CHAPTER 4

DEVELOPMENT AND IMPLEMENTATION OF INTERVENTION PROGRAMME

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4.0 INTRODUCTION

The present chapter focuses on the development of the intervention programme and its implementation on the selected sample. The first half of the chapter deals with the analysis and interpretation of data analyzed from the situational analysis phase. The findings from the situational analysis tools helped in the development of the intervention programme. The second half of the chapter focuses on day wise implementation of the intervention programme. The intervention programme comprise of various methods and techniques used in the teaching learning process to help students understand the concepts and attain the desirable learning outcome.

4.1 IDENTIFICATION OF TOPICS OF PHYSICS FROM STANDARD IX SCIENCE AND TECHNOLOGY TEXT BOOK

In order to identify the topics of physics which were felt difficult by the students and needed intervention, the researcher used three tools: an information schedule of Physics, an interview schedule for students and content analysis of the answer sheets. The objective was to locate the topics wherein the intervention was required. This formed the situational analysis for the present study. The detailed analysis of the three tools is presented below.

4.1.1 Analysis and Interpretation of Information Schedule of Physics

An information schedule of physics was implemented on a sample of one hundred and forty nine X standard students of the selected schools in the month of April 2011. The students were recently promoted to standard X. The responses of the students were analyzed through frequency count and then converted to percentage as shown in Table.4.1

Table 4.1

Percentage Analysis of Information Schedule of Physics

Sr. No.	Content Area	% of Students felt difficulty
1	Concept of acceleration and retardation	67.78
2	Commercial unit of energy	59.73
3	Linear momentum	55.70
4	Quality or timber of sound	55.70
5	Derivations of equation of motion	54.36
6	Numerical on sound	49.66
7	Archimedes's principle	48.99
8	Numerical on work, energy and power	46.97
9	Density	44.29
10	Buoyancy	44.29
11	Numerical on Force and laws of motion	43.62
12	Uniform circular motion	42.95
13	Numerical on motion	42.95
14	Measuring rate of motion : speed	42.28
15	Acceleration due to gravity	42.28
16	Energy transformations	42.28
17	Structure of human ear – Auditory aspect	42.28
18	Galileo's observation and conclusion	41.61
19	Newton's second law of motion	41.61
20	Law of conservation of momentum	40.93
21	Production and propagation of sound	40.93
22	Reflection of sound	40.93
23	Multiple echoes	38.25
24	Numerical on Gravitation	37.58
25	Loudness or intensity of sound	37.58
26	Derivation of law of conservation of momentum	36.91
27	Graphical representation of motion	35.57
28	Relation between speed of sound, frequency and wavelength	34.89
29	Newton's first law of motion	34.22

30	Reverberation	34.22
31	Mathematical formulation of Newton's second law of motion	33.55
32	Numerical on Buoyancy and Archimedes's principle	33.55
33	Application of multiple reflection of sound	33.55
34	Speed with direction : velocity	32.88
35	Weight	32.88
36	Characteristics of sound waves	32.88
37	Echo	32.21
38	Law of conservation of mechanical energy	30.82
39	Applications of law of conservation of momentum	30.20
40	Balanced and unbalanced forces	29.53
41	Applications of Newton's third law	29.53
42	Relation between 'g' and 'G'	29.53
43	Acceleration due to gravity does not depend on the mass of the body	29.53
44	Newton's third law of motion	28.85
45	Variation in acceleration due to gravity	28.85
46	Relation between frequency and time period	28.85
47	Pitch or frequency of sound	28.85
48	Newton's first law and inertia	28.18
49	Newton's first law and force	27.51
50	Inertia and mass	26.17
51	Medical use of ultrasound	24.83
52	Types of inertia	24.16
53	Why objects float or sink in water	24.16
54	Compressions and rarefaction produced in sound	24.16
55	Sound waves: Longitudinal waves	22.81
56	Velocity time graph	22.14
57	SONAR	21.47
58	Concept of distance and displacement	20.80
59	Rate of doing work: Power	20.13
60	Uniform motion	19.46

61	Distance time graph	19.46
62	Equation for velocity time relation	19.46
63	Concept of force	19.46
64	Thrust and pressure	19.46
65	Pressure in fluids	19.46
66	Equation for position time relation	18.79
67	Mass	18.79
68	Transverse wave motion	18.12
69	Industrial use of ultrasound	17.44
70	Equation for position velocity relation	16.77
71	Non Uniform motion	16.10
72	Law of conservation of energy	16.10
73	Newton's universal law of gravitation	14.76
74	Relative density	14.76
75	Expression for kinetic energy	12.08
76	Weight of an object on moon	11.40
77	Kinetic energy	10.73
78	Potential energy of an object at a height	10.73
79	Value of acceleration due to gravity	10.06
80	Range of frequencies	10.06
81	Concept of gravitation	9.39
82	Value of Gravitational constant	9.39
83	Concept of work	8.53
84	Potential energy	7.38
85	Sound needs a medium to travel	7.38
86	Concept of sound	6.71
87	Energy	6.04
88	Speed of sound in different media	6.04
89	Importance of Universal law of Gravitation	5.36
90	Forms of energy	4.69
91	Work done by a constant force	4.02

- From the table above it can be seen that in the chapter Motion, 67.78% of the students felt difficulty in understanding the concept of Acceleration and Retardation, Derivation of equation of motion (54.36 %), Uniform circular motion (42.95 %), speed (42.28 %) and Graphical representation of motion (35.57%).
- In the chapter Force and Laws of Motion, 55.70% of the students felt difficulty in understanding the concept of Linear Momentum, Galileo's observation and conclusion (41.61 %), Newton's second law of motion (41.61%) and Law of conservation of motion (40.93%).
- In the chapter Gravitation and Floating Bodies, 48.99% of the student felt difficulty in understanding the concept of Archimedes's Principle, Density (44.29%), Buoyancy (44.29%) and Acceleration due to gravity (42.28%).
- In the chapter Work and Energy, 59.73% of the students felt difficulty in understanding the concept of Commercial unit of energy and Energy transformations (42.28%).
- In the chapter Sound, 55.70%of the students felt difficulty in understanding the concept of Quality or timbre of sound, Structure of human ear (42.28 %), Reflection of sound (40.93%) and Production and propagation of sound (40.93%).
- Irrespective of chapter, students felt difficulty with numerical which were based on the concepts. It can be interpreted that it might be possible that the students are not conceptually clear with the concepts and thereby application of those concepts in solving numerical becomes difficult for them.

4.1.2 Analysis and Interpretation of Interview schedule

The semi structured interview was conducted on forty randomly selected students of standard X. The researcher developed rapport with the students before the interviews were conducted. They were assured about the confidentiality of the data. The content analysis was done and the analyzed data is presented below.

- Fifty percent of the students interviewed were of the view that physics is interesting and exciting. They said that it helped them to get reasons to the occurrence of many phenomenon in nature with logical proofs. Thirty percent of the students said that physics is hard as it has difficult terms to be defined and formulae's to be remembered. They felt a lot of time is required to

memorize the derivations and they have to write and practice it. Twenty percent of the students were of the view that it is as similar to learning of biology and chemistry. They added that all the three disciplines of science require equal hard work and time investment.

- When asked to compare the physics concepts of standard VIII, IX and X in terms of their difficulty level, eighty five percent of the students said that the concepts of physics at standard VIII were simple and easy to understand. It had no complicated definitions, formulae or numerical to be solved. Twenty five percent of the students felt that physics concepts of standard VIII were neither easy nor too difficult. They had a neutral view.
- Forty five percent of the students felt no difference in the difficulty level of physics concepts in standard IX and standard X. Thirty two point five percent of the students said that they felt the physics concepts in standard IX was difficult as compared to standard X. The reason specified were that physics concept were difficult, numerical in each chapter, formulae's and derivations were to be remembered. A few students (fifteen percent) said that X standard being board, they were more serious in understanding and learning the concept and teachers were also more focused as compared to standard IX and standard VIII. Ten percent of the students were of the view that in standard X they don't have the freedom to skip or omit topics and had the compulsion to learn all concepts. They also felt a lot of pressure and compulsion from the parents and teachers side to perform better whereas in standard IX they were more relaxed and at ease. Twenty two percent of the students felt physics concepts in standard X to be more difficult as compared to standard IX and VIII.
- Thirty percent of the students said that the teacher used lecture method, demonstration method and also asked questions while explaining the concept. Forty percent students said that the teacher kept on talking and writing on the board. They were instructed to take notes in class. The teacher asked question when students made noise or talked in class. Twenty percent of the students felt that the teacher taught well and they understood what was being taught in class. Five percent of the students said that *'the teacher teaches and we listen. Sometimes we do homework of other subject or play games on paper in class, and act as if we are taking notes of the taught subject'*.

- Forty percent of the students said that they felt remembering the derivations, formulae's, definitions and numerical difficult. Fifteen percent of the students said that '*we learn and by heart the definitions and if one word is misplaced here and there, the teacher cuts marks and so it is difficult to write the definitions as it is given in the textbook. Some of the terms are hard to remember'*. Forty five percent of the students had no difficulty in understanding the physics concepts.
- Related to activities performed in class forty percent of the students said that few of the activities given in the text were rarely/sometimes performed by the teacher in the class. When probed on whether discussions were carried out after the activity thirty two percent of the students said that discussions were done/sometimes done after the activity in the class. They also said that at one or two instances when the teacher did an activity it created disciplinary problems and the teacher finally had to conclude. One student said that once the teacher stopped the demonstration and got angry in between as the class became very noisy, "*teacher ne kaha k hum sub jungali hai*" (*the teacher said we are all wild animals*). Fifteen percent of the students said they don't remember any activity done in class. Forty five percent of the students agreed that whatever activities were done in class was done by the teacher and the students were instructed to repeat the activity at home.
- Seventy percent of the students said that activities helped them to associate and relate the concept. They were of the view that activity helped them to easily learn and remember the concept. Rest of the students were of the view that the activities made no difference to their learning of physics concepts.
- Hundred percent of the students were excited about the physics lab and practical work. When probed students said that they were enthusiastic about doing practical and as they work in group and can be out of classroom. They said they are bored sitting in the classroom and listening to teachers all day. In lab they can see new apparatus and also experiment. On further asking how seriously they did the lab work forty five percent of the students said that they do the practical with full concentration and never manipulate with the findings. While fifty five percent of students said that the practical are done in group of four to five students, one of the student performs the practical and the

rest of the group members copies it down. Some of the students also confessed of manipulating the findings and result. When asked how do they perform in practical exam, they said '*wo tho exam ke liye readings rath lene ka*' *(that we by-heart/memorize the readings for exam).* Also they were of the view that weight-age of practical exam is less (only 10%) and that does not make much difference.

- When asked the extent to which the practical work helped to understand the physics concept some of the students (fifty five percent) came out with the fact that the practical are done in first semester and the theory is taught in second semester. They said that at times they forgot what the practical was all about, by the time theoretical concept was taught. When the teachers were asked regarding this, they said that the syllabus is set in that pattern and they cannot go against the set norms. Rest of the students agreed to the fact that practical helped in understanding the concepts.
- Students said that they were given home assignments pertaining to the textbook activities and exercise questions. When asked whether the teacher regularly checked the homework given, students said that sometimes the teacher checked, but most of the time she forgets and they don't remind her. Five percent student shared that the students who reminded the teacher to check the home assignment were tagged as '*champchas* ' (sycophants) of teacher.
- Thirty five percent of the students said that they felt free to ask questions in class during the teaching learning process. Fifteen percent of the students said that only scholar students ask questions and went on to say that even the teacher pose question to scholar student only. When probed into whether the teacher asked questions during the classroom interactions they said *'the questions are for scholar students who are teachers' pet. We are asked questions only when we are caught talking or disturbing the class'.* Fifty percent of the students said that they never asked questions during the classroom interactions.
- Ten percent of the students reported to have referred reference books and internet online material apart from their classroom notes. Eighty percent of the students said that they referred only the class notes dictated by the teachers for

learning and understanding the physics concepts. When probed into how far the class notes helped in attempting the questions pertaining to higher order objectives by just referring to the class notes? The response of the students were mixed, eighty percent of the students said that the teachers notes were enough to answer questions of all level of objectives. Twenty percent of the students said that they referred the question papers of previous years and fix on the probable and important questions for the exams. They said if a certain concept is asked and they find it difficult then they seek help from teachers or friends who go for tuitions. Still if they do not understand it they said that *'ya tho option mai nikal do ya tho rath lo' (either you omit it in option or you rote memorize it).* Ten percent of the students revealed that *'we have revision classes before exams and we make it a point to attend those classes- jo teacher revision karati hai wahi exam mai aatta hai' (whatever is taken up in the revision classes that is sure to come for exam). The teacher doesn't tell us directly, but we know that'.*

- When asked about classroom interactions and discussions facilitated in learning the physics concepts, the students had a mixed opinion. Nearly thirty five percent said that it help them in taking notes and understanding the topic. While twenty seven point five percent students said that at times they were bored and sleepy in the class. They blindly took down what the teacher made them write in class. The rest thirty were neutral and said that sometimes it helped while sometimes it did not. Seven point five percent of the students did not respond to the question and said they don't know.

4.1.3 Analysis and Interpretation from the answer sheets of students

Content analysis of the two hundred and thirty three answer sheets of students of standard IX science and technology was done by the researcher to locate the gap between the expected learning outcome and actual learning outcome. The answer sheets wherein students attempted all questions correctly and those wherein students did not attempt the physics section were omitted from the analysis. The summarized analysis from the reviewed answer sheet is described and presented below:

- Solving word problems in physics was difficult for students. They either used wrong formulae or made mistake in mathematical calculations. Lack of basic

mathematical skills with integers, decimal system, indices and power was seen among the students. It can be interpreted that mastery in basic mathematics facilitated in solving numerical in physics.

- Difficulty in interpretation of symbolic representation of mathematical formulae was common with most of the students. Students found it complex to represent the law or definition in symbolic mathematical formulae. Students were not conceptually clear about the physical interpretation of the symbolic representation of the formulae. This was observed common while in defining, stating and representing Newton's second law of motion, acceleration, momentum and law of conservation of momentum.
- It was observed that most of the students reproduced the mathematical steps of the derivation without supporting it with theory. It could be interpreted that the students are not conceptually clear with the basic concepts and hence they find it difficult to relate one concept with the other while deriving a formulae. Hence they are not able to provide theoretical support to the mathematical steps during derivation.
- It was observed that students' rote memorized the definitions and laws. The following terms were used interchangeably: velocity/speed/acceleration, uniform/non uniform motion, weight/mass, volume/density, echo/reverberation, force/pressure, distance/displacement, weight/volume, reflection/refraction and frequency and amplitude. It could be interpreted that the definitions and laws were not conceptually understood by the students.
- Related to graphical representation of motion it was observed that students felt complexity in plotting the scale on both axis, inscribing the scale plotted, identification of type of motion from the nature of graph and interpreting the plotted graphs with respect to the variables mentioned.
- Classifying and understanding of Scalar quantities and vector quantities was not conceptually clear to students. Students wrongly classified work, mass, weight volume, time, energy, power and density.
- It was observed that when the questions were directly asked students could answer to it, but when the questions were application based students found it difficult to answer. Most of the students could answer the question 'Why uniform circular motion is an accelerated motion?' but the same students

failed to respond to the question 'Can a body have acceleration without change in magnitude of velocity?' It could be interpreted the basic concept of uniform circular motion is not clear to students. The same situation was observed when the laws and concepts were directly asked and when the laws and concepts of physics were asked in the form of events occurring in nature. It can be interpreted that students lacked application of the learnt concept in a real life situation.

- SI units were not specified after the physical quantity. Students also had difficulty in converting CGS unit into SI unit and deriving the SI unit of a particular physical quantity. It can be interpreted that the basic definition and concepts involved in a particular physical quantity is not clear to students which in turn hinders the derivation of its S.I unit.
- Students lacked the utilization of specific and proper scientific terminology. In certain instance it was observed that a student goes on explaining and elaborating the situation where as a single scientific term could be enough. For example the student writes "the box was too heavy and so the box did not move on applying force" wherein the student could write "the box had larger inertia". It could be interpreted that students are not able to use appropriate scientific terminology in describing a scientific event.
- It was observed that students were perplexed regarding the application and interpretation of negative physical quantities: acceleration and retardation, negative force and negative velocity. The lack of clarity of these concepts directly affected the solution of word problems in physics.

4.2 FINDINGS FROM THE SITUATIONAL ANALYSIS PHASE

4.2.1 Findings from the analysis of Information Schedule of Physics

- The responses of the students on the Information Schedule of physics revealed the concepts of acceleration and retardation (67.78%), commercial unit of energy (59.73 %), linear momentum (55.70 %), Quality of timber of sound (55.70 %), and derivation of equation of motion (55.70%) to be the most difficult concepts in physics of standard IX science and technology.
- Irrespective of the chapter, students felt difficulty with solving word problems based on the physics concepts. It can be interpreted that it might be possible

that the lack of conceptual clarity of the concepts hinders its applicability in the form of numerical in physics.

4.2.2 Findings from the analysis of Interview schedule

- Students (30%) felt physics difficult as they felt difficulty in defining the terms, remembering the formulae's and memorizing the derivations. It can be thus interpreted that students felt that the physics concepts needed memorization and more efforts to remember the formulae's and definitions.
- Students (32.5%) felt that the physics concepts in standard IX was difficult as compared to standard X. Students (15%) were of the view that standard X being board, they were more serious in learning the concepts and teachers were also more focused as compared to standard IX. Students (10%) were of the view that in standard X they cannot skip or omit topics and felt compulsion to learn all concepts.
- Students (40%) said that the teacher taught in class and they took notes in class. Questions were asked when the students made noise or talked in the class. It can be interpreted that dictating notes is an important aspect of the present teaching learning process in class room while student interaction and participation is least emphasized.
- Students (40%) said that they memorized the definitions as given in the text. They said that they were graded low if at all they attempted to write the definition in their own words. It implies the emphasis of rote memorization and reproduction of the textbook language.
- Related to activities performed in the class students (40%) said that the activities given in the text were rarely performed by the teacher. The students said that at times when the activity was demonstrated by teacher it created disciplinary problems and the teacher then had to finally conclude. It implies that activities are performed as a ritual in class wherein the discipline in the form of silent participants is given more priority than students understanding and interaction.
- All the students were excited and enthusiastic about doing practical work in lab. Students (55%) confessed of manipulating the findings and result. Most of them also admitted of memorizing the findings and result to reproduce it in the

exam. The finding implies the mere formal procedure of conducting practical lab activities as a part of the curriculum and emphasis on producing the desirable outcome of the performed activity by students.

- The practical lab activities were not supported with the theoretical base. It implies the gap between theory and practical lab work conducted.
- Most of the students (50%) said that they never asked questions during the classroom interactions. Students (15%) were of the view that questions were asked by scholar students only. It implies that classroom participation was restricted to a few students who were considered of higher intellect than the rest of the students in class. It reflects the traditional classroom wherein a teacher is the authority and students mere recipients.
- Students (10%) were of the view that the revision classes before exams helped them to presume the expected questions for exam. They were of the view that whatever was taken up by the teacher in the revision class before exam was sure to be the part of the question paper. It implies that the questions to be asked in the exams were discussed as a part of the revision classes. The examination thus conducted as a part of the evaluation of students' learning outcome does not measure the true learning outcome of students.
- Students (80%) relied on the teachers' class notes for understanding the concepts. Only ten percent students reported to have referred books and internet sources for understanding the physics concepts. It implies the age old traditional classroom where teacher is the only source of knowledge and class notes as the encyclopaedia. Students solely rely on teacher's notes and hardly explore beyond the textbook.

4.2.3 Findings from the analysis of the answer sheets of students

- Students used either wrong formulae or made mistake in mathematical calculations while solving the word problem in physics. Lack of mathematical skills with integers, decimal system, indices and power were seen among the students. It can be interpreted that mastery in basic mathematical skills facilitated in solving numerical in physics.
- Students found it difficult to represent the law or definition in symbolic mathematical formulae. Students lacked conceptual clarity on the physical

interpretation of the symbolic representation of the formulae. This was observed common while defining, stating and representing Newton's second law of motion, acceleration, momentum and law of conservation of momentum.

- It was observed that most of the students reproduced the mathematical steps of the derivation without supporting it with theory. It could be interpreted that the students are not able to relate one concept with the other while deriving the formulae. Hence they fail to provide theoretical support to the mathematical steps during derivation.
- It was found that the terms velocity/speed/acceleration, uniform/non uniform motion, weight/mass, volume/density, echo/reverberation and frequency/amplitude were interchangeably used while defining or explaining a phenomenon. It could be interpreted that the students' rote memorized the definition and laws and when they forget the specific term they interchange it with a term that is nearly associated or linked with it.
- Students were not able to use the specific and appropriate scientific terminologies in explaining a concept/principle.
- It was observed that the students committed errors in plotting the scale on the axis, identifying the type of motion from the nature of graph and interpreting the plotted graph.
- It was observed from the analysis of the answer sheets that when the questions were directly asked students could respond to it correctly but when the questions were framed on the application level, students found difficult to respond. It can be interpreted that the students were not conceptually clear and hence could not respond to the questions framed on the application level. Students lacked application of the concept in a real life situation.
- The lack of clarity on the application and interpretation of physical quantities of acceleration and retardation, negative and positive velocity, object moving against gravity and object falling under the effect of gravity directly affected their solution of word problem in physics.

4.3 DEVELOPMENT OF AN INTERVENTION PROGRAMME

Before the development of the intervention programme the researcher carried out the situational analysis. The situational analysis phase formed the base to design the intervention programme. From the findings of the situational analysis phase, it reflected that activities and experiments were hardly performed in class, and if done was carried out as a mere ritual. The activities were hardly supported with discussion and inquiry based questions. The analysis of answer sheets also revealed the gap between student's actual understanding of the concept and the expected level of understanding of concepts. Higher order questions, as a part of evaluation were indirectly disclosed to students promoting the rote memorization and mere reproduction of information.

The researcher carried out the content analysis of the five chapters of physics from the Science & Technology subject of standard IX. The findings and interpretations drawn from the situational analysis phase were further discussed with the subject experts and finally those topics wherein activities could be developed were finalized. The findings of the situational analysis and expert guidance helped the researcher to select the topics of physics to develop the intervention programme.

The fifth survey of research in education states that 'It is difficult to answer the question: which one of the methods or techniques of teaching is the most effective?' It implies that the selection of any one method may not be sufficed for teaching of different content. The reviewed literature Shelat (2012), Amin (2011), Parvathy (2004) and Deborah (2000) focussed on activity based instructional strategy and are of the view that selection of a particular method of teaching depends on the nature of the content to be taught, the objectives to be achieved and the profile of the students. For the present study a number of activities pertaining to student centred approach were designed with help of reference books, internet sources, discussions with subject experts and referring online educational sites. The activities were developed using the inductive approach. The activities included power –point presentation, group activities, demonstrations, puzzle solving, role play, sports activities, audio visual aids in the form of short animated videos, short video's from movies and audio of different sounds, online videos and you tube videos. The intervention programme also attempted at using the scientific terms in day to day conversations. The designed activities were sent to experts for validation. The suggestions from experts were discussed and the developed programme was modified and finalized. The finalized

intervention programme was implemented on the selected sample of standard IX students for the academic year 2012-2013.

4.4 IMPLEMENTATION OF THE INTERVENTION PROGRAMME

The developed intervention programme was implemented from 9th April 2012 till 5th February 2013. The brief outline of the plan of implementation of the intervention programme is given in table no 3.2. The activities were implemented in classroom using inductive approach wherein known concepts/ situations acted as stimulus for the students to unfold the unknown concepts. The present chapter provides a detailed day wise description of the learning experiences provided to students based on the learning objectives and the students' responses towards the learning experiences. Audio recording of the transaction process was not feasible due to field constrains. Day wise the implementation of the intervention programme is presented below.

4.4.1 Implementation of Entry Level test

Day 1

Total Time: 135 minutes

The researcher was formally introduced to the students as their physics teacher. After the formal introduction of the students, the entry level test was implemented on the students. The students were given the test sheets and they were to respond in the same sheet.

4.4.2 Concept of Motion

Day 2

Total Time: 45 minutes

Learning Objectives

- Students will be able to define motion
- Students will be able to relate the motion of the object with respect to the reference point
- Students will be able to understand that motion and rest are relative and not absolute

Learning Experiences

Images of objects in motion i.e. a cycle in motion, vibrating pendulum, a merry go round, the stars and planets, a boy sitting in the bus and a lady standing outside and an

ant moving on the table were shown to the students. They were asked to observe the images and in the later half questions will be raised on their observations. The following questions were raised in the classroom:

— What were the common aspects in all the images?

— Are the planets in motion?

— If the boy in the bus is in motion, why do the lady and the trees outside the moving bus seem to be in motion to the boy?

— Are we in motion or at rest?

— If I am in space and if I happen to see your classroom from there, will you all be in the state of motion or in the state of rest?

Learning Outcome

Initially when the researcher entered the classroom the students opened their textbook and class note book. When they were told to close the books they asked whether they are not going to study. They were conditioned that teaching learning can take place in the class only when the textbooks are open and notes are dictated in class.

The questions rose proved to be stimulus to the students and they actively shared their views in response. The researcher channelized and connected the different responses of the students to arrive at the desirable learning outcome. By the end of the discussion students could relate that for an object to be in the state of motion or in the state of rest a reference point is required. They could justify that an object may appear to be in motion to one while the same object may be in the state of rest to another depending on the reference point. They could also come up with many more examples from day to day life.

4.4.3 Concept of Distance and Displacement

Day 3

Total Time: 90 minutes

Learning Objectives

— Students will be able to differentiate the terms distance and displacement

— Students will be able to relate the concept to real life situations

Learning Experiences

Students were taken to the yoga room which was a rectangular hall. The students were divided into six groups. Three groups were asked to walk along the perimeter and

reach a particular point. The other three groups were asked to walk along the diagonal and reach the same point. The groups were instructed to walk in such a way that their each step coincided with the other. All the groups were asked to keep a record of the total number of steps taken to reach the final point and the time taken for the same.

Learning Outcome

The observations of the students were taken up for discussion and they could relate the concept of time taken and the number of steps. They could justify why the groups who walked through the diagonal could reach faster at the destination. They could relate the concept of area with distance. The students could come up with the definition of displacement as the shortest distance between initial point and final point. They could relate the phrase '*Go by the hypotenuse and you'll reach faster*' for displacement. They could relate the concept of displacement with the '*snake and the ladder game*' and '*climbing a hill on foot and going by rope way'*.

4.4.4 Concept of Scalar and Vector quantities

Day 4

Total Time: 45 minutes

Learning Objectives

- Students will be able to differentiate the terms Scalar and Vector quantities
- Students will be able to classify the given physical quantities to be scalar or vector

Learning Experiences

The students were given two statements:

1. To reach to the bus stand go straight till the grocers shop, then take a left turn and a post office will come then take a right turn and go straight.
2. To reach the bus stand go straight nearly 5 km, you'll come across a crossroad. Drive to the west covering 4 km and you'll reach near the post office. 1 Km east to the post office is the bus stand.

Learning Outcome

The students were asked which of the statement was more meaningful and why? The responses of the students were channelized to define the variables of magnitude and direction. The students were thus made to understand that in order to define certain physical quantities both magnitude and direction are required while to define certain

physical quantities only magnitude is sufficient. Examples were related and thus the concepts of scalar and vector quantities were explained. The researcher listed a few physical quantities on the blackboard and asked the students to classify them as scalar or vector quantity.

4.4.5 Concept of Uniform Motion

Day 5

Total Time: 90 minutes

Learning Objectives

— Students will be able to explain uniform motion

— Students will be able to plot the graph on the acquired data

— Students will be able to infer the type of motion executed by a simple pendulum

Learning Experience

Required Materials: A bob, string, a stand, graph paper and a stop watch

The students were divided into ten different groups. Each group was given the required materials for the activity. The students were asked to vibrate the pendulum and count the number of vibrations for every one minute. They were to take ten readings each after a minute continuously. They were instructed to plot the graph of time period vs. the number of vibrations.

Learning Outcome

Four groups could perform the activity and plot the graph. Students in the other groups had difficulty with plotting the scale for graph. After the activity the students were asked what could they infer from the graph? The students responded that the graph was somewhat linear/ straight line in nature. The students could relate equal interval of counts with equal time interval and could come up with the concept of uniform motion.

4.4.6 Concept of Non Uniform Motion

Day 6

Total Time: 90 minutes

Learning Objectives

— Students will be able to explain non uniform motion

— Students will be able to plot the graph on the acquired data

Learning Experience

Required Materials: An activity sheet – Digital Symbol Test (refer Appendix A), graph paper and a stop watch.

Each student was given an activity sheet. The students were to perform the activity in a group of two. One of the students performed the activity and the other kept the record of time. The students were to replace the digits in the sheet with the associated symbol in one minute time. The numbers of trials given were ten. At the end of the activity they were to count the number of correct substitution and to give scores. The students were instructed to plot the graph of no of trials vs. the scores on each trail.

Learning Outcome

After the activity the students were asked what could they infer from the graph? The students responded that the graph was not linear, curved in nature. The students related unequal counts in equal time interval and could come up with the concept of non uniformity in the nature of graph. Other example of a bus travelling on a street with heavy traffic was taken up in class to relate the variable of unequal distance travelled by the bus in equal interval of time.

4.4.7 Concept of Speed and Velocity

Day 7

Total Time: 135 minutes

Learning Objectives

- Students will be able to relate the variables of time and distance with speed
- Students will be able to differentiate speed and velocity
- Students will be able to plot the graph of time vs. distance covered
- Students will be able to solve the numerical based on the concept of speed and velocity

Learning Experience

Students were taken to the ground and divided into a group of eight. Each group had four students. The students were to participate in the relay race. Each student of the group was made to stand at 40 metre distance from each other on the ground. The total distance to be covered was 160 metre. At each point a student was allotted the duty to keep the record of time. By the end of the activity, each group had a record of distance travelled by each participant and the time taken to cover that distance.

Learning Outcome

Each group plotted a graph of time vs. distance covered and interpreted who ran faster and who was slow in the race. Students related the action of being fast and being slow with speed. The students were made to relate the variables of distance and time to arrive at the definition of speed. The students were already aware of the concept of scalar and vector quantities, hence it facilitated in understanding the concept of velocity. Relating the direction and magnitude of fastness and slowness, students were able to derive the concept of velocity. The concept was further discussed to derive the formulae to calculate speed and velocity. Students solved numerical based on the calculation of speed and velocity from the given data.

4.4.8 Concept of Acceleration and Retardation

Day 8

Total Time: 90 minutes

Learning Objectives

- Students will be able to define acceleration
- Students will be able to define retardation
- Students will be able to identify accelerated and retarded motion from the video
- Students will be able to relate the variables of velocity and time with acceleration
- Students will be able to relate the concept of acceleration and retardation in a real life situation
- Students will be able to use the terms acceleration and retardation in their day to day conversations.

Learning Experience

Students were shown a three minute video of cycle race from the Hindi movie '*Jo Jita Wohi Sikandar*'. The students were asked the following questions related to the video:

- Which are the concepts you could identify in the video?
- How could one cyclist overtake the other?
- How could the variable of velocity and time be related here?
- Locate the points of increase in velocity and decrease in velocity of the cyclist in the video.

Learning Outcome

The students could relate the concept of velocity, time, uniform and non uniform motion in the video. The students could finally relate the concept of change in velocity with respect to time and derive the concept of acceleration and retardation from the discussion. The students were asked a question:

Do you have the right to accelerate your life to such an extent that it leads to retardation of the life of others?

To sensitize the students towards after effects of rash driving a short you-tube video on road accidents was shown. Attempts were made to sensitize the students the importance of following traffic rules keeping in mind individual and societal safety. Students were thus able to relate the concept of acceleration and retardation in a real life situation.

4.4.9 Concept of Circular Motion

Day 9

Total Time: 90 minutes

Learning Objectives

— Students will be able to define circular motion

— Students will be able to understand that the direction of motion at any instant of time is along the tangent to the circular path at that instant

— Students will be able to explain uniform circular motion is an accelerated motion

Learning Experience

Activity1

The students were taken to the ground. The sports teacher helped the researcher in conducting the activities. On the ground different blocks of different shapes were made with the help of chalk powder. There was a rectangular block, square block, pentagon shaped block, hexagon shaped block, an octagon shaped block and a circular block. The students were asked to run on the perimeter of the blocks and note down how many times they require a change in their direction while running on each block. The observation of the students were taken up and discussed in class.

Learning Outcome

The students observed that at each corner of a particular block they were to change the direction. They could also realize that there speed went zero at the point of change in direction. They could conclude that as the number of sides of a particular block increases the number of turns also increases and it is the maximum in a circle, as the length of each side tends to be zero. Through discussion, the students could understand that the effective direction of motion at any instant is along the tangent to the circular path at that instant.

Day 10

Total Time: 90 minutes

Activity 2

Required Materials: A nylon thread and a small stone

The researcher demonstrated the activity and the students were asked to observe and note down their observations. The researcher tied a piece of thread to a small piece of stone at one of its ends. It was rotated in a circular path with constant speed by holding the thread at the other end. After a few rounds of rotation of the stone the researcher left the stone free by releasing the thread. The activity was repeated for three more times and the stone was released at different positions of the circular path.

Learning Outcome

Students responded and their observations stated that the stone described a circular path with constant speed and when the stone was released the stone tend to move along a straight line. They could also justify that the stone continues to move in the direction it has been moving at that instant and that the direction of motion changed at every instant. They could also come with other examples of merry-go-round, well of death, moon moving around the earth uniformly in a circular motion, artificial satellites around the earth and a cyclist moving over a circular track.

Activity 3

Required Materials: Disc and measure tape.

The sports teacher assisted the researcher in the activity Disc throw. The sports teacher selected twelve students for the disc throw activity. The rest of the students observed them. The sports teacher gave the students demonstration for the disc throw. One by one the twelve students threw the disc and the distance to which the disc fell

was measured. The rest of the class observed them. Discussion was taken up after the activity.

Learning Outcome

The students reported that they could observe the student who threw the disc held the disc in his palm and gave it a circular motion by rotating his body. They could also conclude that the moment he released the disc it moved in the direction in which his body was moving at the time of release. Through inquiry based questions and discussion the students could understand that the speed of the body in a circular motion remains constant but the direction of motion of the body changes continuously and hence uniform circular motion is an accelerated motion.

Frame 4.1: Student throwing the Disc

Frame 4.2: Disc thrown moves in the direction of release

Day 11

Total Time: 90 Minute

Learning Objectives

— Students will be able to relate the concepts and solve the word problem in physics

— Students will be able to derive the S.I units of physical quantities

Learning Experience

The students were given worksheet on numerical. The worksheet consisted of step by step derivation of S.I units from the definition of the physical quantity. It also constituted numerical based on the learnt concepts.

Learning outcome

The researcher guided the students by probing and providing hints to the word problem. It was seen that most of the students could follow the step by step process

and solve the numerical. They could also derive the S.I unit of the physical quantity on their own.

4.4.10 Revision

Day 12

Total Time: 45 minutes

Learning Objectives

— Students will be able to interrelate the concepts of motion

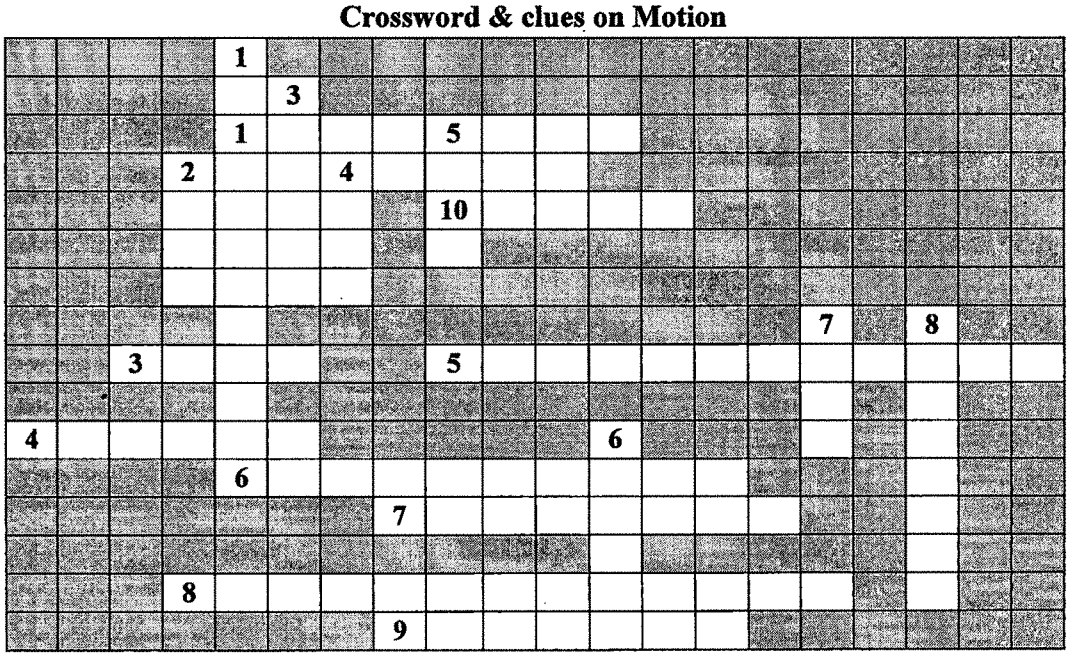
— Students will be able to solve the crossword on motion

A revision class was taken up wherein the concepts were revised by drawing a flow chart of the concept learnt and inter relating the concept with one another. Each student was provided with a worksheet of crossword with clues. They were to solve the crossword with the help of the clues given to them. The students were provided fifteen minutes to solve the crossword. Most of the students were able to solve the crossword on their own. Some of the students had difficulty in understanding the clues given.

The crossword was solved and discussed in the class. The crossword used as a part of the revision activity is presented below:

Table no: 4.2

Crossword & clues on Motion



Down

1. Rate of change of velocity. (12)
2. State of body, when its position doesn't change with time. (4)
3. Scalar quantity. (6)
4. Quantity under *v*- *t* graph that gives distance. (4)
5. Displacement of body changes with respect to this quantity to give velocity. (4)
6. Change in position of object with time. (6)
7. Net displacement of body for a complete circle. (4)
8. Rate of change of displacement. (8)

Across

1. Speed for uniform motion. (8)
2. Type of terms: Rest and Motion. (8)
3. Distance depends on it. (4)
4. It has both direction and magnitude. (6)
5. Shortest distance between two points. (12)
6. Type of motion represented by curved distance-time graph. (10)
7. Sign of decreasing acceleration. (8)
8. Equal distance covered in equal interval of time. (13)
9. S.I unit of time. (6)
10. S.I unit of distance. (5)

4.4.11 Concept of Force

Day 13

Total Time: 45 minutes

Learning Objectives

— Students will be able to define force

— Students will be able to state the S.I unit of force

— Students will be able to explain how force and motion are related

— Students will be able to justify force is the cause of acceleration produced in a body

— Students will be able to identify the effects of force in day to day life activities

Learning Experiences

Students were given the situations of rest and motion of objects. They were asked how an object at rest can be brought into motion. From discussion, the concept of

force could be derived. The students were divided into six different groups and each group was assigned the task to list down the activities from day to day life wherein force is applied to perform the task. They were also to mention the effect seen when the force is applied. Students were given 10 minutes for the task. Discussion was followed by the activity.

Learning Outcome

Students could come up with the definition of force as 'the push and pull' and 'the efforts required to perform a task'. Each group could list down at least ten to fifteen activities of daily life wherein force is applied to perform a particular task. The discussion helped them to categorize the effects of force as change in state of motion, change in direction and change in shape or size of the body. From the listed activities, they could relate force as a cause for acceleration in a body.

4.4.12 Concept of Balanced and Unbalanced Forces

Day 14

Total Time: 90 minutes

Learning Objectives

— Students will be able to define the resultant force

— Students will be able to explain the balanced and unbalanced forces

Learning Experience

Required Materials: A strong rope and powder

Students were taken to the playground and were divided into two teams. The game of tug of war was organised between the two teams.

Learning Outcome

The students could explain that the rope did not move in the beginning as the force applied by both the groups was same and hence the resultant force was zero. The students could thus define the resultant force and explain the concept of balanced force. When the rope moved to a particular side when the force was applied, the students could infer that force applied by one group was more than the force applied by the other and hence the rope moved to the side wherein the force applied was more. Thus they could explain the unbalanced forces. With their experience in the game of tug of war, the students could thus define the balanced and unbalanced forces.

Frame 4.3: Girls playing tug of war

Frame 4.4: Boys playing tug of war

4.4.13 Concept of Frictional Force

Day 15

Total Time: 90 minutes

Learning Objectives

- Students will be able to define the frictional force
- Students will be able to explain the difference in the rate of motion of the ball on a smooth surface and that on a rough surface
- Students will be able to interpret that the direction of the force of friction acts in a direction opposite to the direction of motion of object

Learning Experiences

Activity 1

Required Materials: marble, plastic ball, cricket ball, a crumpled paper, stop watch, sand paper, smooth and rough surfaces, measuring tape and an inclined plane.

The researcher demonstrated the activity. The students were asked to observe. The researcher rolled a marble, a plastic ball, a cricket ball and a crumpled paper simultaneously on an inclined plane kept on a marble floor. The distance travelled by each object was measured and the time taken to travel that distance was noted by the students. The entire activity was repeated after covering the surface of the inclined plane with a sand paper and placing the inclined plane on a muddy surface. The speed of objects in each case was calculated.

Activity 2

Required Materials: marbles, smooth floor, mud, sand, stop watch and measure tape. The students were divided into six groups. Each group was given a kit of the required material and a sheet of observation. The students were to perform the activity and note the observation. The students rolled the marble on a smooth floor of marble, on a muddy ground and on a sheet sprinkled with sand. The distance travelled by the marble each time and the time taken to cover the distance was noted. Each group were to calculate the speed of each object.

Learning Outcome

For both the activities questions were raised in the class and discussion done. The students could come with number of justification of why some objects could travel faster and why some were slow. The discussion was channelized to arrive at a force that opposes motion of objects. Further, the concept was explored to relate the type of surface and the force of friction.

4.4.14 Galileo's Observations and Conclusions

Day 16

Total Time: 45 minutes

Learning Objectives

— Students will be able to comprehend that a body moves with a uniform velocity, if no force is acting on the body.

Learning Experience

An online 2 minute short video showing Galileo's experiment was shown to students from the site

http://cbsc.meritnation.com/study-online/study-material/gtDwzBfpmFfta7dY6.com

This was followed by discussion.

Learning Outcome

The students could observe the motion of a marble on an inclined plane. They could deduce that when a marble roll down an inclined plane its velocity increases and when it moves up an inclined plane its velocity decreases. They could comprehend that when it moves on horizontal plane its velocity remains constant for some time and then finally it comes to rest due to the force of friction acting in the opposite direction of motion. The researcher also related the example of swinging pendulum which stops after sometime.

4.4.15 Concept of Inertia

Day 17

Total Time: 90 minutes

Learning Objectives

— Students will be able to define inertia

— Students will be able to explain why a coin falls in a glass when the card moves away when the card on which the coin is placed is flicked away

— Students will be able to explain why only the last coin moves while the remaining coins fall vertically when a pile of carom coins are kicked hard using a striker.

Learning Experiences

Activity 1

Required Materials: Table, table cloth, a jug, a plate and a bowl.

The researcher demonstrated the activity in the class. A table cloth was laid on the table. The table was set with a jug half filled with water, a plate and a bowl was placed. Then all of a sudden the researcher pulled the tablecloth from under the set table. The students observed the demonstration.

Learning Outcome

The students were curious to know how it could happen. The reason was elicited from them and they could come up with a justification that the pull was all of a sudden and the objects did not have time to undergo the change in their state of rest. Thus the concept of inertia was derived. One of the student related inertia as '*I wanted to get up early today but due to inertia I was not able to get up*'.

Activity 2

Required Materials: Table, carom board, pile of coins, striker.

A carom board with the pile of coins was placed on the table. Individual students were asked to strike the pile of coins hard using a striker. Later on discussion was carried out on their observations.

Learning Outcome

The students observed that in some cases the entire coins got scattered whereas in many of the cases only the last coin moved away while the remaining coins fell vertically. The students could relate the activity 1 and could justify that when the force was evenly applied on all the coins they shattered while when the flick of striker

acted on the last coin the rest of the coins remained in their previous state due to inertia as no force acted on them.

Frame 4.5: Students piling up the carom coins

Frame 4.6: Students striking the pile of coins

Activity 3

Day 18

Total time: 90 minutes

Required Materials: Plastic tumblers, smooth surface cards, a few five rupee coins

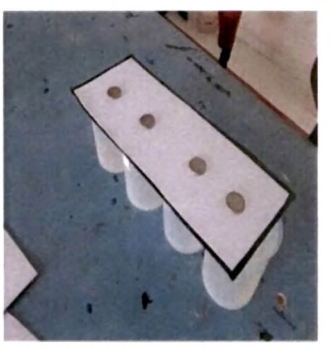
The researcher demonstrated the activity and later on the students were asked to try it out in class in their individual group. A smooth surfaced card was placed on the mouth of a glass tumbler. A five rupee coin was placed on the card. The card was flicked hard with the finger. The students were asked to make their observation and try to justify the cause. The students then performed the activity in their respective group. They were asked to try the activity by simultaneously increasing the number of tumblers and the number of coins and see if they could get the same effect. The students were provided with different shapes of cards and coins to experiment.

Learning Outcome

The students were excited to do the activity on their own. One of the groups could experiment with five coins and five tumblers. They were excited to share the same effect as they got when they tried it with one coin and one tumbler. Some of the students reported that at times the coin also went away with the card but most of the time the card moves away but the coin dropped into the tumbler. Students in group discussed why it happened so. Most of the students could relate that when the card was flicked force when acted only on the card, the coin dropped in the tumbler but

when the force acted both on the card and on the coin; the coin also went away with the card. Questions were raised what will happen if we use a stone instead of the coin? Students could relate activity 1 and 2 and could establish the cause and effect relationship.

Frame 4.7: Activity on Inertia with two coins



Frame 4.8: Activity on Inertia with four coins

4.4.16 Relating Inertia and Mass

Day 19

Total Time: 45 minutes

Learning Objectives

- Students will be able to relate mass with inertia
- Students will be able to identify which of the bodies have higher inertia
- Students will be able to understand larger the mass of the body larger the inertia
- Students will be able to justify that mass of a body is a measure of inertia of the body

Learning Experiences

The students were provided with an activity sheet. They were to estimate which of the objects will require more force to bring that object in motion and which of the objects will require less force. This was followed by discussion and various daily life examples were taken up to relate mass of an object with inertia. The activity sheet used as a part of the learning experience is presented in the table below.

Table 4.3

Activity sheet relating mass and inertia

Sr. No	Objects	Less force required to move the object	More force required to move the object
1	Science text book Std IX		
2	Stone of 60 Kg		
3	An Iron gong		
4	Tuning Fork		
5	A chalk stick		
6	Metal cuboid		
7	Duster		
8	Metal bob		
9	Eraser		
10	Feather		
11	A crumpled paper		
12	A bouquet		
13	LPG gas cylinder		
14	An iron cupboard		
15	Empty suitcase		
16	2 kg cotton		
17	5 kg rice bag		

Learning Outcome

Students interpreted that the more the mass of the object the more force was required to move that object. They were already familiar with the concept of inertia and thus they could relate that the heavier object had more inertia and lighter objects had less inertia. From the discussion they could also conclude that the measure of inertia depends on the mass of the body. They could also relate the example of the force required to push a swing with a man of 80 kg on it and another swing with a child of 20 kg. One of the student in class said ' *Mam, in our class Sneh will have the highest inertia'*. (Sneh was a well built student in the class)

4.4.17 Types of Inertia

Day 20

Total Time: 45 minutes

Learning Objectives

— Students will be able to understand that a body at rest remains at rest and cannot start moving on its own.

— Students will be able to understand that a body in uniform motion can neither get accelerated nor get retarded on its own.

— Students will be able to identify the type of inertia from the given set of examples.

Learning Experiences

Discussion was initiated from the definition of inertia. The state of rest and motion were focussed to arrive at the inertia of rest and inertia of motion. Examples were taken up to relate the concepts. The students were then given a list of examples from day to day life and asked to identify the type of inertia experienced in each example. The list of examples is as follows:

— If a piece of paper placed under a pile of books is suddenly pulled, it does not disturb the pile of books.

— A passenger in a bus tends to fall backward when the bus starts suddenly.

— On shaking or giving jerks to the branches of a tree, the fruits fall down

— A passenger in a moving bus tends to lean forward when the bus stops suddenly

— A person jumping out of a speeding bus may fall forward.

— An athlete runs a certain distance before taking a long jump

— A cyclist does not come to rest immediately after he stops pedalling

— Dust can be removed from a hanging carpet by shaking it or beating it with a stick

— A bullet fired against a glass windowpane makes a hole in it but the glass pane is not cracked

— It is advised to tie our luggage kept on the roof of a bus with a rope

— A passenger experiences a sideway jerk when a bus takes a sharp turn

Learning Outcome

Students could derive the types of inertia from the definition and examples. Most of the students could identify the type of inertia in each of the examples and provide justification. For the rest of the students each example was taken up one by one and discussed in class.

4.4.18 Newton's First Law

Day 21

Total Time: 45 minutes

Learning Objectives

— Students will be able to state Newton's first law of motion.

— Students will be able to relate the concept of inertia with Newton's first law of motion

Learning Experience

The researcher revised the concept of inertia and types of inertia in the class. From the discussion the students could state that a body at rest remains at rest and cannot start moving on its own. They also stated that a body in uniform motion can neither get accelerated nor get retarded on its own. The researcher then combined the two statements given by students to arrive at the Newton's first law of motion. Examples were taken up in class to relate the concept in a real life situation.

Learning Outcome

As the class initiated from the concept of inertia it facilitated students to relate inertia and the first law of motion. They could conclude that Newton's first law of motion defines inertia. They could also comprehend that an external force is required to change the state of motion of an object.

4.4.19 Concept of Momentum

Day 22

Total Time: 90 minutes

Learning Objectives

— Students will be able to relate the variable of mass and velocity with momentum

— Students will be able to define momentum

Learning Experiences

The students were taken to the ground. The students formed two teams and played the game of cricket. The researcher observed the students playing and formulated a few questions for discussion in the class. After the match their experiences of the match were channelized through questions to relate the impact of mass along with velocity to arrive at the concept of momentum.

Learning Outcome

The students could relate the force felt when the cricket ball was moving with high velocity and when the cricket ball was at less velocity. They could identify the importance of mass and velocity of an object coiled together to produce an impact of momentum. The examples of impact produced by massive truck moving at a high speed and a bullet fired from the gun was discussed to arrive at the concept of momentum as the product of mass and velocity. The variable of time as the rate of change in momentum was also taken up during the discussion.

4.4.20 Concept of Gravitational Force

Day 23

Total Time: 45 minutes

Learning Objectives

— Students will be able to define gravitational force

— Students will be able to explain the importance of gravitational force

— Students will be able to explain the centripetal force

Learning Experience

The researcher initiated a discussion in class by relating the first law of motion with the fall of an apple from the tree. The classroom interaction was channelized to elicit the definition of gravitational force from the students. Some of the students were already aware of the centripetal force provided by the force of attraction of the earth. The students were then asked the importance of the gravitational force and the following examples were discussed in detail in class.

— The motion of moon in its orbit around the earth

— The sun and the planets in motion

— The earth revolves in a circular orbit around the sun

— Formation of tides in the sea

— The atmosphere is held near the surface of the earth

— Artificial satellites revolve around the earth of the solar system

— The fall of rain and snow towards the surface of the earth

Learning Outcome

The students were able to provide definition of gravitational force and could justify with examples the importance of gravitational force in nature.

4.4.21 Concept of Acceleration due to gravity

Day 24

Total Time: 45 minutes

Learning Objectives

— Students will be able to define free fall

— Students will be able to understand that the acceleration is produced in a free falling body

— Students will be able to explain the impact of the resistance due to air on free fall

— Students will be able to explain that the acceleration produced in the free falling bodies does not depend on the mass of the falling bodies.

Learning Experiences

The researcher threw a ball upwards and initiated the discussion in the class. Students said that due to gravitational pull the ball will come down. The next question raised was whether the ball underwent a change in velocity with respect to time? The students agreed that the ball initially had certain velocity and it went to zero at the top and again when it returned back it had a different velocity. The discussion was related to change in velocity with respect to time and the concept of acceleration was focussed. The researcher explained that when a body falls towards the earth with no other force acting on it other than the gravitational force, such motion of the body stated to be the free fall. The researcher showed a short online animated video from the site http://cbse.meritnation.com demonstrating Robert Boyle's Experiment on Galileo's argument. A coin and a feather were kept in a glass jar. The air in the jar was removed by using a vacuum pump. After evacuation of air from the glass jar, the glass jar was inverted. Both feather and the coin fell to the bottom of the jar at the same time.

Learning Outcome

The students could relate that objects falling freely toward the surface of earth produce acceleration. They could conclude from the video that in ideal situation the acceleration produced in free falling objects does not depend on the masses of the falling objects. In day to day life the acceleration due to gravity of falling objects is affected by the resistance of air in the atmosphere. Hence the heavier bodies fall faster than the lighter ones.

4.4.22 Acceleration due to gravity at Poles and at Equator

Day 24

Total Time: 45 minutes

Learning Objectives

- Students will be able to infer acceleration due to gravity to be different at different places.
- Students will be able to explain the value of acceleration due to gravity to be maximum at poles
- Students will be able to explain the value of acceleration due to gravity to be minimum at the equator.

Learning Experiences

The students were explained the relation between acceleration due to gravity and the radius of the earth. The researcher derived the relation that acceleration due to gravity is inversely proportional to the square of radius of the earth. A short online animated video from the site http://cbse.meritnation.com/study-online/study-material was shown to the students. The video depicted the radius of the earth to be maximum at equator and minimum at poles. It also showed the gravity on the surface of moon. Discussion was initiated in the class based on the video shown to the students.

Learning Outcome

The students could infer that as acceleration due to gravity and the radius of the earth are inversely related, the acceleration due to gravity is maximum at poles and minimum at equator.

4.4.23 Concept of Mass and Weight

Day 26

Total Time: 45 minutes

Learning Objectives

- Students will be able to calculate the least count of the spring balance
- Students will be able to measure the mass of the body
- Students will be able to calculate the weight of the body
- Students will be able to differentiate the mass of the body from the weight of the body

Learning Experiences

Activity 1

Required Materials: Spring balance of different calibration

The students were divided into five groups and each group was given three different spring balances with different calibration. The students were asked to pick up one of the spring balance and tell the minimum value that the spring balance can measure. The students did not have clarity regarding least measurable value of spring balance. The researcher explained that the concept of least count as the minimum quantity measured by the instrument. The researcher then explained the calculation of least count by taking up different calibrated instruments and also the value represented by each mark on the spring balance. Students were then asked to measure the least count of the given spring balances.

Learning Outcome

The groups of students could calculate the least count of the spring balances provided to them. They could explain what each mark on the spring balance represented. It was noted that the students of different groups exchanged their spring balances to measure the least count of the spring balance with a new calibration.

Activity 2

Materials Required: Spring balance, electronic beam balance, a metal cuboid, metal bobs of different mass, stones of different mass and shape.

The students were taken to the lab and divided into five groups. Each group was provided with a kit of objects, an electronic beam balance and a spring balance. The students were also provided with a sheet to record the observation. The students were

asked to observe the spring balance and calculate the minimum value that the spring balance can measure. The students were asked to weigh each object using a spring balance as well as a electronic beam balance.

Learning Outcome

The groups observed that the measurement of objects with an electronic beam balance and that with the spring balance was nearly same. They were asked whether they measured the mass or weight of the given objects. Most of the students were confused and a mixed response came from students. Three of the groups were of the view that spring balance measured the weight and beam balance measured the mass of the object. The researcher now asked them to define mass and weight to which again there was uncertainty among the groups. The researcher then explained the concept of mass and weight to the students and made them calculate the weight of each object provided to them. The students could thus understand that both spring balance and beam balance actually measured mass, which then needs to be multiplied with the value of acceleration due to gravity on earth to get the weight of the object.

4.4.24 Revision

Day 27

Total Time: 45 minutes

Learning Objectives

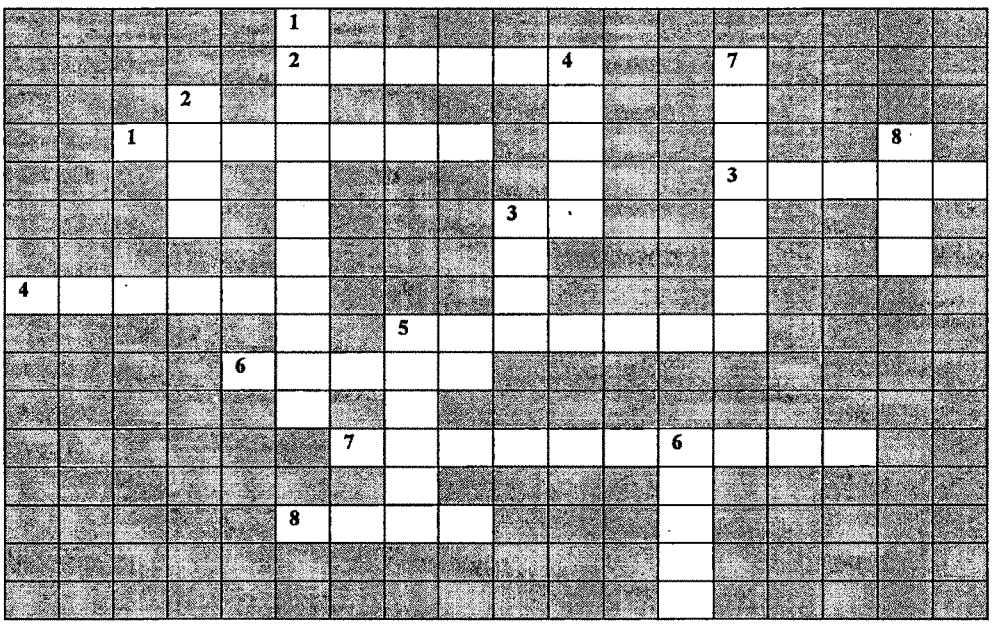
— Students will be able to interrelate the concepts on Gravitation

— Students will be able to solve the crossword on Gravitation

A revision class was taken up wherein the concepts related to Gravitation and acceleration due to gravity were revised by drawing a flow chart of the concept learnt and inter relating the concept with one another. Each student was provided with a worksheet of crossword with clues. They were to solve the crossword with the help of the clues given to them. The students were provided fifteen minutes to solve the crossword. Majority of the students were able to solve the crossword on their own. Some of the students had difficulty in answering the clue no 5 in the across section.
The crossword was solved and discussed in the class. The crossword used as a part of the revision activity is presented below:

Table no: 4.4

Crossword & clues on Gravitation



Down

1. Force of attraction between any two objects in universe. (11)
2. Unit of mass. (4)
3. At this place g is $1/6^{th}$ of g on the earth. (4)
4. Scalar quantity that becomes zero at the highest point of its path when body is thrown vertically upward. (5)
5. *g* is zero here. (6)
6. Gravitation follows this law of Newton. (5)
7. Fall of bodies under gravity alone. (8)
8. It is the same everywhere. (4)

Across

1. Force of gravitation between any object and earth. (7)
2. '*g*' depends on it. (6)
3. Relation between F_{AB} and F_{BA}. (5)
4. Its value is different on different planets. (6)
5. Type of Gravitational Force. (7)
6. '*g*' is maximum here. (5)
7. Nature of force of gravity. (10)
8. Value of weight of an object at centre of earth. (4)

4.4.25 Newton's Second Law of Motion

Day 28

Total Time: 90 minutes

Learning Objectives

— Students will be able to state the second law of motion

— Students will be able to relate mass with acceleration when force acting on the body is constant

— Students will be able to establish the relation between force applied on the body and acceleration produced in the body when mass of the body remains constant

— Students will be able to relate force as product of mass and acceleration produced in a body

Learning Experiences

The students were made to perform an experiment in small groups to

(a) Establish a relation between force and acceleration by keeping mass of the body constant

(b) Establish a relation between mass and acceleration by keeping force acting on the body to be constant

Required Materials: A trolley with smooth wheels, known weights, twine, stop watch, weights, a pulley, a long table and a pan.

Part A: Establish a relation between force and acceleration by keeping mass of the body constant.

The procedure to be followed by each group is as follows:

— Place the trolley on the table such that the distance between the trolley and edge of the table is 1 metre.

— Fix the frictionless pulley to the table and attach a light inextensible twine to the hook of trolley and pass it on to the pulley.

— Attach a pan at the end of the wire.

— Place a standard weight in the pan. Initially the trolley does not move. Gradually increase the weight or load in the pan till the trolley just begins to move.

— Note the time taken to cover the distance using a stopwatch. Record the distance covered and the time taken in the observation table. Calculate the acceleration in the table using the formulae.

— Repeat the experiment by changing the weights in the pan. Now calculate F/a in each case. Record the observation in the table below.

Table 4.5

Observation table to establish relation between force and acceleration

Force	Distance travelled (S)	Time (t) in seconds	$a = 2S/t^2$	F/a

Part B: Establish relation between mass and acceleration by keeping force acting on the body to be constant. The procedure to be followed by each group is as follows.

— Place four weights each of equal mass in the trolley.

— Place sufficient weight in the pan such that the trolley just slides. Note the time taken to cover the distance using a timer.

— Record the values in the observation table. Calculate the acceleration using the formulae. Repeat the experiment by removing 10 gm weight from the trolley each time.

— Calculate the product of mass and acceleration.

Table 4.6

Observation table to establish relation between force and mass

Mass (m) Kg	Distance travelled (S)	Time (t) in seconds	$a = 2S/t^2$	m*a

Learning Outcome:

Students found that in Part A the ratio of F/a is almost constant. Hence they could conclude that force is directly proportional to acceleration. If the force applied on the body is more the acceleration produced in the body is more. From the Part B of the experiment the students could establish the relation that the product of force and mass remains almost constant. Hence they could conclude that product of mass and

acceleration remains constant when force is kept constant. If the mass of the body is less the acceleration produced is more when force applied, to produce acceleration in a body having more mass the force required is more. Finally the students could interpret and establish the relation of force to be directly proportional to the product of mass and acceleration. Once the students could establish the relation between force acting on a body, the mass of the body and the acceleration produced in the body they could understand and state the second law of motion.

4.4.26 Conservation of Momentum

Day 29

Total Time: 45 minutes

Learning Objectives

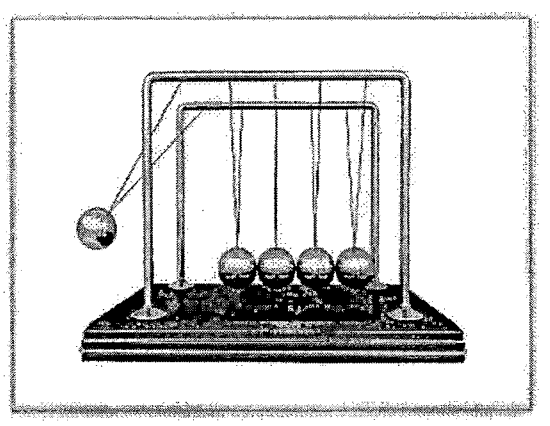
— Students will be able to state the law of conservation of momentum

— Students will be able to explain that the total momentum before collision and after collision remains conserved if no external force acts on the system

Learning Experiences

Required Materials: Newton's Cradle toy/ Executive desk toy

The researcher demonstrated the functioning of Newton's cradle toy. The researcher pulled a ball up and then released it from a height. The students were to note down their observations. The researcher then pulled two balls from the right side of the toy to a certain height and allowed it to swing. Later on the activity was repeated by swinging three balls and four balls simultaneously. Based on students observation discussion was taken up in the class. A model of Newton's cradle toy is given below:



Frame 4.9: Model of Newton's Cradle toy

Learning Outcome:

The students observed that five metal balls hung in a perfectly straight line by thin threads that attach them to two parallel horizontal bars, which in turn is attached to the base. They could observe that when one ball from the right was pulled away and was allowed to fall; it collided with the others with a loud click. Then instead of all four remaining balls swinging out, only the ball on the opposite end instantly swung in an arc almost as high as the release height of the first ball. The same was observed by students in the other two cases when two balls, three balls and four balls were simultaneously pulled and released from the right side of the toy. The discussion in class made the students relate the concept of momentum, as the ball had mass and they acquired velocity. The researcher explained the velocity gain by the other balls when the first ball hit the rest of the balls. Finally the concept of transfer of momentum from one ball to another and the concept of conservation of momentum was derived. The students could thus understand that the total momentum that one ball loses equal to the total momentum the other balls gains.

4.4.27 Newton's Second Law in Daily life

Day 30

Total Time: 90 minutes

Learning Objectives

— Students will be able to relate the second law of motion in day to day life situations.

— Students will be able to explain the relationship between the rate of change of momentum and the impact of force experienced.

Learning Experiences

The students were distributed into six small groups and were provided with a list of everyday experiences. They were to discuss and come up with explanations for the occurrence of certain phenomenon. By the end of the discussion they were to submit the report of discussion. The list of everyday experiences is given below:

— A karate player breaks a pile of tiles or a slab of ice in a single blow

— In cricket, a fielder moves his arms backwards in the direction of ball while taking a catch

— When a car goes out of control, the driver would prefer to hit something soft (say haystack) than something hard (say a concrete wall)
— Athletes performing in the high jump are made to fall either on a cushioned bed or on a sand bed
— Shockers are provided in vehicles
— Athletes are advised to come to stop slowly after finishing a fast race
— Car passengers are advised to wear seat belts
— China and glassware are packed with soft material while transportation
— Springs are provided in car seats

The researcher monitored the groups and responded to queries asked by groups in the form of questions that would direct their thought process.

Learning Outcome:

The students discussed in group for thirty five minutes and each group submitted the report of their discussion. The researcher then asked each group to come up with an oral presentation of the report. Four groups could identify the common concept relating the rate of change in momentum with the impact of force experienced. Once the individual group presentation was done, the researcher summarized and revised the concept in the class.

4.4.28 Newton's Third Law of Motion

Day 31

Total Time: 90 minutes

Learning Objectives

— Students will be able to state the third law of motion
— Students will be able to prove to every action there is an equal and opposite reaction
— Students will be able to infer that the action and reaction act on different bodies.

Learning Experiences

Activity 1

Required Materials: An inflated rubber balloon, thread, adhesive tape and a straw

The activity was demonstrated with the help of student volunteers in the class. The rest of the class noted their observations. A big inflated rubber balloon was tied at

neck using a thread. A straw was fixed on the surface of the inflated balloon using an adhesive tape. A thread was passed through the straw and held by students at both ends. The thread tied to the neck of the inflated balloon was removed and the air inside was allowed to escape from the mouth of the balloon.

Learning Outcome

The students observed that the direction in which the straw moved was opposite to that of the direction of air escaping from the mouth of the balloon. The students could come up with a explanation that the force of air pushed the balloon in the forward direction. The students could also relate the phenomenon of the launching of the rocket. The discussion was channelized to arrive at the terms action and reaction. Finally establishing the cause and effect relationship the statement of Newton's third law of motion was derived. The students could also perceive that the force of action and reaction act on different bodies.

Activity 2

Required Materials: Two spring balance of 0 – 300 g wt, unknown weights and stand.

The students were divided into six small groups. Each group was provided with the required material for the activity. students were provided with an instructional sheet with the following instructions:

— Suspend the spring balance B from a rigid support or stand.

— Join both the spring balance A and B hook to hook.

— Suspend unknown weight at the free end of the spring balance A.

— Record the reading in both the spring balance A and B.

— Repeat the experiment by adding on unknown weights and each time record the reading in the spring balance A and B, in the below table.

Table no 4.7

Observation table on Newton's third law of motion

Sr. No	Reading in spring balance 'A'	Reading in spring balance 'B'

Learning Outcome:

Students recorded the readings in the observation table. They observed every time an unknown weight was suspended the spring balance A and B showed almost the same readings. They also observed that one of the spring balance being in inverted position. They could infer that when an unknown weight is suspended in the spring balance A, it exerts a force (equal to the weight suspended) on spring balance B which is the action force. The spring balance B in return pulls the spring balance A with an equal force, but in opposite direction which is the reaction force. From the activity the students could prove that the action and reaction forces are equal in magnitude but opposite in direction.

Frame 4.10: Arrangement for activity to show action and reaction are opposite in direction

Frame 4.11: Students performing the activity to prove action and reaction are equal in magnitude

4.4.29 Newton's Third Law of Motion in Daily Life

Day 32

Total Time: 90 minutes

Learning Objectives

— Students will be able to relate the third law of motion in day to day life situations.

— Students will be able to identify the action force and the reaction force in a given set of examples.

Learning Experiences

The students were provided with a worksheet of examples from day to day life events. They were asked to identify the action force and the reaction force specifying the direction of force in each case. The students were provided thirty minutes to complete

the task. After the assigned task was completed by students a detailed explanation of each example was taken up in the class.

Learning Outcome:

The students could relate the third law of motion in the examples provided in the worksheet. Most of the students could identify the action and reaction forces along with the direction of the force exerted in each case. From the worksheet they could conclude that the motion is possible in all cases because the action and reaction act on different bodies. The discussion after the task helped them understand and relate the third law with their world outside the classroom. One of the students said that '*when we slap someone or beat someone we also feel some force on our hands i.e. if I beat someone it will be the action force and the pain I feel on my hand will be the reaction force* '.

The worksheet provided to students is presented in the following table.

Table no 4.8

Worksheet on application of Newton's third law of motion

Sr. No	Examples from day to day life experiences	Specify		Specify	
		Action force	Direction of force	Reaction Force	Direction of force
1	A gun recoils when a shot is fired from it.				
2	The motion of jet planes and rockets.				
3	A person walking on road.				
4	A person swimming in river water.				
5	A boatman rowing a boat.				
6	We feel pain in our hand when we hammer a nail into the wooden plank				
7	A rubber ball rebounds when stuck against a hard floor.				
8	Birds fly high in the sky.				
9	A fireman holds a hose pipe tightly when used to extinguish fire.				
10	The boatman ties his boat before allowing the passengers to disembark.				

Day 33

Total Time: 90 minutes

Learning Objectives

— Students will be able to apply the concept and solve the word problem

— Students will be able to derive the S.I units of physical quantities

Learning Experience

The students were given practice in deriving the derivations and S.I Units. The students were provided with a worksheet on numerical. The researcher probed and provided hints to students to guide them in solving the word problems. The session focused on of step by step solving of numerical.

Learning Outcome

Most of the students could follow the hint and solve the word problem. Some of the students could relate the formulae but committed error in mathematical computation of fractions and integers. Solving linear equation and algebraic expressions were common errors committed by students.

4.4.30 Revision

Day 34

Total Time: 45 minutes

Learning Objectives

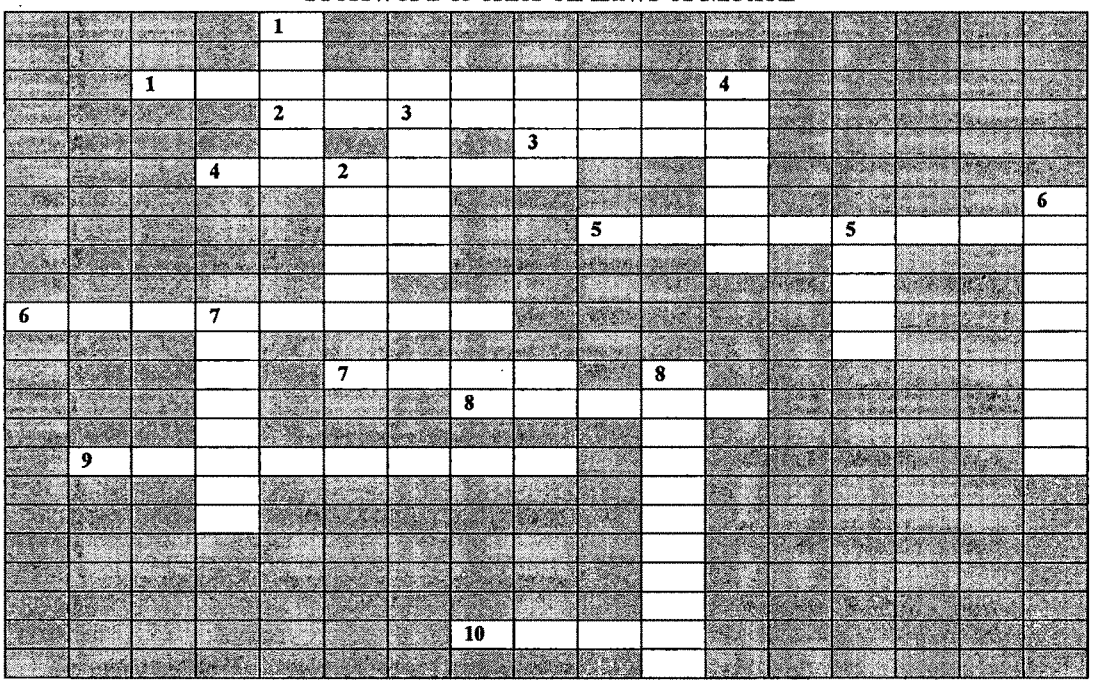
— Students will be able to interrelate the concepts of force and laws of motion

— Students will be able to solve the crossword on force and laws of motion

A revision class was taken up wherein the concepts related to force and laws of motion were revised by drawing a flow chart of the concept learnt and inter relating the concept with one another. Each student was provided with a worksheet of crossword with clues. They were to solve the crossword with the help of the clues given to them. The students were provided fifteen minutes to solve the crossword. Majority of the students were able to solve the crossword on their own. Some of the students had difficulty in answering the clue no 1 and clue no 9 in the across section. The crossword was solved and discussed in the class. The crossword used as a part of the revision activity is presented below:

Table no: 4.9

Crossword & clues on Laws of Motion



Down

1. Quantity that measures rate of change of momentum. (5)
2. Quantity measured by spring balance. (6)
3. It is one of the pair of forces between two interacting bodies. (6)
4. Property of body due to which it resist change in its state of rest. (7)
5. Law of motion that links action and reaction. (5)
6. Type of forces causing acceleration. (10)
7. Force that should be zero for conservation of linear momentum. (8)
8. Negative acceleration. (11)

Across

1. This force is impossible. (8)
2. Every action has it. (8)
3. Its product with force gives impulse. (4)
4. Unit of force. (6)
5. It stops a moving ball. (8)
6. Product of mass and velocity. (8)
7. No change in position of body with time. (4)
8. It is a magnitude of velocity. (5)
9. Acceleration of straight line speed-time graph. (8)
10. Acceleration caused due to balanced forces. (4)

4.4.31 Concept of Pressure

Day 35

Total Time: 135 minutes

Learning Objectives

— Students will be able to define pressure

— Students will be able to relate force and the surface area with pressure

— Students will be able to infer that more the surface area of contact less is the pressure felt.

— Students will be able to provide examples of pressure in daily life

Learning Experience

Activity 1

Required Materials: Inflated balloon, a needle, a heavy book, a duster and a paper weight

The researcher demonstrated the activity in the class. The students were to observe and note their observations. The researcher took a big inflated balloon and placed a heavy book on it and applied force. Then the book was replaced by a duster and finally a paper weight was placed on the surface of the balloon. Next the researcher took the needle and placed it on the surface of the balloon and applied same amount of force. The observations of students were taken up for discussion in class.

Learning Outcome

The students observed that when the book, duster and paper weight was placed one by one on the surface of the balloon the surface in touch with the balloon formed a small curvature. While when the pin was placed on the surface of the balloon it burst out. The discussion focused on what were the things common in each case in the activity. The students could identify that in each case some force was applied on the surface area of the balloon in touch. The discussion was then directed to relating the amount of force in each case. The students said that the force applied in each case was almost same here. So what was different in the case of the pin that made the balloon burst? Though discussion students could relate that in the last case, the pin had pointed end and hence the area in contact with the surface of balloon was minimum as compared to all other cases. The researcher related the concept of force applied on an object and the surface area in contact and derived the concept of pressure.

An anecdote was narrated to help the students relate the S.I unit of pressure. The researcher narrated that once upon a time all the well known scientists planned a get together. They were bored and so thought of playing the game of hide and seek. It was decided that Einstein will seek and other scientists will hide. Everybody could find a place to hide but Newton was confused and couldn't find a place to hide. He was still in the confused state and Einstein came in search and declared Newton out. But Newton was standing still on a square block of unit area and suddenly said that he was not out and that Pascal was out. All the scientists agreed and Pascal had to seek in the next round.

Now the researcher asked the students what could be the justification behind Newton declaring Pascal to be out. The students were attentively listening to the anecdote, and one of the students could justify that as Newton per unit area is pressure which is indeed Pascal.

Activity 2

Required Materials: An iron cuboid, sufficient amount of wet sand, newspaper, spring balance, metre scale and a wooden board.

The students were divided into small groups and each group was provided with the kit of the required material. The students were given the following instruction sheet.

— Measure the length, breadth and thickness of the given iron cuboid with the help of the metre scale.

— Find the least count of the spring balance and measure the weight of the iron cuboid.

— Take sufficient amount of sand and place it on the newspaper on the wooden board. Press it suitably so that the upper surface of the sand is even.

— Place the iron cuboid on the sand so that the face with the maximum area is in contact with the sand. Observe the sand just below the cuboid is depressed.

— Now put the iron cuboid on the sand in two different positions close to the first one so that the other two faces of the cuboid are in contact with the sand one by one

— Observe the depressions in the three cases carefully.

Learning Outcome

The students observed that the depressions in the three cases were different. They could observe that the depression was minimum when the face with the largest area was in contact while it was maximum when the face with the smallest area was in contact. They could understand that since the depressions were different, it implies that the pressure exerted by different faces of the cuboid on the sand was different. They could thus relate that more the surface area in contact, less is the pressure exerted.

Frame 4.12: Depressions produced by the three faces of the cuboid on wet sand

4.4.32 Pressure in Daily Life

Day 36

Total Time: 90 minutes

Learning Objectives

- Students will be able to relate the concept of pressure in day to day life situations
- Students will be able to explain more force on less surface area produce larger pressure
- Student will be able to explain less force on larger surface area produce less pressure

Learning Experience

Required Materials: Sharp Needles, a sharp knife, a blunt knife, a school bag with a broad strap and a hand bag with thin strap

The researcher wrote a question on the board ' *If the force of my hard-work is less than the area of the task allotted to me, will I be under Pressure?' What should I do to deal with the situation?*

Students were then shown each of the material one by one and asked where it is used in our daily life. Questions were raised on why a sharp knife is used in kitchen and not a blunt one? How can the blunt knife be made sharp? What will happen if your school bags are of thin straps instead of broad straps? The researcher then divided the students into small group and provided each group with a list of examples from day to day life. The students were to discuss the cause and effect relationship in each example. The list of examples is given below.

— Your mother uses a sharp knife to cut fruits
— Shreya wears flat shoes when she goes for a morning walk
— Tractors have wide tyres while a bicycle has thin tyres
— Wheels of army tanks have wide steel belt
— High- rise building have wide foundation
— Heavy vehicle have additional six to eight wheels
— Cutting edge of blades and axes are sharpened
— Nails and pins have pointed ends
— A camel can easily walk on sand
— Railway tracks are laid on large sized wooden, iron or cemented sleepers
— Skiers use long flat skis to slide over snow

After the group discussion, a student from each group was asked to present the summary of discussion held in the group.

Learning Outcome

The students had a mixed expression on reading the question written on the board. Some were confused while some could relate the concept of less force and more area leading to larger pressure. They were of the view that the force of hard-work need to be larger to reduce pressure. The students could relate the given examples with the concept of pressure. Three of the groups also relate the concept of friction in example 2 and 11. From the overall discussion in class and in respective group students could derive that in order to increase pressure either increase the force or decrease the area of contact. They could also conclude that in order to decrease the pressure either decrease the force or increase the surface area in contact.

4.4.33 Concept of Buoyancy

Day 37

Total Time: 45 minutes

Learning Objectives

— Students will be able to define buoyant force

— Students will be able to explain why an object appears to be lighter as long as it is inside the liquid

Learning experiences

Required Materials: Two transparent beakers, a piece of wood, a piece of metal, a rubber cork, thumb pins and water.

The researcher demonstrated the activity in the class and the students noted their observations. The researcher placed a piece of wood, a piece of metal at the bottom of the beaker and poured water into it. Then the researcher placed a rubber cork and few thumb pins in the second beaker and poured water into it. The activity was repeated by taking a beaker half filled with water. The researcher placed all the objects on the surface of water. The researcher tried to push the rubber cork and the piece of wood inside the water. The example of lifting of a bucket of water from the well was related with the activity and discussed in the class.

Learning Outcome

The students observed that when the objects were placed on the bottom of the beaker and water was poured into it the piece of wood and the rubber cork shoot to the surface. The same was observed by the students when the objects were placed on the surface of water. The students observed that every time the rubber cork and the piece of wood were pushed downward they flipped to the surface. The students could come up with explanations to justify the cause. They said that the objects that are light they float while those which are heavy will sink. To this one of the student said that the rubber cork is heavier than the thumb pins still it floated. Few of the students also related the concept of gravitational force not enough to pull the objects down. Finally they could conclude to the argument that maybe there is some force which acts against the force of gravitation and restrict the objects to sink down even though it's pushed downward. Thus the concept of buoyant force was derived by the students. The researcher then explained the buoyant force to the students. The researcher gave the example of lifting a bucket full of water from the well. The students said that it is

easy to lift the bucket as long as it is immersed in water as the bucket appears less heavy. The researcher explained that the force of gravitation pulls the object downwards while the buoyant force of the liquid pushes the object upward. Hence when the bucket immersed in water is lifted upward a part of the upward force required to lift the bucket is provided by the buoyant force of the liquid.

4.4.34 Floatation

Day 38

Total Time: 45 minutes

Learning Objectives

— Students will be able to explain why certain objects sink, some float below the surface of water and some float above the surface of water.

Learning Experience

Required Materials: A key, a rubber cork, a comb, pencil, eraser, a thumb pin, a metal bob, a piece of wood, pebbles, beads of plastic, wax and a transparent bucket half filled with water.

The researcher took the transparent bucket half filled with water and dropped the various objects one by one into it. The students were asked to observe and note their observation. The demonstration was followed by a discussion in class.

Learning Outcome

The students observed that certain objects sank, some floated just below the surface of water and some objects floated above the surface of water. The students related the concept of buoyant force that made the object to float on the surface of water. When asked if buoyant force did not act on the objects that sank in water the students could come up with the explanation that the objects that sank were having more weight than the objects that floated. The researcher took a rubber cork and a hair pin of almost same weight and dropped in the bucket and proved the argument incorrect. The students were asked to name the forces that come into action when an object is immersed in water. The students could name the buoyant force acting upward and the gravitational force acting downward. The researcher explained that the gravitational force acting on the body is nothing other than the weight of the body. Hence through discussion the students could understand that when the weight of the body is greater than the buoyant force, the body will sink in water. When the weight of the body is

equal to the buoyant force, the net weight is zero and hence the body will float just below the surface of water. When the weight of the body is less than the buoyant force, the net force acts upward and the body floats above the surface of the water.

4.4.35 Concept of Density

Day 39

Total Time: 90 minutes

Learning Objectives

- Students will be able to define density
- Students will be able to measure the volume of a metal bob by the method of displacement
- Students will be able to determine the density of a metal bob using a spring balance and a measuring cylinder
- Students will be able to relate mass and volume of an object to determine whether the object will sink or float in water
- Students will be able to infer that the sea water is denser than the river water
- Students will be able to compare the density of an object with its characteristic to float or sink in water

Learning experiences

The researcher posed a question *'which of the two is heavier- one kilogram of iron or one kilogram of cotton?'* The students realized that both iron and cotton have the same mass but iron is heavier and cotton is lighter. Iron occupies less volume as compared to cotton having the same mass. The researcher then related the concept of mass and volume of an object to define the concept of density. The students could understand that iron is denser than cotton and hence is heavier. The researcher then related the concept of density with floatation and explained how the density of the object determined whether the object will float or sink in water.

Activity 1

Required Materials: Test tubes, syrup (Rooh Afsa), mustard oil, kerosene, glycerine and water.

The researcher took two test tubes half filled with water each. In one of the test tube kerosene was carefully poured and in the other test tube glycerine was poured. To differentiate glycerine with water a drop of iodine was put into the second test tube.

The students observed and noted their observation. The researcher then took a third test tube and poured the syrup first, then water and finally the mustard oil. The third test tube was shaken and mixed well and kept aside for some time.

Learning Outcome

The students observed that the kerosene floated in the test tube and formed a layer above water, while the glycerine settled at the bottom of the test tube. In test tube three, different layers were formed one on top of another. The students could explain the cause and effect relationship between objects that floated, that settled at the bottom and that formed different layers. They observed that even though the third test tube was shaken the liquids did not get mixed with each other and retained their separate layers. The students established the cause and effect relationship in each case and could relate the concept of density of objects determining whether an object will sink or float in water.

Frame 4.13: Measuring cylinder showing layer of kerosene and water

Frame 4.14: Student observing the layer of glycerine and water

Activity 2

Required Materials: Two beakers, tap water, boiled eggs and 500 gm salt.

The researcher took two beakers filled with tap water. A boiled egg was placed in one of the beakers filled with tap water. In the second beaker 500 gm salt was dissolved and then a boiled egg was placed into it. The students observed and noted their observation. The example of a boat floating in river water and in sea water was related with the activity and discussed in class.

Learning Outcome

The students observed that in the first case the boiled egg sank to the bottom of the beaker while in the second case the boiled egg floated in the salt water. The students could explain that the density of salt water is more than the density of tap water and hence the egg that sank in tap water floated in salt water. They could provide justification to the example of boat floating in river water and in sea water based on the activity done in class.

Day 40

Total Time: 90 minutes

Activity 3

Required Materials: Spring balance (0-100 gwt), measuring cylinder (100 mL), a metal bob, thread and water.

The students were taken to the lab and divided into eight subgroups. Each group was provided with an instruction sheet and the kit of materials required. The instruction sheet consisted of the procedure to conduct the activity with tables of observation and calculations.

The instructional sheet is presented below:

— Calculate the least count of the spring balance.

— Measure the mass of the metal bob using the spring balance.

— Note the least count of the measuring cylinder, and pour some water into the measuring cylinder and place it on a table.

— Note the level of water in the measuring cylinder by reading the lower meniscus.

— Tie the metal bob to a fine thread and lower it gently into the water so that it is completely immersed in water.

— Note the new reading. Record the observation in the table below.

Table No: 4.10

Observation table to measure density of the metal bob

Sr. No	Mass of the metal bob	Initial level of water in measuring cylinder (mL) V_1	Final level of water in measuring cylinder (mL) V_2	Amount of water displaced V mL $V = V_1 - V_2$	Volume of metal bob V mL

Density of the metal bob = Mass of the metal bob / volume of the metal bob

= _____ g/mL

Learning Outcome

The students had difficulty in measuring the least count of the measuring cylinder. The researcher explained the least count of the measuring cylinder on the board and gave examples of different calibrated measuring cylinders. The students were given three measuring cylinders with different calibrations in each group and made to calculate the least count of each measuring cylinder before they started with the activity. The students performed the activity. They could infer that the displacement of water in the measuring cylinder from volume 1 to volume 2 was the change in the volume of water caused due to the weight of metal bob immersed in water. They could thus finally calculate the density of the solid.

Frame 4.15: Student measuring the volume of the metal bob

Frame 4.16: Students performing the activity of measuring the density of solid

4.4.36 Buoyant force and volume of object immersed in liquid

Day 41

Total Time: 45 minutes

Learning Objectives

— Students will be able to infer that more and more volume of object is immersed in liquid, the upward buoyant force acting on it increases

— Students will be able to explain that the buoyant force is directly proportional to the volume of the object immersed in liquid

Required Materials: Spring balance (0-250gwt), beaker, water, and a metal block of length 6 cm.

The researcher demonstrated the activity and the students simultaneously noted the observation in their record sheet. The researcher took the metal block of 6 cm and suspended with the hook of spring balance. Reading on the balance gave the weight of the metal block to be 200 gm. Then the researcher took water in the beaker and lowered the metal block into water such that only 2 cm volume of block is immersed in water. The reading of the spring balance became 190 gm. The researcher further lowered the block to 4 cm in water. The reading on spring balance became 170 gm. Finally the block was completely immersed in water, the reading of the spring balance showed 160 gm. The block was still lowered, but there was no further decrease in weight of the metal block. The example of the rising of a hydrogen balloon was related with the activity during the discussion.

Learning Outcome

The observations of the students were discussed in class. The students could observe that every time the volume of object immersed in water was increased there was loss of weight of object on the spring balance. It implied that the buoyant force on the object increased each time the volume of object immersed in water was increased. They could infer that as more volume of object was immersed in the water the object appeared lighter. When the body was completely immersed in water the maximum loss of weight of object was observed on the spring balance. From the discussion they could conclude that more the volume of object immersed in liquid more is the buoyant force acting on it. The maximum buoyant force acts on an object when it is completely immersed in the liquid. Thus the students could thus explain that the

buoyant force acting on an object is directly proportional to the volume of the object immersed in liquid.

4.4.37 Archimedes's Principle

Day 42

Total Time: 90 minutes

Learning Objectives

- Students will be able to state Archimedes's Principle
- Students will be able to establish the relationship between loss in weight of a metal bob/rubber cork when fully immersed in tap water, with the weight of water displaced by it
- Students will be able to establish the relationship between loss in weight of a metal bob/rubber cork when fully immersed in salt water, with the weight of water displaced by it
- Students will be able to observe that the apparent loss in weight of metal bob/rubber cork in a liquid equals to the weight of the liquid displaced by the metal bob/rubber cork
- Students will be able to observe that the apparent loss in weight of metal bob/rubber cork when dipped in salt solution is more than the apparent loss in weight of metal bob/rubber cork when dipped in tap water

Learning Experiences

Required Materials: Spring balance, overflow can, a metal bob/rubber cork, beaker, tap water and salt water.

The students were taken to the lab. The researcher narrated the story behind Archimedes's discovery of the principle emphasizing weight of his body displacing the volume of water in the tub. The students were then divided into eight subgroups. Each group was provided with the set of materials required to perform the activity along with the instructional sheet. Four groups were given the metal bob as the solid material while the other four were given rubber corks in the kit. The instructional sheet provided to each group had the procedure to perform the activity along with the observation table. The students were instructed to

— Measure the weight of the metal bob/rubber cork by hanging it from a spring balance.

— Fill the overflow can with tap water until it starts overflowing.

— When the dripping of water from the overflow can stops, place an empty beaker under the overflow can.

— Now submerge the metal bob/rubber cork hanging from the spring balance into the overflow can and collect the displaced tap water into the measuring beaker.

— Note down the reading on the spring balance. The reading on the spring balance represents the weight of the metal bob/rubber cork when immersed in tap water.

— Measure the level of water in the measuring beaker and record its volume. This will give the volume of the tap water displaced by the metal bob/rubber cork.

— Repeat the entire activity by taking concentrated salt water instead of tap water.

— Record your observation in the observation table.

Table No: 4.11

Observation table relating loss in weight of solid and volume of liquid displaced

Liquid used	**Weight of the metal bob/rubber cork in air** **W1 gwt**	**Weight of the metal bob/rubber cork in liquid** **W2 gwt**	**Apparent loss in weight of metal bob / rubber cork** **W1- W2**	**Initial volume of liquid** **V1 mL**	**Final volume of liquid** **V2 mL**	**Volume of liquid displaced** **(V2 – V1) mL**
Tap water						
Salt water						

Learning Outcome

Each group performed the activity and recorded the observations in the observation table. They were asked to conclude from the activity from the observations. They

could observe that the value of apparent loss in weight of metal bob/ rubber cork was almost equal to the value of the volume of liquid displaced irrespective of the liquid used. The researcher explained and related the volume of liquid displaced with the weight of the liquid displaced. Thus they could conclude that apparent loss in weight of the metal bob/rubber cork in any liquid was equal to the weight of the liquid displaced by the metal bob/rubber cork. Students related the concept of density to explain why the apparent loss in weight of the solid when dipped in salt solution was observed to be greater than the apparent loss in weight of the solid when dipped in tap water. Finally the students in group co related the observed facts to form the statement of Archimedes's Principle.

Frame 4.17: Students in group performing the activity on Archimedes's principle

Frame 4.18: A student observing the volume of water displaced in the beaker

4.4.38 Archimedes's Principle in daily life

Day 43

Total Time: 45 minutes

Learning Objectives

— Students will be able to relate Archimedes's principle in day to day life situations

— Students will be able to explain the application of Archimedes's principle in day to day life situations

Learning Experience

The researcher initiated a discussion in class by writing the Archimedes's principle on the board. The researcher asked the students 'If they felt any difference between swimming in a pool and swimming in sea water? The responses of the students were

further probed to elicit examples from daily life wherein Archimedes's Principle is applied. Through discussion and probing the students could list a number of examples wherein the principle was applied in daily life. The list of examples is as follows:

— An iron nail sinks in water while a ship made of iron does not sink and keeps on floating.
— Human corpse always floats on the surface of water, but the head stays within water.
— Submarines can move under water.
— Icebergs float on water.
— Fishes can swim deep into the sea and can also rise to the surface of the sea.
— Boats easily sail in sea water as compared to river water.
— When gases like hydrogen or helium are filled in a balloon, it rises up.

Learning Outcome

The students shared their experiences on beach. The researcher picked up the key words: species of fishes, submarines, boats, icebergs and floating of human corpse from the experiences they shared to channelize the discussion in class. The students could come up with various explanations pertaining to the occurrence of the events. The researcher facilitated the students' responses to arrive at the correct explanation. Thus the students could establish a cause and effect relationship to explain the occurrence of the phenomenon.

4.4.39 Revision

Day 44

Total Time: 45 minutes

Learning Objectives

— Students will be able to interrelate the learnt concepts
— Students will be able to solve the crossword on laws of floatation

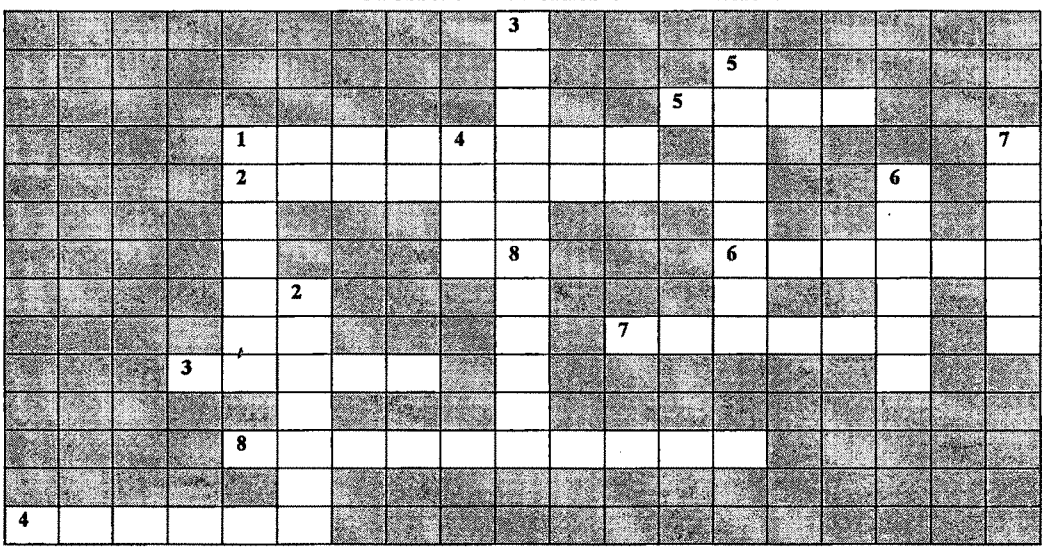
A revision class was taken up wherein the concepts related to floatation was revised by drawing a flow chart of the concept learnt and inter relating the concept with one another. Each student was provided with a worksheet of crossword with clues. They were to solve the crossword with the help of the clues given to them. The students were provided fifteen minutes to solve the crossword. Majority of the students were

able to solve the crossword on their own. Some of the students had difficulty in answering the clue no 3 and clue no 8 in the across section. The crossword was solved and discussed in the class.

The crossword used as a part of the revision activity is presented below:

Table no: 4.12

Crossword & clues on Floatation



Down

1. Unit of pressure. (6)
2. Force experienced by bodies immersed in a fluid. (7)
3. Up-thrust depends on it. (6)
4. If relative density is greater than 1, what happens to body immersed in water? (4)
5. It determines the purity of substance. (7)
6. Term used for liquid and gases both. (5)
7. Unit of up thrust. (6)
8. A body weighs maximum in this. (6)

Across

1. It decreases on increasing the area of contact. (8)
2. Force of gravitation between any object and earth. (7)
3. Body immersed in liquid of relative density less than one. (5)
4. Up-thrust acts in a direction opposite to it. (6)
5. Apparent weight of a body immersed in a liquid. (4)
6. Force acting normal to the surface. (6)
7. Direction of up-thrust. (6)
8. It measures purity of milk. (10)

4.4.40 Concept of Work

Day 45

Total Time: 45 minutes

Learning Objectives

— Students will be able to comprehend the scientific definition of work

— Students will be able to reason out in the given examples whether work is done or not

Learning Experiences

Work being a common term associated with day to day activities the researcher initiated the discussion by eliciting students understanding of the 'work'. The researcher then categorized the examples given by students into three categories.

1. The examples wherein force was applied and there was some displacement of the object.
2. The examples wherein force was applied and no displacement took place.
3. The examples wherein no force was applied and no displacement took place.

Once the categorization was done, the researcher explained the scientific concept of work and logically proved the second and third category of examples incorrect. The students were provided with a worksheet of examples and were asked to reason out whether work was done or not. The students were to specify yes or no in each of the category in the worksheet. The worksheet as a part of learning experience is presented below:

Table No 4.13

Worksheet: Reason out whether scientifically work is done or not

Sr. No	Examples	Whether force act on object?	Whether the object got displaced?	Whether work is done?
1	A sailboat is moving due to wind			
2	A person pushes a luggage trolley along a platform			
3	Food grains are getting dried in the sun			
4	A green plant is carrying out photosynthesis			
5	A man pushes a wall			
6	Ram studied two hours for the test			
7	A man holds a bucket of water			
8	An engine pulls a train			

9	Suma is swimming			
10	A porter has lifted a load on his head			
11	A box is lifted through a height			
12	A pair of bullocks plough the field			

Learning Outcome

Few of the student's response when asked their conception of work were:

I helped my mother to cut the vegetables for dinner

I worked hard for the exams

I referred books for my assignment

We completed the task of drawing diagram

He could hit a boundary at the last minute

Yesterday I studied all night

I ironed my clothes and polished my shoes

Sunday morning I go cycling to the stadium

Every evening I fetch milk from the diary

I saw a movie last Sunday

My mother goes for a morning walk and walks 5 km everyday

I shifted the furniture from the ground floor to the top floor

I got my bicycle repaired

There were many such responses which were categorized and discussed to make the students comprehend the scientific definition of work. Through the discussion and worksheet examples the students could thus define work by relating the force applied on an object and displacement of the object in the direction of force.

4.4.41 Forms of Energy

Day 46, Day 47 & Day 48

Total Time: 135 minutes

Learning Objectives

— Students will be able to define energy

— Students will be able to explain the different forms of energy

— Students will be able to prepare a presentation on the various forms of energy

Learning Experience

Students were divided into ten sub groups. Each group was asked to prepare a presentation on any one form of energy. The form of energy was allotted through the lottery method. The guidelines and instructions regarding the presentation were discussed with students and a time period of one week was given for preparation. One member from the group would present the topic and the rest will answer the queries raised by fellow group members. The group that presented the best would be acknowledged and rewarded. The schedule of presentation was worked out.

Learning Outcome:

Six out of the ten groups were active and approached researcher for reference books and guidance. The researcher had to take follow ups on each group. Six groups prepared power point for the presentation whereas the rest of the four groups orally presented. The presentations were on different forms of energy: Heat energy, light energy, chemical energy, hydro energy, wind energy, sound energy, mechanical energy, tidal energy, nuclear energy and electrical energy. Each group could experience that when focussing on one form of energy they had to relate the other forms of energy also. After each group presented the researcher summarized by plotting a flow chart of different forms of energy with brief description of essential facts. Kinetic energy, potential energy and mechanical energy were emphasized in the discussion.

4.4.42 Energy Transformation and Law of Conservation of Energy

Day 49

Total Time: 45 minutes

Learning Objectives

— Students will be able to explain how energy transforms from one form to another

— Students will be able to explain the law of conservation of energy with an example

Learning Experience

Required Materials: A compressed spring, sulphuric acid in a test tube, test tube holder, test tube stand, a bow and arrow, metal bob, string and a stand.

The researcher first took the test tube with the sulphuric acid and dropped a compressed spring into it. The researcher put back the test tube in the test tube stand. Now the researcher randomly picked up two students from the class and asked them to shoot the arrow using a bow one after the other. Lastly the researcher used the metal bob tied to a string as a simple pendulum. The pendulum was hung to a stand and vibrated. The students were to observe the activities demonstrated and note down their observations.

Learning Outcome

Students observed that when the compressed sprig was dropped in the test tube, fumes started rising out. Through discussion it could be established that the potential of the spring gets converted into kinetic energy which in turn gets dissipated as heat energy. In case of the bow and arrow the students said that the potential energy stored in the bow string gets converted into kinetic energy of the arrow to cover the distance. They could relate that in both cases there was conversion of one form of energy into another. Discussion was initiated to understand how the transformation of one form of energy to another form took place. The vibrations in the simple pendulum was studied and explained in class to locate the points wherein potential energy goes maximum and kinetic energy goes minimum. Those points of maximum kinetic energy and minimum potential energy were also located to understand that when one form of energy increases the other form decreases. Finally the pendulum stops due to loss of energy due the friction with air. Hence the students could conclude that the total energy is conserved in nature and could just be transferred from one form to another. The other examples of the working of an electric geyser, glowing of the electric bulb, burning of cooking gas, working engine of a motor car which is moving, the bullet from the gun, a catapult just releasing a small stone were cited by the students and discussed in class.

4.4.43 Commercial Unit of Energy

Day 50

Total Time: 45 minutes

Learning Objectives

— Students will be able to calculate total energy consumed by electrical appliance at home in one day

— Students will be able to compare the calculated electric bill with the actual electric bill of the month

— Students will be able to draw inferences from the graph of energy consumed vs. days of the month

Learning Experiences

The students were explained the concept of power and commercial unit of energy. The research distributed the copy of electric bill in class. The students were made to read and comprehend the content of the electric bill. The students were given the assignment to list down all electrical appliances used at their home. Each electrical appliance is labelled with the power it consumes. Those appliances that did not have the printed value, the students were asked to visit an electric shop nearby and gather the required information. The students were to note down the power of each electric appliance and the time for which they are operated each day. They were to calculate the electric energy for one day and then for one month, keeping a record of each day of the month of December. They were also to compare the calculated value of the energy consumed to the electricity bill of that month. Finally they were to plot the graph of energy consumed vs. days of the month and draw inference from the graph. The students were asked to maintain a separate record book for the assignment.

Learning Outcome

The researcher had to follow up each week with respect to the assignment allotted to the students. The students submitted the assignment in the report form after forty days of the allocation of the assignment. Most of the students interpreted that the energy consumed on Sundays and holidays was more as compared to other days of the week. The interpretation they gave was that as the members of the house were all at home on Sundays and on holidays they used electrical appliances for longer duration. One of the students wrote "*my mother baked the cake for Christmas and consumed more power and so there was increment in the electric bill*".

4.4.44 Revision

Day 51

Total Time: 45 minutes

Learning Objectives

— Students will be able to interrelate the concepts of energy

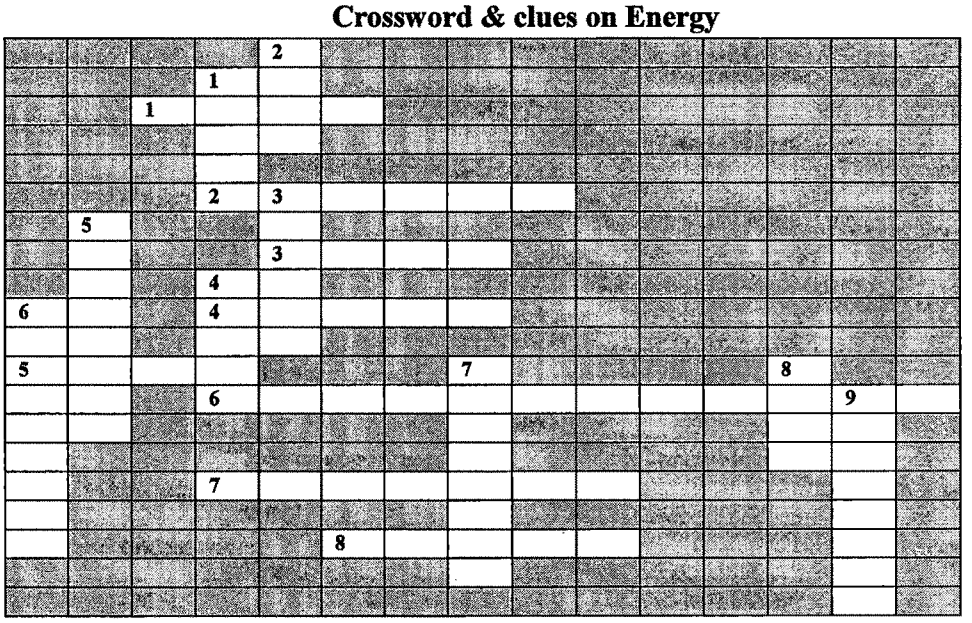
— Students will be able to solve the crossword on energy

A revision class was taken up wherein the concepts related to work and energy was revised by drawing a flow chart of the concept learnt and inter-relating the concept with one another. Each student was provided with a worksheet of crossword with clues. They were to solve the crossword with the help of the clues given to them. The students were provided fifteen minutes to solve the crossword. The students were able to solve the crossword on their own.

The crossword was solved and discussed in the class. The crossword used as a part of the revision activity is presented below:

Table no: 4.14

Crossword & clues on Energy



Down

1. Unit of work done. (4)
2. Work done by gravitational force of earth on satellite. (4)
3. Unit of force. (6)
4. Kinetic energy becomes four times on doubling this quantity. (5)
5. Momentum depends on this quality. (8)
6. Type of energy possessed by stretched string. (9)
7. Type of energy used in household. (8)
8. This energy is obtained from electric energy in the electric gyser. (4)
9. Work done by force opposite to displacement. (8)

Across

1. It is equal to energy. (4)
2. It is capacity to do work. (6)
3. Unit of power. (4)
4. Rate of doing work. (5)
5. It is a scalar quantity which on dividing with work gives power. (4)
6. Work done is product of force and this vector quantity. (12)
7. Type of energy possessed by wind. (7)
8. On doubling the mass of body the potential energy will be changed by this amount.(5)

4.4.45 Concept of Sound

Day 52

Total Time: 45 minutes

Learning Objectives

— Students will be able to define sound

— Students will be able to differentiate sound of music and noise

Learning Experience

Required Materials: Tuning fork, rubber pad, audio of different musical instruments played, set of six steel glasses, water and a pencil.

The researcher initiated a discussion on the topic sound in the class. Audio of different musical instruments were played. A tuning fork was hit on a hard rubber and made to vibrate. The researcher then took a set of six steel glasses and filled them with water up to different levels increasing gradually from one end to another. The water level gradually increased from one end to the other end. Then the researcher took a pencil and stroked the glasses gently. All the glasses were stroked in succession and a rhythmic sound was produced.

Learning Outcome

Students could identify the musical instruments from the audio played. They could come up with the various aspects of sound: sound as music, sound as noise pollution, sound as a sensation, sound as vibrations/oscillations, sound as humming of bees and sound as energy that transfers and travels distance. Hence through discussion in class the students could relate sound to be the sensation created and recognized by ears. They could scientifically relate sound to be a form of energy produced when an object vibrates rapidly. The students felt that the sound produced by stroking the six steel

glasses with gradual increase in the level of water was smoothing to the ear and they identified it similar to the musical sound produced from the instrument '*Jaltarang*'.

4.4.46 Production and Propagation of Sound

Day 53

Total Time: 90 minutes

Learning Objectives

— Students will be able to explain sound is produced through vibration

— Students will be able to infer that the sound created by the source reaches the listener through the particles of the medium

Learning Experience

Activity 1

Required Materials: a slinky, a stop watch and a metre scale

The researcher hung one end of the slinky from a stand. The slinky was allowed to come to the state of rest. Then with the help of the metre scale a small disturbance was produced at the lower end of the slinky. The time for which the disturbance travelled from one end of the slinky to the other end was recorded.

Learning Outcome

Students observed that the disturbance created at one end reached the other end of the slinky within a short time span. The students could thus concluded that the wave propagated through a stretched slinky.

Activity 2

Required Materials: a tuning fork, a rubber pad and a freely suspended bob

The researcher took a tuning fork and hit the pongs of the tuning fork by holding from its stem against a rubber pad. Now the vibrating tuning fork was quickly taken near a freely suspended bob.

Learning Outcome

The students observed that when the tuning fork was hit hard on the rubber pad, the tuning fork produced a buzz sound. When the tuning fork was taken near a freely suspended bob, the bob started moving in the opposite direction. The discussion was initiated in the class and thus the students could infer that sound is produced and propagated through a vibrating body. They could also conclude that the vibrations

were passed on to the freely suspended bob through the air medium and thus the bob came into motion.

Activity 3

Required Materials: a thin wire, two nails fixed on a wooden board, sand, a tuning fork, a rubber pad and a paper rider.

The researcher fixed two nails at a distance of 100 cm on a wooden board. The wooden board was sprinkled with sand. A thin wire was stretched between the two rigid supports tightly. A paper rider was placed on the wire. The researcher now took a tuning fork and hit it hard on the rubber pad and kept it near the paper rider on the wooden board. It was taken care that the tuning fork does not directly touch the paper rider or the string. The students observed and noted their observations.

Learning Outcome

The students observed that when the tuning fork was brought near the wooden board the sand on the wooden board started to scatter to and fro. The thin wire also started vibrating and the paper rider fell. The researcher explained the propagation of sound in the medium. The students could thus conclude that the vibrations produced in tuning fork were passed on to the thin wire and eventually to the paper rider which made it vibrate and fall off. The student could also conclude that the vibrations were transferred through the stem to the wooden board and made the sand particle to vibrate.

4.4.47 Sound needs a medium to travel

Day 54

Total Time: 45 minutes

Learning Objectives

— Students will be able to understand that a material medium is essential for the propagation of sound

— Students will be able to observe that the sound waves cannot travel in vacuum

Learning Experience

The students were shown a short animated online you-video of an experimental set up to prove that sound cannot travel in vacuum. The video was of three minutes forty seconds from the site https://www.youtube.com/watch?v=IkpJttf3D7w. This was

followed by a series of questions and discussions. Examples relating sound travelling in a solid and liquid medium were taken up in class for discussion.

Learning Outcome

Students observed that in the video when a mobile phone was made to ring in a closed jar, the ring could be heard. But when the air in the jar was evacuated through a vacuum pump, they could hear less and less sound. They could relate that the loudness of the sound decreased as the air in jar became less. When there was no air in the glass jar they did not hear any sound. Hence they could conclude that sound waves cannot travel in vacuum. The example of astronaut on moon communicating with each other was taken up as a related example. Then the researcher further asked 'Can sound travel in any other medium other than air?'. The students could come up with the examples of a bell ringing under water, estimating the arrival of train by placing one's ear on the rail tracks, tapping the table at one end and receiving the sound at the other and an example of a toy telephone wherein the sound travels through the strings. Hence the students could thus conclude that that sounds require a material medium to travel.

4.4.48 Amplitude, Frequency and Timbre of Sound

Day 55

Total Time: 90 minutes

Learning Objectives

- Students will be able to explain the amplitude of sound waves
- Students will be able to explain the frequency of sound waves
- Students will be able to identify the sound of high frequency
- Students will be able to identify the sound of high amplitude
- Students will be able to explain the timbre of sound
- Students will be able to relate high amplitude sound with loudness
- Students will be able to relate high frequency sound with high pitch

Learning Experience

Required Materials: A keyboard, audio recorded sound of - chirping of birds, roaring of lion, humming of bees, drum beat, whistle and heart beats.

The students were taken to the music room. The music teacher assisted the researcher in providing learning experience to the students. The students were asked to recognize

the difference in the notes played by the music teacher on the keyboard. The music teacher played a song with loud sound. Again the same notes were played with a low sound. Once the difference was discussed in class, a different note was played on the keyboard. The music teacher now played a fast note on the keyboard, and after a gap of two minute again played the same note at a slow pace. The students were again to recognize the difference in the two notes. The recorded audio was played in class. Three of the students were asked to sing the school anthem as the music teacher played the notes on the keyboard.

Learning Outcome

The students responded that the music teacher played the song with a loud noise and again the same song was played at a low sound. In both cases there was difference in the loudness of the sound produced, initially it was loud sound produced and later on the sound produced was low. The researcher now explained that loudness of sound depended on the amplitude of the sound wave. The concept of amplitude was thus explained to the students and related it with the loudness of sound wave.

When the notes were once played fast and then at a slow space the students responded that though the notes in the first case was fast and in the second case the notes were slow and more time was taken. The researchers then associated the fast note with the number of vibrations with respect to time and defined the term frequency. If the vibrations are increased with respect to time, the frequency of the vibrating body increases. Frequency of sound was then associated with the pitch of sound to establish the relations that high frequency sound had high pitch. The student could thus comprehend that the amplitude decided the loudness of sound while the frequency decided the pitch of sound waves. Students were made to hear the sound of drum beat, roaring of the lion, heart beats, chirping of birds, humming of bees and the whistle sound. They were asked to identify the difference in the sound produced. They could identify the low pitch sounds and the high pitch sounds from the audio. The students were asked whether they were able to identify the voices of their friends who sang together the school anthem with the same amplitude and same frequency notes. The students said that though they sang the same song their voices could be identified differently. Thus the concept of timbre of sound was explained to the students.

4.4.49 Reflection of Sound

Day 56

Total Time: 90 minutes

Learning Objectives

— Students will be able to state the laws of reflection of sound

— Students will be able to explain that the angle of incidence is equal to angle of reflection in sound waves

— Students will be able to infer that the incident sound wave, the reflected sound wave and the normal at the point of incidence lie in the same plane.

Learning Experience

Required Materials: Two PVC tubes of 30 -50 cm length and 3-5 cm in diameter, a drawing board, white paper sheet/drawing sheet, thumb pins, a stop clock and a glass slab.

The researcher revised the concept of incident ray, reflected ray and normal with the students. The laws of reflection of light were also discussed with the students. The students were then taken to yoga room and divided into ten sub groups. Each group was provided with a kit of the materials required. The researcher demonstrated the activity set up and provided instructions that were to be followed. The instructions provided to students are as follows:

— Fix a drawing sheet on a drawing board with the help of pins and draw a horizontal line MM'. Fix a point O at the centre of line MM'. From the point O draw a perpendicular line ON.

— Draw a line PO at any desired angle with the normal using a protractor.

— With the help of a holder place the glass slab along the line MM'

— Place a clock with a loud tick sound at the mouth of the PVC tube A place with its axis along the line PO. Place another PVC tube B at the other side of the line ON

— Adjust the angle of the tube B until the ticking sound of the clock sounds loudest through it.

— Draw the corresponding line OP' wherein the loudest sound of ticking is heard through tube B

— Measure the angle formed by the line OP' with the perpendicular line ON.

— Record the measurements in the observation table.

— Repeat the activity with different angles of incidence.

Table no: 4.15
Observation table for angle made by the axis of the tubes with normal

Sr. No	Angle made by the axis of the tubes	
	Tube A with normal	**Tube B with normal**

Learning Outcome

The students performed the activity in groups. The fans of the hall were switched off and the windows closed so that the sound at the other end of the tube B could be clearly heard. The students initially had difficulty in adjusting the path of the sound waves, but later when the activity was repeated for two more angles they could gain efficiency and accuracy. The students were asked to lift the tube B a little higher from the surface of the paper and try to hear the sound waves. They observed that when the pipe was lifted a little high from the surface they were not able to trace the reflected sound waves. They also observed that the angle made by the axis of the tube A with normal was almost same to that of the angle made by the axis of the tube B with the normal. The students could thus derive that the laws of reflection of light hold true for the sound waves also.

Frame 4.19: Experimental set up for reflection of sound waves

4.4.50 Reflection of Sound in Daily Life

Day 57

Total Time: 45 minutes

Learning Objectives

— Students will be able to observe that a clarinet could amplify the sound waves

— Students will be able to observe that a bugle could produce a loud sound

— Students will be able to hear the amplified sound of their heart beats

Learning experiences

Materials Required: A stethoscope, a clarinet and a bugle.

The students were taken to the play ground. The sports teacher assisted the researcher in providing learning experience to the students. The students were familiar with the three instruments. The sports teacher demonstrated the use of the clarinet and the bugle. Then the students were asked voluntarily to try and see how a clarinet and a bugle work. Three stethoscopes were then circulated among groups of students to try out its function.

Learning Outcome

Students showed excitement in trying out the use of clarinet and the bugle. Though most of the students tried to blow the clarinet but only two boys could succeed in blowing the clarinet and the bugle. The students observed that a forceful blow of air inside the bugle got amplified and produced a loud sound. The students were excited to hear the amplified sound of their own heart beats. The experiences of the students were discussed and the researcher explained the construction of the instruments promoting multiple reflection of sound. Other related examples of megaphone, hearing aid and sound boards were taken up during the discussion.

Frame 4.20: Clarinet and Bugle- instruments to amplify sound waves

4.4.51 Concept of Echo and Reverberation

Day 58

Total Time: 45 minutes

Learning Objectives

— Students will be able to define echo

— Students will be able to define reverberation

— Students will be able to explain how echo is different from reverberation

Learning Experience

A three minute online you tube video/audio on echo and reverberation was played in the class. The audio from the site http://www.youtube.com/watch?v=n3m5abtOpOy consisted of echo sound produced from the hilly areas and reverberated sound produced in an auditorium. The students were asked whether the two sounds could produce the same sensation to the ear or where the effect of two sounds different.

Learning Outcome

The students could identify the two sounds produced in the audio/video to be different from each other. They could come up with explanations to how the two sounds produced were different. They could identify the sound produced from the hilly areas to be echo as some of the students have experienced the effect while others had seen the effect in movies. They said that the sound of echo is produced in open hilly areas and that the entire word/sentence spoken by the speaker can be repeatedly heard again and again. The students were not sure of the second phenomenon and said that it sounded like echo but was different as the entire word is not repeated and only a mix of sound could be heard back. The sounds cannot be distinctly heard. The words were repeated so fast that it almost overlaps and gradually fades away. The responses of the students were thus channelized and directed to arrive at the definition of echo. The researcher summarized the observations of the students regarding the second phenomenon and explained the concept of reverberation. The students could thus differentiate echo from reverberation though both occur due to multiple reflection of sound.

4.4.52 Ultra Sound in Daily Life

Day 59

Total Time: 45 minutes

Learning Objectives

— Students will be able to explain the medical uses of ultrasound

— Students will be able to explain the industrial uses of ultrasound

Learning Experience

The researcher initiated the discussion in the class relating the frequency and velocity of ultrasound. The researcher explained the properties of ultrasound to travel along well defined straight paths even in the presence of obstacles. The example of ultrasound waves used by bats in locating their prey was discussed in class. A power point presentation of images representing the application of ultrasound was shown to students.

Learning Outcome

The students were explained the industrial uses of ultrasound. They were familiar with the terms echocardiography and sonography. The students were keen to know how ultrasonic waves can be used to correct the power of the eye, removal of cataract and breaking of kidney stones. The students could thus understand the application of ultrasound waves in daily life.

4.4.53 Auditory Aspect of Human Ear

Day 60

Total Time: 90 minutes

Learning Objectives

— Students will be able to state the function of each part of the human ear

— Students will be able to explain the function of outer ear, middle ear and inner ear

— Students will be able to explain how sound waves are amplified by the inner ear

— Students will be able to comprehend the conversion of sound vibrations into nerve impulses send to brain for interpretations.

— Students will be able to enact a role play to explain the function of each part of the human ear

Learning Experience

Materials Required: A three dimensional model of inner structure of human ear and a chart of inner structure of human ear.

The students were shown an animated online you tube video of three and a half minute on 'ear anatomy/inside the ear/ 3D human ear animation video from the site http://www.youtube.com/watch?v=p30y4lodZu4. The video features the function of each part of the human ear and presents the animation of the how each part functions in relation to another to convert the sound vibration into nerve impulses which are sent to brain. Once the video was seen the students had idea regarding the auditory function of the human ear. The researcher then explained the concept with the help of a three dimensional model and chart of inner structure of human ear. The concept was revised by role play method.

Learning Outcome

The students drew a diagram of the structure of human ear in their notebooks and wrote the function of each part of the human ear on their own. Students were randomly picked up from the class and were associated with the parts of the human ear. Each student prepared a tag of the part they were associated with, and pined up on their shirts. Now all the parts came together and aligned themselves to form the structure of human ear. The students enacted a role play to explain the function of each part of the human ear.

4.4.54 Revision

Day 61

Total Time: 45 minutes

Learning Objectives

— Students will be able to interrelate the concepts of sound

— Students will be able to solve the crossword on concepts of sound

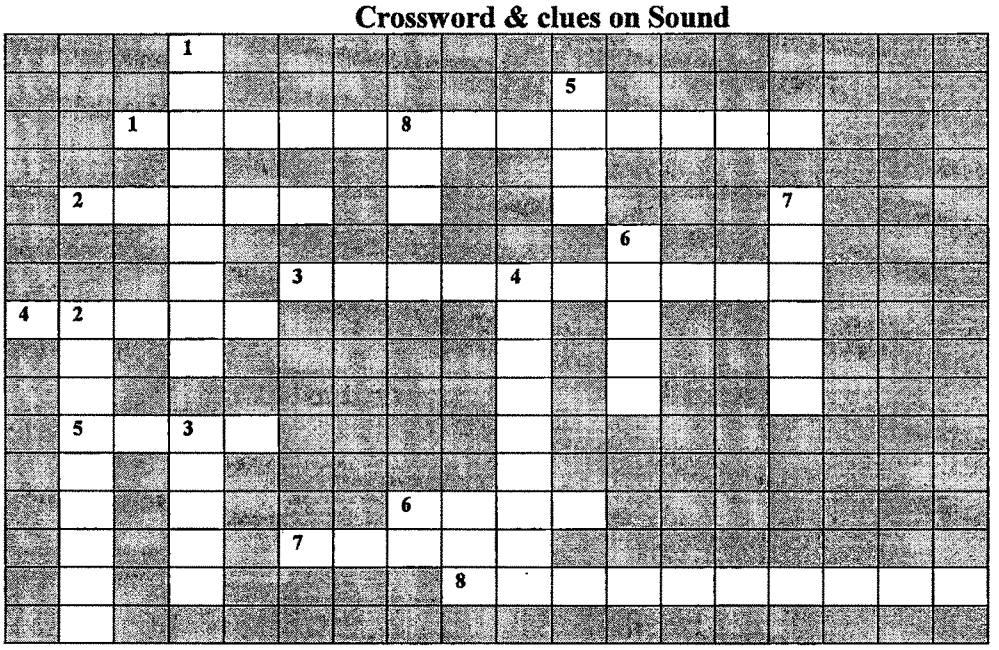
A revision class was taken up wherein the concepts related to sound was revised by drawing a flow chart of the concept learnt and inter-relating the concept with one another. Each student was provided with a worksheet of crossword with clues. They were to solve the crossword with the help of the clues given below. The students were provided fifteen minutes to solve the crossword. Majority of the students were able to

solve the crossword on their own. Some of the students were not able to identify the instrument used to measure the depth of the sea.

The crossword was solved and discussed in the class. The crossword used as a part of the revision activity is presented below:

Table no: 4.16

Crossword & clues on Sound



Down

1. Reciprocal of time. (9)
2. Word used interchangeably for loudness. (9)
3. Unit of frequency. (5)
4. Loudness depends on it. (9)
5. Disturbance produced in medium. (4)
6. Instrument used to measure the depth of sea. (6)
7. Sound can't propagate through it. (6)
8. It finds its prey using ultrasound wave. (3)

Across

1. Multiple reflection of sound in a hall. (13)
2. Example of longitudinal wave. (5)
3. Sound having frequency greater than 20 Hz. (10)
4. Quantity determined by frequency. (5)
5. Reflection of sound from hills. (4)
6. Sound with large amplitude. (4)
7. Medium in which speed of sound is maximum. (5)
8. Bouncing back of sound on hitting metallic object. (10)

The present chapter discussed in detail the development of the intervention programme. The chapter describes the implementation of the developed intervention programme at length day wise. It described the learning experiences provided to the students based on the learning objectives framed and the students' response to the learning experiences they underwent. The next chapter deals with the analysis and interpretation of the data analysed through employing various data analysis techniques.