Construction And Try-out Of Computerised Programmed Learning Material For The Students Of Standard 9th In Science And Technology

Research Report For
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1. Introduction

Development of any country is mostly measures by the development of their human resources, economy, industrial development and education of the country. From the above all elements, we can consider education as an important element because other all elements directly or indirectly depended on the education. Hence, education is the centre point of the development of the country. The American Commission on Teacher Education rightly observes, "The quality of a nation depends upon the quality of its citizens. The quality of its citizens depends not exclusively, but in critical measure upon the quality of their education, the quality of their education depends more than upon any single factor, upon the quality of their teacher." Same way in our country NCTE (1998)[1] stated in Quality Concerns in Secondary Teacher Education, — "The teacher is the most important element in any educational program. It is the teacher who is mainly responsible for implementation of the educational process at any stage." Hence, the importance of teacher in teaching-learning process is observed. If teacher is effective and innovative than the learning process would be easier and enjoyable for their students. Therefore teacher must use different teaching methods to make their students learn.

In 21st century it is believed that learning takes place in mind of learner. Learner is a constructor of their own knowledge. And the learner is the centre point in teaching-learning process. So, the teaching methods which are student centric will be effective. There are certain student centric methods available like: project method, assignment method, group discussion method, programmed learning, brain storming etc. Programmed learning method is student centric as well as self learning method which was popularised by great psychologist B.F. Skinner. He gave psychological principles like principle of small step, principle of actively participation etc. of programmed learning. He also proves that programmed learning is very effective self learning method. If teacher is capable to write good programmes according to their student's requirement then student can learn their own without any help of teacher. Phrase "स्वाध्यायः परमं तपः" (swadhyayah paramam tapah) means self learning is a best way of learning noted in ancient Sanskrit Taitariya Upanishad. Hence, not a modern science or modern researches shows

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[1]National Council for Teacher Education (NCTE) (1998). *NCTE Document.* New Delhi:Member Secretary, NCTE.

the usefulness and effectiveness of self learning, our ancient Indian philosophy also suggest the same.

Now a day, ICT has made changed the world by reaching in every field and make every field more effective, simple and errorless. For example, in traffic field use of CCTV on cross roads solves many problem like, signal breaking, entry in wrong side etc. Same way use of ICT in education solves many problem of education system like over crowed class. If teacher teaches through website or by video streaming there is no need to come at class for all the students and the problem of over crowded class is solved. Use of ICT in self learning manner is proven very useful and effective. Many researches like Gowri, Minolin & Thenmozhi (2013)[2], Jeffries (2001)[3], Weber and Lennon (2007)[4] etc. researched on comparison between traditional method and self learning or self directed web based learning method. These researches show the effectiveness of self learning or self directed web based learning method.

It is believed that Science and Technology subject is difficult to learn for the

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[2]Gowri, M.P., Minolin, M. & Thenmozhi (2013). Web based vs. traditional: a comparison of two instructional methods to teach obstetrical palpation for antenatal mothers among B.Sc. (N) II year students. *IOSR journals of research & methodology in education, Vol. 3 (4),* 41-44. Retrieved from http://www.iosrjournals.org/iosr-jrme/papers/Vol-3%20Issue-4/G0344144.pdf?id=7370

[3]Jeffries, P.R. (2001). Computer versus lecture: a comparison of two methods of teaching oral medication administration in a nursing skills laboratory. *The Journal of Nursing Education. Vol. 40(7),* 323-9. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed?term=Jeffries%20PR%5BAuthor%5D&cauthor=true&cauthor_uid=1159668

[4]Weber, M.J. & Lennon, R. (2007). Compare the effectiveness of a Web-based course delivery system to a traditional course delivery system, *The Journal of Educators Online, Vol. 4(2).* Retrieved from http://www.thejeo.com/Archives/ Volume4 Number2/Weber%20Final.pdf

learners. May be it is true because of the nature of Science and Technology subject. Observation, data keeping, analysis, interpretation etc are the required skill to learn Science and Technology effectively. Hence, it became headache for the many learners. But if teacher present the subject in simple and self learning way the learners may like it and learn easily.

To make learning of Science and Technology easy, simple and enjoyable teacher should develop programmed learning for the teaching of Science and Technology. Computerised programmed learning material is better option because it comes with multimedia. Is it so? Is it true that computerised programmed learning material for Science and Technology is more effective than the conventional lecture method? Suchquestions raised in mind of investigator. Hence, investigator decided to carry out this study.

2. Statement of the Problem

The investigator has decided to construct and try out computerised programme learning material for Science and Technology subject. The title of the present study is,

"Construction And Try-out Of Computerised Programmed Learning Material For The Students Of Standard 9th In Science And Technology"

3. Definition of the Key Words

Programmed Learning.

Programmed learning is a form of operant conditioning. "Programmed learning is based on behaviourist theories of learning which aims to shape behaviour into predetermined patterns by strengthening stimulus-response bonds." Entwistle, N. (1994)[5]. Actually programmed learning material is a series of very small steps, called frames. Each frame contains some information and a statement with a blank that the student fills in. The student then uncovers the correct answer before going on to the

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[5]Entwistle, N.(1994). *Styles in Learning and Teaching: An Integrated Outline of Educational Psychology for Students, Teachers and Lecturers.* London: David Fulton Publishers, p. 226.

next frame. If the student's answer is correct it is positively reinforced by this progress to the next frame; if not, the student immediately sees the correct answer. Each frame may either introduce a new idea or repeat material covered earlier. The lessons start from the student's initial knowledge and in small steps proceeds to a final learning goal. Because of active student participation, small steps, immediate feedback, and reinforcement, programmed learning can be very effective.

There are two types of programming are used: linear and branching programming. Linear programming immediately reinforces student responses that are correct. Each 'bit' of information is presented in a "frame," and a student who has made a correct response proceeds to the next frame. All students work through the same sequence.

In branching programming, the student who responds incorrectly will either be returned to the original frame, or routed through a sub programme designed to remedy the deficiency indicated by the wrong choice. This process is repeated at each step throughout the programme, and a student may be exposed to differing amounts of material depending upon errors made.

Computerised Programmed Learning Material.

Currently, the principles of programmed learning are being applied in computer assisted instruction (CAI). The computer can be used to present learning material and help students learn through a variety of techniques such as quizzes, simulations, explorations, and tests.

In present study slides are prepared on computer as ‘frame’ of programmed learning by systematic analysis of the unit of Science and Technology. This was considered as a computerised programme learning material for the present study.

Science and Technology.

Text book of Science and Technology of standard 9^{th} published by Gujarat State Text Book Board, Gujarat State is considered as Science and Technology in this study.

4. Objectives

Objectives of the present study were as follows:

1. To construct the computerised programmed learning material for one unit of Science and technology of standard 9.

2. To compare the educational achievement of students in Science and technology of experimental group and controlled group.

3. To compare the educational achievement in Science and technology of grant-in-aid and self-financed school students.

4. To compare the educational achievement in Science and technology of boy and girl students.

5. To examine the interactive effect of independent variable on the educational achievement of students in Science and technology.

5. Variables of the Study

The variables in the study were:

Table-1

Classification of Variables According to Categories

Sr. No	Type of Variable	Variable	Level	Category
1	Independent	Teaching Method	2	- Computerised Programme Learning - Lecture
2	Independent	School Type	2	- Grant-in-Aid - Self finance
3	Independent	Gender	2	- Boy - Girl
4	Dependent	Score on achievement test	-	-

6. Hypotheses of the Study

Hypotheses of the present study were as follows:

Ho_1. There will be no significant difference between the mean scores obtained on achievement test by the students of experimental group and controlled group.

Ho_2. There will be no significant difference between the mean scores obtained on achievement test by the students of grant-in-aid school and self-financed school.

Ho_3. There will be no significant difference between the mean scores obtained on achievement test by the boy and girl students.

Ho_4. There will be no significant difference between the mean scores obtained on achievement test by the students of grant-in-aid school and self-financed school of experimental group.

Ho_5. There will be no significant difference between the mean scores obtained on achievement test by the boy and girl students of experimental group.

Ho_6. There will be no combined effect of method of teaching and school type of students upon the mean scores obtained on achievement test by students.

Ho_7. There will be no combined effect of method of teaching and gender of students upon the mean scores obtained on achievement test by students.

Ho_8. There will be no combined effect of school type and gender of students upon the mean scores obtained on achievement test by students.

Ho_9. There will be no combined effect of method of teaching, school type and gender of students upon the mean scores obtained on achievement test by students.

7. Limitations of the Study

Limitations of the present study were as follows:

- The scope of present study is limited to Ahmedabad City of Gujarat State.
- This study was conducted for the Standard-9^{th} Students of Gujarati medium.
- This study was limited to Unit ‘Chemical bonding’ of Science and Technology subject only.

8. Population, Sample and Method of the Study

Population

Here, the main objective of the present study was to construct a computerised programmed learning material for the students of Standard-9^{th} of Gujarati medium of

Ahmedabad City in Science and Technology. Therefore, all the students of Standard-9th of Ahmedabad City who were study in Gujarati Medium in academic year 2015-16 became the population for the present study.

Sample

Selection of sample is very important part of any research work. Sample should be represents the whole population. If investigator makes error in selecting sample then the finding of the study will be no of use. Therefore, investigator should select the sample very carefully. In present study investigator kept following points in mind to select the appropriate sample.

- Sample should represent the whole population.
- Each member of the population should have the chance to be selected.
- Sample should be selected without any bias.

To select sample with precautions mentioned above investigator randomly selected one grant-in-aid school and one self-financed school from Ahmedabad city. This study was experimental study hence, two classes of std.9 required from each selected school. Investigator selected 9-A as experimental group and 9-B as controlled group from the each school. Then matched randomization technique was used on the bases of the annual exam score in Science & Technology subject at std. 8 of the students to select the final sample for experimental and control group. The details about the sample have been tabulated in table-2.

Table-2

Sample of the study

Sr. No.	**Name of School**	**Type of school**	**Experimental Group**		**Controlled Group**		**Total**
			Boys	**Girls**	**Boys**	**Girls**	
1.	Shri Durga Vidyalaya, Maninagar	Grant-in-Aid	10	10	10	10	**40**
2.	Jay Somnath school, Vejalpur	Self-financed	10	10	10	10	**40**
Total			**20**	**20**	**20**	**20**	**80**

Table-2 shows that there were 80 students of 9th standard selected as sample. From these 40 students were from grant-in-aid school and 40 students were from self-financed school. Further it indicates that 20 boys and 20 girls were selected in experimental group as well as in controlled group.

Method of the Study

Present study was about to construction and tryout of computerised programmed learning material for students of standard 9th in Science and Technology, experimental research method was selected for the present study.

9. Tools of the study

The following tools were used to collect the data for the present study.

(I.) Self made achievement test based on Blue Print for unit "Chemical bonding". (Attached Appendix-1)

(II.) Computerised programme learning material for unit "Chemical bonding". (CD Attached Appendix-II)

10. Construction of computerised programmed learning material

Investigator followed steps to construct computerised programme learning material are given below :

1. **Selection of the unit.** For the selection of the unit, investigator studied the whole text-book of Science & technology of standard 9th in detail. At that time investigator has kept in mind that which unit is maximum appropriate for self-learning as well as computerised programmed learning. After that investigator asked Science and Technology subject teachers of secondary schools that which unit is difficult to understand by students. Most of the teachers pointed out the unit "Chemical bonding". By studying text-book and gathering information from teachers, investigator decided to select unit "Chemical bonding" for construction and tryout of computerised programmed learning material.
2. **Content analysis.** In the beginning of the study the selected unit "Chemical bonding" was divided in to four sub-topics. 1. Chemical bond, Types of Chemical bond and Ionic bond, 2. Crystal structure and Properties of Ionic compound, 3. Covalent bond and Partial Covalent bond, 4. Properties of

compound with Covalent bond, Hydrogen bond were the sub-topics derived by the content analysis of the unit.

3. **Preparing primary programmed learning material.** After content analysis, construction of primary programmed learning material was done. For that investigator followed guideline given by Ellington, H.[6]. Investigator gone through following steps for constructing primary programmed material.

   (a) Establishing objectives for the programme : At this stage investigator clearly defined eight learning objectives from the unit "Chemical bonding".

   (b) Choosing a programme model : Actually Ellington suggested 'choosing content for the programme' as second step but in present study content was selected initially so there is no need to follow the second step given in guideline. Hence, investigator followed third step that is choosing a programme model. There are many models to construct programmed learning such as simple linear programme, linear programme with 'washhead' and 'washback', simple branching programme, branching programme with herringbone etc. For this study investigator selected linear programme with 'washhead' and 'washback' model. This model enables learner to repeat part of programme if they have not succeeded in mastering the material.

   (c) Designing a programme : After choosing a model for programme investigator has drawn up an overall design for the programme using flow diagram. The flow diagram of the programme is as follow :

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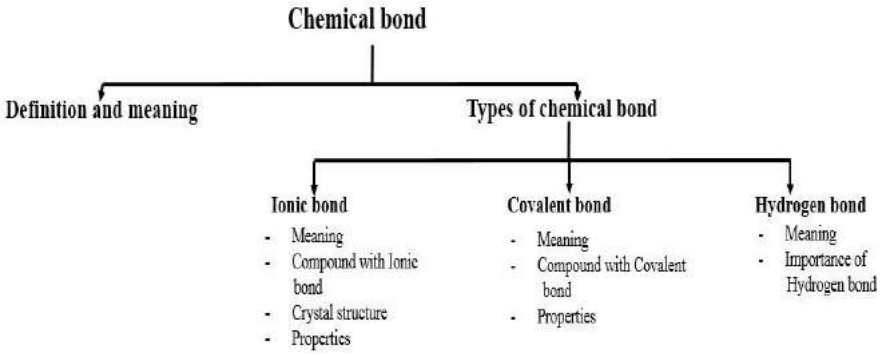
[6]Ellington, H. (1987). How to design programmed learning material, Aberdeen : RGIT. Retrieved from https://files.eric.ed.gov/fulltext/ED289495.pdf

Figure : 1

Flow diagram of the overall design for the programme



(d) Writing frames : The next and last step after preparing flow diagram was to write frames. In this step investigator wrote teaching frames, testing frames and response frames of programmed learning material for the unit "Chemical bonding".

4. **Evaluation by an expert.** Once a primary programmed learning material was developed, it was sent to the subject expert as well as programmed learning expert for the purpose of logical validation. The list of experts is as follow :

Table - 3

List of experts

Sr.No.	Name of expert	Qualification	Designation
1.	Dr.Rohini P. Upadhyaya	M.Sc., M.Phil., Ph.D.	Principal, Smt. M.N.K. Dalal Education College for Women, Ahmedabad
2.	Dr. Amit Mali	M.Sc., M.Ed., Ph.d., NET	Assistant Professor, Department of Education, Veer Narmad South Gujarat University, Surat
3.	Dr. Viral Jadav	M.Sc., M.Ed., Ph.d., NET	Assistant Professor, Shri Prakash College of education, Ahmedabad
4.	Dr. Ketan Gohel	M.Sc., M.Ed., Ph.D., GSET	Assistant Professor, Shri C. H. Shah Maitri vidyapeeth mahila college of education, Surendranagar

5. **Final programmed learning material**. After taking suggestions on primary programmed learning material for the unit "Chemical bonding" from the experts, investigator had made necessary correction according to expert's suggestions and prepare final programmed learning material for the unit "Chemical bonding".
6. **Construction of computerised programme learning material**. MS Office PowerPoint software was used to create computerised programme learning material from final programmed learning material. This was done with the help of computer technician.

7. **Primary study.** After constructing computerised programmed learning material, the primary study was carried out on 6 students. The purpose of the primary study was to know that whether the students can understand instruction given in the slides, content and the sequence of content, overall appearance of slides etc. After completion of primary study investigator asked students regarding instruction given in slides, presentation of content etc. and collected information to construct final computerised programmed learning material.
8. **Constructing final computerised programmed learning material.** The final computerised programmed learning was developed on the basis of the suggestions of experts as well as the result of the primary study. Final computerised programmed learning material on unit "Chemical bonding" is attached as appendix – II.

11. Procedure of experiment and data collection

Experimental group and controlled group were formed for the try-out of the computerised programmed learning. Pairing method based on marks obtained in Science and Technology subject in final examination of std. 8 by the students and types of school was used for group formation.

At initial stage investigator had taken permission to carry out experiment from the school principals of the selected school. After that experimental group was taught the unit "Chemical bonding" with computerised programmed learning material, while controlled group was taught same unit traditionally. After teaching, both the group has faced the achievement test on the unit "Chemical bonding" constructed by investigator. Thus, the design of present experimental study was two group post-test. And the schedule of conducting experiment in selected grant-in-aid school and self-finance school are shown in table-4 and table-5 respectively.

Table : 4

Time-table of experiment in grant-in-aid school

Durga vidyalaya, Maninagar					
Sr.No.	**Date**	**Period**	**Group-1 Experimental group, Std. 9-A**	**Period**	**Group-2 Controlled group, Std. 9-B**
1	06/12/2016	2nd	Chemical bond, Types of Chemical bond and Ionic bond	6th	Chemical bond, Types of Chemical bond and Ionic bond
2	07/12/2016	2nd	Crystal structure and Properties of Ionic compound	6th	Crystal structure and Properties of Ionic compound
3	08/12/2016	6th	Covalent bond and Partial Covalent bond	2nd	Covalent bond and Partial Covalent bond
4	09/12/2016	6th	Properties of compound with Covalent bond, Hydrogen bond	2nd	Properties of compound with Covalent bond, Hydrogen bond
5	10/12/2016	4th	Exam	3rd	Exam

Table : 5

Time-table of experiment in self-finance school

Jay Somnath school, Vejalpur					
Sr.No.	Date	Period	Topic for Group-1 Experimental group, Std. 9-A	Period	Topic for Group-2 Controlled group, Std. 9-B
1	20/12/2016	5th	Chemical bond, Types of Chemical bond and Ionic bond	3rd	Chemical bond, Types of Chemical bond and Ionic bond
2	21/12/2016	5th	Crystal structure and Properties of Ionic compound	3rd	Crystal structure and Properties of Ionic compound
3	22/12/2016	3rd	Covalent bond and Partial Covalent bond	5th	Covalent bond and Partial Covalent bond
4	23/12/2016	3rd	Properties of compound with Covalent bond, Hydrogen bond	5th	Properties of compound with Covalent bond, Hydrogen bond
5	24/12/2016	3rd	Exam	5th	Exam

After completion of experiment achievement test based on Blue Print was administered on the students of standard-9th of both grant-in-aid school and self-finance school. Necessary instructions were given to the students to fill up achievement test. After the completion, answer sheets were collected back to check whether the students had filled up all the necessary information properly or not. Thus, data was collected from the entire sample.

12. Data analysis and interpretation

After collecting data, collected data were classified according to variables. Frequency distributions were also prepared for different groups. Descriptive statistical measurements were calculated based on the frequency distribution of each group. For testing null hypothesis t-ratio and F-ratio were used. For statistical calculation SPSS V.16

computer programme was used. The results of testing hypothesis are presented one by one as follow:

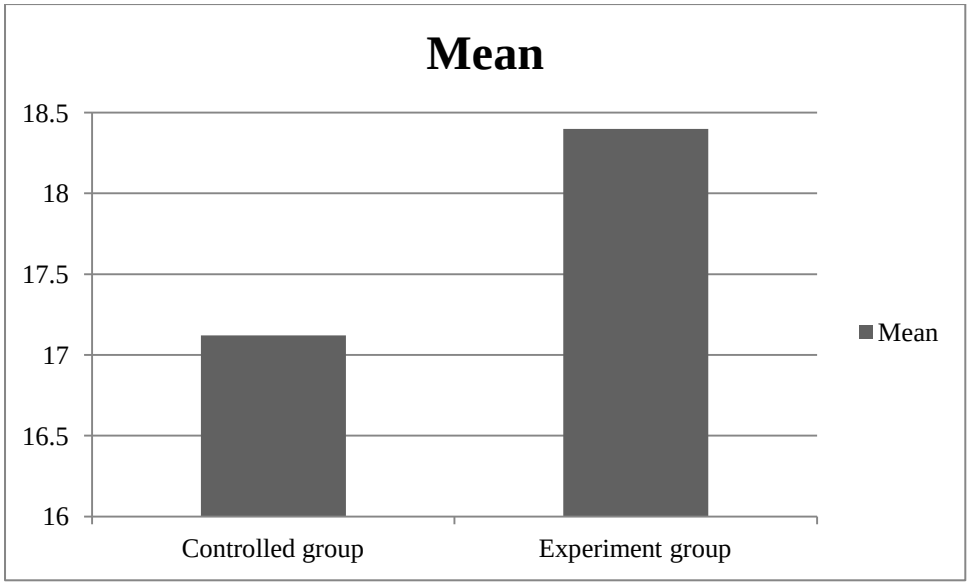
The first null hypothesis of the present study was "There will be no significant difference between the mean scores obtained on achievement test by the students of experimental group and controlled group." To test this null hypothesis t-ratio was calculated and the detail of the statistical analysis is shown in table-6.

Table - 6

Comparison of mean achievement score of controlled group and experimental group

Group	**N**	**Mean**	**S.D.**	**SED**	**M. Diff.**	**t-value**	**Remark**
Controlled	40	17.12	2.32	0.012	1.28	2.41	Significant at 0.01 level
Experimental	40	18.40	2.39				

Table – 6 shows that mean of scores achieved on the achievement test by controlled group students is 17.12 and experimental group students is 18.40; standard deviation is 2.32 and 2.39; standard error of mean difference is 0.012 and t-value is 2.41. So, it can be said that calculated t-value is greater than table value 2.37 at df 78 at 0.01 significance level. So, Null Hypothesis **(Ho1)** is not accepted. Thus, it can be said that significant difference found between achievement score of experimental group students and control group students. Hence, by comparing mean scores, experimental group student's means scores is higher than the mean of scores achieved by the control group students. Thus, experimental group students were found to have higher in achievement than control group students, which shows that teaching method is affecting variable to achievement. Graphical presentation of mean of achieved score as per table-6 is given in graph -1.



Graph - 1

Comparison of mean achievement score of controlled group and experimental group

The second null hypothesis of the present study was "There will be no significant difference between the mean scores obtained on achievement test by the students of grant-in-aid school and self-financed school." To test this null hypothesis t-ratio was calculated and the detail of the statistical analysis is shown in table-7.

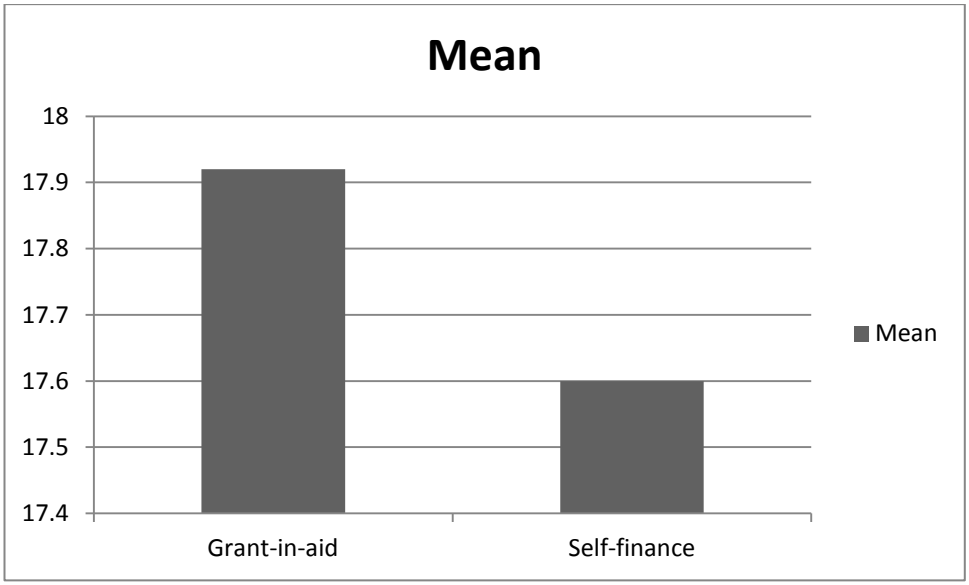
Table - 7

Comparison of mean achievement score of Grant-in-aid schools students and Self-finance schools students

Type of school	**N**	**Mean**	**S.D.**	**SED**	**M. Diff.**	**t-value**	**Remark**
Grant-in-aid	40	17.92	2.65	0.071	0.32	0.596	Not significant at 0.05 level
Self-finance	40	17.60	2.20				

Table – 7 shows that mean of scores achieved on the achievement test by Grant-in-Aid school students is 17.92 and Self-finance school students is 17.60; standard deviation is 2.65 and 2.20; standard error of mean difference is 0.071 and t-value is 0.596. So, it can be said that calculated t-value is less than table value 1.66 at df 78 at 0.05 significance level. So, Null Hypothesis **(Ho2)** is not rejected. Thus, it can be said that no

significant difference found between achievement score of Grant-in-Aid school students and Self-finance school students. It means that type of school is not affecting variable to achievement. Graphical presentation of mean of achieved score as per table-7 is given in graph -2.



Graph - 2

Comparison of mean achievement score of grant-in-aid schools students and Self-finance schools students

The third null hypothesis of the present study was "There will be no significant difference between the mean scores obtained on achievement test by the boy and girl students." To test this null hypothesis t-ratio was calculated and the detail of the statistical analysis is shown in table-8.

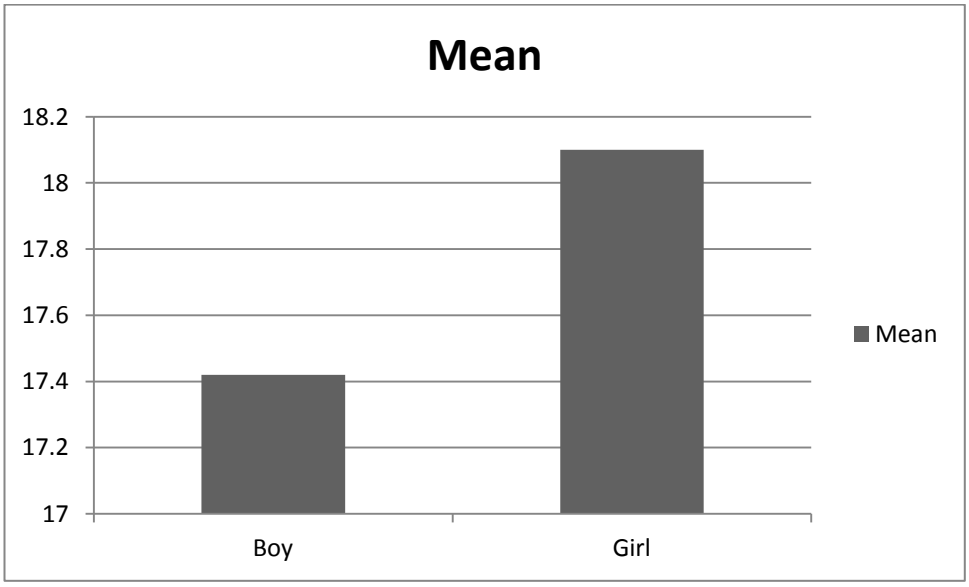
Table - 8

Comparison of mean achievement score of boys and girls

Gender	N	Mean	S.D.	SED	M. Diff.	t-value	Remark
Boy	40	17.42	2.75	0.11	0.68	1.24	Not significant at 0.05 level
Girl	40	18.10	2.03				

Table – 8 shows that mean of scores achieved on the achievement test by boy students is 17.42 and girl students is 18.10; standard deviation is 2.75 and 2.03; standard error of mean difference is 0.11 and t-value is 1.24. So, it can be said that calculated t-

value is less than table value 1.66 at df 78 at 0.05 significance level. So, Null Hypothesis **(Ho3)** is not rejected. Thus, it can be said that no significant difference found between achievement score of boy students and girl students. It means that gender is not affecting variable to achievement. Graphical presentation of mean of achieved score as per table-8 is given in graph -3.



Graph - 3

Comparison of mean achievement score of boys and girls

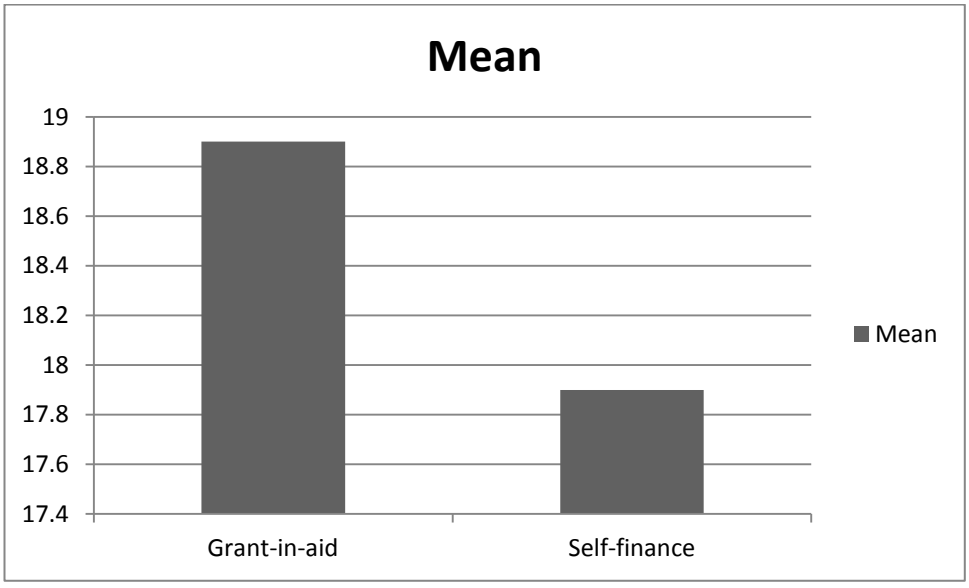
The fourth null hypothesis of the present study was "There will be no significant difference between the mean scores obtained on achievement test by the students of grant-in-aid school and self-financed school of experimental group." To test this null hypothesis t-ratio was calculated and the detail of the statistical analysis is shown in table-9.

Table - 9

Comparison of mean achievement score of Grant-in-aid school students and Self-finance school students of experimental group

Type of school	N	Mean	S.D.	SED	M. Diff.	t-value	Remark
Grant-in-aid	20	18.90	2.29	0.035	1.0	1.33	Not significant at 0.05 level
Self-finance	20	17.90	2.44				

Table – 9 shows that mean of scores achieved on the achievement test by Grant-in-Aid school students of experimental group is 18.90 and Self-finance school students of experimental group is 17.90; standard deviation is 2.29 and 2.44; standard error of mean difference is 0.035 and t-value is 1.33. So, it can be said that calculated t-value is less than table value 1.68 at df 38 at 0.05 significance level. So, Null Hypothesis **(Ho4)** is not rejected. Thus, it can be said that no significant difference found between achievement score of Grant-in-Aid school students and Self-finance school students of experimental group. It means that there was no significant effect of type of school on the achievement of experimental group's students. Graphical presentation of mean of achieved score as per table-9 is given in graph -4.



Graph - 4

Comparison of mean achievement score of grant-in-aid school students and self-finance school students of experimental group

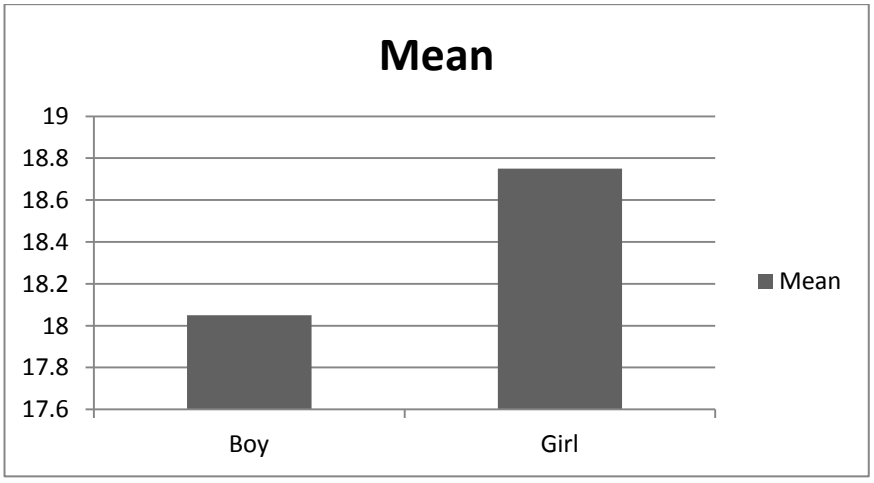
The fifth null hypothesis of the present study was "There will be no significant difference between the mean scores obtained on achievement test by the boy and girl students of experimental group." To test this null hypothesis t-ratio was calculated and the detail of the statistical analysis is shown in table-10.

Table - 10

Comparison of mean achievement score of boy students and girl students of experimental group

Gender	N	Mean	S.D.	SED	M. Diff.	t-value	Remark
Boy	20	18.05	2.85	0.229	0.7	0.923	Not significant at 0.05 level
Girl	20	18.75	1.83				

Table – 10 shows that mean of scores achieved on the achievement test by boy students of experimental group is 18.05 and girl students of experimental group is 18.75; standard deviation is 2.85 and 1.83; standard error of mean difference is 0.229 and t-value is 0.923. So, it can be said that calculated t-value is less than table value 1.68 at df 38 at 0.05 significance level. So, Null Hypothesis **(Ho5)** is not rejected. Thus, it can be said that no significant difference found between achievement score of boy students and girl students of experimental group. It means that there was no significant effect of gender on the achievement of experimental group's students. Graphical presentation of mean of achieved score as per table-10 is given in graph -5.



Graph - 5

Comparison of mean achievement score of boy students and girl students of experimental group

To know the combine effects of independent variables investigator created null hypothesis no. 6, 7, 8 and 9. The sixth null hypothesis was "There will be no combined effect of method of teaching and school type of students upon the mean scores obtained on achievement test by students." The seventh null hypothesis was "There will be no combined effect of method of teaching and gender of students upon the mean scores obtained on achievement test by students." The eighth null hypothesis was "There will be no combined effect of school type and gender of students upon the mean scores obtained on achievement test by students." and the ninth null hypothesis was "There will be no combined effect of method of teaching, school type and gender of students upon the mean scores obtained on achievement test by students." To test these null hypotheses F-ratio was calculated and the required statistical analysis is given in table – 11.

Table - 11

F-ratio, Mean achievement score of students in reference to teaching method, type of school and gender

Variable	N	Df	Sum of square	Mean of square	F-ratio	Remarks
Method of teaching × Type of school	80	1	9.112	9.112	1.734	Not significant at 0.05 level
Method of teaching× Gender	80	1	0.013	0.013	0.002	Not significant at 0.05 level
Type of school × Gender	80	1	2.812	2.812	0.535	Not significant at 0.05 level
Method of teaching ×Type of school × Gender	80	1	32.512	32.512	6.188	Significant at 0.05 level
Error	80	72	378.300	5.254		
Total	80	80	25706.99			

Table-11 shows that the sum of squares of achievement score in reference to method of teaching and type of school was 9.112. Mean of square was 9.112 and the value of F-ratio was 1.73 which is less than table value 3.96 at 0.05 significance level. So, Null Hypothesis **(Ho6)** is not rejected. Thus, it can be said that no significant difference found between achievement score in reference to method of teaching and type of school. It means that there was no significant combined effect of method of teaching and type of school on the achievement of students.

Table : 11 shows that the sum of squares of achievement score in reference to method of teaching and type of school was 0.013. Mean of square was 0.013 and the value of F-ratio was 0.002 which is less than table value 3.96 at 0.05 significance level. So, Null Hypothesis **(Ho7)** is not rejected. Thus, it can be said that no significant difference found between achievement score in reference to method of teaching and gender. It means that there was no significant combined effect of method of teaching and gender on the achievement of students.

Table : 11 shows that the sum of squares of achievement score in reference to type of school and gender was 2.812. Mean of square was 2.812 and the value of F-ratio was 0.535 which is less than table value 3.96 at 0.05 significance level. So, Null Hypothesis **(Ho8)** is not rejected. Thus, it can be said that no significant difference found between achievement score in reference to type of school and gender. It means that there was no significant combined effect of type of school and gender on the achievement of students.

Table : 11 shows that the sum of squares of achievement score in reference to method of teaching, type of school and gender was 32.512. Mean of square was 32.512 and the value of F-ratio was 6.188 which is greater than table value 3.96 at 0.05 significance level. So, Null Hypothesis **(Ho9)** is not accepted. Thus, it can be said that significant difference found between achievement score in reference to method of teaching, type of school and gender. It means that there was significant combined effect of method of teaching, type of school and gender on the achievement of students.

13. Major findings

1. Effect of teaching method found on achievement of students. Experimental group students were more superior than control group students as far as achievement of subject knowledge of unit “Chemical bonding”.
2. Effect of type of school not found on achievement of students. Grant-in-aid school students and self-finance school students were found to have equal as far as achievement of subject knowledge of unit “Chemical bonding”.
3. Effect of gender not found on achievement of students. Boy students and girl students were found to have equal as far as achievement of subject knowledge of unit “Chemical bonding”.

4. Effect of type of school not found on achievement of experimental group students. Grant-in-aid school and self-finance school students of experimental group were found to have equal as far as achievement of subject knowledge of unit “Chemical bonding”.
5. Effect of gender not found on achievement of experimental group students. Boy and girl students of experimental group were found to have equal as far as achievement of subject knowledge of unit “Chemical bonding”.
6. Combined effect of method of teaching and type of school not found on achievement of students as far as achievement of subject knowledge of unit “Chemical bonding”.

7. Combined effect of method of teaching and gender not found on achievement of students as far as achievement of subject knowledge of unit “Chemical bonding”.

8. Combined effect of type of school and gender not found on achievement of students as far as achievement of subject knowledge of unit “Chemical bonding”.

9. Combined effect of method of teaching, type of school and gender found on achievement of students as far as achievement of subject knowledge of unit “Chemical bonding”.

14. Conclusion

By this study computerised programmed learning material and achievement test for the unit “Chemical bonding” was developed, which are useful for further work. The

major findings show that teaching through computerised programmed learning material is more effective than traditional lecture method for teaching of Science and Technology subject. Hence, teacher should developed computerised programmed learning material for at least some topics of Science and Technology subject, so they can teach Science and Technology more effectively.

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Appendix-I

Achievement test based on Blue Print and answer key

Blue Print

Table-1

Marks and percentage according to objective

Sr.No.	Objective	Marks	Percentage (%)
1	Knowledge	7	28%
2	Understand	13	52%
3	Usage	5	20%
4	Skill	0	00%
Total		**25**	**100%**

Table-2

Marks and percentage according to content

Sr.No.	Content	Marks	Percentage (%)
1	Chemical bond, types of chemical bond, Ionic bond	7	28%
2	Crystal structure, Properties of Ionic compound	6	24%
3	Covalent bond, partial covalent bond	5	20%
4	Properties of compound with covalent bond, Hydrogen bond	7	28%
Total		**25**	**100%**

Table-3

Marks and percentage according to types of questions

Sr.No.	**Type of Question**	**Marks**	**Percentage (%)**
1	Essay Type	0	00%
2	Short Type	0	00%
3	Objective Type	25	100%
Total		**25**	**100%**

Blue-Print for Post test

Sr.No.	Content ↓	Objectives →	Knowledge			Understanding			Usage			Skill			Total			Total
		Question Type →	E	S	O	E	S	O	E	S	O	E	S	O	E	S	O	
1	Chemical bond, types of chemical bond, Ionic bond							5(5)			2(2)						7(7)	7(7)
2	Crystal structure, Properties of Ionic compound				3(3)			2(2)			1(1)						6(6)	6(6)
3	Covalent bond, partial covalent bond				2(2)			2(2)			1(1)						5(5)	5(5)
4	Properties of compound with covalent bond, Hydrogen bond				2(2)			4(4)			1(1)						7(7)	7(7)
	Total (as per question type)				7(7)			13 (13)			5(5)						25 (25)	25 (25)
	Total (as per objectives)		7(7)			13(13)			5(5)			--			25 (25)			25 (25)

Figure shown in ( ) bracket indicate no. of question and figure shown out of the ( ) bracket indicate marks.

Achievement Test
એકમ કસોટી : રાસાયણિક બંધન

ધોરણ : ૯ કુલ ગુણ : ૨૫

તા. ..... સમય : ૩૫ મિનિટ

સૂચના : નીચે આપેલા પ્રશ્નોના ઉત્તર યોગ્ય વિકલ્પ પસંદ કરીને ઉત્તર પત્રમાં યોગ્ય સ્થાને આપો.

૧. રાસાયણિક બંધના નિર્માણ સમયે ઈલેક્ટ્રોનની ..... થાય છે.

(અ) ભાગીદારી (બ) આપ-લે (ક) ફેરબદલી (ડ) આપ-લે કે ભાગીદારી

૨. કોઈ એક સંયોજનમાં આયનીય બંધ બને છે, તેમાં કોઈ એક પરમાણુ ઋણ આયન બનાવે છે તો નીચેનામાંથી તેના માટે શું સાચું છે?

(અ) તેની બાહ્ય કક્ષામાં ૩,૪,કે ૫ ઈલેક્ટ્રોન હશે.

(બ) તેની બાહ્ય કક્ષામાં ૫,૬,કે ૭ ઈલેક્ટ્રોન હશે.

(ક) તેની બાહ્ય કક્ષામાં ૩,૨,કે ૧ ઈલેક્ટ્રોન હશે.

(ડ) તેની બાહ્ય કક્ષામાં ૧,૨,કે ૩ ઈલેક્ટ્રોન હશે.

૩. મેગ્નેશિયમ આયનની ઈલેક્ટ્રોન રચના જણાવો.

(અ) ૨,૮,૧ (બ) ૨,૮,૨ (ક) ૨,૮ (ડ) ૨,૮,૬

૪. સોડિયમ ક્લોરાઇડમાં સોડિયમ એક ઇલેક્ટ્રોન ..... છે અને ક્લોરિન એક ઇલેક્ટ્રોન ..... છે. તેમની વચ્ચે ઇલેક્ટ્રોનની આપ-લે થવાથી ..... બંધ રચાય છે.

(અ) ગુમાવે, મેળવે, સહસંયોજક

(બ) મેળવે, ગુમાવે, સહસંયોજક

(ક) મેળવે, ગુમાવે, આયનીય

(ડ) ગુમાવે, મેળવે, આયનીય

૫. MgO સંયોજન બનવા માટે O પરમાણુ કેવું વર્તન કરશે?

(અ) O એક ઈલેક્ટ્રોન ગુમાવશે.

(બ) O એક ઈલેક્ટ્રોન મેળવશે.

(ક) O બે ઈલેક્ટ્રોન ગુમાવશે.

(ડ) O બે ઈલેક્ટ્રોન મેળવશે.

૬. સોડિયમ પરમાણુનો પરમાણુ ક્રમાંક ૧૧ છે તો તેનું સ્થાન આવર્ત કોષ્ટકમાં કયા સમૂહમાં હશે?

(અ) આઠમો સમૂહ (બ) પહેલો સમૂહ (ક) બીજો સમૂહ (ડ) સાતમો સમૂહ

૭. કોઈ પણ તત્ત્વની ક્રિયાશીલતા શાને આભારી હોય છે?

(અ) તેમાં રહેલ પ્રોટોનને (બ) તેમાં રહેલ ઈલેક્ટ્રોનને (ક) તેમાં રહેલ ન્યુટ્રોનને (ડ) તેમાં રહેલ ઈલેક્ટ્રોન, પ્રોટોન અને ઈલેક્ટ્રોનને

૮. NaClની સ્ફટિક રચનામાં એક ઋણ આયન સાથે કેટલાં ધન આયનો જોડાયેલા હોય છે?

(અ) પાંચ (બ) ચાર (ક) છ (ડ) સાત

૯. મોટાભાગનાં આયનીય સંયોજનો ..... ભૌત્તિક સ્વરૂપે મળે છે. ને તે ..... હોય છે.

(અ) ઘન, નરમ (બ) ઘન, સખત (ક) પ્રવાહી, નરમ (ડ) પ્રવાહી અને તરલ

૧૦. NaCl ..... દ્રાવ્ય અને ..... અદ્રાવ્ય હોય છે.

(અ) બેન્ઝિન, પાણી (બ) પાણી, ધ્રુવીય દ્રાવક (ક) ધ્રુવીય દ્રાવક, પાણી (ડ) પાણી, બેન્ઝિન

૧૧. આયનીય સંયોજનનાં ગલનબિંદુ અને ઉત્કલનબિંદુ ઊંચા હોય છે. – કારણ કે...

(અ) તે સ્ફટિક રચના ધરાવે છે.

(બ) તેમાં ધન અને ઋણ આયનો વચ્ચે આંતર આયનીય આકર્ષણ પ્રબળ છે.

(ક) અ અને બ બંને

(ડ) એક પણ નહીં

૧૨. આયનીય સંયોજનની વિદ્યુત વાહકતા માટે નીચેનામાંથી શું સાચું છે?

(અ) તે વિદ્યુતવાહક છે.

(બ) તેનું જલીય દ્રાવણ વિદ્યુત અવાહક છે.

(ક) તે વિદ્યુત અવાહક છે.

(ડ) એક પણ નહીં

૧૩. ક્લોરિનનો અણુ બનવા માટે ..... ક્લોરિન પરમાણુઓ ..... ઈલેક્ટ્રોનની ..... કરે છે.

(અ) બે, ૧-૧, ભાગીદારી

(બ) એક, ૨-૨, ભાગીદારી

(ક) બે, ૧-૧, આપ-લે

(ડ) એક, ૨-૨, આપ-લે

૧૪. હાઇડ્રોજન અણુમાં તેના બે પરમાણુઓ વચ્ચે કેટલા સહસંયોજક બંધ હોય છે?

(અ) બે (બ) ત્રણ (ક) ચાર (ડ) એક

૧૫. નીચેનામાંથી કયું સંયોજક ત્રિ-સંયોજક છે?

(અ) ઓક્સિજન (બ) નાઈટ્રોજન (ક) કાર્બન (ડ) ક્લોરિન

૧૬. ધ્રુવીય સહસંયોજક બંધમાં કયા પરમાણુ પરમાણુ પર $\delta+$ નિશાની હોય છે?

(અ) વધુ વિદ્યુત ઋણતા ધરાવતાં પરમાણુ પર

(બ) એરોની જમણી બાજુ પર રહેલ પરમાણુ પર

(ક) ઓછી વિદ્યુત ઋણતા ધરાવતા પરમાણુ પર

(ડ) બંધન ઈલેક્ટ્રોન યુગ્મ જેની નજીક રહે છે તે પરમાણુ પર

૧૭. કેવી પરિસ્થિતિમાં ધ્રુવીય સહસંયોજક બંધ બની શકે નહિ?

(૧) જ્યારે બંને પરમાણુઓ એક જ તત્વના હોય

(૨) જ્યારે બંને પરમાણુઓની વિદ્યુત ઋણતામાં ઓછો તફાવત હોય

(૩) જ્યારે બંને પરમાણુઓની વિદ્યુત ઋણતામાં મોટો તફાવત હોય

(૪) જ્યારે બંને પરમાણુઓની વિદ્યુત ઋણતા સમાન હોય

(અ) પરિસ્થિતિ ૧, ૩ અને ૪

(બ) પરિસ્થિતિ ૧, ૨ અને ૪

(ક) પરિસ્થિતિ ૨, ૩ અને ૪

(ડ) પરિસ્થિતિ ૧, ૨ અને ૩

૧૮. સહસંયોજક બંધની રચના સમયે નીચેનામાંથી શું થાય છે?

(અ) ઈલેક્ટ્રોન ગુમાવવામાં આવે (બ) ઈલેક્ટ્રોન મેળવવામાં આવે

(ક) ઈલેક્ટ્રોનની ભાગીદારી થાય (ડ) ઈલેક્ટ્રોનની આપ-લે થાય

૧૯. નીચે આપેલ સંયોજનો પૈકી કયા સંયોજનમાં આયનીય અને સહસંયોજક બંધ સાથે હશે?

(અ) NaCl (બ) NaOH (ક) KCl (ડ) HBr

૨૦. સહસંયોજક બંધ ધરાવતા સંયોજનો કેવી ભૌતિક અવસ્થામાં હોય શકે?

(અ) ઘન (બ) પ્રવાહી (ક) વાયુ (ડ) ઘન, પ્રવાહી, અને વાયુ ત્રણેય

૨૧. આયનીય સંયોજનો અને સહસંયોજક બંધ ધરાવતાં સંયોજનોના ગલનબિંદુની તુલના કરવાથી શું કહી શકાય?

(અ) આયનીય સંયોજનોનું ગલનબિંદુ નીચું હોય (બ) આયનીય સંયોજનોનું ગલનબિંદુ ઊંચું હોય

(ક) બંનેના ગલનબિંદુ સમાન હોય (ડ) કશું કહી શકાય નહિ.

૨૨. નીચેનામાંથી કયું સંયોજન નિર્બળ વિદ્યુત વાહક છે?

(અ) KCl (બ) HBr (ક) NaCl (ડ) O_2

૨૩. HFનાં બે કે વધુ અણુઓ એકબીજાની નજીક એક ચોક્કસ આકર્ષણથી જોડાયેલા રહે છે તે કારણે રચાતા બંધને કયા બંધ તરીકે ઓળખવામાં આવે છે?

(અ) સહસંયોજક (બ) આયનીય (ક) ધ્રુવીય સહસંયોજક (ડ) હાઈડ્રોજન

૨૪. નીચેનામાંથી કયું વિધાન હાઈડ્રોજન બંધનું મહત્વ દર્શાવતું નથી?

(અ) પૃથ્વી પરના પાણીનું બાષ્પીભવન વધારે છે.

(બ) વનસ્પતિ કોષ તથા પ્રાણી કોષમાં પાણીનો સંગ્રહ કરવામાં મદદ કરે છે.

(ક) દવાઓની અસરકારકતા વધારમાં ઉપયોગી

(ડ) કૃત્રિમ રેસાવાળા કાપડ ઝડપી સુકાય છે.

૨૫. એમોનિયાના બે અણુઓ વચ્ચે કેટલા હાઈડ્રોજન બંધ આવેલા હોય છે?

(અ) બે (બ) ત્રણ (ક) એક (ડ) ચાર

એકમ કસોટી : રાસાયણિક બંધન

Answer Key

૧. (ડ)

૨. (બ)

૩. (ક)

૪. (ડ)

૫. (ડ)

૬. (બ)

૭. (બ)

૮. (ક)

૯. (બ)

૧૦. (બ)

૧૧. (ક)

૧૨. (ક)

૧૩. (અ)

૧૪. (ડ)

૧૫. (બ)

૧૬. (ક)

૧૭. (અ)

૧૮. (ક)

૧૯. (બ)

૨૦. (ડ)

૨૧. (બ)

૨૨. (ડ)

૨૩. (ડ)

૨૪. (અ)

૨૫. (ક)

એકમ કસોટી : રાસાયણિક બંધન

ઉત્તર પત્ર (Answer sheet)

વિદ્યાર્થીનો રોલ નં. : .....

નોંધ : ક્રમાંકની સામે આપેલ ( ) જગ્યામાં સાચો વિકલ્પ લખો.

૧. ( )
૨. ( )
૩. ( )
૪. ( )
૫. ( )
૬. ( )
૭. ( )
૮. ( )
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૧૦. ( )
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૨૪. ( )
૨૫. ( )

Appendix-II

CD of computerised programmed learning material for unit "Chemical bonding"