VALIDITY OF SCIENCE ITEMS IN THE STUDENT SELECTION TEST IN TURKEY

A THESIS SUBMITTED TO
THE GRADUATE SCHOOL OF SOCIAL SCIENCES
OF
MIDDLE EAST TECHNICAL UNIVERSITY

BY

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IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR
THE DEGREE OF MASTER OF SCIENCE
IN THE DEPARTMENT OF
ELEMENTARY SCIENCE AND MATHEMATICS EDUCATION

JULY 2008

Approval of the Graduate School of Social Sciences.

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ABSTRACT

VALIDITY OF SCIENCE ITEMS IN THE STUDENT SELECTION TEST IN TURKEY

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July 2008, 126 pages

This thesis presents content-related and construct-related validity evidence for science sub-tests within Student Selection Test (SST) in Turkey via underlying the content, cognitive processes, item characteristics, factorial structure, and group differences based on high school type. A total number of 126,245 students were present in the research from six type of school in the data of SST 2006. Reliability Analysis, Item Analysis, Principle Component Analysis (PCA) and one-way ANOVA have been carried out to evaluate the content-related and construct-related evidence of validity of SST. SPSS and ITEMAN programs were used to conduct the above-mentioned analyses. According to the results of content analysis, science items in the SST 2006 found to be measuring various cognitive processes under knowledge, understanding and problem solving cognitive

domains. Those items loaded under three factors according to PCA findings which were measuring very close dimensions. Moreover, a threat to validity was detected via one-way ANOVA due to significant mean difference across high school types.

Keywords: Content Analysis, Content Validity, Construct Validity, Item Analysis, Principle Component Analysis (PCA), Science Tests, Student Selection Test.

ÖZ

TURKİYE DE ÖĞRENCİ SEÇME SINAVINDA (ÖSS) KULLANILAN FEN SORULARININ GEÇERLİĞİ

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Temmuz 2008, 126 sayfa

Bu çalışma, Türkiye'de Öğrenci Seçme Sınavında yer alan fen testlerinin kapsam ve yapı geçerliğiyle ilgili ipuçlarını, kapsam, bilişsel süreçler, madde özellikleri, faktör yapısı ve okul türünden kaynaklanan farklılıkları dikkate alarak sunar. Kullanılan veride, 2006 yılı Öğrenci Seçme Sınavında yer alan ve altı farklı okul türünden seçilen 126,245 öğrenci bulunmaktadır. Öğrenci Seçme Sınavının kapsam ve yapı geçerliğine ait ipuçları, Güvenirlik Analizi, Madde Analizi, Temel Bileşenler Faktör Analizi ve Tek Yönlü Varyans Analizi yürütülerek değerlendirilmiştir. Bahsedilen analizleri yürütürken SPSS ve ITEMAN bilgisayar programları kullanılmıştır. Kapsam Analizi sonuçlarına göre, 2006 ÖSS fen soruları bilgi, anlama ve problem çözme seviyelerindeki çeşitli bilişsel süreçleri ölçmektedir. Bu sorular Temel Bileşenler Faktör Analizinde, çok yakın boyutları

ölçen üç farklı faktör altında yüklenmişlerdir. Diğer taraftan, Tek Yönlü Varyans Analizi sonucunda bulunan lise türleri arasındaki fen puanı farkı ile geçerlik tehdidi tespit edilmiştir.

Anahtar Kelimeler: Kapsam Analizi, Kapsam Geçerliği, Yapı Geçerliği, Madde Analizi, Temel Bileşenler Faktör Analizi, Fen Testleri, Öğrenci Seçme Sınavı.

To my parents Nurhan and Serhat,
and my brother Serkan

ACKNOWLEDGMENTS

I would like the express sincere appreciation both to Prof. Dr. Giray Berberoğlu for his warm guidance, supports and patience, and to Assist. Prof. Dr. Semra Sungur for her meaningful donations, and positive criticism throughout this research. This study would never be completed without their continuous encouragement and motivation.

I am grateful to Assoc. Prof. Dr. Jale Çakıroğlu and Assoc. Prof. Dr. Ceren Tekkaya for their supportive guidance throughout my undergraduate and graduate education in Middle East Technical University.

I wish to thank to Ertuğrul Özdemir and Elif Adıbelli from Middle East Technical University for their contributions to this study.

I would like to thank to my parents and my brother for their unlimited help, courage and love throughout my life and my education.

Thanks go to my benevolent friends Vural, Canan, Ceren and Gökhan for their motivation.

Lastly, special thanks to Kemal for his continuous support and technical contributions throughout this study.

TABLE OF CONTENTS

PLAGIARISM iii

ABSTRACT iv

ÖZ vi

ACKNOWLEDGMENTS ix

TABLE OF CONTENTS x

CHAPTER

1. INTRODUCTION 1

1.1 University Entrance Examination in Turkey 1

1.2 Content of the Student Selection Test (SST) 2

1.2.1 Content of the First Stage of the SST (SST-1) 3

1.2.2 Content of the Second Stage of the SST (SST-2) 3

1.3 Purpose of the Research 4

1.4 Inspected Questions of the Research 5

1.5 Significance of the Research 6

1.6 Definitions of Key Terms 7

2. REVIEW OF RELATED LIRETARURE 11

2.1 Studies Related with Science and Technology 11

2.2 Studies Related with Mathematics 18

2.3 Studies Related with English Proficiency 21

3. METHODOLOGY OF THE RESEARCH 24

3.1 Subjects of the Research 24

3.2 Instrument of the Research 26

3.3 Data Analyses of the Research 27

3.3.1 Content Analysis 27

3.3.2 Statistical Analyses 28

4. RESULTS OF THE RESEARCH 29

4.1 Content Analysis 29

4.1.1 Science-1 29

4.1.2 Science-2 37

4.2 Statistical Analysis 42

4.2.1 Preliminary Analysis 42

4.2.2 Reliability Analysis 43

4.2.3 Item Analysis 44

4.2.3.1 ITEMAN Results 45

4.2.3.2 Formats of Items 47

4.2.4 Factor Analysis 48

4.2.4.1 Assumptions 48

4.2.4.1.1 Sample Size 48

4.2.4.1.2 Factorability of the Correlation Matrix 49

4.2.4.1.3 Multicollinearity & Singularity 49

4.2.4.2 Interpretation of Communalities and Variance 50

4.2.4.3 Deciding on Number of Factors 50

4.2.4.4 Interpretations of Factors 50

4.2.5 Comparing Means for School Groups 53

4.2.5.1 Assumptions 53

4.2.5.1.1 Random Sampling 53

4.2.5.1.2 Independence of Observations 53

4.2.5.1.3 Normality 53

4.2.5.1.4 Homogeneity of Variance 54

4.2.5.2 Interpretations of Mean Scores 54

5. CONCLUSION, DISCUSSION and RECOMMENDATIONS 56

5.1 Conclusion 56

5.2 Discussion 57

5.3 Recommendations 60

5.4 Limitation 62

REFERENCES 63

APPENDICES... 68

A. Preliminary Analysis 69

B. Item Analysis 81

C. Factor Analysis 92

D. One-way between Groups ANOVA 103

E. Science Items in Student Selection Test 2006 107

LIST OF TABLES

TABLES

Table 1.1 Tests Related to Common Courses 3

Table 1.2 Tests Related to Field Courses 4

Table 3.1 Frequency Distribution of the Research Subjects According to School Types 25

Table 3.2 Distribution of Science Items in SST 2006 27

Table 4.1 Content Analysis of Science-1 29

Table 4.2 Content Analysis of Science-2 37

Table 4.3 Descriptive Statistics for total Science Score on Six School Types 43

LIST OF FIGURES

FIGURES

Figure 1.1 Number of Applicant to SST across Years 6

Figure 2.1 NAEP Erosion Item 13

CHAPTER I

INTRODUCTION

1.1 University Entrance Examination in Turkey

Until 1960s, since there was a limited number of high school graduates, most of the universities admitted university students without any test. When the number of applicants exceeds the capacity of the departments, universities selected students based on order of application, relevance of school field of applicants (quantitative or verbal) with the education given in the department, and high school graduation degree of applicants. In 1960s, many universities started to administer their own selection tests; however the selection was neither fair nor objective. In 1974, Inter-universities Board founded the Inter-universities Student Selection and Placement Center (ISSPC) and applied the test entitled "Central System". Till 1981, ISSPC conducted all student selection and placement procedures; then, in 1981 Student Selection and Placement Center (SSPC, in Turkish OSYM) established under the Higher Education Council (HEC, in Turkish YOK). Between 1981 and 1999 two tests were administered as university entrance exams. The first was the Student Selection Test (SST), administered in April in every year. Students who could pass this test took the Student Placement Test (SPT) in June. In 1999, the SPT was completely removed and the test administered only once a year while the SST and its items relied on the format of the previous SSTs. Beginning from 2006, although the test administered at once, the SST items divided into two stages. The first stage of the test (SST-1) had the same content with the previous SSTs, while the second stage (SST-2) included items from whole high school curriculum (OSYM, 2006).

1.2 Content of the Student Selection Test (SST)

There are two major tests as verbal ability and quantitative ability. The former consists of two sub-tests which are 1) proficiency in the Turkish mother tongue, and 2) ability to reason using the basic concepts and generalizations of social science subjects. Similarly, quantitative ability test has two sub-tests such as 1) ability to make use of basic mathematical concepts and rules, and 2) ability to reason using the basic concepts and principles of natural science subjects (OSYM, 1984, as cited in Berberoğlu, 1996).

Berberoğlu (1996) provided a clear explanation about the content of the SST. He stated that items in the tests are prepared in the light of the secondary school courses and Bloom's (1979) taxonomy of educational objectives. Especially higher order thinking skills such as comprehension, application, analysis and synthesis are underlined in the content. Materials and concepts used while preparing test items are generally derived from the high school curricula although the main purpose of the SST is not assessing the high school curricula. In the verbal ability part, items of Turkish language are categorized into two groups like items assessing the basic principles of grammar and items assessing the reading comprehension skills. History, geography, psychology and sociology are the four sub-tests in the social science section. Similarly in the quantitative ability part, items of mathematics sub-test are selected from different subject matters but categorized into three groups which are computation, word problems, and geometry. In the natural sciences section, there are clusters of physics, chemistry and biology items. All of the items in the test are multiple-choice with five alternatives. There might be a problem of equivalence of forms throughout the years due to each year a parallel form of test is administered because of the privacy reasons. Even though there is no empirical evidence about equivalence, framework provided by Student Selection and Placement Center evinces that there is at least a content-wise parallelism.

1.2.1 Content of the First Stage of the Student Selection Test

First stage of the SST (SST-1) is defined as "tests related to common courses" (OSYM, 2006). In Turkey, beginning from the second year of high school (grade level 10), students select study fields as science-mathematics (quantitative), Turkish-mathematics (equal weight), and Turkish-social (verbal). In the 9th grade, the first year of high school, all of the students are given all types of courses which are the above-mentioned common courses. With respect to these courses, there are four sub-tests in the SST-1: Turkish (Tur), Social Sciences (Soc-1), Mathematics (Math-1), and Science (Sci-1). Number of items for each test is shown in Table 1.1.

Table 1.1
Tests Related to Common Courses

Test name	*Number of items*
Turkish (Tur)	30
Social Sciences (Soc-1)	30
Mathematics (Math-1)	30
Science (Sci-1)	30
Total	120

Before 2006 administration, items in the SST developed according to basic skills and objectives in the elementary curriculum and in the first year curricula of high school such as understanding, implicating and establishing relations etc. In 2006, the SST-1 remained on this principle and continued to measure the same content (OSYM, 2006).

1.2.2 Content of the Second Stage of the Student Selection Test

Unlike the first stage, there are "tests related to field courses" in the second stage of the Student Selection Test (SST-2) covered the whole secondary curricula

(OSYM, 2006). There are four sub-tests namely, Literature-Social Sciences (Lit-Soc), Social Sciences-2 (Soc-2), Mathematics-2 (Math-2), and Science-2 (Sci-2). Below table summarizes the distribution of items in the sub-tests.

Table 1.2

Tests Related to Field Courses

Test name	*Number of items*
Literature-Social Sciences (Lit-Soc)	30
Social Sciences-2 (Soc-2)	30
Mathematics-2 (Math-2)	30
and Science-2 (Sci-2)	30
Total	120

1.3 Purpose of the Research

The intent of the present research is to explore content-related validity evidence via content analysis (content and cognitive process measured and construct-related validity evidence via factor analysis and comparisons of groups of examinees from different schools of the Student Selection Test (SST) 2006 in Turkey. A total of 59 science items, 30 science items in the SST-1 and 29 science items in the SST-2 examined also for the item characteristics. The consistency of the content of science subtests with the content definition provided by OSYM is the main aspect of the study. Moreover, considering Berberoğlu's (1996) explanations, measured dimensions and cognitive processes assessed in the test are interpreted by both content analysis and the factor analysis by use of the SST 2006 data. Lastly, as a thread to validity, possibility of test bias across different high school students are investigated since the test includes a heterogeneous group of examinees.

Since test validation is an on-going process, recommendations for further validity research on the Student Selection Test are provided. The results of the

study are assumed to be both used for further validation studies and benefited by test developers to decrease content and construct related validity threats in Student Selection and Placement Center in Turkey.

1.4 Inspected Questions of the Research

1. What are the content specifications of the items in the science sub-tests in the SST 2006?

1.1 Which subject fields or content categories are measured by the items in the Science-1 and Science-2 sub-tests of the SST 2006?

1.2 Which cognitive processes are measured by the items in the Science-1 and Science-2 sub-tests of the SST 2006?

1.3 What are the grade levels in curricula of the items in the Science-1 and Science-2 sub-tests of the SST 2006?

2. What is the reliability coefficient of the SST 2006 tests?

3. What are the psychometric characteristics of the items in the Science-1 and Science-2 sub-tests of the SST 2006?

3.1 What are the difficulty levels (p) of the items the Science-1 and Science-2 sub-tests of the SST 2006?

3.2 What are the discrimination values (D) of the items in the Science-1 and Science-2 sub-tests of the SST 2006?

3.3 What are the point biserial correlation values (r) of the items in the Science-1 and Science-2 sub-tests of the SST 2006?

4. What is the factorial structure of the science items in the SST 2006?

5. Is there any difference in the science performance of the students across different high school types?

1.5 Significance of the Research

In 1982-1983 school year, number of high school graduates was 179,004, whereas in 1997-1998 school year, this number increased to 476,698. Similarly, total number of applicants to the SST was increased from 299,906 in 1974 to 1,479,562 in 1999 (OSYM 1986 as cited in Koksal, 2002) as seen from Figure 1.1

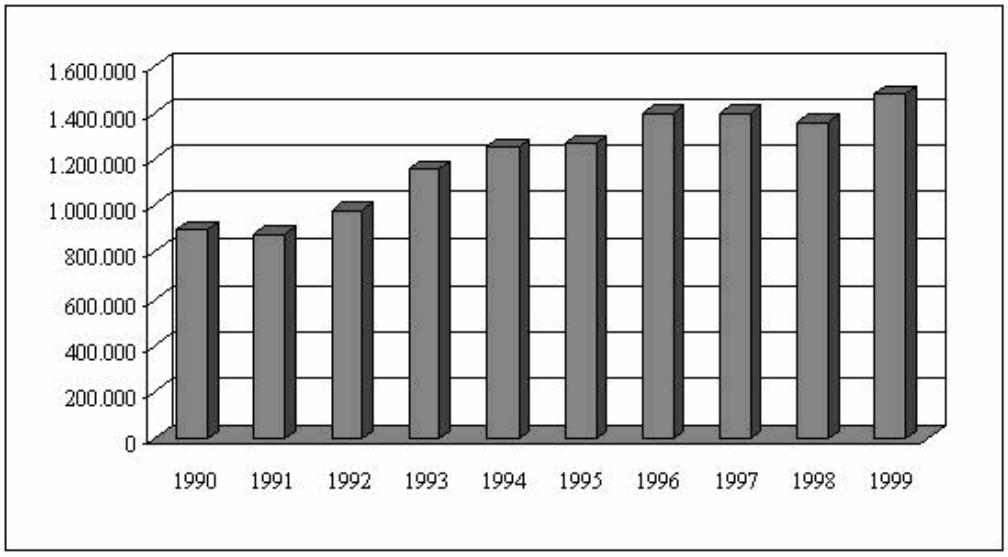

Figure 1.1
Number of Applicants to SST across Years
(YOK, 2000).

These numbers might provide an idea about the increasing demand for higher education in Turkey. In the light of changing circumstances, educational developments and curriculum reforms, OSYM also updates mission and formats of the SSTs. Although continuing renews are necessary in educational system which is a dynamic one, frequently changing type of the SSTs over years, validity as one of the primary issues to be borne into mind.

Achievement and ability tests serve to several purposes such as admission, placement, diagnostic and research purposes (Crocker&Algina, 1986; Millman& Greene, 1989; and Baker, 2006). Validity is concerned one of the certain characteristics of all measurements should have, regardless of the type of instrument or the use of results of measurement (Gronlund and Linn, 1990). They defined validity as: "Appropriateness of the interpretations made from test scores and other evaluation results, with regard to particular use" (p.47). Moreover, they stated that validity is always concerned with the purposed interpretations of measurements and the particular use of the results.

Since the purpose of the SST is to select students who have the potential to be successful in higher education (OSYM, 2007), interpretations derived from test scores should be correct regarding with student selection and placement. Therefore, the SSTs should be valid to make fair selection and placement of examinees.

1.6 Definitions of Key Terms

Content: According to Haladyna (1997) there are four types of content like facts, concepts, principles and procedures.

1. **Facts:** These are the basic knowledge that is not disagreed.
   i.e.: Water boils at 100 Celsius degrees at standard atmospheric pressure.
2. **Concepts:** These are classes of objects or events sharing a common set of defining characteristics.
   i.e.: Volume, weight, speed, originality, appropriateness.

3. **Principles**: These are explaining relationships between the concepts such as cause and effect, relationship between two concepts, laws of probability and axioms.

4. **Procedures:** Series of mental or physical acts arriving to a particular result.

Cognitive Processes: In Bloom's (1979) taxonomy the major categories were knowledge, comprehension, application, analysis, synthesis and evaluation.

Krathwohl (2002) revised Bloom's taxonomy and designated the cognitive processes in dimensions as remember, understand, apply, analyze, evaluate and create.

1. **Remember:** Calling the knowledge from long-term memory. Relevant processes are recognizing and recalling.

2. **Understand:** Meaning the instruction, and oral, written and graphic communication. Interpreting, exemplifying, classifying, summarizing, inferring, comparing and explaining are cognitive processes of understand.

3. **Apply:** Carrying out or using a series of steps in the given condition including executing and implementing as the cognitive tasks.

4. **Analyze:** Breaking the whole into its parts and relating the parts to each other. Differentiating, organizing and attributing are the processes respectively.

5. **Evaluate:** Making judgments on a given criterion or standard such as checking and critiquing.

6. **Create:** To form a novel whole or an original product, putting the parts together. Relevant process are generating, planning and producing.

Haladyna (1997) also provided cognitive behaviors as understanding, problem solving, critical thinking and creativity. In addition to understanding level is nearly the same with Krathwoh's one, critical thinking shares the properties of evaluate and analyze, while creativity is close to the create. Even tough being close to the apply level it is still beneficial to explain problem solving as a separate dimension.

Problem Solving: Although there are many different definitions in the literature, Haladyna (1997) established it as a set of mental steps leading to the realization of a goal (p.22). It includes cognitive processes such as comparing, computing, identifying a problem, and determining the way of solution.

In recent years, the view of scientific inquiry had significant effects on the newly constructed elementary and secondary programs by Ministry of National Education in Turkey. Since, the SST measures the skills in the curricula, science process skills are one of the considerations of this research in addition to above defined cognitive processes.

Science Process Skills: The skills of making comparisons and classifications, making prediction, inferring, making observations, hypothesis formulating and testing, controlling variables, proposing procedures, designing experiment, analyzing data, and drawing conclusions (MoNE, 2006).

While describing the term validity, definitions of true score, error score and reliability in classical test theory are useful (Zimmerman, 1998).

True Score: The average of the observed scores obtained in an infinite number of the same testing from the same individual (Crocker& Algina, 1986; Ebel, 1979).

Error Score: The difference between the observed scores and the true score of the individual (Crocker& Algina, 1986; Ebel, 1979).

Reliability: The consistency of the true scores and the observed scores on a test is called reliability (Crocker& Algina, 1986; Ebel, 1979).

Validity: "the degree to which the test is capable of achieving certain aims of the test users" (American Educational Research Association [AERA], American Psychological Association [APA], and National Council on Measurement and Evaluation [NCME], 1966, p.12). There are mainly three types of validity evidence.

1. **Content-related evidence:** How well the tasks in test are represented the measured domain of tasks (Gronlund and Linn, 1990).

2. **Criterion-related evidence**: It predicts future performance or estimates current performance on a criterion rather than test itself (Gronlund and Linn, 1990).

3. **Construct-related evidence:** How well test score interprets a meaningful measure of some characteristics or quality (Gronlund and Linn, 1990).

CHAPTER II

REVIEW OF RELATED LITERATURE

This chapter concerns with the validity concept and the validation studies in the domains of science and technology, mathematics, and English language in the literature. Since the present study concerns the validity of Student Selection Test, other researchers' studies were taken into consideration in detail to understand validity and validation precisely.

2. 1 Studies Related with Science and Technology

Sireci and Huff (2003-2004) evaluated content validity in terms of the domain relevance and domain representation of 1999 and 2000 administrations of a state mandated 10^{th} grade science assessment. In addition to item similarity ratings from extremely similar (1) to not at all similar (10), as subject matter experts (SMEs), at least 4 years experienced 10 teachers presented four different types of taxonomies which were Bloom's taxonomy (1956), cognitive areas as reported in the state's test documentation, science assessment in the National Assessment of Educational Processes (NAEP) 2000, and descriptors by the National Science Teachers Association (2002). However, Bloom's taxonomy selected as the best framework by SMEs after discussions. To be matched with its content area, each item considered to fulfill 70% criterion requirement which is the placement of this item in the same area by 7 out of 10 SMEs. By the use of multidimensionality scaling (MDS), item similarity ratings in terms of content and cognitive representations of assessment by SMEs were analyzed. The content areas Earth& space sciences, Life sciences, and Physical sciences were well

represented with at least three-fourth representation rate in the test. Technology area was not represented as well as the other three, the congruency of which was about 30% in 1999, and 50% in 2000 tests. Moreover, the Inquiry area could not represented at all in both administrations. With the help of results attained from this study, the state department of education improved the test via revising Technology area with Technology/Engineering, and removing the Inquiry area from the test completely.

In her thesis, Koksal (2002) assessed the content of biology items of from 1998 through 2001 Secondary School Institutions Student Selection and Placement Tests (SSISSPT) in terms of cognitive process measured, found empirical evidence via factor analysis for different cognitive dimensions measured in the test, and investigated achievement difference across gender groups of biology items in the tests. For factor analysis part, 10,000 students from 1999 and 2000 tests, and 5000 students from 2001 test were selected randomly as sample of the study. In the previous elementary science curriculum than 2002, from level 4 to level 8 biology units guided the subject matter checklist and the cognitive process derived from Taxonomy of Educational Objectives used by Ministry of National Education which were knowledge, comprehension, solving problem and science process skills. In the scope of content analysis, 4 biology educators determined the cognitive processes of 34 biology items and then results were examined for internal consistency by SPSS software. Alpha value was .678 and correlations between ratings of four experts were ranging from .235 and .616. "Living Things& Life" concluded as the most frequently measured unit (41%) and "Reproduction& Inheritance in Living Things and Knowing Our Body" was found the less frequently measured (14%), and "Human& Environment" unit was not measured in any of the tests. Moreover item difficulty and discrimination levels were searched by using ITEMAN program.

Solano-Flores and Nelson-Barber (2001) recommended a new concept namely cultural validity and what this denotes for science assessment. Evidence for cultural validity defined as social and cultural factors shape individual mind's

and affect the way of making sense and solving science items. They provided examples for how cultural validity perspective can improve the assessment quality in five areas which are student epistemology, student language proficiency, cultural world views, cultural communication and socialization styles, and student life context and values. Moreover, they argued that the present assessment practices should be revised by taking into consideration minority students' cultural backgrounds and their epistemology should be also considered while validating an assessment.

The most striking example from cultural validity perspective was about the first area, student epistemology. They asked to a Latino girl one of the 4th grade science question from National Assessment for Educational Progress (NAEP), 1996 including two pictures of the same river and mountains. In the first (picture A), mountains are not high and round like in shape while the river is wide; while in the second one (picture B), mountains are high and sharp and the river is narrow. It is asked in this item which one of the pictures belongs today and which belongs millions of years ago (Figure 2.1).

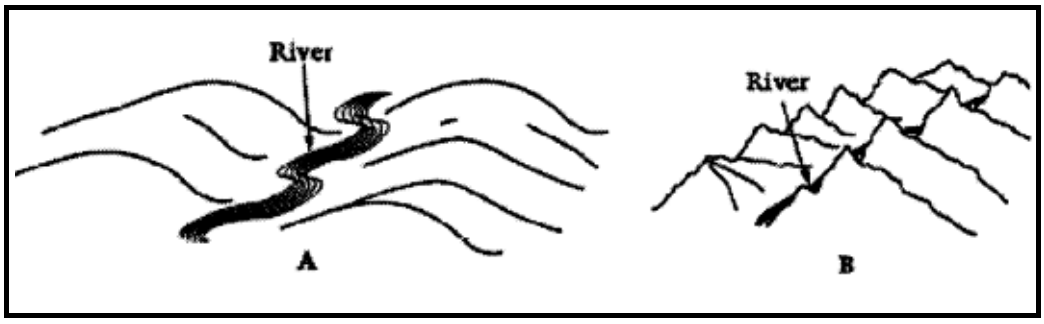

Figure 2.1
NAEP (1996) Erosion Item
(as cited in Solano-Flores and Nelson-Barber, 2001, p. 558)

Although the student selected the wrong choice for today (B), after the interview she pointed out A for the today picture because she recalled an experience during discussions that she went to a place looking like the picture B, but explained that she have never seen a mountain like in the picture A so it

should be in the past. As a result, regardless of the concept of erosion, she answered the item by her daily life experiences that shows good understanding of scientific concepts occurs if the concept is discussed related with the everyday life experiences authors concluded.

Shaw (1997) explored the threats to the validity of science performance-based assessment of 96 English Language Learners (ELLs) whose mother language was not English from 9th to 12th grades in five schools. 4-day performance-based assessment entitled Rate of Cooling Performance Assessment (ROC) on the concept of heat transfer approached via comparison of the insulation quality of different fabrics. Day 1 included group-work to find a solution to the given problem, Day 2 included creating an experiment design, Day 3 allowed for conducting the experiment and Day 4 involved analyzing data gathered by experiment. The rubric was five point as 4= exemplary, 3= adequate, 2= inadequate, 1= poor, and 0= no response. To evaluate face, construct and consequential validity of the assessment, he conducted both qualitative (questionnaires, field notes from observations, interview etc.) and quantitative analysis (calculating analysis of variance for each scored item, testing the variable effects on both English language proficiency and science proficiency, and their correlations). The main validity issue was whether the assessment can measure scientific literacy instead of English language proficiency. Language proficiency interfered with only the experimental procedure; on the other hand, graphs, calculations, and final question concluded by students were significantly affected by science proficiency.

Hamilton, Nussbaum, Kupermintz, Kerkhoven, and Snow (1995) examined validity of NELS: 88 science test in the scope of test multidimensionality as a second study in a series of four. NELS: 88 data composed of math, science, history and reading test scores obtained from 24,600 8th grade students and follow up questionnaires and tests obtained when students become 10th and 12th graders. The NELS: 88 science tests included 25 multiple choice items in 8th grade. 7 of these removed and replaced to compose 10th grade

science items. No proficiency levels for science test were provided unlike math test. Different kinds of principal components and factor analysis conducted to intercorrelations among science test items on the selected data composed of 5,014 subjects as sample at 8th and 10th grades. For the 8th grade, 12 items loaded strongly on the first factor named as Everyday or Elementary Science (ES) requiring scientific knowledge can easily learned outside school. The second factor includes 4 items with the concepts of chemical change, mixtures compounds, and solubility so it was named as Chemistry Knowledge (CK). The third factor called Scientific Reasoning (SR) and included 5 items requiring graphical interpretations, hypothesis construction and manipulation of numeric equations. The fourth factor was composed of four items involved scientific concepts such as photosynthesis, barometric pressure, cool/warm air movement and it was named as Reasoning with Knowledge (RK). Moreover, 3 factors identified for 10th grade science items. The first one was Quantitative Science (QS) including 12 items with mathematical operating such as calculating and graph interpreting. The second one was Spatial-mechanical Reasoning (SM) with 5 items including map, picture, diagram interpreting. The last factor namely Basic Knowledge and Reasoning (BKR) have 8 items assessing knowledge of scientific concepts and their applications to simple reasoning situations.

As the last study in a series of four, Nussbaum, Hamilton and Snow (1997) inspected the science achievement test with the full sample of 8th, 10th and 12th grades respectively 23,630, 16,826, 14,134 numbers of subjects. Because of computational restrictions, random third of 8th graders and random halves of 10th and 12th graders examined. According to the result of promax rotated three factor solution, first factor was Quantitative Science (QS) including 8 items, the second one was Spatial-mechanical Reasoning (SM) with 5 items, and third factor was Basic Knowledge and Reasoning (BKR) having 12 items. These results almost the same with the 10th grade analysis expect 3 items moving from QS to BKR. At 8th grade analysis, the first factor appeared a combination of items CK and RK and this factor named as Formal Knowledge (FK). Items constructed factor ES in the previous study made up the second factor, SR made up the third factor and

additional fourth factor occurred containing 2 items was not given name. As a result of this and previous study, researchers decided to robustness of three dimensions which are QS, SM and BKR.

Ayala, Yin, Schultz, and Shavelson (2002) examined whether performance assessments could bring together three reasoning dimensions found by Hamilton and colleagues to validate these dimensions and examine consistency of student performance across three science achievement measures. 30 multiple choice, 8 constructed response items (8^{th} grade and 12^{th} grade) from NELS, National Assessment of Educational Progress (NAEP) and Third International Mathematics and Science Study (TIMMS) were administered 343 students and 3 performance assessment each targeted nominally one of three reasoning dimensions (basic knowledge and reasoning [BKR], quantitative science reasoning [QS], spatial-mechanical reasoning [SM]) were administered 35 students. As basic knowledge and reasoning performance assessment Electric Mysteries selected, students were provided batteries, wire, bulbs to prepare an electric circuit. As quantitative science performance assessment, Aquacraft was used and students asked to determine the cause of a chemical explosion. For spatial-mechanical reasoning one, students provided Earth glob in a box, flashlight and towers models to detect path of the Sun in sky using shadows of towers. These different measures (multiple choice, constructed response, performance assessment) of science achievements were correlated in a moderate level meaning these different measurements bind together different aspects of science achievement. However, correlational patterns of student scores on items did not found grouped unlike reasoning and knowledge dimensions.

Another study conducted by Kuforiji (1992), intended to develop and establish reliability and validity of an achievement test which measures technological literacy for senior high school students. The research was made up of selection of test population and content universe, identifying cognitive behavior, constructing table of specifications, writing test items, pilot administration, item analysis, and verification of content validity, analysis of

expert responses and final administration of test. A paper and pencil technology test consisting of 80 multiple choice items with five alternatives related to measure only the cognitive domain in Bloom's taxonomy applied students from school grade from 7 to 12. Each student answered 40 items from A, B, C, or D booklets within 40 minutes. After this pilot application, sufficient number of good items was obtained by item analysis. In the verification of content validity section of the study, 10 technology literacy experts who are researchers or college professors and 5 senior high school teachers evaluated the item relevancy to content area and objective intended to measure. Technology teachers rated each item in terms of clarity and simplicity of language; on the other hand, technology education experts rated the relevance to the intended measurement of technological literacy and evaluated accuracy of categorization of items. To select items for final administration, a mean rating 7.5 or more out of 10 (Likert-type) by high school teachers, 75 percent and more (Yes/No) for both relevance and categorization by technology experts were the 3 criteria. After item analysis-considering difficulty and discrimination values- 28 of 80 items in the pilot administration were removed for the final administration. Then, 52 test items were placed in questionnaire format to content review by the same criteria used previously. As a result of content validation 40 items of 52 were selected according to expert ratings and 6 of them removed after item analysis by use of SYSTAT software. 34 items were selected for the final administration and then statistical analyses such as reliability and establishment of tentative norms for gender and socio-economic groups of students conducted.

Although the present study concerns the validity of science sections in the Student Selection Test, other studies in different domains were taken into consideration in detail to get an in-depth understanding of the validity and the validation studies.

2. 2 Studies Related with Mathematics

Bagnal, (2004) examined the reliability and validity of mathematics achievement tests administered to grade 5 and 7 students in Prince George School District, in Canada. Since 1995, the school District Mathematics Achievement Tests (DMAT) administered to 5^{th} and 7^{th} grade students. Because of the large sample size (1296 5^{th} grade, 1175 7^{th} grade students), classical test analysis could conduct on small data sets. Regarding to reliability, internal consistency of the tests by individual item responses, and difficulty level by calculating mean score, discrimination by point-biserial correlation and discrimination index were interpreted. In addition to classical item analysis, assumptions free item analysis and item response logistic models were benefited. It was concluded that test has internal consistency and procedures used for marking multipoint test items were sufficient to rater reliability for most of the items used in test, item difficulty and discrimination values were found appropriate to use and these items would be used for other assessment purpose. Regarding to content validity, matching the content of each test to the content of curriculum in British Colombia, analyzing mathematical process such as communication, estimation, problem solving, reasoning, technology and visualization was done that provided description of learning outcome by drawing table of specifications for each test. The table of specifications clarified that School District Mathematics Committee (SDMC) members designed and implemented DMATs successfully. Moreover student's math achievement test scores in 2000 and math grades for 1999-2000 school year were compared as an evidence of concurrent validity.

As a first study in a series of four, Kupermintz, Ennis, Hamilton, Talbert and Snow (1995) demonstrated validity and usefulness of National Educational Longitudinal Study of 1988 (NELS: 88) math tests via defining psychologically meaningful sub-scores in relation to teacher, student and school variables. They used randomly selected $1/16^{th}$ of 24,600 students to form quarter-samples and then half-samples of 8^{th} and 10^{th} grade data. Conventional factor analysis with promax rotation applied to 20 items common on both 8^{th} and 10^{th} grade tests, factor

solutions were found the same for both grades. 2 factors addressed Math Reasoning (MR) requiring inferential reasoning and Math Knowledge (MK) requiring knowledge and straightforward computation dimensions. In addition, regression analyses indicated student attitudes, instructional variables, course and program types related more to MK, while gender, socio-economic status, and ethnicity more related with MR. Strong effect detected for the course and program types in schools. Students got higher scores on math knowledge if they have taken algebra and geometry courses, but lower achievers have taken only general math courses.

Kupertmintz and Snow (1997) conducted a research as the third study in the same series of construct validity study. In addition to 8^{th} and 10^{th} grades, this study covered 12^{th} grade data from NELS: 88. According to their total score in 8^{th} grade, three forms administered to students. Form L for low to 2,554 students, Form M for medium to 7,717 students and Form H for high to 3,965 students. From the pool of 81 items (58 of them came from 8^{th} and 10^{th} grade items), 8 items appeared on all forms, 13items appeared only on Form L, 15 appeared only on Form H, 15 were common on Forms M and H, 2 were common on Forms L and H. A total of 14,236 students who completed the math tests in 12^{th} grade were available. As a result of full factor analysis, Form L included four factors but the first two factors were almost excellently consistent with the previous study done with 8^{th} and 10^{th} grade data in terms of MR and MK distinction. Form M again presented MR and MK as the major factors with a third minor factor including basic algebra concepts and a fourth minor factor resembling third factor of Form L. Unlike the first and second forms, Form H addressed a separate structure reflecting differences in problem solving in addition to the content with five factors. These were called Compound Mathematical Reasoning (CMR), Concrete Mathematical Reasoning (NMR), Applied Algebra Knowledge (AAK), Spatial Visualization (SV) and Algebra Systems Comprehension (ASC). They stated that the first two have similarities with MR.

Hendelsman (1997) examined both content and construct validity of High School Competency Test (HSCT) administered in Florida, the United States and dominant factors of HSTC associated with Grade Ten Assessment Test (GTAT), a basic achievement test. The main purpose of minimum competency tests was explained that whether a student mastered the minimum competencies to earn a regular high school diploma instead of a certificate. From 61,757 students who were administered both reading and math sections of HSTC in October 1994 and GTAT in April, 1994, a random sample of 2000 students were selected by using SAS program. Content validity evidence consisted of documentation from schools where minimum skills were taught in the local district and results of exploratory factor analysis used to examine underlying structure of the GTAT and the HSTC, and construct validity evidence analyzed through confirmatory factor analysis results of HSTC. 2 factors founded as dominant for HSCT which measures minimum competencies in both communication and arithmetic however these factors might be measuring the same psychological construct since inter-factor correlation was greater than .6. Regarding to GTAT purported to measure reading comprehension and mathematics, inter-factor correlation .69 interpreted the test was measuring the same psychological construct like HSCT.

In attempt to validation of curriculum-based mathematics measures monitoring disabled and non-disabled elementary 4th grade students in regular education classroom as a main study, Parke (1995) developed a curriculum-based math achievement test as a pilot study via using measures established within the framework of curriculum-based measurement (CBM) model to identify math application outcomes that guide the district curriculum. Sample of pilot study was 239 students from level 4 and level 5, while 224 students from other school were included in the sample of the main study, all of then were from different ethnic and socioeconomic groups. After obtaining difficulty levels of test items, a sample of teachers rated how well items presented 4th grade math curriculum to present information about content validity. By 5 teachers who did not contribute the test development, each item rated on a sixth-point scale, and items judged as very representative of the fourth-grade math curriculum. By using the same sixth-point

scale, 9 teachers who included neither test development nor validation of the pilot CBM administration rated the 45 items of APP1 (one of the subtests in main study). The overall mean rating of content validity was 5.6 which correspond between "representative" and "very representative" categories. In addition to content validation, subtests of standardized math achievement test and student's classroom math performance were used to explore relationship between CBM math application and CMB math computation probes which addressed criterion-related in the study.

2. 3 Studies Related with English Proficiency

Abella, Urrutia, and Shneyderman (2005) compared the test performance of English Language Learners (ELL) via comparing their test performance using both English-language (Stanford Achievement Test, 9th ed.) and Spanish-language (Aprenda, 2nd ed.) achievement tests. These tests included the similar content-area in the two languages. Although there are two sections in the tests as reading and mathematics, because of being less dependent on language math components of the tests targeted to compare students' achievement. A total of 934 students in 4th grade with different proficiency levels (such as beginning, advanced and proficient) and 744 students in 10th grade from different levels of English-language proficiency examined by 48 multiple-choice items covering the same content of content in two of the languages. 57% of the students were Hispanic (Spanish or Latin American) while 17% of them ELL. Test validity in this study referred to the discrepancy in student achievement due to language proficiency instead lack of content-area on the two tests one is in English and the other was in Spanish. As a result, all ELL students performed better on Spanish-language test than English-language test and English-language literacy skill was not a significant factor affecting math achievement whereas home-language literacy skill was.

Kurtulus (2002) investigated reliability, content and construct validity of a pilot English proficiency test administered to 8th grade students at Middle East

Technical University Development Foundation private high school. The proficiency test was composed of 100 items in five necessary skills, which were Use of English, Reading Comprehension, Listening, Writing and Speaking; however 61 of them from three subsections, Use of English, Reading Comprehension, and Listening were used in the study. Subjects were 215 examinees, all of whom were 8th grade students and they would decided to pass or take a year of English preparation class depending on their scores of this test. By the exam committee table of specifications prepared, which included aim of the items and type of the task and format of the items. In the content validation study, instead of content (objectives), the skill domains were matched to the table of specifications because of the nature of the proficiency tests by the reseracher. Grammar, vocabulary, reading, and listening sub-skills were found well represented in terms of the aim of proficiency tests which is attaining general language skills of individuals; however vocabulary section seemed to be integrated in grammar sub-section that was not aimed actually and be expected to become separate sub-dimensions as in the structure of the test. Overall, test was concluded as a representative of measured skills and a good sample of proficiency test. Principal Component Analysis was also run in SPSS to gain construct-related evidence of validity.

Ataman (1999) conducted a study to examine reliability, validity, and equivalence of two tests, Department of Basic English Proficiency Tests (DBEPT), administered in June 1998 and September 1998 at METU. The population of the study consisted of 1755 students who took the test in June 1998 and 2864 who took the test in September 1998. Total tests were 100 points and examinees got 59.49 minimum score considered as successful. DBEPTs were made up of 70 grammar, 20 vocabulary, and 45 reading comprehension skills (total 135) multiple-choice items. Content-wise evaluation of the DBEPT was carried out by the researcher in relation to the objectives and instruction. Predetermined objectives (parallel to Department of Basic English curricular objectives) were listed for the grammar, vocabulary and reading comprehension subtests as the test specification and principal component analysis results were

used to serve content-related evidence of validity. When grammar, vocabulary and reading comprehension subtests were treated as independent tests, listed objectives did not loaded as meaningful factors instead items loaded as easy and difficult ones. Item difficulty, tem discrimination, reliability analysis were also examined in the study.

In the light of the aforementioned studies in the literature, the present study aims at acquiring content-related and construct-related validity evidence through conducting content analysis, principal component analysis and one-way between groups analysis of variance across high school types.

CHAPTER III

METHODOLOGY OF THE RESEARCH

3.1 Subjects of the Research

This research consists of 126,245 students who are first time applicants (current last grade of high school students in the application time) as the subjects. Every year, students at the last grade of high school, students who graduated previous years but were not placed in a higher education program, and university students who want to change their university or program admit the University Entrance Exam all over the country (MoNE, 2007). Although, secondary education in Turkey consists of General High Schools and Vocational and Technical High Schools, for the present study the reason why subjects from the latter one were not preferred was the excess amount of missing values because of the low rate of answering science items in the test.

In the SST 2006 data, including graduates of previous academic years there were 1,511,596 examinees who took the Student Selection Test throughout Turkey. For the current research, graduates of academic year 2005-2006, who were not took University Entrance Exam before, were selected. The total number of 2005-2006 graduates were 600, 226.

Moreover, types of high school that students graduated were taken into consideration while deciding the subjects of the research. Secondary education in Turkey consists of General High Schools and Vocational and Technical High Schools. For the present study the reason why subjects from the latter one were

not preferred was the excess amount of missing values because of the low rate of answering science items in the test. Selected school types and their codes are General High School (GHS), General Private High School (GPHS), Anatolian High School (AHS), General Private High School with Foreign Language Instruction (GPHS_FLI), Science High School (SHS), and General High School with Intensive Foreign Language Program (GHS_FLP). Therefore, 406,941 students remained in the data.

The last concern was the study fields of the students in selected schools. These schools have different fields of study such as Social Sciences, Mathematics, Science and Foreign Language. Since the current research is interested in science sections of the test, students from Science field were considered appropriate for the study. They were 126,768 in number.

Among selected subjects according to graduation status**,** school type, and study field, as a final procedure 523 of them removed due to answering none of science items in the test. As a result of the selection procedure, the sample of the 2006 data includes a total number of 126,245 subjects. Table 3.1 presents the frequency distributions of the subjects for each school type.

Table 3.1

Frequency Distribution of the Research Subjects According to School Types

School Type	*# of students*	*% of students*
GHS	65,058	51.5
GPHS	1,714	1.4
AHS	27,550	21.8
GPHS_FLI	4,488	3.6
SHS	4,715	3.7
GHS_FLP	22,720	18.0
Total	126,245	100.0

3.2 Instrument of the Research

In this study, the Student Selection Test (SST) 2006 is used as instrument. Since 1981, the SST has been administered every year in a parallel form but the content of the test such as number of items in each section, and subject matters covered in the items based on the national curriculum might diverse for years. The SST 2006 has two stages different from the previous SSTs with one stage. The first stage of the test (SST-1) consisting of four sections namely Turkish, Social Science-1, Mathematics-1 and Science-1. Similarly the second stage of the test (SST-2) consisting of four sections as Literature-Social Science, Social Sciences-2, Mathematics-2 and Science-2. Each section in both the SST-1 and the SST-2 has 30 items and the test is including 240 items in total.

Since this study deals with science sections of the test, 30 items in Science-1 section and 30 items in Science-2 section were examined. The items in the former section were developed according to basic skills and objectives in the elementary curriculum and in the first year curriculum of high school such as understanding, implicating and establishing relations. On the other hand, the items within the latter were covering whole content of secondary curriculum (OSYM, 2006).

Furthermore, in all SSTs, all of the items were in the form of multiple-choice with five alternatives (four distracters and one correct choice).

The SST 2006 was composed of two stages as the SST-1 and the SST-2. Science sub-tests as Science-1 and the SST-2 have three sections as physics, chemistry and biology in each stage. Normally, there should be 13 physics, 9 chemistry and 8 biology items in both the SST-1 and the SST-2 yielding a total number of 60 science items. However, one chemistry item in the second section deleted from data by the Student Selection and Placement Center. According to stages and sections of the test, number of science items is shown in below table.

Table 3.2

Distribution of Science Items in the SST 2006

Content Domain	*# of items in SST-1*	*# of items in SST-2*	Total
Physics	13	13	26
Chemistry	9	8	17
Biology	8	8	16
Total	30	29	59

3.3 Data Analyses of the Research

In the current research, data obtained from the SST 2006 were used. The data were analyzed with regard to classical test theory perspective according to the following procedure:

3.3.1 Content Analysis

Content specifications of the science items were examined via content analysis by use of previous science course books of 6^{th}, 7^{th} and 8^{th} grades, elementary science curriculum and previous secondary physics, chemistry and biology curricula by the researcher. As subject matter experts (SMEs), two research assistants from Middle East Technical University were contributed the study while interpreting content measured in the science tests. One of whom areas of expertise was science while another's one was physics. As a result, agreement was reached by SMEs and the researcher about content category and cognitive processes measured in the science subtests of the SST 2006.

3.3.2 Statistical Analyses

1. Preliminary Analysis: As part of preliminary analysis mean, standard deviation, skewness and kurtosis values were examined and frequency histograms were created.

2. Reliability Analysis: Cronbach's alpha coefficient was computed to assess reliability of the SST 2006 in SPSS Version 11.5.

3. Item Analysis: Item and Test Analysis Program –ITEMAN- Version 3.5 by Assessment Systems Corporation, 1994 used for conducting item analysis for the 59 science items in both the SST-1 and the SST-2.

4. Factor Analysis: Principal Component Analysis with Varimax Rotated Solution in SPSS 11.5 version was performed to interpret factor structures of science sections of the SSTs. Items in the SST-1 and the SST-2 were taken into consideration as a whole to examine factor structures of the science sections of tests.

5. Comparing Means for School Groups: To compare mean science scores of six different school groups, one-way between groups ANOVA with Post-hoc tests was conducted.

CHAPTER IV

RESULTS OF THE RESEARCH

In this chapter results of the present research are described in two main sections. First section presents the results of content analysis of science sections of the SST 2006 (Appendix F). To evaluate the content-related validity of Science-1 and Science-2 tests, results of content analysis and the content structure of the SST provided by OSYM are compared. In the second section, results of the statistical analyses such as preliminary analyses, reliability and item analyses, and one-way ANOVA for school groups are described. Moreover, the latter section includes results of Principal Component Analysis which is explaining factor structures and construct-related validity evidence for the SST 2006.

4.1 Content Analysis

By means of content analysis, 59 science items were analyzed in terms of content category and cognitive process measured by science sections of the test. The results of the analysis were presented for each of the items below. Moreover, difficulty (*p*) and discrimination (*D* and *r*) levels obtained by item analysis were interpreted for every science item in the SST-1 and the SST-2.

4.1.1 Science-1

Table 4.1 interprets the results of content analysis for Science-1 subtest.

Table 4.1

Content Analysis of Science-1

Item	*Content Domain*	*Content Category*	*Cognitive Process*	*Grade Level*	*p*	*D*	*r*
Sc1_1	Physics	Properties of matter	Comparing measurements and quantities	Elementary	.80	.36	.31
Sc1_2	Physics	Vectors	Predicting result from given information	9th	.67	.56	.42
Sc1_3	Physics	Work	Relating two or more concepts	Elementary	.49	.35	.26
Sc1_4	Physics	Pressure of liquids	1. Inferring cause-effect relationship 2. Interpreting graph	Elementary	.39	.48	.38
Sc1_5	Physics	Buoyancy of liquids	Comparing measurements and quantities	Elementary	.48	.70	.53
Sc1_6	Physics	Pressure of liquids	Determining way for solution	Elementary	.56	.54	.41
Sc1_7	Physics	Classifications and conversions of matter	1. Knowledge of facts 2. Predicting result from given information	Elementary	.19	.50	.58
Sc1_8	Physics	Light and optics	Comparing results of observation	11th	.41	.52	.42
Sc1_9	Physics	Light and optics	Classifying concepts	11th	.59	.58	.43
Sc1_10	Physics	Refraction of light	Concluding results of observation	11th	.20	.37	.42
Sc1_11	Physics	Static electricity	Interpreting of observation	Elementary	.32	.54	.47

Table 4.1

Content Analysis of Science-1 (continued)

Item	*Content Domain*	*Content Category*	*Cognitive Process*	*Grade Level*	*p*	*D*	*r*
Sc1_12	Physics	Current electricity	Relating elements of problem	Elementary	.57	.50	.38
Sc1_13	Physics	Magnet	Comparing results of observation	Elementary	.71	.41	.32
Sc1_14	Chemistry	Properties of matter Solubility	1. Knowledge of concepts 2. Classifying conditions	Elementary	.52	.64	.47
Sc1_15	Chemistry	Mole and Avogadro number	Knowledge of procedures (algorithms)	9th	.35	.59	.50
Sc1_16	Chemistry	Classifications and conversions of matter	1.Computing 2. Interpreting graph	Elementary	.42	.80	.62
Sc1_17	Chemistry	Classifications of matter	1. Knowledge of procedures 2. Classifying procedures	Elementary	.53	.70	.53
Sc1_18	Chemistry	Periodic table	1. Knowledge of concepts 2. Classifying concepts	Elementary	.48	.66	.50
Sc1_19	Chemistry	1. Structure of atom 2. Orbital and electron configuration	1. Knowledge of procedures 2. Illustrating electron configurations of elements	9th	.34	.46	.39

Table 4.1

Content Analysis of Science-1 (continued)

Item	*Content Domain*	*Content Category*	*Cognitive Process*	*Grade Level*	*p*	*D*	*r*
Sc1_20	Chemistry	1. Classifications and conversions of matter 2. Chemical bonds 3. Acids, bases and salts	Explaining cause-effect relationship	9th	.34	.53	.45
Sc1_21	Chemistry	1. Classifications and conversions of matters 2. Solubility	1. Translating knowledge into another form 2. Interpreting graph	Elementary	.28	.51	.48
Sc1_22	Chemistry	1. Solubility 2. Temperature and solubility relationship	1. Translating knowledge into another form 2. Interpreting graph	9th	.39	.65	.50
Sc1_23	Biology	Basic components of organisms	Knowledge of principles	9th	.60	.59	.43

Table 4.1

Content Analysis of Science-1 (continued)

Item	*Content Domain*	*Content Category*	*Cognitive Process*	*Grade Level*	*p*	*D*	*r*
Sc1_24	Biology	1. Structure of plants 2. Osmotic pressure 3. Types of solutions 4. Energy molecules	Relating two or more concepts	Elementary	.43	.60	.47
Sc1_25	Biology	Nucleic acids	Knowledge of facts	Elementary	.24	.46	.46
Sc1_26	Biology	1. Structure of plants 2.Organelles 3. Enzymes 4. Energy molecules	Knowledge of concepts	Elementary	.57	.60	.45
Sc1_27	Biology	Ecology and organisms	Predicting reason from given information	Elementary	.31	.61	.53
Sc1_28	Biology	Excretion system	Relating two or more conditions	Elementary	.55	.34	.24

Table 4.1

Content Analysis of Science-1 (continued)

Item	*Content Domain*	*Content Category*	*Cognitive Process*	*Grade Level*	*p*	*D*	*r*
Sc1_29	Biology	Inheritance	Knowledge of principles	Elementary	.08	.06	.05
Sc1_30	Biology	Population genetics	Knowledge of facts	Elementary	.37	.28	.21

There were 13 physics (43%), 9 chemistry (30%) and 8 biology (27%) items in Science-1 test as mentioned in 2006 Action Report of OSYM. In this report, cognitive process measured in the Science-1 test was defined as "items on thinking with basic concepts and principles in science". More specifically, considering basic knowledge and skills expected to be acquired during elementary education and the first year of secondary education, 9th grade, understanding, predicting and establishing relations are the objectives of the SST-1 (OSYM, 2006).

In terms of content division, there were 22 items from the scope of elementary curriculum, 5 items from the 9th grade level of secondary curriculum 3 items from 11th grade curriculum; all of those were physics items covering the content category of "Light".

As seen above analysis, in terms of cognitive process 30 items in the 2006 Science-1 test, were mainly composed of knowledge level and understanding level items with the exception of 3 problem solving items. A total of 9 chemistry items, only Sc1_15 was in knowledge level and 5 of biology items were also measuring the same level.

10 physics items were measuring cognitive processes in understanding level in addition to 3 chemistry and 3 biology items. However, some of these items were assessing more than one single cognitive process of understanding level such as Sc1_4, Sc1_21, and Sc1_22.

Only 2 of physics items were in problem solving level via assessing cognitive processes as determining way for solution and concluding results of observation.

There were items measuring different levels together. For instance, 5 items measuring different cognitive processes from both knowledge and understanding

levels (Sc1_7, Sc1_14, Sc1_17, Sc1_18, and Sc1_19). In addition, Sc1_16 was measuring both understanding and problem solving levels of cognitive processes.

Moreover, many of the items are confusing to interpret which content represented in the items. 6 items had two or more content categories trying to be assessed, and 8 items were measuring more than one cognitive process either in the same or in the different cognitive levels. These two make the item ambiguous in terms of content measured via individual item and the overall science tests. Item Sc1_7 is only one of the examples of this ambiguity. Unless students know the fact that water freezes at zero Celsius degree under 1 atmospheric pressure, and water-ice mixture is in heat equilibrium in this situation, it is impossible to predict the result stated in the item. Although cognitive process is to predict possible results of being equilibrium, students need to know too much information such as what heat equilibrium is, when it is occurred, what relationship exists between water and ice when equilibrium is reached etc. It is obvious that this item is trying to assess different facts and concepts in one situation. As a result, Sc1_7 item becomes a very difficult one with a very low proportion of correct answers (Appendix E).

Another example is item Sc1_20 which is measuring explaining cause-effect relationships of chemical events. However, in each alternative there is a different cause-effect relationship and students need to know all of these relationships correctly to find the wrong relationship which is the key alternative. Alternative A asks comparisons of melting-freezing points of Sodium (Na) and Potassium (K) elements and the comparisons of weakness of their bonds as the result, B assesses the cause-effect relation between phases of different elements and the valence electron numbers of these elements, alternative C asks for effect of phases of H_2S and H_2O on hydrogen bonding of H_2O and the , D wants students to evaluate strength of acidity of HF and HCl and their results in chemical bonds, and E assess the result of being more soft of the graphite than diamond. As stated, there are five different cause-effect relationships assessed in

item Sc1_20 and students have to know all to find the wrong relation but it is not an easy task. (Appendix E).

Regarding to item characteristics, difficulty level of Science-1 items ranges between .08 and .80, discrimination ranges between .06 and .81, and the corrected point biserial, which interprets discrimination level of the items, ranges between .05 and .62. In terms of physics items, difficulty ranges between .19 and .80, while discrimination *D* ranges from .35 to .27, discrimination *r* ranges between .32 and .62. Difficulty of chemistry ones ranges between .28 and .23, *D* ranges between .46 and .80, while *r* of them ranges between .39 and .62. In addition, difficulty of biology items ranges from .08 to .60, as *D* ranges from .06 to .61, and *r* ranges from .05 to .53.

4.1.2 Science -2

Table 4.2 interprets the results of content analysis for Science-2 subtest.

Table 4.2

Content Analysis of Science-2

Item	*Content Domain*	*Content Category*	*Cognitive Process*	*Grade Level*	*p*	*D*	*r*
Sc2_1	Physics	Mass and weight	Predicting result from given information	9th	.47	.68	.51
Sc2_2	Physics	Motion	Computing by formula	10th	.06	.07	.16
Sc2_3	Physics	Potential energy	Computing by formula	10th	.30	.61	.55
Sc2_4	Physics	Linear momentum and collisions	Inferring cause-effect relationship	10th	.30	.48	.42
Sc2_5	Physics	Electric field	Classifying concepts	9th	.37	.65	.52
Sc2_6	Physics	Electric current	Interpreting conditions	9th	.13	.18	.25
Sc2_7	Physics	Electric current	Inferring cause-effect relationship	9th	.23	.55	.57
Sc2_8	Physics	Waves	1. Knowledge of procedures 2. Computing by formula	11th	.23	.41	.40
Sc2_9	Physics	Light and optics	Comparing measurements and quantities	11th	.20	.47	.53
Sc2_10	Physics	Dispersion of light	Predicting results of observation	11th	.41	.61	48
Sc2_11	Physics	Waves	Computing by formula	11th	.18	.44	.51
Sc2_12	Physics	Electric field	Determining way for solution	9th	.21	.45	.47
Sc2_13	Physics	Kinetic energy	1.Computing 2. Interpreting graph	10th	.19	.39	.42

Table 4.2

Content Analysis of Science-2 (continued)

Item	*Content Domain*	*Content Category*	*Cognitive Process*	*Grade Level*	*p*	*D*	*r*
Sc2_15	Chemistry	Neutralization of acids and bases	Computing by formula	10th	.28	.62	.58
Sc2_16	Chemistry	Velocity of chemical reactions	Solving equations	10th	.48	.81	.61
Sc2_17	Chemistry	Equilibrium in chemical reactions	Predicting reason from given information	10th	.34	.74	.62
Sc2_18	Chemistry	Oxidation and reduction reactions	1. Knowledge of concepts 2. Predicting result from given information	11th	.37	.76	.62
Sc2_19	Chemistry	1. Hydrocarbons 2. Isomers 3. Hybridization	1.Knowledge of concepts 2. Computing	11th	.33	.59	.51
Sc2_20	Chemistry	1. Hydrocarbons 2. Chemical reactions	Knowledge of procedures (algorithms)	11th	.32	.62	.53
Sc2_21	Chemistry	Alcohols and ethers	1. Knowledge of facts 2. Translating knowledge into another form	11th	.39	.56	.44
Sc2_22	Chemistry	Optical isomers	Comparing observations and qualities	11th	.46	.67	.52

Table 4.2

Content Analysis of Science-2 (continued)

Item	*Content Domain*	*Content Category*	*Cognitive Process*	*Grade Level*	*p*	*D*	*r*
Sc2_23	Biology	Photosynthesis	Knowledge of principles	11th	.26	.48	.43
Sc2_24	Biology	Metabolism in cell	1. Knowledge of principles 2. Inferring cause-effect relationships	9th	.21	.40	.42
Sc2_25	Biology	Mitosis	Knowledge of concepts	9th	.22	.36	.37
Sc2_26	Biology	1.Metabolism in cell 2. Circulatory system 3. Excretory system	Inferring cause-effect relationship	9th 10th	.16	.36	.42
Sc2_27	Biology	Digestive system	1. Knowledge of procedures 2. Ordering steps of procedures	10th	.24	.49	.50
Sc2_28	Biology	Nervous system	Inferring cause-effect relationship	10th	.22	.45	.47
Sc2_29	Biology	Inheritance	1. Knowledge of procedures 2. Predicting reasons of observation	11th	.20	.38	.42
Sc2_30	Biology	Population genetics	1. Knowledge of concepts 2. Knowledge of principles 3. Exemplifying concepts and principles	11th	.33	.44	.35

Since one of chemistry items cancelled in Science-2 test, there were 13 physics (43%), 8 chemistry (27%) and 8 biology (27%) items in Science-2 test. In addition to the test content distribution, content measured in Science-2 test was defined as "whole curriculum of secondary education" in the Action Report of OSYM (OSYM, 2006).

In terms of content division, there were 7 items from the 9^{th} grade secondary curriculum, 9 items from the 10^{th} grade level of secondary curriculum and 12 items from 11^{th} grade curriculum. In addition one of the biology items consists of both 9^{th} and 10^{th} year content dimensions.

As seen above analysis, in terms of cognitive process, 29 items in the 2006 Science-2 test were composed of knowledge, understanding and problem solving levels.

There were items measuring a single specific cognitive process. Those were1 chemistry and 2 biology items in knowledge level, while 7 physics, 2 chemistry and 2 biology items measuring cognitive processes in understanding level, and 4 physics and 2 chemistry items measuring problem solving in science.

Moreover, there were items measuring more than one cognitive process with different cognitive levels. 2 of chemistry and 4 of biology items were measuring both knowledge and understanding levels cognitive processes. Also, there were 1 physics (Sc2_8) and 1 chemistry (Sc2_19) items measuring both knowledge and problem solving levels. Finally, 1 physics item which is Sc2_13 was measuring cognitive processes from both understanding and problem solving levels.

Like the items in Science-1 test, most of the items were difficult to decide the content measured in the item due to being composed of more than one content categories and cognitive processes. A total of 29, 3 items were trying to assess more than one content category and 9 items were intended to measure more than

one cognitive processes coming from different levels. One of the examples of these items is item Sc2_25 (Appendix E). It includes many different concepts such as triploid endosperm, zygote, embryo, tube nucleus, generative nucleus, and sperm. It is impossible to select the correct alternative unless knowing all of these terminologies.

Regarding to item characteristics, difficulty level of Science-2 items ranges between .06 and .48, discrimination index (*D*) ranges between .07 and .81, while the corrected point biserial value which interprets discrimination level (*r*) of the items, ranges between .16 and .62. In terms of physics items, difficulty ranges between .06 and .47, *D* ranges between .07 and .68, while *r* between .16 and .57. Difficulty of chemistry ones ranges between .28 and .48, *D* of them ranges between .56 and .81, and *r* ranges between .44 and .62. In addition, difficulty of biology items ranges between .16 and .33, while *D* ranges between .36 and .49, and *r* ranges between .35 and .50.

4.2 Statistical Analysis

4.2.1 Preliminary Analysis

All variables included in the data analysis examined by relevant descriptive statistics, frequency distributions and skewness and kurtosis values in addition to the missing value analysis (Appendix A). Those variables were, 59 science items used in factor analysis, graduation status, school types, field of study as independent variables and total science score as dependent variable. There were 126, 245 examinees from selected six schools, all of them were the last year of secondary schools and all of them were in science field in their schools. There were no missing value in terms of school type, graduation status and field of the study. Descriptive statistics for the SST 2006 were presented in Table 4.3 for the six different school types with the means, standard deviations, skewness and kurtosis values.

Table 4.3

Descriptive Statistics for Total Science Score on Six School Types

School Type	*Mean*	*SD*	*Skewness*	*Kurtosis*	*# of students*
GHS	14.32	7.75	1.15	1.92	65,058
GPHS	21.29	12.25	.72	- .17	1,714
AHS	32.41	11.50	- .12	- .70	27,550
GPHS_FLI	26.02	13.80	.33	-. 90	4,488
SHS	42.01	11.11	-1.02	.62	4,715
GHS_FLP	22.45	10.41	.49	- .23	22,720
Total	21.28	12.72	.76	-. 27	126,245

This table reveals that in the SST 2006 data, total science scores of graduates of Science High School (*M*= 42.01, *SD*= 11.11) were respectively higher than science scores of graduates of Anatolian High School (*M*= 32.41, *SD*= 11.50), General Private High School with Foreign Language Instruction graduates (*M*= 26.02, *SD*= 13.80), General High School with Intensive Foreign Language Program graduates (*M*= 22.45, *SD*= 10.41), General Private High School graduates (*M*= 21.29, *SD*= 12.25), and General High School graduates (*M*= 14.32, *SD*= 7.75).

4.2.2 Reliability Analysis

Before conducting reliability analysis in SPSS 11.5 version, normality of the total science score was checked by use of descriptive statistics. If skewness and kurtosis values are zero, the distribution is normal; to be considered reasonably normal these values should between -2 and +2 (Tabachnick & Fidell, 2001). They stated that in larger sample size, effect of deviation from zero skewness and kurtosis declines. For the present research, distribution of the total science score is reasonable normally distributed (*N*= 126,245, kurtosis= - .268, skewness= .760).

Reliability of the SST 2006 assessed via calculating Cronbach's alpha coefficient for internal consistency of the scores. Ebel (1979) stated that any test having reliability coefficient at least .90 yields high reliable scores and the reliability is a measure of appropriateness of the test to the ability level of the examinees rather than the test itself. For the SST 2006 scale, Cronbach's alpha coefficient was .94 which represents high reliability of the test scores to the group of examinees in 2006.

In the scope of classical test theory, reliability coefficient is defined mathematically as the ratio of true score variance to observed score variance (Crocker& Algina, 1986, p.116). For the currently analyzed test, it is concluded that at least 94% of the true score variance explained in the observed score variance.

4.2.3 Item Analysis

ITEMAN Version 3.5 by Assessment Systems Corporation, 1994 used for conducting item analysis for the 59 science items in both the SST-1 and the SST-2. The reason why the Science-1 items and Science-2 items were not separated for item analysis was the similarity of the cognitive processes measured in tests according to results of content analysis.

ITEMAN provides analysis according to classical perspective. It calculates proportions or percentages of the true choice as item difficulty (denoted *p*). For dichotomously scored items (multiple choice items), mean score represents this proportion and total test score variance is assumed to be maximized when the *p*= .50 (Crocker& Algina, 1986). Also, index of discrimination (denoted *D*) is provided for dichotomously scored items using upper 27% lower 27% of the examinees. According to Ebel's criteria *D* is interpreted as:

$.40 \geq D$ → very good items
$39 \geq D \geq .30$ → reasonably good but possibly subject to improvement
$.29 \geq D \geq .20$ → marginal items, usually needing and being subject to improvement
$.19 \geq D$ → poor items, to be rejected or improved by revision
(Ebel, 1979, p. 267).

Moreover, Pearson product moment correlation coefficient is used to measure relationship between each item score and the whole test score. These correlational discrimination indices (denoted *r*) are point biserial and biserial correlation coefficients. For the present research, point biserial correlation was selected with the correction of spuriousness. That means, the individual item score does not included in the total test score. In this study, point biserial value was also examined for distractors to evaluate whether they are working as expected. In achievement testing, if an item discriminates between examines, high scoring examinees have a high probability of answering this item correctly, whereas low scoring examinees have a low probability of answering this item correctly (Crocker& Algina, 1986). So, it is expected from a discriminating item:

- key option is selected by high achievers,
- distractors of an item are selected by low achievers,
- high achievers do not prefer to omit the item.

If an item is correctly answered by lower examinees instead upper ones, the discrimination value of the item would be negative.

4.2.3.1 ITEMAN Results

Considering *p* values in ITEMAN results, items Sc1_3, Sc1_5, Sc1_6, Sc1_9, Sc1_12, Sc1_14, Sc1_17, Sc1_18, Sc1_23, Sc1_26, Sc1_28 and Sc2_16 have *p* values ranging from .48 to .59. These items are considered ideal in terms of difficulty. Most of their *D* values are also greater than .40 except item Sc1_3 (*D*= .35) and item Sc1_28 (*D*= .34). Considering both *D* and corrected point biserial *r,* item Sc1_12 (*r*= .38) needs a very little improvement while item Sc1_3

(*r*= .26), and item Sc1_28 (*r*= .24) need to be improved. Revisions on distractors might be enough to improve these items because *r* values for some alternatives are lower such as A, B, D alternatives of Sc1_3 item, B of Sc1_12 item and E of Sc1_28 item. In brief, these 12 items are relatively well constructed compared to the rest of the test (Appendix B).

Items Sc1_1, Sc1_2, Sc1_13, are easier, their *p* values are .80, .67, and .71 respectively. Sc1_1 item discriminates reasonably (*D*= .36), but needs little improvement. The improvement might be on distractors B, C, and D which are almost not functioning because 1%, 3% and 4% of the examinees selected these. Item Sc1_2 discriminates well (*D*= .56, *r*= .42) but B, C, and D distractors still need improvement because of the lower rate of selection. Similarly, B, C, and D alternatives are not working expectedly of item Sc1_13 (*D*= .41, *r*= .32).

Moreover, some items are neither difficult nor easy such as items Sc1_8 (*p*= .41, *D*= .52), Sc1_16 (*p*= .42, *D*= .80), Sc1_24 (*p*= .43, *D*= .60), Sc2_1 (*p*= .47, *D*= .68), Sc2_10 (*p*= .41, *D*= .61), and Sc2_22 (*p*= .46, *D*= .67). These items are very good in terms of discriminating and need no revision.

There are too difficult items in the test, these are items Sc1_29 (*p*= .05), Sc2_2 (*p*= .06), Sc2_6 (*p*= .13), Sc2_13 (*p*= .19), and Sc2_26 (*p*= .16). Two of them need to be eliminated from the test which are item Sc1_29 (*D*= .06) and 32 (*D*= .07). Item Sc2_6 is also very difficult (*p*= .13) but it can be improved by revision (*D*= .18, *r*= .25).

Since items below .40 difficulty level considered as hard (Haladyna, 2004), the rest of the items in the test which are Sc1_4, Sc1_7, Sc1_10, Sc1_11, Sc1_15, Sc1_19, Sc1_20, Sc1_21, Sc1_22, Sc1_25, Sc1_27, Sc1_30, Sc2_3, Sc2_4, Sc2_5, Sc2_7, Sc2_8, Sc2_9, Sc2_11, Sc2_12, Sc2_15, Sc2_17, Sc2_18, Sc2_19, Sc2_20, Sc2_21, Sc2_23, Sc2_24, Sc2_25, Sc2_27, Sc2_28, Sc2_29, Sc2_30 are considered as difficult items because *p* ranges between .19 and .39. However, most of these difficult items are functioning well instead item Sc1_30

(*D*= .28, *r*= .21) which is marginal and needs revision and item Sc2_25 (*D*= .36, *r*= .37) which is reasonable good but needs improvement.

To sum item characteristics, 3 items are easy compared to the test. Although they are functioning, their alternatives need to be improved. 5 items are too difficult. However, too difficult items do not functioning well. 33 of all items are difficult, 31 of them functioning well and 2 of them need improvement or revision. Also, 6 items are neither easy nor difficult and they are discriminating well. Mean difficulty of all of 59 items is .36 interprets the test is hard for the examinees.

The last issue is the percentages of the missing values of the 59 science items. As seen both from the frequencies (Appendix A) and percentages of omitting the item (Appendix B), missing proportion is greater than the correct responses even it exceeds the total amount of correct and wrong responses.

4.3.2.2 Formats of Items

As part of item analysis, styles of the items in Scince-1 and Science-2 test examined. Even though all items are in multiple-choice format (MC), there are mainly four types of MC items. First style includes only a stem with one sentence and 5 alternatives. This was named as "conventional MC" by Haladayna (2004). (i.e. Sc1_15). The second type includes a written explanation with one or two sentences before the stem (i.e. Sc1_14). In addition to the written information, third type involves a picture, figure or graph (i.e. Sc1_9). All of these tree formats are still conventional MC. The fourth type entitled "complex MC" including three or more explanatory information before the stem, and alternatives including one or more of these previously given choices (Haladyna, 2004). Most of these items in the SST also have a pictorial or graphical figure.

4.2.4 Factor Analysis

After assumptions such as sample size, factorability of the correlation matrix, and multicollineraity& singularity were checked; Principal Component Analysis with Varimax Rotated Solution was conducted in SPSS 11.5 version to interpret factor structure and construct-related validity of the test.

4.2.4.1 Assumptions

4.2.4.1.1 Sample Size

According to different views, from 2 subjects per variable to 20 subjects per variable could be considered accurate sample size for factor analysis (Stevens, 2002). Moreover, contrary to popular rules, Guadagnoli and Velicer (1988) stated that the absolute magnitude of the loadings and the absolute sample size are the most important factors. Number of variables per component is also important. Their recommendations were:

1) Components with four or more loadings above .60 in absolute value are reliable regardless of sample size.
2) Components with ten or more low (.40) loadings are reliable as long as sample size is greater than 150.
3) Components with only a few loadings should not be interpreted unless sample size is at least 300 (as cited in Stevens, 2002, p.395).

Since there are 126,245 subjects in the SST 2006 administration, and 59 variables, sample size is significantly greater than the minimum need. Moreover, according to 2nd and 3rd suggestions, this sample size is large enough in order to interpret both factors with ten or more low loading (smaller than .40) and factors including only a few loading.

4.2.4.1.2 Factorability of the Correlation Matrix

Tabachnick & Fidell (2001) indicated that correlation matrix should include at least some correlation (r= .30) to be considered as factorable. Although there are a few items having r values lower than .30 in the "correlation matrix" output of SPSS, most of the items correlate each other reasonably.

Another consideration is the Kaiser-Meyer-Olkin (KMO) statistic which measures the sampling adequacy. They argued values equal or greater than .60 are required for the factorability of the correlation matrix. For the present study, KMO value is .99 clarifies that the correlation matrix is factorable.

The last criterion for factorability is Bartlett's Test of Sphericity which hypothesizes that all the correlations in the correlation matrix are zero. Since factor analysis would be meaningless if all correlations are zero, this test is desired to be significant ($p < .05$). In this analysis, Bartlett's test is significant (p =.000), therefore there is not an identity matrix and factor analysis is appropriate.

4.2.4.1.3 Multicollinearity & Singularity

Although mild multicollinearity is not a problem for factor analysis extreme multicollinearity (i.e. variables that are very highly correlated) and singularity (variables that are perfectly correlated) cause problems in factor analysis Moreover, the determinant of the r- matrix should be less than .00001 to avoid multicollinearity and singularity (Field, 2005). Since each of 59 items correlates in acceptable levels and the determinant of the correlation matrix is 9.82×10^{-11}, neither multicollinearty nor singularity problems exist.

4.2.4.2 Interpretation of Communalities and Variance

Since Principal Component Analysis in SPSS works on the preliminary assumption that all variance is common; hence all communalities is 1.00 before extraction, and "extraction" label shows how much the common variance of an item accounts for extracted factors in the data (Field, 2005). In this data, communalities after extraction range between .15 and .77, therefore; 15 % of the variance in item 36 and 77 % of the variance in item 29 is explained by extracted factors (Appendix C).

4.2.4.3 Deciding on Number of Factors

There are different methods while deciding on number of factors provided by Stevens (2002). Kaiser's criterion and secree test considered for the present study. According to Kaiser's criterion, factors with eigenvalues are greater than 1 should be retained. In this study, the first three factors are interpretable which accounted for 39.397% of the total variance with the rotated solution. Their eigenvalues are respectively 20.572, 1.631 and 1.041. These factors revealed factor loadings between .769 and - .068. The factor loadings and communalities are presented in Appendix C.

As seen from the scree plot, since the 4^{th} plot is the first factor to be level off, before it, 3 factors can be retained and this finding is compatible with Kaiser's criterion (Appendix C).

4.2.4.4 Interpretations of Factors

Factor 1

The results of the factor analysis evince that eigenvalue of Factor 1 is 20.572 and explains 34.868% of the total variance. There are 38 items a total of 59 items under Factor 1. Their loadings are between .717 and .352. A total of 38

items in the first factor 23 items come from the SST-1 and 15 items come from the SST-2. Disregarding test type, there are 16 physics, 15 chemistry and 7 biology items under this factor. 5 of them are in knowledge, 20 of them in understanding and 4 of them are in problem solving level. In addition to items measuring one specific cognitive level, 7 items measuring both knowledge and understanding, 1 item measuring both knowledge and problem solving (specifically computing), and 1 item measuring understanding and problem solving are loaded under Factor 1. As a result, items under Factor 1 are seem to be assessing too many different cognitive processes with various levels which are mainly understanding and knowledge of science as well as some problem solving level processes. Moreover, this factor includes a considerable amount of all four types of items formats defined in the item analysis.

In regard to item characteristics, their difficulties are between .80 and .24, while discrimination values *D* are between .81 and .34 and *r* is between .62 and .24. When mean difficulty of items calculated under first factor it is found as .44. Most of the items under Factor 1 (as compatible with the item analysis results) functioning well with a reasonable difficulty and discrimination levels.

Factor 2

Factor 2 has an eigenvalue of 1,631 and accounts for 2.765% of the total variance. There are 18 items load under Factor 2 with loading values between .578 and .335. 13 of them come from the SST- 2 and 5 items come from the SST-1. Irrespective of test type, there are 10 physics, 2 chemistry and 6 biology items under Factor 2. Among these items, 2 of them measures knowledge of science, 7 items measure understanding of science with different cognitive processes while 4 items measure problem solving abilities of examinees. In addition, there are 3 items measuring knowledge and understanding, 1 items measuring knowledge and problem solving and 1 item measuring both understanding and problem solving. Considering cognitive process measured,

items under Factor 2 assess a very similar dimension with Factor 1. Also, Factor 2 composes each of the four formats of the items.

With respect to item characteristics, difficulties of items range between .34 and .06, *D* values range between .53 and .07, as *r* ranges between .58 and .16. Mean difficulty of these 18 items is .21 and many items are functioning reasonably although some need improvement and revision. Although difficulties of these items indicate a factor with similar but more difficult items compared to Factor 1, it is concluded that Factor 2 still measures the same dimension.

Factor 3

According to PCA results, 3 of biology items – Sc1_29, Sc1_30, and Sc2_30- were grouped under Factor 3 with factor loadings - .875, .287 and .279. This factor explains 1.764% of the total test variance with a 1.041 eigenvalue. 2 of them come from the SST- 1 and they are in knowledge level, whereas 1 item coming from the SST- 2 measures both knowledge and understanding. If closely examined, these 3 items construct a meaningful cluster because not only content but also types of questions are almost identical.

Furthermore, in terms of item characteristics these 3 items are similar because they are difficult (*p* values of them are .08, .33 and .37) and 2 of them discriminating poor while 1 needs a revision (*r* values of them are .05, .35, .21). In addition, the mean difficulty of these three items is .26. Also, format of all of these items are the same which is complex MC.

As a result, science tests in the SST 2006 are multidimensional including three factors. However, the items clustered under factors according to their item characteristics (mainly difficulty) rather than measured cognitive processes. Especially cognitive processes measured with items under Factor 1 and 2 are very close but their mean difficulties are different respectively .44 and .21.

4.2.5 Comparing Means for School Groups

One-way between groups ANOVA was conducted in SPSS 11.5 version in order to compare science ability of students from six types of schools. Before the analysis, assumptions such as random sampling, independence of observations, normality and homogeneity of variances were checked.

4.2.5.1 Assumptions

4.2.5.1.1 Random Sampling

Instead of 523 students who answered none of the items, all of the subjects in the science field of study from six types of schools included in the analysis, a total number of 126,245 subjects can be considered as the population itself rather than the sample. Since population is the group which enables random sampling (Tabachnick & Fidell, 2001), there is no need to violate random sampling assumption.

4.2.5.1.2 Independence of Observations

According to Cardinal& Aitken (2006) another assumption of ANOVA is observations within an experimental condition (group) are independent. Since the science score of subjects does not influence the other group members, it is concluded that this assumption is satisfied.

4.2.5.1.3 Normality

In their book, Cardinal& Aitken (2006) explained that scores for every condition should be normally distributed. Remembering descriptive statistics, science scores for six school groups were distributed reasonably normal.

4.2.5.1.4 Homogeneity of Variance

It is assumed for ANOVA each of the groups have the same variance (Cardinal& Aitken, 2006). That means variability of science score for each group should be the same. In order to satisfy this assumption Levene test in SPSS should not significant *(p* > .05). However, in the present research the test is significant (*p*= .000) means variance of the six school types are not equal. When the ratio of the largest standard deviation to the smallest is smaller than 2, the amount of difference of variance for each group can be accepted even the assumption is violated (Huizing, 2007). The ratio is 1.78 for the current study means there is a violation of this assumption, but ANOVA is still robust.

When the group variances are not equal, Dunnett's C test can be used for the group comparisons (Huizing, 2007). In this study variances of science scores for six types of school is not equal, Dunnett's C test is used for Post-hoc comparisons.

4.2.5.2 Interpretations of Mean Scores

The impact of school type on science score as measured by the SST 2006 was explored by helps of one-way between groups analysis of variance. Subjects of the research were divided into six groups based on the school type (group 1: General High School, group 2: General Private High School, group 3: Anatolian High School, group 4: General Private High School with Foreign Language Instruction, group 5: Science High School, group 6: General High School with Intensive Foreign Language Program). There is a statistically significant mean difference at *p*< .05 level in science score of six school groups (*F* [5, 126,239] = 18,808.829, *p*= .000) with a large effect size (*partial eta squared*= .427).

Since equal variances not assumed in the present research Dunnett's C test performed for the Post-hoc comparison. According to Dunnett's C test, the mean science score of General High School (*M*= 14.32, *SD*= 7.75) is significantly lower

than all other school types which are General Private High School (*M*= 21.29, *SD*= 12.25), Anatolian High School (*M*= 32.41, *SD*= 11.50), General Private High School with Foreign Language Instruction (*M*= 26.02, *SD*= 13.80), Science High School (*M*= 42.01, *SD*= 11.11), and General High School with Intensive Foreign Language Program (*M*= 22.45, *SD*= 10.41).

General Private High School (*M*= 21.29, *SD*= 12.25) has the second lowest science score significantly lower than Anatolian High School (*M*= 32.41, *SD*= 11.50), General Private High School with Foreign Language Instruction (*M*= 26.02, *SD*= 13.80), Science High School (*M*= 42.01, *SD*= 11.11), and General High School with Intensive Foreign Language Program (*M*= 22.45, *SD*= 10.41).

Science score of General High School with Intensive Foreign Language Program (*M*= 22.45, *SD*= 10.41) is meaningfully lower than Anatolian High School (*M*= 32.41, *SD*= 11.50), General Private High School with Foreign Language Instruction (*M*= 26.02, *SD*= 13.80), Science High School (*M*= 42.01, *SD*= 11.11).

The mean science score of the General Private High School with Foreign Language Instruction (*M*= 26.02, *SD*= 13.80) is significantly lower than both Anatolian High School (*M*= 32.41, *SD*= 11.50) and Science High School (*M*= 42.01, *SD*= 11.11).

Finally, science score of examinees from Anatolian High School (*M*= 32.41, *SD*= 11.50) is remarkably lower than examinees from Science High School (*M*= 42.01, *SD*= 11.11).

In conclusion, high school type is considered as a significant effect in students' science scores in the SST 2006.

CHAPTER V

CONCLUSION, DISCUSSION and RECOMMENDATIONS

5.1 Conclusion

In the present study content-related and construct-related evidence of validity were examined for the science sections of 2006 administration of the Student Selection Test (SST) by means of content analysis, factor analysis and one-way between groups ANOVA across six high school types. As related features, reliability of the test score and characteristics of the science items examined.

In terms of measured content, science sub-tests found to be assessing a very broad content from elementary science curriculum and secondary physics, chemistry and biology curricula. Most of the items needed to know more than one knowledge and terminology to understand the item and choose the key alternative. In addition to excess information included in one item, there were more than one cognitive processes measured in the items as either knowledge, understanding and problem solving levels or their various combinations such as knowledge& understanding, knowledge& problem solving, and understanding& problem solving.

Results of factor analysis were also consistent to the results of the content analysis. There were three factors explaining 39.397% of the total variance. Items loaded under Factor 1 and Factor 2 were composed of knowledge, understanding and problem solving items with various cognitive processes. Similarly, most those

items were measuring more than one content and more than a single cognitive process. It was very difficult to interpret what was measuring under these items via examining the items loaded under these two factors but their cognitive processes were very close. Items seemed to be clustered according to their difficulty levels, that items under Factor 2 were more difficult than the ones under Factor 1. Regarding to Factor 3, there were three biology items all were in complex multiple-choice format with similar contents such as inheritance and population genetics.

Moreover, a statistically significant mean difference was detected across six high school types and this might be a thread to validity of the SST 2006, even it might address test bias across school types.

According to reliability analysis and item analysis, the SST 2006 data had a high internal consistency (α = .94), but the test was difficult to all examinee group (p= .36) although there was a few number of easy items.

5.2 Discussion

The content of the test investigated by content analysis was consistent with the content structure of the science tests defined by OSYM. The test is found to consistent with the OSYM's (2006) content definition in terms of content category, grade level distributions and cognitive processes measured in the Science-1 and Science-2 sections with some exceptions. There are 3 items in Scinece-1 tests coming from 11^{th} grade (items related to field courses) unlike the others come from elementary and 9^{th} grades which are called "items related to common courses" by OSYM. However, the information provided by OSYM about the test content is very limited.

On the other hand, Berberoglu (1996) stated, the science items are assessing higher order thinking skills such as application, analysis, synthesis and evaluation in Bloom's (1979) taxonomy. However, science items fail to assess

analysis, synthesis and evaluation levels in the 2006 administration of the SST. Plenty of items measure cognitive processes in knowledge and understanding levels according to Krathwohl's (2002) taxonomy, but there are only 8 items in problem solving one measuring "determining a way for solution" the others measuring "computing". To sum up there is no item in analyze, evaluate and create levels of Krathwohl's taxonomy.

In terms of science process skills (SPS), Sc1_1, Sc1_5, Sc1_8, Sc1_9, Sc1_13, Sc2_5, Sc2_9, Sc2_22 measure comparing-classifying dimensions of SPS, while Sc1_4, Sc2_4, Sc2_26, Sc2_28 measure inferring dimension, and Sc1_2, Sc1_27, Sc2_1, Sc2_10, Sc2_17 assess predicting dimension. However, SPS such as making observations, hypothesis formulating and testing, controlling variables, proposing procedures, designing experiment, analyzing data, and drawing conclusions do not emphasized in the SST 2006 science items.

According to Haladyna (2004) every item should reflect only a specific content and only a single particular cognitive process. However, there are some items in the SST 2006 including more than a single content (Sc1_19, Sc1_20, Sc2_26) and items referring more than a cognitive process (Sc1_4, Sc1_16, Sc1_21, Sc1_22, Sc2_13). What measured in the items is become ambiguous due to including more content or cognitive task. For example, graphical interpretation interferes the cognitive process assessed all of the above-mentioned items which is unintended. If a student wrongly answered the item, it would be unknown which of the cognitive processes is lack for this student. The similar problem arises when the item includes two or more content.

Although being popular in formal testing, complex MC form is problematic for some reasons (Haladyna, 2004). First, these items are more difficult than other types of MC forms; second, sometimes it provides evidence for the correct choice (for instance if an examinee knows one of the choices is not correct, he can eliminate the distractors including this choice); third, some studies evinced that complex MC found less discriminating; and last it is more difficult to

construct and read (Haladyna& Dawning, 1989). There is a plenty of complex MC items in the SST 2006 science subtests. A total of 59 items, 22 items are in that form, 15 of them come from Science-1 and 7 come from Science-2 sections.

Haladyna (2004) also offers to minimize the reading time with items as brief as possible and to avoid use negative expressions in the stem as well as in the alternatives. Most of the questions in the test are lengthy and needs too much time to read and understand. Also, there are negatively expressed stems in the SST 2006 such as Sc1_10, Sc1_15, Sc1_18, Sc1_20, Sc1_26, Sc2_10, Sc2_21 and Sc2_22.

Another consideration is the length of options should be nearly the same because especially lower achievers tend to choice the longest option which is possibly the correct one (Haladyna, 2004). Items in the science tests having inconsistency in the lengths of options are Sc1_15, Sc1_20, Sc1_22, Sc1_24, Sc2_12, Sc2_16, Sc2_18, Sc2_19 and Sc2_29.

Regarding to item characteristics, too difficult items do not claimed as well discriminating items. Moreover, mean difficulty of .36 shows that test is difficult for whole group although all of group is composed of first time administered students in 2006 and they have the same study field as science.

As seen from reliability analysis the internal consistency of the science test is found high. Ebel (1979) stated that if the range of the ability in the examinee group is wider, the reliability of the scores increases. For the SST 2006, there are a large number of subjects and the range of their ability level might diverse and the high internal consistency might be found because of this reason.

With respect to factor analysis, there were undesired lower correlation between variables reveals the test items are not measuring the same construct. This result was consistent to the findings of the content analysis and factor analysis. However, in spite of the fact that the test seemed to be measuring three

factors items loaded on these factors are not different in terms of cognitive processes measured. Since the forms of the items are also very consistent in Factor 1 and Factor 2, difficulty constructs the factor structures of the test mainly.

According to the results of analysis of variance, there were found significant differences between groups with large effect sizes although the students for the research selected similar types of high schools (all were general public and private high schools), and although all of the students graduated from the same field of study which is science. As considered comparable, even Anatolian High School and Science High School graduates performed remarkably different in the SST 2006 in science. This might be a thread to validity if this difference addresses a test bias rather than being a real science achievement difference.

5.3 Recommendations

As a result of the present research findings and discussions, following recommendations are provided for both the test developers in OSYM and researchers validating the SST.

- OSYM needs to clarify and extend the content definitions of the science sections of the test. Writing objectives for every item before the item constructed, preparing a table of specification including content, cognitive process and item type would be beneficial.

- In addition to knowledge, understanding and problem solving, items should emphasize higher order thinking skills, and more science process skills.

- In the SST 2006 science tests, most of the items do not seemed to be included basic topics derived from daily life situations. If content of the items would include real life situations and students' daily life experiences

instead remote memorization of knowledge, these made more sense for the examinees and positively affected their understanding and solving of the items.

- To avoid ambiguity about measured content and cognitive processes, items should be prepared based on a single content and cognitive task.

- While items are preparing, test developers should give more attention to ability of examinee group to prevent the test being difficult. That might also decrease the missing value percentages for each item.

- Use of different types of MC formats such as matching and true-false might increase the item quality. Moreover, complex MC formats should be avoided.

- Length of the item stem, and information given for solution should be as minimized as possible to decrease reading time for the items.

- Alternatives of the items should be prepared in a more meticulous manner. The length of them should be as equal as possible.

- Further research would be meaningful to detect whether this difference represents a real science achievement difference of examinees across selected six school types or there is a test bias that is the difference caused by test itself with items functioning in favor of either group.

- Research including not only general school types but also vocational and technical school types would certainly detect larger inequalities across school types. Such a study would be carried out by further research.

- With every aspect, the similar research might be repeated for the SST 2007 because 2006 and 2007 administrations of the tests have the same characteristics.

5.4 Limitation

In this research, a great difference of science score found between selected school types but the reason of the difference could not be determined. To interpret this difference between groups of examinees across high school types, differential item functioning analysis would be expressive.

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APPENDICES

APPENDIX A

Preliminary Analyses

Missing Values of Items

Sc1_1	*Frequency*	*Percent (%)*
0	21,719	17.2
1	100,492	79.6
Missing	4,034	3.2
Total	126,245	100

Sc1_2	*Frequency*	*Percent (%)*
0	30,696	24.3
1	84,455	66.9
Missing	11,094	8.8
Total	126,245	100.0

Sc1_3	*Frequency*	*Percent (%)*
0	44,796	35.5
1	61520	48.7
Missing	19,929	15.8
Total	126,245	100.0

Sc1_4	*Frequency*	*Percent (%)*
0	52,988	42.0
1	49,510	39.2
Missing	23,747	18.8
Total	126,245	100.0

Sc1_5	*Frequency*	*Percent (%)*
0	49,975	39.6
1	61,200	48.5
Missing	15,070	11.9
Total	126,245	100.0

Missing Values of Items (continued)

Sc1_6	*Frequency*	*Percent (%)*
0	39,665	31.4
1	70,316	55.7
Missing	16,264	12.9
Total	126,245	100.0

Sc1_7	*Frequency*	*Percent (%)*
0	90,471	71.7
1	24,073	19.1
Missing	11,701	9.3
Total	126,245	100.0

Sc1_8	*Frequency*	*Percent (%)*
0	65,569	51.9
1	51,912	41.1
Missing	8,764	6.9
Total	126,245	100.0

Sc1_9	*Frequency*	*Percent (%)*
0	37,669	29.8
1	74,241	58.8
Missing	14,335	11.4
Total	126,245	100.0

Sc1_10	*Frequency*	*Percent (%)*
0	64,868	51.4
1	25,386	20.1
Missing	35,991	28.5
Total	126,245	100.0

Sc1_11	*Frequency*	*Percent (%)*
0	62,395	49.4
1	40,692	32.2
Missing	23,158	18.3
Total	126,245	100.0

Missing Values of Items (continued)

Sc1_12	*Frequency*	*Percent (%)*
0	34,851	27.6
1	71,704	56.8
Missing	19,690	15.6
Total	126,245	100.0

Sc1_13	*Frequency*	*Percent (%)*
0	26,386	20.9
1	89,309	70.7
Missing	10,550	8.4
Total	126,245	100.0

Sc1_14	*Frequency*	*Percent (%)*
0	35,420	28.1
1	66,263	52.5
Missing	24,562	19.5
Total	126,245	100.0

Sc1_15	*Frequency*	*Percent (%)*
0	58,748	46.5
1	44,118	34.9
Missing	23,379	18.5
Total	126,245	100.0

Sc1_16	*Frequency*	*Percent (%)*
0	35,610	28.2
1	53,021	42.0
Missing	37,614	29.8
Total	126,245	100.0

Sc1_17	*Frequency*	*Percent (%)*
0	30,128	23.9
1	66,813	52.9
Missing	29,304	23.2
Total	126,245	100.0

Missing Values of Items (continued)

Sc1_18	*Frequency*	*Percent (%)*
0	36,491	28.9
1	60,899	48.2
Missing	28,855	22.9
Total	126,245	100.0

Sc1_19	*Frequency*	*Percent (%)*
0	29,668	23.5
1	43,027	34.1
Missing	53,550	42.4
Total	126,245	100.0

Sc1_20	*Frequency*	*Percent (%)*
0	46,090	36.5
1	43,364	34.3
Missing	36,791	29.1
Total	126,245	100.0

Sc1_21	*Frequency*	*Percent (%)*
0	64,350	51.0
1	35,516	28.1
Missing	26,379	20.9
Total	126,245	100.0

Sc1_22	*Frequency*	*Percent (%)*
0	43,865	34.7
1	49,279	39.0
Missing	33,101	26.2
Total	126,245	100.0

Sc1_23	*Frequency*	*Percent (%)*
0	25,118	19.9
1	75,806	60.0
Missing	25,321	20.1
Total	126,245	100.0

Missing Values of Items (continued)

Sc1_24	*Frequency*	*Percent (%)*
0	38,834	30.8
1	54,749	43.4
Missing	32,662	25.9
Total	126,245	100.0

Sc1_25	*Frequency*	*Percent (%)*
0	72,770	57.6
1	30,270	24.0
Missing	23,205	18.4
Total	126,245	100.0

Sc1_26	*Frequency*	*Percent (%)*
0	34,061	27.0
1	71,369	56.5
Missing	20,815	16.5
Total	126,245	100.0

Sc1_27	*Frequency*	*Percent (%)*
0	58,889	46.6
1	39,765	31.5
Missing	27,591	21.9
Total	126,245	100.0

Sc1_28	*Frequency*	*Percent (%)*
0	43,773	34.7
1	69,598	55.1
Missing	12,874	10.2
Total	126,245	100.0

Sc1_29	*Frequency*	*Percent (%)*
0	76,857	60.9
1	10,391	8.2
Missing	38,997	30.9
Total	126,245	100.0

Missing Values of Items (continued)

Sc1_30	*Frequency*	*Percent (%)*
0	57,240	45.3
1	46,210	36.6
Missing	22,795	18.1
Total	126,245	100.0

Sc2_1	*Frequency*	*Percent (%)*
0	30,226	23.9
1	59,110	46.8
Missing	36,909	29.2
Total	126,245	100.0

Sc2_2	*Frequency*	*Percent (%)*
0	36,687	29.1
1	7,109	5.6
Missing	82,449	65.3
Total	126,245	100

Sc2_3	*Frequency*	*Percent (%)*
0	34,031	27.0
1	37,382	29.6
Missing	54,832	43.4
Total	126,245	100.0

Sc2_4	*Frequency*	*Percent (%)*
0	47,429	37.6
1	37,468	29.7
Missing	41,348	32.8
Total	126,245	100.0

Sc2_5	*Frequency*	*Percent (%)*
0	28,350	22.5
1	46,821	37.1
Missing	51,074	40.5
Total	126,245	100.0

Missing Values of Items (continued)

Sc2_6	*Frequency*	*Percent (%)*
0	44,467	35.2
1	16,837	13.3
Missing	64,941	51.4
Total	126,245	100.0

Sc2_7	*Frequency*	*Percent (%)*
0	36,117	28.6
1	28,667	22.7
Missing	61,461	48.7
Total	126,245	100.0

Sc2_8	*Frequency*	*Percent (%)*
0	56,533	44.8
1	29,424	23.3
Missing	40,288	31.9
Total	126,245	100.0

Sc2_9	*Frequency*	*Percent (%)*
0	31,114	24.6
1	25,006	19.8
Missing	70,125	55.5
Total	126,245	100.0

Sc2_10	*Frequency*	*Percent (%)*
0	31,528	25.0
1	52,073	41.2
Missing	42,644	33.8
Total	126,245	100.0

Sc2_11	*Frequency*	*Percent (%)*
0	35,121	27.8
1	22,638	17.9
Missing	68,486	54.2
Total	126,245	100.0

Missing Values of Items (continued)

Sc2_12	*Frequency*	*Percent (%)*
0	41,080	32.5
1	26,646	21.1
Missing	58,519	46.4
Total	126,245	100.0

Sc2_13	*Frequency*	*Percent (%)*
0	42,748	33.9
1	24,554	19.4
Missing	58,943	46.7
Total	126,245	100.0

Sc2_15	*Frequency*	*Percent (%)*
0	33,152	26.3
1	34,944	27.7
Missing	58,149	46.1
Total	126,245	100.0

Sc2_16	*Frequency*	*Percent (%)*
0	20,503	16.2
1	60,347	47.8
Missing	45,395	36.0
Total	126,245	100.0

Sc2_17	*Frequency*	*Percent (%)*
0	26,581	21.1
1	42,495	33.7
Missing	57,169	45.3
Total	126,245	100.0

Sc2_18	*Frequency*	*Percent (%)*
0	32,519	25.8
1	46,733	37.0
Missing	46,993	37.2
Total	126,245	100.0

Missing Values of Items (continued)

Sc2_19	*Frequency*	*Percent (%)*
0	41,010	32.5
1	41,117	32.6
Missing	44,118	34.9
Total	126,245	100.0

Sc2_20	*Frequency*	*Percent (%)*
0	17,360	13.8
1	40,760	32.3
Missing	68,125	54.0
Total	126,245	100.0

Sc2_21	*Frequency*	*Percent (%)*
0	42,033	33.3
1	49,518	39.2
Missing	34,694	27.5
Total	126,245	100.0

Sc2_22	*Frequency*	*Percent (%)*
0	30,274	24.0
1	58,218	46.1
Missing	37,753	29.9
Total	126,245	100.0

Sc2_23	*Frequency*	*Percent (%)*
0	31,472	24.9
1	32,904	26.1
Missing	61,869	49.0
Total	126,245	100.0

Sc2_24	*Frequency*	*Percent (%)*
0	50,784	40.2
1	26,138	20.7
Missing	49,323	39.1
Total	126,245	100.0

Missing Values of Items (continued)

Sc2_25	*Frequency*	*Percent (%)*
0	43,704	34.6
1	28,076	22.2
Missing	54,465	43.1
Total	126,245	100.0

Sc2_26	*Frequency*	*Percent (%)*
0	52,805	41.8
1	20,519	16.3
Missing	52,921	41.9
Total	126,245	100.0

Sc2_27	*Frequency*	*Percent (%)*
0	14,906	11.8
1	29,697	23.5
Missing	81,642	64.7
Total	126,245	100.0

Sc2_28	*Frequency*	*Percent (%)*
0	56,868	45.0
1	27,946	22.1
Missing	41,431	32.8
Total	126,245	100.0

Sc2_29	*Frequency*	*Percent (%)*
0	43,509	34.5
1	25,494	20.2
Missing	57,242	45.3
Total	126,245	100.0

Sc2_30	*Frequency*	*Percent (%)*
0	42,269	33.5
1	42,175	33.4
Missing	41,801	33.1
Total	126,245	100.0

Frequencies of Items

	Skewness	*Kurtosis*
Sc1_1	-1.686	.843
Sc1_2	-1.056	-.885
Sc1_3	-.319	-1.899
Sc1_4	.068	-1.995
Sc1_5	-.203	-1.959
Sc1_6	-.580	-1.663
Sc1_7	1.423	.024
Sc1_8	.234	-1.945
Sc1_9	-.692	-1.522
Sc1_10	.973	-1.053
Sc1_11	.431	-1.815
Sc1_12	-.737	-1.457
Sc1_13	-1.296	-.320
Sc1_14	-.637	-1.595
Sc1_15	.287	-1.917
Sc1_16	-.401	-1.839
Sc1_17	-.818	-1.331
Sc1_18	-.518	-1.732
Sc1_19	-.374	-1.860
Sc1_20	.061	-1.996
Sc1_21	.603	-1.636
Sc1_22	-.116	-1.986
Sc1_23	-1.162	-.651
Sc1_24	-.345	-1.881
Sc1_25	.906	-1.180
Sc1_26	-.757	-1.427
Sc1_27	.395	-1.844
Sc1_28	-.468	-1.781
Sc1_29	2.352	3.532
Sc1_30	.214	-1.954
Sc2_1	-.683	-1.533
Sc2_2	1.832	1.355
Sc2_3	-.094	-1.991
Sc2_4	.236	-1.944
Sc2_5	-.507	-1.743

Frequencies of Items (continued)

	Skewness	*Kurtosis*
Sc2_6	1.010	-.980
Sc2_7	.232	-1.946
Sc2_8	.665	-1.558
Sc2_9	.219	-1.952
Sc2_10	-.507	-1.743
Sc2_11	.443	-1.804
Sc2_12	.436	-1.810
Sc2_13	.562	-1.685
Sc2_15	-.053	-1.997
Sc2_16	-1.133	-.717
Sc2_17	-.474	-1.776
Sc2_18	-.365	-1.867
Sc2_19	-.003	-2.000
Sc2_20	-.880	-1.226
Sc2_21	-.164	-1.973
Sc2_22	-.666	-1.557
Sc2_23	-.045	-1.998
Sc2_24	.676	-1.542
Sc2_25	.446	-1.801
Sc2_26	.981	-1.038
Sc2_27	-.703	-1.506
Sc2_28	.726	-1.474
Sc2_29	.541	-1.707
Sc2_30	.002	-2.000

APPENDIX B

Item and Test Analysis Program (ITEMAN) Results

Item Statistics						*Alternative Statistics*				
Seq. No.	*Scale -Item*	*Prop. Correct*	*Disc. Index*	*Point Biser.*	*Alt.*	*Prop. Total*	*Endorsing Low*	*Endorsing High*	*Point Biser.*	*Key*
Sc1_1	1-1	.80	.36	.31	A	.09	.16	.03	-.20	
					B	.01	.02	.00	-.09	
					C	.03	.05	.01	-.11	
					D	.04	.08	.01	-.15	
					E	.80	.59	.95	.31	*
					Other	.03	.00	.00	-.21	
Sc1_2	1-2	.67	.56	.42	A	.67	.38	.93	.42	*
					B	.05	.10	.00	-.18	
					C	.07	.12	.02	-.17	
					D	.07	.11	.02	-.16	
					E	.06	.09	.02	-.14	
					Other	.09	.00	.00	-.29	
Sc1_3	1-3	.49	.35	.26	A	.05	.06	.04	-.05	
					B	.03	.04	.02	-.06	
					C	.49	.33	.68	.26	*
					D	.22	.21	.17	-.09	
					E	.05	.10	.01	-.16	
					Other	.16	.00	.00	-.24	
Sc1_4	1-4	.39	.48	.38	A	.13	.21	.02	-.24	
					B	.03	.05	.01	-.10	
					C	.20	.13	.24	.04	
					D	.06	.08	.02	-.12	
					E	.39	.17	.65	.38	*
					Other	.19	.00	.00	-.34	
Sc1_5	1-5	.48	.70	.53	A	.48	.16	.86	.53	*
					B	.10	.13	.05	-.14	
					C	.06	.09	.01	-.15	
					D	.14	.19	.04	-.21	
					E	.09	.18	.01	-.25	
					Other	.12	.00	.00	-.28	
Sc1_6	1-6	.56	.54	.41	A	.02	.03	.00	-.09	
					B	.02	.03	.01	-.07	
					C	.20	.25	.09	-.21	
					D	.56	.30	.84	.41	*
					E	.08	.13	.03	-.17	
					Other	.13	.00	.00	-.29	

Item and Test Analysis Program (ITEMAN) Results (continued)

Item Statistics						*Alternative Statistics*				
Seq. No.	*Scale -Item*	*Prop. Correct*	*Disc. Index*	*Point Biser.*	*Alt.*	*Prop. Total*	*Endorsing Low*	*Endorsing High*	*Point Biser.*	*Key*
Sc1_7	1-7	.19	.50	.58	A	.10	.08	.12	.01	
					B	.19	.03	.53	.58	*
					C	.04	.05	.01	-.10	
					D	.36	.51	.08	-.40	
					E	.21	.14	.22	-.01	
					Other	.09	.00	.00	-.22	
Sc1_8	1-8	.41	.52	.42	A	.13	.18	.05	-.18	
					B	.23	.25	.13	-.17	
					C	.41	.20	.72	.42	*
					D	.11	.14	.07	-.13	
					E	.05	.08	.01	-.14	
					Other	.07	.00	.00	-.22	
Sc1_9	1-9	.59	.58	.43	A	.04	.09	.00	-.17	
					B	.06	.11	.00	-.19	
					C	.59	.29	.87	.43	*
					D	.17	.19	.11	-.12	
					E	.03	.05	.01	-.12	
					Other	.11	.00	.00	-.34	
Sc1_10	1-10	.20	.37	.42	A	.17	.15	.15	-.05	
					B	.20	.07	.44	.42	*
					C	.15	.15	.10	-.11	
					D	.14	.14	.10	-.10	
					E	.06	.07	.03	-.10	
					Other	.29	.00	.00	-.25	
Sc1_11	1-11	.32	.54	.47	A	.05	.06	.02	-.09	
					B	.32	.10	.65	.47	*
					C	.18	.18	.14	-.09	
					D	.22	.22	.12	-.16	
					E	.05	.07	.03	-.08	
					Other	.18	.00	.00	-.36	
Sc1_12	1-12	.57	.50	.38	A	.15	.20	.06	-.19	
					B	.01	.02	.00	-.07	
					C	.02	.05	.00	-.13	
					D	.57	.33	.83	.38	*
					E	.09	.15	.05	-.15	
					Other	.16	.00	.00	-.26	

Item and Test Analysis Program (ITEMAN) Results (continued)

Item Statistics						*Alternative Statistics*				
Seq. No.	*Scale -Item*	*Prop. Correct*	*Disc. Index*	*Point Biser.*	*Alt.*	*Prop. Total*	*Endorsing Low*	*Endorsing High*	*Point Biser.*	*Key*
Sc1_13	1-13	.71	.41	.32	A	.10	.12	.05	-.13	
					B	.03	.06	.01	-.13	
					C	.04	.06	.01	-.12	
					D	.05	.08	.02	-.11	
					E	.71	.49	.89	.32	*
					Other	.08	.00	.00	-.25	
Sc1_14	1-14	.52	.64	.47	A	.07	.08	.04	-.09	
					B	.04	.05	.02	-.07	
					C	.03	.05	.00	-.12	
					D	.14	.20	.04	-.22	
					E	.52	.22	.85	.47	*
					Other	.19	.00	.00	-.38	
Sc1_15	1-15	.35	.59	.50	A	.05	.07	.01	-.12	
					B	.23	.18	.17	-.09	
					C	.09	.11	.03	-.14	
					D	.35	.12	.71	.50	*
					E	.11	.14	.05	-.15	
					Other	.19	.00	.00	-.38	
Sc1_16	1-16	.42	.80	.62	A	.12	.10	.06	-.11	
					B	.12	.15	.03	-.19	
					C	.42	.08	.87	.62	*
					D	.02	.03	.01	-.07	
					E	.02	.04	.00	-.10	
					Other	.30	.00	.00	-.50	
Sc1_17	1-17	.53	.70	.53	A	.11	.17	.02	-.22	
					B	.53	.20	.90	.53	*
					C	.05	.08	.01	-.13	
					D	.04	.06	.01	-.12	
					E	.04	.05	.01	-.10	
					Other	.23	.00	.00	-.39	
Sc1_18	1-18	.48	.66	.50	A	.48	.16	.83	.50	*
					B	.06	.08	.03	-.10	
					C	.08	.10	.03	-.13	
					D	.06	.09	.02	-.14	
					E	.09	.08	.06	-.06	
					Other	.23	.00	.00	-.44	

Item and Test Analysis Program (ITEMAN) Results (continued)

Item Statistics						*Alternative Statistics*				
Seq. No.	*Scale -Item*	*Prop. Correct*	*Disc. Index*	*Point Biser.*	*Alt.*	*Prop. Total*	*Endorsing Low*	*Endorsing High*	*Point Biser.*	*Key*
Sc1_19	1-19	.34	.46	.39	A	.03	.04	.02	-.06	
					B	.03	.04	.01	-.10	
					C	.12	.08	.13	.01	
					D	.05	.06	.03	-.07	
					E	.34	.14	.60	.39	*
					Other	.42	.00	.00	-.39	
Sc1_20	1-20	.34	.53	.45	A	.04	.04	.03	-.05	
					B	.34	.12	.65	.45	*
					C	.11	.12	.06	-.11	
					D	.17	.14	.14	-.07	
					E	.04	.05	.04	-.04	
					Other	.29	.00	.00	-.41	
Sc1_21	1-21	.28	.51	.48	A	.28	.10	.60	.48	*
					B	.05	.06	.02	-.10	
					C	.03	.04	.00	-.11	
					D	.05	.06	.01	-.11	
					E	.39	.33	.31	-.10	
					Other	.21	.00	.00	-.38	
Sc1_22	1-22	.39	.65	.50	A	.06	.07	.01	-.12	
					B	.08	.11	.02	-.17	
					C	.16	.09	.19	.06	
					D	.05	.05	.02	-.09	
					E	.39	.10	.75	.50	*
					Other	.26	.00	.00	-.50	
Sc1_23	1-23	.60	.59	.43	A	.04	.05	.03	-.05	
					B	.03	.03	.03	-.04	
					C	.60	.31	.89	.43	*
					D	.08	.13	.01	-.20	
					E	.04	.07	.01	-.14	
					Other	.20	.00	.00	-.39	
Sc1_24	1-24	.43	.60	.47	A	.07	.07	.04	-.08	
					B	.08	.08	.05	-.07	
					C	.09	.08	.08	-.04	
					D	.43	.17	.77	.47	*
					E	.06	.10	.02	-.15	
					Other	.26	.00	.00	-.43	

Item and Test Analysis Program (ITEMAN) Results (continued)

Item Statistics						*Alternative Statistics*				
Seq. No.	*Scale -Item*	*Prop. Correct*	*Disc. Index*	*Point Biser.*	*Alt.*	*Prop. Total*	*Endorsing Low*	*Endorsing High*	*Point Biser.*	*Key*
Sc1_25	1-25	.24	.46	.46	A	.04	.05	.03	-.05	
					B	.24	.07	.53	.46	*
					C	.04	.05	.03	-.06	
					D	.17	.17	.12	-.10	
					E	.32	.34	.21	-.17	
					Other	.18	.00	.00	-.29	
Sc1_26	1-26	.57	.60	.45	A	.03	.05	.00	-.11	
					B	.04	.05	.02	-.07	
					C	.17	.22	.06	-.21	
					D	.04	.07	.01	-.14	
					E	.57	.28	.88	.45	*
					Other	.16	.00	.00	-.34	
Sc1_27	1-27	.31	.61	.53	A	.25	.26	.15	-.16	
					B	.03	.05	.00	-.11	
					C	.31	.07	.68	.53	*
					D	.15	.16	.09	-.13	
					E	.04	.06	.02	-.10	
					Other	.22	.00	.00	-.36	
Sc1_28	1-28	.55	.34	.24	A	.55	.38	.72	.24	*
					B	.12	.14	.08	-.10	
					C	.06	.09	.03	-.12	
					D	.14	.17	.10	-.11	
					E	.03	.03	.02	-.06	
					Other	.10	.00	.00	-.20	
Sc1_29	1-29	.08	.06	.05	A	.08	.05	.11	.05	*
					B	.13	.11	.11	-.05	
CHECK THE KEY					C	.03	.05	.01	-.10	
A was specified, D works better					D	.37	.14	.68	.43	?
					E	.08	.11	.02	-.17	
					Other	.31	.00	.00	-.42	
Sc1_30	1-30	.37	.28	.21	A	.37	.22	.50	.21	*
					B	.04	.07	.01	-.13	
					C	.15	.11	.23	.11	
					D	.16	.21	.07	-.19	
					E	.10	.13	.08	-.10	
					Other	.18	.00	.00	-.20	

Item and Test Analysis Program (ITEMAN) Results (continued)

Item Statistics						Alternative Statistics				
Seq. No.	Scale -Item	Prop. Correct	Disc. Index	Point Biser.	Alt.	Prop. Total	Endorsing Low	Endorsing High	Point Biser.	Key
Sc2_1	1-31	.47	.68	.51	A	.02	.03	.00	-.09	
					B	.08	.09	.03	-.11	
					C	.05	.07	.02	-.12	
					D	.47	.15	.83	.51	*
					E	.09	.09	.06	-.09	
					Other	.29	.00	.00	-.46	
Sc2_2	1-32	.06	.07	.16	A	.05	.05	.03	-.07	
					B	.06	.03	.10	.16	*
		CHECK THE KEY			C	.12	.06	.19	.14	
		B was specified, D works better			D	.06	.03	.12	.17	?
					E	.07	.05	.08	.02	
					Other	.65	.00	.00	-.32	
Sc2_3	1-33	.30	.61	.55	A	.30	.05	.66	.55	*
					B	.04	.04	.03	-.06	
					C	.07	.07	.04	-.09	
					D	.10	.14	.03	-.17	
					E	.06	.05	.04	-.05	
					Other	.43	.00	.00	-.41	
Sc2_4	1-34	.30	.48	.42	A	.02	.03	.01	-.05	
					B	.12	.10	.08	-.08	
					C	.30	.10	.58	.42	*
					D	.05	.06	.03	-.09	
					E	.18	.09	.24	.09	
					Other	.33	.00	.00	-.48	
Sc2_5	1-35	.37	.65	.52	A	.02	.03	.01	-.08	
					B	.08	.05	.07	-.02	
					C	.37	.10	.74	.52	*
					D	.10	.09	.08	-.06	
					E	.02	.03	.01	-.06	
					Other	.40	.00	.00	-.51	
Sc2_6	1-36	.13	.18	.25	A	.05	.03	.06	.02	
					B	.19	.11	.27	.11	
					C	.13	.07	.25	.25	*
					D	.08	.08	.07	-.04	
					E	.04	.04	.02	-.06	
					Other	.51	.00	.00	-.32	

Item and Test Analysis Program (ITEMAN) Results (continued)

Item Statistics						Alternative Statistics				
Seq. No.	Scale -Item	Prop. Correct	Disc. Index	Point Biser.	Alt.	Prop. Total	Endorsing Low	Endorsing High	Point Biser.	Key
Sc2_7	1-37	.23	.55	.57	A	.23	.04	.58	.57	*
					B	.05	.05	.03	-.06	
					C	.07	.05	.07	-.01	
					D	.08	.07	.06	-.05	
					E	.09	.08	.05	-.09	
					Other	.49	.00	.00	-.46	
Sc2_8	1-38	.23	.41	.40	A	.15	.10	.15	-.00	
					B	.04	.04	.03	-.06	
					C	.16	.11	.18	.01	
					D	.10	.12	.04	-.14	
					E	.23	.07	.47	.40	*
					Other	.32	.00	.00	-.38	
Sc2_9	1-39	.20	.47	.53	A	.06	.05	.05	-.04	
					B	.08	.06	.06	-.05	
					C	.06	.03	.11	.08	
					D	.20	.03	.51	.53	*
					E	.04	.03	.05	.00	
					Other	.56	.00	.00	-.50	
Sc2_10	1-40	.41	.61	.48	A	.01	.02	.00	-.08	
					B	.02	.03	.01	-.07	
					C	.08	.09	.06	-.08	
					D	.41	.14	.75	.48	*
					E	.14	.15	.09	-.11	
					Other	.34	.00	.00	-.43	
Sc2_11	1-41	.18	.44	.51	A	.05	.04	.03	-.05	
					B	.16	.10	.18	.03	
					C	.03	.05	.01	-.09	
					D	.04	.04	.05	.01	
					E	.18	.03	.47	.51	*
					Other	.54	.00	.00	-.45	
Sc2_12	1-42	.21	.45	.47	A	.03	.03	.02	-.04	
					B	.21	.04	.49	.47	*
					C	.05	.04	.04	-.03	
					D	.17	.08	.26	.14	
					E	.07	.06	.06	-.04	
					Other	.46	.00	.00	-.53	

Item and Test Analysis Program (ITEMAN) Results (continued)

Item Statistics						Alternative Statistics				
Seq. No.	Scale -Item	Prop. Correct	Disc. Index	Point Biser.	Alt.	Prop. Total	Endorsing Low	Endorsing High	Point Biser.	Key
Sc2_13	1-43	.19	.39	.42	A	.19	.04	.43	.42	*
					B	.05	.04	.04	-.03	
					C	.03	.03	.01	-.08	
					D	.07	.05	.06	-.03	
					E	.19	.08	.31	.17	
					Other	.47	.00	.00	-.52	
Sc2_15	1-44	.28	.62	.58	A	.05	.03	.06	.01	
					B	.06	.04	.04	-.03	
					C	.06	.04	.05	-.02	
					D	.28	.04	.66	.58	*
					E	.09	.04	.10	.02	
					Other	.46	.00	.00	-.60	
Sc2_16	1-45	.48	.81	.61	A	.48	.10	.91	.61	*
					B	.05	.06	.02	-.09	
					C	.03	.04	.01	-.09	
					D	.05	.05	.03	-.07	
					E	.03	.03	.01	-.08	
					Other	.36	.00	.00	-.58	
Sc2_17	1-46	.34	.74	.62	A	.03	.03	.01	-.08	
					B	.09	.06	.08	-.02	
					C	.34	.05	.78	.62	*
					D	.03	.03	.01	-.07	
					E	.05	.02	.07	.05	
					Other	.45	.00	.00	-.62	
Sc2_18	1-47	.37	.76	.62	A	.06	.06	.03	-.09	
					B	.37	.06	.82	.62	*
					C	.06	.05	.03	-.08	
					D	.07	.06	.03	-.09	
					E	.07	.06	.05	-.05	
					Other	.37	.00	.00	-.55	
Sc2_19	1-48	.33	.59	.51	A	.06	.07	.03	-.10	
					B	.05	.05	.02	-.08	
					C	.12	.07	.12	-.00	
					D	.10	.09	.09	-.04	
					E	.33	.08	.68	.51	*
					Other	.35	.00	.00	-.49	

Item and Test Analysis Program (ITEMAN) Results (continued)

Item Statistics						*Alternative Statistics*				
Seq. No.	*Scale -Item*	*Prop. Correct*	*Disc. Index*	*Point Biser.*	*Alt.*	*Prop. Total*	*Endorsing Low*	*Endorsing High*	*Point Biser.*	*Key*
Sc2_20	1-49	.32	.62	.53	A	.02	.02	.01	-.05	
					B	.03	.03	.02	-.04	
					C	.04	.03	.04	-.01	
					D	.06	.04	.04	-.04	
					E	.32	.08	.69	.53	*
					Other	.54	.00	.00	-.52	
Sc2_21	1-50	.39	.56	.44	A	.12	.14	.06	-.14	
					B	.39	.14	.70	.44	*
					C	.09	.07	.11	.02	
					D	.07	.07	.06	-.06	
					E	.05	.06	.03	-.08	
					Other	.27	.00	.00	-.43	
Sc2_22	1-51	.46	.67	.52	A	.04	.05	.01	-.10	
					B	.10	.09	.06	-.08	
					C	.06	.07	.03	-.09	
					D	.46	.16	.83	.52	*
					E	.04	.05	.02	-.09	
					Other	.30	.00	.00	-.47	
Sc2_23	1-52	.26	.48	.43	A	.05	.06	.03	-.07	
					B	.05	.04	.06	.04	
					C	.10	.08	.10	-.01	
					D	.06	.05	.04	-.04	
					E	.26	.06	.54	.43	*
					Other	.49	.00	.00	-.43	
Sc2_24	1-53	.21	.40	.42	A	.10	.04	.20	.19	
					B	.07	.08	.04	-.10	
					C	.21	.06	.46	.42	*
					D	.10	.07	.09	-.03	
					E	.14	.10	.10	-.07	
					Other	.39	.00	.00	-.46	
Sc2_25	1-54	.22	.36	.37	A	.05	.04	.04	-.03	
					B	.12	.05	.20	.14	
					C	.05	.04	.03	-.05	
					D	.22	.08	.44	.37	*
					E	.13	.10	.14	.00	
					Other	.43	.00	.00	-.47	

Item and Test Analysis Program (ITEMAN) Results (continued)

Item Statistics						*Alternative Statistics*				
Seq. No.	*Scale -Item*	*Prop. Correct*	*Disc. Index*	*Point Biser.*	*Alt.*	*Prop. Total*	*Endorsing Low*	*Endorsing High*	*Point Biser.*	*Key*
Sc2_26	1-55	.16	.36	.42	A	.16	.03	.39	.42	*
					B	.16	.14	.15	-.04	
					C	.06	.05	.05	-.04	
					D	.11	.07	.17	.11	
					E	.09	.07	.08	-.02	
					Other	.42	.00	.00	-.43	
Sc2_27	1-56	.24	.49	.50	A	.04	.04	.04	-.01	
					B	.03	.03	.02	-.06	
					C	.03	.03	.01	-.06	
					D	.24	.05	.54	.50	*
					E	.02	.02	.01	-.05	
					Other	.65	.00	.00	-.46	
Sc2_28	1-57	.22	.45	.47	A	.10	.07	.11	.00	
					B	.22	.06	.51	.47	*
					C	.04	.05	.02	-.07	
					D	.19	.14	.16	-.05	
					E	.12	.10	.11	-.03	
					Other	.33	.00	.00	-.45	
Sc2_29	1-58	.20	.38	.42	A	.20	.06	.44	.42	*
					B	.05	.04	.04	-.03	
					C	.06	.04	.05	-.02	
					D	.14	.08	.16	.03	
					E	.10	.06	.12	.04	
					Other	.45	.00	.00	-.46	
Sc2_30	1-59	.33	.44	.35	A	.15	.10	.18	.05	
					B	.07	.05	.07	.00	
					C	.06	.06	.05	-.04	
					D	.33	.13	.57	.35	*
					E	.06	.05	.06	-.03	
					Other	.33	.00	.00	-.47	

** Correlations have been corrected for spuriousness.

Scale Statistics

Scale	*1*
N of Examinees	126,245
Mean	21.277
Variance	161.892
Std. Dev.	12.724
Skew	.760
Kurtosis	-.268
Minimum	.000
Maximum	59.000
Median	18.000
Alpha	.941
SEM	3.095
Mean P	.361
Mean Item-Tot.	.444
Mean Biserial	.590
Max Score (Low)	12
N (Low Group)	37,142
Min Score (High)	28
N (High Group)	35,447

There were 126,245 examinees in the data file.

APPENDIX C

Factor Analysis

Descriptive Statistics

Item	*Mean*	*Std. Deviation*	*Analysis N*
Sc1_1	.86	.352	6,714
Sc1_2	.81	.391	6,714
Sc1_3	.71	.452	6,714
Sc1_4	.66	.475	6,714
Sc1_5	.75	.432	6,714
Sc1_6	.77	.419	6,714
Sc1_7	.60	.489	6,714
Sc1_8	.70	.460	6,714
Sc1_9	.75	.431	6,714
Sc1_10	.58	.494	6,714
Sc1_11	.63	.482	6,714
Sc1_12	.79	.410	6,714
Sc1_13	.83	.376	6,714
Sc1_14	.77	.423	6,714
Sc1_15	.69	.463	6,714
Sc1_16	.76	.425	6,714
Sc1_17	.79	.407	6,714
Sc1_18	.73	.443	6,714
Sc1_19	.71	.455	6,714
Sc1_20	.68	.468	6,714
Sc1_21	.63	.483	6,714
Sc1_22	.65	.477	6,714
Sc1_23	.83	.378	6,714
Sc1_24	.73	.444	6,714
Sc1_25	.56	.496	6,714
Sc1_26	.81	.395	6,714
Sc1_27	.65	.477	6,714
Sc1_28	.70	.459	6,714
Sc1_29	.12	.321	6,714
Sc1_30	.52	.500	6,714
Sc2_1	.77	.420	6,714
Sc2_2	.26	.437	6,714
Sc2_3	.72	.450	6,714
Sc2_4	.60	.490	6,714
Sc2_5	.75	.431	6,714

Descriptive Statistics (continued)

Item	*Mean*	*Std. Deviation*	*Analysis N*
Sc2_6	.42	.493	6,714
Sc2_7	.68	.466	6,714
Sc2_8	.56	.496	6,714
Sc2_9	.64	.480	6,714
Sc2_10	.75	.432	6,714
Sc2_11	.58	.494	6,714
Sc2_12	.57	.495	6,714
Sc2_13	.52	.499	6,714
Sc2_15	.68	.465	6,714
Sc2_16	.79	.406	6,714
Sc2_17	.73	.442	6,714
Sc2_18	.74	.439	6,714
Sc2_19	.68	.465	6,714
Sc2_20	.77	.422	6,714
Sc2_21	.67	.471	6,714
Sc2_22	.78	.417	6,714
Sc2_23	.57	.495	6,714
Sc2_24	.53	.499	6,714
Sc2_25	.54	.498	6,714
Sc2_26	.44	.497	6,714
Sc2_27	.74	.440	6,714
Sc2_28	.58	.494	6,714
Sc2_29	.56	.497	6,714
Sc2_30	.59	.492	6,714

Correlation Matrix (a)

Determinant	9.818E-11

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy	.994
Bartlett's Test of Sphericity	
Approx. Chi-Square	154,223.128
df	1,711
Sig.	.000

Communalities

Item	*Initial*	*Extraction*
Sc1_1	1.000	.421
Sc1_2	1.000	.464
Sc1_3	1.000	.227
Sc1_4	1.000	.348
Sc1_5	1.000	.620
Sc1_6	1.000	.448
Sc1_7	1.000	.570
Sc1_8	1.000	.344
Sc1_9	1.000	.444
Sc1_10	1.000	.447
Sc1_11	1.000	.409
Sc1_12	1.000	.435
Sc1_13	1.000	.401
Sc1_14	1.000	.493
Sc1_16	1.000	.564
Sc1_17	1.000	.575
Sc1_18	1.000	.490
Sc1_19	1.000	.253
Sc1_20	1.000	.342
Sc1_21	1.000	.434
Sc1_22	1.000	.290
Sc1_23	1.000	.390
Sc1_24	1.000	.351
Sc1_25	1.000	.405
Sc1_26	1.000	.426
Sc1_27	1.000	.424
Sc1_28	1.000	.205
Sc1_29	1.000	.766
Sc1_30	1.000	.194
Sc2_1	1.000	.490
Sc2_2	1.000	.257
Sc2_3	1.000	.539
Sc2_4	1.000	.265
Sc2_5	1.000	.377
Sc2_6	1.000	.149
Sc2_7	1.000	.531
Sc2_8	1.000	.328
Sc2_9	1.000	.416
Sc2_10	1.000	.355
Sc2_11	1.000	.398
Sc2_12	1.000	.349
Sc2_13	1.000	.279
Sc2_15	1.000	.435

Communalities (continued)

Item	*Initial*	*Extraction*
Sc2_16	1.000	.542
Sc2_17	1.000	.461
Sc2_18	1.000	.548
Sc2_19	1.000	.431
Sc2_20	1.000	.360
Sc2_21	1.000	.281
Sc2_22	1.000	.487
Sc2_23	1.000	.216
Sc2_24	1.000	.280
Sc2_25	1.000	.268
Sc2_26	1.000	.196
Sc2_27	1.000	.448
Sc2_28	1.000	.381
Sc2_29	1.000	.363
Sc2_30	1.000	.192

Extraction Method: Principal Component Analysis

Total Variance Explained

Component	*Initial Eigenvalues*			*Extraction Sums of Squared Loadings*			*Rotation Sums of Squared Loadings*		
	Total	*% of Variance*	*Cumulative %*	*Total*	*% of Variance*	*Cumulative %*	*Total*	*% of Variance*	*Cumulative %*
1	20.572	34.868	34.868	20.572	34.868	34.868	14.039	23.795	23.795
2	1.631	2.765	37.633	1.631	2.765	37.633	7.963	13.497	37.293
3	1.041	1.764	39.397	1.041	1.764	39.397	1.242	2.104	39.397
4	.958	1.623	41.020						
5	.942	1.597	42.617						
6	.907	1.537	44.154						
7	.881	1.493	45.648						
8	.868	1.471	47.119						
9	.860	1.458	48.577						
10	.834	1.414	49.991						
11	.803	1.360	51.351						
12	.799	1.354	52.705						
13	.793	1.344	54.049						
14	.782	1.325	55.374						
15	.776	1.315	56.689						
16	.769	1.304	57.993						
17	.754	1.279	59.271						
18	.746	1.264	60.535						
19	.726	1.230	61.765						
20	.722	1.224	62.989						
21	.714	1.210	64.199						
22	.708	1.200	65.399						
23	.694	1.177	66.575						

Total Variance Explained (continued)

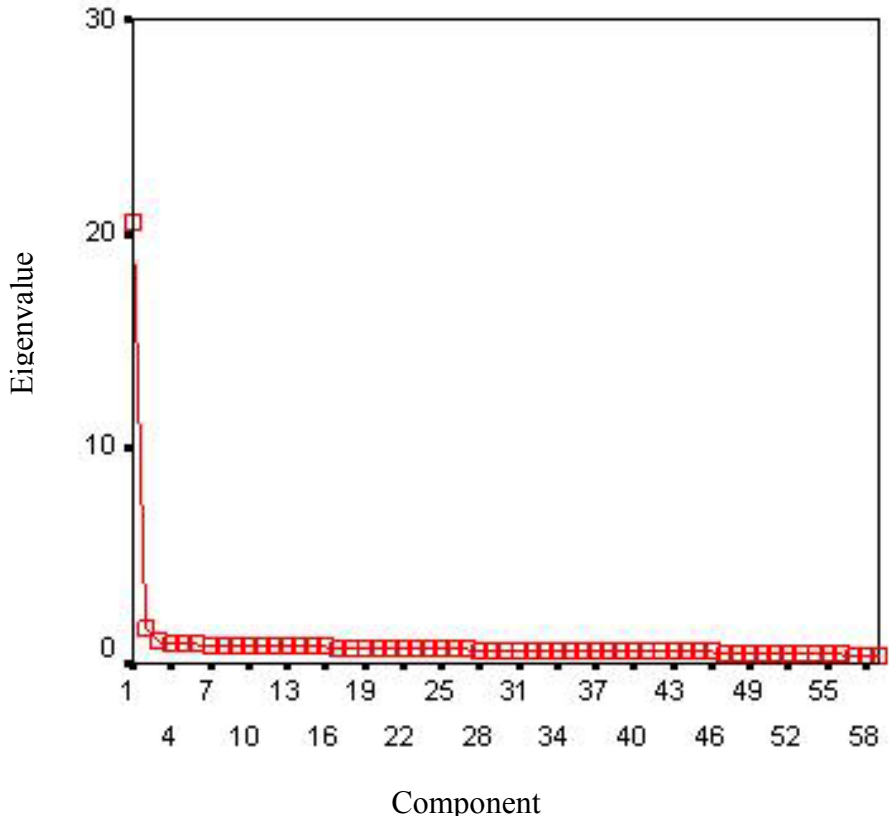
Component	*Initial Eigenvalues*			*Extraction Sums of Squared Loadings*			*Rotation Sums of Squared Loadings*		
	Total	*% of Variance*	*Cumulative %*	*Total*	*% of Variance*	*Cumulative %*	*Total*	*% of Variance*	*Cumulative%*
24	.685	1.161	67.736						
25	.665	1.126	68.862						
26	.664	1.125	69.987						
27	.650	1.102	71.089						
28	.644	1.091	72.180						
29	.638	1.082	73.262						
30	.634	1.075	74.337						
31	.623	1.055	75.392						
32	.610	1.033	76.426						
33	.608	1.030	77.456						
34	.602	1.020	78.476						
35	.593	1.006	79.482						
36	.584	.990	80.472						
37	.581	.985	81.457						
38	.579	.981	82.437						
39	.569	.965	83.402						
40	.561	.950	84.352						
41	.555	.940	85.293						
42	.551	.934	86.227						
43	.549	.931	87.158						
44	.545	.923	88.081						
45	.538	.912	88.993						

Total Variance Explained (continued)

Component	*Initial Eigenvalues*			*Extraction Sums of Squared Loadings*			*Rotation Sums of Squared Loadings*		
	Total	*% of Variance*	*Cumulative %*	*Total*	*% of Variance*	*Cumulative %*	*Total*	*% of Variance*	*Cumulative %*
46	.534	.905	89.897						
47	.527	.893	90.791						
48	.513	.870	91.660						
49	.503	.853	92.514						
50	.501	.849	93.363						
51	.493	.836	94.199						
52	.475	.806	95.004						
53	.468	.793	95.798						
54	.456	.772	96.570						
55	.431	.730	97.301						
56	.417	.706	98.007						
57	.410	.696	98.703						
58	.398	.675	99.378						
59	.367	.622	100.000						

Extraction Method: Principal Component Analysis

Scree Plot



Component Matrix (a)

	Component		
	1	*2*	*3*
Sc1_5	.769	-.157	.063
Sc1_16	.741	-.104	.057
Sc2_18	.739	-.038	.016
Sc1_7	.729	.167	.102
Sc2_3	.728	-.087	.031
Sc1_17	.728	-.213	-.004
Sc2_7	.724	.068	.049
Sc2_16	.712	-.185	.021
Sc1_14	.691	-.127	.006
Sc2_22	.689	-.109	-.019
Sc1_18	.684	-.142	.031
Sc2_1	.680	-.163	.006
Sc2_17	.678	-.042	-.012
Sc2_27	.666	-.053	-.036
Sc1_15	.660	.064	-.010
Sc2_15	.657	.051	.021

Component Matrix (a) (continued)

	Component		
	1	*2*	*3*
Sc2_19	.654	.058	.025
Sc1_6	.653	-.142	.029
Sc1_27	.649	.059	.000
Sc1_12	.642	-.151	.002
Sc1_9	.635	-.199	.035
Sc1_2	.632	-.254	-.015
Sc1_11	.630	.088	.065
Sc2_9	.628	.133	.064
Sc1_26	.626	-.179	-.042
Sc1_21	.625	.186	.091
Sc2_5	.608	-.083	.019
Sc1_25	.607	.190	-.013
Sc2_11	.607	.170	.035
Sc1_10	.605	.269	.092
Sc2_10	.593	-.049	-.017
Sc1_13	.591	-.228	-.005
Sc1_24	.590	-.010	-.053
Sc1_4	.588	-.031	.021
Sc1_23	.586	-.207	-.063
Sc2_20	.583	-.079	-.121
Sc1_8	.582	.045	.057
Sc1_20	.574	.097	.053
Sc1_1	.572	-.297	-.073
Sc2_28	.571	.233	-.024
Sc2_8	.545	.167	.060
Sc2_12	.532	.219	.133
Sc2_21	.525	-.070	-.009
Sc1_22	.523	-.120	-.041
Sc2_29	.511	.297	-.118
Sc1_19	.496	.031	-.078
Sc2_4	.489	.157	.013
Sc1_3	.475	.036	-.009
Sc2_13	.468	.243	-.026
Sc2_23	.461	-.059	-.022
Sc2_24	.450	.267	-.080
Sc1_28	.449	.016	-.060
Sc2_26	.428	.113	-.028
Sc2_25	.402	.311	-.099
Sc1_30	.359	.089	-.239
Sc2_30	.346	.107	-.247
Sc2_6	.298	.242	.041
Sc2_2	.216	.452	.075
Sc1_29	-.058	-.055	.871

Extraction Method: Principal Component Analysis. a) 3 components extracted.

Rotated Component Matrix (a)

	Component		
	1	*2*	*3*
Sc1_5	.717	.326	.005
Sc1_17	.713	.249	.063
Sc2_16	.686	.265	.039
Sc1_16	.663	.352	.011
Sc1_2	.660	.159	.062
Sc2_1	.647	.263	.051
Sc2_3	.642	.354	.036
Sc1_18	.639	.284	.029
Sc1_1	.634	.082	.110
Sc1_14	.633	.298	.055
Sc1_9	.632	.211	.015
Sc2_18	.621	.399	.056
Sc2_22	.621	.308	.081
Sc1_6	.613	.267	.027
Sc1_13	.611	.157	.049
Sc1_26	.610	.213	.093
Sc1_12	.608	.250	.053
Sc1_23	.593	.164	.107
Sc2_17	.573	.357	.077
Sc2_27	.569	.338	.100
Sc2_7	.548	.480	.028
Sc2_5	.542	.287	.037
Sc2_20	.513	.260	.174
Sc2_10	.508	.302	.073
Sc2_15	.503	.424	.049
Sc2_19	.496	.428	.045
Sc1_15	.496	.433	.080
Sc1_4	.495	.318	.036
Sc1_22	.493	.201	.085
Sc1_27	.490	.423	.070
Sc1_24	.481	.327	.112
Sc2_21	.466	.246	.057
Sc1_11	.461	.443	.005
Sc1_8	.447	.380	.005
Sc2_23	.407	.216	.065
Sc1_19	.380	.303	.129
Sc1_3	.363	.303	.059
Sc1_28	.352	.265	.106
Sc1_10	.336	.578	-.013
Sc1_7	.497	.568	-.016
Sc1_21	.401	.522	-.014
Sc2_29	.235	.522	.188
Sc2_28	.325	.516	.097
Sc1_25	.380	.503	.087

Rotated Component Matrix (a)

	Component		
	1	*2*	*3*
Sc2_12	.308	.500	-.064
Sc2_2	-.087	.499	-.022
Sc2_11	.393	.492	.038
Sc2_9	.433	.478	.008
Sc2_25	.139	.473	.160
Sc2_24	.204	.467	.143
Sc2_13	.235	.465	.089
Sc2_8	.346	.456	.006
Sc1_20	.410	.417	.011
Sc2_4	.305	.412	.047
Sc2_6	.101	.373	.006
Sc2_26	.279	.335	.079
Sc1_29	.022	.021	-.875
Sc2_30	.207	.258	.287
Sc1_30	.229	.253	.279

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a Rotation converged in 4 iterations.

Component Transformation Matrix

Component	*1*	*2*	*3*
1	.809	.579	.101
2	-.586	.808	.067
3	.042	.114	-.993

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.

APPENDIX D

One-way between Groups ANOVA

Test of Homogeneity of Variances

Levene Statistic	*df1*	*df2*	*Sig.*
2,453.613	5	126,239	.000

Dependent Variable: total science score

ANOVA

	Sum of Squares	*df*	*Mean Square*	*F*	*Sig.*
Between Groups	87,25,486.376	5	1,745,097.275	18,808.829	.000
Within Groups	11,712,549.063	126,239	92.781		
Total	20,438,035.439	126,244			

Dependent Variable: total science score

Post Hoc Tests: Multiple Comparisons (Dunnett C)

(I) School Type	*(J) School Type*	*Mean Difference (I-J)*	*Std. Error*	*95% Confidence Interval*	
				Lower Bound	*Upper Bound*
GHS	GPHS	-6.9750(*)	.29735	-7.8233	-6.1267
	AHS	-18.0942(*)	.07567	-18.3099	-17.8786
	GPHS_FLI	-11.7055(*)	.20821	-12.2991	-11.1119
	SHS	-27.6896(*)	.16463	-28.1590	-27.2203
	GHS_FLP	-8.1353(*)	.07549	-8.3504	-7.9201
GPHS	GHS	6.9750(*)	.29735	6.1267	7.8233
	AHS	-11.1192(*)	.30380	-11.9859	-10.2526
	GPHS_FLI	-4.7305(*)	.36045	-5.7586	-3.7024
	SHS	-20.7146(*)	.33715	-21.6764	-19.7529
	GHS_FLP	-1.1603(*)	.30375	-2.0268	-.2937
AHS	GHS	18.0942(*)	.07567	17.8786	18.3099
	GPHS	11.1192(*)	.30380	10.2526	11.9859
	GPHS_FLI	6.3888(*)	.21733	5.7692	7.0083
	SHS	-9.5954(*)	.17601	-10.0972	-9.0937
	GHS_FLP	9.9590(*)	.09786	9.6801	10.2379

Post Hoc Tests: Multiple Comparisons (Dunnett C) (continued)

(I) School Type	*(J) School Type*	*Mean Difference (I-J)*	*Std. Error*	*95% Confidence Interval*	
				Lower Bound	*Upper Bound*
GPHS_FLI	GHS	11.7055(*)	.20821	11.1119	12.2991
	GPHS	4.7305(*)	.36045	3.7024	5.7586
	AHS	-6.3888(*)	.21733	-7.0083	-5.7692
	SHS	-15.9842(*)	.26193	-16.7309	-15.2374
	GHS_FLP	3.5702(*)	.21726	2.9508	4.1896
SHS	GHS	27.6896(*)	.16463	27.2203	28.1590
	GPHS	20.7146(*)	.33715	19.7529	21.6764
	AHS	9.5954(*)	.17601	9.0937	10.0972
	GPHS_FLI	15.9842(*)	.26193	15.2374	16.7309
	GHS_FLP	19.5544(*)	.17593	19.0528	20.0559
GHS_FLP	GHS	8.1353(*)	.07549	7.9201	8.3504
	GPHS	1.1603(*)	.30375	.2937	2.0268
	AHS	-9.9590(*)	.09786	-10.2379	-9.6801
	GPHS_FLI	-3.5702(*)	.21726	-4.1896	-2.9508
	SHS	-19.5544(*)	.17593	-20.0559	-19.0528

* The mean difference is significant at the .05 level.

Tests of Between-Subjects Effects

Source	*Type III Sum of Squares*	*df*	*Mean Square*	*F*	*Sig.*	*Partial Eta Squared*	*Noncent. Parameter*	*Observed Power(a)*
Corrected Model	8,725,486.376(b)	5	1,745,097.275	18,808.829	.000	.427	94,044.146	1.000
Intercept	22,554,970.728	1	22,554,970.728	243,099.682	.000	.658	243,099.682	1.000
School Type	8,725,486.376	5	1,745,097.275	18,808.829	.000	.427	94,044.146	1.000
Error	11,712,549.063	126,239	92.781					
Total	77,589,188.000	126,245						
Corrected Total	20,438,035.439	126,244						

Dependent Variable: total science score

a Computed using alpha = .05

b R Squared = .427 (Adjusted R Squared = .427

APPENDIX E

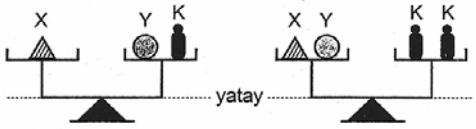
Science Items in Student Selection Test 2006

A

FEN BİLİMLERİ–1 TESTİ (Fen–1)

1. **Bu testte sırasıyla,**
   Fizik (1–13)
   Kimya (14–22)
   Biyoloji (23–30)
   ile ilgili 30 soru vardır.
2. **Cevaplarınızı, cevap kâğıdının Fen Bilimleri–1 Testi için ayrılan kısmına işaretleyiniz.**

1.



Şekil I Şekil II

Şekil I ve II deki eşit kollu teraziler, kefelerindeki X, Y ve K cisimleri ile yatay dengede olduğuna göre,

I. X in kütlesi K ninkinden büyüktür.

II. X in kütlesi Y ninkinden küçüktür.

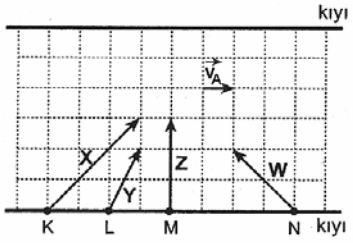
III. Y nin kütlesi K ninkinden küçüktür.

yargılarından hangileri doğrudur?

A) Yalnız I B) Yalnız II C) Yalnız III

D) I ve II E) I ve III

2.



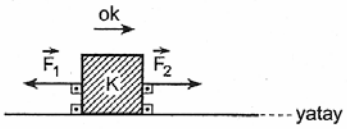
Yere göre akıntı hızı $\vec{v}_A$ olan bir ırmağın kıyısındaki K, L, M, N noktalarından yüzmeye başlayan X, Y, Z, W yüzücülerinin suya göre hız vektörleri şekildeki gibidir.

Bu yüzücülerden <u>hangi ikisi</u> karşı kıyıya aynı noktadan çıkar?

A) X ile Y B) X ile W C) Y ile Z

D) Y ile W E) Z ile W

3.



<u>Sürtünmesiz</u> yatay bir düzlemde duran K cismini, ok yönünde hareket ettiren şekildeki $\vec{F}_1$, $\vec{F}_2$ kuvvetleri t sürede W işini yapıyor.

Buna göre, hareket yönü aynı kalmak koşuluyla,

I. $\vec{F}_1$ in büyüklüğünü artırma

II. $\vec{F}_2$ nin büyüklüğünü azaltma

III. K nin kütlesini azaltma

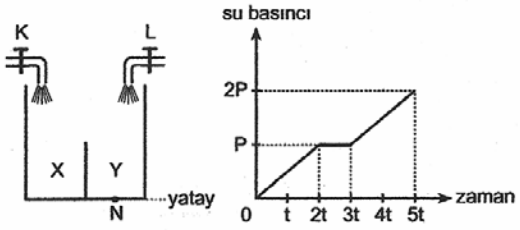
işlemlerinden hangisi yapılırsa, aynı t sürede yapılan W işi artar?

A) Yalnız I B) Yalnız II C) Yalnız III

D) I ya da II E) I ya da III

Diğer sayfaya geçiniz.

4.



Şekil I Şekil II

Düşey kesiti Şekil I deki gibi olan silindir biçimli kap, X bölmesine K musluğundan, Y bölmesine de L musluğundan sabit debilerle akan suyla 5t sürede ağzına kadar dolduruluyor. Bu süreçte kabın N noktasındaki su basıncını zamana bağlayan grafik de Şekil II deki gibi oluyor.

X bölmesinin hacmi Y ninkine eşit olduğuna göre,

I. K ve L musluklarından akan suların debileri birbirine eşittir.

II. K musluğu L musluğundan önce açılmıştır.

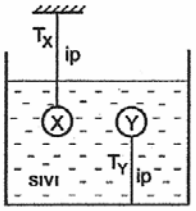
III. L musluğu K musluğundan önce açılmıştır.

yargılarından hangileri doğrudur?

A) Yalnız I B) Yalnız II C) Yalnız III

D) I ve II E) I ve III

5.



Birer ipe bağlı X, Y cisimleri bir sıvı içinde şekildeki konumda dengede kalıyor.

İplerdeki gerilme kuvvetlerinin T_X, T_Y büyüklükleri sıfır olmadığına göre,

I. X in özkütlesi Y ninkinden büyüktür.

II. X in kütlesi Y ninkinden büyüktür.

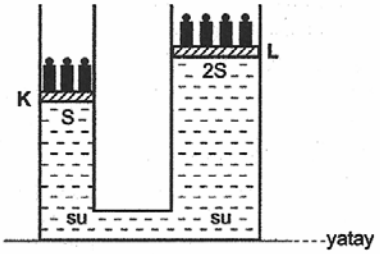
III. T_X, T_Y den büyüktür.

yargılarından hangileri kesinlikle doğrudur?

A) Yalnız I B) Yalnız II C) Yalnız III

D) I ve IJ E) II ve III

6.



Pistonlarının alanları S, 2S olan bir su cenderesi, pistonlarının üzerine konan özdeş cisimlerle şekildeki gibi dengede kalıyor.

Aşağıdaki işlemlerden hangisi yapılırsa, yeni denge konumunda kollardaki su yükseklikleri birbirine eşit olur?

(Pistonların sızdırmaz olduğu varsayılacak, ağırlıkları önemsenmeyecektir.)

A) K ve L pistonlarının üzerine aynı cisimlerden birer tane daha koyma

B) K ve L pistonlarının üzerinden birer tane cisim alma

C) Yalnızca L pistonunun üzerine aynı cisimden bir tane daha koyma

D) Yalnızca K pistonunun üzerinden bir tane cisim alma

E) Yalnızca L pistonunun üzerinden bir tane cisim alma

7. Deniz kenarında yapılan bir deneyde, ısıca yalıtılmış bir kapta bulunan 0 °C taki suya, sıcaklığı 0 °C ın altında olan bir buz parçası atılıyor. Bir süre sonra ısıl denge kuruluyor ve kapta su-buz karışımı olduğu gözleniyor.

Buna göre,

I. Kaba atılan buzun bir kısmı erimiştir.

II. Kaptaki suyun bir kısmı donmuştur.

III. Kaptaki suyun sıcaklığı azalmıştır.

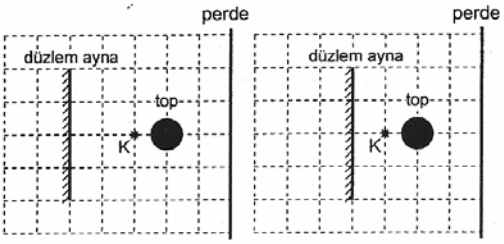
yargılarından hangileri doğrudur?

A) Yalnız I B) Yalnız II C) Yalnız III

D) I ve III E) II ve III

Diğer sayfaya geçiniz.

8.



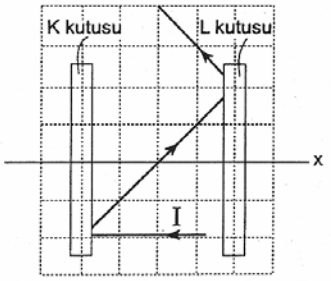
Şekil I Şekil II

Karanlık ortamdaki perde önüne, bir top, noktasal K ışık kaynağı ve düzlem ayna Şekil I deki gibi yerleştirildiğinde, perdedeki tam gölgenin alanı S_T, yarıgölgenin alanı da S_Y oluyor.

Düzlem ayna Şekil II deki konuma getirilirse S_T ve S_Y değerleri için ne söylenebilir?

	S_T	S_Y
A)	Büyür	Büyür
B)	Büyür	Değişmez
C)	Büyür	Küçülür
D)	Küçülür	Büyür
E)	Küçülür	Değişmez

9.

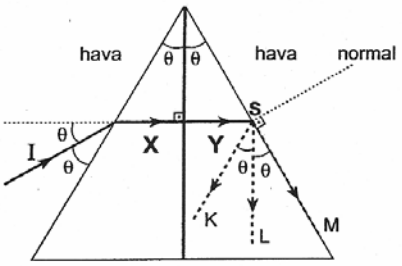


Şekildeki K, L kutularına birer ayna yerleştirilmiştir. K kutusundaki aynaya gelen I ışık ışını şekildeki yolu izleyerek düzenekten çıkıyor.

Şekildeki x ekseni küresel aynalar için asal ekseni, düzlem aynalar için de normalin doğrultusunu gösterdiğine göre, K ve L kutularındaki aynaların türü için ne söylenebilir?

	K deki aynanın türü	L deki aynanın türü
A)	Düzlem	Düzlem
B)	Düzlem	Çukur
C)	Çukur	Düzlem
D)	Çukur	Tümsek
E)	Tümsek	Çukur

10.



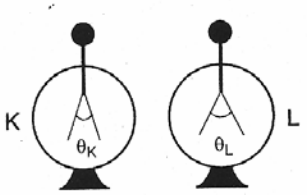
Birbirine yapışık X, Y prizmalarının tepe açıları θ dır. X e gelen I ışık ışını S noktasına kadar şekildeki yolu izliyor.

$\theta = 30^\circ$ ve X in kırma indisi, Y ninkinden küçük olduğuna göre, bu ışın S noktasından sonra kesikli çizgilerle belirtilen K, L, M yollarından hangilerini <u>kesinlikle izleyemez</u>?

A) Yalnız K yi B) Yalnız L yi C) Yalnız M yi
D) K ve L yi E) K ve M yi

Diğer sayfaya geçiniz.

11.



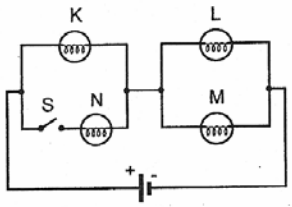
Şekildeki özdeş K, L elektroskoplarından K artı (+), L eksi (–) elektrikle yüklenmiştir. K nin yaprakları arasındaki θ_K açısı, L nin yaprakları arasındaki θ_L açısından küçüktür. Elektroskopların topuzları birbirine dokundurulup ayrıldığında, her ikisinin de yaprakları arasındaki açı θ oluyor.

Buna göre, aşağıdaki yargılardan hangisi kesinlikle yanlıştır?

A) $\theta = \theta_K$ B) $\theta = \theta_L$ C) $\theta > \theta_K$

D) $\theta < \theta_K$ E) $\theta < \theta_L$

12.



Özdeş K, L, M, N lambalarından oluşan şekildeki devrede S anahtarı açıkken K, L, M lambaları ışık veriyor.

S anahtarı kapatılırsa K, L, M lambalarından hangilerinin parlaklığı artar?

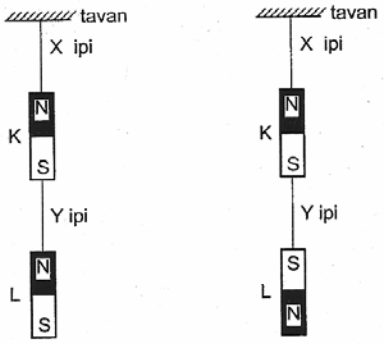
(Üretecin içdirenci önemsenmeyecektir.)

A) Yalnız K nin B) Yalnız L nin

C) K ve L nin D) L ve M nin

E) K, L ve M nin

13.



Özdeş K, L çubuk mıknatısları tavana Şekil I deki gibi asıldığında, X, Y iplerindeki gerilme kuvvetlerinin büyüklükleri sırasıyla T_X, T_Y oluyor.

L mıknatısı ters çevrilerek Şekil II deki gibi asılırsa, T_X ve T_Y değerleri için ne söylenebilir?

	T_X	T_Y
A)	Artar	Artar
B)	Artar	Değişmez
C)	Azalır	Azalır
D)	Değişmez	Değişmez
E)	Değişmez	Artar

Diğer sayfaya geçiniz.

14. Oda sıcaklığında, bir kaptaki arı suya eşit kütlelerde çay şekeri ve etil alkol konarak kabın ağzı kapatılıyor, çay şekeri ve etil alkolün tamamının çözünmesi sağlanıyor.

Bu çözünme tamamlandığında, oda sıcaklığında olan kaptaki çözünmüş maddelerin aşağıdaki özelliklerinden hangisinin çözünme öncesine göre değişmesi beklenir?

A) Kütleleri

B) Molekül sayıları

C) Molekül kütleleri

D) Kimyasal yapıları

E) Moleküller arası etkileşimleri

15. **Kütlesi bilinen fakat formülü bilinmeyen, ideal davranışta gaz halindeki bir bileşiğin mol sayısı, aşağıdaki bilgilerden hangisiyle doğru olarak <u>hesaplanamaz</u>?**

A) Mol kütlesi

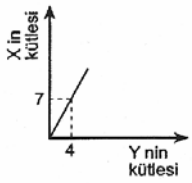
B) Molekül sayısı

C) Normal koşullardaki hacmi

D) Atomlarının mol kütlesi

E) Normal koşullarda bir gramının hacmi

16. X ve Y element atomları birleşerek I. ve II. bileşikleri oluşturmaktadır. Bu bileşiklerle ilgili grafikler ve açıklamalar aşağıda verilmiştir.



I. Bileşik

Yandaki grafik, I. bileşikteki X in kütlesinin Y nin kütlesiyle değişimini göstermektedir.

II. Bileşik

Yandaki grafik, II. bileşikteki X in kütlesinin bu bileşiğin kütlesiyle değişimini göstermektedir.

Bu grafiklere göre, aynı miktar X ile birleşen I. bileşikteki Y miktarının II. bileşikteki Y miktarına oranı kaçtır?

A) $\frac{1}{8}$ B) $\frac{1}{4}$ C) $\frac{1}{2}$ D) 1 E) 4

17. **Aşağıdaki iyonların hangisinde toplam elektron sayısı diğerlerinden farklıdır?**

($_1H$, $_6C$, $_7N$, $_8O$)

A) NH_4^+ B) CN^- C) OH^-

D) N^{-3} E) O^{-2}

Diğer sayfaya geçiniz.

18. **Aşağıda atom numaraları verilen element çiftlerinden hangisindeki I. element ile II. element, periyodik tablonun aynı grubunda yer almaz?**

	I. element	II. element
A)	4	22
B)	3	19
C)	10	36
D)	5	13
E)	8	34

19. **$_{29}X$ element atomuyla ilgili,**

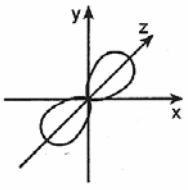
I. Elektronlarının orbital şeması

[Ar] $\underset{4s}{\boxed{\uparrow\downarrow}}$ $\underset{3d}{\boxed{\uparrow\downarrow}\ \boxed{\uparrow\downarrow}\ \boxed{\uparrow\downarrow}\ \boxed{\uparrow\downarrow}\ \boxed{\uparrow\downarrow}}$

biçimindedir.

II. X^+ iyonunun elektron dağılımı $[Ar]\,3d^{10}$ dur.

III. $3p_z$ orbitalindeki elektronlarının bulunma olasılıklarının dağılımı



şeklindedir.

yargılarından hangileri doğrudur?

$(_{18}Ar)$

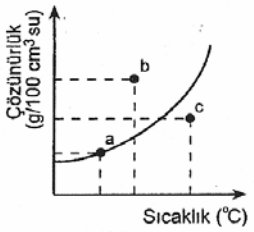
A) Yalnız I B) Yalnız II C) I ve III

D) II ve III E) I, II ve III

20. **Atomlar ve moleküller arasındaki bağlarla ilgili aşağıdaki durumlardan hangisi, karşısında verilen nedenle açıklanamaz?**

	Durum	Nedeni
A)	Potasyumun erime sıcaklığı sodyumunkinden küçüktür.	Potasyumdaki metalik bağın sodyumdakinden daha zayıf olması
B)	İyot katı, flor gazdır.	Florun iyonik bağlı bileşiklerinde yalnız negatif değerlik alması
C)	H_2S gaz, H_2O sıvıdır.	H_2O da hidrojen bağının etkin olması
D)	Sulu çözeltilerinde, HF zayıf asit, HCl kuvvetli asittir.	Hidrojen ile flor arasındaki bağın daha kuvvetli olması
E)	Grafit, elmastan daha yumuşaktır.	Grafitin tabakalı yapıda olması ve tabakaları arasında zayıf van der Waals kuvvetlerinin bulunması

21. Bir X katısının sudaki çözünürlüğünün sıcaklıkla değişimi grafikteki gibidir.



Bu grafikle ilgili,

I. a noktasında çözelti doymuştur.

II. b noktasında çözelti doymamıştır.

III. c noktasında çözelti aşırı doymuştur.

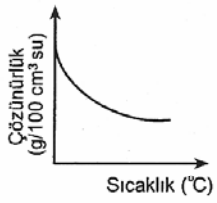
yargılarından hangileri doğrudur?

A) Yalnız I B) Yalnız II C) Yalnız III

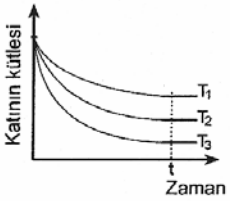
D) II ve III E) I, II ve III

Diğer sayfaya geçiniz.

22. Aşağıdaki I. grafik, bir X katısının sudaki çözünürlüğünün sıcaklıkla değişimini, II. grafik de T_1, T_2, T_3 sıcaklıklarında çözünme süresince bu katının kütlesinin zamanla değişimini göstermektedir.



I. grafik



II. grafik

Bu grafiklere göre, aşağıdaki yargılardan hangisi yanlıştır?

A) X in çözünürlüğü ekzotermiktir.

B) X in doygun çözeltisi ısıtılırsa çökelme olur.

C) Sıcaklıklar arasında $T_3 < T_2 < T_1$ ilişkisi vardır.

D) T_1, T_2, T_3 sıcaklıklarındaki çözeltiler t anında doygun haldedir.

E) X in T_1 sıcaklığındaki çözünürlüğü T_2 ve T_3 tekinden fazladır.

23. Hücrede gerçekleşen biyokimyasal olaylarla ilgili,

I. Hücre içi enerji üreten reaksiyonların başlaması için enerji gerekir.

II. Metabolik bir yolda yer alan enzimler birbirini izleyerek işlev görür.

III. Reaksiyonun başlaması için enzimin bulunması her zaman yeterlidir.

açıklamalarından hangileri doğrudur?

A) Yalnız I B) Yalnız II C) I ve II

D) I ve III E) II ve III

24. Aşağıdakilerden hangisi turgor basıncı yüksek olan bir bitki hücresinin turgor basıncının azalmasını sağlar?

A) Hücrenin izotonik bir ortama konması

B) Hücrenin, sitoplazmasındaki çözünmüş maddeleri dış ortama atması

C) Hücrenin hipotonik bir ortama konması

D) Hücrenin, ozmotik basıncı yüksek bir ortama konması

E) Hücrenin ATP kullanarak suyu içine alması

25. Nükleik asitlerin,

I. organel yapısında yer alma,

II. protein sentezinde rol oynama,

III. aminoasitleri tanıma

özelliklerinden hangileri RNA çeşitlerinin tümünde bulunur?

A) Yalnız I B) Yalnız II C) Yalnız III

D) I ve II E) II ve III

Diğer sayfaya geçiniz.

26. **Normal çevre koşullarında, bitkilerin kloroplastlarında aşağıdaki olaylardan hangisi gerçekleşmez?**

A) Enzimlerin kullanılması

B) ATP üretimi

C) DNA nın eşlenmesi

D) Organik madde üretimi

E) Yağ depolanması

27. Kapalı bir deney ortamında, deneyin başlangıcından 24 saat sonra, karbondioksit ve serbest azot miktarının azaldığı, oksijen miktarının arttığı gözleniyor.

Bu değişikliğe, aşağıdakilerin hangisinde verilen iki canlı grubunun birlikte yaşaması neden olur?

A) Yeşil bitki – Mantar

B) Parazit bitki – Mantar

C) Baklagiller – Nitrifikasyon bakterileri

D) Yeşil bitki – Parazit bitki

E) Mantar – Çürükçül bakteriler

28. **Sıcak ve kuru bir ortamda bulunan ve yeterli miktarda su alamayan normal bir insanın vücudunda,**

I. vücut iç sıcaklığında artma,

II. terleme,

III. doku sıvısındaki tuz miktarında azalma

olayları, aşağıdakilerin hangisinde verilen sıraya göre gerçekleşir?

A) I – II – III B) I – III – II

C) II – I – III D) III – I – II

E) III – II – I

29. Aynı türden kırmızı çiçekli iki bitki arasında yapılan birinci çaprazlama sonucunda $\frac{3}{4}$ ü kırmızı çiçekli, $\frac{1}{4}$ ü beyaz çiçekli olan F_1 dölü elde edilmiştir. F_1 dölünden alınan kırmızı çiçekli iki bitkiyle yapılan ikinci çaprazlamadan elde edilen F_2 dölündeki tüm bitkiler kırmızı çiçekli olmuştur.

Buna göre,

I. Birinci çaprazlamaya alınan bireylerin ikisi de heterozigottur.

II. F_1 dölündeki bireylerin bir kısmı homozigot bir kısmı heterozigottur.

III. İkinci çaprazlamaya alınan bireylerin ikisi de heterozigottur.

ifadelerinden hangileri kesinlikle doğrudur?

A) Yalnız I B) Yalnız II C) Yalnız III

D) I ve II E) II ve III

30.

I. Adaptasyon

II. Mutasyon

III. Kalıtsal varyasyon

Bir populasyondaki bireyler, yukarıdakilerden hangilerini "doğal seçilim"le kazanır?

A) Yalnız I B) Yalnız II C) Yalnız III

D) I ve II E) II ve III

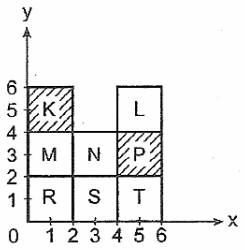
FEN BİLİMLERİ–1 TESTİ BİTTİ.

A

FEN BİLİMLERİ–2 TESTİ (Fen–2)

1. Bu testte sırasıyla,
   Fizik (1–13)
   Kimya (14–22)
   Biyoloji (23–30)
   ile ilgili 30 soru vardır.
2. Cevaplarınızı, cevap kâğıdının Fen Bilimleri–2 Testi için ayrılan kısmına işaretleyiniz.

1.

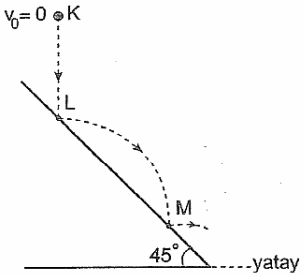


Türdeş ve özdeş 10 kareden oluşan şekildeki düzgün ince levhanın L, M, N, R, S, T parçaları tek; K, P parçaları da çift katlıdır.

Buna göre, bu levhanın kütle merkezinin koordinatları (x,y) aşağıdakilerden hangisidir?

A) (2,2) B) (2,3) C) (2,4) D) (3,3) E) (3,4)

2.



K noktasında durgun iken serbest bırakılan bir bilye, düşey kesiti şekildeki gibi olan eğik düzlemle L noktasında esnek çarpışma yaparak M noktasına ulaşıyor.

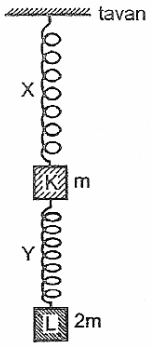
Bilye KL yolunu t sürede aldığına göre, LM yolunu kaç t sürede alır?

$\left(\sin 45^\circ = \cos 45^\circ = \frac{\sqrt{2}}{2};\ g = 10\ m/s^2\right)$

A) $2\sqrt{2}$ B) 2 C) $\sqrt{2}$ D) 1 E) $\frac{\sqrt{2}}{2}$

Diğer sayfaya geçiniz.

3. Özdeş X, Y yayları ile kütleleri sırasıyla m, 2m olan K, L cisimleri şekildeki gibi birbirine bağlanarak tavana asılıyor. Denge konumunda X yayında depolanan (esneklik) potansiyel enerji E_X, Y yayında depolanan da E_Y oluyor.

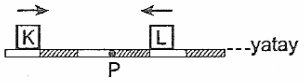


Buna göre, $\frac{E_X}{E_Y}$ oranı kaçtır?

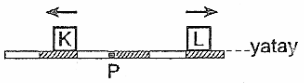
(Yayların kütleleri önemsenmeyecektir.)

A) $\frac{9}{4}$ B) $\frac{3}{4}$ C) $\frac{2}{3}$ D) $\frac{1}{2}$ E) $\frac{1}{4}$

4.



Şekil I



Şekil II

Sürtünmesiz yatay bir ray üzerinde birbirine doğru sabit hızlarla gelen K, L cisimlerinin $t_0 = 0$ anındaki konumu Şekil I deki gibidir. Bu cisimler, $t_0 = 0$ anından t süre sonra P noktasında çarpışıyor ve bu çarpışmadan t süre sonra da Şekil II deki konuma geliyor.

Buna göre,

I. K nin kütlesi L ninkine eşittir.

II. Çarpışma esnektir.

III. Çarpışmadan önce, K nin momentumunun büyüklüğü L ninkine eşittir.

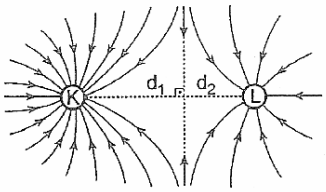
yargılarından hangileri doğrudur?

(Bölmeler eşit aralıklıdır.)

A) Yalnız I B) Yalnız II C) I ve II

D) I ve III E) II ve III

5.



Elektrikle yüklü iletken K, L kürelerinin konumu ve bunlara ilişkin kuvvet çizgilerinin biçimi ile yönü şekildeki gibidir.

K nin yükünün büyüklüğü q_K, L ninki q_L ve $d_1 > d_2$ olduğuna göre, q_K ve q_L nin büyüklükleri ve işaretleri için aşağıdakilerden hangisi doğrudur?

A) $q_K = q_L$, ikisi de – işaretlidir.

B) $q_K < q_L$, ikisi de – işaretlidir.

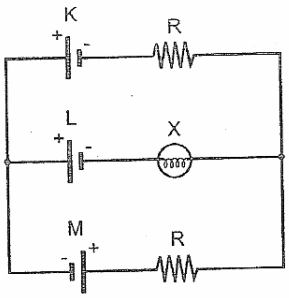
C) $q_K > q_L$, ikisi de – işaretlidir.

D) $q_K > q_L$, ikisi de + işaretlidir.

E) $q_K < q_L$, ikisi de + işaretlidir.

Diğer sayfaya geçiniz.

6.



K, L, M üreteçleri, X lambası ve özdeş R dirençlerinden oluşan şekildeki elektrik devresinde, X lambasından akım geçmiyor.

Buna göre,

I. K nin elektromotor kuvveti M ninkinden büyüktür.

II. K nin elektromotor kuvveti L ninkinden büyüktür.

III. L nin elektromotor kuvveti M ninkinden büyüktür.

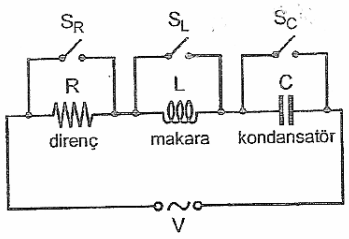
yargılarından hangileri <u>kesinlikle</u> doğrudur?

(Üreteçlerin içdirençleri önemsenmeyecektir.)

A) Yalnız I B) Yalnız II C) I ve II

D) I ve III E) II ve III

7.



S_R, S_L, S_C anahtarları açık olan şekildeki RLC devresinden sabit frekanslı alternatif akım geçiyor.

Aşağıdaki işlemlerden hangisi yapılırsa devreden geçen alternatif akımın etkin değeri <u>kesinlikle</u> artar?

A) Yalnız S_R yi kapatmak

B) Yalnız S_L yi kapatmak

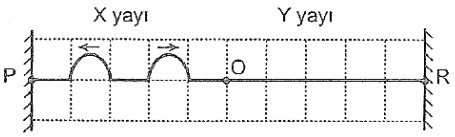
C) Yalnız S_C yi kapatmak

D) S_R ve S_L yi birlikte kapatmak

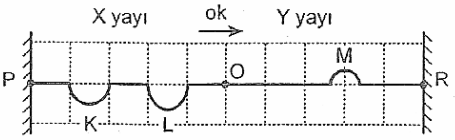
E) S_R ve S_C yi birlikte kapatmak

Diğer sayfaya geçiniz.

8.



Şekil I



Şekil II

O noktasında uç uca eklenmiş, farklı kalınlıktaki X ve Y yayları P, R duvarları arasına gerilmiştir. $t_0 = 0$ anında hareket yönleri ve biçimleri Şekil I deki gibi olan iki atmanın, t_1 anında Şekil II de belirtilen K, L, M atmalarına dönüşmüş olduğu görülüyor.

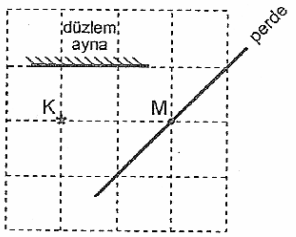
Buna göre, K, L, M atmalarından hangilerinin hareketi ok yönündedir?

A) Yalnız K nin B) Yalnız L nin

C) Yalnız M nin D) K ve L nin

E) L ve M nin

9.



Şekildeki düzenekte noktasal K ışık kaynağının perdedeki M noktası çevresinde oluşturduğu aydınlanma şiddeti, düzenekte düzlem ayna varken E_1, düzlem ayna yokken de E_2 oluyor.

Buna göre, $\frac{E_1}{E_2}$ oranı kaçtır?

$\left(\sin 45^\circ = \cos 45^\circ = \frac{\sqrt{2}}{2}\right)$

A) $\frac{1}{2}$ B) $\frac{1}{\sqrt{2}}$ C) $\frac{3}{2}$

D) $1+\frac{1}{\sqrt{2}}$ E) $2+\frac{1}{\sqrt{2}}$

10. Karanlık odada yapılan bir Young deneyinde (çift yarıkta girişim) kullanılan ışık kaynağı, yalnız tek dalgaboylu kırmızı ile tek dalgaboylu yeşil renklerin karışımından oluşan ışık yayıyor.

Bu deneyde kullanılan beyaz perdede, aşağıdakilerden hangisi oluşmaz?

A) Kırmızı aydınlık saçak

B) Yeşil aydınlık saçak

C) Sarı aydınlık saçak

D) Beyaz aydınlık saçak

E) Karanlık saçak

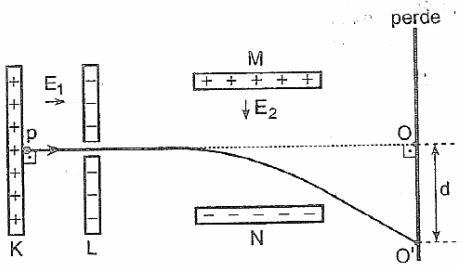
11. Compton olayında, λ dalgaboylu bir foton, elektronla etkileştikten sonra, momentumunun büyüklüğünün $\frac{1}{3}$ ünü kaybederek saçılıyor.

Buna göre, saçılan fotonun dalgaboyu kaç λ dır?

A) $\frac{4}{9}$ B) $\frac{2}{3}$ C) 1 D) $\frac{9}{4}$ E) $\frac{3}{2}$

Diğer sayfaya geçiniz.

12.



Düşey kesiti şekildeki gibi olan düzenekte, iletken K, L levhaları arasındaki elektrik alanının büyüklüğü E_1, iletken M, N levhaları arasındakinin de E_2 dir. K levhası önünden ilk hızsız harekete başlayan bir proton d kadar saparak, perdeye O' noktasında çarpıyor.

Levhaların ve perdenin konumlarını değiştirmeden, E_1 ve E_2 için aşağıdaki işlemlerden hangisi yapılırsa d uzaklığı <u>kesinlikle küçülür</u>?

A) Yalnız E_1 i azaltmak

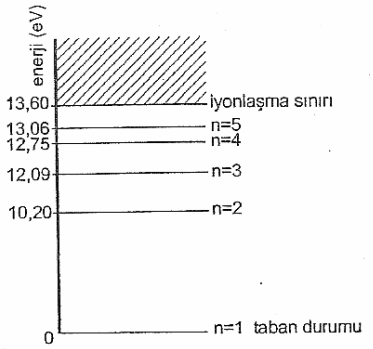
B) Yalnız E_1 i artırmak

C) Yalnız E_2 yi artırmak

D) Hem E_1 i hem de E_2 yi azaltmak

E) E_1 i azaltıp E_2 yi artırmak

13.



Hidrojen atomunun enerji düzeylerinden bazıları şekildeki gibidir. Hızlandırılmış bir elektron, taban enerji durumundaki 2 hidrojen atomu ile etkileşiyor.

Bu hidrojen atomlarının ikisinin birden iyonlaşabilmesi için, elektronun <u>en az</u> kaç eV luk kinetik enerji taşıması gerekir?

A) 27,20 B) 26,12 C) 25,50

D) 24,18 E) 20,40

Diğer sayfaya geçiniz.

14. Bir X_2 gazının 0,5 molü, aynı mol sayısında Y_2 gazıyla tam olarak birleşip potansiyel enerjisi 70 kkal/mol olan X_2Y_2 bileşiğini oluşturmuş ve tepkime sonucunda 200 kkal ısı açığa çıkmıştır.

Buna göre,

I. X_2Y_2 bileşiğinin oluşum entalpisi 400 kkal/mol dür.

II. Tepkimeye girenlerin potansiyel enerjisi 470 kkal dir.

III. Tepkime ısısı (ΔH) 200 kkal/mol dür.

yargılarından hangileri doğrudur?

A) Yalnız II B) Yalnız III C) I ve II

D) II ve III E) I, II ve III

15. **Aşağıdakilerin hangisinde verilen I. çözeltiyle II. çözelti eşit hacimlerde karıştırıldığında, oluşan çözeltinin pH si 7 olur?**

(Oluşan çözeltinin hacmi, karıştırılan çözeltilerin hacimlerinin toplamına eşittir.)

	I. çözelti	II. çözelti
A)	pOH = 1	$[H^+] = 1x10^{-13}$ M
B)	pH = 2	$[H^+] = 1x10^{-2}$ M
C)	pH = 13	$[OH^-] = 1x10^{-1}$ M
D)	pH = 4	pH = 10
E)	pH = 3	pOH = 11

16. İki basamaktan oluşan bir tepkimedeki yavaş ve hızlı adımların tepkime denklemleri şöyledir:

$X(g) + Y_2(g) \rightarrow XY_2(g)$ yavaş

$XY_2(g) + X(g) \rightarrow 2XY(g)$ hızlı

Bu tepkimeyle ilgili aşağıdaki ifadelerden hangisi doğrudur?

A) Toplam tepkime denklemi; $2X(g) + Y_2(g) \rightarrow 2XY(g)$ dir.

B) Tepkimenin hız bağıntısı $T_H = k[XY_2][X]$ tir.

C) Tepkimenin hızı Y_2 nin derişimine bağlı değildir.

D) Yavaş adımda eşik enerjisini geçen molekül sayısı daha fazladır.

E) Sıcaklık değişimi tepkimedeki basamakların hızını etkilemez.

17. Kimyasal bir denge tepkimesinde tepkime kabının hacmi değiştirildiğinde dengenin etkilenmediği, aynı tepkimede sıcaklık artırıldığında ise denge sabitinin büyüdüğü bilinmektedir.

Bu denge tepkimesi aşağıdakilerden hangisi olabilir?

A) $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) + 22,0$ kkal

B) $C(k) + H_2O(g) \rightleftharpoons CO(g) + H_2(g)$ $\Delta H = +31,4$ kkal/mol

C) $N_2(g) + O_2(g) + 43,5$ kkal $\rightleftharpoons 2NO(g)$

D) $2SO_3(g) \rightleftharpoons 2SO_2(g) + O_2(g)$ $\Delta H = -47,0$ kkal/mol

E) $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$ $\Delta H = -4,0$ kkal/mol

Diğer sayfaya geçiniz.

18. X ile Y nin indirgenme gerilimleri şöyledir:

$X^{+2}(suda) + 2e^- \rightarrow X(k) \quad E^\circ = -0,40\ V$

$Y^{+2}(suda) + 2e^- \rightarrow Y(k) \quad E^\circ = 0,80\ V$

Buna göre, X ve Y ile oluşturulan X – Y piliyle ilgili aşağıdaki ifadelerden hangisi yanlıştır?

A) X yükseltgenir, Y^{+2} indirgenir.

B) X elektrodu katot, Y elektrodu anottur.

C) Çözeltideki Y^{+2} iyonlarının derişimi zamanla azalır.

D) X elektrodunun kütlesi zamanla azalır.

E) Dış devrede elektronlar X ten Y ye doğru gider.

19. **Alkanlarla (C_nH_{2n+2}) ilgili aşağıdaki ifadelerden hangisi yanlıştır?**

A) Karbon atomu sayısı ardışık olan iki alkan molekülü arasındaki fark CH_2 dir.

B) Karbon atomları sp^3 hibritleşmesi yapar.

C) İki farklı alkil halojenür kullanılarak Würtz senteziyle üç değişik alkan elde edilebilir.

D) Apolar yapılarından dolayı suda çözünmeleri beklenmez.

E) Karbon sayısı üç olan alkanın iki yapı izomerisi vardır.

20. Kapalı formülü C_4H_6 olan X ve kapalı formülü C_4H_8 olan Y bileşikleri düz zincirli doymamış hidrokarbonlardır. Uygun koşullarda, bir mol X e bir mol H_2O nun katılma tepkimesi sonucunda keton, bir mol Y ye bir mol H_2O nun katılma tepkimesi sonucunda ise alkol bileşiklerinin oluştuğu bilinmektedir.

Buna göre,

I. Bir mol X e iki mol HBr katılır.

II. X iki tane π bağı, Y ise bir tane π bağı içerir.

III. Bir mol Y ye bir mol H_2 katıldığında n-bütan oluşur.

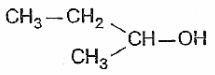
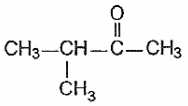
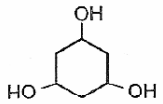
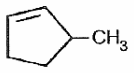
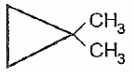
yargılarından hangileri doğrudur?

A) Yalnız II B) Yalnız III C) I ve II

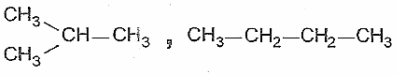
D) I ve III E) I, II ve III

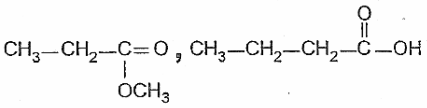
Diğer sayfaya geçiniz.

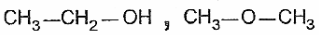
21. **Aşağıda yapısal formülleri verilen bileşiklerden hangisinin IUPAC sistemine göre adı karşısında verilen değildir?**

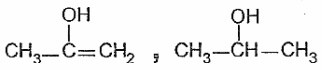
	Yapısal formülü	Adı
A)		2-Bütanol
B)		2-Metil-3-bütanon
C)		Siklohekzan-1,3,5-triol
D)		3-Metilsiklopenten
E)		1,1-Dimetilsiklopropan

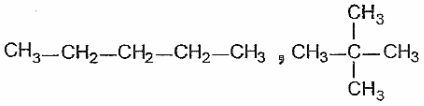
22. **Aşağıdakilerin hangisinde verilen iki bileşik birbirinin yapı izomeri değildir?**

A) 

B) 

C) 

D) 

E) 

Diğer sayfaya geçiniz.

23. **Fotosentezde aynı klorofil molekülünün tekrar tekrar kullanılabilmesini aşağıdakilerden hangisi sağlar?**

A) Ortamda ADP moleküllerinin bulunması

B) Oksijenin sudan ayrılması

C) Yüksek enerjili elektron enerjilerinin ATP lerde tutulması

D) P ~ 5C ~ P bileşiğinin serbest karbondioksiti tutması

E) Elektron taşıma sistemine elektron aktarılması

24. **Stomaların gece kapanmasını, kilit hücrelerinde,**

I. glukozun nişastaya çevrilmesi,

II. ozmotik basıncın düşmesi,

III. hücre içinde karbondioksit birikmesi,

IV. suyun komşu epidermis hücrelerine geçmesi

olaylarının hangi sırayla gerçekleşmesi sağlar?

A) I – II – IV – III B) II – III – I – IV

C) III – I – II – IV D) IV – I – II – III

E) IV – II – III – I

25. **Kapalı tohumlu diploit bir bitkide,**

I. mikrospordan tüp çekirdeğinin oluşması,

II. triploit endosperm çekirdeğinin oluşması,

III. zigottan embriyo oluşması,

IV. üretken (generatif) çekirdekten sperm çekirdeklerinin oluşması

olaylarından hangileri mitozla gerçekleşir?

A) I ve II B) II ve III C) II ve IV

D) I, III ve IV E) II, III ve IV

26. **İnsanda, kan plazmasının ozmotik basıncının artması, aşağıdakilerden hangisine neden olur?**

A) Atılan idrar miktarının azalmasına

B) Kanda glukoz miktarının artmasına

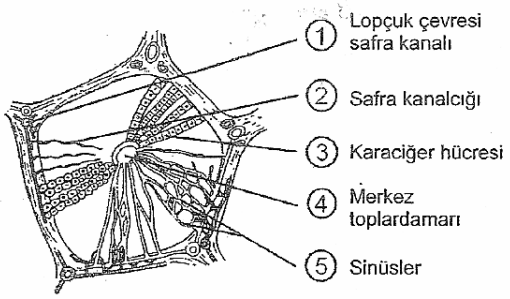
C) İdrarda glukoz miktarının azalmasına

D) İdrarla atılan tuz miktarının artmasına

E) İdrarla atılan üre miktarının artmasına

Diğer sayfaya geçiniz.

27.



Yukarıdaki şemada, insan karaciğerini oluşturan lopçuklardan biri, numaralanmış bazı damarları, kanalları ve bir kısım hücreleriyle gösterilmiştir. Karaciğerin lopçuklarında gerçekleşen olaylar arasında,

I. üretilen safra sıvısının uzaklaştırılması,

II. depolanmış öncül A vitamininden oluşturulan A vitamininin kan dolaşımına gönderilmesi

olayları da vardır.

Lopçuklarda I. ve II. olaylarla ilgili madde akışının gerçekleştiği yapılar ve bu yapıların madde akışına göre sıralanışı aşağıdakilerin hangisinde doğru olarak verilmiştir?

	I. olay	II. olay
A)	1 → 2 → 3	3 → 2 → 4
B)	2 → 4 → 5	1 → 4 → 3
C)	3 → 5 → 4	2 → 3 → 1
D)	3 → 2 → 1	3 → 5 → 4
E)	4 → 3 → 1	5 → 2 → 4

28. Botoks, insanda uygulandığı bölgede sadece motor sinirlerdeki iletimi engellemek için kullanılan bir maddedir.

Buna göre, botoks, uygulandığı bölgede,

I. uyarıların alınarak merkezi sinir sistemine iletilmesi,

II. tepki organında cevap oluşması,

III. uyarıların merkezi sinir sisteminde algılanması

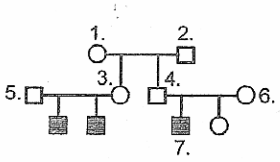
işlevlerinden hangilerini engeller?

A) Yalnız I B) Yalnız II C) Yalnız III

D) I ve II E) II ve III

Diğer sayfaya geçiniz.

29.



□: Fenotipinde, izlenen özellik görülmeyen erkek birey

○: Fenotipinde, izlenen özellik görülmeyen dişi birey

▩: Fenotipinde, izlenen özellik görülen erkek birey

Yukarıdaki soyağacı, eşeye bağlı olarak kalıtılan bir özelliği göstermektedir.

İzlenen özellik bakımından, bu soyağacındaki bireylerle ilgili aşağıdaki ifadelerden hangisi doğrudur?

A) 1. ve 6. bireylerin izlenen özellikle ilgili genotipleri aynıdır.

B) 2. ve 4. bireylerin izlenen özellikle ilgili genotipleri farklıdır.

C) 3. bireyde izlenen özellikle ilgili allel bulunmaz.

D) 5. birey taşıyıcıdır.

E) 7. birey homozigottur.

30. Himalaya tavşanlarında kuyruk, kulak ve ayak uçları siyah, vücudun diğer kısımları beyaz renklidir. Bir deneyde, bir Himalaya tavşanının sırt bölgesindeki bir alan tıraş edilip bu kısma buz yastığı konmuştur. Bu bölgede yeni çıkan kılların siyah olduğu görülmüştür.

Deneyin bundan sonraki aşamalarında:

I. Yukarıda sözü edilen tavşan, sırt bölgesinde çıkan siyah kıllar tıraş edildikten sonra, doğal ortama bırakıldığında bu bölgede tekrar beyaz kılların çıkması

II. Başka bir tavşanın sırt kılları tıraş edilip bu bölgeye sıcak yastık uygulanması sonucunda bölgede beyaz kılların çıkması

III. Sırtında siyah bölge oluşturulan başka bir tavşanın doğal üreme ortamında üremesiyle oluşan yavruların kıl renklerinin Himalaya tavşanlarının normal kıl renklerinde olması

durumunda, bunlardan hangileri modifikasyon kanıtı olarak kullanılabilir?

A) Yalnız I B) Yalnız II C) Yalnız III

D) I ve III E) II ve III

FEN BİLİMLERİ–2 TESTİ BİTTİ.