CHAPTER III

METHOD AND PROCEDURE
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DESIGN OF THE STUDY

The present investigation was designed to identify the percentage of high school students who attain the formal operativity level of cognitive development, as also to examine the relationship of formal operations abilities, namely, proportionality, propositional logic and combinatorial analysis as assessed on six different Piagetian tasks, with achievement in science. For this purpose descriptive method has been employed.

Bivariate relationship has been used to study the relationship of each of three cognitive abilities (proportionality, propositional logic and combinatorial analysis) with achievement in Physics, Biology, Chemistry and total science achievement. The clusters of variables going together have been examined by submitting the intercorrelation matrix to Factor Analysis and Rotation of Factors. Further, use of multiple regression equations has been made to determine the predictive efficiency of proportionality, propositional logic and combinatorial analysis singularly and conjointly towards the criterion variables of achievement in Physics, Biology and Chemistry as well as the total science achievement.
SAMPLE

(A) Sample for preliminary try-out of the Science Achievement test comprised 40 students belonging to grade ten, selected randomly from high schools from where the main sample for the investigation at hand was drawn (Table 3.1). However these subjects were not included in the main sample.

Table 3.1

DISTRIBUTION OF SAMPLE IN THE STANDARDIZATION OF SCIENCE ACHIEVEMENT TEST (PRELIMINARY TRY-OUT)

<table>
<thead>
<tr>
<th>Test</th>
<th>No. of Subjects</th>
<th>Total Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Govt. Khalsa Senior School</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Govt. Senior Secondary School</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Govt. Senior Secondary School for Girls, Mansa Joga</td>
<td>10</td>
<td>10</td>
</tr>
</tbody>
</table>

(B) A sample of one hundred pupils of class ten, was drawn randomly from two schools (one urban and one rural school) for estimating the reliability of science achievement test. Though the test was administered on a sample of 100 pupils, but only 90 could be followed in the second testing because of absentees and incomplete responses.
School marks obtained by (the same sample for estimating reliability) students in the final test of IXth class were correlated with score on standardized test for estimating the validity of test.

(C) The sample for the main study consisting of 409 students (Boys = 206; Girls = 203) of grade X was drawn on the basis of Multi-stage Stratified Random Sampling technique from the State of Punjab. There are three educational zones - Ferozepur, Patiala and Jalandhar in Punjab. For reasons of practical difficulties of handling the complexities involved in the study requiring administration of six individually administered Piagetian tasks and the inclusion of rural and urban students of both sexes, only one zone i.e. Ferozepur was selected randomly. This zone has three districts - Ferozepur, Bhatinda and Faridkot. Out of these three districts, two districts namely, Bhatinda and Faridkot were randomly drawn. Then a list of schools separately for urban (119) and rural (313) areas of these two districts was prepared. Selection of four schools from urban area and six schools from the rural area was done randomly and separately. As the number of students studying in grade tenth in urban and rural schools was found to be approximately equal, so equal number
<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Name of Schools</th>
<th>Urban No. of Subjects</th>
<th>Boys</th>
<th>Girls</th>
<th>Rural No. of Subjects</th>
<th>Boys</th>
<th>Girls</th>
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<tbody>
<tr>
<td>2.</td>
<td>Govt. Senior Secondary School for Boys, Mansa.</td>
<td>51</td>
<td></td>
<td></td>
<td>Govt. High School, Kotra.</td>
<td>13</td>
<td>17</td>
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<tr>
<td>3.</td>
<td>Govt. High School for Boys, Malout.</td>
<td>51</td>
<td></td>
<td></td>
<td>Govt. Senior Secondary School, Khiala Kalan.</td>
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<td>18</td>
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<td>4.</td>
<td>Govt. High School for Girls, Malout.</td>
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<td></td>
<td></td>
<td>Govt. High School, Malout Pind.</td>
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<tr>
<td>5.</td>
<td>Govt. High School, Danewala.</td>
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<td></td>
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<tr>
<td>Total</td>
<td>102 + 103</td>
<td>104 + 100</td>
<td>104</td>
<td>100</td>
<td></td>
<td>205</td>
<td>204</td>
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</tbody>
</table>

N = 409
of urban and rural students were randomly drawn from the schools, selected for the study.

The school-wise details of the sample are given in Table 3.2.

TOOLS

The incorporation of basic ideas and their development concerning concrete and formal operations in the monumental work of Inhelder and Piaget (1958), "The Growth of Logical Thinking from Childhood to Adolescence" made the delicate problem of selection of tasks (tools) simple. Flavell (1963) comments, "This book, besides constituting the only major study of adolescent reasoning by Piaget group, also contains a thorough theoretical analysis of concrete operations, formal operations and the relation between the two." (p.8).

With the publication of this book, Piaget was able to present the most complete account of his stages in the development of logical thinking. From the symbolic model of the actual process of thinking by Piaget and from a systematic empirical study of the induction of physical laws in children and adolescents by Inhelder, a 'striking convergence' was found between the empirical and analytical results. The set of operational structures was to be based on Propositional logic and a 'formal' mode of thought as distinguished from the 'concrete' operational thought.
Further, the techniques of propositional logic were found to be inadequate to analyse the integrated structure of operations found in the adolescent's formal thinking. Empirical investigations showed that a series of operational schemata namely Combinatorial operations, propositions, double systems of reference, a schema of mechanical equilibrium equality between action and reaction, multiplicative probabilities, and correlations appear along with Propositional logic. Reference to only specific operations of propositional logic were not enough to explain the development of operational schemata and propositional logic together. Rather, it was found necessary to refer to the 'integrated structures' on which they were based i.e. to the dual structure of the lattice and the group of four transformations. Also illumination was provided for the earlier set of concrete structures and Inhelder and Piaget were able to describe the changes in logical operations between childhood and adolescence, while analysing and isolating the formal structures, marking the completion of the operational development of intelligence. The work records the results of fifteen separate experiments divided into those demonstrating the development of propositional logic and the operational schemata of formal logic.

A. In the present investigation six tasks were adapted from Inhelder and Piaget's (1958) tasks included in
‘The Growth of Logical Thinking from Childhood to Adolescence’. Five of these tasks have already been used successfully used by Bala (1980), Grover (1983), Gakhar & Gupta (1987) in their research work.

I. **Proportionality**, was measured through two tasks as given below:
   (a) Equilibrium in the Balance.
   (b) The Projection of Shadows.

II. Following two tasks were used in order to measure **Propositional logic**:
   (a) Law of Floating Bodies and Elimination of Contradictions.
   (b) The Oscillation of Pendulum and the Operation of Exclusion.

III. The ability of **Combinatorial analysis** was tested with the help of two tasks namely:
   (a) Combination of Coloured and Colourless Chemical Bodies.
   (b) Combination of Coloured and Colourless tokens (taken from cups).

B. Subject-wise achievement in Physics, Biology and Chemistry was measured through the science achievement test which was developed and standardized by the investigator herself (Details in Chapter No.IV). The addition of subject-wise scores led to obtaining a total science achievement score.
TASK I (a) EQUILIBRIUM IN THE BALANCE

This task was employed to find out the operational schema of equilibrium between action and reaction, while taking into account the role of proportionality.

The experiment is set up in a way that would force the question of proportionality. When two unequal weights \( W \) and \( W' \) are balanced at unequal distances \( L \) and \( L' \) (from an axis), the amount of work \( WH \) and \( W'H' \) needed to move them to heights \( H \) and \( H' \) corresponding to these distances are equal. Thus, we have the double proportion:

\[
\begin{align*}
\frac{W}{W'} & = \frac{L'}{L} \quad \frac{H'}{H} \\
\end{align*}
\]

The result is that finding the law presupposes the construction of the proportion, \( \frac{W}{W'} = \frac{L'}{L} \) and spelling out its explanation implied in understanding of the proportion \( \frac{W}{W'} = \frac{H'}{H} \).

A balance scale is used - its meter long beam has zero at its centre and 0 to 50 cms. markings on either side. The balance is equipped with slotted weights (Fig.3.1).

The children are asked to find the weight that should be suspended on the second beam as well as the position of suspension in order to balance a weight that the experimenter has suspended to the first beam.
Figure 3.1 Task I(a) EQUILIBRIUM IN THE BALANCE

Figure 3.2 Task I(b) THE PROJECTION OF SHADOWS
SCORING

Level I: The subject fails to distinguish instrument from the actions of the objects that they trying to control. His response is restricted to removal of weight, just to try a new and different course action when he has failed in his earlier attempt. At t level, the subject, of course, understands that weight needed on both sides to achieve balance and even that weights should be approximately equal. His actions are t restricted to successive corrections and are not strictly reversible.

Level II: The subject discovers by trial and er that equilibrium between a smaller weight at a great distance and a greater weight at a smaller distance possible, but he does not yet draw out gene correspondences, and tries to achieve equilibrium w substitutions - additions or subtractions.

Level III: The subject tries to balance two uneq weights by means of oriented displacement on the basis hypothesis that the same object 'will weigh more' at greater distance from an axis and less when brought clo to it. He works by simple qualitative corresponden without metrical proportions.

Level IV: Metrical operations emerge here. subject discovers the law in the form of proportion W/W', L/L' by suspending weights simultaneously.
Level V: The highest level five is allotted when the subject explains the above law in terms of amount of weight. He begins to observe inclinations and distances in height being covered, while making successive and alternate suspensions of the weight.

**TASK I (b) THE PROJECTION OF SHADOWS**

In this experiment, the law to be discovered is that the size of the shadows of the rings is directly proportional to their diameters and inversely proportional to the distance between them and the light source.

The projection of shadows involves a base board, a screen attached to one end of this, a light source and rings of varying diameters. The light source and the rings can be moved along the baseboard. The subject is asked to produce two shadows of the same size, using different rings (Fig. 3.2).

**SCORING**

**Level I:** The child has no idea of how to produce shadows.

**Level II:** The child is able to order serially sizes of the rings and can formulate accurate correspondences at equal distances. But he cannot read distances to the sizes of the rings.

**Level III:** The child clearly understands compensation between the distance and the size of the rings. The child begins to understand the fact that the closer...
object is to the screen, the smaller the shadow on the screen. So, the child tends to calculate distances from the screen rather than from the light source.

**Level IV:** The child assumes proportionality from the start. The subject begins to calculate distances from the light source rather than from the screen, and in his calculation, he takes into account the distance between the light source and the first ring and not simply the distances between the rings. He is able to verify his hypothesis on a single case and does not form the notion of generalising.

**Level V:** At this stage, the subject is able to generalize the law and give explanations. Once the explanation is discovered, the proportions are deduced from the total figure.

**TASK II (a) LAW OF FLOATING BODIES AND ELIMINATION OF CONTRADICTIONS:**

Through this experiment the law that objects float if their density or specific gravity is less than that of water', has to be found. Subject has to establish two relationships density - that is the relation of weight to volume and specific gravity - that is the relation between the weight of the object and an equivalent amount of water. The law to be discovered states a relation between only two large classes: that of bodies whose density is less than the
density of water and that of bodies whose density is greater.

A given number of desperate objects are presented to the subject along with three cubes of equal volume having different densities and an empty cube with 'Plasti walls' (with a density of about one) to facilitate accurate comparisons with the density of water (Fig.3.3). The child is asked to (a) classify the objects according to whether they float or not; (b) give for each object the reason for so classifying it; (c) conduct the experiment; and (d) sum up the results observed in view of establishing the law.

SCORING

Level I: This level is assigned when the child cannot classify objects. the child gives multiple or often contradictory formulations without extending the same properties to other analogous bodies. He adopts, either explanation alternatively without perceiving the incompatibility or in his view the bodies that float are either those that are light because they are large. Bodies float or sink equally well if they are large, small, heavy or light (or even by association because they are round, long etc.).

Level II: The child succeeds in making double entry classification with reference to weight and volume which gives four possibilities: (a) the small light objects, (b)
Figure 3.3 Task II(a) LAW OF FLOATING BODIES AND ELIMINATION OF CONTRADICTIONS

Figure 3.4 Task II(b) THE OSCILLATION OF PENDULUM AND THE OPERATION OF EXCLUSION
the small non-light objects, (c) the large light objects, (d) the large heavy objects.

Level III: At this level, weight begins to be conserved by the child. But since the volume is not conserved at this stage, formulation of an operatic relationship between two is yet not possible. The child does not relate the object’s weight to that of an equal amount of water but rather to the water contained in the entire receptacle.

Level IV: At this level, the child relates weight of the body to the weight of the equal quantity of water - a quantity of cork would float because the cork is less heavy than the same quantity of water. The child at this level admits the conservation of weight and volume. He tests specific hypotheses and rejects all of them without discovering the law.

Level V: The highest level five is assigned when the child relates weight of the body in question to the weight of the equal volume of water and thus discovers the law exemplified.

TASK II (b) THE OSCILLATION OF PENDULUM AND THE OPERATIONALISM OF EXCLUSION

This task is meant to test Propositional logic, which requires isolation of the effective factor by dissociating it from the others and excluding the inoperative ones.
The material consists of a pendulum i.e. a sol object suspended by a string. The child is provided with what is necessary to vary the length of the string, the weight of the object suspended and the amplitude of the swing (Fig. 3.4). He is asked to explain the frequency of the oscillations of the pendulum. The variables which, seeing the apparatus, one might think to be relevant are the length of the string, the weight of the object fastened to the string, the height of the dropping point, and the force of the push given by the subject. Since only one of these factors is actually relevant, the problem is to isolate it from the other three to exclude them.

**SCORING**

**Level I**: Level one is assigned when the child explains things on the basis of physical actions: impetus imparted by the subject is considered as the real cause of the variations in the frequency of the oscillations. Because of lack of serial ordering and exact correspondence, the subject cannot either give an objective account of the experiment or give consistent explanations which are not mutually contradictory. He cannot distinguish between impetus which he gives and notion which is independent of his action.

**Level II**: Level two is assigned when the subject can order the length, and elevations serially and can also judg
the differences between observed frequencies of objects.

Serial ordering of weight is not yet possible. The subject discovers the inverse relationship between the length of string and the frequency of oscillation. However, she cannot yet isolate the variables.

**Level III:** At this level, subject can order and handle all forms of serial ordering correspondence which make the variation of the four factors possible, but she lacks a formal combinatorial system, does not conceive of the multiplicity of combinations that can be drawn from them. He does not begin to isolate variables.

**Level IV:** When the subject has tendency deliberately vary two factors simultaneously and even tendency not to vary particular factor under consideration to rightly conclude in so far as it relates to the frequency of length but not for weight or impetus.

**Level V:** The highest level five is assigned when subject is able to isolate all of the variables present and use the method of varying a single factor while holding other things equal.

**TASK III (a) COMBINATION OF COLOURED AND COLOUR CHEMICAL BODIES:**

In studying the formation of mathematical operations of combinations, permutations and arrangements,
experiment made us of combinations which were not betw
substances alone but between some substances and
indicator.

The subject is provided with AC, a bure
containing sulphuric acid N/4; B, a burette contain
custic soda (N/4); E, three glasses of water and Ind
little phenolphthalein in three other glasses of wa
(Fig.3.5).

There are eight combinations: Ind x B; Ind x
E x B; E x AC; Ind x B x E; E x Ind; B x AC, of which
produce pink colour - Ind x B and Ind x B x E. The child
asked to produce pink colour.

SCORING:

Level I: Subject's responses are limited to rando
associating two elements at a time and noting the resul
The explanation is given by simple phenomenalism.

Level II: In certain cases, glasses 'E' and 'I
are conceived of as identical. The glasses are successiv
associated with base 'B' and acid 'AC'; combinations of
type (B x Ind), (B x E), (AC x Ind), (AC x E) are made.
does not occur to the subject to combine the two glas
between themselves (E x Ind) even after establishing th
differences nor to combine the two burettes (B x AC). Th
combinations are restricted to four base combinations (gl
E x burette B), (glass Ind x burette B), (glass E x bure
AC), and (glass Ind x burette AC).
Figure 3.5 Task III(a) COMBINATION OF COLOURED AND COLOURLESS CHEMICAL BODIES

Figure 3.6 Task III(b) COMBINATION OF COLOURED AND COLOURLESS TOKENS
Even after discovering the law \( \text{Ind} \times B = \text{pink} \), subject does not conclude that the colour is due to combination; rather he thinks that the base and indicator contain it.

**Level III:** At this level, notable innovation is appearance of combinations between two glasses \( E \times I \) indicating that there is no longer only double er multiplicative table but a search for all the possible combinations. But colour is yet thought to be virtually contained in 'B' and in 'Ind' or that there is a "co-pellet" hidden in it.

**Level IV:** After having produced the four base combinations, the child bases his explanation of how colour is formed on the combination as such. He favours a combination of three elements to study the success results.

**Level V:** The highest level five is assigned when child sets up method straight off with the proof in mind: The child ascertains that the colour results from \( B \times \) and he identifies water in three glasses and 'something other than water in the other three that is one glass the two burettes. He is also able to specify that it discolours the coloured liquid.

**TASK III (b) COMBINATION OF COLOURED AND COLOURLESS TOKES**

To study that how far children are able to make mathematical operations of combinations, permutations
arrangements this experiment made use of combinations were between some substances. The experiment was like the one where children were given six coloured cups containing tokens of the same colour as that of the cup. They were instructed to make up all possible pairs with tokens taken from the same cup (Fig. 3.6).

**SCORING**

**Level I:** The children associate two elements randomly. The explanation is given by simple phenomenal operations containing neither proof nor even hypothesis.

**Level II:** The children are in possession of logical multiplication operations of one-by-one correspondence. True combinatorial operation has appeared as yet, but the true operation of correspondence and serial ordering - i.e. first de-termining the objects and then to combine them in a specific order.

**Level III:** Here reactions are analogous to proceeding ones but with a visible progress i.e. the idea of combining two-by-two and three-by-three combinations. These n-by-n combinations are not systematic. They are obtained by simple trial and error method.

**Level IV:** Children use systematic method in making n-by-n combinations.

**Level V:** Highest level five is assigned when children are able to make all types of combinations, permutations and arrangements systematically i.e. with a systematic method.
explicit formulation of mathematical expression

Performance is based on exhaustive method.

DATA COLLECTION

Science Achievement Test (prepared and standardized by the investigator, details in Chapter IV 'Development and Standardization of Science Achievement Test') was given to groups, followed by individual administration of Piagetian tasks to one student at a time. Each task takes about 15 minutes and the total time required to be spent or the subject for administering the Piagetian Tasks comes to about two hours.

Data collection was done in a separate room in school. The facility of a separate room was sought by approaching the Heads/Principals of the schools and securing their cooperation. Before the administration of the test, students were contacted in their classes to fix the time for the achievement test. Accordingly, students were called in groups of about 40 for the test administration. After each subject in the sample was contacted individually, the time for the administration of Piagetian tasks, instructions were read by the students and doubts were cleared by the investigator. As the test-items are multiple-choice type, subjects were required to tick mark the correct answer in the Test-booklet. (Cop
<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Name of School</th>
<th>Description of time period</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Govt. Senior Secondary School for girls, Mansa.</td>
<td>2.5.1990 – 22.5.1</td>
</tr>
<tr>
<td>2</td>
<td>Govt. Senior Secondary School, Bhaini Bagha.</td>
<td>23.5.1990 – 2.6.1</td>
</tr>
<tr>
<td>3</td>
<td>Govt. Senior Secondary School for Boys, Mansa.</td>
<td>2.7.1990 – 21.7.1</td>
</tr>
<tr>
<td>4</td>
<td>Govt. High School, Kotra.</td>
<td>23.7.1990 – 3.8.1</td>
</tr>
<tr>
<td>5</td>
<td>Govt. Senior Secondary School, Khiala Kalan.</td>
<td>4.8.1990 – 25.8.1</td>
</tr>
<tr>
<td>6</td>
<td>Govt. High School for Boys, Malout.</td>
<td>27.8.1990 – 15.9.1</td>
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<tr>
<td>7</td>
<td>Govt. High School for Girls, Malout.</td>
<td>17.9.1990 – 6.10.1</td>
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<tr>
<td>8</td>
<td>Govt. High School, Malout Pind.</td>
<td>8.10.1990 – 3.11.1</td>
</tr>
<tr>
<td>9</td>
<td>Govt. High School, Danewala.</td>
<td>5.11.1990 – 10.11.1</td>
</tr>
<tr>
<td>10</td>
<td>Govt. High School, Burj Sidhwan.</td>
<td>12.11.1990 – 24.11.1</td>
</tr>
</tbody>
</table>
Science Achievement Test in the Appendix III). The duration of test was two and a half hours.

During the individual administration of Piagetian Task in the second session, the interview Protocol consisted of the investigator asking questions pertinent to the response omitted by the subject. The Piagetian method of describing and studying the learning process is flexible and coherent and in a sense reconciles clinical experimental approaches (Inhelder and Piaget, 1958). A balance of the disadvantages of pure observation on one hand and standardized tests on the other, Piaget adopted a method of conducting free conversations with children and directing their conversations towards the non-explicit regions of child’s thought. Sets of experimental apparatus presented in interviews and the child verbally communicated his/her ideas while checking his working hypothesis in manipulation of the apparatus. His/her verbal results were evaluated qualitatively as to the type of thinking revealed by involvement in the problem situations. The same approach was followed by the investigator in the present study administering Piagetian tasks.

The tasks were administered in the same order to the student that is starting with Equilibrium in the Balance the Projection of Shadows was given as the second task, third one being Law of Floating Bodies and the Elimination...
of Contradictions, the Oscillation of Pendulum a: Operation of Exclusion was kept as fourth task, a Combination of Coloured and Colourless Chemical Bodies. Combination of Coloured and Colourless tokens were given the fifth and the sixth tasks respectively. All tasks were administered in one sitting with a gap of 5 minutes between the two tasks.

SCORING

Concept of stage - 'Levels' of behaviour were used as yardsticks in describing the results of Pia experimentation. Level one corresponding to stage I (operational stage); level two to stage IIa (early concrete operations/appearance of concrete thought); level three to stage IIb (concrete operations); level four to stage IIIa (appearance of formal operations/transtitional shift); and finally level five to stage IIIb (formal operations). These stages were employed with minor modifications of the original levels when deemed necessary. The term 'level', therefore, has been used at times to be simply a synonym of stage others to differentiate successive movements within a stage.

In order to subject the data to statistical analysis, a numerical value of 1, 2, 3, 4, and 5 were allotted to one, two, three, four and five respectively.
STATISTICAL TECHNIQUES:

The following statistical techniques were employed in the analysis of the data:-

(1) Mean, Standard Deviation, Skewness and Kurtosis were calculated for examining the nature of distribution of various sets of scores. Also values of mean, percentages were respectively used to compare subjects across various groups on three abilities to identify formal operations.

(2) t-ratios were worked out between means of different abilities across rural-urban areas as also across sex.

(3) Pearson’s Product Moment Correlations were computerised to find out the relationship between different cognitive abilities and achievement in science.

(4) Multiple Regression Equations were used to determine the predictive efficiency of various cognitive abilities in different combinations towards science achievement.

(5) Factor Analysis along with Rotation of factors was employed for the purpose of identification of common factors underlying formal operations and science achievement.
<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>VARIABLE</th>
<th>CODE</th>
</tr>
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<tbody>
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<td>1.</td>
<td>Equilibrium in the Balance</td>
<td>T_I</td>
</tr>
<tr>
<td>2.</td>
<td>The Projection of Shadows</td>
<td>T_II</td>
</tr>
<tr>
<td>3.</td>
<td>Law of Floating Bodies &amp; Elimination of Contradictions.</td>
<td>T_III</td>
</tr>
<tr>
<td>4.</td>
<td>The Oscillation of Pendulum and the Operation of Exclusion.</td>
<td>T_IV</td>
</tr>
<tr>
<td>5.</td>
<td>Combination of Coloured &amp; Colourless Chemical Bodies.</td>
<td>T_V</td>
</tr>
<tr>
<td>6.</td>
<td>Combination of Coloured and Colourless Tokens.</td>
<td>T_VI</td>
</tr>
<tr>
<td>7.</td>
<td>Proportionality</td>
<td>T_I+II</td>
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<td>8.</td>
<td>Propositional Logic</td>
<td>T_III+IV</td>
</tr>
<tr>
<td>9.</td>
<td>Combinatorial Analysis</td>
<td>T_V+VI</td>
</tr>
<tr>
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<td>Proportionality, Propositional Logic &amp; Combinatorial Analysis</td>
<td>T_PT</td>
</tr>
<tr>
<td>11.</td>
<td>Achievement in Physics</td>
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<td>12.</td>
<td>Achievement in Chemistry</td>
<td>Chemist</td>
</tr>
<tr>
<td>13.</td>
<td>Achievement in Biology</td>
<td>Biology</td>
</tr>
<tr>
<td>14.</td>
<td>Achievement in Physics, Chemistry &amp; Biology</td>
<td>Science</td>
</tr>
</tbody>
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