माध्यमिक शिक्षा मण्डल मध्यप्रदेश, भोपाल माध्यमिक शिक्षा मण्डल मध्यप्रदेश, भोपाल

NCERT अभिग्रहित हाई स्कूल परीक्षा पाठ्यक्रम

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SCIENCE

(CLASSES IX–X)

Rationale

The exercise of revising the syllabus for science and technology has been carried out with "Learning without burden" as a guiding light and the position papers of the National Focus Groups as points of reference. The aim is to make the syllabus an enabling document for the creation of textbooks that are interesting and challenging without being loaded with factual information. Overall, science has to be presented as a live and growing body of knowledge rather than a finished product.

Very often, syllabi – especially those in science – tend to be at once overspecified and underspecified. They are overspecified in that they attempt to enumerate items of content knowledge which could easily have been left open, e.g., in listing the families of flowering plants that are to be studied. They are underspecified because the listing of 'topics' by keywords such as 'Reflection' fails to define the intended breadth and depth of coverage. Thus there is a need to change the way in which a syllabus is presented.

The position paper on the teaching of science – supported by a large body of research on science education – recommends a pedagogy that is hands-on and inquiry-based. While this is widely accepted at the idea level, practice in India has tended to be dominated by chalk and talk methods. To make in any progress in the desired direction, some changes have to be made at the level of the syllabus. In a hands-on way of learning science, we start with things that are directly related to the child's experience, and are therefore specific. From this we progress to the general. This means that 'topics' have to be reordered to reflect this. An example is the notion of electric current. If we think in an abstract way, current consists of charges in motion, so we may feel it should be treated at a late stage, only when the child is comfortable with 'charge'. But once we adopt a hands-on approach, we see that children can easily make simple electrical circuits, and study several aspects of 'current', while postponing making the connection with 'charge'.

Some indication of the activities that could go into the development of a 'topic' would make the syllabus a useful document. Importantly, there has to be adequate time for carrying out activities, followed by discussion. The learner also needs time to reflect on the classroom experience. This is possible only if the content load is reduced substantially, say by 20-25%.

Children are naturally curious. Given the freedom, they often interact and experiment with things around them for extended periods. These are valuable learning experiences, which are

essential for imbibing the spirit of scientific inquiry, but may not always conform to adult expectations. It is important that any programme of study give children the needed space, and not tie them down with constraints of a long list of 'topics' waiting to be 'covered'. Denying them this opportunity may amount to killing their spirit of inquiry. To repeat an oft-quoted saying: "It is better to uncover a little than to cover a lot." Our ultimate aim is to help children learn to become autonomous learners.

Themes and Format

There is general agreement that science content up to Class X should not be framed along disciplinary lines, but rather organised around themes that are potentially cross-disciplinary in nature. In the present revision exercise, it was decided that the same set of themes would be used, right from Class VI to Class X. The themes finally chosen are: Food; Materials; The world of the living; How things work; Moving things; People and ideas; Natural phenomena and Natural resources. While these run all through, in the higher classes there is a consolidation of content which leads to some themes being absent, e.g. Food from Class X.

The themes are largely self-explanatory and close to those adopted in the 2000 syllabus for Classes VI-VIII; nevertheless, some comments may be useful. In the primary classes, the 'science' content appears as part of EVS, and the themes are largely based on the children's immediate surroundings and needs: Food, Water, Shelter etc. In order to maintain some continuity between Classes V and VI, these should naturally continue into the seven themes listed above. For example, the Water theme evolves into Natural resources (in which water continues to be a sub theme) as the child's horizon gradually expands. Similarly, Shelter evolves into Habitat, which is subsumed in The world of the living. Such considerations also suggest how the content under specific themes could be structured. Thus clothing, a basic human need, forms the starting point for the study of Materials. It will be noted that this yields a structure which is different from that based on disciplinary considerations, in which materials are viewed purely from the perspective of chemistry, rather than from the viewpoint of the child. Our attempt to put ourselves in the place of the child leads to 'motion', 'transport' and 'communication' being treated together as parts of a single theme: Moving things, people and ideas. More generally, the choice of themes – and sub themes – reflects the thrust towards weakening disciplinary boundaries that is one of the central concerns of NCF-2005.

The format of the syllabus has been evolved to address the underspecification mentioned above. Instead of merely listing 'topics', the syllabus is presented in four columns: Questions, Key concepts, Resources and Activities/Processes.

Perhaps the most unusual feature of the syllabus is that it starts with questions rather than concepts. These are key questions, which are meant to provide points of entry for the child to start the process of thinking. A few are actually children's queries ("How do clouds form?"), but the majority are questions posed by the adult to support and facilitate learning (provide 'scaffolding', in the language of social constructivism). It should be clarified here that these questions are not meant to be used for evaluation or even directly used in textbooks.

Syllabus for Secondary and Higher Secondary Levels

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...with the questions, key concepts are listed. As the name suggests, these are those ... which are of a key nature. Once we accept that concept development is a complex ..., we must necessarily abandon the notion that acquisition of a specific concept will be the outcome of any single classroom transaction, whether it is a lecture or an activity. A number of concepts may get touched upon in the course of transaction. It is not necessary to list all of them.

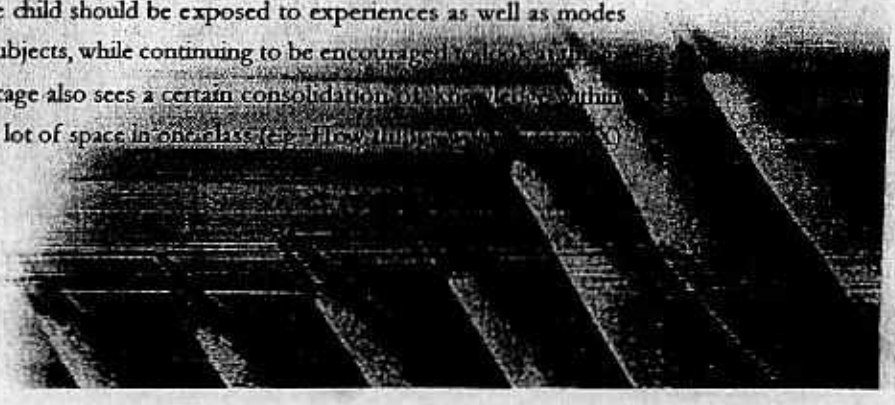
The columns of Resources and Activities/Processes are meant to be of a suggestive nature, for both teachers and textbook writers. The Resources column lists not only concrete materials that may be needed in the classroom, but a variety of other resources, including out-of-class experiences of children as well as other people. Historical accounts and other narratives are also listed, in keeping with the current understanding that narratives can play an important role in teaching science. The Activities column lists experiments, as normally understood in the context of science, as well as other classroom processes in which children may be actively engaged, including discussion. Of course, when we teach science in a hands-on way, activities are not add-ons; they are integral to the development of the subject. Most experiments/activities would have to be carried out by children in groups. Suggestions for field trips and surveys are also listed here. Although the items in this column are suggestive, they are meant to give an idea of the unfolding of the content. Read together with the questions and key concepts, they delineate the breadth and depth of coverage expected.

The Secondary Stage

At the secondary stage, abstraction and quantitative reasoning come to occupy a more central place than in the lower classes. Thus the idea of atoms and molecules being the building blocks of matter makes its appearance, as does Newton's law of gravitation.

One of the traps which we have to avoid is the attempt to be comprehensive. While the temptation exists even in lower classes, at the secondary stage it is particularly strong. This may manifest itself in two ways: adding many more concepts than can be comfortably learnt in the given time frame, and enumeration of things or types of things, even where there is no strong conceptual basis for classification. Thus we may end up with a mass of information that the child has to perforce memorise. An example is the listing of nine types of glass. In the present revision, no attempt is made to be comprehensive. Unnecessary enumeration is avoided. The processes by which factual knowledge can be acquired is more important than the facts themselves.

At this stage, while science is still a common subject, the disciplines of physics, chemistry and biology are beginning to emerge. The child should be exposed to experiences as well as modes of reasoning that are typical of these subjects, while continuing to be encouraged to look at things across disciplinary boundaries. This stage also sees a certain consolidation of ... within themes. As a result, a theme may get a lot of space in one class (e.g. ...) while being absent from the other.



Topics/ Sub-theme	Questions	Key concepts	Resources	Activities/ Processes
1. Food Higher yields	What do we do to get higher yields in our farms?	Plant and animal breeding and selection for quality improvement, use of fertilizers, manures; protection from pests and diseases; organic farming	Visit to any fish/ bee/dairy/pig etc farms; data showing harmful effects of insecticides; process for the preparation of compost, vermi-compost	Collection of weeds found in fields of different crops; collection of diseased crops; discussion and studying composting/vermi-composting (Periods 8)
2. Materials Material in our clothing	What kinds of clothes help us keep cool? Why do wet clothes feel cool?	Cooling by evaporation. Absorption of heat.	Work done in Class VII, glassware, heat source, black paper, thermometers	Experiments to show cooling by evaporation. Experiments to show that the white objects get less hot. (Periods 5)
Different kinds of materials	In what way are materials different from each other? Is there some similarity in materials?	All things occupy space, possess mass. Definition of matter	Everyday substances like wood, salt, paper, ice, steel, water, etc.	To feel the texture, observe the colour and lustre, effect of air, water and heat, etc. on each of the materials (Periods 4)
	In how many ways can you group the different materials you see around? How do solids, liquids and gases	Solid, liquid and gas; characteristics – shape, volume, density; change of state – melting, freezing,	Wax, water, ice, oil, sugar, camphor/ ammonium chloride/ naphthalene balls	Sorting out a medley of materials, in various ways. Observe shape and physical state of different materials.

Syllabus for Secondary and Higher Secondary Levels

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	Questions	Key concepts	Resources	Activities/ Processes
	differ from each other? Can materials exist in all the three states?	evaporation, condensation, sublimation.		Observe effect of heat on each of the resources. (Teacher to perform the experiment for camphor, ammonium chloride and naphthalene.) **(Periods 4)**
What are things made of?	What are things around you made of? What are the various types of chemical substances?	Elements, compounds and mixtures Heterogeneous and homogeneous mixtures. Colloids and suspensions.	Samples of commonly available elements, compounds and mixtures. Samples of solution, suspension and colloid.	Discussion on claims 'Air is a mixture' (Mixture of what? How can these be separated?), 'Water is compound' and 'Oxygen is an element'.
	Do substances combine in a definite manner?	Equivalence – that x grams of A is chemically not equal to x grams of B.	Historical accounts Glassware, chemicals (oxalic acid, sodium hydroxide, magnesium ribbon).	Titration using droppers or syringes, quantitative experiments.
	How do things combine with each other? Are there any patterns which can help us guess how things will combine with each other?	Particle nature, basic units: atoms and molecules Law of constant proportions. Atomic and molecular masses.	Kits for making molecular models Historical account including experiments of Lavoisier and Priestley.	Discussion on the fact that elements combine in a fixed proportion through discussion on chemical formulae of familiar compounds.

Theme/ Sub-theme	Questions	Key concepts	Resources	Activities/ Processes
	How do chemists weigh and count particles of matter	Mole concept Relationship of mole to mass of the particles and numbers. Valency Chemical formulae of common compounds.		Simple numericals to be done by the students. A game for writing formulae. e.g. criss crossing of valencies to be taught through dividing students into pairs. Each student to hold two placards: one with the symbol and the other with the valency. Keeping symbols in place, teacher to move only valencies to form the formula of a compound.
What is there inside an atom?	Can we see an atom or a molecule under a microscope or by some other means? What is there inside an atom?	Atoms are made up of smaller particles: electrons, protons, and neutrons. These smaller particles are present in all the atoms but their numbers vary in different atoms. Isotopes and isobars.	Charts, films etc.	Brief historical account of Rutherford's experiment. (Periods 18)
3. The World of the Living Biological Diversity	How do the various plants around us	Diversity of plants and animals – basic	Specimens of some animals and plants	Discussion on diversity and the

	Questions	Key concepts	Resources	Activities/ Processes
	differ from each other? How are they similar? What about animals? How are they similar to and different from each other?	issues in scientific naming, Basis of classification, Hierarchy of categories/groups, Major groups of plants (salient features) (Bacteria, Thallophyta, Bryophyta, Pteridophyta, Gymnosperms and Angiosperms). Major groups of animals (salient features) (Non-chordates up to phyla and Chordates up to classes).	not easily observable around you.	characteristics associated with any group. (Periods 14)
What is the living being made up of?	What are we made up of? What are the different parts of our body? What is the smallest living unit?	Cell as a basic unit of life; Prokaryotic and eukaryotic cells, multicellular organisms; cell membrane and cell wall, cell organelles: chloroplast, mitochondria, vacuoles, ER, Golgi Apparatus; nucleus, chromosomes – basic structure, number. Tissues, organs, organ systems, organism.	Permanent slides, model of the human body.	Observation of model of human body to learn about levels of organization – tissue, organ, system, and organism, observe blood smears (frog and human), cheek cells, onion peel cell, Spirogyra, Hydrilla leaves (cyclosis). (Periods 12)

Unit/ Sub-units	Questions	Key concepts	Resources	Activities/ Processes
		Structure and functions of animal and plant tissues (four types in animals; meristematic and permanent tissues in plants).		
How do we fall sick?	What are the various causes of diseases? How can diseases be prevented? How can we remain healthy?	Health and its failure. Disease and its causes. Diseases caused by microbes and their prevention – Typhoid, diarrhoea, malaria, hepatitis, rabies, AIDS, TB, polio; pulse polio programme.	Newspaper articles, information from health centres, photographs of various causal organisms. Photographs, permanent slides of bacteria.	Surveying neighbourhood to collect information on disease occurrence pattern. Studying the life cycle of the mosquito and malarial parasite. Discussion on how malaria is spread, how to prevent mosquito breeding. **(Periods 10)**
How do substances move from cell to cell?	How do food and water move from cell to cell? How do gases get into the cells? What are the substances that living organisms exchange with the external world? How do they obtain these substances?	Diffusion/exchange of substances between cells and their environment, and between the cells themselves in the living system; role in nutrition, water and food transport, excretion, gaseous exchange.	Egg membrane, *Rhoeo* leaves, sugar, microscope, slides.	Looking at closed and open stomata, plasmolysis in *Rhoeo* leaf peels. **(Periods 15)**

	Questions	Key concepts	Resources	Activities/ Processes
4. Moving Things, People and Ideas Motion	How do we describe motion?	Motion – displacement, velocity; uniform and non-uniform motion along a straight line, acceleration, distance-time and velocity time graphs for uniform and uniformly accelerated motion, equations of motion by graphical method; elementary idea of uniform circular motion.		Analysis of motion of different common objects. Drawing distance-time and velocity-time graphs for uniform motion and for uniformly accelerated motion. **(Periods 12)**
Force and Newton's laws	What makes things change their state of motion?	Force and motion, Newton's laws of motion: inertia of a body, inertia and mass, momentum, force and acceleration. Elementary idea of conservation of momentum, action and reaction forces.	Historical accounts; Experiences from daily life, wooden and glass boards, sand balls, wooden support, some coins (say of Rs 2 or Rs 5), tumbler, balloons etc.	Demonstrating the effect of force on the state of motion of objects in a variety of daily-life situations. Demonstrate the change in direction of motion of an object by applying force. **(Periods 10)**
Gravitation	What makes things [illegible]	Gravitation; universal law of gravitation,	Spring balance	Analysis of motion of ball falling down

Theme/ Sub-theme	Questions	Key concepts	Resources	Activities/ Processes
	Do all things fall in the same way?	force of gravitation of the earth (gravity), acceleration due to gravity; mass and weight; free fall.		and of ball thrown up. Measuring mass and weight by a spring balance. (Periods 7)
Work, energy and power	How do we measure work done in moving anything? How does falling water make a mill run?	Work done by a force, energy, power; kinetic and potential energy; law of conservation of energy.	Rope (or string), board or plank, wooden block, ball, arrow, bamboo stick, spring, etc.	Experiments on body rolling down inclined plane pushing another body. Experiments with pendulum. Experiments with spring. Discussion. (Periods 6)
Floating bodies	How does a boat float on water?	Thrust and pressure. Archimedes' principle, buoyancy, elementary idea of relative density.	Cycle pump, board pins, bulletin board, mug, bucket, water etc.	Experiments with floating and sinking objects. (Periods 4)
How do we hear from a distance?	How does sound travel? What kind of sounds can we hear? What is an echo? How do we hear?	Nature of sound and its propagation in various media, speed of sound, range of hearing in humans; ultrasound; reflection of sound; echo and sonar. Structure of the human ear (auditory aspect only).	String, ball or stone as bob, water tank, stick, slinky, rope, echo tube, rubber pipe etc. Model or chart showing structure of the ear.	Experiment on reflection of sound. (Periods 10)

Theme/ Subtheme	Questions	Key concepts	Resources	Activities/ Processes
6. How things Work 6. Natural Phenomena 7. Natural Resources Balance in Nature	Why do air, water and soil seem not to be consumed? How does the presence of air support life on earth? How have human activities created disturbances in the atmosphere? How does nature work to maintain balance of its components?	Physical resources: air, water, soil. Air for respiration, for combustion, for moderating temperatures, movements of air and its role in bringing rains across India. Air, water and soil pollution (brief introduction). Holes in ozone layer and the probable damages. Bio-geo chemical cycles in nature: water, oxygen, carbon, nitrogen.	Daily newspapers, magazines and other reading materials. Weather reports over a few months and air quality reports over the same time period. Case study material.	Case studies of actual situation in India with more generalised overview of inter relationship of air, water, soils, forests. Debates on these issues using resources mentioned alongside, visit to/ from an environmental NGO; discussion. (Periods 15)

SCIENCE CLASS X

Theme/ Subtheme	Questions	Key concepts	Resources	Activities/ Processes
1. Food 2. Materials Different kinds of materials	Why are some substances sour and some bitter in taste?	Acids, bases and salts: General properties, examples and uses	Orange juice, lemon juice, soap solution, litmus solution, zinc,	Testing different substances with indicators

Theme/ Sub-theme	Questions	Key concepts	Resources	Activities/ Processes
	Why does soap solution feel slippery? Why does seawater taste salty?		copper and aluminium metals Acids: hydrochloric acid, sulphuric acid, nitric acid. Bases: sodium hydroxide. Common salt	Neutralisation reactions **(Periods 5)**
	Why does iron rust? Why does painted iron not rust? Why is burning sensation removed when one takes antacids? Why do substances stop burning in the absence of air? Why is flame seen when substances burn? Can substances burn without flame? Why does a matchstick kept in the blue part of the flame not burn? Why is a red coating formed on the zinc rod when it is kept in copper sulphate solution? What is the material of the coating?	Types of chemical reactions: combination, decomposition, displacement, double displacement, precipitation, neutralisation, oxidation and reduction in terms of gain and loss of oxygen and hydrogen.	Turmeric, limejuice, vinegar, baking soda, washing soda, yeast, hot water. Materials such as iron nails, copper strip, aluminium strip, zinc strip, galvanised strip, petri dishes with and without covers, container that can be filled with water, cotton wool, etc.	Mixing pairs of substances mentioned alongside, to see the reactions – discussion on chemistry in the kitchen, chemistry inside our bodies. Carrying out simple reactions that encompass decomposition, displacement, double displacement, precipitation, neutralisation, oxidation and reduction. **(Periods 10)**

How things change/react with one another?	How do copper, silver, iron exist in nature?	Brief discussion of basic metallurgical processes. Properties of common metals. Elementary idea about bonding.	Samples of metals: iron, copper, lead, silver, zinc, aluminium, gold; of non-metals: sulphur, graphite; of alloys: steel, brass.	Discussions on metallurgical processes and simple experiments involving metals, with chemical reactions.
	What is the composition of natural gas used for cooking? What is petrol? What is vinegar?	Carbon compounds, elementary idea about bonding. Saturated hydrocarbons, alcohols, carboxylic acids: (no preparation, only properties).	Models.	Experiments involving reactions of carbon and its compounds with chemical reactions. Use of models. **(Periods 16)**
Materials of common use	How is common salt obtained? Besides its use in food, is it used for other purposes? What makes washing soda and baking soda different materials? How does bleaching powder make paper and cloth white? What is the white material that is used for making casts? How do soaps clean clothes? Can some other	Soap – cleansing action of soap.	Kit containing various materials like common salt, washing soda, baking soda, lime, lime stone, bleaching powder, plaster of Paris, soaps, alcohol.	Use of kit materials for demonstration as well as performing of experiments by student of properties. Visits to factories. **(Periods 8)**

		material be used for cleaning clothes? Why does a man lose control on his body after drinking alcohol? Why do people become blind on drinking denatured alcohol?			
	How are elements classified?	How do chemists study such a large number of elements?	Gradations in properties: Mendeleev periodic table.	Brief historical account, charts, films etc.	Predicting trends on the basis of the table. (Periods 5)
	3. The World of the Living Our Environment	What will happen if we bury different materials in the soil? What will happen if we kill all insects? Some of us eat meat; some do not – what about animals?	Our Environment: Environmental problems, what can we do? Bio degradable, non-biodegradable. Ozone depletion.	Discussion on food habits of animals, finding out the various waste materials produced and their disposal in different parts of the country.	Activity of burying different materials in the soil and studying periodically what happens; construction of food web using models, classification of some common plants and animals as consumers etc. (Periods 8)
	How do we stay alive?	What are the processes needed for living?	Define 'living' things; Basic concept of nutrition, respiration, transport and excretion in plants and animals.	Models and charts of various systems in animals, and parts in plants.	Study various things around to decide whether they are living/non living. (Periods 15)

14

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Control in the living	Why do roots grow towards the ground? Can we make them grow upwards? Why do stems grow upwards?	Tropic movements in plants; Introduction to plant hormones; Control and coordination in animals: voluntary, involuntary and reflex action, nervous system; chemical coordination: animal hormones.	Young plants for experiments, seeds, Kit materials, Pavlov's experiment on conditioned reflex	Experiments on tropic movements in plants – geotropism, hydrotropism, phototropism, interaction of factors; experiment on apical dominance; demonstration of reflex action. **(Periods 10)**
Reproduction in the living	Do plants and animals have similar reproductive cycles? Can we decide how many children are born in a family?	Reproduction in plants and animals. Need for and methods of family planning. Safe sex vs. HIV/AIDS. Childbearing and women's health.	Permanent slide L.S. grain; charts/ specimens of embryos, egg. Charts and other materials on family planning. Newspaper reports on HIV/AIDS.	Study pollen tube growth and pollen tubes on a stigmatic mount, mount soaked seeds to see embryonal axis, cotyledons etc., seed germination – epigeal and hypogeal; structure of the hen's egg. Discussion on family planning and responsible parenting **(Periods 10)**
Heredity and evolution	Why are we like our parents? Did similar plants and animals exist in the past? Did life always exist?	Heredity; Origin of life: brief introduction; Basic concepts of evolution.	Data and worksheet from Mendel's experiments; specimen of fossil	Phenotypic ratio 3:1, 2:1., 9:3:3:1 **(Periods 10)**

15

4. Moving Things, People and Ideas 5. How things work Electric Circuits	In which direction does current flow inside a conductor?	Potential difference, potential	Battery, conductor voltmeter, ammeter, connecting wire, key.		Using a simple electric circuit, show that charges flow from higher potential to lower potential. Use the analogy of flow of water from higher (potential to highest energy) lower height (lower potential energy).
	How is potential difference across a conductor related to current through the conductor?	Ohm's law	-do- And rheostats		Using a circuit consisting of a conductor, battery, key, voltmeter and ammeter, establish a relationship between potential difference and current and hence Ohm's law.
	How can you arrange a given set of resistors so that the same current flows through all?	Series combination of resistances.	-do- and given set of resistors		Using the Ohm's law circuit, establishing the properties of series combination and the rule for resistance.

16

	How are appliances connected in a house?	Parallel combination of resistances.	do-	Establishing the rule for parallel combination of resistors.
	How much heat is generated when a current I flows through a resistor?	Power dissipated due to current. Inter relation between P, V, I and R.	Appliances based on heating effect of current in daily life.	Identification of appliances in daily life base on heating effect of current. Calculation of power in daily life situations. (Periods 12)
Magnets	How does the needle of a compass change direction when placed at different points near a magnet?	Magnetic field Field lines	A magnet, compass, white sheet, drawing board, drawing pins.	Drawing magnetic field lines in vicinity of a bar magnet.
	[illegible] produced by [illegible] field?	Field due to a current carrying wire. Field due to current carrying coil or solenoid.	A battery, a conductor, compass, key, A coil, A solenoid.	Demonstrating that a current carrying conductor produces a magnetic field. Demonstrating the magnetic field produced by a current carrying coil or solenoid.
	What happens to a current carrying conductor when it is placed in a magnetic field?	Force on current carrying conductor Fleming's left hand rule.	A small rod, stand and two wires for suspending the rod, a strong horseshoe magnet.	Demonstrating that a current carrying conductor when placed in a magnetic field experiences force.

Sub-theme				Processes
	How does the above effect help us to design machines to do work?	Electric motor.	Appliances using motors.	Demonstrating the working of a motor. Identifying the appliances based on electric motors.
	What do you observe when a magnet is moved towards a wire connected to a galvanometer?	Electromagnetic induction. Induced potential differences, induced current.	Two coils of wire, a magnet, a galvanometer. Iron nails, battery, switch.	Demonstrating the phenomenon of electromagnetic induction. Demonstrating that current is induced in a coil kept near a coil in which current changes.
	How can the phenomenon of electromagnetic induction be used to design a device to generate electricity?	Electric generator. principle and working	A simple model of electric generator.	Demonstrating the principle and working of a generator.
	Does the current produced by a generator have the same direction all the time?	Direct current. Alternating current; frequency of AC. Advantage of AC over DC.	Model of electric generator.	Familiarising with voltage and frequency of AC in our homes.
	How are the bulbs etc/ connected to the AC source in our homes?	Domestic electric circuits	Demonstration board for domestic electric circuit.	Explaining the working of domestic electric circuits. Demonstrating

18

				use of a fuse in domestic circuit. (Periods 12)
6. Natural Phenomena	Why is paper burnt when light passing through a lens [illegible]?	Convergence and divergence of light.	Experience. Double convex lens	Observation of convergence and divergence with lenses
	Does a spherical mirror also exhibit similar phenomenon? Can we see a full image of a tall building using a small mirror?	Images formed by a concave mirror, related concepts centre of curvature, principal axis. Optical centre, focus, focal length.	A candle, stand to hold a mirror, meter scale	Exploring and recording features of images formed by a concave mirror, by placing an object beyond c.c., between c.c. and focus, and between pole and focus; ray diagrams.
	Why [illegible] spoon [illegible]	Refraction; laws of refraction.	Glass slab, pins	Activity to explore laws of refraction.
	What do lenses do? How do they [illegible]	Images formed by a convex lens; Functioning of lens in human eye; problems of vision and [illegible]	Convex lens.	Activity exploring and recording features of images formed by convex lens. Ray diagrams. Studying the glasses used by

			Application of spherical mirrors and lenses.		human beings to correct different vision defects.
		Why does the path of light change on entering a different medium?	Appreciation of concept of refraction; velocity of light; refractive index; twinkling of stars; dispersion of light.	Concepts learnt earlier.	Activities studying refraction.
		Why or how does a prism disperse light?	Dispersion of light.	Prism, pins.	Observation of objects through prisms; tracing rays refracted through a prism; discussion.
		Why is the sky blue?	Scattering of light.	Observations and experience.	Activity showing scattering of light in emulsion etc. (Periods 25)
	7. Natural Resources Conservation of Natural Resources	How can we contribute to protect environment in our locality? What are the major global environmental issues of direct relevance	Management of natural resources. Conservation and judicious use of natural resources. Forest and wild life, coal and petroleum conservation.	Articles/stories on conservation; Posters on environmental awareness.	Case studies with focus on commercial activities exploiting natural resources. Effect of these on varies cycles in nature.

Theme/ Sub-theme	Questions	Key concepts	Resources	Activities/ Processes
	What are the steps expected on the part of local administration to maintain balances in nature in your region? How can we help?	People's participation. Chipko movement. Legal perspectives in conservation and international scenario.	Case studies on Chipko movement; CNG use.	Making posters/ slogans for creating awareness.
The regional environment	How does the construction of big dams affect the life of the people and the regional environment? Are rivers, lakes, forests and wild life safe in your area?	Big dams: advantages and limitations; alternatives if any. Water harvesting. Sustainability of natural resources.	Case study material on dams. Resource material on water harvesting.	Case studies with focus on issues of construction of dams and related phenomena (actual/ probable). Debates on issues involved.
Sources of energy	What are the various sources of energy we use? Are any of these sources limited? Are there reasons to prefer some of them over others?	Different forms of energy, leading to different sources for human use: fossil fuels, solar energy; biogas; wind, water and tidal energy; nuclear energy. Renewable versus non-renewable sources.	Experience; print material on various sources of energy, materials to make a solar heater.	Discussion. Making models and charts in groups. Making a solar heater/cooker. **(Periods 8)**

MATHEMATICS
(CLASSES IX–XII)

This syllabus continues the approach along which the syllabi of Classes I to VIII have been developed. It has been designed in a manner that maintains continuity of a concept and its applications from Classes IX to XII.

The salient features of the syllabus are the following:

(i) The development and flow is from Class I upwards, not from college level down.

(ii) It is created keeping in mind that the time for transacting it is approximately 180 hours, a realistic figure based on feedback from the field.

(iii) The time given for developing a concept/series of concepts is allowing for the learner to explore them in several ways to develop and elaborate her understanding of them and the inter-relationships between them. While transacting the syllabus, we expect that the learner would be allowed a variety of opportunities for exploring mathematical concepts and processes, to help her construct her understanding of these.

(iv) The focus is on developing the processes involved in mathematical reasoning. Accordingly, the learner requires plenty of opportunity and enough time to develop the processes of dealing with greater abstraction, moving from particular to general to particular, moving with facility from one representation to another of a concept or process, solving and posing problems, etc.

(v) Linkages with the learner's life and experiences, and across the curriculum, need to be focused upon while transacting the curriculum. The idea is to allow the learner to realize how and why mathematics is all around us.

(vi) We note that it is at the secondary stage, the child enters into more formal mathematics. She needs to see the connections with what she has studied so far, consolidate it and begin to try and understand the formal thought process involved. With this in view two areas, related to mathematical proofs/reasoning and mathematical modelling, have been introduced from Class IX to XII, in a graded manner. Since these areas are thought of for the first time at these stages and the required awareness is lacking, it was decided to have these topics as appendices in the textbooks. This will give an opportunity to teachers

and students to get exposure to these concepts. It is proposed that these topics may be considered for inclusion in the main syllabi in due course of time.

Secondary Stage

General Guidelines

1. All concepts/identities must be illustrated by situational examples.
2. The language of 'word problems' must be clear, simple, and unambiguous.
3. All proofs to be produced in a non-didactic manner, allowing the learner to see flow of reason. Wherever possible give more than one proof.
4. Motivate most results. Prove explicitly those where a short and clear argument reinforces mathematical thinking and reasoning. There must be emphasis on correct way of expressing their arguments.
5. The reason for doing ruler and compass construction is to motivate and illustrate logical argument and reasoning. All constructions must include an analysis of the construction, and proof for the steps taken to do the required construction must be given.

Class IX

Units

I. Number Systems
II. Algebra
III. Coordinate Geometry
IV. Geometry
V. Mensuration
VI. Statistics and Probability

Appendix: 1. Proofs in Mathematics.
2. Introduction to Mathematical Modelling.

Unit I. Number Systems

Real Numbers (Periods 20)

Review of representation of natural numbers, integers, rational numbers on the number line. Representation of terminating/non-terminating recurring decimals, on the number line through successive magnification. Rational numbers as recurring/terminating decimals.

Examples of nonrecurring/non terminating decimals such as $\sqrt{2}, \sqrt{3}, \sqrt{5}$ etc. Existence of non-rational numbers (irrational numbers) such as $\sqrt{2}, \sqrt{3}$ and their representation on the number line. Explaining that every real number is represented by a unique point on the number line, and conversely, every point on the number line represents a unique real number.

Existence of $\sqrt{x}$ for a given positive real number x (visual proof to be emphasized). Definition of nth root of a real number.

Recall of laws of exponents with integral powers. Rational exponents with positive real bases (to be done by particular cases, allowing learner to arrive at the general laws).

Rationalisation (with precise meaning) of real numbers of the type (and their combinations) $\frac{1}{a+b\sqrt{x}}$ and $\frac{1}{\sqrt{x}+\sqrt{y}}$ where x and y are natural numbers and a, b are integers.

Unit II: **Algebra**

Polynomials (Periods 25)

Definition of a polynomial in one variable, its coefficients, with examples and counter examples, its terms, zero polynomial. Degree of a polynomial. Constant, linear, quadratic, cubic polynomials; monomials, binomials, trinomials. Factors and multiples. Zeros/roots of a polynomial/equation. State and motivate the Remainder Theorem with examples and analogy to integers. Statement and proof of the Factor Theorem. Factorisation of $ax^2 + bx + c$, $a \neq 0$ where a, b, c are real numbers, and of cubic polynomials using the Factor Theorem.

Recall of algebraic expressions and identities. Further identities of the type:

$(x + y + z)^2 = x^2 + y^2 + z^2 + 2xy + 2yz + 2zx$, $(x \pm y)^3 = x^3 \pm y^3 \pm 3xy(x \pm y)$,

$x^3 + y^3 + z^3 - 3xyz = (x + y + z)(x^2 + y^2 + z^2 - xy - yz - zx)$ and their use in factorization of polynomials. Simple expressions reducible to these polynomials.

Linear Equations in Two Variables (Periods 12)

Recall of linear equations in one variable. Introduction to the equation in two variables. Prove that a linear equation in two variables has infinitely many solutions, and justify their being written as ordered pairs of real numbers, plotting them and showing that they seem to lie on a line. Examples, problems from real life, including problems on Ratio and Proportion and with algebraic and graphical solutions being done simultaneously.

Unit III: **Coordinate Geometry** (Periods 9)

The Cartesian plane, coordinates of a point, names and terms associated with the coordinate plane, notations, plotting points in the plane, graph of linear equations as examples; focus on linear equations of the type $ax + by + c = 0$ by writing it as $y = mx + c$ and linking with the chapter on linear equations in two variables.

Unit IV. Geometry

1. *Introduction to Euclid's Geometry* (Periods 6)

History – Euclid and geometry in India. Euclid's method of formalizing observed phenomenon into rigorous mathematics with definitions, common/obvious notions, axioms/postulates, and theorems. The five postulates of Euclid. Equivalent versions of the fifth postulate. Showing the relationship between axiom and theorem.

1. Given two distinct points, there exists one and only one line through them.
2. (Prove) Two distinct lines cannot have more than one point in common.

2. *Lines and Angles* (Periods 10)

1. (Motivate) If a ray stands on a line, then the sum of the two adjacent angles so formed is 180° and the converse.
2. (Prove) If two lines intersect, the vertically opposite angles are equal.
3. (Motivate) Results on corresponding angles, alternate angles, interior angles when a transversal intersects two parallel lines.
4. (Motivate) Lines, which are parallel to a given line, are parallel.
5. (Prove) The sum of the angles of a triangle is 180°.
6. (Motivate) If a side of a triangle is produced, the exterior angle so formed is equal to the sum of the two interior opposite angles.

3. *Triangles* (Periods 20)

1. (Motivate) Two triangles are congruent if any two sides and the included angle of one triangle is equal to any two sides and the included angle of the other triangle (SAS Congruence).
2. (Prove) Two triangles are congruent if any two angles and the included side of one triangle is equal to any two angles and the included side of the other triangle (ASA Congruence).
3. (Motivate) Two triangles are congruent if the three sides of one triangle are equal to three sides of the other triangle (SSS Congruence).
4. (Motivate) Two right triangles are congruent if the hypotenuse and a side of one triangle are equal (respectively) to the hypotenuse and a side of the other triangle.
5. (Prove) The angles opposite to equal sides of a triangle are equal.
6. (Motivate) The sides opposite to equal angles of a triangle are equal.
7. (Motivate) Triangle inequalities and relation between 'angle and facing side'; inequalities in a triangle.

4. *Quadrilaterals* (Periods 10)

1. (Prove) The diagonal divides a parallelogram into two congruent triangles.
2. (Motivate) In a parallelogram opposite sides are equal and conversely.
3. (Motivate) In a parallelogram opposite angles are equal and conversely.

4. (Motivate) A quadrilateral is a parallelogram if a pair of its opposite sides is parallel and equal.
5. (Motivate) In a parallelogram, the diagonals bisect each other and conversely.
6. (Motivate) In a triangle, the line segment joining the mid points of any two sides is parallel to the third side and (motivate) its converse.

5. *Area* (Periods 4)

Review concept of area, recall area of a rectangle.

1. (Prove) Parallelograms on the same base and between the same parallels have the same area.
2. (Motivate) Triangles on the same base and between the same parallels are equal in area and its converse.

6. *Circles* (Periods 15)

Through examples, arrive at definitions of circle related concepts, radius, circumference, diameter, chord, arc, subtended angle.

1. (Prove) Equal chords of a circle subtend equal angles at the centre and (motivate) its converse.
2. (Motivate) The perpendicular from the centre of a circle to a chord bisects the chord and conversely, the line drawn through the centre of a circle to bisect a chord is perpendicular to the chord.
3. (Motivate) There is one and only one circle passing through three given non-collinear points.
4. (Motivate) Equal chords of a circle (or of congruent circles) are equidistant from the centre(s) and conversely.
5. (Prove) The angle subtended by an arc at the centre is double the angle subtended by it at any point on the remaining part of the circle.
6. (Motivate) Angles in the same segment of a circle are equal.
7. (Motivate) If a line segment joining two points subtends equal angle at two other points lying on the same side of the line containing the segment, the four points lie on a circle.
8. (Motivate) The sum of the either pair of the opposite angles of a cyclic quadrilateral is 180° and its converse.

7. *Constructions* (Periods 10)

1. Construction of bisectors of a line segment and angle, 60°, 90°, 45° angles etc, equilateral triangles.
2. Construction of a triangle given its base, sum/difference of the other two sides and one base angle.
3. Construction of a triangle of given perimeter and base angles.

Unit V: Mensuration

1. *Areas* (Periods 4)

Area of a triangle using Heron's formula (without proof) and its application in finding the area of a quadrilateral.

2. *Surface Areas and Volumes*

(Periods 10)

Surface areas and volumes of cubes, cuboids, spheres (including hemispheres) and right circular cylinders/cones.

Unit VI: Statistics and Probability

1. *Statistics*

(Periods 15)

Introduction to Statistics: Collection of data, presentation of data – tabular form, ungrouped/ grouped, bar graphs, histograms (with varying base lengths), frequency polygons, qualitative analysis of data to choose the correct form of presentation for the collected data. Mean, median, mode of ungrouped data.

2. *Probability*

(Periods 12)

History, Repeated experiments and observed frequency approach to probability. Focus is on empirical probability. (A large amount of time to be devoted to group and to individual activities to motivate the concept; the experiments to be drawn from real-life situations, and from examples used in the chapter on statistics).

Appendix

1. *Proofs in Mathematics*

What a statement is; when is a statement mathematically valid. Explanation of axiom/ postulate through familiar examples. Difference between axiom, conjecture and theorem. The concept and nature of a 'proof' (emphasize deductive nature of the proof, the assumptions, the hypothesis, the logical argument) and writing a proof. Illustrate deductive proof with complete arguments using simple results from arithmetic, algebra and geometry (e.g, product of two odd numbers is odd etc.). Particular stress on verification not being proof. Illustrate with a few examples of verifications leading to wrong conclusions – include statements like "every odd number greater than 1 is a prime number". What disproving means, use of counter examples.

2. *Introduction to Mathematical Modelling*

The concept of mathematical modelling, review of work done in earlier classes while looking at situational problems, aims of mathematical modelling, discussing the broad stages of modelling – real-life situations, setting up of hypothesis, determining an appropriate model, solving the mathematical problem equivalent, analyzing the conclusions and their real-life interpretation, validating the model. Examples to be drawn from ratio, proportion, percentages, etc.

Class X

Units

I. Number Systems

II. Algebra

III. Trigonometry

IV. Coordinate Geometry

V. Geometry

VI. Mensuration

VII. Statistics and Probability

Appendix: 1. Proofs in Mathematics

2. Mathematical Modelling

Unit I: Number Systems

Real Numbers (Periods 15)

Euclid's division lemma, Fundamental Theorem of Arithmetic – statements after reviewing work done earlier and after illustrating and motivating through examples. Proofs of results – irrationality of $\sqrt{2}, \sqrt{3}, \sqrt{5}$, decimal expansions of rational numbers in terms of terminating/non-terminating recurring decimals.

Unit II: Algebra

1. *Polynomials* (Periods 9)

Zeros of a polynomial. Relationship between zeros and coefficients of a polynomial with particular reference to quadratic polynomials. Statement and simple problems on division algorithm for polynomials with real coefficients.

2. *Pair of Linear Equations in Two Variables* (Periods 15)

Pair of linear equations in two variables. Geometric representation of different possibilities of solutions/inconsistency.

Algebraic conditions for number of solutions. Solution of pair of linear equations in two variables algebraically – by substitution, by elimination and by cross multiplication. Simple situational problems must be included. Simple problems on equations reducible to linear equations may be included.

3. *Quadratic Equations* (Periods 15)

Standard form of a quadratic equation $ax^2 + bx + c = 0$, $(a \neq 0)$. Solution of quadratic equations (only real roots) by factorization and by completing the square, i.e., by using quadratic formula. Relationship between discriminant and nature of roots.

Problems related to day-to-day activities to be incorporated.

4. *Arithmetic Progressions* (AP) (Periods 8)

Motivation for studying AP. Derivation of standard results of finding the n^{th} term and sum of first n terms.

Unit III: Trigonometry

1. *Introduction to Trigonometry* (Periods 18)

Trigonometric ratios of an acute angle of a right-angled triangle. Proof of their existence (well defined); motivate the ratios, whichever are defined at 0° and 90°. Values (with proofs) of the trigonometric ratios of 30°, 45° and 60°. Relationships between the ratios.

Trigonometric Identities: Proof and applications of the identity $\sin^2 A + \cos^2 A = 1$. Only simple identities to be given. Trigonometric ratios of complementary angles.

2. *Heights and Distances* (Periods 8)

Simple and believable problems on heights and distances. Problems should not involve more than two right triangles. Angles of elevation/depression should be only 30°, 45°, 60°.

Unit IV: Coordinate Geometry

Lines (In two-dimensions) (Periods 15)

Review the concepts of coordinate geometry done earlier including graphs of linear equations. Awareness of geometrical representation of quadratic polynomials. Distance between two points and section formula (internal). Area of a triangle.

Unit V: Geometry

1. *Triangles* (Periods 15)

Definitions, examples, counterexamples of similar triangles.

1. (Prove) If a line is drawn parallel to one side of a triangle to intersect the other two sides in distinct points, the other two sides are divided in the same ratio.
2. (Motivate) If a line divides two sides of a triangle in the same ratio, the line is parallel to the third side.
3. (Motivate) If in two triangles, the corresponding angles are equal, their corresponding sides are proportional and the triangles are similar.

4. (Motivate) If the corresponding sides of two triangles are proportional, their corresponding angles are equal and the two triangles are similar.
5. (Motivate) If one angle of a triangle is equal to one angle of another triangle and the sides including these angles are proportional, the two triangles are similar.
6. (Motivate) If a perpendicular is drawn from the vertex of the right angle to the hypotenuse, the triangles on each side of the perpendicular are similar to the whole triangle and to each other.
7. (Prove) The ratio of the areas of two similar triangles is equal to the ratio of the squares on their corresponding sides.
8. (Prove) In a right triangle, the square on the hypotenuse is equal to the sum of the squares on the other two sides.
9. (Prove) In a triangle, if the square on one side is equal to sum of the squares on the other two sides, the angles opposite to the first side is a right triangle.

2. *Circles* (Periods 6)

Tangents to a circle motivated by chords drawn from points coming closer and closer to the point.

1. (Prove) The tangent at any point of a circle is perpendicular to the radius through the point of contact.
2. (Prove) The lengths of tangents drawn from an external point to a circle are equal.

3. *Constructions* (Periods 6)

1. Division of a line segment in a given ratio (internally).
2. Tangent to a circle from a point outside it.
3. Construction of a triangle similar to a given triangle.

Unit VI: Mensuration

1. *Areas Related to Circles* (Periods 12)

Motivate the area of a circle; area of sectors and segments of a circle. Problems based on areas and perimeter/circumference of the above said plane figures.

(In calculating area of segment of a circle, problems should be restricted to central angle of 60°, 90° and 120° only. Plane figures involving triangles, simple quadrilaterals and circle should be taken.)

2. *Surface Areas and Volumes* (Periods 12)

1. Problems on finding surface areas and volumes of combinations of any two of the following: cubes, cuboids, spheres, hemispheres and right circular cylinders/cones. Frustum of a cone.

2. Problems involving converting one type of metallic solid into another and other mixed problems. (Problems with combination of not more than two different solids be taken.)

Unit VII: Statistics and Probability

1. *Statistics* (Periods 15)

Mean, median and mode of grouped data (bimodal situation to be avoided).
Cumulative frequency graph.

2. *Probability* (Periods 10)

Classical definition of probability. Connection with probability as given in Class IX.
Simple problems on single events, not using set notation.

Appendix

1. *Proofs in Mathematics*

Further discussion on concept of 'statement', 'proof' and 'argument'. Further illustrations of deductive proof with complete arguments using simple results from arithmetic, algebra and geometry. Simple theorems of the "Given ..... and assuming... prove .....". Training of using only the given facts (irrespective of their truths) to arrive at the required conclusion. Explanation of 'converse', 'negation', constructing converses and negations of given results/statements.

2. *Mathematical Modelling*

Reinforcing the concept of mathematical modelling, using simple examples of models where some constraints are ignored. Estimating probability of occurrence of certain events and estimating averages may be considered. Modelling fair instalments payments, using only simple interest and future value (use of AP).

Higher Secondary Stage

General Guidelines

(i) All concepts/identities must be illustrated by situational examples.

(ii) The language of 'word problems' must be clear, simple and unambiguous.

(iii) Problems given should be testing the understanding of the subject.

(iv) All proofs to be produced in a manner that allow the learner to see flow of reasons. Wherever possible, give more than one proof.

(v) Motivate results, wherever possible. Prove explicitly those results where a short and clear argument reinforces mathematical thinking and reasoning. There must be emphasis on correct way of expressing the arguments.