THE VISION OF NEP 2020:
Integrating Bharatiya Knowledge System in Physics Textbooks

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Vidya Bharati Uchcha Shiksha Sansthan

Vidya Bharati
Uchcha Shiksha Sansthan

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FOREWORD

This book, *The Vision of NEP 2020: Integrating Bharatiya Knowledge System in Physics Textbooks*, is an outcome of sustained efforts of Vidya Bharti Uchcha Shikhsha Sansthan and Sardar Patel University, Mandi, Himachal Pradesh, HIM Science Congress Association, Himachal Pradesh, Central University of Himachal Pradesh and Vigyan Bharati towards implementation of various recommendations of NEP 2020 in School Curriculum. With the announcement of National Education Policy 2020, government agencies and pioneer organizations working in the field of education have come into action to work on National Curriculum Framework and State Curriculum Frameworks. These endeavours are seeing huge participation from intellectuals and stakeholders in the academic fields to prepare content and design school textbooks based on the mandate of NEP 2020. This research volume is a germane contribution in this direction and provides a strategic plan towards development of syllabi and new textbooks in Physics subject to be developed for all stages and classes.

In developing this volume, Vidya Bharti Uchcha Shikhsha Sansthan has taken a pioneer initiative towards accomplishing the intent of NEP in re-connecting and re-establishing the foundations of age-old Indian Education System and connect it with global pedagogical developments. The book provides lucid insights into the history of physics in India and the impact of introducing it in school syllabi for preparing students future ready yet strongly rooted in Indian values.

In covering this facet, this book also presents an extensive list of reference books and primary texts that can be used to re-design physic textbooks for different stages and classes in school. This judiciously written volume is an integral contribution to the countrywide efforts towards implementation of National Education Policy 2020. I am particularly pleased to provide an entry point to this volume and welcoming all policy makers, academics, scholars, authors and readers. Last but not the least, I would like to express our gratitude to all our partner institutions, collaborators and particularly IKS Division of MoE, AICTE, GoI, Sardar Patel University, Mandi, Himachal Pradesh, Him Science Congress Association, Himachal Pradesh, Central University of Himachal Pradesh and Vigyan Bharati for supporting us in this project.

Prof. Kailash Chandra Sharma
President, Vidya Bharati Uchcha Shiksha Sansthan

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PREFACE

India i.e. Bharat has a legacy of scientific knowledge system and rich cultural heritage. The knowledge system is developed over several millennia and manifested in the form of science, technology, medicine, agriculture, arts and literature. As such, this land has provided invaluable knowledge stuff to the whole world from time immemorial and contributed the social order to the fullest. The oldest world class Universities of the world like Takshashila, Nalanda, Vikramshila and Vallabhi, etc and the magnificent works of the great scholars like Charaka and Susruta, Aryabhata, Bhaskaracharya, Chanakya, Madhava, Patanjali, Panini and Thiruvalluvar are the remnants of such an extensive traditional legacy of knowledge creation and dissemination.

No doubt, Indian traditional knowledge and cultural heritage have been always admired by the world, but unfortunately, apart from the traditional practice, a larger portion of the treasure of knowledge is either lost or remained folded and veiled in the personal possessions or stacked in the various libraries worldwide.

There is a long tradition of holistic and multidisciplinary learning in India i.e. from 'liberal arts' (i.e., a liberal notion of the arts) in the Universities to the extensive literatures of various subjects across fields. The National Education Policy-2020 is committed to bring this tradition back to education system, as it is exactly the kind of education needed for the 21st century. As such, the students will have an ample of opportunities to exercise, e.g. they would be able to convert Indian wisdom into the applied aspect of the modern scientific technology.

In ancient India, the aim of education was far beyond the acquisition of knowledge for material prosperity, i.e. complete realization and liberation of the self. Therefore, exploring the immense potential of knowledge in India is truly important for the nation's identity, pride, self-esteem as well as for its economy.

Physics is considered important to understand basic concepts in Chemistry, Botany, Zoology, Physiology, Engineering and Agricultural Science. Moreover, studying Physics usually develops the analytical thinking in student, which in turn helps him face a real life problem. Looking at the present demand of R & D sectors, rural industries and market forces school level Physics curriculum need to be revised. Incorporation of Indian Knowledge System in Physics Curriculum will help in giving the R & D a new dimension and National Education Policy-2020 is aimed at fulfilling this very objective.

Chapter–1

NATIONAL EDUCATION POLICY 2020: HIGHLIGHTS[1]

Introduction

Education is fundamental for achieving full human potential, developing an equitable and just society, and promoting national development. Providing universal access to quality education is the key to India's continued ascent, and leadership. Universal high-quality education is the best way forward for developing and maximizing our country's rich talents and resources for the good of the individual, the society, the country, and the world.

The world is undergoing rapid changes in the knowledge landscape. With various dramatic scientific and technological advances, such as the rise of big data, machine learning, and artificial intelligence, many unskilled jobs worldwide may be taken over by machines, while the need for a skilled workforce, particularly involving mathematics, computer science, and data science, in conjunction with multidisciplinary abilities across the sciences, social sciences, and humanities, will be increasingly in greater demand.

Education thus, must move towards less content, and more towards learning about how to think critically and solve problems, how to be creative and multidisciplinary, and how to innovate, adapt, and absorb new material in novel and changing fields. Pedagogy must evolve to make education more experiential, holistic, integrated,

1. This chapter consists of extracts from NEP 2020 relevant to science curriculum

inquiry-driven, discovery-oriented, learner-centred, discussion-based, flexible, and, of course, enjoyable. The curriculum must include basic arts, crafts, humanities, games, sports and fitness, languages, literature, culture, and values, in addition to science and mathematics, to develop all aspects and capabilities of learners; and make education more well-rounded, useful, and fulfilling to the learner.

National Education Policy 2020 is the first education policy of the 21st century and aims to address the many growing developmental imperatives of our country. This Policy proposes the revision and revamping of all aspects of the education structure, including its regulation and governance, to create a new system that is aligned with the aspirational goals of 21st century education, including SDG4, while building upon India's traditions and value systems.

The rich heritage of ancient and eternal Indian knowledge and thought has been a guiding light for this Policy. The pursuit of knowledge (*Jnan*), wisdom (*Pragyaa*), and truth (*Satya*) was always considered in Indian thought and philosophy as the highest human goal. The aim of education in ancient India was not just the acquisition of knowledge as preparation for life in this world, or life beyond schooling, but for the complete realization and liberation of the self.

The Indian education system produced great scholars such as Charaka, Susruta, Aryabhata, Varahamihira, Bhaskaracharya, Brahmagupta, Chanakya, Chakrapani Datta, Madhava, Panini, Patanjali, Nagarjuna, Gautama, Pingala, Sankardev, Maitreyi, Gargi and Thiruvalluvar, among numerous others, who made seminal contributions to world knowledge in diverse fields such as mathematics, astronomy, metallurgy, medical science and surgery, civil engineering, architecture, shipbuilding and navigation, yoga, fine arts, chess, and more. Indian culture and philosophy have had a strong influence on the world. These rich legacies to world heritage must not only be nurtured and preserved for posterity but also researched, enhanced, and put to new uses through our education system.

Principles of NEP 2020

The purpose of the education system is to develop good human beings capable of rational thought and action, possessing compassion and empathy, courage and resilience, scientific temper and creative imagination, with sound ethical moorings and values. It aims at producing engaged, productive, and contributing citizens for building an equitable, inclusive, and plural society as envisaged by our Constitution.

The fundamental principles relevant to computer education that will guide both the education system at large, as well as the individual institutions within it are:

- Multidisciplinarity and a **holistic education** across the sciences, social sciences, arts, humanities, and sports for a multidisciplinary world in order to ensure the unity and integrity of all knowledge;
- **Creativity and critical thinking** to encourage logical decision-making and innovation;
- **Extensive use of technology** in teaching and learning, removing language barriers, increasing access for *Divyang* students, and educational planning and management;
- **Synergy in curriculum across all levels of education** from early childhood care and education to school education to higher education;
- **A rootedness and pride in India**, and its rich, diverse, ancient and modern culture and knowledge systems and traditions;

The Vision of NEP 2020

The National Education Policy envisions an education system rooted in Indian ethos that contributes directly to transforming India, that is Bharat, sustainably into an equitable and vibrant knowledge

society, by providing high-quality education to all, and thereby making India a global knowledge superpower.

SCHOOL EDUCATION

This policy envisages that the extant 10+2 structure in school education will be modified with a new pedagogical and curricular restructuring of 5+3+3+4 covering ages 3-18.

Early Childhood Care and Education

Para 1.1 of NEP 2020 states that Universal provisioning of quality early childhood development, care, and education must thus be achieved as soon as possible.

Foundational Literacy and Numeracy: An Urgent & Necessary Prerequisite to Learning

As per para 2.1 of NEP 2020 the ability to read and write, and perform basic operations with numbers, is a necessary foundation and an indispensable prerequisite for all future schooling and lifelong learning. Para 2.4 of NEP 2020 asserts that on the curricular side, there will be an increased focus on foundational literacy and numeracy - and generally, on reading, writing, speaking, counting, arithmetic, and mathematical thinking - throughout the preparatory and middle school curriculum, with a robust system of continuous formative/adaptive assessment to track and thereby individualize and ensure each student's learning. Specific hours daily - and regular events over the year-on activities involving these subjects will be dedicated to encourage and enthuse students. Teacher education and the early grade curriculum will be redesigned to have a renewed emphasis on foundational literacy and numeracy. Para 2.6 also recommends that A national repository of high-quality resources on foundational literacy and numeracy will be made available on the Digital Infrastructure for Knowledge Sharing (DIKSHA).

Technological interventions to serve as aids to teachers and to help bridge any language barriers that may exist between teachers and students, will be piloted and implemented.

Para 2.8 states that enjoyable and inspirational books for students at all levels will be developed, including through high-quality translation (technology assisted as needed) in all local and Indian languages, and will be made available extensively in both school and local public libraries.

Curtailing Dropout Rates and Ensuring Universal Access to Education at All Levels

As per NEP 2020 para 3.1, One of the primary goals of the schooling system must be to ensure that children are enrolled in and are attending school.

Curriculum and Pedagogy in Schools

Restructuring school curriculum and pedagogy in a new 5+3+3+4 design

As per para 4.1 of NEP 2020, the curricular and pedagogical structure of school education will be reconfigured to make it responsive and relevant to the developmental needs and interests of learners at different stages of their development, corresponding to the age ranges of 3-8, 8-11, 11-14, and 14-18 years, respectively. The curricular and pedagogical structure and the curricular framework for school education will therefore be guided by a 5+3+3+4 design, consisting of the Foundational Stage (in two parts, that is, 3 years of Anganwadi/pre-school + 2 years in primary school in Grades 1-2; both together covering ages 3-8), Preparatory Stage (Grades 3-5, covering ages 8-11), Middle Stage (Grades 6-8, covering ages 11-14), and Secondary Stage (Grades 9-12 in two phases, i.e., 9 and 10 in the first and 11 and 12 in the second, covering ages 14-18).

Para 4.2 also states that the Middle Stage will comprise three years of education, building on the pedagogical and curricular style of the Preparatory Stage, but with the introduction of subject teachers for learning and discussion of the more abstract concepts in each subject that students will be ready for at this stage across the sciences, mathematics, arts, social sciences, and humanities. Experiential learning within each subject, and explorations of relations among different subjects, will be encouraged and emphasized despite the introduction of more specialized subjects and subject teachers. The Secondary Stage will comprise of four years of multidisciplinary study, building on the subject-oriented pedagogical and curricular style of the Middle Stage, but with greater depth, greater critical thinking, greater attention to life aspirations, and greater flexibility and student choice of subjects.

Holistic development of learners

Para 4.4 asserts that the key overall thrust of curriculum and pedagogy reform across all stages will be to move the education system towards real understanding and towards learning how to learn - and away from the culture of rote learning as is largely present today.

Reduce curriculum content to enhance essential learning and critical thinking

Para 4.5 articulates that Curriculum content will be reduced in each subject to its core essentials, to make space for critical thinking and more holistic, inquiry-based, discovery-based, discussion-based, and analysis-based learning.

Experiential learning

Para 4.6 of NEP 2020 states that In all stages, experiential learning will be adopted, including hands-on learning, arts-integrated and sports-integrated education, story-telling-based pedagogy,

among others, as standard pedagogy within each subject, and with explorations of relations among different subjects. To close the gap in achievement of learning outcomes, classroom transactions will shift, towards competency-based learning and education. The assessment tools (including assessment "as", "of", and "for" learning) will also be aligned with the learning outcomes, capabilities, and dispositions as specified for each subject of a given class.

Empower students through flexibility in course choices

Para 4.9 claims that students will be given increased flexibility and choice of subjects to study, particularly in secondary school.

Multilingualism and the power of language

Wherever possible, the medium of instruction until at least Grade 5, but preferably till Grade 8 and beyond, will be the home language/ mother tongue/local language/regional language. Thereafter, the home/local language shall continue to be taught as a language wherever possible. This will be followed by both public and private schools. High-quality textbooks, including in science, will be made available in home languages/mother tongue. All efforts will be made early on to ensure that any gaps that exist between the language spoken by the child and the medium of teaching are bridged. In cases where home language/mother tongue textbook material is not available, the language of transaction between teachers and students will still remain the home language/mother tongue wherever possible. Teachers will be encouraged to use a bilingual approach, including bilingual teaching-learning materials, with those students whose home language may be different from the medium of instruction. All languages will be taught with high quality to all students; a language does not need to be the medium of instruction for it to be taught and learned well. Para 4.12 states that extensive use of technology will be made for teaching and learning of different languages and to popularize language learning.

Para 4.17 frames that the importance, relevance, and beauty of the classical languages and literature of India cannot be overlooked. Sanskrit, while also an important modern language mentioned in the Eighth Schedule of the Constitution of India, possesses a classical literature that is greater in volume than that of Latin and Greek put together, containing vast treasures of mathematics, philosophy, grammar, music, politics, medicine, architecture, metallurgy, drama, poetry, storytelling, and more (known as 'Sanskrit Knowledge Systems'), written by people of various religions as well as non-religious people, and by people from all walks of life and a wide range of socio-economic backgrounds over thousands of years. Sanskrit will thus be offered at all levels of school and higher education as an important, enriching option for students, including as an option in the three-language formula. It will be taught in ways that are interesting and experiential as well as contemporarily relevant, including through the use of Sanskrit Knowledge Systems, and in particular through phonetics and pronunciation. Sanskrit textbooks at the foundational and middle school level may be written in Simple Standard Sanskrit (SSS) to teach Sanskrit through Sanskrit (STS) and make its study truly enjoyable.

Curricular Integration of Essential Subjects, Skills, and Capacities

As per para 4.23, while students must have a large amount of flexibility in choosing their individual curricula, certain subjects, skills, and capacities should be learned by all students to become good, successful, innovative, adaptable, and productive human beings in today's rapidly changing world. In addition to proficiency in languages, these skills include: scientific temper and evidence-based thinking; creativity and innovativeness; sense of aesthetics and art; oral and written communication; health and nutrition; physical education, fitness, wellness, and sports; collaboration and teamwork;

problem solving and logical reasoning; vocational exposure and skills; digital literacy, coding, and computational thinking; ethical and moral reasoning; knowledge and practice of human and Constitutional values; gender sensitivity; Fundamental Duties; citizenship skills and values; knowledge of India; environmental awareness including water and resource conservation, sanitation and hygiene; and current affairs and knowledge of critical issues facing local communities, States, the country, and the world.

Para 4.24 proclaims that concerted curricular and pedagogical initiatives, including the introduction of contemporary subjects such as Artificial Intelligence, Design Thinking, Holistic Health, Organic Living, Environmental Education, Global Citizenship Education (GCED), etc. at relevant stages will be undertaken to develop these various important skills in students at all levels. Para 4.25 claims that mathematics and mathematical thinking will be very important for India 's future and India's leadership role in the numerous upcoming fields and professions that will involve artificial intelligence, machine learning, and data science, etc. Thus, mathematics and computational thinking will be given increased emphasis throughout the school years, starting with the foundational stage, through a variety of innovative methods, including the regular use of puzzles and games that make mathematical thinking more enjoyable and engaging. Activities involving coding will be introduced in Middle Stage.

Para 4.26 enunciates that every student will take a fun course, during Grades 6-8, that gives a survey and hands-on experience of a sampling of important vocational crafts, such as carpentry, electric work, metal work, gardening, pottery making, etc., as decided by States and local communities and as mapped by local skilling needs. A practice-based curriculum for Grades 6-8 will be appropriately designed by NCERT while framing the NCFSE 2020-21. All students will participate in a 10-day bagless period

sometime during Grades 6-8 where they intern with local vocational experts such as carpenters, gardeners, potters, artists, etc. Similar internship opportunities to learn vocational subjects may be made available to students throughout Grades 6-12, including holiday periods. Vocational courses through online mode will also be made available. Bagless days will be encouraged throughout the year for various types of enrichment activities involving arts, quizzes, sports, and vocational crafts. Children will be given periodic exposure to activities outside school through visits to places/monuments of historical, cultural and tourist importance, meeting local artists and craftsmen and visits higher educational institutions in their village/ Tehsil/District/State.

Para 4.27 determines that "Knowledge of India" will include knowledge from ancient India and its contributions to modern India and its successes and challenges, and a clear sense of India's future aspirations with regard to education, health, environment, etc. These elements will be incorporated in an accurate and scientific manner throughout the school curriculum wherever relevant; in particular, Indian Knowledge Systems, including tribal knowledge and indigenous and traditional ways of learning, will be covered and included in mathematics, astronomy, philosophy, yoga, architecture, medicine, agriculture, engineering, linguistics, literature, sports, games, as well as in governance, polity, conservation. Specific courses in tribal ethno-medicinal practices, forest management, traditional (organic) crop cultivation, natural farming, etc. will also be made available.

Para 4.29 reveals that all curriculum and pedagogy, from the foundational stage onwards, will be redesigned to be strongly rooted in the Indian and local context and ethos in terms of culture, traditions, heritage, customs, language, philosophy, geography, ancient and contemporary knowledge, societal and scientific needs, indigenous and traditional ways of learning etc. – in order to ensure

that education is maximally relatable, relevant, interesting, and effective for our students. Stories, arts, games, sports, examples, problems, etc. will be chosen as much as possible to be rooted in the Indian and local geographic context. Ideas, abstractions, and creativity will indeed best flourish when learning is thus rooted.

National Curriculum Framework for School Education (NCFSE)

Para 4.30 states that the formulation of a new and comprehensive National Curricular Framework for School Education, NCFSE 2020-21, will be undertaken by the NCERT - based on the principles of this National Education Policy 2020, frontline curriculum needs.

Transforming Assessment for Student Development

Para 4.34 asserts that the aim of assessment in the culture of our schooling system will shift from one that is summative and primarily tests rote memorization skills to one that is more regular and formative, is more competency-based, promotes learning and development for our students, and tests higher-order skills, such as analysis, critical thinking, and conceptual clarity. The primary purpose of assessment will indeed be for learning; it will help the teacher and student, and the entire schooling system, continuously revise teaching-learning processes to optimize learning and development for all students. This will be the underlying principle for assessment at all levels of education. Para 4.35 expresses that AI-based software could be developed and used by students to help track their growth through their school years based on learning data and interactive questionnaires for parents, students, and teachers, in order to provide students with valuable information on their strengths, areas of interest, and needed areas of focus, and to thereby help them make optimal career choices.

Equitable and Inclusive Education: Learning for All

Para 6.15 states that capacities of teachers in the teaching of science, mathematics, language, and social studies will be developed including orientation to new pedagogical practices.

HIGHER EDUCATION

Quality Universities and Colleges: A New and Forward-looking Vision for India's Higher Education System

Para 9.1 specifies that Higher education plays an extremely important role in promoting human as well as societal well-being and in developing India as envisioned in its Constitution - a democratic, just, socially-conscious, cultured, and humane nation upholding liberty, equality, fraternity, and justice for all. Higher education significantly contributes towards sustainable livelihoods and economic development of the nation. Para 9.1.1 describes that according to 21st century requirements, quality higher education must aim to develop good, thoughtful, well-rounded, and creative individuals. It must enable an individual to study one or more specialized areas of interest at a deep level, and also develop character, ethical and Constitutional values, intellectual curiosity, scientific temper, creativity, spirit of service, and 21st century capabilities across a range of disciplines including sciences, social sciences, arts, humanities, languages, as well as professional, technical, and vocational subjects. A quality higher education must enable personal accomplishment and enlightenment, constructive public engagement, and productive contribution to the society. It must prepare students for more meaningful and satisfying lives and work roles and enable economic independence. Para 9.1.2 states that for the purpose of developing holistic individuals, it is essential that an identified set of skills and values will be incorporated at each stage of learning, from pre-school to higher education.

Some of the major problems currently faced by the higher education system in India presents in para 9.2 are

- Less emphasis on the development of cognitive skills and learning outcomes;
- A rigid separation of disciplines, with early specialization and streaming of students into narrow areas of study;
- Limited access particularly in socio-economically disadvantaged areas, with few HEIs that teach in local languages
- Lesser emphasis on research at most universities and colleges, and lack of competitive peer-reviewed research funding across disciplines;

Towards a More Holistic and Multidisciplinary Education

Para 11.1 describes that India has a long tradition of holistic and multidisciplinary learning, from universities such as Takshashila and Nalanda, to the extensive literatures of India combining subjects across fields. Ancient Indian literary works such as Banabhatta's Kadambari described a good education as knowledge of the 64 Kalaas or arts; and among these 64 'arts' were not only subjects, such as singing and painting, but also 'scientific 'fields, such as chemistry and mathematics, 'vocational ' fields such as carpentry and clothes-making, 'professional 'fields, such as medicine and engineering, as well as 'soft skills' such as communication, discussion, and debate. The very idea that all branches of creative human endeavour, including mathematics, science, vocational subjects, professional subjects, and soft skills should be considered 'arts', has distinctly Indian origins. This notion of a 'knowledge of many arts' or what in modern times is often called the 'liberal arts' (i.e., a liberal notion of the arts) must be brought back to Indian education, as it is exactly the kind of education that will be required for the 21st century.

As per para 11.2 NEP 2020, assessments of educational approaches in undergraduate education that integrate the humanities and arts with Science, Technology, Engineering and Mathematics (STEM) have consistently showed positive learning outcomes, including increased creativity and innovation, critical thinking and higher-order thinking capacities, problem-solving abilities, teamwork, communication skills, more in-depth learning and mastery of curricula across fields, increases in social and moral awareness, etc., besides general engagement and enjoyment of learning. Research is also improved and enhanced through a holistic and multidisciplinary education approach.

Para 11.3 describes that a holistic and multidisciplinary education would aim to develop all capacities of human beings -intellectual, aesthetic, social, physical, emotional, and moral in an integrated manner. Such an education will help develop well-rounded individuals that possess critical 21st century capacities in fields across the arts, humanities, languages, sciences, social sciences, and professional, technical, and vocational fields; an ethic of social engagement; soft skills, such as communication, discussion and debate; and rigorous specialization in a chosen field or fields. Such a holistic education shall be, in the long term, the approach of all undergraduate programmes, including those in professional, technical, and vocational disciplines. Para 11.4 states that a holistic and multidisciplinary education, as described so beautifully in India 's past, is indeed what is needed for the education of India to lead the country into the 21st century and the fourth industrial revolution. Even engineering institutions, such as IITs, will move towards more holistic and multidisciplinary education with more arts and humanities. Students of arts and humanities will aim to learn more science and all will make an effort to incorporate more vocational subjects and soft skills. As per para 11.5, Imaginative and flexible curricular structures will enable creative combinations of

disciplines for study, and would offer multiple entry and exit points, thus, removing currently prevalent rigid boundaries and creating new possibilities for life-long learning.

Para 11.7 asserts that Departments in Languages, Literature, Music, Philosophy, Indology, Art, Dance, Theatre, Education, Mathematics, Statistics, Pure and Applied Sciences, Sociology, Economics, Sports, Translation and Interpretation, and other such subjects needed for a multidisciplinary, stimulating Indian education and environment will be established and strengthened at all HEIs. Credits will be given in all Bachelor's Degree programmes for these subjects if they are done from such departments or through ODL mode when they are not offered in-class at the HEI.

Optimal Learning Environments and Support for Students

According to para 12.1, effective learning requires a comprehensive approach that involves appropriate curriculum, engaging pedagogy, continuous formative assessment, and adequate student support. The curriculum must be interesting and relevant, and updated regularly to align with the latest knowledge requirements and to meet specified learning outcomes. High-quality pedagogy is then necessary to successfully impart the curricular material to students; pedagogical practices determine the learning experiences that are provided to students, thus directly influencing learning outcomes. The assessment methods must be scientific, designed to continuously improve learning and test the application of knowledge. Last but not least, the development of capacities that promote student wellness such as fitness, good health, psycho-social well-being, and sound ethical grounding are also critical for high-quality learning.

Catalysing Quality Academic Research in All Fields through a new National Research Foundation

As per para 17.1, Knowledge creation and research are critical in growing and sustaining a large and vibrant economy, uplifting society,

and continuously inspiring a nation to achieve even greater heights. Para 17.2 states that a robust ecosystem of research is perhaps more important than ever with the rapid changes occurring in the world today, e.g., in the realm of climate change, population dynamics and management, biotechnology, an expanding digital marketplace, and the rise of machine learning and artificial intelligence. If India is to become a leader in these disparate areas, and truly achieve the potential of its vast talent pool to again become a leading knowledge society in the coming years and decades, the nation will require a significant expansion of its research capabilities and output across disciplines. Para 17.4 describes that The societal challenges that India needs to address today, such as access for all its citizens to clean drinking water and sanitation, quality education and healthcare, improved transportation, air quality, energy, and infrastructure, will require the implementation of approaches and solutions that are not only informed by top-notch science and technology but are also rooted in a deep understanding of the social sciences and humanities and the various socio-cultural and environmental dimensions of the nation. Facing and addressing these challenges will require high-quality interdisciplinary research across fields that must be done in India and cannot simply be imported; the ability to conduct one 's own research also enables a country to much more easily import and adapt relevant research from abroad.

Para 17.5 states that in addition to their value in solutions to societal problems, any country's identity, upliftment, spiritual/ intellectual satisfaction and creativity is also attained in a major way through its history, art, language, and culture. Research in the arts and humanities, along with innovations in the sciences and social sciences, are, therefore, extremely important for the progress and enlightened nature of a nation.

Para 17.7 describes that India has a long historical tradition of research and knowledge creation, in disciplines ranging from science

and mathematics to art and literature to phonetics and languages to medicine and agriculture. This needs to be further strengthened to make India lead research and innovation in the 21st century, as a strong and enlightened knowledge society and one of the three largest economies in the world. Para 17.8 explains that this Policy envisions a comprehensive approach to transforming the quality and quantity of research in India. This includes definitive shifts in school education to a more play and discovery- based style of learning with emphasis on the scientific method and critical thinking. This includes career counselling in schools towards identifying student interests and talents, promoting research in universities, the multidisciplinary nature of all HEIs and the emphasis on holistic education, the inclusion of research and internships in the undergraduate curriculum, faculty career management systems that give due weightage to research, and the governance and regulatory changes that encourage an environment of research and innovation. All of these aspects are extremely critical for developing a research mindset in the country.

Professional Education

As per para 20.6 of NEP 2020 India must also take the lead in preparing professionals in cutting-edge areas that are fast gaining prominence, such as Artificial Intelligence (AI), 3-D machining, big data analysis, and machine learning, in addition to genomic studies, biotechnology, nanotechnology, neuroscience, with important applications to health, environment, and sustainable living that will be woven into undergraduate education for enhancing the employability of the youth. Para 22.2 describes that the promotion of Indian arts and culture is important not only for the nation but also for the individual. Cultural awareness and expression are among the major competencies considered important to develop in children, in order to provide them with a sense of identity, belonging, as well

as an appreciation of other cultures and identities. It is through the development of a strong sense and knowledge of their own cultural history, arts, languages, and traditions that children can build a positive cultural identity and self-esteem. Thus, cultural awareness and expression are important contributors both to individual as well as societal well-being. Para 22.15 asserts that due to its vast and significant contributions and literature across genres and subjects, its cultural significance, and its scientific nature, rather than being restricted to single-stream Sanskrit Pathshalas and Universities, Sanskrit will be mainstreamed with strong offerings in school - including as one of the language options in the three-language formula - as well as in higher education. It will be taught not in isolation, but in interesting and innovative ways, and connected to other contemporary and relevant subjects such as mathematics, astronomy, philosophy, linguistics, dramatics, yoga, etc. Thus, in consonance with the rest of this policy, Sanskrit Universities too will move towards becoming large multidisciplinary institutions of higher learning. Departments of Sanskrit that conduct teaching and outstanding interdisciplinary research on Sanskrit and Sanskrit Knowledge Systems will be established/strengthened across the new multidisciplinary higher education system. Sanskrit will become a natural part of a holistic multidisciplinary higher education if a student so chooses. Sanskrit teachers in large numbers will be professionalized across the country in mission mode through the offering of 4-year integrated multidisciplinary B.Ed. dual degrees in education and Sanskrit.

Technology Use and Integration

Para 23.1 describes that India is a global leader in information and communication technology and in other cutting-edge domains, such as space. The Digital India Campaign is helping to transform the entire nation into a digitally empowered society and knowledge economy.

While education will play a critical role in this transformation, technology itself will play an important role in the improvement of educational processes and outcomes; thus, the relationship between technology and education at all levels is bi-directional. Para 23.2 states that given the explosive pace of technological development allied with the sheer creativity of tech-savvy teachers and entrepreneurs including student entrepreneurs, it is certain that technology will impact education in multiple ways, only some of which can be foreseen at the present time. New technologies involving artificial intelligence, machine learning, block chains, smart boards, handheld computing devices, adaptive computer testing for student development, and other forms of educational software and hardware will not just change what students learn in the classroom but how they learn, and thus these areas and beyond will require extensive research both on the technological as well as educational fronts.

Para 23.5of NEP 2020 explains that the thrust of technological interventions will be for the purposes of improving teaching-learning and evaluation processes, supporting teacher preparation and professional development, enhancing educational access, and streamlining educational planning, management, and administration including processes related to admissions, attendance, assessments, etc. Para 23.6 acknowledges that a rich variety of educational software, for all the above purposes, will be developed and made available for students and teachers at all levels. All such software will be available in all major Indian languages and will be accessible to a wide range of users including students in remote areas and *Divyang* students. Teaching-learning e-content will continue to be developed by all States in all regional languages, as well as by the NCERT, CIET, CBSE, NIOS, and other bodies/institutions, and will be uploaded onto the DIKSHA platform.

Para 23.7 claims that Particular attention will need to be paid to emerging disruptive technologies that will necessarily transform

the education system. When the 1986/1992 National Policy on Education was formulated, it was difficult to predict the disruptive effect that the internet would have brought. Our present education system's inability to cope with these rapid and disruptive changes places us individually and nationally at a perilous disadvantage in an increasingly competitive world. For example, while computers have largely surpassed humans in leveraging factual and procedural knowledge, our education at all levels excessively burdens students with such knowledge at the expense of developing their higher-order competencies. Para 23.8 states that this policy has been formulated at a time when an unquestionably disruptive technology -Artificial Intelligence (AI) 3D/7D Virtual Reality - has emerged. As the cost of AI-based prediction falls, AI will be able to match or outperform and, therefore, be a valuable aid to even skilled professionals such as doctors in certain predictive tasks. AI's disruptive potential in the workplace is clear, and the education system must be poised to respond quickly. Para 23.9 declares that in response to MHRD's formal recognition of a new disruptive technology, the National Research Foundation will initiate or expand research efforts in the technology. In the context of AI, NRF may consider a three-pronged approach: (a) advancing core AI research, (b) developing and deploying application-based research, and (c) advancing international research efforts to address global challenges in areas such as healthcare, agriculture, and climate change using AI.

Para 23.10 describes that HEIs will play an active role not only in conducting research on disruptive technologies but also in creating initial versions of instructional materials and courses including online courses in cutting-edge domains and assessing their impact on specific areas such as professional education. Once the technology has attained a level of maturity, HEIs with thousands of students will be ideally placed to scale these teaching and skilling efforts, which will include targeted training for job readiness.

Disruptive technologies will make certain jobs redundant, and hence approaches to skilling and deskilling that are both efficient and ensure quality will be of increasing importance to create and sustain employment. Para 23.11 states that Universities will aim to offer Ph.D. and Masters programmes in core areas such as Machine Learning as well as multidisciplinary fields "AI + X" and professional areas like health care, agriculture, and law. They may also develop and disseminate courses in these areas via platforms, such as SWAYAM. For rapid adoption, HEIs may blend these online courses with traditional teaching in undergraduate and vocational programmes. HEIs may also offer targeted training in low-expertise tasks for supporting the AI value chain such as data annotation, image classification, and speech transcription. Efforts to teach languages to school students will be dovetailed with efforts to enhance Natural Language Processing for India's diverse languages.

As per para 23.12, As disruptive technologies emerge, schooling and continuing education will assist in raising the general populace 's awareness of their potential disruptive effects and will also address related issues. This awareness is necessary to have informed public consent on matters related to these technologies. In school, the study of current affairs and ethical issues will include a discussion on disruptive technologies such as those identified by NETF/ MHRD. Appropriate instructional and discussion materials will also be prepared for continuing education. Para 23.13 explains that data is a key fuel for AI-based technologies, and it is critical to raise awareness on issues of privacy, laws, and standards associated with data handling and data protection, etc. It is also necessary to highlight ethical issues surrounding the development and deployment of AI-based technologies. Education will play a key role in these awareness raising efforts. Other disruptive technologies that are expected to change the way we live, and, therefore, change the way we educate students, include those relating to clean and renewable energy, water

conservation, sustainable farming, environmental preservation, and other green initiatives; these will also receive prioritized attention in education.

Online and Digital Education: Ensuring Equitable Use of Technology

As per para 24.4 of NEP 2020, Given the emergence of digital technologies and the emerging importance of leveraging technology for teaching-learning at all levels from school to higher education, this Policy recommends the following key initiatives:

- Pilot studies for online education: Appropriate agencies, such as the NETF, CIET, NIOS, IGNOU, IITs, NITs, etc. will be identified to conduct a series of pilot studies, in parallel, to evaluate the benefits of integrating education with online education while mitigating the downsides
- Digital infrastructure: There is a need to invest in creation of open, interoperable, evolvable, public digital infrastructure in the education sector that can be used by multiple platforms and point solutions, to solve for India's scale, diversity, complexity and device penetration.
- Online teaching platform and tools: Appropriate existing e-learning platforms such as SWAYAM, DIKSHA, will be extended to provide teachers with a structured, user-friendly, rich set of assistive tools for monitoring progress of learners.
- Content creation, digital repository, and dissemination: A digital repository of content including creation of coursework, Learning Games & Simulations, Augmented Reality and Virtual Reality will be developed, with a clear public system for ratings by users on effectiveness and quality. For fun based learning student-appropriate tools like apps, gamification of Indian art and culture, in multiple

languages, with clear operating instructions, will also be created. A reliable backup mechanism for disseminating e-content to students will be provided.

- Addressing the digital divide: Given the fact that there still persists a substantial section of the population whose digital access is highly limited, the existing mass media, such as television, radio, and community radio will be extensively used for telecast and broadcasts.
- Virtual Labs: Existing e-learning platforms such as DIKSHA, SWAYAM and SWAYAMPRABHA will also be leveraged for creating virtual labs so that all students have equal access to quality practical and hands-on experiment-based learning experiences. The possibility of providing adequate access to SEDG students and teachers through suitable digital devices, such as tablets with pre-loaded content, will be considered and developed.
- Training and incentives for teachers: Teachers will undergo rigorous training in learner-centric pedagogy and on how to become high-quality online content creators themselves using online teaching platforms and tools.
- Online assessment and examinations: Appropriate bodies, such as the proposed National Assessment Centre or PARAKH, School Boards, NTA, and other identified bodies will design and implement assessment frameworks encompassing design of competencies, portfolio, rubrics, standardized assessments, and assessment analytics.
- Blended models of learning: While promoting digital learning and education, the importance of face-to-face in-person learning is fully recognized. Accordingly, different effective models of blended learning will be identified for appropriate replication for different subjects.

- Laying down standards: As research on online/digital education emerges, NETF and other appropriate bodies shall set up standards of content, technology, and pedagogy for online/digital teaching-learning.

CHAPTER – 2

EXTRACTS OF 331st REPORT: REFORMS IN CONTENT AND DESIGN OF SCHOOL TEXT BOOKS[1]

Department-Related Parliamentary Standing Committee on Education, Women, Children, Youth and Sports has presented the "Three Hundred and Thirty First Report of the Committee on "Reforms in Content and Design of School Text books". The report focuses on:

- Removing references to un-historical facts and distortions about our national heroes from the text books;
- Ensuring equal or proportionate references to all periods of Indian History;
- Highlighting the role of great historic women achievers.

The relevant highlights of the report are given below

- The report elaborates upon National Curriculum Framework that will provide roadmap for the development of new generation of textbooks providing more space to experiential learning for bringing in students the conceptual clarity and motivate students

1 This report was presented by Dr. Vinay P. Sahasrabuddhe, Chairman Department-related Parliamentary Standing Committee on Education, Women, Children, Youth and Sports on 26th November, 2021

for self-learning and self-assessment to improve not only cognitive skills but also the social -personal qualities.

- New NCF for School Education will guide the development of new generation textbooks across the subject areas. The new generation textbooks across subject areas will take care of the thematic, inter-disciplinary and multi-disciplinary approaches to highlight Indian culture and traditions, national heroes including women achievers and great regional personalities besides providing coverage to different phases of Indian history.
- NCF must focus on restructuring of stages of curriculum and pedagogy as 5+3+3+4, more focus is on Early Childhood Care and Education and Foundational Literacy and Numeracy, Integration of Pre-vocational Education from classes 6 to 8, Integration of Knowledge of India across the stages, focus on the holistic development through experiential learning, flexibility in choice of subjects etc.
- The report further informs about new ways for promotion of experiential learning, art integrated learning, sports integrated learning and competency-based learning, including internships, 10 bag less days, peer tutoring, interdisciplinary and multidisciplinary projects and development of fun-based student appropriate learning tools to promote and popularize Indian arts and culture etc.
- It also highlights different pedagogies such as group discussions, mock drills, excursion trips, visits to various places, such as zoo, museum, local store or restaurant; field study, classroom interactions, etc. were also being used to support experiential learning. Also, opportunities were provided to break subject boundaries by integration of art forms (visual or performing arts, such as dance, design, painting, photography, theatre, writing, etc.), stories, pictures, fun activities or games, sports,

etc. for holistic learning of concepts of science and mathematics without burden.

- It further states that the future syllabi and textbooks will be based on goals and competencies which will lead towards mapping of core essentials with competencies hence lessening the curriculum burden and focusing on holistic learning and development. The curriculum and syllabi should provide lots of space for experiential learning and textbooks will be based on competencies rather than content.
- NEP, 2020 recommends integration of knowledge of India across the stages and subject areas in the curriculum. Under this concern, as per the directions of new National Curriculum Framework for school education, various activities including development of digital and audio-video materials will be taken up.
- Thematic, interdisciplinary and multidisciplinary approaches to highlight Indian Culture and Traditions, our National Heroes including women achievers and great personalities from different regions of the country and perspective of equity, integrity, gender parity, constitutional values and concern for environment and other sustainable development goals.
- Experiential Learning through projects and age-appropriate activities, simple language, glossary, more in-text and end-text assessment questions and reduction of curriculum load to core essentials.
- All textbooks will be visually rich with illustrations, photographs, maps, etc., the illustrations and activities will be age/class appropriate. Local flavor will be added to the core essentials in textbooks of the States, to showcase the diversity of the country.
- Local flavor will be added to the core essentials in textbooks of the States, to showcase the diversity of the country. NCERT

has been working towards bringing dictionary on Indian sign language, which will help in developing material in sign language. The upcoming books and other materials based on the new NCFSC will follow the same pursuit in future.

- More emphasis on role of women: Role of women as rulers, their role in knowledge sector, social reforms, Bhakti movement, art and culture, freedom struggle **(Jnana Prabodhini, Pune)**. Coverage of great historic women heroes belonging to different periods of Indian History including Gargi, Maitreyi, rulers like Rani of Jhansi, Rani Channamma, Chand Bibi, Zalkari Bai etc. will be taken up in the new textbooks, supplementary materials and e-content.
- National initiatives such as Swachh Bharat, Digital India, 'Beti Bachao Beti Padhao', 'Demonetization', GST etc. were integrated in the new textbooks in the review of syllabi and textbooks in 2017-18. Contents were added in history textbooks regarding knowledge, traditions and practices of India. For example, addition of material on Vikram Samvat, Metallurgy, Shivaji Maharaj, Paika revolt, Subhash Chandra Bose, Swami Vivekanand, Ranjeet Singh, Rani Avantibai Lodhi and Sri Aurbindo Ghosh.
- The objective of teaching history was to instil high self-esteem in students, National Renaissance, National unity, Social Inclusion and establish links with cultural roots. Thus following points are to be kept in mind while writing text books:
    - Depicting cultural unity
    - Linguistic heritage- importance of Sanskrit, Prakrit and Pali for national unity and international spread.
    - Linking Indian languages.
    - Civilization development -Vedic to present.

- Comparison of scientific temper with other civilizations on scientific and objective ground.
- History of sacrifices of various segments of Indian society for saving cultural values.
- Social inclusion.
- India and its cultural boundaries.
- Civilization proofs of India in other countries of the world.
- Religio-cultural emissaries from India should have proper place.
- Local, national as well as international influence of any event or thought should be highlighted. **(Bharatiya Shikshan Mandal, New Delhi)**

- The representatives of **Vidya Bharti** also put forth their views on the subject and pointed out certain factual distortions about vedic tradition, incompatibility of certain facts with constitutional ideals and values in the school textbooks. They suggested a thorough review and removing of such distortions/ discrepancies from the school textbooks. They also mentioned about 'My NEP' programme launched to reach non-academic people and to make them learn about the things in the National Education Policy in a nutshell.
- Inclusion of History of North East India: Bhakti and social movements in Assam and Manipur, tribal heroes who fought against British, contribution of Arunachal and Manipur with reference to Azad Hind Fauj and 1962 war, dynasties in Assam, Manipur, Tripura, Meghalaya. **(Jnana Prabodhini, Pune)**
- Post-independence History of Indian pride also needs to be stressed: Story of ISRO, story of BARC, story of cooperative movement (Story of Amul), story of restorations (Somnath, Hampi, archaeological sites such as Lothal) etc. **(Jnana Prabodhini, Pune)**

- The Design of textbooks should be:
  - Curriculum of history can be organized in an ascending order. The scope of curriculum grows with the growth of experience sphere of students from local to global.
  - Digitization of textbooks to make them attractive and dynamic document to go beyond text/ printed form: need to add audio-visuals with QR codes.
  - Inclusion of intellectual games, simulations. VR Games modeled to let students experience the historical times (for example 'Real lives') **(Jnana Prabodhini, Pune)**
- As far as the Modern period is concerned, some leaders have received more weightage as compared to others. The role of Subhash Chandra Bose, Sardar Patel, Bhagat Singh, Ram Prasad Bismil, Lala Lajpat Rai, Khudiram Bose, Surya Sen, and even the women revolutionaries must be highlighted. The contribution of Veer Savarkar needs to be given enough weightage. **(Public Policy Research Centre, New Delhi)**
- The representatives pointed out that proportionate representation across Region, Time Period, and Events should be given in the Textbooks. South and East Indian dynasties have been highly under-represented. The history of great kingdoms like the Marāṭhas, Coḷas, and Vijayanagara as well as the early Kāśmīra dynasties, Kaliṅgas, Gaṅgas, Gajapatis, Kākatiyas, Ahoms, Ceras, Pallavas, Pāṇḍyas, Pālas, Senas, and Pratihāras either get a passing mention or not even that. The crucial role they played in our history must be elaborated. They further added that we must include these dynasties, which represent the very spirit of Bhāratīya Civilization that the Radhakrishnan Committee wanted every student to imbibe. **(Samvit Research Foundation, Bengaluru).** The following points were further added:

- Bhāratīya saṃskṛti has been widespread from Mesopotamia in the West to Japan in the East, from the Himalayas in the North to Indonesia in the South
- The Zend Avesta has significant relationship with the late Ṛigvedic period
- Our Itihāsas and Purāṇas, particularly the Rāmāyaṇa, have been an integral part of the culture of many regions of Southeast Asia.

- The representatives also added that the history curriculum hardly emphasizes the role played by women in our history. It is important for students to learn –
  - the importance our civilization has given to women and how women participated in all aspects of life over the centuries
  - the freedom and opportunities available to women in public life
  - the great achievements of women from ancient times until the present day
  - the temporary changes in status of women in the wake of invasions
  - to progressively appreciate that our paramparā has a beautiful and holistic perspective of strītva that is far beyond modern formulations.
- They further suggested that this can best be accomplished by exposing the children to factual information from the past:-
  - Introduce the three great goddesses of the Vedas – Bhāratī, Ilā, Sarasvatī. Introduce a few Veda-suktas for which women are the mantra-draṣṭāriṇīs. In the Vedic period, mention woman scholars, brahmavādinīs, and mantra-draṣṭāriṇīs, including instances of where women learnt the Vedas.

- Present the dynamic role played by women in the Rāmāyaṇa and Mahābhārata. Give a complete picture of women-related references in the smṛtis.
- Portrayal of women in various classical literary accounts (e.g. Kālidāsa's Mālavikāgnimitra) that indirectly shows how the society was shaping up at that time.
- The critical contributions of queens in every century and every region across communities. Prominent rājamātas who played a role in shaping their children as rulers; important women warriors, scholars, poetesses, philanthropists, public personalities, sanyāsinīs, philosophers, saints, and freedom fighters

- The Committee is of the view that there should be an appropriate comparison of the portrayal of women heroes like Rani Laxmi Bai, Zalkari Bai, Chand Bibi etc vis-a-vis their male counterparts. The Committee observes that the women heroes from different regions and eras should be given equal weightage highlighting their contributions in the history textbooks.
- The Committee also observes that notable women in all fields, and their contributions, like that of Ahilyabai Holkar, Abala Bose, Anandi Gopal Joshi, Anasuya Sarabhai, Arati Saha, Aruna Asaf Ali, Kanaklata Deka, Rani Ma Guidinglu, Asima Chatterjee, Captain Prem Mathur, Chandraprabha Saikini, Cornelia Sorabji, Durgavati Devi, Janaki Ammal, Mahasweta Devi, Kalpana Chawla, Kamaladevi Chattopadhyay, Kittur Chennamma, M. S. Subbulakshmi, Madam Bhikaiji Cama, Rukmini Devi Arundale, Savitribai Phule and many others have not found adequate mention in NCERT textbooks.
- The Committee observes that generally Women are underrepresented in school textbooks, many a times shown through images in traditional and voluntary roles, leading to

formation of gender stereotypes in the impressionistic minds of students and feels that there is a need to undertake an analysis of the textbooks from the Gender perspective as well.

- The Committee observes that in the suggestions received regarding updation of NCERT books, emphasis was laid on providing equal representation to the North-East Indian States and the History. It was suggested that developmental models and economic policies should have sections dealing with and talking about the complex realities and demographics of the North-East along with the history of civilizations and tribal communities of the North-eastern region. Furthermore, the textbook content should also ensure adequate balance in representing Hill areas and Plains areas so as to recognise both communities adequately.

Subject Experts

Prof. J.S. Rajput, Former Director, NCERT in his submission before the Committee stated that Reforms in the content and design of Textbooks should focus on the following aspects:

a. Distortion of historical facts where one ruler is remembered and other equally prominent one's finds no mention.

b. Not only periods, history must be just and objective to considerations of regional imbalances, historical contributions of the communities, people and practices.

c. Social and cultural distortions must not be presented by those bound by prejudices and biases.

He stated that the content and design of textbooks is a product of Policy on Education, Curriculum Framework to be developed after its sensitive comprehension, followed by the process of preparing detailed syllabus for each textbook; for each grade /class. The quality

and content of the textbook shall depend on the quality of the authors; that include depth, seriousness, professional competence and commitment of individuals and institutions assigned the task. A good textbook can be authored only by those who are lifelong learners.

It was emphasized that National level textbooks are essential for several reasons, but it must be remembered that local element of curriculum also cannot be ignored. A class three textbook on environmental education just cannot be same in Tripura and Thiruvananthapuram. Hence, it is necessary to strengthen expertise and institutions at the State level. We need high level experts in textbook writing, evaluation, assessment, growing up, guidance, and all that children could need. now education is not only about/through textbooks, but textual materials for online learning, self-learning, digital learning, open and distance learning, and a couple of other terms that are in vogue. It has to be hybrid teaching and learning in future. Things have changed drastically in 2020, and some of the impacts shall continue in future as well.

New discoveries are taking place, new facts are coming up, and textbooks just cannot remain the same. This is worsened if the history is written with certain pre-conceived biases resulting out of politically-constrained ideological bindings. History writing in India has suffered on these unacceptable considerations, and it must be extracted - and liberated -out of gross subjectivity and ideological bias to transparent objectivity, and openness of mind, willingness to enter into dialogue with those holding diametrically opposite views. New facts have emerged around us; say; Aryan Invasion theory, Saraswati River, Ram Setu, and so many more solely because of new scientific advancements and new tools that have led to new researches. These just cannot be ignored in preparing new textbooks. ndian history writing needs a thorough professional review. As it was determined to highlight certain individuals, regimes and eras, it suffers from

serious imbalances of every possible type. He further pointed out the British tried to downgrade the great contributions of ancient India in philosophy, science, mathematics, spirituality, medicine and other fields and it was continued to be neglected in our textbooks. While considerable initiatives were taken for removing gender bias and caste discriminations, history writing remained confined to the hegemony of a select group of few academics for over five decades. The post- independence history books are deficient on 'linking Indians to India'; and this includes history, heritage and culture. In fact, this aspect needs serious informed and scholarly deliberations before textbooks are prepared in response to the NEP-2020.

The second most important aspect that no textbook writer could ignore pertains to the need for strengthening social cohesion and religious amity. Racial discrimination and caste considerations - in varied connotations – have not vanished fully even in what are known as most advanced societies. We must accept that these challenges still exist even before us; and these require an attitudinal transformation. Our Children must know that different religions are a reality, that no religion could claim superiority over any other.

Shri Hukmdev Narayan Yadav, Ex-MP, Lok Sabha emphasized the importance of the subject and suggested for detailed discussion with more stakeholders and eminent educationists. The focus should not 'be only on facts and figures while writing Indian history but it should focus on the deep essence of the nature of Indian history in order to make it more understandable.

Shri Shankar Sharan, Eminent Educationistal so deposed before the Committeeon the above subject and highlighted various topics for inclusion/ exclusion in NCERT text-books. He drew the attention of the Committee Members as to why the text-books had references to unhistorical/ distorted facts and why a section of intellectuals insisted on keeping it. Focusing on this will only help in removing such discrepancies.

Recommendations

In view of the evidences gathered throughout the process, the Committee strongly recommends that:

- While creating the content for textbooks, inputs from experts from multiple disciplines should be sought. This will ensure balance and diversity of views. It should also be ensured that books are free of biases. The textbooks should instill commitment to values enshrined in the constitution and should further promote national integration and unity.
- There is a pressing need to develop high-quality textbooks and effective teaching methods. Thus mandatory standards related to text-book content, graphics and layout, supplementary materials, and pedagogical approaches should be developed. Such standards are needed for printed as well as digital textbooks.
- There is a need to have more child-friendly textbooks. This is possible through enhanced use of pictures, graphics, QR codes, and other audio-visual materials. Children should be taught through enhanced used of games, plays, dramas, workshops, visits to places of historical importance, museums etc. as such approaches will ignite their inquisitiveness and analytical abilities.
- The initiative of Maharashtra State Bureau of Textbook Production & Curriculum Research known as Ekatmik Pathya Pustak conceived in 2018-19 to lighten the school bag is appreciable. Towards this, the Bureau has created quarter-specific integrated material for Marathi, English, Mathematics and 'Play, Do, Learn' for Class I students into a single book. A similar approach may be adopted by others. Such initiative will be aligned to the School Bag Policy of New Education Policy (NEP), 2020 as laid out in Section 4.33.

- Education must be provided in the light of values enshrined in the constitution which cannot be taught by mere delivery of information. The pedagogy woven around textbooks has a lasting impact on the minds of the student and hence learning-by-experiment methodology should be compulsorily used by all teachers. Such an approach will enhance positive attitude towards learning amongst students.
- The prioritization of development of foundational skills amongst primary students is required by the NEP-2020, and therefore necessitates the use of information technology and digital devices. Therefore, digital content should be created and disseminated using satellite technology to enhance our students' capabilities and potentials. Such approaches will further curriculum reform and will also help develop more effective operational models for content delivery, and learning. Introduction of modern technologies/ methodologies for the dissemination of information as part of teaching strategies should be undertaken preferably after enabling the possibility of the same uniformly in every part of the country. Schools in remote corners of the country should be suitably equipped for the same.
- The primary school textbooks should serve two purposes; provide strong foundation in core areas such as reading, writing and arithmetic, and provoke curiosity so that students can rapidly expand their knowledge in later years. This is also in alignment with NEP 2020's goal of promoting competency-based learning.
- The NCERT and SCERTs should primarily focus on providing core content through their textbooks. Detailed information and supplementary materials may be provided

through other texts, videos, reference books, A/V files, etc. Further, textbooks should be anchored in facticity. Any presentation of data or survey results should be appropriately referenced. Textbooks should be designed to provoke curiosity and analytical abilities, should be tuned to cognitive capability of the student, and should employ simple language. Further, efforts should be made to design textbooks in ways such that project-based, art-integrated, and experiential learning models can be deployed for effective education. In this way, our textbooks will promote scientific temper, innovation, and also the four Cs; Communication, Collaboration, Creativity, and Critical Thinking.

- The Ministry should explore the possibility of developing a core class-wise common syllabus for various subjects for implementation by CBSE, CICSE and various other State education Boards as this will go a long way in maintaining uniformity in educational standards of school students across the country.
- Our textbooks should highlight the lives of hitherto unknown men and women from different states and districts who have positively influenced our national history, honour, and one-ness. This may require content production teams to dig deeper into local sources of knowledge, including oral ones, and identify linkages between the local and the national. In this way, our textbooks should elicit "Unity in Diversity" of India emphasizing that diversity in India is in fact diverse manifestation of the innate one-ness or intrinsic unity.
- The textbooks should include content on world history and India's place in the same. In this regard, special emphasis must be placed on the histories of other countries of the

world. This is aligned with international guidelines which argue for study of history through a multi-perspective approach. Further, sufficient emphasis must also be placed on the connects between histories of South-East Asia and India. This would be very useful in the context of India's Look East policy.

- Our history textbooks should be continually updated, and account for post-1947 history as well. In addition, an option of conducting review of National Curricular Framework at regular intervals should be kept.
- The Department of School Education & Literacy and NCERT should carefully study how other ancient civilizations/ countries teach their own histories to their respective citizens through textbook content, and areas of emphasis. The results of such a study should be used to improve our own history textbooks and teaching methods taking into consideration history at the grassroots level preferably at the district levels. Further, the State Boards may prepare district-wise history books that will impart knowledge about local historical figures to the students.
- The NCERT should consider the suggestions received by this Committee, while framing the NCF and syllabus of the textbooks. For avoiding content overload on students, NCERT in collaboration with SCERT should identify State-specific historical figures for inclusion in respective SCFs. Efforts may also be made to incorporate and highlight the contributions of the numerous local personalities in various fields in State curriculum.
- The NCERT and SCERT should incorporate the ancient wisdom, knowledge and teachings about life and society from Vedas and other great Indian Texts/ Books in the school

curriculum. Also, educational methodologies adopted in the ancient Universities like Nalanda, Vikramshila and Takshila should be studied and suitably modified to serve as a model reference for teachers so as to benefit them in improving their pedagogical skills for imparting education in the present day context.

- Contributions of ancient India in the fields of Philosophy, Science, Mathematics, Medicine, Ayurveda, Epistemology, Natural sciences, Politics, Economy, Ethics, Linguistics, Arts, etc may also be included in the textbooks. The traditional Indian knowledge systems should be linked with modern science and presented in the contemporary context in NCERT textbooks.
- New technologies should be adopted for better pedagogy for the education of History. Further a permanent mechanism to make suitable rectifications through additions or deletions in the textbooks in a structured manner needs to be established.
- All books especially history books other than published by Government agencies used for supplementary reading may be in consonance with the structure/ content of NCERT books to avoid discrepancies. Also, Ministry of Education should develop a monitoring mechanism for ensuring the same.
- There is a need for discussing and reviewing, with leading historians, the manner in which Indian freedom fighters, from various regions/parts of the country and their contributions get place in History textbooks. This will result in more balanced and judicious perception of the Indian freedom struggle. This will go a long way in giving due and proper space to the freedom fighters hitherto

unknown and oblivious in the freedom movement. Review of representation of community identity based history as of Sikh and Maratha history and others and their adequate incorporation in the textbooks will help in a more judicious perspective of their contribution.

- In order to address the underrepresentation of Women and girls in school textbooks or them being depicted only in traditional roles, a thorough analysis from the view point of gender bias and stereotypes should be undertaken by NCERT and efforts be made to make content portrayal and visual depiction gender inclusive. The textbooks should have greater portrayal of women in new and emerging professions, as role models with a focus on their contributions and pathway of achieving the same. This will help in instilling self-esteem and self confidence among all, particularly girls. Also, while examining the textbooks, other issues like environment sensitivity, human values, issues of children with special needs etc can also be looked up for adequate inclusion in the School textbooks.
- The significant role played by women in the freedom movement and in various other fields needs adequate representation in the textbooks as it would go a long way in understanding the issues in a better way for the next generation of students.
- One of the major social ills afflicting our society in the present times is the malaise of drug addiction cutting across the class divide. It has far-reaching adverse effects on the socio-economic structure of the country, and that concerted efforts are required to be made by the government agencies as well as the civil society to combat this menace. As part of these efforts, the ill effects of such addiction must be

adequately and suitably highlighted in strong words, in the content of school text books to caution the impressionable young minds of students against falling prey to luring tactics of anti-social elements and resulting in waywardness. Similarly, the textbooks should have separate elements spreading awareness against internet addiction and other such aspects that are harmful to the society.

- Taking into account the voluminous number of suggestions received from teachers, students, Institutions for updating the syllabus of NCERT textbooks incorporating various subjects, an internal Committee be set up by Ministry of Education and NCERT to examine the suggestions so received and incorporate the same in curriculum as deem fit.
- All NCERT and SCERT textbooks must be published in all Eighth Schedule languages of the Constitution of India, besides Hindi and English. Further, efforts for developing textbooks in local languages (those not part of the Eighth Schedule) be also made. These will help the children in understanding the subjects better as the content will be in their mother tongue.
- To supplement the textbook content, field visits/ excursions should be introduced as a compulsory part of learning experience. As an initiative in this regard, textbooks can introduce a "Box Format" near the name of the place being mentioned stating the importance of that place whether religious, historical, etc. promoting the readers to visit it. This would further promote North-South and East-West integration.

Chapter–3

NEP & DEVELOPING NEW TEXT BOOKS[1]

Prof. Chand Kiran Saluja
Director, Sanskrit Promotion Foundation, New Delhi

Prof. Chand Kiran Saluja emphasizes upon the various aspects of New Education Policy- 2020 such as building a culture of reading across the country. NEP-2020 has focused upon the development of curriculum, syllabus and textbook and it envisions a new way of learning which is not merely text book focused. Earlier, NCF 2005 had also mentioned that learning should be active rather than textbook centric only. Textbooks as a single source of education are not enough; they are important but are not only a teaching material. Therefore, a large number of packages should be developed at State and District levels with adequate provision for cluster and school level modifications and supplementary materials. To understand a textbook one needs to understand the curriculum and the aims of education. The present-day classroom practices

1 Based on the Keynote Address delivered by Prof. Chand Kiran Saluja in the Prparatory Workshop on Textbooks: Indian Knowledge System and Languages organized by VBUSS on 3rd & 4th February, 2022 and Keynote Lecture in the Two-day National Workshop on Sanskrit in the light of NEP 2020 & Indian Knowledege Systems organized by Central Sanskrit University, Delhi and Shri Lal Bahadur Shastri National Sanskrit University, Delhi on 4th & 5th June 2022.

are, in almost all schools of the country, totally dominated by the textbook. As a result, it has acquired an aura and a standard format. What is needed is not a single textbook but package of teaching learning method and material that could be used to engage the child in active learning. The textbook thus becomes a part of this package and not just a teaching learning material e.g., it connects the past with the present and should lead to experiential learning which means taking classroom to the field and vice versa. Therefore, a large number of packages should be developed at state and district levels with adequate provision for cluster and school level modifications and supplementary materials. This essentially means establishing proper coordination between the textbook designing committees at national and regional levels. The establishment of NCERT and SCERT are the part of this purpose only. The cluster system envisaged in the NEP, 2020 is also a part of this exercise. The availability of a number of alternative TLM packages of approved quality to the increased choice of the teachers may go a long way in introduction of IKS. To understand the textbook, one must understand the relationship between the curriculum and aims of education. There is a difference between curriculum and syllabus. The syllabus is something that is taught to the student in the classroom but curriculum involves vast level of activities including the syllabus. In simple terms, the curriculum starts from the moment a student enters the school environment and continues to be involved into till the end of the school hours and thereafter too in the form of doing various activities given by the teachers. Part I of the NEP, 2020 document outlays various objectives of education.

Textbooks are to be prepared based on certain pre-suppositions in relation to imparting of education and these presuppositions are guided by social, physical and psychological aspects of learners.

- The presentation of the textbook should be organized keeping certain things in mind such as what should be the topic of a lesson, how should study be conducted, how should vocabulary related to the lesson be organized etc.
- The objective of the textbook should not aim at merely addressing the curiosity in the minds students alone but also to create more curiosity among them. Therefore, the preparation of the textbooks should aim at invoking curiosity in the minds of learners.
- Textbook is an instructional material. It is not only for teaching but for learning as well. Therefore, textbooks should be designed keeping teaching-learning textual material based on a teaching model in mind.
- We must collect material for the preparation of textbooks first. As envisaged in the NEP, 2020, such material useful for the preparation of textbooks should be able to establish proper explanation of the idea to be taught, should be able to invoke thinking process among children, the textbook should be able to develop critical faculty among students and they should highlight Indianness or Indian values embedded in them.
- A Teaching Model essentially means designing educational activities and situations (classroom situations to learn).
- Constructive Teaching Learning Situation: NEP 2020 in its part 4 maintains that textbooks should not be an exercise of merely providing answers to the questions but students should be enabled to find out answers to the questions in their minds. Constructive approach used in NEP document means students should be equipped to find out answers that are already in their minds through the means of textbooks. NEP document says education should move towards less content and more towards learning about how to think critically and solve problems, how

to be creative and multidisciplinary, and how to innovate, adapt and absorb new material in novel and changing fields.

- Pedagogy must evolve to make education more experiential, holistic, integrated, inquiry driven, discovery oriented, learner-centric, discussion based, flexible and of course, enjoyable.
- Education should evolve into a process that recognizes, accepts and develops the potential of the learner.
- This must also be born in mind that while teaching, a teacher is not merely teaching in the classroom but he/she is also learning from the experiences of his/her students which he/she can bring in use for teaching the next batch of students. Part 4 of the NEP 2020 also emphasizes on art oriented and play oriented ways of teaching-learning process. Art cannot be understood only in terms of narrow understanding like drawing but seeing and perceiving things with different aspects associated with a particular issue is also an art.
- Textbooks should be prepared by drawing connections between cause and effect related to a particular issue as well.
- Activities prescribed for students should not be merely individual student centric but they should also develop group behavior among them. The NEP too has said that such activities will help students to keep in tune with the developments of the 21st century and should imbibe constitutional values among students, e.g., fundamental duties, environmental concerns etc.
- Approach to preparing textbooks should not be followed in isolation but must have an inter-disciplinary approach for example, textbook preparing committees on science, social sciences and languages should come together and device strategies in this regard.

- Textbooks for students should enable them not to learn what's being taught in the classroom for that moment or year alone but they should develop the sense of learning things continually.
- Thus, textbook should inculcate the thoughts and ideas on social justice, equality, scientific development, and national unity, cultural preservation of India, developing wholesome personality, developing resources to their fullest and using them in sustainable ways.
- Section 4.31 of the NEP provides for developing textbooks at national level keeping local issues and local aspects in the center stage. It lays emphasis on the constructive approach based on the discussions, explanations and utility of the learnt knowledge in practical life. It also talks of including supplementary material in the textbooks. It also talks of including bunch of books derived from the national and local sources.
- The reduction in content and increased flexibility of school curriculum renewed emphasis on constructive rather than rote learning. This must be accompanied by parallel changes in school textbooks. All textbooks shall aim to contain the essential core material (together with discussion, analysis, examples and applications) deemed important on a national level, but at the same time contain any desired nuances and supplementary material as per local contexts and needs. Wherever possible schools and teachers will also have choices in the textbooks they employ from among a set of textbooks that contain the requisite national and local material - so that they may teach in a manner that is best suited to their own pedagogical styles as well as to their students and communities' needs.
- Section 4.32 of the NEP provides for coordination between NCERT and SCERT to develop textbooks in various

languages spoken in India. They must derive from the sources across regions in India. "The aim will be to provide such quality textbooks at the lowest possible cost -namely, at the cost of production/printing - in order to mitigate the burden of textbook prices on the students and on the educational system. This may be accomplished by using high-quality textbook materials developed by NCERT in conjunction with the SCERTs; additional textbook materials could be funded by public-philanthropic partnerships and crowd sourcing that incentivize experts to write such high-quality textbooks at cost price.

- States will prepare their own curricula (which may be based on the NCFSE prepared by NCERT to the extent possible) and prepare textbooks (which may be based on the NCERT textbook materials to the extent possible), incorporating State flavour and material as needed. While doing so, it must be borne in mind that NCERT curriculum would be taken as the nationally acceptable criterion. The availability of such textbooks in all regional languages will be a top priority so that all students have access to high-quality learning. All efforts will be made to ensure timely availability of textbooks in schools. Access to downloadable and printable versions of all textbooks will be provided by all States/UTs and NCERT to help conserve the environment and reduce the logistical burden."
- Section 4.33 provides for "Concerted efforts, through suitable changes in curriculum and pedagogy, will be made by NCERT, SCERTs, schools, and educators to significantly reduce the weight of school bags and textbooks.
- In this regard, it's important to look at 1992 Committee Recommendations on how should the textbooks be also the 2005 NCF recommendation on the curriculum.

- Textbooks should include topic, role of the concerned topic, syllabus, self-study material, pictorial representations, structuralism, experiential learning, communication, students' participation, empowering teachers, culture, constitutional values, skills required for the 21st century, research aptitude, supplementary books etc.
- Education should be the process of humane learning presupposing a specific social nature and a process by which children grow into the intellectual life for those around them.
- Education should enable the child to look at the environment around her/ his in a holistic manner and does not compartmentalize any topic into science and social science.
- Therefore, an attempt should be made in the textbook so that it will help a child to locate every theme in physical, social and cultural contexts critically so that the child can make informed choices in his/her life.
- The challenge in relation to writing a textbook at national level lies in the fact that it should reflect the multicultural dimensions of the Indian society. Every effort should be made to include every community in the country giving due space to their culture and way of life so that all of them feel important.
- The position paper by the textbook preparation committees previously constituted had observed that- While writing textbooks….."who is the child we are addressing was the big question. Does a child study in the big of school of the metro city or the school in the slums, a small-town child, one in village school or one in the remote mountainous areas? One also needed to tackle the difference of gender, class, culture, religion, language, geographical locations etc. These are some of the issues addressed in the book, which the teacher will also

have to handle sensitively in her own ways." While preparing textbooks these issues of concern must be deliberated over.

- There is need to inculcate the habit of reading among our students and for that to happen the books must be prepared in a way that they become attractive for them.
- We need to pay attention to the section 4.35 of the NEP in this regard. It says, "The progress card of all students for school-based assessment, which is communicated by schools to parents, will be completely redesigned by States/UTs under guidance from the proposed National Assessment Centre, NCERT, and SCERTs. The progress card will be a holistic, 360-degree, multidimensional report that reflects in great detail the progress as well as the uniqueness of each learner in the cognitive, affective, and psychomotor domains. It will include self-assessment and peer assessment, and progress of the child in project-based and inquiry- based learning, quizzes, role plays, group work, portfolios, etc., along with teacher assessment. The holistic progress card will form an important link between home and school and will be accompanied by parent-teacher meetings in order to actively involve parents in their children's holistic education and development. The progress card would also provide teachers and parents with valuable information on how to support each student in and out of the classroom. AI-based software could be developed and used by students to help track their growth through their school years based on learning data and interactive questionnaires for parents, students, and teachers, in order to provide students with valuable information on their strengths, areas of interest, and needed areas of focus, and to thereby help them make optimal career choices." These issues must be kept in mind while preparing textbooks.

- The interdisciplinary approach of seeking knowledge is not new to us in India. The Sushrutsamhita has quite elaborately spoken about it in the following words-

एकंशास्त्रमधियानो न विद्याछास्त्रनिश्चयं
तस्माद बहुश्रुताः शास्त्रंविजनीयचिकित्स्काः
शास्त्रंगुरुमुखोदीर्णमादायोपास्य चासकृत
यः कर्मकुरुतेवैद्यः स वैद्योन्य तू तस्कराः
(सुश्रुत संहिता सूत्रस्थानम4. 6-8)

- Our education should make students competent, experienced and capable enough to expand their knowledge on their own. While writing books, the interests of all students of society belonging to different gender, class, culture, religion and geographic locations should be kept in mind.
- The textbooks should be structured primarily in the five parts, viz. 1. Curriculum or syllabus as per our educational needs and objectives. 2. Collection of the material and its sequencing or sorting for the intended purpose, for example, the collected material can used for designing syllabus of various classes. 3. Evaluation of the utility of the syllabus or curriculum. 4. Presentation of the collected material in the textbooks and 5. background checking meaning whether there is any need for further improvement in the designed books and its syllabus (**पतिपृष्ठि**). It has been very beautifully said in the Indian knowledge traditions in the following shloka of Shukarhasyopanishad-

श्रवणंतु गुरोः पूर्वं मननंतदनन्तरम् ।
निदिध्यासनमित्येतत् पूर्णबोधस्य कारणम् ।।
(शुकरहस्योपनिषद्)
श्रवण > मनन > निधिध्यासन

Chapter–4

CONTENT DEVELOPMENT OF PHYSICS CURRICULUM IN INDIAN PERSPECTIVES IN THE LIGHT OF NEP-2020 (CPINEP-2022): A REPORT

VBUSS, organised a two day workshop at Sardar University, Mandi, HP to discuss possible restructuring of Physics curriculum in Indian Context. There were 7 sessions and thirteen speakers of International repute, who presented their talk on the theme. After each session there were discussion and deliberations on the various aspects, concepts and contents of the talk. The participants were teachers, lecturers who are teaching the subjects for year and Ph D scholars, who are future teachers.

The workshop started with introductory remark by Convenor Dr. Gourishankar Sahoo, who described how Indian approach to scientific endeavor is holistic and holy. Both living bodies with entities embedded in it like mind and soul and non living bodies made of up solid, liquid, gas, energy, space, time etc. were well described by Kanad in Vaiseshik Darshan. He emphasized the need of rewriting physics text books incorporating Indian knowledge system in it. Chief Guest Prof. Dev Dutt Sharma, Honorable Vice Chancellor, Sardar University,Mandi in his address requested all to pronounce the current policy as National Education Policy-2020, not New Education Policy-2022. He said that this NEP-2020 will

revolutionalize the education system of India. Chief Speaker, Prof. Nagesh Thakur, renowned educationist and Member, Executive Council, NAAC, said that Swami Vivekananda described the need of an education system coherent with our society and culture. He said that teaching method and methodology is equally important as the subject itself. Prof. Ruchir Gupta, JNU in his speech described the efforts of VBUSS to help academicians and government in structuring Indian education system keeping India's need and incorporating mandates of NEP-2020. Key note speaker Dr. Bindu Radhamany, IIT, Mandi in her presentation described how teaching can me made a fun for students and interesting for them. Prof. Deepak Pathania, Convener, described the need of Interdisciplinary research.

In his presentation Prof. R. C. Verma, renowned researcher on history of Indian science and currently Adjunct Professor, Central University of Punjab, has given a brief description to physics & physical world. He described how in India physics was a science covering material as well as spiritual sphere. He cited the idea & theory of philosophers & scientists like Buddha, Kapila, Kanad and how these ideas shaped the discourse in physical sciences. He proposed a model and put forth a structure, how to introduce physics to intermediate student. In his presentation Prof. B. C. Chauhan, Professor, Central University of Himachal Pradesh, described the units used for measuring distance, time, temperature, weight etc. by Indians since centuries. He explained how zero discovered by Aryabhatta revolutionalised the units & measurement of physical entities. He described citing our ancient texts, the motion both linear & rotational, and described the laws of motion.

Dr. Vikas Thakur, Vallabh Govt. College, Mandi in his presentation described how Bhaskar and other Indian scholars are well versed in the concept of force before Newton. He also described the contribution of Indian scholars in the field of work, energy & power.

Prof. Avinash C. Pandey, Director, Inter University Acceleration Centre in his presentation described the unit Link & Pralink used by Indians to measure temperature and discussed its merits & drawbacks. He explained the concept of elasticity and cited the verses in ancient Indian texts which beautifully describe elastic properties of matter. He also discussed in detail Indian contribution in mechanical properties of solid and fluid and also thermal properties of matter.

Prof. Rajesh Sharma, Professor & Head, Department of Physics, Sardar Patel University, Mandi described the concept of heat and Indian contribution in this subject with an emphasis of M. N. Shah's contribution. He also cited Sanskrit verses which describes thermodynamics & kinetic theory.

Prof. Gourang Chandra Mohanty, Retd. Professor & Principal, Khallikote Govt. College, Berhampur described the concept of gravitation and proved with original Sanskrit verses & their scientific meaning which proves that Indian researchers like Bhaskar, Lilavati and others developed the concept of Gravitation much before than Newton. He also explained motion under gravitation force with examples from Aryabhattiyam, Surya Siddhanta, Siddhanta Siromani etc.

Prof. Suneet Dwivedi, Professor of Physics, Allahabad University, explained the shape of earth & other planetary bodies in his presentation. He said 'Bhugole' etymologically meaning earth is spherical and, we have given the name of the subject on earth as 'Bhugole' since centuries. He described heliocentric & geocentric theories and their conflicts and explained how geo-heliocentric theory proposed by Indian astronomers has advantageous position over these two. He, with examples and explanation proved how Indian Astronomers are well versed in planetary motion and Solar system.

Dr. Rajendra S. Dhaka, Indian Institute of Technology, Delhi in his presentation cited Indian contribution in electricity and

magnetism. He described how Indians are well acquainted with five types of permanent magnets, with their nomenclature and meaning. He also explained magnetic properties of matter, electromagnetic induction with emphasis on Indian contribution in these subjects. He said IEEE recently published a note of acknowledgement and acclaim to Acharya Jagdish Chandra Bose for his invention of radio waves and first wireless communication or electromagnetic wave transmission to a distance.

Dr. Ram Prasad Prajapati presented a talk on Indian contribution in the field of atomic and nuclear physics. He cited original verses of Vaishesik Darsan and proved how Kanad developed the concept of atomism much before, Democrites, Hiparcus and others and his theory is complete and is still relevant for modern researchers unlike Democritus and Dalton. He also cited a verse from Vaishesik Darsan in which he said about Biparita Anu, etymologically meaning antiparticle. He explained Vedic verses and proved that the current concept of creation and evolution of universe was beautifully described in Vedic texts.

Dr. Debi Prasad Das, Senior Principal Scientist, CSIR-IMMT, presented the contribution of Rishi 'Swati' in the development of earlier musical instruments like Tabla, Mridangam, Flutes by observing the sound created when raindrops falls upon leaf of different size and shape. The velocity of light calculated by our ancestors was nearly same to the current value. He presented the contribution of Bharat Ratna C. V. Raman in developing the theory of sound produced by various musical instruments like Vina, Mridangam, flute, Tabla etc. and his works were published in reputed journals like nature. He is the person who single handedly developed the science and mathematics of musical instruments.

Prof. Ram Nata Jha, Professor of Sanskrit and Indic Studies, Jawaharlal Nehru University, New Delhi in his talk described how a number of researchers in ancient India calculated the velocity

of light i.e. an electromagnetic wave with excellent accuracy. He described in detail, Indian contribution developing ray and wave optics as a subject.

Prof Ravi Prakash Arya, Chair Professor, Maharshi Dayananda University, Rohtak in his presentation described Indian contribution in Astronomy & cosmological time measurement. Dr. Abhishek Srivastava, Associate Professor IIT-BHU presented the contribution of Indian Astronomers in Astrophysics and Cosmology. These include scientists born after independence as well as those of ancient India.

All the participants took part in discussion & deliberation after each presentation. In the closing ceremony the pro-vice chancellor of Sardar Patel University, Mandi described the need of incorporating IKS in college curriculum as per NEP-2020. President, VBUSS, Professor Kailash Chandra Sharma in his talk said that space and time concept and the analogy between them was given by Kanad and till now our children didn't feel to respect it- said Swami Vivekananda. Professor Surendra Sharma in his talks highlighted that teaching curriculum must be prepared looking on the need of society and industry. Child psychology must been taken into consideration while developing the current curriculum. Dr. Gourishankar Sahoo, Convener said that in India, experimentation has been placed at a respectable and high position since long time. He quoted Mahamana Madan Mohan Malaviya and said that Indian Science is the future of the society. Shri Jnan ji in his talk described the reason why Saraswati Sishya Vidya Mandira model is successful in India.

Chapter–5

FULFILLING THE VISION OF NEP 2020 IN PHYSICS TEXT BOOKS

India i.e. Bharat has a legacy of scientific knowledge system and rich cultural heritage. The knowledge system is developed over several millennia and manifested in the form of science, technology, medicine, agriculture, arts and literature. As such, this land has provided invaluable knowledge stuff to the whole world from time immemorial and contributed the social order to the fullest. The oldest world class Universities of the world like Takshashila, Nalanda, Vikramshila and Vallabhi, etc and the magnificent works of the great scholars like Charaka and Susruta, Aryabhata, Bhaskaracharya, Chanakya, Madhava, Patanjali, Panini and Thiruvalluvar are the remnants of such an extensive traditional legacy of knowledge creation and dissemination.

No doubt, Indian traditional knowledge and cultural heritage have been always admired by the world, but unfortunately, apart from the traditional practice, a larger portion of the treasure of knowledge is either lost or remained folded and veiled in the personal possessions or stacked in the various libraries worldwide.

There is a long tradition of holistic and multidisciplinary learning in India i.e. from 'liberal arts' (i.e., a liberal notion of the arts) in the Universities to the extensive literatures of various subjects across fields. The National Education Policy-2020 is committed to bring this tradition back to education system, as it is exactly the kind of

education needed for the 21st century. As such, the students will have an ample of opportunities to exercise, e.g. they would be able to convert Indian wisdom into the applied aspect of the modern scientific technology.

In ancient India, the aim of education was far beyond the acquisition of knowledge for material prosperity, i.e. complete realization and liberation of the self. Therefore, exploring the immense potential of knowledge in India is truly important for the nation's identity, pride, self-esteem as well as for its economy.

Physics which is considered as a royal subject is very much important to understand basic concepts in Chemistry, Botany, Zoology, Physiology, Engineering and Agricultural Science. Moreover, studying Physics usually develops the analytical thinking in student, which in turn helps him face a real life problem. So, students and parents take utmost care to learn Physics at schools and college level. Looking at the present demand of R & D sectors, rural industries and market forces, school level Physics curriculum need to be revised. Incorporation of Indian Knowledge System in Physics Curriculum will help in giving the R & D a new dimension and National Education Policy-2020 is aimed at fulfilling this very objective.

प्रत्यख्यानुभबम न लुम्पति बचे युक्ति।।

सिद्धांत दर्पण, स्पष्टाधिकार, षष्ठ प्रकाश, श्लोक 2, सामंत चन्द्रशेखर

"*No one can refute experimental findings by whatever argument and theory*"

Experimentation is placed atop by Indian researchers since time immemorial. Any theory was validated only after it was proved in laboratory, unlike Philosophy. Western science was evolved from philosophy and early philosophers were considered as founding fathers of western science. May be because of this, Science was earlier termed as, "Physico Philosophia". The modern science is based on

experimental findings. So, any theoretician is awarded the prestigious Nobel Prize only after the theory is validated in the laboratory. Mahanana Pt. Madan Mohan Malviya once remarked, "Higher Education is the basic building block in the creation of inclusive, equitable and diverse knowledge society." The main objective of Education in his view is to amalgam Character, Industry and Integrity. Tagore's education philosophy was naturalism, humanism, internationalism and idealism. BHU and Shantiniketan established by Mahamana and Tagore evolved as world class Universities.

Western science both ancient and modern focused on outward analysis, where was ancient Indian research aimed at inward observation, neglecting outward progress. In modern times Tagore defines education as something that enables mind to find out that ultimate truth which emancipates us from the bondage of dust and gives us wealth not of things but of inner light, not of power but of love. It is the process of enlightenment. It is divine wealth. It helps in realization of truth. Both the approach created their own vision and world view. Western research evolved around materialistic growth, where as Indian thinkers tried to bring a balance between material and spiritual growth. In western science, philosophy and culture, Man is at the center where as Indians consider everybody in the world from tree to birds and animals as their own. Because the philosophy of coexistence with nature, Indian civilization has a continuum from thousands of years, whereas western modern science is struggling to address many issues like air, water, light pollution, global warming, pandemics and many more within a couple of century. Hence, India has a key role in shaping the worldview of western leaders in science and technology in recent times.

Utkalmani Gopabandhu Das aptly remarked that the present education system destroys the Indian values and national individuality. He wanted a system of education rooted in the national heritage, that places equal emphasis on culture of body, heart and mind; integrates

them harmoniously. He was an advocate of indigenous system of education and established Satyavadi Vana Vidyalaya in 1909, which has produced many a scholars and national leaders.

The present education system is nothing but the product of Macaulay model and still following its very philosophy. Macaulay had said in British parliament on 02.02.1835, "*I propose that we replace her (India) old and ancient education system, her culture, for the Indians think that all that is foreign and English is good, and greater than their own, they loss their self esteem, their native culture and they will become what we will want them, a truly dominated nation*." This thought is still prevalent in our education and school and college curriculum. In England you find equal importance to theory and experiment in science subjects, say Physics. But, here theory is dominant in curriculum and entrance process for engineering, medicine, agriculture and higher studies in science subjects say Physics. You cannot find the mention of contribution of a single Indian scientist in school and college textbooks, where as western scientists like Dalton, Rutherford and Bohr and many more were everywhere. The idea of matter or dravya are first time given by *Kanāda* (6^{th} Century B.C.) and mentioned in his famous texts Vaisheshika Sutra. He has not only discussed about the fundamental elements of the matters but also the space, time, laws of motion, fluidity, kinematics etc. Before Greek philosophers Leucippus, Democritus (5^{th} Century BC) who said that all the matter consists of earth (solid), water (liquid), air (gas), fire (plasma), *Kanāda* (6^{th} Century BC) put forth the theory that the living and nonliving beings, consists of of *Pruthvi* (solid), *āp* (liquid), *vayu* (air), *tejas* (plasma/energy), *ākash* (space), *kāla* (time), *dik* (vectors/directional parameter), *mana* (mind), *ātmā* (soul). Except soul the role of all others in the formation of matter and life is understood only in recent times. Modern science is still in the search of *ātmā*. So, Mahanana Pt. Madan Mohan Malviya aptly remarketed that

ancient Indian science is modern in its approach and ultra modern in its future. Similarly, the understanding of the evolution of this universe can be done using the Big bang theory in modern physics. But in our *Rigvedas* there is detailed explanation about the creator, destroyer and governing gods. Even the Newton's first law could not explain the role of the external force responsible for the expansion of this universe but it is explained in the Rigvedas. In addition to this, there are great Indian mathematician, astronomers who have developed number system, mathematical and astronomical tools to understand the solar system and planetary system about which there is nothing mentioned in the text books. The greatest physicist Erwin Schrodinger aptly remarked that like *Vedānta*, science also takes help of similarity to understand various phenomena, because argument and logic have their own limitations and after guiding you to some extend it left you alone. After studying Indian philosophy many concepts of quantum mechanics, which were seemed to be abstract and vague idea for me, I could understand, said Heisenberg. There is an urgent need of changing the Macaulay model by giving equal importance to theory and experiments and place Indian Physicist like *Aryabhat, Bhāskar, Kanād, Prasastapāda, Bharadwāj, Suka, Swāti, Sayanācharya, Mahavirācharya, Varāhmihir*, C. V. Raman, M. N. Shah, S. N. Bose, S. Chandrasekhar, Homi J. Bhabha, and many more along with Newton, Galileo, Edison, Bohr and others.

Under the chairmanship of Dr. K. Kasturirangan, the world famous Indian scientist and involvement of scholars like Dr. Majul Bhargava the National Education Policy (NEP-2020) is prepared, which is aiming at giving equal importance to theory and experiments and inclusion of Indian Knowledge System in school and college curriculum along with other features to make Indian education inclusive. One of the key features of NEP-2020 is multi-dimensional education being offered to students in the Gurukulas through Guru Shishya Parampara and prestigious universities like *Nalanda,*

Takshashila, *Vikramshila* etc focused on developing the overall holistic personality of the students. Vocational education which was there in Indian Gurukula system and experimented at *Satyavādi Vana Vidyālaya*, BHU and in many Institutions built during pre-Independence era is another key feature of NEP-2020. NEP-2020 is aiming at keeping market forces at a arms length from educational institutions. Mahamana was of the view that higher education should not become subservient to the forces of market. Gopabandhu, Togore, Mahamana successfully kept market forces out of academic campuses.

Study of Physics is very important in every walk of Life. From engineering to medicine and agriculture Physics play a vital role. In India, present day Physics curriculum was adopted nearly few decades ago. In National Education Policy 1986, it remained same almost as previous. Some restructure was initiated through NCF 2005, but that too fails to satisfy the desired aspiration. The changing requirement of globalized world further presses the demand to restructure it. We have to prepare such a curriculum so that everyone should like to study it and the course content can be world class. Moreover, the inclusion of Indian Knowledge System can create self esteem in the child.

India i.e. Bharat has a legacy of scientific knowledge system and rich cultural heritage. The knowledge system is developed over several millennia and manifested in the form of science, technology, medicine, agriculture, arts and literature. As such, this land has provided invaluable knowledge stuff to the whole world from time immemorial and contributed the social order to the fullest. The oldest world class Universities of the world like Takshashila, Nalanda, Vikramshila and Vallabhi, etc and the magnificent works of the great scholars like Charaka and Susruta, Aryabhata, Bhaskaracharya, Chanakya, Madhava, Patanjali, Panini and Thiruvalluvar are the remnants of such an extensive traditional legacy of knowledge creation and dissemination.

No doubt, Indian traditional knowledge and cultural heritage have been always admired by the world, but unfortunately, apart from the traditional practice, a larger portion of the treasure of knowledge is either lost or remained folded and veiled in the personal possessions or stacked in the various libraries worldwide.

There is a long tradition of holistic and multidisciplinary learning in India i.e. from 'liberal arts' (i.e., a liberal notion of the arts) in the Universities to the extensive literatures of various subjects across fields. The National Education Policy-2020 is committed to bring this tradition back to education system, as it is exactly the kind of education needed for the 21st century. As such, the students will have an ample of opportunities to exercise, e.g. they would be able to convert Indian wisdom into the applied aspect of the modern scientific technology.

In ancient India, the aim of education was far beyond the acquisition of knowledge for material prosperity, i.e. complete realization and liberation of the self. Therefore, exploring the immense potential of knowledge in India is truly important for the nation's identity, pride, self-esteem as well as for its economy.

Physics which is considered as a royal subject is very much important to understand basic concepts in Chemistry, Botany, Zoology, Physiology, Engineering and Agricultural Science. Moreover, studying Physics usually develops the analytical thinking in student, which in turn helps him face a real life problem. So, students and parents take utmost care to learn Physics at schools and college level. Looking at the present demand of R & D sectors, rural industries and market forces, school level Physics curriculum need to be revised. Incorporation of Indian Knowledge System in Physics Curriculum will help in giving the R & D a new dimension and National Education Policy-2020 is aimed at fulfilling this very objective.

Chapter–6

DEVELOPING NEW TEXT MATERIAL IN PHYSICS: AN APPROACH PAPER

All the universal processes respect the principle of causality. Matter has inherent causality, meaning that it is capable of generating an effect within itself as its cause. However, it has incapability of being destroyed as an effect. In any process nothing is created and nothing is destroyed. So the number of atoms in the effect is the same as that in the cause.

In an atmosphere of rivalry and counterfeiting other schools, each of them and their sub schools (~100) kept growing quite actively as late as the medieval times. They may differ on certain aspects and/or introduce new dimensions.

- ***Nyāya Darshana*** believes that the means of realization of the truth is through right knowledge, however, it accept the plural representation of matter given by the *Vaiśeṣika* School. Regarding the positioning in space, later *Nyaya*-thinkers conceived of three-axes mutually perpendicular to each other. Thus, the position of any pointin space, relative to another point, could be given in terms of three distances only. Thereby, it anticipates rudimentary ideas of the solid geometry.
- ***Mimāmsā*** *Darshana* also accepts *Parmānu* theory ofthe *Vaiśeṣika* School largely. However, it raised objection against the chemical action. It believes that the natural phenomena

take place due to **Energy** (*Shakti*), which is eternal and super sensuous. Energy can neither be created nor be destroyed (**Conservation Law**). Depending on effects it produces, energy is inferred to be of various types, but there is no intrinsic difference in them.Light is treated as particle, and is in a state of high motion. *Mimamsa* school recognises it as radiation proceeding away from the source.

Avedic ***Jaina, Hinayāna-Buddhist*** and ***Chārvāka*** schools, though accepted the concept of Elements and Atoms, developed their own theories.

- In the ***Jaina*** *Darshana*, matter (*Pudgal*) is eternal and always undergoes transformations. '***Pud***' means to *combine* and '***gal***' means to *dissociate.Jaina -Parmānus* are identical without any qualitative and quantitative differences. Every *Parmānu* is capable of producing any touch, colour, taste and odour. Combination of two or more atoms takes place due to the inherent attributes of the *Parmānus* : **attractive force** (*snigdha*) and **repulsive force** (*ruksha*). To forma bond the *Parmānus*musthave opposite qualities. Normally, two homogeneous *Parmanus* do not unite. *Jaina* School states that Time is not all-pervasive, and proposes *Kālānus* which are infinitesimal, innumerable, discrete, indivisible and invisible (Quanta of time).
- ***Hinayāna Buddhist*** School allows separate, independent, but momentary, existence of objective world, a whirlwind consisting of *Parmānus* . However, *Parmānus* are not as material stuff but as the dynamic energy. There are eight kinds of the *Parmānus* :four primary (Earth, Water, Fire, Air), and four secondary (Odour, Taste, Colour, Touch). Since *Parmānus* undergo phase-changes (appearance and disappearance) continually, everything has momentary existence. The so-called permanence of the world perceived

by us is said to be a function of our thought process. They denied the objective existence of the Time. Interdependence of the moments following one another creates the illusion of stability. Space is treated only as a field for the phase changes to take place.

- ***Chārvaka Darshana*** believes that the external world exists objectively, independently of any consciousness. It developed spontaneously, without outside interference, but in a law-governed fashion. The laws are capable of change only through physical action rather than through ideas, magic, or prayer. It accepted only the first four material elements (Earth, Water, Air, and Fire) as the basis of all things. These elements are spontaneously active, with a force of their own (*savabhava*) inherent in them. They do not regard life as separate principle. Everything, organic or inorganic, is produced of matter through chance. Perception is only source of knowledge, and inference has no value for *Chārvakas*. So, they could not offer any theory about the evolution of the world.
- *Vedānta Darshana* developed its own principle of causality, called *Vivartavāda*, in which *Brahman (*under the influence of *Maya*) acts as the cause of all actions in the universe. *Māya*, and by implication the universe, originate out of *Brahman*, not by a process of evolution, but of **Self-alienation** (*Vivarta*). So the entire universe is merely an imposition upon that unchanging reality, a false and illusory appearance. *Māya* is the material cause of the universe.
- Self-alienation of *Brahman*, acting through *Māya*, produces Ether/Space (*Ākasha*)-one, infinite, ubiquitous, inert, and all-pervasive. Other Elements (Air, Fire, Water, and Earth) evolve from Ether, which in turn produce gross elements

(*Mahābhutas*).Since matter is constantly undergoing changes of state, the effect acts like a cause in a new collocation. Like *Sāmkhya*, It also denies objective existence of Space (*Dik*) and Time (*Kāla*).

Science based completely on materialism and negating spiritualism as old thoughts and superstitions is the root cause of many a global problems like loss of ethical values, economic disparity, ecological problems, global warming, sky rocketing cost of health. This can only be solved if the student learn materialistic methods of experiments and theory and realize spiritual feelings.

In *Vaiśeṣika Sutra* first chapter, Pratham Ahnikam, Sloka 5, *Maharshi Kanād* (5th Century B.C.)

writes

"प्रुथिव्यापस्तेजो वायुराकाशम कालो दिगात्मा मन इति द्रव्याणि।।''

Mana or Mind is half known and *Atmā* or Soul is completely unknown for our scientists. Since, all other physical entities mentioned in this *Sloka(Verse)* have physical significance in making the non-living entities around us, there should be investigation to reveal the physical properties of Mind and Soul. This is only possible if we eradicate perception of abhorrence from young minds so far as Indian science is concern. Incorporation of Indian concepts likes this, need to be incorporated in Physics curriculum. Chapter 1 of 11th standard text book, which is on Introduction to Physics and Physical world, need to be rewrite completely so that both materialistic and spiritual aspects of Physics as a subject can be established.

Again, E. C. G. Sudarshan pointed out how the *Vaiśeṣika* conceptualization of atom is closer to the modern quantum mechanics than Greek model of atom developed by Democritus. J. S. Hagelin has tried to explain consciousness using the field concept.

The Cosmology is known as "*Khagola*" here. "*Kha*" means space or cosmos and "*Gola*" means spherical. So, spherical shape

of Universe or Cosmos was known to our ancestor's long back. In *Hiraṇyagarbha Sūkta, Rigveda* (10:121), the creation of Universe is nicely explained, which need to be included in the said chapter. Out of hundred seers eighteen seers tends towards naturalism!

In Sāmkhya School Maharshi Kapil (6th Century B.C.) explained

1) Two Elements Theory
2) Evolutionary Universe
3) Principle of Causality
4) Purpose in Cosmic Evolution

So, principle of causality is explained in India much before Newton!

Though seeds of the cyclic theory of universe are found in the *Shwetashwter Upanishad*, it was fully developed later by Vedanta School of *Adi Shankar*. This theory concerns the creation of the universe as an event recurring periodically from all eternity.

Many western scientists acknowledge the contribution of Indian concepts in developing present science.

- "The unity and continuity of Vedanta are reflected in the unity and continuity of Quantum Mechanics. This is entirely consistent with the Vedanta concept of All in One."

  —E. Schrödinger

- "Quantum theory will not look ridiculous to people who have read Vedanta."

  –W. Heisenberg

- "I go to the Upanishads to ask questions."

  —N. Bohr

- "All perceptible matter comes from a primary substance filling all space, the *Akasha*, which is acted upon by the life-giving *Prana* calling into existence, in never ending cycles, all things and phenomena."

  —N. Tesla

- "When I read the Bhagavad-Gita and reflect about how God created this universe everything else seems so superfluous and cosmic religious feeling is the strongest and noblest motive for scientific research."

—A. Einstein

1. The other introductory chapter of Physics Text book is Unit, Dimensions, Scalar and Vector. *Surya-Siddhānta*, enumerates nine systems of measurements of time, and thus have explained nine units of time. *In Siddhānta-Darpan (Pratham Prakāsh, Sloka 25-30)* different smaller units of time is given and it is worth noting that the smallest unit of time i.e. '*Truti*' used by *Samanta* is ~4.9382E-6 s, which is of the order of μs.

Sl No.	*Samanta's Unit for measuring time*	*Modern units equivalent to that unit*
1	1 *truti*	4.938E-6 s
2	1 *laba*	4.938E-4 s
3	1 *nimisa*	1.48 E-2 s
4	1 *kāsthā*	0.266 s
5	1 *guru varna*	0.4 s
6	1 *prāna*	4 s
7	1 *kalā*	8 s
8	1 *bighati/pala*	24 s
9	1 *khyaṇa*	240 s or 4 min
10	1 *danda/ghati*	1440 s or 24 min
11	1 *muhurta*	2880 s or 48 min
12	1 *day or naxatra dina*	86400 s
13	1 *divya/asura dina*	360 years
14	1 *mahā yuga/chatur yuga*	4.32E6 years
15	*1 manwantar*	3.0672E8 years
16	1 day of *Brahma*	8.64 E9 years
17	The life span of this *Brahma*	3.11 E 14 years

In subsequent verses (slokas) largest unit of time known to him is described and it is ~3.11 X 10E14 years. Again, it is interesting to note that one day of *Brahma* (referred in mythologies as the creator of everything) is 8.64E9 years as per the calculations of *Samanta* and he has a bold prediction that out of the current holy day of present *Brahma*, 1.97E9 years has been elapsed. Modern calculation and prediction is of the view that ~ 1.38 E10 years from Big Bang (creation of universe) has been passed till date. Again, *Samanta* is of the view that this *Brahma* will live for all total 3.11E14 years. The two values are not very far from each other. Again, in the text different time measuring low cost instruments like *Chapa Yantra, Golardha Yantra, Chakra Yantra Swayambaha Yantra* etc. are discussed in detail. So, different terminology used by different Indian scholars for units and measurement need to be compared and the historical development of units and measurement systems needs to be placed in our textbooks. Decimal system which has revolutionalized the measurement system completely, was the greatest contribution of Indian since Vedic era. *Vaiśeṣika Sutra* first chapter, *Pratham Ahnikam, Sloka 5, Maharshi Kanāda* (5^{th} Century B.C.) says about a physical entity *"Dik"* which is synonymous with direction and the concept of scalar and vector are there in India since time immemorial. These, things need to be placed in text books.

2. So far as Mechanics is concern, Indian texts have vast treasure of knowledge. Sanskrit is called *"Sruti"*. It is communicated from teacher to disciple through oral communication. So, when people start talking in Sanskrit and as the language developed, it has no written script. So, you can write Sanskrit in any script you desire. Devnagri English script is not very popular among people, so in this report Sanskrit verses are written in Hindi Devnagri script which is very well known from the length and

breadth of the country. However, while writing text book the writes can chose English Devnagri script to write Sanskrit verses.

In *Vaiśeṣika Sutra* force concept was elaborated in detail.

वेग: निमित्तविशेषात कर्मणो जायते।

Translation: Action on objects generates motion. **Law:** The change of motion is due to impressed force.

वेग: निमीतापेख्यात कर्मणो जायते नियातदिक क्रिया प्रबंध हेतु।

Translation: The external action being direction causes the motion to be directional.

Law: The change of motion is proportional to the motive force impressed and is made in the direction of the right line in which the force is impressed.

वेग: संयोगविशेषविरोधी।।

Translation: An equal and opposite action can neutralize the motion. **Law:** To every action there is always an equal and opposite reaction.

(V.S. 1-1-14; Physics in Ancient India, N.G. Dongre, S. G. Nene, pg-74)

So, long before Sir. Issac Newton, in *Prasastapāda Bhāsya*, causality is explained. Force is the cause of motion-our Rishis knows it. The detail behavior of force was also explained in *Prasastapāda Bhāsya*.

Kanāda describes in detail the following types of causes:

Material cause (*Samvayi Karana*),
Non-material cause (*Asamvayi Karana*),
Instrumental cause (*Nimitta Karana*),
Efficient cause (*Adrishta Karana*).

For example, *Parmānus* are material **cause** for formation of diatoms (**effect**). Similarly, diatoms act as **cause** of next formation

(**effect**), and so on. By themselves, the *Parmanus* cannot produce anything, else they would involve into a continuous creation. An unseen force (*Adrishta*) is efficient cause and is responsible for their combination. Time is considered to be instrumental cause of Creation, Persistence, and Destruction of all the gross objects.

In the *Vaiśeṣika Darshana*, there exists an absolute difference between the cause and its effect though there is continuity between them (a mysterious tie). The cause in each case brings about the effect but is immediately absorbed into the effect, which in turn plays the function of another cause to continue the process.

Let's have a look on *Vaisesik Sutra*, Chapter 1, 1st Ahnika, Verse-7

उत्खेपणमबक्षेपणमाकुँचन प्रसारणगमनमिति कर्मणि।।77।।

So, in Vaisheshika Sutra by Kanād

1) upward motion (उत्क्षेपण)
2) downward motion (अवक्षेपण)
3) motion due to the release of tensile stress (आकुञ्चन)
4) shearing motion (प्रसारण)
5) general Type of motion (गमन)

In *Vaiśeṣika Sutra, Kanād* (6th Century B.C.) explained five types of motion.

So, it can be concluded that thoughts on motion, its different types, it's cause all are there in our scientific tradition since ages and are being discovered by different sage.

While, we shall discuss on planetary motion we will see how our ancestors have clear idea of rotational motion.

Bhāskarachārya in his classic text *Siddhānta Siromani* (भास्कराचार्य के ग्रंथ 'सिद्धांत शिरोमणि' के गोलाध्याय के यंत्राध्याय के श्लोक 53 से 56 तक) gave description of water wheel.

तम्रादिमयस्यांकुशरूपनलस्याम वुपूर्णस्य।53।

एक कुंडजलान्तद्वितीयमग्रम त्वाधोमुखम च बहीः युगापन्मुक्त चेत क नलेन कुंडाव्दहिः पतति।।54।।

नेम्याम बब्ध्वा घटिकास्च्क्र जलयांत्रवत तथा धार्यम नलकप्रच्युतसलिलं पतित यथा तदघती मध्ये।।55।।

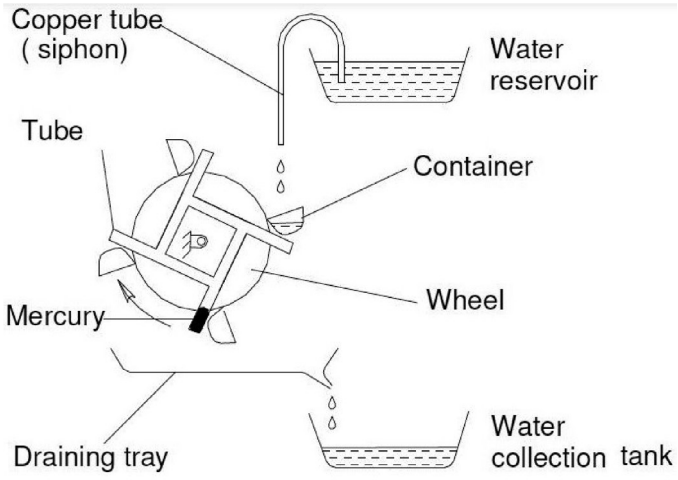
भ्रमति ततस्तत सततं पूर्णघटिभीः समक्रूस्टम चक्रचुतं तदुदकम कुंडे याति प्रणालीकया।56।

Translation

That is, if one takes a copper rod folds it like an elephant driver's hook and dips one end in a vessel of water and leaves the other end face downwards outside, then all the water of the vessel will flow out of the tap. Tie the vessels and place them in a circle. Place the two ends of the axis in such a way that the water that falls from the tap, falls into the vessel. This way, the circle will go on continuously and the water that falls from circle falls into the reservoir through the drain.

We can have a schematic diagram and model of the said water wheel:

प्रकृत्या पार्थिबम श्थिरम शेषेषु सहजा गतिः।
अतः प्रायेण सा जन्म ख्श्यताबेब प्रयत्नतः।



Schematic Diagram

Model

Samarāngan Sutradhar written by King *Bhoja* (समरांगण सूत्रधार ग्रंथ (राजा भोज द्वारा 1150 ई. में सम्पादित) had given description of machine.

This *sloka* gives us fundamental knowledge about Machines:

Translation

The earth is naturally stationary. All machines, with respect to this static earth, are forms of motion produced in matter by artificial means. The main means and works of the machines have been described in the book *Yantrarnav* (यंत्रार्णव ग्रंथ)।

Bharadwāj rishi has given a detail description of a general machine.

दंडैश्चक्रेच दन्तेश्च सरणीभ्रमणादिभी:
श्क्तेरुत्पाम्दंम कि वा चालानम यन्त्रमुक्ष्यते।।

यंत्र (Machine) is a contrivance consisting of,

(1) दंड-Lever, (2) चक्र-Pulley, (3) दंत-toothed wheel, (4) सरणि-inclined plane, (5) भ्रमण–Screw

All these are required for producing शक्ति **(Power or motion)** of changing its direction.

Each Machine has three parts

(1) बीज-the producer of action

(2) कीलक-the pin bringing power and work

(3) शक्ति-the ability of doing the work. Thus, a machine moves because of its three parts, five means and the activities that they do. These together create a variety of movements.

N.G. Dongre, S. G. Nene in their book, 'Physics in Ancient India' (Pg 90) writes, "According to *Vaisheshika*, teja possesses a bright luminance. It is atomic by nature. The energy imparts heat sensation, so the bodies in conjunction with energy quanta attain high temperature. The conjunction of energy quantum brings the change in motion and chemical reactions are due to conjunction of energy quanta, and vice versa."

So, we can say force, motion, work, energy and power all these concepts were not unknown to our rishi (sage).

3. Let's discuss whether important concepts in properties of matter were known to our rishi or not

Elasticity is one of the important properties of bodies having densely populated elemental parts. *Udayan* in his classic text '*Nyaya Kārikāvali*' writes

स्थितिस्थापकसंस्कार:
क्षीत: कवाचीच्चतूश्वपि।
अतिन्द्रियोसौ विज्नेय:
क्वचित स्पन्देपी कारणं।।59।।

He describes the elasticity (***स्थितिस्थापक***) property as a result of vibrational (स्पन्दन) motion. N.G. Dongre, S. G. Nene in their book, 'Physics in Ancient India' (Pg 75) writes, "If pressure is applied on a body, a resisting pressure known as stress is developed by the material. When the external deforming force ceases, this stress brings the body to its original position or shape. The stress is due to cohesive action between the molecules. The property by virtue of which this stress gets developed is known as elasticity. The definition expressed by *Vaiśeṣika* is not different from what is stated in Physics." The popular definition of Elasticity by Wagstaff is also very similar, "Elasticity is a general name given to that property of a body in virtue of which it resists, and recovers from change of shape or volume. All substance resist changes in volume, and so have what is termed bulk elasticity, but it is only solids that have elasticity of shape; no fluid, liquid or gas can offer a permanent resistance to change of shape."

In second chapter, first *Āhnika* of *Vaiśeṣika* the properties of solid, liquid and gaseous states are explained along with plasma state and space.

रूपसरगंधस्पर्शवती पृथिवी।।1।।

रूपरसस्पर्शवत्य आपोद्रव्याः स्त्रिग्धाः।।2।।

तेजोरूपस्पर्शवत।।3।।

त आकाशे न विद्यते।।4।।

स्पर्शश्च वायो।।5।।

So, we can say *Vaiśeṣika* says about the properties of matter like this-

The five infra-atoms (*Tanmatras*) correspond to five senses: Word (शब्द),Touch (स्पर्श), Form (रूप), Taste (रस), and Smell (गंध). These share characteristics of both Mind and Matter, and establish the link between continuum and discrete (similar to the quantum

field-particle duality!) aspects of the universe. Indivisible atoms of *Vaiśeṣika* School are products out of five *Tanmatras* as given below:

From Word emerges Space/Ether;

From Word and Touch emerges Air (Gaseous matters);

From Word, Touch and Form emerges Plasma/Fire;

From Word, Touch, Form and Taste emerges Water (Liquid);

From Word, Touch, Form, Taste and Smell emerges Earth (Solid objects).

Vaiśeṣika considers liquid as colourless, cold, cohesive and perfect fluidity writes N.G. Dongre, S. G. Nene in their book, 'Physics in Ancient India' (Pg 57). He further explains that due to adhesive force (स्नेह), liquids can be used to form pastes. Dravatwa shows that molecules have cohesive forces; it also builds surface tension at the free surface of a liquid. Fluidity is not eternal for real liquids. In nature, water normally occurs as liquid and, therefore, *Vaiśeṣika* has described it as representative of liquid state.

Vaiśeṣika considers the temperature of gas neither hot nor cold, since temperature in general, is relative to the surrounding atmosphere-interprets N.G. Dongre, S. G. Nene in pg 57. The conjuction or disjunction of heat with the gas may show rise or fall in temperature of the gas. *Vaiśeṣika* also explains how different gases can be mixed together. The gaseous molecules of different gases due to conjuction of heat, may braek into atoms and reconstitute new molecules of different properties. So, *Vaiśeṣika* don't treat gas as a physical entity rather a state of matter. Gases, being matter, may exert large mechanical forces on obstructing bodies, e.g. due to pressure or wind velocity the motion of an arrow is resisted in air. *Vaiśeṣika* described the matter qualitatively.

4. Concept of Heat and Temperature

Baroda State Library preserved an ancient text by *Maharshi Bharadwāj*, known as '*Vaimānik Prakaran*' of '*Yantra Sarvaswa*'.

There a temperature scale, '*Link*' was used. We know, to define a temperature scale one need two (lower and higher) standard temperatures and the number of divisions to be made between these two standard temperatures. In centigrade and *Link* system, the number of divisions are 100 and 50 respectively, writes N.G. Dongre, S. G. Nene in their book, 'Physics in Ancient India' (Pg 98). *Link* has 50 divisions between freezing point of water and melting point of gold. He also writes *Prālink (PL)* is 0.885 °C and compared it with *Link (L).* His Comparison of Temperature Scales (Pg 99) :

$$\frac{C}{100} = \frac{PL}{113}$$

	Centigrade (1/100) system	*Link (1/50) system*
Melting point of gold	1062 0C	1200 0PL/500PL
Boiling point of water	100 0C	1130PL
Melting point of ice	00C	00PL/00L
Absolute zero	-273 0C	-3080PL

5. Concept of Gravitation, gravitational motion and Geocentric and Heliocentric concept

Since time immemorial, the study of Geography is popularly known as '*Bhugole*' (भूगोल). *Bhu(*भू*)* is synonymous with Earth and '*Gole*' (गोल) means spherical. The academia, influential in our education system has been spreading a false propaganda that Indians believe that Earth is like a plate. 14th Century

Astronomer *Nilakanta* has written

भूगोल 'खेषुदिग' व्यासो

भमध्ये ब्योमंद्यर्ध्यः स्तितः।।14क।। (SD, क)

So, he says that Terrestrial sphere is 1050 *yojans* in diameter and it stands in the sky in the centre of celestial sphere, as lowest point.

Varāh (505 AD-587 AD) in *Paulasikā Siddhānta (P.S.)* writes

पंचमहाभुतमयस्तारागणपन्जरे महीगोलः

खेयस्कान्तस्थो लोह इवावस्थितो ब्रूतः।।1।। (*Varāha*, P.S., 13, 1)

According to him Earth is spherical and constituted of the five elements, which stands poised in region of space as if it is an iron ball held in position in a cage of magnets. *Bhaskarāchārya* (11th Century A.D.) *in Siddhāanta Siromani*, *Golāddhyāya Bhubanakosha* writes

चला पृथ्वी स्थिर भाति भुगोलो ब्योमनी तिष्टती।। (*Siddhāanta Siromani*, *Golāddhyāya Bhubanakosha*) The sun is static, the Earth is moving. The sphere of Earth exists in space. This is called heliocentric theory proposed by Copernicus nearly 300 years later (15th -16th Century AD). The shape of North Pole and South Pole was also described by him.

कपिथा फलबतपृथ्वी उत्तर दक्षिणायः सामं।। (*Siddhāanta Siromani*, *Golāddhyāya Bhubanakosha*) Shape of the Earth is spherical with both ends (North and south) flattened.

The rotation of Earth (around its axis) from east to west was also described by the great Astronomer *Āryabhatta* (776 AD -550 AD)

अनुलोम गतिनोस्थः पश्यत्यचलं
बिलोमगम यदवत
अचलानी भानी तदवत सम
पश्चिमगनी लंकायाम।। (*Āryabhattiya, Golapāda*-1)

Lālā also writes

सद्येव नित्यं प्रवहेण वायुना
निरख्यदेशोपरीगो भपंजरः
स्वपश्चिमाशाभीमुखेपी नीयते–
स्युरामराणामपसव्यसब्यगः।।3।। (SiDhVr, 1.8.3)

The celestial sphere, at the Earth's equator, is constantly carried towards the west by the *Pravāha* wind. To the gods (at the North Pole), it appears to move (from the left) to the right and the demons (at the South Pole from the right) to the left. (3).

Just as a person in a boat moving forward sees the stationery objects (on bank) as moving backwards, the stationery stars are seen in Lanka (at the equator) as moving towards the west. In text books, it is written that Sir Isaac Newton (1686) was first put forth the concept of gravitation. The famous equation

$$F_G = -G\frac{m_1 m_2}{r^2}\hat{r}$$

Where G = 6.67 X 10^{-11} N.m^2/kg^2

It has unified celestial and terrestrial phenomenon. Same, Gravitational force is responsible for falling of apple on earth and motion of stars and planets. Gravitational force exerted by Earth on an object at a distance. Acceleration due to gravity is

$$g = G\frac{m}{r^2}$$

Many people might have not know that *Bhaskarāchārya* in *Golāddhyāya Bhubanakosha* writes

मरुचला भुरचला स्वभावतो यतो
बिचित्रावतवस्तु शक्त्यः।।5।।
आकृस्टीशक्तिश्च महितया यत खस्थं
गुरु स्वाभिमुखं स्वशक्त्या।
समेसमन्त्यात क्व पतत्वयीम खे।।6।। (*Siddhāanta Siromani*, *Golāddhyāya Bhubanakosha*)

The verse explains that Earth has its attractive force. Due to its force of attraction, it attracts objects having mass. On Earth, Sun and planetary objects our ancestors had said many important things.

Āryabhatta writes, "Half of the sphere of the earth, the planets, and the asterisms is darkened by their shadow and half being turned towards the sun is lighted according to their size. The sphere of the earth, being quite round, situated in the centre of the space in the middle of the circle of asterisms surrounded by the orbit of the

planets, consists of water, Earth, fire and air. Just as the ball formed by a *Kadamba* flower is surrounded on all sides by blossoms, so it the earth surrounded on all sides by all creatures terrestrial and aquatic."

In *Surya Siddhānta* Chapter 12 verse 43 it is written that

मेरारुभयतो मध्ये ध्रुवतारे नभः स्थिते। निरक्षदेशसंस्थानामुभये क्षितिजाश्रिये।।12. 43।।

"On both sides of the *Meru* (i.e. the north and south poles of the earth) the two polar stars are situated in the heaven at their zenith. These two stars are in the horizon of the cities situated on the equinoctial regions".

In his seminal work, *Varāhamihira* builds on assumptions of *Rigvedic* times and accurately estimates the circumference of the earth as 3200 *yojans*. Earth's circumference: distance around Earth. It is measured around the Equator, it is 40075.017 km. He writes

योजनशतानी भूमेः परिमाणम षोडश द्विगुणतानी

तायपति मेरुमद्ध्यात बिषुबस्थेर्कः ख्हिति चैबम।।18।।

(*Varāha, P. S.*, 13.18-19)

Bhāskar II in *Siddhānta Siromani* had estimated the circumference of Earth (4967 yojan) –

प्रोक्तो योजनसंख्यया कुपरिधिः 'सप्तान्गनन्दाधयम'

तद्व्यासः 'कुभुजन्गसायकभूबः' 'सिद्धांशकेनाधिकाः'।

पृष्ठक्ष्येंत्रफलं तथा 'युगगुणत्रीशच्छरास्टदयो'

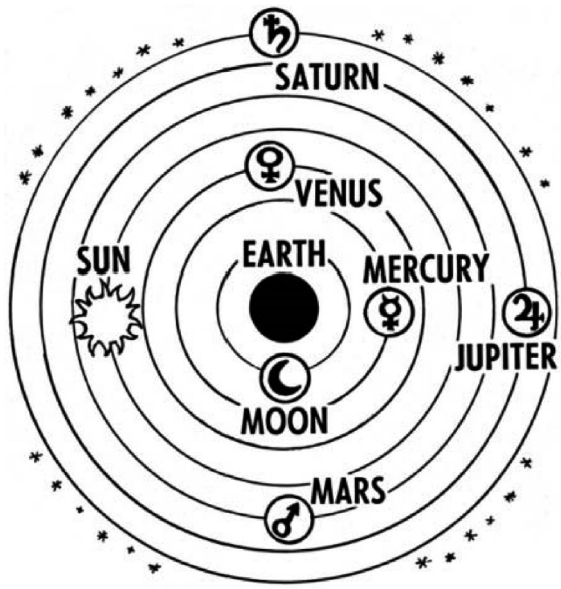
भूमेः कंदुकजालवत कुपरिधिव्यासाहतेः प्रस्फुटम।। (*Bhāskara II, Siddhānta Siromani, 2.2.52*)

In western soil many scientists laid down their life in the controversy whether Heliocentric theory is right or Geocentric theory is right. Let's discuss what these two theories are –

Geocentric model

Sun and the other planets revolved around Earth, which remained stationary. Until 15th Century widely accepted and taken as holy

truth (proposed & preserved mainly in European religious texts). In western thinking, for about 2000 years, the astronomical models proposed by Aristotle and Ptolemy were thought to be accurate representations of the planets and their orbits. Earth was the centre of the universe and the Sun and all the planets revolved around it in circular orbits. Earth was believed to be completely motionless, fixed in one position. The planets were thought to be composed of an unchanging substance ('ether') not found on Earth, and their orbits were thought to be circular, a view that was elevated by the religious groups to the level of religious dogma.

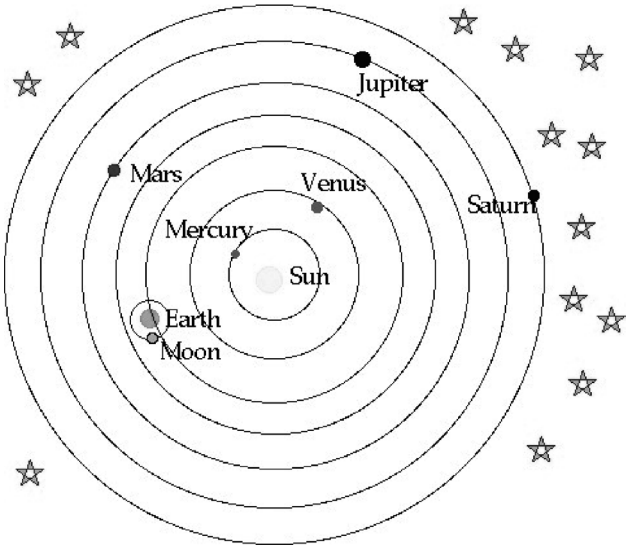


Pictorial representation of Geocentric model

Heliocentric Model

Sun is at the centr re of the Universe and/or Solar System. Heliocentr rism is opposed to geocentrism and currently tto modern geo-heliocentrism, which places the eartth at the centre. In the 16th and 17th centuriess, the theory was revived and defended by Copern

nicus, Galileo, and Kepler, it became the centr re of a major dispute. This theory gives us a far more accurate picture r of solar system and forms s the foundations of our understanding of the univverse. Although it wasn't until much later tha at the heliocentric theory was accepted in Europe, itt had already been accepted in other parts of th he world.



Pictorial representation of Heliocentric model

In India the idea was like this.

1. The earliest traces of a counter-intuitive idea that it is the Earth that is actually moving and the Sun that is at the centre of the solar system (hence the concept of heliocentrism) is found in several Vedic Sanskrit texts written in ancient India.
2. *Yājnavalkya* (c. 9th-8th century BC) recognized that the Earth is spherical and believed that the Sun was "*the centre of the spheres*" as described in the *Vedas* at the time.
3. In *Shatapatha Brāhmana* (8.7.3.10) he states: "The sun

strings these worlds -the earth, the planets, and the atmosphere -to him on a thread."

4. He recognized that Sun was much larger than Earth, which would have influenced early heliocentric concept.
5. He also accurately measured relative distances of Sun and Moon from the Earth as 108 times the diameters of these heavenly bodies, close to the modern measurements of 107.6 for the Sun and 110.6 for the Moon.
6. A solar calendar was described in the *Shatapatha Brāhmana*.
7. The Vedic Sanskrit text *Āitareya Brahmana* (2.7) (9^{th} -8^{th} century BC) also states*: "The Sun never sets nor rises that's right. When people think the sun is setting, it is not so; they are mistaken."*
8. This indicates that the Sun is stationary (hence the Earth is moving around it), which is elaborated in a later commentary *Vishnu Purana* (2.8) (c. 1^{st} century), which states: "The sun is stationed for all time, in the middle of the day. [...] Of the sun, which is always in one and the same place, there is neither setting nor rising."
9. The Indian astronomer -mathematician *Āryabhatta* (476-550 AD), in his magnum opus *Āryabhattiya*, propounded a heliocentric model in which the Earth was taken to be spinning on its axis and the periods of the planets were given with respect to a stationary Sun.
10. He was also the first to discover that the light from the Moon and the planets was reflected from the Sun, and that the planets follow an elliptical orbit around the Sun.
11. He propounded an eccentric elliptical model of the planets, on which he accurately calculated many astronomical constants, such as the times of the solar and lunar eclipses, and the instantaneous motion of the Moon.

12. *Bhāskara* (1114-1185 AD) expanded on *Āryabhatta's* heliocentric model in his astronomical treatise *Siddhanta-Shiromani*, where he mentioned the law of gravity, discovered that the planets don't orbit the Sun at a uniform velocity, and accurately calculated many astronomical constants based on this model, such as the solar and lunar eclipses, and the velocities and instantaneous motions of the planets.
13. Arabic translations of *Āryabhatiya* were available from 8th Century, while Latin translations were available from the 13th Century, before Copernicus had written *De revolutionibus orbium coelestium*,
14. So it's quite likely that *Āryabhat's* work had an influence on Copernicus' ideas.
15. In 14th Century, *Nilakantha* wrote a book called *Tantrasangraha,* by revising *Āryabhatt's* theories.
16. He proposed a partial heliocentric model of the solar system in which all the planets except Earth revolved around the Sun, but the Sun in turn revolved around Earth.
17. Nicolaus Copernicus in 16th century made advances on the heliocentric planetary model: Sun as the centre of the solar system [Earth revolved around the Sun, not the other way round, as proposed by geocentric system].
18. Although Copernican model also believed the orbits of the planets to be circular, they are actually elliptical.
19. As the earth is also just one of the planets, the idea of the other planets being made of something else ('ether') was rejected.
20. Over the time, however, the Catholic Church began to become more adamant about protecting the geocentric view and became the primary opposition to the Heliocentric view.

21. For advancing heliocentric theory Galileo was put under house arrest for the last several years of his life.
22. Tycho Brahe, another proficient astronomer, refuted Copernicus's heliocentric theory and proposed an alternative one, much like *Nilakantha's* partial heliocentric model.
23. Johannes Kepler soon published his findings in *Epitome of Copernican Astronomy*, which grew in influence in the decades that followed.
24. Isaac Newton, through his ideas of universal gravitation, explained Kepler's laws and provided solid bedrock for the heliocentric theory.
25. Thus, the popular belief that in the West, that before Copernicus, the doctrine of heliocentrism was unheard of, or incomprehensible, is simply false.
26. For most scholars in this period, heliocentrism had one extremely major and obvious problem: if the Earth were spinning and moving around the Sun, people and objects would tend to fall off or spin out into space; an object dropped from a tower would fall behind the tower as the latter rotated with the Earth and would land to the West; and so on.
27. Indian texts were greatly used by Arabic and Muslim Scholars *like Al-Biruni, Tusi, al-Urdi*, and *Ibn al-Shatir*.
28. These texts increasingly translated into Latin after the 11th century (as a result of the increasing contact of Western countries with the Muslim world through Islamic Spain and the Crusades).
29. Explorers and traders were also increasingly venturing out beyond Europe, thus introduced the West to the great Indian heliocentric traditions.

30. Quite clearly, in developing their theories of planetary motion, Copernicus, Galileo, Kepler, Newton and others were indebted to the earlier work of great Indian astronomers Aryabhata and others for their original work on heliocentrism/geocentrism towards resolving significant problems in the Ptolemaic system.
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MODERN SCIENCE (Heliocentric view is not the absolute and only truth)

1. Sun is not the centre of the universe, but one of innumerable stars was strongly advocated by Giordano Bruno; Galileo made the same point, but said very little on the matter, perhaps not wishing to incur the church's wrath.
2. Sun is not at geometric centre of any planet's orbit, but rather at one focus of the elliptical orbit.
3. Furthermore, to the extent that a planet's mass cannot be neglected in comparison to the Sun's mass, the centre of gravity of the solar system is displaced slightly away from the centre of the Sun.

4. Giving up the whole concept of being "at rest" is related to the principle of relativity.
5. Assuming an unbounded universe, there is no privileged position in space (special theory of relativity).
6. The Sun is also not in the geometrical 'centre' of the solar system as it was thought in the theories, nor does it stay still, since it constantly revolves around the centre of the Milky Way.
7. In modern calculations, the origin and orientation of a coordinate system often have to be selected.
8. Relation of the two pictures (*geocentricity and heliocentricity)* is reduced to a mere coordinate transformation and it is the main tenet of the Einstein theory that any two ways of looking at the world which are related to each other by a coordinate transformation are entirely equivalent from a physical point of view.
9. The geocentric and heliocentric theories are now seen as reference frames for our solar system.

NCERT Class 11 (Chapter 8: Gravitation)

Complicated schemes of motion were put forward by Ptolemy in order to describe the observed motion of the planets.

Similar theories were also advanced by Indian astronomers some 400 years later.

1. Seminal contribution of Indian Scientists in advancing the theories related to shape of the earth, geocentric and heliocentric models is not highlighted
2. While there is no doubt that the students need to learn the modern (e.g., of Kelper, Newton, Einstein etc.) and advance concepts on related topics, however, it is highly imperative that

we tell the students about the original contributions made by great Indian scientists and how their all important (observation based/mathematically derived) concepts have greatly helped in developing the modern concepts.

3. Systematic evolution of concepts rather than picking them unsystematically: enhancing quality of physics education without compromising with the standards
4. A short chapter covering brief introduction of interdisciplinary/ emerging areas of state-of-the-art research in Physics (obviously of societal and national interest)
5. This will not only help in improvising and providing value addition to existing knowledge base in the cutting-edge research areas of Physics but will also help in developing new concepts leading to innovation and development of novel physics based technology Taking the relative motion concept, both geocentric and heliocentric models can be explained and will coexist. The Samanta Chandrasekhar's Geo-heliocentric model, where all the planets are moving around Sun in elliptical orbits, except taking into consideration earth and moon, need to be placed in text books. It gives mathematical benefits of Copernican system with the philosophical and physical benefits of Ptolemaic system. This is very similar to that put forth by the great, Tycho Brahe.
6. **Electricity and magnetism; Semiconductor devices; Communication system**

   Maharshi Agastya in *Agastya Samhitā* described the method to produce electricity.

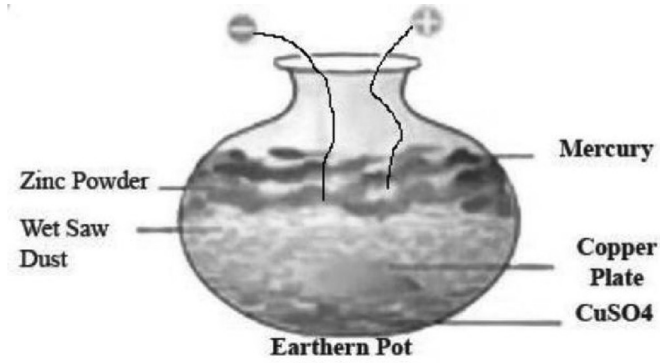
   "Take an earthen ware; put the copper sheet in it. Cover it first with copper sulphate and then by moist sawdust. After that, put a mercury-amalgamated zinc sheet on top of the sawdust to avoid polarization. The contact will produce an energy known

by the twin name of *Mitra-Varuna Shakti* (Electricity). Water will be dividing by this current *into Prānavayu* and *Udānavāyu*.

सम्श्ताप्य मृणमये पात्रे ताम्रपत्रं सुसंस्कृतं
छादयेच्छिखिग्रीवेन चाद्राभी: काष्ठपान्सुभी:
दस्तालोष्ट निधातव्य: पारदाच्छादितस्यत:
संयोगाज्जायते तेजो मित्रावरुण संगीतं (*Agastya Samhitā:* Suresh Soni, The Glorious Scientific Tradition of India, Chapter 4)

Agastya Samhitā also gives details of using electricity for Electroplating. He figured out the method of polishing copper or gold or silver by the battery, Due to such brilliant invention, *Rishi Agastya* is also called *Kumbodbhav* (Battery Born).

India is the third largest producer of electricity in the world. The national electric grid in India has an installed capacity of 399.467 GW as of 31 March 2022.



Here six types of methods were elaborated which can produce electricity

- **Tadit**—the one produced by friction from silk,
- **Saudamini**—that produced by friction from gems / glass,
- **Vidyut**—produced from friction among clouds,

- **Shatakoti alias Shatakumbhi**—that produced from a battery of hundreds of cells,
- **Hradini**—that obtained from storage cells,
- **Ashani**—the one emanating from motion of magnetic rod.

Magnetic materials were not unknown to our ancestors. *Rasārnav Patala* written in 12th century B.C. described five types of magnetic materials.

भ्रामकम चुम्बकम चैव कर्शकम द्रावकम तथा
एबम चतुर्विधम कान्तं रोमकान्तम च पंचमम
एक द्वित्री चतुह पंचसर्वतो मुखमेब तत
पीतं कृष्णं तथा रक्तं
त्रिबर्नम स्यात् पृथक पृथक।।

(*Rasārnav Patala*, Chapter 40, verse 21,)

The five types of magnets described here are*: bhrāmak, chumbak, karsak, drābak.*

To measure magnetic prope erties Indian scientists Sir Shanti Swaroop Bhatnaga r and K.N. Mathur had designed 'Bhatnagar-Mathur Maagnetic Interference Balance' in the year 1928.

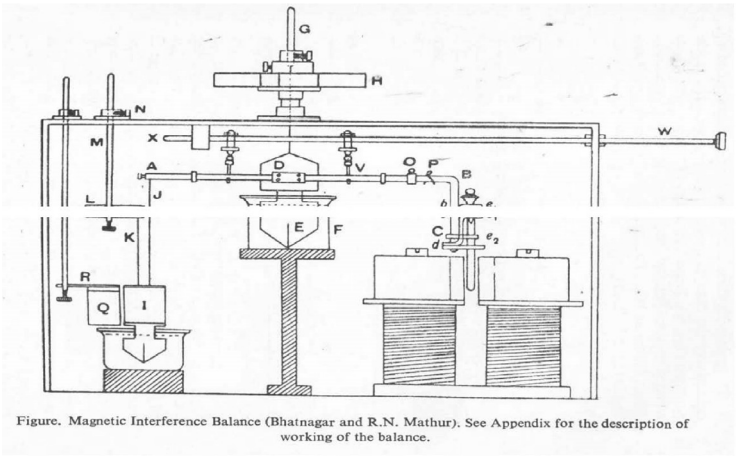


Figure. Magnetic Interference Balance (Bhatnagar and R.N. Mathur). See Appendix for the description of working of the balance.

Picture courtesy: puchd.ac.in

A very small weight of thhe substance, of the order 0.01 gm. and a chang ge in diamagnetic susceptibility of the order of 0.2 per r cent or even less can easily be detected by this instr rument.

Āchārya Jagdish Chandr ra Bose carried out experiments on refraction, diffraction, and polarization independently. He ev ven fabricated a device for producing electromaagnetic waves. In November 1895, Bose presented a a public demonstration at Town Hall in Calcutta, where he sent an electromagnetic wave (radio wave)) across 75 feet, passing through walls to remotely ring a bell and to explode some gunpowder. (India Tooday, November 30, 2016) Bose developed the use of Galena crystals for making receivers, both for sho ort wavelength radio waves and for white and ult traviolet light. His pioneering work in the field was reccognized by his peers. Sir Neville Mott, (won Nobe el Prize in 1977 for his contributions to solid state electrronics), used to say that, J.C. Bose was at least sixty y years ahead of his time. On 12 December 1901, Marco oni demonstrated long distance radio wave transmiss sion. (Frontline, 21 March 1998) The Institute of EElectrical and Electronics Engineers (IEEE), a New York-based international body, called J. C. Bo ose the 'Father of Radio Science'. (Revathi Krishn nan, The Print, 30 November 2020) But, nobody even knows the contribution of Bose in long distance wireless communication!

Bantval Jayant Baliga, an Indian electrical engineering has done seminal work in the field of semiconductor devices. His work related with invention of the insulated gate bipolar transistor (IGBT) is noteworthy. Pabitra K. Nayak at Tata Institute of Fundamental Research-Hyderabad, lead the research group for the development of efficient next-generation low-cost semiconductor materials.

7. The building blocks of matter (Atoms, neuclei and sub atomic particles)

Greek Philosophers Leucippus (5th Century B.C.) and Democritus (46 B.C. – 370 B. C.) were credited for giving atomic theory in our

text books. They opined that everything is composed of "atoms," which are physically, but not geometrically, indivisible; that between atoms, there lies empty space; that atoms are indestructible, and have always been and always will be in motion; that there is an infinite number of atoms and of kinds of atoms, which differ in shape and size. Of the mass of atoms, Democritus said, "The more any indivisible exceeds, the heavier it is." Now, we know that experiments by several investigators have proved that atoms and nuclei can be disintegrated in suitable environment. They also gave some ideas about atomic world which are proved to be obscure by modern scientists. Democritus, along with Leucippus and Epicurus, proposed that the solidness of the material corresponded to the shape of the atoms involved. Iron atoms are solid and strong with hooks that lock them into a solid; water atoms are smooth and slippery; salt atoms, because of their taste, are sharp and pointed; and air atoms are light and whirling, pervading all other materials. They explained the connection by material links in which single atoms were supplied with attachments: some with hooks and eyes, others with balls and sockets. The Democritean atom interacts with other atoms mechanically. But, we know atoms interact quantum-mechanically via electric and magnetic force fields.

Maharshi Kanāda (6th Century BC) in *Vaiśeṣika Sutra* writes about an entity, *Anu* and he further writes about *Paramanu* **(Atom).** *Param* means ultimate and *Anu* means constituent. He further writes about sub atomic particles like electron and its anti particle positron, proton and its anti particle anti proton, neutron and its anti particle anti neutron.

अतो विपरीतमणु II10 II(*Vaiśeṣika Sutra,* Chapter 7*, First Āhnikam,* Verse 10)

Viparita means Anti-and *Anu* means particle. P. A. M. Dirac first put forth the theory only in the 1930 (Theory of Electrons and Protons) and scientists in modern time had seen the possibility of

getting an anti particle. However, the "negative-energy electrons" of Dirac turned out to be positrons, and not protons, what he used to believe. Before this verse *Kanāda* writes

कारण बहुत्वाच्च II9 II(*Vaiśeṣika Sutra,* Chapter 7*, First Āhnikam,* Verse 9) There are many reasons of the formation of anti particle. He further writes

संयोगिनो दंडात समवयिनो विशेषाच्च II19II (*Vaiśeṣika Sutra,* Chapter 7*, Second Āhnikam,* Verse 19)

Atomic and subatomic particles can join together and also can disintegrate in nuclear reaction. It is worth noting that atomic and sub atomic particles join with each other in a process 'recombination'. Indian scientist Meghnad Saha had formulated the famous 'Saha equation', which is used by scientists to determine the temperature at which recombination occurs.

So far as combination of atoms to form molecule is concern, *Kanāda* writes (Ramesh C. Verma, Evolution of Universe and Concepts of Matter: Some Ancient Indian Views, Vedic Path (Gurukul Kangri Vishwavidyala), LVII, (2000))

Due to their motion, two atoms may combine to form **diatom** (*Davyunaka*). It is also invisible.

- Three diatoms form an object (*Trasrenu*), which is visible.
- Its size is compared with motes floating in the Sun-beam.
- Numerically speaking, its size is 349525 *th* part of an inch, ~ 70 nano cm.
- More than three diatoms can also combine.
- All atoms are in a state of constant activity whirling, circling, or vibrating (*Parispanda*).

Chemical changes caused by heat.

Prasastapāda proposed that the *tejas* (heat) factor affected molecular groupings (*vyuhas*), thus causing chemical changes. Chain of production of grosser objects thus continues. Formation

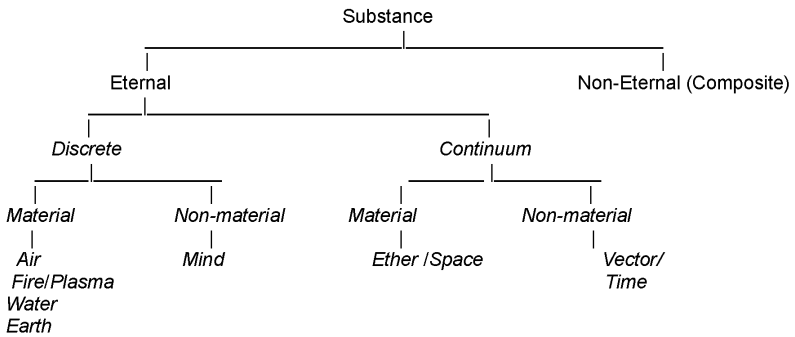
of objects and changes in them takes place through physical as well as chemical actions.

Kanāda further writes

पृथ्वीब्यापस्तेजो वायुरकाशम कालो दिगात्मा मन इति द्रव्याणि

The living and nonliving beings, consists of *Pruthvi* (solid), *āp* (liquid), *vayu* (air), *tejas* (plasma/energy), *ākash* (space), *kāla* (time), *dik* (vectors/directional parameter), *mana* (mind), *ātmā* (soul). Except soul, the role of all other physical and metaphysical entities, in the formation of matter and life is understood only in recent times. Modern science is still in the search of *ātmā*. So, Mahanana Pt. Madan Mohan Malviya aptly remarketed that ancient Indian science is modern in its approach and ultra modern in its future.

The substance we had discussed can be shown as–



8. Waves and oscillations; Ray and wave optics; Light as an electromagnetic wave

Our ancestors knew about both longitudinal and transverse waves. The musical instruments used by our households and the exact calculation of velocity of sound are the beautiful example of our perception.

Sāyanāchāya (13th century A.D.) writes

योजनानाम सहस्त्रे द्वेद्वेशते द्वे च योजने।

एकेन निमिषार्धेन क्रममाण नमोस्तुति।।

The translation is like this: O Light ! I bow before you, who travels 2202 *yojan* in one *nimish*. By converting *yojan* into kilometer and *nimish* into second, the velocity of light was found to be 3.02 Lakh kilometers. (Suresh Soni, The Glorious Scientific Tradition of India, Chapter 12, Trans. Odia, Pg 107).

9. Sound and Musical Instruments

Māndukya Upanishad (5th Century B.C.) says "*Chanting (Māntrik Sound) creates vibration in mind and body".* In the *Nātya Sāstra*, compiled by *Bharat Muni* (200 B.C.), musical instruments have been divided into four main categories on the basis of how sound is being produced.

ततं चैवावनध्यं च धनं सुषिरमेब च
चतुर्विधं तू बिज्नेयमातोद्यम लक्ष्यणान्वीतम्।।

Pānini said that sound is of four types:

(1) *Parā*-that is transcendental

(2) *Pasyanti*-that is pictorial

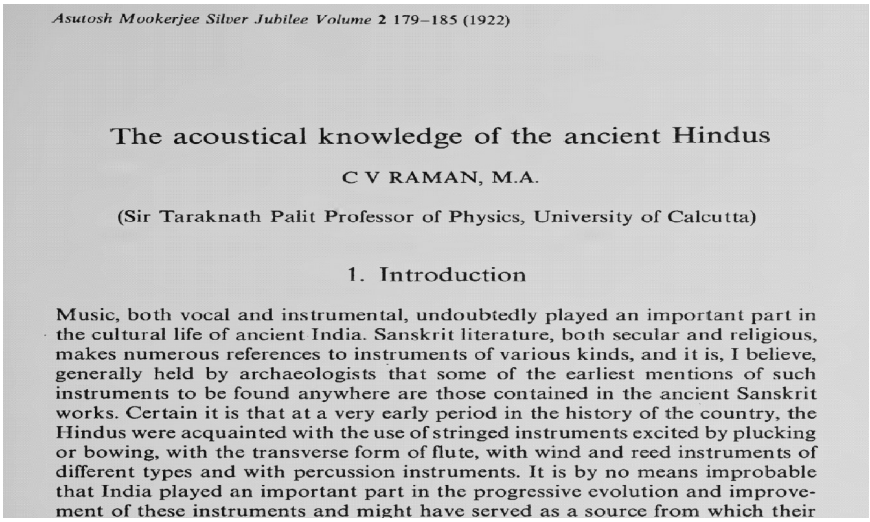
(3) *Madhyamā* – that is intermediary

(4) *Vaikhari* – that is articulate speech

We have a believe that there was a *rishi* '*Swāti*', who had designed various musical instruments like *Mridangam, Tabla* etc. by observing the sound created by rain water, when it falls upon leaves of different size and shape. (Suresh Soni, The Glorious Scientific Tradition of India, Trans. Odia, Pg 27).

Nobel laureate Bharat Ratna C.V. Raman (1888-1970) was an acoustician par excellence. His work on the violin is considered a classic. His famous landmark paper, 'On The Mechanical Theory of Vibration of Bowed Strings' was perhaps the most important contribution to the theory of the violin since Helmholtz. He also worked on the *Mridangam* and *Tabla* which produce harmonic vibrations, and *Tānpura* and *Veena* which appear to violate the

Young-Helmholtz law in producing their range of harmonic vibrations. His work on piano, flute, drums, ektara, violin and stretched strings are worth reading. He had published around 100 research publications in Nature and other reputed Journals, which had revolutionalized the entire discourse on sound and musical instruments. In his studies on the wave motion of strings with discontinuous velocity distribution, Raman invented an amazingly simple way of producing an initial velocity distribution that varies linearly with distance from one end and suddenly drops to zero at the other end. He arranged the string to carry a weight at one end and made it execute a pendular swing about the other. The string was suddenly brought to rest at the desired point by a suitably placed knife edge in its path. Using carbon arc lights, mirrors, tuning forks and photographic plates, he obtained curves that rival the oscillographic pictures of today. His praise for ancient Indian scholars is worth mentioning-



Asutosh Mookerjee Silver Jubilee Volume 2 179–185 (1922)

The acoustical knowledge of the ancient Hindus

C V RAMAN, M.A.

(Sir Taraknath Palit Professor of Physics, University of Calcutta)

1. Introduction

Music, both vocal and instrumental, undoubtedly played an important part in the cultural life of ancient India. Sanskrit literature, both secular and religious, makes numerous references to instruments of various kinds, and it is, I believe, generally held by archaeologists that some of the earliest mentions of such instruments to be found anywhere are those contained in the ancient Sanskrit works. Certain it is that at a very early period in the history of the country, the Hindus were acquainted with the use of stringed instruments excited by plucking or bowing, with the transverse form of flute, with wind and reed instruments of different types and with percussion instruments. It is by no means improbable that India played an important part in the progressive evolution and improvement of these instruments and might have served as a source from which their

We suggest a new chapter on, "Sound and Musical Instruments" in 11th class text book.

10. Astronomy and Astrophysics

Āryabhatta, Varāhamihir, Brahmagupta, Bhāskar, Satānanda, Sāmanta Chandrasekhar and many more are internationally acclaimed researchers. Their major works are in the field of astrophysics and astronomy. In India, astronomy is twofold; mathematical astronomy (*Ganita Joytish*) and predictive astronomy (*Phalita Jyotish*). In modern times Meghnad Saha's (18931956) seminal works, to name a few, 'Thermal ionization', "Elements in the Sun", "On the problems of temperature radiation of gases', 'On a physical theory of stellar spectra' led the foundation of modern astrophysics. Nobel laureate Subramanyan Chandrasekhar (1888-1970) and his famous, 'Chandrasekhar Limit' predicts a finite mass limit for a relativistic degenerate body like white dwarfs. His theoretical contributions in modern astrophysics are worth reading.

Let's discuss the astronomical calculation of Indian scholars and its accuracy.

Table 1: Sidereal periods of the planets in mean solar days

Planet/Star/ Satellite	*Surya Siddhānta*	*Siddhānta Siromani*	*Siddhānta Darpan*	*Modern values*
Sun	365.25875	365.25843	365.25875	365.25636
Moon	27.32167	27.32114	27.32167	27.3216615
Mars	686.9975	686.9979	686.9857	686.97982
Mercury	87.9585	87.9699	87.9701	87.969256
Jupiter	4332.3206	4332.2408	4332.6278	4332.589
Venus	224.6985	224.9679	224.7023	224.70080
Saturn	10765.7730	10765.8152	10759.7605	10759.23

Table 2: Inclination of the obits of planets to the ecliptic (The quantities are in degree, minute and second)

Planet /Satellite	*Surya Siddhānta*	*Siddhānta Siromani*	*Siddhānta Darpan*	*Modern values*
Moon	4 30 0	4 30 0	5 09 0	5 08 33

Mars	1 30 0	1 50 0	1 51 0	1 50 59
Mercury	5 55 0	6 55 0	7 20 0	7 00 18
Jupiter	1 00 0	1 16 0	1 18 41	1 18 18
Venus	2 46 0	3 60 0	3 23 0	3 23 41
Saturn	2 00 0	2 40 0	2 29 0	2 29 10

Table 3: Radii of orbit of planets

Planet	*Surya Siddhānta*		*Siddhānta Darpan*		*Modern values as in 1840*
	Even quadrant	*Odd quadrant*	*Even quadrant*	*Odd quadrant*	
Sun	1.00	1.00	1.00	1.00	1.00
Mercury	0.3694	0.3667	0.386	0.388	0.3817
Venus	0.7278	0.7222	0.725	0.727	0.7233
Mars	1.5319	1.5513	1.5126	1.5184	1.5237
Jupiter	5.1429	5.0000	5.1428	5.2173	5.2028
Saturn	9.2308	9.000	9.230	9.9.4773	9.5389

Table 4: Greatest equations of sun and moon (The quantities are in degree, minute and second)

Celestial body	*Surya Siddhānta*	*Siddhānta Siromani*	*Modern values as in 1899*
Sun	2 10 30	1 55 33	1 55 19
Moon	5 2 46	5 1 10	6 3 41

Contribution of our ancient scholars along with the seminal works of researchers of modern time like D. S. Kothari, P. C. Vaidya, J. V. Narlikar, A. K. Raychaudhuri, T. Padmnabhan, V. K. Kapahi, S. M. Chitre, H.M. Antia etc. need to be placed in a separate chapter in 12th class text book.

In this backdrop, Vidya Bharati Uchcha Shiksha Sansthan (VBUSS) which is a voluntary organization working in the field of education with a focus on policy implementation and structural reforms in India's Higher Education landscape, Sardar Patel University, Mandi as Venue Partner and Vijnan Bharti as Knowledge Partner and Him Science Congress Association

and Central University Himachal Pradesh as collaborators have jointly organizing two days preparatory workshop titled "Content Development of Physics Curriculum in Indian Perspectives in the light of NEP-2020(CPINEP)" at Sardar Patel University, Mandi, New Delhi, on 29-30 June, 2022. This approach paper contains the recommendations evolved in this national workshop after detail discussions and deliberations.

Concluding Remarks

NEP-2020 aims at student centric text books and teaching. The curriculum need to be designed in such a manner that Indian students can compete with the students of developed countries in research and innovation. Every student must be employable and self pride will be inculcated in the minds of the student. Creativity and stress free environment will be ensured in class room.

NEP-2020 is aimed at complete restructuring of text books and pedagogy to ensure stress free and creative learning. It desires that students should be prepared for world class research and innovation. This can be achieved only if curriculum will develop a feeling of self esteem and respect for their own culture among the students. Incorporating Indian knowledge system in curriculum will help a lot to achieve this objective. Synchronizing science, sociology and psychology will create such a curriculum which will fulfill the actual aim of the framers of NEP-2020.

Chapter–7

THEMATIC HIGHLIGHTS

The suggested contents and the logic for suggestion are explained in detail Chapter 5. However, these can be summarized chapter wise in existing text books of Physics. NCERT 11th standard Text book:

Chapter 1: (Introduction to Physics and Physical World) Need to be rewritten to inculcate spiritual spirit among the reader with materialistic methods of study. The approach is described earlier in this report.

Chapter 2: (Units and Measurements) To include Indian systems of Units and measurements as described in Chapter 5 along with the present SI System.

e.g. units of time:

Sl No.	*Samanta's Unit for measuring time*	*Modern units equivalent to that unit*
1	1 *truti*	4.938E-6 s
2	1 *laba*	4.938E-4 s
3	1 *nimisa*	1.48 E-2 s
4	1 *kāsthā*	0.266 s
5	1 *guru varna*	0.4 s
6	1 *prāna*	4 s
7	1 *kalā*	8 s
8	1 *bighati/pala*	24 s
9	1 *khyaṇa*	240 s or 4 min
10	1 *danda/ghati*	1440 s or 24 min
11	1 *muhurta*	2880 s or 48 min
12	1 *day or naxatra dina*	86400 s

13	1 *divya/asura dina*	360 years
14	1 *mahā yuga/chatur yuga*	4.32E6 years
15	1 *manwantar*	3.0672E8 years
17	1 day of *Brahmā*	8.64 E9 years
18	The life span of this *Brahmā*	3.11 E 14 years

Units of temperature:
Link and *Prālink*

$$\frac{C}{100} = \frac{PL}{113}$$

	Centigrade (1/100) system	*Link (1/50) system*
Melting point of gold	1062 ^{0}C	1200 ^{0}PL/50^{0}PL
Boiling point of water	100 ^{0}C	113^{0}PL
Melting point of ice	0^{0}C	0^{0}PL/0^{0}L
Absolute zero	-273 ^{0}C	-308^{0}PL

And measuring units for distance and other parameters, Chapter 3, 4, 5, 6, 7 : (Mechanics) To include Indian scientists contribution in the field of motion (5 types which are broader than current description) and mechanics and which was discovered earlier than Newton's laws of motion.

Chapter 8 : (Gravitation) To include Indian scientist's contribution to name a few *Nilakantha, Varāh, Bhāskar, Āryabhatta, Lālā*, in discovering and developing the concept of gravitation and gravitational force, which was much earlier than the birth of Newton. Detail description of geo-centric and helio-centric concepts need to be incorporated in new text books. Few data and detail description is given in Chapter 5 of this report.

Chapter 9, 10, 11: (Properties of matter) *Kanād* has given a broad and more accurate description and classification of matter and energy. *Udayan's* description of elasticity is also apt mentioning.

The concept of matter and energy and material classification as formulated by Indian scientists need to replace the current one.

Chapter 12, 13: (Thermodynamics, Kinetic theory)

The concept of heat and units of temperature measurement of *Bharadwāj* need to be included in current text books. Chapter 14, 15: (Waves, oscillations) Contribution of Indian scientists in these two fields needs to be incorporated in these two chapters. NCERT 12th standard Text book: Chapter 1, 2, 3, 4,5,6, 7, 8, 9: (Electricity and Magnetism) To include Indian scientist's contribution in the field of Electricity and Magnetism as suggested in

Chapter 5 of this report. Chapter 10, 11, 12 (Optics and Nature of light) To include the contribution of *Sāyanāchārya* and other scientists in new course content of text books. Chapter 13, 14: (Atomic and nuclear world) The contributions of Indian scientists like *Kanād*, *Prasastapāda* and others in this field need to be

included in the course content of Physics. The concept, terminology and frontier research in this field given by Indian scientists need to be explained citing the present experimental findings and students will in this way will able to understand that how visionary Indian scientists were.

Chapter 15, 16 (Communication systems) Ācharya Jagdish Chandra Bose has discovered and demonstrated the radio wave communication much earlier than Markoni and IEEE has already acknowledged it. We need to acknowledge his contributions in the field of communication and incorporate these in our text books. Similarly other scientists who have contributed in this field as described in Chapter 5 of this report need to be incorporated.

Suggestion of Including two New Chapters

1. Chapter on Astronomy and Astrophysics

Astronomy and astrophysics is as old as our human civilization. It is an emerging field in current scenario. A new chapter on astronomy

need to be included in 11th /12th text books where contribution of Indian scientists from *Āryabhatta* to Padma Vibhushan Subrahmanyan Chandrasekhar need to be incorporated. Chapter 5 of this report contains some data and description.

2. Chapter on Sound and Musical Instrument

Song and music is an integral part of Indian society and culture. It is there in all of our rituals. It is an emerging field in current scenario. A new chapter on astronomy need to be included in 11th /12th text books where contribution of Indian scientists from *Swāti* to Bharat Ratna Chandrasekhara Venkata Raman need to be incorporated. Chapter 5 of this report contains some data and description.

In Chapter 5 of this report a detail description of the concepts and Indian scientist's contributions in developing Physics as a subject was given and the suggested readings and references given after these thematic highlights can be referred for writing Physics text books for 11th and 12th standard.

There are an overall bunch of suggestions for writing new text books in Physics

1. Contribution of Indian Scientists may be incorporated in each chapter. This will create a sense of self respect among students and will give justice to original contributor.
2. Two new chapter (1) Sound and Musical Instrument (2) Astronomy and Astrophysics may be added in the text book. In these two fields the contribution of Indian scholars are immense and important. These two subjects have their presence in each and every household of the country. So, inclusion of these two subjects will motivate student to pursue research and development in these two important fields. Expertise in the science of musical instrument also open space for vocational learning and will create large scale employment.

3. Human brain has two parts: logical/reasoning, pictorial learning. Placing pictures and cartoon related with the subject will accelerate learning process of the student. Earth is round-so a picture of *Varāha* holding earth on its mouth and similar cartoons can be introduced.
4. In introductory part of each chapter a *sloka* (verse) of our scientists, original English quote or equation of modern Indian/ Western scientists, who actually conceived the basic idea and concepts of the chapter, may be given.
5. Footnotes in each chapter may contain conceptual doubt clearing of the student.
6. Historical perspectives may be given at the end of each chapter.
7. Experimental verification of the theory may be given while explaining any theory in a chapter.
8. The chapters should be written in such a way that interdisciplinary learning and vocational education be incorporated in it.

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LIST OF CONFERENCE/WORKSHOP PARTICIPANTS (EXCLUDING INVITED SPEAKERS AND RESOURCE PERSONS)

This is the list of delegates who came from different institutions from all over India to participate in the two-days National Workshop on "**Content Development of Physics Curriculum in Indian Perspectives in the light of NEP-2020 (CPINEP-2022)**' organized by Vidya Bharti Uchcha Shiksha Sansthan on 29th & 30th June, 2022 at Sardar University, Mandi, HP.

S. No.	*Name*	*Designation*	*Institution*
1	Prabhakar Mishra	PGT	Saraswati Bal Mandir, Mahrauli
2	Pankaj Kumar	Principal	BDS Vidya Mandir, Noida
3	Dr. Vikas Thakur	Assistant Professor	Vallabh Govt College, Mandi
4	Sapna Kumari	PGT, Physics	DAV Public School, Rangri, Manali
5	Dr. Anil Kumar Sharma	PGT, Physics	DAV Sen. Sr. Public School, Barmana
6	Krishan Kumar Sharma	PGT	DAV PS Bilaspur, HP
7	Vandna Sharma	PGT, Physics	DAV public school, Sundernagar
8	Bhim Singh	PGT, Physics	DAV public School, Gohar
9	Prince Thakur	PGT, Physics	DAV PS GREYOH
10	Deepak Kumar	PGT, Physics	DAV Public School, Nerchowk

11	Puneet Dutt	PGT, Physics	DAV Public School, Ghumarwin
12	Nirankush Verma	PGT, Physics	DAV PS, Hamirpur
13	Sushil Kumar	PGT, Physics	DAV CPS, Mandi
14	Dr. Rohit Sharma	PGT, Physics	DAV CPS, Mandi
15	Vipin Kumar	Principal	Durgawati Hemraj Tah Saraswati Vidya Mandir
16	Somgir	Principal	LR SVM, Muradnagar , Ghaziabad
17	Manjul Sood	PGT, Physics	DAV PS, Palampur
18	Ritakshi Shukla	TGT	DAV PS, Palampur
19	Arun Kumar Bakshi	PGT, Physics	GSSS BALLAH Tehsil Palampur, Kangra
20	Vikas Gupta	PGT, Physics	BD DAV PS, Dharamshala
21	Jitender Kumar	Assistant Professor	VGC, Mandi
22	Dr. Jitender Paul Sharma	Teaching Faculty	HPTU, Hamirpur
23	Ruchika	PGT, Physics	SVM Kumar Sain
24	Chhavinder Prakash Gautam	PGT, Physics	AMSVM Sr. Sec School Manali
25	Devinder Dutt Sharma	PGT, Physics	SVM Sr. Sec. School, Samoli Rohru, Shimla
26	Pawan Kumar	PGT	SVM Him Rashmi Vikasnagar Shimla
27	Raj Kumari	Assistant Professor	GC Bassa
28	Dr. Neha Sharma	Assistant Professor	SPU Mandi
29	Dr. Monika Sharma	Assistant Professor	SPU Mandi
30	Kanahaya Ram Saini	Assistant Professor	SPU Mandi
31	Deepak	Assistant Professor	SPU Mandi

32	Dr. Tara	Assistant Professor	SPU Mandi
33	Dr. Manjula Sharma	Assistant Professor	SPU Mandi
34	Dr. Shobhna Chaudhary	Assistant Professor	SPU Mandi
35	Dr. Surinder Paul	Assistant Professor	Central University of Himachal Pradesh
36	Phoola	PGT	SVM Vikasnagar
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39	Dr. Gaurav Kapoor	Assistant Professor	SPU Mandi
40	Dr. Jagdeep Verma	Assistant Professor	SPU Mandi
41	Dr. Karan Gupta	Associate Professor	SPU Mandi
42	Dr. Chetan Chauhan	Assistant Professor	SPU Mandi
43	Dr. Lakhveer Singh	Associate Professor	SPU Mandi
44	Dr. Narinder Singh	Assistant Professor	SPU Mandi
45	Dr. Akshay Kumar	Associate Professor	SPU Mandi
46	Dr. Samriti	Assistant Professor	SPU Mandi
47	Dr. Radhika Jamwal	Assistant Professor	SPU Mandi
48	Dr. Ashish Kumar	Assistant Professor	SPU Mandi
49	Yachna Sharma	Assistant Professor	GDC Drang

50	Sanjay	Principal	DAV Jogindernagar
51	Dr. Ritesh Verma	Assistant Professor	Shoolini University
52	Dr. Rohit Jasrotia	Assistant Professor	Shoolini University
53	Dr Sarita	TGT	GHS Mandi
54	Rahul Kalia	Research Scholar	Shoolini University
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57	M. L. Sharma	L. A.	Shoolini University
58	Kritagya	L. A.	SPU Mandi
59	Shital Kumar	PGT Physics	LMSVM Bashing, Kullu
60	Dr. Kranti	Assistant Professor	Shoolini University, Solan
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