A STUDY OF THE CORRELATIONS OF SPECIFIED EXAMINATIONS IN THE ORIENTATION PROCEDURE TO GRADES IN FRESHMAN CHEMISTRY

by

NORMAN DALE ROGERS

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INTRODUCTION

This study had its origin in the thesis of Guy Burger Homman which was submitted at Kansas State College in May, 1950. In this thesis Mr. Homman made several recommendations for a plan of segregation to be followed in placing students in sections according to their ability. The Chemistry Department studied his recommendations and adopted a plan which embodied some of his proposals. Because this plan applied to the population studied in this work, it was thought advisable to present the details of the plan.

During freshman orientation week all freshmen enrolled in a curriculum which included Chemistry I were given the Iowa Placement Chemistry Aptitude Examination. This test was introduced into the freshman test battery specifically for segregating Chemistry students. Students who ranked at and above the fiftieth percentile on total score were placed in the "A" group. Those who ranked below this level were put in the "B" group. The student had no option as to the group in which he would be placed.

This segregation extended to the recitation and laboratory sections but not to the lecture sections. Instructors put emphasis on fundamentals in group "B", while in group "A" the instructor assumed that the students already had a working knowledge of the fundamentals of chemistry and dwelt more on the theory and application of chemistry.

All students used the same text book and took the same lecture examinations. Examinations were not given in the recitation sec-

tions. Different laboratory manuals were used by the two groups, creating a necessity for the administration of separate laboratory examinations to the two groups.

Each laboratory instructor submitted a final average in terms of a percentage grade for each student to the head of the department. Results of each lecture examination were reported to the same office in the same form.

Final grades were computed by the head of the department. The lecture examinations were weighted in such a manner that they amounted to three-fourths of the final percentage grade. The percentage grades for all students were placed on one curve from which the final letter grade was determined. The above are the unique characteristics of the population studied.

The purpose of this thesis was three-fold. The first and major purpose was to see how closely the segregating instrument, the Iowa Placement Chemistry Aptitude Examination, correlated with final grades in Chemistry I. It was also deemed advisable to compare the effectiveness of the Iowa Placement Examination with the American Council on Education Psychological Examination which was already in the battery of tests given to freshmen entering Kansas State College. The ultimate purpose of this comparison was to determine if the introduction of the Iowa Placement Examination as a segregating instrument was justified or if the ACE might not have been used for the same purpose. The third purpose was to attempt to find some of the intervening variables which lower the effectiveness of statistical prediction. It was thought that this might be accom-

plished by interviewing a sample of those who markedly exceeded expectations as shown by the Iowa Placement Examination and those who failed to meet expectations by the same criterion. The records of the Counseling Bureau concerning these individuals were also to be utilized in an attempt to give a more complete picture of the individual and develop something of a case study.

METHODS

All freshmen who enrolled in Chemistry I in the fall semester of 1950 and completed the course were included in the population studied. The number of students comprising the population was two hundred nineteen.

The final percentage grades in Chemistry I were compared with Iowa Placement Examination results through the use of the product-moment method of computing the coefficient of correlation. Not only was this comparison made using the total raw score versus final grades, but it was also made for the raw scores on each sub-test as opposed to final grades. A similar comparison was made of final grades and total raw scores and sub-test raw scores on the ACE.

Since the population studied was somewhat unique, it was felt that some device should be used to show how this population would compare to other populations. The ninety-five percent confidence interval was chosen because it indicates that ninety-five times out of one hundred the correlation would fall within certain calculated limits.

It was also felt that the significance of the difference be-

tween the correlations for total raw scores on the two examinations when compared to final grades should be computed. The level of confidence was computed to meet this need.

This study did not attempt to sort out all over- and under-achievers. Only a few cases of marked discrepancy were chosen as tentative subjects for study. These were selected by surveying the scattergram of total raw scores on the Iowa Placement Examination versus final percentage grades. Two over-achievers and two under-achievers were selected for study from this small group. One more student was studied as a special case to show the dangers of mis-classification in the segregation system.

No set form of interview was used. The student was assured that all information was confidential and that he would not be identified in any manner in the thesis. He was asked to tell anything which he felt might account for the discrepancy between his indicated aptitude and his final grade. The interviews were allowed to progress freely at the interviewer's discretion. All cooperated quite willingly, conversing from fifteen minutes to one-half hour.

The Counseling Bureau record folders of the students were then consulted. Information such as entrance examination scores, past academic record, et cetera was synthesized with the interview results to present case studies of the individual.

REVIEW OF RELATED LITERATURE

Several studies were found pertaining to a previous edition of the Iowa Placement Examination. Correlations between this test and

final grades seemed to range from $\neq .57$ to $\neq .26$. Cornog and Stoddard (1) indicated that they found a range of from $\neq .57 \pm .04$ to $\neq .26 \pm .14$. Reusser (6) also reported a correlation of $\neq .570 \pm .053$ between chemistry aptitude and marks in chemistry. However, the correlations seem to group around $\neq .40$ to $\neq .45$. Studies by Cornog and Stoddard (1) and Smith and Trimble (8) show this tendency. Cornog and Stoddard reported a grouping around $\neq .44$ and Smith and Trimble found the grouping tendency at $\neq .42$. The University of California, as indicated in correspondence quoted by Homman (3), claims a correlation of $\neq .62$ between final grades and the placement test in use there. However, this test is not identified.

Studies relating the ACE to overall grades are numerous. However, few studies have been made that show the relationship existing between the ACE and grades in specific courses. Wallace (9) reported a correlation between the quantitative or Q-score and chemistry grades of $\neq .426$. Between verbal or L-score and grades the correlation was $\neq .374$. The total score or T-score showed a correlation of $\neq .453$ with grades.

Osborne et al. (5) reported a correlation of $\neq .43$ between Q-score and chemistry grades, $\neq .46$ between L-score and grades, and $\neq .44$ between T-score and grades. An interesting part of his study was the separation of the sample into males and females. He found that the ACE showed a better correlation to the grades of females than it did to the grades of males. Using the Q-score he found the correlation for females to be $\neq .47$, while for males

it was $\neq .42$. Using the L-score he found the correlations to be $\neq .56$ and $\neq .43$, respectively. For the T-score the result was $\neq .58$ and $\neq .42$, respectively. These differences were found to be significant at the .01 level of confidence.

Homman (3) studied a random sample of Kansas State College students and found the T-score on the ACE yielded a correlation of $\neq .50$ with chemistry grades. Merzebacher (4) reported that Q-score and grades showed a correlation of $\neq .447 \pm .058$.

These studies as a group would seem to indicate that the usual correlation between ACE and grades falls between $\neq .420$ and $\neq .500$ if we disregard Osborne's study of correlation for females separately.

Gerberich (2) reported a study which might be of some significance to this work. He correlated the T-score on the ACE with grade point averages of freshmen for the first semester. This study was made over a period of three years. For the first year of the study he found a correlation of $\neq .463$; the second year correlation was the highest-- $\neq .576$; the third year yielded a correlation of $\neq .546$.

These students were all given a questionnaire to fill out. The group that failed to achieve at the expected level as predicted by the ACE was compared to the group that exceeded expectations. The low group consistently indicated that they more frequently had difficulty paying attention in class, had difficulty taking notes, both in class and over reading assignments, had trouble

interpreting graphs found in their reading assignments, belonged to a fraternity or sorority, played freshman football or intramural sports, and found college work much harder than high school work.

The high group indicated that they handed in all assignments on time, crammed for examinations, had a quiet place for study at home or studied in the library, had a car for use at any time, played freshman basketball, liked their subjects and instructors, and got a square deal in all their courses.

No significant difference in the group was found on such things as feeling tired, illnesses resulting in absences, nervousness during examinations, and working to meet part of their expenses.

RESULTS OF RESEARCH AND DISCUSSION

The results of statistical analysis of data collected concerning the Iowa Placement Examination are found in Table 1.

Table 1. Correlations of the Iowa Placement Chemistry Aptitude Examination total raw scores and sub-test raw scores vs final percentage grades in Chemistry I and the ninety-five percent confidence interval for each correlation.

	Correlation	Ninety-five percent confidence interval
Total raw score	±.66	±.58 to ±.73
Mathematics	±.52	±.42 to ±.61
Formulation	±.47	±.36 to ±.56
Chemistry information	±.47	±.35 to ±.56
Reading	±.46	±.35 to ±.56

Reading from Table 1, it is found that the total raw scores on the Iowa Placement Examination yielded a correlation with final percentage grades in Chemistry I of ⨍.66 and that the ninety-five percent confidence interval ranged from ⨍.58 to ⨍.73. This would mean that ninety-five times out of one hundred the correlation would be between ⨍.58 and ⨍.73. When the raw scores on the mathematics sub-test were correlated with final grades the result was ⨍.52 with a confidence interval of from ⨍.42 to ⨍.61. The result obtained when the formulation sub-test raw scores were correlated with final grades drops to ⨍.47 as it does for the chemistry information sub-test. However, on the former the confidence interval is from ⨍.36 to ⨍.56 and on the latter the lower limit drops to ⨍.35. When the reading sub-test was compared to final grades the resulting correlation was ⨍.46 with a confidence interval of ⨍.35 to ⨍.56.

Table 2 contains the results of statistical analysis of the data collected concerning the ACE.

Table 2. Correlations of the American Council on Education Psychological Examination total raw scores and its sub-test raw scores vs. final grades in Chemistry I and the ninety-five percent confidence interval for each correlation.

	: Correlation	: Ninety-five percent confidence interval
Total raw score	⨍.45	⨍.34 to ⨍.54
Quantitative	⨍.38	⨍.26 to ⨍.49
Verbal	⨍.36	⨍.24 to ⨍.47

Reading from Table 2, it is found that the total raw scores on the ACE yielded a correlation of ⁄.45 with final percentage grades in Chemistry I and had a ninety-five percent confidence interval of ⁄.34 to ⁄.54. When the quantitative score was correlated with final grades the result was ⁄.38 with a confidence interval of ⁄.26 to ⁄.49. The verbal score yielded a correlation of ⁄.36 with a confidence interval of ⁄.24 to ⁄.57.

Certain features are at once evident from an examination of the tables. The correlation found with the Iowa Placement Examination was higher than that found for the ACE. Next it is seen that all sub-tests of the Iowa Placement Examination yielded correlations higher than that for the total on the ACE although the correlations for the formulation, chemistry information, and reading sub-tests are not significantly higher. The close agreement of the confidence interval would indicate that these results might quite easily be reversed with the total on the ACE yielding a higher correlation than the sub-tests on the Iowa Placement Examination.

It would be less probable that the correlation using the mathematics sub-test would ever fall below the correlation found using total score on the ACE due to the smaller amount of overlap existing between the respective confidence intervals. The fact that there is no overlap between the confidence intervals of correlations found using total scores on both tests would seem to indicate that there is little probability that the ACE would ever yield a higher correlation with chemistry grades than the

Iowa Placement Examination. This postulate is further borne out by the fact that the difference in the correlations is found to be significant at the .001 level of confidence.

CASE STUDIES AND DISCUSSION

It will be remembered that an attempt was to be made to determine some of the factors which intervene between a student's indicated aptitude and his grades through the use of case studies. The case studies which follow attempt to provide the reader with a picture of the individual in his present college environment. These students are special cases and were selected for study because they were special cases. This fact should constantly be before the reader as he studies the following cases.

Cases of Over-Achievement

The first case to be studied is that of student number one hundred ninety-six (Appendix, Table 3), an over-achiever according to the criterion utilized. He enrolled in the Pre-Veterinary course and was nineteen years old when he entered Kansas State College. He came from a farm family. One of his brothers was enrolled in the Veterinary School at Kansas State College.

His high-school grades were "S's" and "M's" indicating that he was a student who received some grades of superior and some of average. He ranked thirty-first in a graduating class of sixty. He was active in athletics, captaining both the football and basketball teams. His high school principal remarked that

he was "one of the most outstanding boys that has graduated from this school."

On the Individual Record Form filled out by all freshmen, he indicated the following as his occupational choices: (1) Doctor of Veterinary Medicine, (2) Doctor of Medicine, (3) Farmer, and (4) Agricultural Agent. He indicated that he had extensive information about his chosen occupation and that he was quite certain of his choice.

He also indicated that he was a slow reader. He checked that he liked shop-work and athletics. The only extra-class activity in which he indicated a desire to participate was intramural athletics.

In another section of the Individual Record Form the student is requested to check any problems which might apply to him. He checked: (1) I have too few social contacts, (2) I do not know how to take good lecture notes, and (3) I usually have difficulty understanding what I read.

He did not achieve too well on his entrance examinations. His rank on the ACE was at the fifteenth percentile. On the Cooperative English Achievement test he ranked at the third percentile. His feeling that he was a slow reader and did not understand what he read was borne out by the Diagnostic Reading Test. He ranked at the fourth percentile as to speed and at the fifth percentile as to comprehension. He enrolled in the Reading Clinic operated by the Counseling Bureau in an attempt to better his reading skills.

The Strong's Vocational Interest Blank showed his major in-

terests to lie in the agricultural-technical fields. Also, relatively strong interests were indicated in the art-medical and social service fields. His interest maturity was at the sixteenth percentile.

The Minnesota Personality Scale scores were all below average indicating that he had not made a very satisfactory adjustment. The socialization score was at the thirty-fifth percentile.

On the basis of his rank at the nineteenth percentile on the total score of the Iowa Placement Examination he was placed in a "B" group of recitation and laboratory in chemistry. His final grade was seventy-nine percent or "B", and the scattergram showed him to be an over-achiever. However, he did not attain this distinction in some of his other courses as his grade point average for the semester was .5000.

When interviewed, he stated that he had taken no high school chemistry. As to the course at Kansas State College, he thought that the laboratory sessions contributed much to his learning effort because "it is easier to learn about things if you can work with them." The students in his corner of the laboratory spent quite a bit of time discussing why the experiments came out as they did. He stated he was very interested in chemistry or in any science and that made him more willing to put in time on chemistry rather than some other course.

He felt he learned the most, however, by trying to help a friend who was having trouble with chemistry. After discussing it with his friend he was aware of the things he didn't understand and could ask his instructor to explain those points to him.

Here then is a boy whose test results would indicate only moderate success with course work and his grade-point average for the semester bears that out. Yet it is found that his grade in chemistry exceeds expectations. Why? Does his lack of socialization cause him to compensate by studying? Maybe, but why don't his other grades show the results if this is true? He seems to have solved the problem when he stated in his interview that he was interested in chemistry and spent more time on it. Evidently he was motivated to study Chemistry and not other courses.

The other case of over-achievement was a twenty-two year old married veteran. He is number ninety-seven in Table 3 in the Appendix. The son of a steel-worker, he was enrolled in the Pre-Veterinary curriculum. His record folder was unavailable so information from his Individual Record Form is missing.

The high school record of this man shows that he made mostly "C's" with an occasional "B", "A", and "D". He was graduated fifty-sixth in a class of one hundred and three, indicating a student of average achievement.

His rank at the forty-fifth percentile would also indicate that he was of about average ability as compared to other college freshmen. On the Cooperative English Achievement test he dropped to the eighteenth percentile. On the Diagnostic Reading test he ranked at the forty-seventh percentile in speed and at the thirty-first percentile as to level of comprehension. He enrolled in the reading clinic during the semester to try to improve his

reading ability. The Minnesota Personality Scale indicated that he was emotionally well balanced though under-socialized.

The Strong's Vocational Interest Blank indicated that his major interests most resembled those of men in the field of sales. Art-medicine was second with agricultural-technical third as to strength of interests.

Because of his rank at the thirty-fourth percentile on the Iowa Placement Examination he was placed in the "B" group of recitation and laboratory. The scattergram showed that his final grade of eighty percent or "B" was a distinct over-achievement.

His interview added but little information. He had taken chemistry in high school about seven years previously, but felt that he had gotten little out of it. He felt that the Reading clinic might be helping him by teaching him better methods of study. He stated that he had to get a good grade in chemistry because it would contribute heavily to his grade point average if he were to get into Veterinary School. He let other courses go to study chemistry and as a result his semester grade point average was 1.2143 despite his "B" in Chemistry I.

Although very little information was available on this boy it seems that it was a case of high motivation in Chemistry with again the possibility of the influence of under-socialization.

Cases of Under-Achievement

The next case to be taken up is one of under-achievement.

Student number one hundred and four in Table 3, Appendix, was enrolled in Milling Administration. He came from a small family in a Kansas town where his father was self-employed as a pharmacist. During the first semester he had no contact with his freshman adviser.

His high school record is rather undistinguished. His grades were mostly "B's" and "C's" and he ranked one hundred thirteenth in a graduating class of one hundred forty-four.

In his Individual Record Form he indicated that he did not consider himself to be a slow reader and also indicated that his study habits were average.

As to occupational preference he indicated the following choices: (1) working in the business office of a milling company, (2) accountant, (3) office manager, (4) Certified Public Accountant, and (5) Chemistry lecturer. However, he indicated that he was uncertain as to his choice and had been influenced in making his choice by numerous friends who were already enrolled in Milling Administration at Kansas State College.

On the check-list of problems he checked the following items: (1) I have been unable to determine how much I should study, (2) I am unable to determine what I would like to do, and (3) I have trouble making myself study.

According to the ACE, this boy had ability somewhat better than the average of college freshmen as he ranked at the sixty-second percentile on this test. On the Cooperative English Achievement test he ranked at the forty-fifth percentile. On

the Diagnostic Reading test he ranked at the fifty-seventh percentile in reference to speed and at the forty-seventh percentile as to level of comprehension.

The Minnesota Personality Scale shows a well adjusted individual with an exceptionally high socialization score (ninety-seventh percentile) indicating over-socialization. No record was made of this boy's ever having been administered the Strong's Vocational Interest Blank.

His rank at the ninety-first percentile on the Iowa Placement Examination caused him to be placed in the "A" group of both recitation and laboratory. His final grade in the course was sixty percent or "D". On the basis of the scattergram he was chosen for study as an under-achiever.

In the interview he told that he had taken a high school chemistry course that was one of the best in the state. Although he made only a "C" in the course he learned enough to "get by" in college chemistry without studying and proceeded to do so. He felt that it was his own fault that he got a low grade in the course since he did not study; he could see no need to study if he could "get by". This attitude must have extended to other courses as he gained no grade points for the semester.

He stated that his laboratory instructor was not well liked by the class as a whole but that he had no complaint. The atmosphere of the laboratory was not conducive to learning--everyone rushed through the experiments so that they could get home.

There is some indication that this boy might be too well

socialized for his own good. His score on the Minnesota Personality Scale indicates this as do two of the three problems checked on the Individual Record Form. Another clue might be found in his indecision as to an occupational choice.

The essential feature of the case seems to be lack of motivation. The boy had a good chemistry course in high school from which he learned much, although making a "C". This is attested to by the fact that he ranked at the ninety-first percentile on the Iowa Placement Examination in Chemistry. Finding that his previous training was sufficient to allow him to "get by" in college chemistry, he was quite content to go through the course without working.

The other case of under-achievement studied was that of an eighteen year old boy enrolled in Agriculture (number one hundred thirty-six, Table 3, Appendix). His father was director of International General Electric in Rio de Janerio, Brazil.

He indicated that he had spent much time in Brazil and felt sorry for the farmers there. He would like to go to Brazil to work at farm improvement in an effort to show these people better methods of farming. He indicated that he was very certain of this choice of occupation and had extensive information about it.

The only problem that he checked was that he had trouble determining how much time to devote to his studies. His freshman adviser noted that the boy had trouble developing good study habits and seemingly spent too much time in fraternity and social activities.

On the ACE this boy ranked at the fifty-fifth percentile indicating slightly above average ability. His Cooperative English Achievement test rank was at the forty-ninth percentile. His Diagnostic Reading test rank was at the forty-fourth percentile as to speed and at the twenty-fifth percentile as to level of comprehension. The Strong's Vocational Interest Blank indicated that his major interests were in the agricultural-technical field with relatively strong interests in social service. The Minnesota Personality Scale of low emotional adjustment and above average socialization.

On the basis of his rank at the ninety-third percentile on the Iowa Placement Examination he was placed in an "A" group in recitation and laboratory. His final grade was seventy-four percent or "C". The scattergram showed him to be a marked case of under-achievement.

In the interview this boy stated that he had taken high school chemistry and that he felt that should have enabled him to get a good grade in chemistry at college. However, he felt that the adjustment was too great for him to make in his first semester. He indicated that one specific adjustment was learning to take good notes in class.

His laboratory section was similar to the one mentioned in the previous case. The instructor let the students go as soon as they had finished the experiment. Consequently, the students rushed through the experiments as rapidly as possible with little thought as to the meaning of them.

He felt that his recitation instructor was good and that it was there he gained what little information he did acquire. He felt that he could have gotten a good grade in chemistry if he had tried but that he was just content to "drift along with the class." Evidently he was content to "drift" in some other courses, too as his first semester grade point average was .9333.

It seems possible that this boy might be trying to fulfill some emotional need through social activities. His Minnesota Personality Test shows some indication of this and the comment of his freshman adviser lends further credence to the idea. However, the most manifest clue shown is lack of motivation.

A Case of Misclassification

The final case is that of student one hundred eighty-seven in Table 3, Appendix. This boy was misclassified when the students were segregated at the first of the semester. Since this case is given only to show some of the results of misclassification the Counseling Bureau record folder was not used.

On the ACE he ranked at the thirteenth percentile, the same as his rank on the Cooperative English Achievement test. The Diagnostic Reading test results ranked him at the eighth percentile on speed and the tenth percentile as to level of comprehension. On the Iowa Placement Examination his rank was at the first percentile.

Despite his low rank on the Iowa Placement Examination he was placed in an "A" group in recitation. He was correctly placed

in a "B" laboratory. His final grade in the course was fifty-one percent and he was given a condition. He elected to take the course over.

In the interview he told of how he felt the recitation group in which he was placed lowered his level of achievement. All other students in his section had taken high-school chemistry. The recitation instructor didn't teach any of the fundamentals and talked about things he couldn't understand. Since the rest of the class had taken chemistry in high-school they could understand the instructor's lectures. He said that he asked very few questions in class because the instructor and other students made him feel stupid--after all he was the only one in the class who didn't understand the basic fundamentals about which he needed to ask questions. He tried to get help from the recitation instructor after class but the explanations were still beyond his level of comprehension.

He felt that his laboratory instructor was very good to him and patient with him. Late in the semester he found out that this instructor was willing and able to help him and he immediately took advantage of this aid. When he finally started getting help his test grades rose to "C's", but it was too late in the semester to do him any good as far as passing the course was concerned. At the time of the interview the student was retaking the course and making an "A".

On the scattergram, this student's final grade, though not passing, showed as an over-achievement. It is felt by this writer that his achievement was extraordinary considering the handicap

under which he was forced to operate.

The trends found in the interviews are interesting to note even though they cannot be accepted as proven traits of their respective groups. It can be noted that both under-achievers came from the "A" group and both over-achievers from the "B" group. It is recognized by the writer that the selection of cases through use of the scattergram is a strong factor in this trend.

Both over-achievers were Pre-Veterinary students, enrolled in Reading Clinic, were below average on the ACE, were in a "B" group and seemed to be under-socialized.

Both under-achievers were in an "A" group, took high school chemistry, were above average on the ACE, were in laboratory sections that were not conducive to learning, and seemed to be over-socialized.

The main trend seems to lie in the difference in motivation, shown by the two groups. The interviews with both over-achievers seemed to indicate that these boys had expended much extra effort in an attempt to raise their chemistry grades. Both under-achievers seemed to be quite content to take low grades in the course and put forth little effort.

CONCLUSIONS

In the light of previous studies reported it would seem that the correlation found for the Iowa Placement Examination was relatively high. The correlation found in this study was $\neq .66$ while the

best correlation previously reported was .62 at the University of California as quoted by Homman (3). This correlation seems to be quite high when considered in relation to the fact that most people feel that the correlation of a single test to final grades can seldom exceed .70 (7).

When the ACE correlations are compared to other studies, the population studied here is seen to be similar. The range indicated by previous studies of the ACE and chemistry grades was .42 to .50. The correlation found by this study was .45.

When the results of the Iowa Placement Examination are compared with results of the ACE the conclusion seems obvious. Since the correlations were .66 and .45, respectively, and since this difference was found to be significant at the .001 level of confidence, it is concluded that the Iowa Placement Examination is a better instrument than the ACE to use as a basis for segregating chemistry students according to ability. It is felt by this writer that the introduction of this test into the battery of entrance examinations for this purpose was justified.

When the case studies were examined it was seen that, whatever the contributing factors, motivation and attitude toward the course played important parts in determining final grades. Misclassification was seen as a serious handicap and great care should be taken to avoid this error.

SUGGESTIONS FOR FURTHER RESEARCH

There seems to be a need to study over- and under-achievement as measured by a more precise instrument than the scattergram utilized in this study. Questions that such a study, or studies, might attempt to answer are many. A few possibilities follow.

(1) Is there a significant difference between over- and under-achievers as to having had high school chemistry? (2) Are those whose percentile ranks are high more prone to be under-achievers than those whose percentile ranks are low on the ACE? If so, can this tendency be attributed to centripetal drift? (3) Do more under-achievers come from the "A" group--high percentile rank on the Iowa Placement Examination--than from the "B" group? Can this tendency, if found, be attributed to centripetal drift? (4) Is there a significant difference between over and under-achievers as to socialization scores on the Minnesota Personality Scale? (5) Do the under-achievers feel that they have gotten the grade they deserved? Have they been discriminated against in some-way? (6) Do some instructors have a significantly larger number of over- or under-achievers in their sections than other instructors in the Department? (7) Does the Pre-Veterinary curriculum contribute a significantly larger percentage of over-achievers than other curriculums?

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APPENDIX

Sample of the Iowa Placement Chemistry Aptitude Examination

Registration No.	Series CA-2 Form **M**

IOWA PLACEMENT EXAMINATIONS

NEW SERIES, REVISED

CHEMISTRY APTITUDE

Constructed by

G. D. STODDARD, L. W. MILLER, AND JACOB CORNOG

Revised by

JACOB CORNOG AND D. B. STUIT

Name ..... Date .....
(Print) Last First Middle

Grade or Class..... Age..... Date of Birth..... Sex.....

School or College..... City.....

GENERAL DIRECTIONS

This is a test to see how quickly and accurately you can think in the field of chemistry. The test consists of four parts with special directions for each part. Read the directions carefully and examine the samples so you will know exactly how to do the exercises. On page 2 an answer sheet is provided on which you are to place *all* of your responses. This answer sheet is to be torn from the booklet when you begin work. *Do not write any answers on the test booklets.*

The sample exercises indicate how your responses are to be recorded. When the signal is given, begin to work on Part 1 and stop when time is called. If you should finish before time is called you may go back over any previous part, but do not go on to the next part until told to do so.

Answer the questions in order as you come to them, but do not spend too much time on any one item. You should answer all questions on which you have some information, but *do not guess.* A certain proportion of your score will be deducted for wrong answers. If you make a mistake, erase your first mark completely. *Items for which more than one answer is checked will be scored wrong.*

Part	Time	Raw Score	Scale Score	Percentile
1. Mathematics	15			
2. Formulation	7			
3. Reading	18			
4. Information	7			
Total	47			

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ANSWER SHEET

Chemistry Aptitude Test

Part 1

(25 items)

(1) (2) (3) (4) (5)

1. ○ ○ ○ ○ ○
2. ○ ○ ○ ○ ○
3. ○ ○ ○ ○ ○
4. ○ ○ ○ ○ ○
5. ○ ○ ○ ○ ○
6. ○ ○ ○ ○ ○
7. ○ ○ ○ ○ ○
8. ○ ○ ○ ○ ○
9. ○ ○ ○ ○ ○
10. ○ ○ ○ ○ ○
11. ○ ○ ○ ○ ○
12. ○ ○ ○ ○ ○
13. ○ ○ ○ ○ ○
14. ○ ○ ○ ○ ○
15. ○ ○ ○ ○ ○
16. ○ ○ ○ ○ ○
17. ○ ○ ○ ○ ○
18. ○ ○ ○ ○ ○
19. ○ ○ ○ ○ ○
20. ○ ○ ○ ○ ○
21. ○ ○ ○ ○ ○
22. ○ ○ ○ ○ ○
23. ○ ○ ○ ○ ○
24. ○ ○ ○ ○ ○
25. ○ ○ ○ ○ ○

Score = No. Right

= ☐

Part 2

(10 items)

(1) (2) (3) (4) (5)

1. ○ ○ ○ ○ ○
2. ○ ○ ○ ○ ○
3. ○ ○ ○ ○ ○
4. ○ ○ ○ ○ ○
5. ○ ○ ○ ○ ○
6. ○ ○ ○ ○ ○
7. ○ ○ ○ ○ ○
8. ○ ○ ○ ○ ○
9. ○ ○ ○ ○ ○
10. ○ ○ ○ ○ ○

Score = No. Right × 3

= ☐ × 3

= ☐

Part 3

(30 items)

Section A

(1) (2) (3) (4) (5)

1. ○ ○ ○ ○ ○
2. ○ ○ ○ ○ ○
3. ○ ○ ○ ○ ○
4. ○ ○ ○ ○ ○
5. ○ ○ ○ ○ ○
6. ○ ○ ○ ○ ○
7. ○ ○ ○ ○ ○
8. ○ ○ ○ ○ ○
9. ○ ○ ○ ○ ○
10. ○ ○ ○ ○ ○

Section B

1. ○ ○ ○ ○ ○
2. ○ ○ ○ ○ ○
3. ○ ○ ○ ○ ○
4. ○ ○ ○ ○ ○
5. ○ ○ ○ ○ ○
6. ○ ○ ○ ○ ○
7. ○ ○ ○ ○ ○
8. ○ ○ ○ ○ ○
9. ○ ○ ○ ○ ○
10. ○ ○ ○ ○ ○

Section C

1. ○ ○ ○ ○ ○
2. ○ ○ ○ ○ ○
3. ○ ○ ○ ○ ○
4. ○ ○ ○ ○ ○
5. ○ ○ ○ ○ ○
6. ○ ○ ○ ○ ○
7. ○ ○ ○ ○ ○
8. ○ ○ ○ ○ ○
9. ○ ○ ○ ○ ○
10. ○ ○ ○ ○ ○

Score = No. Right

= ☐

Part 4

(45 Items)

	T	F		T	F
1.	○	○	24.	○	○
2.	○	○	25.	○	○
3.	○	○	26.	○	○
4.	○	○	27.	○	○
5.	○	○	28.	○	○
6.	○	○	29.	○	○
7.	○	○	30.	○	○
8.	○	○	31.	○	○
9.	○	○	32.	○	○
10.	○	○	33.	○	○
11.	○	○	34.	○	○
12.	○	○	35.	○	○
13.	○	○	36.	○	○
14.	○	○	37.	○	○
15.	○	○	38.	○	○
16.	○	○	39.	○	○
17.	○	○	40.	○	○
18.	○	○	41.	○	○
19.	○	○	42.	○	○
20.	○	○	43.	○	○
21.	○	○	44.	○	○
22.	○	○	45.	○	○
23.	○	○			

A =
R =
W (A-R) =

Score = R—W = ☐

(Tear along this line)

PART 1. MATHEMATICS

(Time limit, 15 minutes)

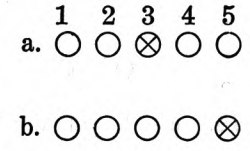
Directions: The exercises in this part represent the most commonly used arithmetical and algebraic skills in first year chemistry. Solve each of the problems, find the answer among the five choices, and record your answer by making an × in the appropriate circle on the answer sheet. Study the samples.

SAMPLE: A. $3x = 15$; what does x equal?

(1) 2 (2) 3 (3) 5 (4) 7 (5) 10

B. $4a + 7 = 35$; what does a equal?

(1) 3 (2) 4 (3) 5 (4) 6 (5) 7



For the first sample, 5 is the correct answer so circle three in marked with an ×. The answer for the second sample is 7, so circle five has been checked.

---

1. $v^2 = 2gs$; what does s equal?

(1) $v^2 - 2g$ (2) $v^2 + 2g$ (3) $\frac{v^2}{2g}$ (4) $\frac{v}{g}$ (5) $\frac{2g}{v^2}$

2. $bx = 2$; what does b equal?

(1) $2x$ (2) $\frac{x}{2}$ (3) $\frac{2}{x}$ (4) $x-2$ (5) $2-x$

3. $s = vt$; what does t equal?

(1) sv (2) $\frac{v}{s}$ (3) $s-v$ (4) $v-s$ (5) $\frac{s}{v}$

4. What is the square root of 1156.00?

(1) 26 (2) 34 (3) 36 (4) 289 (5) 578

5. $m-n = a-b$; what does n equal?

(1) $a-b+m$ (2) $a-b-m$ (3) $a+b-m$ (4) $b-a+m$ (5) $a+b+m$

6. Reduce to a common denominator: $\frac{1}{a} - \frac{1}{b}$.

(1) $\frac{2}{a-b}$ (2) $\frac{2}{ab}$ (3) $\frac{b-a}{ab}$ (4) $a-b$ (5) $\frac{b-a}{a-b}$

7. What is 14% of .06?

(1) .84 (2) .084 (3) .0084 (4) .233 (5) .0233

8. Solve for x: $\frac{12.2}{18.3} = \frac{x}{21.9}$

(1) 2/3 (2) 2 (3) 13.6 (4) 14.6 (5) 32.8

9. Solve for x: $\frac{x}{3} = 2y^2$.

(1) $\frac{2y^2}{3}$ (2) $\frac{2y^2}{-3}$ (3) $2y^2-3$ (4) $3-2y^2$ (5) $6y^2$

10. Divide: $.0024 \div .0004$.

(1) 6 (2) .6 (3) .06 (4) .006 (5) .0006

11. Simplify: $\sqrt{x^2y^2}$.

(1) xy (2) $(xy)^2$ (3) x^2y^2 (4) $\sqrt{x^2} \cdot \sqrt{y^2}$ (5) $(-xy)(xy)$

Turn to Page 4.

12. What is the reciprocal of $\frac{a}{2b}$?

(1) $\frac{2b}{a}$ (2) $2ab$ (3) ab (4) $4a^2b^2$ (5) $\frac{4b^2}{a^2}$

13. $a^2-b^2 = c^2$; what does b equal

(1) $\sqrt{a^2-c^2}$ (2) $(a-c)(a+c)$ (3) $\sqrt{c^2-a^2}$ (4) $a-c$ (5) $c+a$

14. $c^2-1 = -d^2$; if d is $\frac{1}{2}$, what is c^2?

(1) .50 (2) .75 (3) —.75 (4) 1.25 (5) —1.25

15. $\frac{a}{y} = b$; what does y equal?

(1) ab (2) $\frac{a}{b}$ (3) $a-b$ (4) $b-a$ (5) $\frac{b}{a}$

16. $\frac{a}{3b} = \frac{x}{y}$, what does b equal?

(1) $\frac{ay}{3x}$ (2) $\frac{3b}{ay}$ (3) $3aby$ (4) $\frac{3by}{a}$ (5) $\frac{3ay}{b}$

17. Combine: $x-(x-a) =$

(1) $2x+a$ (2) $2x-a$ (3) $a-2x$ (4) a (5) $-a$

18. Write with an exponent $\sqrt[3]{a+b}$.

(1) $(a+b)^{1/3}$ (2) a^3+b^3 (3) $(a+b)^{-3}$ (4) $(a+b)^3$ (5) $(a+b)^{-1/3}$

19. If $x = y+z$, how much less than x is z?

(1) $x-y$ (2) $x+y$ (3) x (4) y (5) $y-x$

20. What kind of proportion is represented by the statement "the larger the diameter the greater the area"?

(1) Direct (2) indirect (3) inverse (4) variable (5) squared

21. If $\frac{W_2}{W} = \frac{W}{W_1}$, what is the value of W?

(1) W_2W_1 (2) $\frac{W_2}{W_1}$ (3) $\sqrt{\frac{W_2}{W_1}}$ (4) $\sqrt{W_2W_1}$ (5) $-W_2W_1$

22. What is the mean of 3, 8, 0, 7, and 2?

(1) 0 (2) 4 (3) 5 (4) 20 (5) 336

23. Simplify $\frac{\frac{x}{2}}{x}$.

(1) $\frac{x^2}{2}$ (2) $2x^2$ (3) $\frac{x}{2}$ (4) 2 (5) $\frac{1}{2}$

24. A man judged a distance of 20 yards to be 25 yards. What was his per cent of error?

(1) .20% (2) 20% (3) .25% (4) 25% (5) .80%

25. Find the numerical value for x: $x = \frac{6 \times 10^2 \times 2 \times 10^3}{3 \times 10^4}$.

(1) 4 (2) 40 (3) 400 (4) 4000 (5) 40,000

End of Part 1.

PART 2. FORMULATION

(Time limit, 7 minutes)

Directions: In this part you are to read each statement or short paragraph and do what it tells you to do. In most cases this involves writing an algebraic expression for what the statement says. As in Part 1, select the correct answer from among the five choices and mark the appropriate circle on the answer sheet with an ×. Study the samples.

SAMPLE: A. If x is a number, twice that number would be expressed algebraically as:

(1) x (2) x^2 (3) 2x (4) $2x^2$ (5) 4x

B. If x and y represent two numbers, their sum would be expressed as:

(1) x+y (2) xy (3) x—y (4) x^2y^2 (5) $\frac{x}{y}$

	1	2	3	4	5
a.	○	○	⊗	○	○
b.	⊗	○	○	○	○

---

1. Letting x represent the length of an edge of a cube, write the *simplest* algebraic expression which represents the volume of the cube.

(1) x^2 (2) x^3 (3) 9x (4) 3x (5) $\sqrt[3]{x}$

2. The length of a certain rectangle is twice its width. Letting w represent the width, write an algebraic expression for the perimeter of the rectangle.

(1) 4w (2) 8w (3) 6w (4) $2w^2$ (5) 4w+2

3. If a barrel of gasoline containing x gallons will propel an automobile y miles in 5 hours, what is the mileage travelled per gallon of gasoline?

(1) $\frac{x}{y}$ (2) $\frac{y}{x}$ (3) xy (4) $\frac{5x}{y}$ (5) $\frac{5y}{x}$

4. An airplane travels at a uniform velocity of m miles per hour for one hour and consumes x gallons of gasoline during that time. How many gallons of gasoline will be needed to travel a distance of y miles?

(1) $\frac{xy}{m}$ (2) $\frac{xm}{y}$ (3) $\frac{x}{my}$ (4) $\frac{y}{mx}$ (5) $\frac{m}{xy}$

5. Bill and Bob row a boat across a lake. Bob rows y miles, and Bill rows the rest of the distance. If Bill rows three miles farther than Bob, how wide is the lake.

(1) y—3 (2) 3y+2 (3) 2y+3 (4) y+3 (5) 2y+6

6. The electrical output of the larger of two dynamos is five units more than three times the smaller. What is the output of the larger dynamo if the output of the smaller is represented by x?

(1) 15x (2) 5x+3 (3) x+8 (4) x+15 (5) 3x+5

7. The force (f) required to break a new manila rope is equal to the product of a constant (m) and the square of the circumference (c) of the rope. Express in equation form.

(1) f = cm (2) $f = \frac{m}{c}$ (3) $f = m^2c$ (4) $f = mc^2$ (5) $f = m^2c^2$

8. The specific gravity of a substance is defined as the ratio of the weight of any volume of the substance to the weight of an equal volume of water. Letting *s.g.* represent the specific gravity of the substance, x the weight of the substance and w the weight of an equal volume of water, express the above relationship in equation form.

(1) $s.g. = \frac{w}{x}$ (2) $s.g. = \frac{x}{w}$ (3) s.g. = xw (4) w = s.g.x (5) $x = \frac{w}{s.g.}$

9. In a cylindrical tumbler filled with water the total force F against the bottom is equal to the weight of the column of liquid resting on the bottom. The weight is determined by the area (A) of the bottom, the depth h of the water, and the weight d of a unit volume of the water. Express the force F in terms of area, depth and density.

(1) $F = \frac{Ah}{d}$ (2) F = Ahd (3) $F = \frac{hd}{A}$ (4) $F = \frac{Ad}{h}$ (5) $F = A^2hd$

10. If a quantity of gas is subjected to a temperature change, the ratio of the original volume V_1 to the new volume V_2 is the same as the ratio of the original absolute temperature T_1 to the new temperature T_2, the pressure P remaining constant. Express in equation form.

(1) $\frac{V_1}{T_1} = \frac{V_2}{T_2}$ (2) $\frac{T_1}{V_1} = \frac{T_2}{V_2}$ (3) $\frac{V_2}{V_1} = \frac{T_1}{T_2}$ (4) $\frac{V_1}{V_2} = \frac{T_1}{T_2}$ (5) $P\frac{V_1}{V_2} = \frac{T_1}{T_2}$

End of Part 2.

PART 3. READING

(Time limit, 18 minutes)

Directions: This is a test of your ability to read thoroughly and comprehensively in the field of chemistry. Read the materials below carefully as you will be asked to apply the facts in various ways.

SECTION A

The chemical name of ordinary table salt is sodium chloride. It is represented by the symbol NaCl. "Na" stands for the Latin word for sodium and "Cl" for chlorine or chloride. Thus the formula NaCl indicates that table salt is composed of sodium and chlorine. When sodium chloride or a similar substance is dissolved in water the resulting solution will carry an electric current. This conductivity of salt solutions is best explained by the ionization theory.

According to this theory, sodium chloride exists in water solution as a very large number of very small separate pieces of sodium and an equally large number of very small separate pieces of chlorine. Each individual piece of sodium carries a unit positive charge of electricity and is called a positive ion. It is indicated by the symbol Na^+. Similarly each separate piece of chlorine is a negative ion carrying a unit negative charge and is indicated by the symbol Cl^-. When solid sodium chloride is caused to form by evaporation of the solution or by other means, the positive Na^+ and the negative Cl^- ions join in equal numbers to form solid NaCl. In any solid or solution the total number of positive charges must always equal the total number of negative charges. Hence it would be impossible to have sodium chloride in which there were twice as many pieces of Cl^- as there were of Na^+ and the formula $NaCl_2$ would be *incorrect.*

But the smallest pieces into which some substances divide when dissolved may carry more than one unit charge. Copper chloride ($CuCl_2$) solution contains copper ions and chloride ions. *Each* copper ion carries *two* positive unit charges and is indicated by the symbol Cu^{++} while each chloride ion as in sodium chloride solution carries one negative charge and is represented by Cl^-. Thus in a copper chloride solution there are twice as many chloride ions as there are copper ions but each copper ion carries twice as many charges and the *total number of positive charges equals the total number of negative charges* in the solution. Different kinds of ions may carry as many as four positive or negative charges each. Chemical formulas must be written so as to indicate that the positive and negative charges are equal in number.

In the following exercises the correct number of charges + or − is given for the ions indicated by the formulas. Select from among the five choices the formula which has the correct set of sub-numbers, making an × in the circle corresponding to your choice on the answer sheet.

SAMPLES: A. Na^+ Cl^-

(1) NaCl (2) Na_2Cl (3) $NaCl_2$ (4) Na_2Cl_2 (5) Na_3Cl_2

B. Cu^{++} Cl^-

(1) CuCl (2) $CuCl_2$ (3) Cu_2Cl (4) Cu_2Cl_2 (5) $CuCl_3$

	1	2	3	4	5
a.	⊗	○	○	○	○
b.	○	⊗	○	○	○

In Sample A, the correct formula is NaCl so the first circle is marked with an ×. In Sample B, the correct formula is $CuCl_2$ so the second circle is marked with an ×.

1. K^+ Cl^-

(1) K_2Cl (2) KCl (3) KCl_2 (4) K_2Cl_4 (5) K_2Cl_3

2. Ba^{++} Cl^-

(1) $BaCl_2$ (2) BaCl (3) Ba_2Cl_2 (4) Ba_2Cl (5) Ba_3Cl_3

3. K^+ S^{--}

(1) K_3S_4 (2) KS (3) K_4S_2 (4) K_2S (5) KS_2

4. Sb^{+++} Cl^-

(1) Sb_3Cl (2) Sb_2Cl (3) Sb_3Cl_3 (4) Sb_2Cl_4 (5) $SbCl_3$

5. Sb^{+++} S^{--}

(1) SbS_2 (2) SbS_3 (3) Sb_3S (4) Sb_2S_3 (5) Sb_3S_2

6. Mg^{++} S^{--}

(1) Mg_2S_4 (2) Mg_3S_2 (3) MgS (4) Mg_2S_3 (5) Mg_2S

7. Sn^{++++} Cl^-

(1) Sn_3Cl_4 (2) SnCl (3) $SnCl_4$ (4) Sn_4Cl (5) $SnCl_3$

8. Sn^{++++} S^{--}

(1) SnS_2 (2) Sn_3S_4 (3) SnS_4 (4) Sn_2S (5) SnS

9. Sn^{++++} X^{---}

(1) SnX_2 (2) Sn_3X_4 (3) Sn_4X_3 (4) SnX (5) Sn_2X_2

10. K^+ X^{---}

(1) K_3X (2) K_2X_2 (3) KX_3 (4) K_3X_4 (5) K_2X_4

SECTION B

At times an ion may contain more than one kind of element. For example, the formula for silver nitrate is Ag (NO_3). As one nitrate (NO_3) ion combines with one silver (Ag) ion which has $1+$ charge, the (NO_3) group must have $1-$ charge, in order for the charges to balance.

In the following exercise, select from among the five choices the formula which has the correct set of sub-numbers, making an × in the circle corresponding to your choice on the answer sheet. Keep in mind the fact that the number of charges + and — must always balance.

A table of ions and the number of charges is provided below:

$Zn^{++} = 2+$	$Fe^{+++} = 3+$	$(SO_4)^{--} = 2-$	$(PO_4)^{---} = 3-$
$K^{+} = 1+$	$H^{+} = 1+$	$(NO_3)^{-} = 1-$	$S^{--} = 2-$
$Ag^{+} = 1+$		$(OH)^{-} = 1-$	

						1	2	3	4	5
SAMPLE:	(1) $Ag(SO_4)$	(2) $Ag(SO_4)_2$	(3) $Ag_2(SO_4)$	(4) $Ag_2(SO_4)_2$	(5) $Ag_3(SO_4)_2$	○	○	⊗	○	○

1.	(1) $Zn_2(SO_4)$	(2) $Zn(SO_4)_2$	(3) $Zn(SO_4)$	(4) $Zn_3(SO_4)_2$	(5) $Zn_2(SO_4)_3$
2.	(1) $K_2(SO_4)$	(2) $K(SO_4)$	(3) $K_3(SO_4)_2$	(4) $K_2(SO_4)_3$	(5) $Zn_2(NO_3)_3$
3.	(1) $Zn(OH)$	(2) $Zn_3(OH)_2$	(3) $Zn(OH)_3$	(4) $Zn(OH)_2$	(5) $Zn_2(OH)_3$
4.	(1) $Fe(NO_3)_2$	(2) $Fe_3(NO_3)_2$	(3) $Fe_2(NO_3)_3$	(4) $Fe(NO_3)$	(5) $Fe(NO_3)_3$
5.	(1) FeS	(2) Fe_3S_2	(3) Fe_2S_3	(4) FeS_3	(5) Fe_3S
6.	(1) $Zn(NO_3)$	(2) $Zn_3(NO_3)_2$	(3) $Zn(NO_3)_2$	(4) $Zn_2(NO_3)$	(5) $Zn_2(NO_3)_3$
7.	(1) $Zn(PO_4)$	(2) $Zn_3(PO_4)_2$	(3) $Zn(PO_4)_2$	(4) $Zn_2(PO_4)$	(5) $Zn_2(PO_4)_3$
8.	(1) $Fe(SO_4)$	(2) $Fe(SO_4)_2$	(3) $Fe_3(SO_4)_2$	(4) $Fe_2(SO_4)_3$	(5) $Fe_2(SO_4)$
9.	(1) $K_2(PO_4)_3$	(2) $K_2(PO_4)$	(3) $K(PO_4)$	(4) $K_3(PO_4)$	(5) $K_2(PO_4)_3$
10.	(1) $Fe_3(PO_4)_2$	(2) $Fe_2(PO_4)$	(3) $Fe(PO_4)_2$	(4) $Fe_3(PO_4)_3$	(5) $Fe(PO_4)$

SECTION C

The chemical name of a compound is based upon the ions of which it is composed. You have already found that ions unite in proportion to charges carried, i.e., an ion with $2+$ charges will unite with 2 ions with $1-$ charge, or a single ion with $2-$ charges, etc.

Using the table of ions and names given below, select the correct formula for each of the compounds from among the five choices, note its number and make a cross × in the corresponding circle on the answer sheet.

Potassium $K^{+} = 1+$	Lead $Pb^{++} = 2+$	Arsenate $(AsO_4)^{---} = 3-$
Aluminum $Al^{+++} = 3+$	Chloride $Cl- = 1-$	
Barium $Ba^{++} = 2+$	Carbonate $(CO_3)^{--} = 2-$	

						1	2	3	4	5
SAMPLE: Lead chloride										
(1) $PbCl$	(2) $PbCl_2$	(3) Pb_2Cl	(4) Pb_2Cl_3	(5) Pb_3Cl_2		○	⊗	○	○	○

1.	Lead carbonate				
	(1) $Pb(CO_3)$	(2) $Pb(CO_3)_2$	(3) $Pb_2(CO_3)$	(4) $Pb_2(CO_3)_3$	(5) $Pb_3(CO_3)_2$
2.	Barium chloride				
	(1) Ba_2Cl_3	(2) $BaCl_2$	(3) Ba_2Cl_2	(4) $BaCl$	(5) Ba_3Cl_2
3.	Aluminum chloride				
	(1) $AlCl$	(2) $AlCl_2$	(3) Al_2Cl	(4) Al_2Cl_3	(5) $AlCl_3$
4.	Aluminum arsenate				
	(1) $Al(AsO_4)_2$	(2) $Al_2(AsO_4)$	(3) $Al_2(AsO_4)_3$	(4) $Al(AsO_4)$	(5) $Al_3(AsO_4)_2$
5.	Aluminum carbonate				
	(1) $Al(CO_3)$	(2) $Al(CO_3)_2$	(3) $Al_2(CO_3)$	(4) $Al_3(CO_3)_2$	(5) $Al_2(CO_3)_3$
6.	Lead arsenate				
	(1) $Pb(AsO_3)$	(2) $Pb(AsO_4)_2$	(3) $Pb_2(AsO_4)$	(4) $Pb_2(AsO_4)_3$	(5) $Pb_3(AsO_4)_2$
7.	Potassium carbonate				
	(1) $K(CO_3)$	(2) $K(CO_3)_2$	(3) $K_2(CO_3)$	(4) $K_2(CO_3)_3$	(5) $K_3(CO_3)_2$
8.	Barium arsenate				
	(1) $Ba(AsO_4)$	(2) $Ba(AsO_4)_2$	(3) $Ba_2(AsO_4)$	(4) $Ba_2(AsO_4)_3$	(5) $Ba_3(AsO_4)_2$
9.	Barium carbonate				
	(1) $Ba(CO_3)$	(2) $Ba(CO_3)_2$	(3) $Ba_2(CO_3)$	(4) $Ba_2(CO_3)_3$	(5) $Ba_3(CO_3)_2$
10.	Potassium arsenate				
	(1) $K(AsO_4)$	(2) $K_3(AsO_4)$	(3) $K(AsO_4)_3$	(4) $K_2(AsO_4)_3$	(5) $K_3(AsO_4)_3$

End of Part 3.

PART 4. INFORMATION

(Time limit, 7 minutes)

Directions: Examine each statement below and decide whether it is true or false. If the statement is true, place an × in the appropriate circle of the first or "true" column on the answer sheet; if the statement is false, place an × in the second circle, this being in the "false" column.

If you do not know the answer to an item, skip it and go on to the next one.

	T	F
SAMPLE: A. Gold is a metal.	a. ⊗	○
B. Copper is a compound.	b. ○	⊗

1. Rusting and burning involve the same kind of chemical reaction.
2. Hydrochloric acid is used in automobile batteries.
3. The smallest unit into which a substance may be divided and still retain its chemical properties is the electron.
4. Helium is preferable to hydrogen for use in zeppelins chiefly because it is more buoyant.
5. Application of heat tends to speed up most chemical reactions.
6. Pure water conducts electricity better than a solution containing common salt.
7. Water is an element.
8. The essential chemical reaction in photography is called photosynthesis.
9. The feeling of discomfort experienced in a crowded room is primarily due to a deficiency of oxygen.
10. Oxygen is the gas given off from a bottle of pop.
11. Freezing of water is a physical rather than a chemical change.
12. At normal room temperatures all metals are solids.
13. The molecules of a gas are always in motion.
14. A substance which cannot be decomposed by chemical means is known as an element.
15. The number of elements is now thought to be eighty-seven.
16. If a burning splinter is placed in a bottle of carbon dioxide gas it wil be extinguished.
17. Increasing the pressure lowers the boiling point of water.
18. Oxygen is more abundant than other gases in the earth's atmosphere.
19. The total amount of energy in the universe is constantly changing.
20. A thermometer measures the quantity of heat in a substance.
21. Acid solutions turn red litmus paper blue.
22. If a solution of chlorine in water is exposed to sunlight, hydrochloric acid is formed.
23. If a gas flame under a pan of boiling water is increased, the temperature of the water remains the same.
24. All the chemical elements found in living organisms are also found in non-living matter.
25. The boiling point of distilled water is lower than the boiling point of sea water.
26. One of the chief causes of hardness in water is calcium bicarbonate.
27. Cream has less density than skim milk.
28. A kiloliter is equal to 10,000 liters.
29. The density of water, in its liquid state, is independent of its temperature.
30. The sun was the original source of the energy obtained from gasoline.
31. The bubbles emerging from a diver's suit become smaller as they approach the surface.
32. Energy is furnished to the body by the oxidation of food.
33. The chemical name for common table salt is sodium chlorate.
34. Carbon monoxide gas has a distinctive odor.
35. Diamonds and charcoal are both composed of the same element.
36. Other things being equal, a piece of iron will rust more rapidly at 40° F. than at 100° F.
37. Solidified carbon monoxide gas is commonly known as "dry ice".
38. When a candle is burned, one of the products formed is water.
39. Hydroflouric acid attacks glass containers.
40. The element helium was discovered to exist on the sun before it was discovered on the earth.
41. Vinegar should be used to neutralize hydrochloric acid spilled on the skin or clothing.
42. Water at 2° C. is less dense than water at 4° C.
43. Vinegar is a dilute solution of acetic acid.
44. The essential function of a baking powder is to liberate carbon dioxide.
45. Green plants, when exposed to sunlight, remove oxygen from the air and restore carbon dioxide.

End of Part 4. End of test.

Table 3. Final percentage grades in Chemistry I and total and subtest raw scores on the American Council on Education Psychological Examination and on the Iowa Placement Chemistry Aptitude Examination for each student.

Student number	Final percentage grade in Chemistry I	Iowa Placement Chemistry Aptitude Examination					American Council on Education Psychological Examination		
		Total raw score	Mathematics	Formulation	Reading	Information	Total raw score	Quantitative	Verbal
1	67	58	9	21	11	17	103	42	61
2	47	21	2	9	4	6	82	43	39
3	81	81	15	18	30	18	113	57	46
4	51	52	3	3	16	21	65	32	33
5	77	16	5	9	1	1	91	29	62
6	99	128	25	33	31	39	116	47	69
7	57	30	6	12	9	3	105	45	60
8	79	77	23	27	11	16	102	45	57
9	60	74	11	18	31	14	116	35	81
10	71	69	12	7	31	19	130	52	78
11	92	97	18	21	30	28	123	51	72
12	80	63	8	12	28	15	92	41	51
13	90	43	16	18	1	8	84	43	41
14	50	39	16	18	6	-1	100	46	54
15	65	57	5	21	23	8	80	37	43
16	86	59	8	15	26	10	108	53	55
17	64	53	9	12	18	14	118	46	72
18	79	108	22	24	31	34	139	87	52
19	72	58	8	75	26	9	105	48	57
20	71	93	22	30	10	31	132	59	73
21	83	107	20	24	30	36	124	50	74
22	80	109	24	27	30	28	116	47	69
23	37	12	7	6	12	-13	89	35	54
24	60	65	15	21	17	12	113	47	66
25	65	88	14	21	30	23	106	52	54
26	73	46	14	6	10	16	86	45	41
27	96	123	24	30	31	38	117	44	73
28	47	49	14	12	13	10	103	47	56
29	53	34	8	9	12	5	92	38	54 *
30	67	86	17	21	30	18	78	37	41
31	68	20	12	15	0	-7	109	60	49
32	80	89	20	24	22	23	110	44	66
33	78	71	14	12	14	31	115	52	63
34	65	70	23	21	19	7	121	51	70
35	83	67	15	21	20	11	135	65	70

Table 3, (cont.)

Student number	Final percentage grade in Chemistry I	Iowa Placement Chemistry Aptitude Examination					American Council on Education Psychological Examination		
		Total raw score	Mathematics	Formula	Reading	Information	Total raw score	Quantitative	Verbal
36	67	42	11	18	10	3	76	39	37
37	74	69	12	9	30	18	100	46	54
38	78	95	9	15	31	40	128	48	80
39	62	63	18	18	15	12	123	51	72
40	57	52	9	10	16	17	141	55	86
41	60	72	12	9	26	25	109	43	66
42	55	26	4	6	9	7	91	27	64
43	74	45	8	0	28	9	75	40	35
44	66	84	19	27	28	10	130	60	70
45	75	44	9	12	17	6	67	26	41
46	71	65	5	18	18	24	99	29	70
47	74	97	17	24	29	27	140	65	75
48	74	64	12	15	28	9	63	27	36
49	64	61	5	15	30	11	109	48	61
50	75	69	18	6	29	16	85	32	53
51	23	13	5	6	2	0	63	16	47
52	93	104	22	27	30	25	112	46	66
53	77	77	5	21	30	21	130	43	87
54	75	27	10	15	3	-1	112	48	64
55	46	55	20	21	4	10	113	53	58
56	88	88	22	18	30	18	130	59	71
57	92	81	15	18	27	21	123	40	83
58	59	33	4	3	20	6	67	27	40
59	73	53	16	24	7	6	129	56	73
60	48	50	15	12	20	3	100	23	77
61	44	21	10	3	3	5	64	18	46
62	49	14	6	9	6	-7	85	38	47
63	61	51	5	12	18	16	92	37	55
64	82	79	22	30	7	20	93	44	49
65	96	110	23	30	30	27	128	43	85
66	75	52	14	15	10	13	99	39	60
67	61	21	3	3	5	10	90	28	62
68	58	32	5	4	11	12	86	35	51
69	59	15	9	12	1	-7	78	37	41
70	81	91	14	12	30	35	107	35	72
71	95	77	13	21	26	17	88	36	52
72	89	76	13	12	30	21	116	45	71
73	66	51	16	18	4	13	101	46	55
74	54	22	8	3	7	4	50	18	32
75	38	21	1	3	11	6	86	41	45

Table 3, (cont.)

Student number	Final percentage grade in Chemistry I	Iowa Placement Chemistry Aptitude Examination					American Council on Education Psychological Examination		
		Total raw score	Mathematics	Formula	Reading	Information	Total raw score	Quantitative	Verbal
76	76	68	20	21	17	10	94	41	53
77	74	77	9	21	20	27	119	52	67
78	82	47	7	15	24	1	116	52	64
79	78	54	8	6	28	22	113	36	77
80	82	47	10	9	29	-1	85	32	53
81	65	53	11	24	14	4	102	57	95
82	78	44	4	5	10	25	97	43	54
83	77	88	17	15	28	28	110	35	75
84	47	18	4	6	4	4	84	34	50
85	79	51	5	18	5	23	123	43	79
86	80	53	12	15	10	16	91	41	50
87	76	82	14	21	30	17	136	63	73
88	92	106	23	15	30	38	126	50	76
89	55	42	6	21	2	13	98	37	61
90	67	44	9	12	9	14	92	30	62
91	68	47	9	18	11	9	117	46	71
92	66	33	3	9	13	8	92	31	61
93	65	44	11	6	10	17	103	50	53
94	61	49	9	12	18	10	118	47	71
95	82	62	18	12	20	12	116	48	68
96	69	16	3	6	4	3	92	37	55
97	80	32	1	6	24	1	101	42	59
98	78	98	13	18	30	37	104	34	70
99	63	13	2	9	3	-1	128	52	76
100	74	29	1	6	13	9	41	16	25
101	80	61	6	3	30	22	100	37	63
102	88	72	11	9	28	24	110	45	65
103	85	85	15	24	28	18	105	47	58
104	60	89	17	27	21	24	111	55	56
105	64	18	9	6	8	-5	94	33	61
106	71	51	5	12	29	5	100	38	62
107	83	97	23	24	29	21	134	53	81
108	58	5	0	6	-6	5	79	29	50
109	57	42	3	9	20	10	64	16	48
110	78	91	16	24	29	22	103	41	62
111	95	85	15	15	28	27	131	52	79
112	91	56	21	18	11	6	87	40	47
113	87	59	20	21	20	-2	120	47	73
114	62	71	9	15	28	19	81	40	41

Table 3, (cont.)

Student number	Final percentage grade in Chemistry I	Iowa Placement Chemistry Aptitude Examination					American Council on Education Psychological Examination		
		Total raw score	Mathematics	Formulation	Reading	Information	Total raw score	Quantitative	Verbal
115	67	71	8	21	15	27	134	49	85
116	33	28	5	6	7	10	74	18	56
117	79	36	3	15	4	14	115	50	65
118	44	25	3	9	7	6	76	35	41
119	73	63	10	18	18	17	125	48	77
120	79	40	9	21	10	1	85	40	45
121	76	61	8	9	19	25	104	44	60
122	52	34	7	18	8	1	91	33	58
123	52	39	6	18	14	1	95	45	50
124	48	51	17	15	9	10	96	34	62
125	72	60	11	21	17	11	116	49	67
126	79	67	14	18	12	23	135	55	80
127	45	41	14	18	4	5	94	47	47
128	68	73	11	21	29	12	85	36	49
129	87	93	20	21	31	21	128	62	66
130	89	88	20	27	25	16	138	58	80
131	90	98	19	18	27	34	117	41	76
132	70	66	1	15	31	19	77	38	39
133	48	36	9	9	11	7	107	33	74
134	47	33	6	3	14	10	60	16	44
135	77	57	6	21	15	15	104	41	63
136	74	93	18	18	31	26	107	47	60
137	67	77	14	21	29	13	78	37	41
138	67	31	10	0	20	1	80	39	41
139	70	74	9	6	28	31	75	23	52
140	94	93	20	21	29	23	143	53	90
141	93	105	22	30	28	25	127	45	82
142	68	63	8	9	15	31	107	49	67
143	82	42	12	18	7	5	134	47	88
144	67	27	9	6	4	8	52	22	30
145	64	46	7	9	21	9	132	56	76
146	76	96	22	18	27	29	119	44	75
147	83	25	8	6	13	-2	28	18	10
148	55	21	3	9	5	4	100	39	61
149	44	21	9	9	4	-1	97	48	49
150	66	62	19	24	13	6	88	38	50
151	66	32	5	3	13	11	77	30	47
152	68	37	10	15	1	11	99	39	60
153	76	57	13	15	13	16	107	45	62
154	60	47	16	3	25	3	69	29	40

Table 3, (cont.)

Student number	Final percentage grade in Chemistry I	Iowa Placement Chemistry Aptitude Examination: Total raw score	Math-ematics	Formula-tion	Reading	Information	American Council on Education Psychological Examination: Total raw score	Quantitative	Verbal
155	94	88	22	9	28	29	113	35	78
156	76	72	17	15	19	21	139	54	85
157	41	29	4	9	10	6	62	31	31
158	86	59	14	27	16	2	113	49	64
159	77	30	6	9	3	12	91	37	54
160	83	56	5	6	28	17	75	25	50
161	47	30	5	9	12	4	107	45	62
162	77	58	9	18	25	6	105	41	64
163	55	36	8	6	20	2	97	40	57
164	42	54	0	12	29	13	93	31	62
165	44	24	6	12	6	0	107	51	56
166	86	82	11	18	31	22	121	64	57
167	68	78	7	9	27	35	113	42	71
168	74	41	7	12	31	1	121	46	75
169	90	68	17	24	10	17	114	50	64
170	76	42	7	5	16	14	116	51	65
171	66	69	14	18	22	15	113	47	66
172	66	66	15	18	30	3	97	48	49
173	73	44	5	12	14	13	88	41	47
174	74	63	7	15	30	11	121	55	66
175	63	45	7	27	0	11	108	36	72
176	86	93	19	21	30	23	118	49	69
177	83	98	16	27	26	29	137	66	71
178	90	85	12	24	29	20	120	38	85
179	80	37	6	9	8	14	94	36	58
180	70	70	22	27	14	7	131	56	75
181	70	84	13	15	30	16	94	22	72
182	94	86	21	27	30	8	119	55	64
183	52	60	13	15	19	13	90	43	47
184	56	25	9	3	0	13	72	35	37
185	76	91	20	21	31	19	80	40	40
186	92	95	22	21	21	31	111	54	57
187	51	6	8	5	9	-16	76	35	41
188	65	56	9	12	17	18	99	38	61
189	65	20	5	3	6	6	103	41	62
190	85	102	23	24	29	26	134	47	87
191	81	79	7	21	28	23	91	30	61
192	50	20	4	12	4	0	60	33	27
193	57	43	9	6	25	3	92	38	54
194	76	78	12	21	29	16	118	48	70

Table 3, (concl.)

Student number	Final percentage grade in Chemistry I	Iowa Placement Chemistry Aptitude Examination					American Council on Education Psychological Examination		
		Total raw score	Mathematics	Formulation	Reading	Information	Total raw score	Quantitative	Verbal
195	84	72	14	18	30	10	89	36	53
196	79	22	3	9	9	1	79	40	39
197	75	63	7	15	31	10	85	28	57
198	48	52	3	21	9	19	107	36	71
199	69	85	13	24	31	17	117	44	63
200	84	45	8	18	2	17	111	43	68
201	67	18	3	12	6	-3	87	34	53
202	83	72	11	12	28	21	116	44	72
203	92	106	22	24	30	30	114	43	71
204	65	82	11	12	31	38	113	45	68
205	73	23	9	9	4	1	80	34	46
206	63	34	5	15	9	5	122	48	74
207	66	65	18	15	30	2	88	36	52
208	49	35	9	15	7	4	81	40	41
209	50	32	8	9	3	12	89	39	50
210	82	53	10	18	16	9	115	58	57
211	67	72	11	18	30	13	91	34	57
212	74	60	9	15	19	7	116	43	73
213	30	15	3	6	3	3	79	18	61
214	64	44	5	9	20	10	100	46	54
215	47	24	9	6	29	0	79	45	34
216	53	31	6	9	9	7	97	35	62
217	67	44	7	3	25	9	59	32	37
218	80	63	14	15	31	3	108	47	61
219	95	108	23	14	18	53	148	69	79

A STUDY OF THE CORRELATIONS OF SPECIFIED EXAMINATIONS IN THE ORIENTATION PROCEDURE TO GRADES IN FRESHMAN CHEMISTRY

by

NORMAN DALE ROGERS

B.S., Kansas State College
of Agriculture and Applied Science, 1950

AN ABSTRACT OF A THESIS

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MASTER OF SCIENCE

Department of Education and Psychology

KANSAS STATE COLLEGE
OF AGRICULTURE AND APPLIED SCIENCE

1951

The Iowa Placement Chemistry Aptitude Examination was incorporated into the battery of tests given to freshmen entering Kansas State College in the fall of 1951 as a basis for segregating students enrolled in Chemistry I according to ability. This study attempted to test the effectiveness of the segregating instrument by correlating total and sub-test scores with final percentage grades in Chemistry I and computing the 95 percent confidence interval for each correlation.

It was wondered whether the American Council on Education Psychological Examination, already included in the test battery, might not have been used for the same purpose. Therefore, the scores on the ACE were compared with final grades in the manner described. To further test the validity of conclusions drawn, the level of confidence was computed for the difference in the correlations found using total test scores as final grades.

An attempt was made to find some of the variables that intervene between indicated aptitude and final grades. This was done through the use of case studies of over- and under-achievers and one special case. The over- and under-achievers were chosen by the use of the scattergram showing total raw scores on the Iowa Placement Examination and final percentage grades. The case studies combined test results, Counseling Bureau records and interviews.

Previous research had indicated that the results of the ACE yielded correlations of between $\pm .42$ to $\pm .50$ when compared with chemistry grades. Research on an earlier edition of the Iowa Placement Examination indicated the usual range of correlations

with chemistry grades to lie between ⁄.40 to ⁄.45. The highest reported correlation between a single test and chemistry grades that was found was ⁄.62 for an unidentified test at the University of California.

Results of this study showed a correlation of ⁄.45 with a 95 percent confidence interval of ⁄.34 to ⁄.54 between the ACE and chemistry grades and ⁄.66 with a confidence interval of ⁄.58 to ⁄.73 between the Iowa Placement Examination and chemistry grades. The difference in these correlations was found to be significant at the .001 level of confidence. Therefore, it was concluded that the Iowa Placement Examination was the better test to use for segregating chemistry students and that its introduction into the test battery was justified.

Although the case studies showed many trends, it seemed possible to justify only one conclusion; i.e.: that, whatever factors might enter in, motivation and attitude toward the course played important parts in determining final grades.