> • As per NSLM, in given condition $\vec{a} = 0$, the sustem will not accelerate, hence *option (b) is correct.* <br> • If body is in state of motion then as per NFLM, it will move is conditional and hence *option (c) is correct* <br> • As per NSLM in given condition $\vec{a} = 0$ and system will not accelerate and *option (d) is not correct.* <br> ***Thus answer is option (b) and (c).*** |
| I-19 | Given that $\vec{F}_{ext} \ne 0 = Ma$, here $M$ is mass the system and hence as per NSLM acceleration of the COM is . $a \ne 0$, one of the variable whose value is part of the answer; this automatically rules out option (a) and (c) where $a = 0$ . Now in respect of second variable $v_0$ at any instant $t$ its value as per First equation of kinematics $v_0 = u + at$, which depends upon the only variable $u$, the initial velocity, which is unknown. If , $u = v_0 - at$ then only $v_0 = 0$ *is possible as in option (bd)* with $a \ne 0$, and if $u \ne v_0 - at$ then $v_0 \ne 0$ *is possible as in option (d)* . Thus *answer is (b) and (d).* |
| I-20 | Let us consider the two balls a system of masses having a mass $M = 2m$, where $m$ is mass of each ball. One system is thrown up, the only external force acting on it is gravitational force $F_{ext} = Mg$ and hence acceleration of COM of $M$ shall be $a = \dfrac{F_{ext}}{M} = \dfrac{Mg}{M} = g$ . Thus, in firnal form of acceleration it rules out Option (a) since it is independent of direction of two balls; Option (b) since it is independent of the masses of two balls; Option (c) since it depends upon speed of two balls. The only option left is (d) where given that $a = g$, the same has been established. Hence *answer is (d).* |
| I-21 | Let a block of mass $M$ moving with velocity $\vec{V}$ breaks will have momentum $\vec{P} = M\vec{V}$ into two parts of masses $m_1$ and $m_2$ and move with velocities $\vec{v}_1$ and $\vec{v}_2$ respectively and there momentum shall be |

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| | $\vec{p}_1 = m_1\vec{v}_1$ and $\vec{p}_2 = m_2\vec{v}_2$. Since, - consequence of breaking is question for two parameters momentum and kinetic energy, each of this shall be analysed to answer the question – <br>• The block is moving in air and breaks, and no external force is mentionedand hence as per NFLM, momentum shall be conserved, and hence $\vec{P} = \vec{p}_1 + \vec{p}_2$, therefore **option (a) is correct** <br>• As a corollary **option (c) is incorrect** <br>• Breaking of particle is result of internal forces, and some part of kinetic energy of initial mass $KE = \frac{1}{2}MV^2$, and of the two split masses is $KE_1 = \frac{1}{2}m_1v_1^2$ and $KE_2 = \frac{1}{2}m_2v_2^2$. As per principle of conservation of energy $KE = KE_1 + KE_2 + \Delta KE$, here, $KE = KE_1 + KE_2 + \Delta KE$ As regards $\Delta KE$ it is not equal to ZERO, since it is energy spent in splitting of the mass into two, and hence $KE \neq (KE_1 + KE_2)$. Thus, while total energy is conserved kinetic energy is not hence **option (b) is incorrect**. As a consequence total kinetic energy would change, i.e. **option (d) is correct**. <br>Thus **answer is option (b) and (d).** |
| I-22 | Unit vector along the axis of rotation $(\vec{A})$ is perpendicuar to the plane of vectors, velocity of particle $(\vec{B})$ and distance of particle from the axis of rotation $(\vec{C})$. Since, $\vec{A} \cdot \vec{B} = AB\cos\theta = AB\cos 90^0 = 0$, angle $\theta = 90^0$ as shown in the figure. Hence, **answer is (c).** |
| I-23 | Unit vector along the axis of rotation $(\vec{A})$ is perpendicuar to the plane of vectors, resultant force on the particle $(\vec{B})$ and distance of particle from the axis of rotation $(\vec{C})$. Since, $\vec{A} \cdot \vec{B} = AB\cos\theta = AB\cos 90^0 = 0$, angle $\theta = 90^0$ as shown in the figure. Hence, **answer is (c).** |
| I-24 | The system is shown in the figure. Angular momentum of the particle is $\vec{L} = \vec{r} \times \vec{v} = rv\sin(-\theta)\hat{n} = v(r\sin\theta)(-\hat{n})$. In this factor $v$ is constant, despite changing $r$ and $\theta$ another factor $r\sin\theta$ is constant and $(-\hat{n})$ is unit normal vector in opposite direction. Accordingly, angular moment is product of three constants and hence it is also constant. Hence, **answer is (b)** |
| I-25 | In the given system as shown in the figure, $r$ known, dependence of $\omega$ is required to be ascertained which turn out to be $\omega \propto v$. Hence, options (a), (b) and (c) are ruled out, and the only **correct option is (d).** |
| I-26 | Given quantities are redfined in figure. System has two coaxially fixed pulleys, and hence if smaller puller of radius $r$ rotates through an angle $\theta$ about its axis, another pulley of radius $2r$ shall allso rotate throgh same angle. Since strings do not slip, hence in rotation of the system through an angle $\theta$ string attached to masses A and B shall be released by length $x = r\theta$ and $y = (2r)\theta = 2r\theta$. Thus it is evident that $y = 2x$, hence **answer is (c).** |
| I-27 | A body as shown in the figure is rotating about axis X-X' with a uniform angular velocity $\omega$. Then resultant force experienced by particle P$_i$, to keep uniformy rotating with $\omega$, shall be $\vec{F}_i = -m_i r_i \omega^2 \hat{r}$, i.e. centripetal force and shall be in the direction vector $(-)\hat{r}_i$. This dirction vector $(-)\hat{r}_i$ is perpendicular to the vertical axis of rotation, i.e. horizontal and intersection axis X-X' **inconformance with option (c).** This **rules** |

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| | *out option (a),;* since it is not skewed about the axis **option (b) is also ruled out;** *option (d) is ruled out* since *option (c) is correct. Hence,* **answer is (c).** |
| I-28 | It rotation of a body is non uniform it implies $\frac{d\omega}{dt} = \alpha \neq 0$ and therefore at an instant when particle has parameters angular velocity $\omega$, tangential velocity $v$, radial distance from axis $r$, will have radial acceleration $\vec{a}_r = (-)\frac{v^2}{r}\hat{r}$ and tangential acceleration $\vec{a}_t = \frac{dv}{dr}\hat{t}$, accordingly, resultant acceleration and in turn force will be in the horizontal plane of vectors $\hat{r}$ and $\hat{t}$ but, skewed in the direction of velocity if $\frac{dv}{dt} > 0$ and skewed backward if $\frac{dv}{dt} < 0$. This proves **options (a), (c) and (d) are incorrect** and **option (b) is the answer**. |
| I-29 | Position vector $\vec{r}$ is w.r.t origin and $\vec{\Gamma} = \vec{r} \times \vec{F} = rF\sin\theta\,\hat{n}$ it means $\vec{\Gamma}$ is perpedicular to the plane containing vectors $\vec{r}$ and $\vec{F}$ and in-turn vectors $\vec{r}$ and $\vec{F}$. Hence, $\vec{r}\cdot\vec{\Gamma} = 0$ and $\vec{F}\cdot\vec{\Gamma} = 0$ which makes both the conditiona in option (a) correct. In **rest of the option (b) and (c) and (d)** either of the coditions is stated nont equal to to zero and they **are incorrect**. Hence, **answer is (a).** |
| I-30 | Let, uniform rod of length $l$ and mass $m$ has mass density per unit length $\rho = \frac{m}{l}$. Since, table is mooth hence entire centipetal force shall get transferred on clamp, when the rod rotates through a angular velocity $\omega$ and this force shall be $F = \int_0^l (dr\rho)r\omega^2 = \rho\omega^2 \int_0^l r\,dr = \rho\omega^2\left[\frac{r^2}{2}\right]_0^l = \frac{1}{2}\rho\omega^2 l^2 = \frac{1}{2}(\rho l)\omega^2 l = \frac{1}{2}m\omega^2 l$. This conforms with **option (d) and it is correct.** Rest of the **options (a), (b) and (c) are incorrect**. Hence **answer is (d)** |
| I-31 | As shwn in the figure, when a uniform rod is kept vertically, its CG is passing through its base. Since rod is on a smooth surface there will be no frictiobal surface. When it is rotated slightly , and allowed to make its free fall, there is no external force except gravitational force, and hence, COM sglich is ahall move along $g$ until it reaches O. And for this to happen lower end of the rod will get displaced from ts initial position O by $\frac{l}{2}$, and this can happen in any direction around point O. This inference is contained only in option (c). |
| I-32 | Moment of inertia of a circular plate is $I = M\frac{R^2}{2}$, is a standard value. Now for disc P, $M_p = (4\pi r^2 t)\rho = 4\pi r^2 t$ and for disc Q $M_q = \left(4\pi(4r)^2\frac{t}{4}\right)\rho = 16\pi r^2 t$. Now with known formulation of |

I, $I_p = M_p \dfrac{r^2}{2} = 4\pi r^2 t \dfrac{r^2}{2} = 2\pi r^4 t$, and     $I_q = M_q \dfrac{(4r)^2}{2} = 16\pi r^2 t \dfrac{16r^2}{2} = 108\pi r^4$. Thus, it is evident from analysis $I_p < I_q$. Hence, ***answer (c).***

***N.B.:*** *There are standard values e.g. vlaue of I for a circular disc. If derivations of such stnadrad results are carried out, independently, it becomes easy to remember, Ths task of memorizing standard values is reduced drastically. It is, therefore, advised to carry out derivation of each formula and standard results.*

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| I-33 | It is known that $\vec{\Gamma} = I\vec{\alpha}$, here $\vec{\Gamma}$ is torque, $I$ is moment of inertia and angluar acceeration is $\vec{\alpha} = \dfrac{d\vec{\omega}}{dt}$. Now, mass of disc A, $M_A = (4\pi r^2 t)\rho = 4\pi r^2 t$ and for disc B is $M_B = \left(4\pi(4r)^2 \dfrac{t}{4}\right)\rho = 16\pi r^2 t$. Now with known formulation of I, $I_A = 4\pi r^2 t \dfrac{r^2}{2} = 2\pi r^4 t$, and     $I_B = 16\pi r^2 t \dfrac{16r^2}{2} = 108\pi r^4$. Since same torque is applied on both the discs hence $\vec{\Gamma} = I_A \dfrac{d}{dt}\vec{\omega}_A = I_B \dfrac{d}{dt}\vec{\omega}_B \rightarrow \dfrac{I_A}{I_B} = \dfrac{\left|\dfrac{d}{dt}\vec{\omega}_B\right|}{\left|\dfrac{d}{dt}\vec{\omega}_A\right|} = \dfrac{r_B \dfrac{d}{dt}v_B}{r_A \dfrac{d}{dt}v_A}$. From the given data of radii and derived values of MI, the conclusion can be written as $\dfrac{I_A}{I_B} = \dfrac{2\pi r^4 t}{108\pi r^4 t} = \dfrac{4r_A \dfrac{d}{dt}v_B}{r_A \dfrac{d}{dt}v_B}$. Accordingly, $\dfrac{d}{dt}v_A = 216 \dfrac{d}{dt}v_B$. Since linear acceleration of a particle on rim A is greater than that of a particle on rim B, velocity of particles at any instant shall be $v_A > v_B$. Hence, ***answer is (a)*** |
| I-34 | Since tube is not filled with water, in state of rest on a horizontal plane, water will spread across length uniformply. Let mass of liquid is $m$, and length of the tube is $l$ having mass $M$ hence MI of liquid $I_l = \dfrac{ml^2}{12}$ and MI of tube $I_t = \dfrac{Ml^2}{12}$. But when the tube is set in rotation about its perpendicular bisector, the mass shall distribute uniformly, to fill both ends of the tube, across its cross-section. Accordingly, new value of moment of inertia of water shall be $I_l' = 2\left(\dfrac{m}{2}\right)\left(\dfrac{l}{2}\right)^2 = \dfrac{ml^2}{4}$. In $I_l$ and $I_l'$ numerator is same but denominator in $I_l'$ and hence $I_l' > I_l$ is small i.e. on rotation moment of inertia of water increases, and hence **answer is (a)** . |
| I-35 | This can be answered by radial symmetry about centre O. But, an anlytical answer can be evolved by taking a small section of wire PQ of length $r\Delta\theta$, between two radial displaced by an angle $\Delta\theta$, having a mass $\Delta m = \left(\dfrac{M}{\pi r}\right)r\Delta\theta = \dfrac{M}{\pi}\Delta\theta$, here $\dfrac{M}{\pi r}$ is mass per unit length. It is to be noted that wire is only along arc. There is no wire along diameter, if t were it would change the answer. Taking, $\Delta\theta \rightarrow 0$, coordinates of element PQ, shall be $x = r\cos\theta$ and $y = r\sin\theta$. And |

$I_{xx} = \dfrac{M}{\pi}\int_0^\pi (r\sin\theta)^2\,d\theta = \dfrac{Mr^2}{\pi}\int_0^\pi \sin^2\theta\,d\theta$ and likewise, $I_{xx} = \dfrac{Mr^2}{\pi}\int_0^\pi \cos^2\theta\,d\theta$. Further, by

*Perpendicular Axis Theorem* required moment of inertia shall be

$I_O = I_{XX} + I_{YY} = \dfrac{Mr^2}{\pi}\left(\int_0^\pi \sin^2\theta\,d\theta + \int_0^\pi \cos^2\theta\,d\theta\right) = \dfrac{Mr^2}{\pi}\int_0^\pi \left(\sin^2\theta + \cos^2\right)d\theta = \dfrac{Mr^2}{\pi}\int_0^\pi d\theta$. It leads to a line

$I_O = \dfrac{Mr^2}{\pi}\cdot\pi = Mr^2$. Hence, ***answer is (a).***

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| I-36 | Moment of inertia is $I = Mk^2$, here $M$ is the mass and $k$ is radius of gyration, which depends upon geometry of mass fistribution and not mass density. Two bodies are identical shall have same $k$ and volume $V$, and hence $I_1 = M_1 k^2$ and $I_2 = M_2 k^2$, but and depend upon density $\rho$ and in instant case density of first body of aluminum is lower than that of iron i.e. $\rho_1 < \rho_2$.Therefore, $\dfrac{I_1}{I_2} = \dfrac{V\rho_1 k^2}{V\rho_1 k^2} = \dfrac{\rho_1}{\rho_2}$, and hence, with the knowledge of densities of aluminium and iron, $I_1 < I_2$ hence ***answer is (a).*** |
| I-37 | Let mass of three particles, as shown in figure, and identified as A, B, and C be $m_1$, $m_2$ and $m_3$. Then position vector of centre of mass shall be $\vec{R} = \dfrac{m_1 a\hat{i} + m_2 a\hat{j} + m_3 a\hat{k}}{m_1 + m_2 + m_3}$. Given that $\vec{R} = 0$, is not possible since all the masses are along (+)ve $\hat{i}$, $\hat{j}$ and $\hat{k}$. Hence, determining $I_{zz} = I_{xx} + I_{yy}$ by Perpendicuar Axis Theorem is not possible as principle of COM and Moment of Inertia can not be incosistent. Hence, answer can not be deduced with given information. Hence, ***answer is (d)*** |
| I-38 | The information given is utilized to construct figure. Normal force, assuming cubical block of side $a$ has uniform density, so as to have its COM at O, its centre. Since Normal force shall pass through O,hence its torque at O shall be Zero. ***Hence, answer is (a)*** |
| I-39 | Moment of inertia of circular ring is $I = Mr^2$. When it is revolving with an angular velocity $\omega$, around its ventre O, its angular momentum would be $\Gamma = I\omega = Mr^2\omega$. While it is revolving, two particles A and B, each of mass $m$, are attached to the ring at two diamatrically opposite points new moment of inertia would become $I' = (M + 2m)r^2$, let its angular velocity change to $\omega'$ and accordingly its angular momentum becomes $\Gamma' = I'\omega' = (M + 2m)r^2\omega'$. By principle of conservation of angular momentum it would lead to $\Gamma = \Gamma' \rightarrow Mr^2\omega = (M + 2m)r^2\omega' \rightarrow \omega' = \dfrac{M\omega}{M + 2m}$. This conslusion is consistent with option (b). Hence ***answer is (b)*** *N.B.: The nature of attachment is without any external force, hence instead of principle of energy conservation, principle of conservation of momemtum has been applied in this case.* |

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| I-40 | Persons, sitting on rotating stool initially with arms stretched when fold his arms, no external force is applied. Folding of arms would change moment of inertia of the system $I$ , and accordingly its angular velocity $\omega$ would also change, but its angular momentum would remain $\Gamma = I\omega = I'\omega'$. Hence, **answer is option (c).** |
| I-41 | When a wheel is rolling with velocity $v_0$ , without slipping as there is no mention of slipping, its centre is moving with velocity $v_0$ in the direction of rolling with same velocity , as much as each particle on the periphery also with a velocity $v_0$ in direction tangential to the point on circular periphery , as hown in the figure. Points A and C are at the level of centre of the wheel O. Therefore, taking point A, since $v_A = v_0$ and angle between $\vec{v}_A$ and $\vec{v}_0$ is $90^0$ its speed would $\sqrt{2}v_0$ be along diagonal of the square, and same can be verified for particle C.. Thus **answer is (c).** |
| I-42 | Let M is the mass of wheel and is set to revolve at angular speed $\omega$ and translation velocity of COM $v$. Let time taken to cover both angular and linear displacements simultaneously be $t$. Accordingly, $d = ut + \frac{1}{2}at^2$ and $\theta = \omega t + \frac{1}{2}\alpha t^2$. In motion of a cylindrical or spherical object on a surface four cases can occur **(i)** $\omega = 0, v \neq 0$, pure sliding and can occor on a smooth surface; **(ii)** $v = r\omega$, will have pure rolling. Since wheel is pushed forward, and hence at point of contact with base surface will be backward; **(iii)** $v > r\omega$, in this case, particle of wheel in contact with the base surface has forward motion and hence frictional force shall be backward; **(iv)** $v < r\omega$, it is a case when particle of wheel in contact with base surface is travelling backward and hence frictional force would act forward. In the instant case $\theta = \omega t = 2\pi$ and hence peripheral distance covered by particle in time $t$ would be $p = r\theta = r(\omega t) = 2\pi r = 125.6$ cm, while linear ditance covered by COM $d = vt = 60$ cm. Since duration is same, it implies $v < r\omega$ it belongs to case (iv). Hence, from above analysis, frictional force on wheel would act forward. **Thus, answer is (a)** |
| I-43 | Point to be noted is scotter is moving on a frictionless surface. It implies that there is no role of friction in motion of scooter. Motion of scooter on road due power transmitted by engine to the wheel is inly due to friction. In absence of friction, on a fricionless surface, increase in petrol supply would only increase angular velocity of the wheel, and thus input power would be stored in rotational kinetic energy of wheel, without increase in linear velocity of scooter. **Hence, answer is (d).** |
| I-44 | Moment of inertia of a the given objects of mass M are $I_{SS} = \frac{2}{5}MR^2$ , $I_{SS} = \frac{2}{3}MR^2$ , and $I_D = \frac{2}{3}MR^2$. Since, incline surface is stated to be smooth, there would be pure slipping and hence time taken by each of the object, to reach the botton, would be governed by second equations of kinematics and is independent of their MIs, and would be same. **Hence, answer is (d).** |
| I-45 | Moment of inertia of a the given objects of mass M are $I_{SS} = \frac{2}{5}MR^2$ , $I_{SS} = \frac{2}{3}MR^2$ , and $I_D = \frac{2}{3}MR^2$. Since, surface is frictiona and hence each of he object would experiencea frictional force drag $f = \mu Mg\cos\theta$ and a forward push $F = Mg\sin\theta$. Since, pur rolling occurs, therefore, linear |

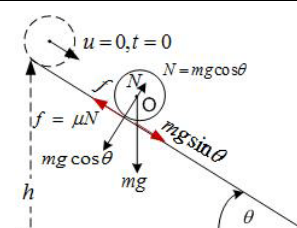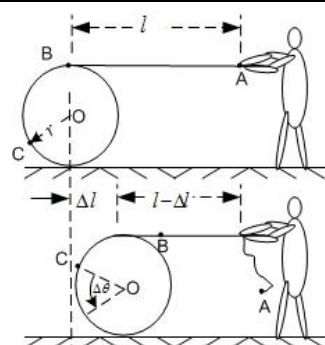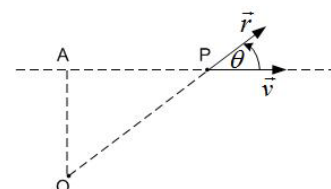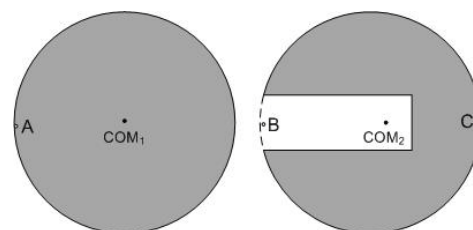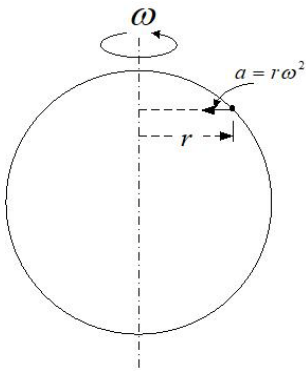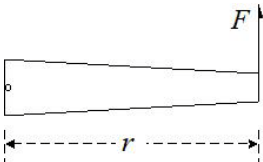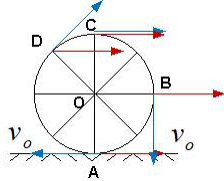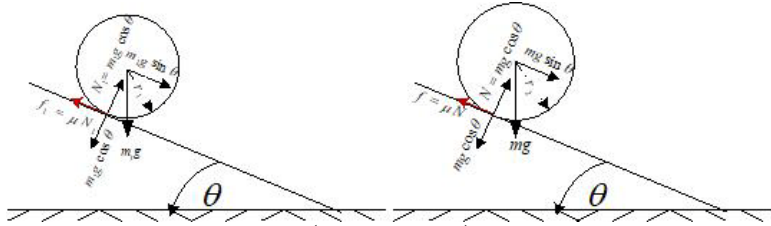| | |
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| | acceleration   $a = \dfrac{F-f}{M} = \dfrac{Mg\sin\theta - \mu Mg\cos\theta}{M} = g\sin\theta - \mu g\cos\theta$ . And , angular acceleration $\alpha = \dfrac{fR}{I} = \dfrac{\mu Mg\cos\theta}{I}$ . . Since,  $I$  is different for the three objects  and hence  $\alpha$  would also be different, despite each having same frictional force  $f$ . But, since  $a$ is independent of  $I$ , as per second equation of kinematics, time to reach bottom would be same. ***Hence, answer is (d).*** <br><br>***N.B.:*** *For pure rolling necessary condition is  $a = R\alpha$ , and  I  is dependent on , despite objects having same mass and radius, and hence their angular velocities  $\omega$  on reaching the ground would be different. It can be verified that since vertical fall for all objects, on the incline,  is same for all objects, as per Law of conservation of energy  $\Delta PE = \Delta KE_L + \Delta KE_R$ , here,  $\Delta KE_L$  is change in change in kinetic energy of linear motion, and  $\Delta KE_R$ is change in rotational  kinetic energy is same for all the three objects..* |
| I-46 | Moment of inertia of a the given objects of mass M are  $I_{SS} = \dfrac{2}{5}MR^2$ ,  $I_{SS} = \dfrac{2}{3}MR^2$ , and  $I_D = \dfrac{2}{3}MR^2$ . Since,  surface is frictiona and hence each of he object would experiencea frictional force drag  $f = \mu Mg\cos\theta$  and a forward push  $F = Mg\sin\theta$ . Since,  pur rolling occurs, therefore, linear acceleration   $a = \dfrac{F-f}{M} = \dfrac{Mg\sin\theta - \mu Mg\cos\theta}{M} = g\sin\theta - \mu g\cos\theta$ . And , angular acceleration $\alpha = \dfrac{fR}{I} = \dfrac{\mu Mg\cos\theta}{I}$ . . Since,  $I$  is different for the three objects  and hence  $\alpha$  would also be different, despite each having same frictional force  $f$ . But, since  $a$ is independent of  $I$ , as per third equation of kinematics, linear velocity of each object on reaching the bottom would be same, so also their kinetic energy would be same. <br><br> It given that there is no pure rolling i.e.  $a \neq R\alpha$ , and  $I$  is dependent on , despite objects having same mass and radius, and hence their angular velocities  $\omega$  on reaching the ground would be different. But, as per Law of Conservation of Energy  $\Delta PE = \Delta KE_L + \Delta KE_R$ , here,  $\Delta KE_L$  is change in change in linear kinetic energy which is same for all objects, as derived above, and hence arithmatically   $\Delta KE_R$ , ***change in rotational kinetic energy would also be same for all the three objects***. This can be verified, by applying equations oof rotational kinematics. ***Hence, answer is (d).*** |
| I-47 | The given problem has been split in, for illustration, in two figures. In initial case man is holding end A of string wrapped over cylinder and particle B of the string is last point of contact of string with cylinder of radius  $r$ . Let another particle C of the string is at a linear length  $l$ from particle B. While pulling string cylinder undergoes pure rolling and therefore if point B moves forward by a distance  $\Delta l$  the point rotates through an angle $\Delta\theta = \dfrac{\Delta l}{r}$ .   Thus eventually the man pulls the cylinder towards him by a distance   $\Delta l$ , the rolling causes unwrapoing of string of length by another length  $\Delta l$  due to rotation of cylinder an angle  $\Delta\theta$ . Accordingly to pull cylinder towards him through a length  $\Delta l$  the string that passes through his hands is  $2\Delta l$ . Thus for the man to keep string pulling the string, till cylinder reaches him, cylinder has to move towards man through a distance  $l$ , hence is the length of the string that passes through hands of the man is  $2l$ . ***Hence, answer is (b).*** |

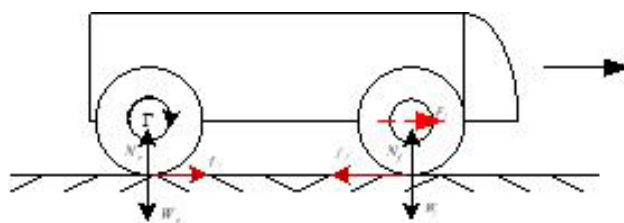| | |
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| I-48 | It requires to be distinguish between rotation and revolution. An object when turn around an axis within its geometry called nternal axis it is rotation, and when axis lies outside its geometry then it is rotation. These definitios are applied to two shapes, One has COM₁ and is symmetrical about X-axis and Y-axis. In this Axis of rotation may pass through centre of mass or anywhere within the shape e.g point A. Thus axis of rottaion may pass through COM, but not compulsoary. ***This makes option (b) correct and makes makes requirement in option (a) as incorrect.*** In  another shape is symmetrical about X-axis by un-symmetrical about Y- axis, due to a notch cut out of it. In this, through COM2 is outside its body but is within the outer periphary, so also point B, while point C is within the body. Thus axis or rotation is within outer periphary but not necessarily through the body. ***This makes option (d) correct but makes makes requirement in option (c) as incorrect.*** ***Thus option (b) and (d) ae correct.*** |
| I-49 | In inertial frame, equations (A) and (B) are valid. But, in non-inertial frame equation (A), angular momentum in inertial frame $L$ is based on instantaneous value of $\omega$ and hence it would be valid. But, as regards equation (B), $\dfrac{dL}{dt} = \Gamma = I\alpha$  where,  $\alpha$ is angular acceleration of object. But,  in non-inertial frame, it implies that  i.e. $\alpha = \alpha_i = \alpha_{ni} + \alpha_{ni,i} \to \alpha_{ni} = \alpha_i - \alpha_{ni,i}$. Thus torque is dependent on $\alpha_i - \alpha_{ni,i}$ and not merely $\alpha_i$. These two conditions are specified only in option (b). ***Hence, answer is (b).*** |
| I-50 | The problem is explained in figure where paticle P has a mass $m$ with a position vector $\vec{r} = r\hat{r}$ and moving along a stright line with a velocity $\vec{v} = v\hat{v}$. Accordingly, angluar momentum  is $\vec{L} = \vec{r} \times \vec{v} = (r\hat{r}) \times (v\hat{v}) = rv(\hat{r} \times \hat{v}) = rv(\sin(-\theta)\hat{n}) = (r\sin\theta)v(-\hat{n}) = pv(-\hat{n}).$ Here, $p$ is the perpendicular distance AO of the line from O and is fixed by the given geometry. Further, velocity of the particle is given to be constant (uniform) and $(-\hat{n})$ is unit normal vector toward the plane of vector $\vec{r}$ and . Thus all the constituent quantities of $\vec{L}$ so also it is. Analysing each of the given option leas to – <br><br> (a) For $\vec{L}$ to be zero either $r = 0$, or $v = 0$ or $\theta = 0$, none of these are given hence cannot be zero, and ***option (a) is incorrect***. <br> **(b)** If point O is on straight line then $p = 0$ which being a coefficient will make $\vec{L} = 0$. Hence, ***option (b) is correct.*** <br> *(c)* For any point away from the line collinear to the velocity $p \neq 0$, and hence by corollary of (b) $\vec{L} \neq 0$, hence ***option (c) is correct.*** <br> (d) $\vec{L}$ remains constant at any given point be it on the line or outside it, irrespective of position P of particle , hence ***option (d) is correct.*** <br> ***Accordingly, answers are (b), (c) and (d).*** |
| I-51 | In case of linear motion $\vec{F}\Delta t = \Delta\vec{P} \to \vec{F}\Delta t = m\Delta\vec{v}$ while in case of angular motion, $\vec{\Gamma}\Delta t = \Delta\vec{L} \to (\vec{r} \times \vec{F})\Delta t = I\Delta\vec{\omega}$. With this analytical statement each option is being analysed . <br><br> *(a)* Since, given body is rigid and hence both its mass and shaperemains unchanged. Given that $\vec{F} = 0$, therefore $\Delta\vec{L} = 0$ hence angular momentum would remain constant. Hence, ***option (a) is correct.*** <br> (b) Since, mass of rigid body remains constant, hence with the given $\vec{F} = 0$ linear momentum would remain constant. Hence, ***option (b) is correct***. |

(c) As per NSLM ,for $\vec{F}=0$ , $\Delta V=0$ and $\Delta \omega =0$, therefore kinetic energy of linear motion and rotational motion would also remain constant. Hence, ***option (c) is correct***.

(d) Rigid body by its definition maintains its geometry and mass density, and hence its moment of inertia remains constant. Hence, ***option (d) is correct***.

***Answer is (a), (b), (c) and (d).***

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| I-52 | As per pralllel axis theorem moment of inertia of a body is $I_{xx}=I+Md^2$, here $I=\dfrac{\sum m_i r_i^2}{\sum m_i}$ is moment of inertia of a body about an axis passing through its COM let us call it principal axis (PA) and it depends upon choice of axes, $M$ is mass of the body, $I_{xx}$ is Momememt of inertia aout any axis X-X parallel to the axis passing through COM and $d$ is distance of the line. Given that MI of same body about Two axis, A and B, out of which A is passing through COM and hence its distance with principal axis $d=0 \to I_A = I$ while for axis B $I_B = I+Md^2$ such that $d \neq 0$ since it is not passing through PI and $d^2 > 0$ irrespective of $d$ is (+)ve or (-)ve . Accordingly, analysis of options goes as under – <br><br> (a) Taking an example of rectangular body its MI taken along an axis passing through COM and parallel to length is smaller than MI taken on an axis parallel to width. This is unlike circlular plate, ring or a sphere. Since, in the problem neither shape of body nor its oientation is given and hence it can relation between $I_A$ and $I_B$ can not be established and hence ***this option is incorrect.*** <br><br> (b) From analysis at (a) if axis through COM is parallel to length and another axis is chosen anti parallel to the axis, but geometrically so placed that $I_A < I_B$ and henceit makes certainty of ***this option incorrect.*** <br><br> (c) Analysis above makes ***this option as correct.*** <br><br> (d) In case axes are not parallel, but geometrical positioning is not known therefore, from above analysis this option can not be ascertained and hence ***this option is also incorrect.*** <br><br> ***Correct answer is option (c).*** |
| I-53 | Given that a sphere is rotating about a diameter without mentioning that diameter is about a fixed axis or not. Accordingly, the diameter is taken as fixed axis. Thus analysis of options goes as under – <br><br> (a) Every particle on the sphere, a rigid body would experience a radial acceleration $a=r\omega^2$ as shown in the figure. And there is no linear acceleration since sphere is rotating abot its diameter. Hence ***this option is incorrect.*** <br><br> (b) Particles on the diameter always remain at diameter with $r=0 \to a=0$ from the analysis at (a) above, hence ***this option is correct***. <br><br> (c) Sphere is symmetrical about diameter and sphere is a rigid body and irrespective position of the particle on surface i.e. distance from the diameter, angular speed at any instant shall remain same and hence proposition ***option of different angular speeds is incorrect***. <br><br> (d) Linear speed is of a particly on surface is $\lvert \vec{v}\rvert = \lvert \vec{r}\times \vec{\omega}\rvert = r\omega \sin\theta$, here $\theta$ depends upon position of the article and hence despite $r$ and $\omega$ remaining constant linear speed $\lvert \vec{v}\rvert$ cannot be constant and hence ***option (d) is incorrect.*** <br><br> ***Answer is option (b)*** |

| I-54 | It is known that $\vec{\Gamma} = \vec{r} \times \vec{F} = rF \sin\theta \vec{n} = rF\,\vec{n}$ , problem states that $\theta = 90^0$,.<br><br>While, $\vec{\Gamma} = I\,\vec{\alpha} \rightarrow \vec{\alpha} = \dfrac{rF\,\vec{n}}{I}$ . Thus, as per analysis-<br><br>  (a) $\vec{F}$ is taken to be constant since no variation in it is defined. Likewise, $r = l$ i.e. length of the rod but its $I$ is dependent on pivot i.e. axis of rotation and hence would influence $\vec{\alpha}$ and ***hence this answer is incorrect***.<br>  (b) Since parameters given in this option depend upon $\alpha$ , which itself at (a) is incorrect and hence dependence of these parameters on position of pivot is incorrect. Thus, ***this option is incorrect***.<br>  (c) Since, $\vec{p} = I\vec{\omega}$ and therefore by logic of (a & b) above and $\omega = \omega_0 + \alpha t$ , ***this option is incorrect***.<br>  (d) From the equation of torque, $\vec{\Gamma} = rF\,\vec{n}$ in given case both $r$ and $F$ are constant irrespective of the end chosen to be pivot and hence ***this option is correct.***<br>***Answer is option (d).*** |
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| I-55 | Magnitude of velocity of all particles at the periphary of the wheel having a linear velocity $v_o$ is also $v_o$ but, in a direction of tangent at the point. Each particle shall have a linear velocity with linear velolicty $v_o$ parallel to the roadand a tangential velocity $v_o$ as shown for the points identified in the question. Accordingly, each of the option is being analyzed is supported with a figure.<br>    (a) Linear and tangential velocity vectors of point A are equal and opposite and hence resultant velocity shall be Zero. Hence, ***this is correct option.***<br>    (b) As shown in the figure resultant of linear and tangential velocities for point B and D shall be $v_0 < 2v_0$ and for point C shall be $2v_0$. Thus none of the points has velocity equal to $v_0$, hence this ***option is incorrect.***<br>    (c) Resultant velocity of point C is $2v_0$ as already analyzed at (b) above, and hence ***this answer is correct.***<br>    (d) Magnitude of velocity of point B is greater than $v_0$ as already analyzed at (b) above, and hence ***this answer is correct.***<br>***Thus answer is (a), (c) and (d).*** |
| I-56 | Taking the two spheres of masses $m_1$ and $m_2$ radii $r_1$ and $r_2$ respectively. Their MI shall be $I_1 = \dfrac{2}{5}m_1 r_1^2$ and $I_2 = \dfrac{2}{5}m_2 r_2^2$ respectively. Torques and angular acceleration shall be experienced by the the two sphere shall be $\Gamma_1 = f_1 r_1 = (\mu m_1 g \cos\theta)\,r_1 = I_1 \alpha_1 \rightarrow \alpha_1 = \dfrac{(\mu m_1 g \cos\theta)\,r_1}{\dfrac{2}{5}m_1 r_1^2} = \dfrac{5}{2}\dfrac{\mu g \cos\theta}{r_1}$ and<br><br>$\Gamma_2 = (\mu m_2 g \cos\theta)r_2 = I_2 \alpha_2$ which bu analogy works out to $\alpha_1 == \dfrac{5}{2}\dfrac{\mu g \cos\theta}{r_2}$ . Since spheres are not<br><br>slipping and hence $v = r\omega \rightarrow a = r\alpha$ . Accordingly, $a_1 = r_1\left(\dfrac{5}{2}\cdot\dfrac{\mu g \cos\theta}{r_1}\right) = \dfrac{5}{2}\mu g \cos\theta$ and likewise,<br><br>$a_2 = \dfrac{5}{2}\mu g \cos\theta$ .Since linear accelerations of both the sphere are same and both roll down same slope from same height anf hence both would reach bottom of the incline together. Hence, among the given |

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| | options only (c) is correct.<br>**Answer is (c).** |
| I-57 | In the problem, moment of inertia of a hollow sphere is $I_{HS} = \dfrac{1}{2}MR^2$ and that of a solid sphere<br><br>$I_{SS} = \dfrac{2}{5}MR^2$ for two sphere having same mass and radii. Both the sphere would experience similar<br><br>frictional force $f$ that causes rolling, and hence angular acceleration of the spheres can be<br><br>determined with $\Gamma = fR = I\alpha = M\,k^2 R^2 \alpha \rightarrow \alpha = \dfrac{f}{k^2 MR}$. Here, $k^2$ is 0.4 for solid sphere and 0.5 for<br><br>hollow sphere. Thus, angular angular acceleration of solid sphere would be higher than that of hollow<br>sphere since- **a)** it is nversly proprtional to $k^2$, and **b)** $k^2$ is larger for hollow sphere. Since both the<br>sphere are rolling where $v = R\omega$ and hence angular and linear speed attained by solid sphere while<br>rolling down same inclined rough plane would also be higher. Using this analysis each of the option is<br>being examined –<br><ul><li>(a) Since angular acceleration of hollow sphere is less and than solid sphere, and hence time taken by it reach ground shall be more by second equation of kinematics. ***Hence, this option is incorrect***.</li><li>(b) Since, angular acceleration of solid sphere is higher, and speed attaied by it on reaching the bottom would also be more. Hence , ***this option is correct***.</li><li>(c) Kinetic energy of the sphere is $KE = KE_R + KE_L = Mgh$, where $KE_R$ is kinetic energy of rotational motion and $KE_L$ is kinetic energy of linear motion and $Mgh$ is potential energy utilized during descend through height $h$ on the rough inclined plane. Since, $Mgh$ is constant and same for both the given spheres. Hence, ***this option is incorrect***.</li><li>(d) From the above analysis, since linear velocities of both the sphere are not same and hence lineear momentum $p = Mv$ would also be different, hence ***this answer is incorrect***.</li></ul>***Answer, is option (b)*** |
| I-58 | Rolling of a sphere on a plane requires a frictional force and in absence of this sphere cannot roll.<br>Necessary requirement of frictional force $f = \mu N = \mu Mg\sin\theta$, here $\theta$ is the angle between normal to<br>the surface and direction of $\theta$ Since no mention of any external force is made it is considered to be<br>zero. Thus, anlysing the problem for each option –<br><ul><li>(a) In this case $\theta = 0 \rightarrow \sin\theta = 0 \rightarrow f = 0$ and hence no rolling would take place. But, since there is no external force, it would also not slide on smooth horizontal surface, it would remain in state of rest. Thus question of rolling ruled out, which makes ***this option is an incorrect answer***. </li><li>(b) In case of smooth inclined plane though $\theta \neq 0$, yet $f = 0$ since $\mu = 0$ and hence necessary condition for rolling is not satisfied. This makes ***this option is correct answer***.</li><li>(c) On a rough plane $\mu \neq 0$ that makes $f \neq 0$ which satisfies condition of rolling. Thus in the event of any external force sphere would tend to roll. This makes ***this option is incorrect answer***.</li><li>(d) On inclined rough plane, $\theta \neq 0$, $\mu \neq 0$ ad hence $f \neq 0$, which satisfies condition of rolling. Further, there is an external force due to gravity $F = mg\sin\theta$ which would set the sphere to roll. Hence, ***this option is incorrect answer***.</li></ul>***Correct answer is option (b).*** |
| I-59 | Given is rear-wheel driven car in which for motion of car in forward direction torque $\Gamma$ in clockwise direction is supplied to the wheel by engine as shown in the figure. Since frictional force on rear wheels $f_r$ acts opposite to the direction of motion, and frictional force at the point of contact of rear |

wheels with the road must act in anti-clockwise direction as shown in the figure.

As regards, front wheels  rotate due to push $F_f$ created by linear motion of car, in forward direction, due to rotation of rear wheels. Therefore, it would experience frictional force  $f_f$ in backward direction, setting front wheels to also rotate in clockwise direction, in unison with rear wheels. Accordingly, each of the given option is being examined –

(a) **This option is correct** and is discussed in analysis above.

(b) Direction of friction is analyzed to be in backward direction and hence **this answer is correct.**

(c) Rotation of rear wheel is cause of action the frictional force  $f_r$  on rear wheel, has to be more than or equal to effect frictional force  $f_f$  on the front wheel. Considering some assorted losses during motion of car, magnitude of frictional force of rea wheel shall be greater that frctional force of front wheel, which has an overall effect of motion of car.Accordingly, **this option is correct**.

(d) It is analyzed at (c) above $f_R > \left| - f_F \right| \to f_R + f_F > 0$ and hence net frictional force on car shall be in forward direction, **which makes thos option incorrect**.

**Answer is (a), (b) and (c).**

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**I-60**

In pure rolling on an inclined plane  $v = r\omega$ , $a = \dfrac{mg \sin\theta - f}{m} \to f = m(g\sin\theta - a)$ ,

$fr = I\alpha = \left(\dfrac{2}{5}mr^2\right)\left(\dfrac{a}{r}\right) \to f = \dfrac{2}{5}ma$  while frictional force is   $f = \mu mg \cos\theta$ . Condition for pure

rolling is  $\mu > \dfrac{2}{7} g \tan\theta$ it leads to  $f > \left(\dfrac{2}{7} g \tan\theta\right)(mg\cos\theta) \to f = \dfrac{2}{7}mg^2\sin\theta$ . But, it is  given that
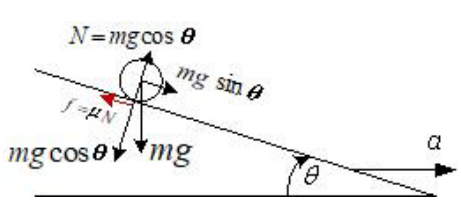
$\mu = \dfrac{1}{7} g \tan\theta$ this would make actual frictional force  $f_{actual} = \dfrac{1}{7}mg^2\sin\theta \to f_{actual} < f$ would be less than

that required for pure rolling. Therefore, extra push created by downward gravitational force would cause translational motion together with the rotation of sphere about its centre. Thus, **answer is option (c).**

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**I-61**

In case of a sphere rolled on a horizontal surface if it slows down it means it is apparently experiencing a linear retardation. But, actually it is experiencing angular retardation. Since, during rolling $v = r\omega$  and, therefore, when $\omega = 0 \to v = 0$.Accordingly each of the option is being analyzed –
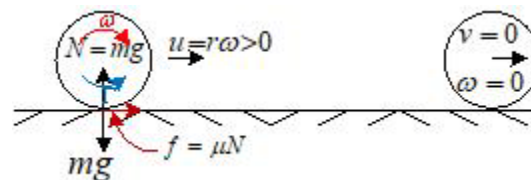
(a)  When sphere is rolling forward, particle of sphere in contact with horizontal surface is tending to move backward in clockwse direction. Eventually, frictional force  $f = \mu N = \mu mg$ would act in forward direction. Thus, torque $\Gamma = fr = I\alpha$ would act in anti-clockwise direction to create an angular retardation. As result of the retardation during rolling $(v = r\omega)$linear velocity would decrease. Further, as per first equation of kinematics applied to angular motion after certain time $t$ angular velocity of sphere would become ZERO to make it come to rest, i.e.  $0 = \omega_0 - \alpha t$ . This is **consistent with option (a) and is correct.**

(b) From the analysis at (a) above since angular velocity is decreasing and hence **option (b) is incorrect.**

(c) Since with decrease of  $\omega$ linear velocity  $v$ is also decereasing and hence linear momentum  $p = mv$ would also decrease until sphere comes to rest. Accordingly, **option (c) is incorrect**.

(d) Since  $\omega$  is retarding as sphere rolls, as analyzed at (a) above,  angular momentum $L = I\omega$ would

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| | also decrease. Thus this ***option (d) is also correct***.<br>***Answer is option (a) and (d)*** |
| I-62 | Force digram of the problem is shown in the figure, where car is having an acceleration n horizontal road $a = g\tan\theta$. Component of this acceleration along the inclined plane is $a' = a\cos\theta = (g\tan\theta)\cos\theta = g\sin\theta$. Since ball is on inclined plane it will tend to roll down and hence frictional force with given parameters would be $f = \mu N = \mu mg\cos\theta$. Condition for force $f'$ that will allow the sphere to roll down the plane with an acceleration $g\sin\theta$ would be $mg\sin\theta - f' = m(a\sin\theta) = ma\sin\theta \to f' = 0$. Since, this leads to that sphere tending to roll down would remain in its position; virtually the the sphere in a non-inertial frame with an acceleration down the plane $g\sin\theta$ causing a pseudo force to create an equilibrium. Accordingly analysis of options is as under -<br>(a) If sphere is set on pure rolling, the torque created by $\Gamma = fr$ created by friction about COM of sphere, would continue to roll the sphere at the same posotion on the inclined plane. Thus, this ***option (a) is correct***.<br>*(b)* Equilibrium of forces along the plane will not let the sphere slip down as per NFLM. Hence, ***option (b) is incorrect***.<br>(c) Equilibrium of forces along the plane would not allow increase of velocity as per NSLM. Hence ***option (c) is incorrect***.<br>(d) By logic at (c), ***option (d) is also incorrect***.<br>***Thus answer is (a).***<br>***N.B.:*** *This phenmenon of sphere rolling at sae position can be visualized from the fact that gravitational force along the slope, and psuedo force on the sphere caused by acceleration of car are equal and opposite. Thus, the roll of the sphereof the inclined plane is nullified by the displacement of the inclined plane due to accelerated car. Virtually position of the sphere remains unchanged. Nevertheless, rolling of sphere about its centre continues due to torque created by the frictional force.* |

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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

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## Theme Song :

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

इतनी शक्ति हमें देना दाता, मन का विश्वास कमजोर 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 ||



# **T**ogether **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 ...*