THE EFFECTS OF HIGH SCHOOL CHEMISTRY COURSES ON SUCCESS IN FRESHMAN COLLEGE CHEMISTRY

by

HARRY BERNHARDT OLSON

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INTRODUCTION

For some years there has been a lively interest in the question whether having taken a high school course in chemistry is a help or a hindrance to the student pursuing the college freshman course in chemistry. It is not unusual to hear students attending college without high school chemistry complain that they lacked foundation for the college course. Likewise, some of those who have taken high school chemistry maintain that the high school course was misleading.

The question has been discussed in county teachers meetings, in meetings of science teachers, and in the Science Round Tables of the Kansas Teachers Association and has developed much difference of opinion.

Conferences with chemistry teachers here at Kansas State College and at a number of other institutions reveal a similar lively interest and difference of opinion.

The reader of teachers' professional and scientific literature also finds much evidence of interest elsewhere in the question as to the value of high school chemistry courses to those continuing the subject in college. In some cases studies have been made which heighten one's interest in the question.

Conferences with various faculty members in the departments of chemistry and education and investigation of the records available here at Kansas State college led to the

conviction that data were available for making a study of the effects of high school chemistry courses on the student's subsequent work in college freshman chemistry. Accordingly, such a study was planned with the hope that the results would prove helpful in planning high school work and in counseling students.

REVIEW OF LITERATURE

A careful search for reports of studies bearing upon the question as to the desireability of college students in chemistry having had high school chemistry reveals a few significant studies. Fornelius (7, p. 427), outlined the problem as follows:

"Students come by their knowledge of chemistry in different ways; that is, high school experience and training, reading, and home laboratory."

He found that the high schools of the state differ greatly in the emphasis placed upon laboratory work. Some have well equipped laboratories and give their students very good training. Others have very meager equipment, hardly enough to give the student any training. Still others, because of curtailed budgets, offer no laboratory work whatever and few demonstrations by the instructor. In the home laboratory the young enthusiast seldom disciplines himself to real investigational practice but is attracted largely by the spectacular or entertainment aspects of chemical reactions. Since chemistry is an

experimental science, we must take the position that no full understanding of this science can be obtained without some real laboratory experience.

In this connection Fernelius stated: "Some of these freshmen rank high above the average in chemical knowledge and ability. Such students always present a challenge to the college. What should be done to meet the needs of these students?"

This writer emphasizes that most of the college and university chemistry teachers feel that there must be a weakness in the high school chemistry course. This weakness undoubtedly exists in most of the smaller schools and even in some of the larger schools, but the small schools must and do use the State Course of study and teach the state prescribed text. The larger schools in the first and second class cities are given the privilege to select a different text if they desire to do so.

Another study bearing upon this problem was that of Foster (8, p. 746) who reported a study of correlation of grades in high school and college chemistry. Foster stated that: "Neither high school physics nor high school mathematics seems to have any appreciable effect on college chemistry, the principal factors being high school chemistry and intelligence."

Likewise Rogers (12, p. 336) reported that: "Students who have had a specific science in both high school and college achieve a higher grade in that science in college if they continue in the specific science."

On the contrary he indicated later in the article that:

"Students who take chemistry for the first time in college have a 50-50 chance of passing and one chance in four of obtaining a grade acceptable for graduation."

In the face of such findings Ward (13, p. 499) still doubted whether students can safely be counseled concerning the desirability of taking high school chemistry. He said:

> There is altogether too much bunk being spread around about objectives, preparing for life, motivating for this, that, and the other occupation in life, which, of course, no one really knows at his high school age. We are merely trying to project the results of our maturity into the minds of youth and deceiving ourself into thinking that we have discovered what is wrong with everything. The colleges in the east (Brown University) do not require that students repeat the high school course, but start them where they left off in high school.

In reporting a study bearing on this subject Clark (2, p. 285-289) remarked:

> On the initial achievement test given the first day of class work the high school chemistry student showed a very significant superiority. But by using the same test after two quarters of instruction he found a very small difference existed. This would indicate that the student without high school chemistry learned more in the two quarters than those who had high school chemistry, because they had practically closed the ten per cent gap, although the students that had high school chemistry still held a 0.9 per cent better grade on the test.

Then Clark added that his conclusions might not apply to any other college, but seemed to give pretty satisfactory evidence of worthy achievement for the chemistry department at Muskingum College, and hoped that it might prove a suggestive problem to other colleges that are curious about similar problems.

METHOD OF PROCEDURE

Gathering Data

Preparatory to this study a tabulation sheet was arranged upon which the following data were gathered in columns: Name of the freshman student, the town where his high school was located, whether he studied chemistry in high school, the number of hours enrolled in college chemistry the first and second semesters, the grades received for the first and second semester in chemistry, and curriculum in which he was pursuing the chemistry course; also the Test Scores on the Freshman Aptitude Tests in General and Mathematical knowledge.

These data were collected at the Registrar's office with the exception of the Aptitude Test scores which were collected from the files in Dr. J. C. Peterson's office.

Data on a group of 690 freshmen carrying college freshman chemistry were collected.

Arranging Paired Groups

In order to make a valid study it seemed desirable to set up groups paired as completely as possible with respect to all conditions except high school training in chemistry. Accordingly, from the entire group of 690 freshmen in 1939, for which data were gathered it was found possible to set up two groups of 60 students each, paired with respect to curriculum,

percentile rank on the Freshman Aptitude Test, percentile rank in mathematics ability as revealed by this test, from high schools of the same classification, and from towns of the same approximate size. Furthermore, students from college towns were matched by others from college towns. This was done by using the State Educational Directories and the Clasons Green Guide[1] for Kansas.

Another group of 40 pairs of students was selected and paired by Divisions of the College, namely: General Science, Agriculture, Engineering, Home Economics and Veterinary Medicine keeping the same constants in this group as were kept in the first group with the exception of the curriculum. The same type of correlation was used for comparison.

A third group numbering 100 pairs was formed by combining these two groups.

RESULTS

Having arranged the groups as described the college grades in chemistry were weighted as follows: A-5 points, B-4 points, C-3 points, D-2 points, and F and Con. -1 point. Then a chemistry index was set up because several courses require split grades, one grade for laboratory work, another grade for class room or lecture work. The index was set up by taking the number of weighted points and dividing by the number of hours and so each student was tabulated with the correct chemistry index.

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[1] City and road guide by the Clason Map Co., Denver, Colo.

The index scores were used in the correlation with the test scores.

Each group was treated in the same manner using the second semester college index in chemistry, but the groups became smaller on account of some of the students not enrolling in chemistry for the second semester.

The reasons for not enrolling in chemistry the second semester were numerous. Upon investigation it was determined that most of the students that did not enroll in chemistry the second semester had completed the required amount of chemistry for the courses they were pursuing. Others dropped from school on account of financial difficulties, others on account of sickness, and several dropped out of chemistry because they failed in chemistry the first semester.

Since the freshman aptitude tests were taken as a factor in setting up the paired groups the question naturally arose as to their predictive value for chemistry students; to answer this question correlations were calculated. The results are found in Tables 1 and 2. It is immediately evident that the correlations are not high. Applying the test that when a correlation is four times the probable error it is significant and when six times, highly significant, it is found that the general index has significant predictive value in all cases except for the 40 with high school chemistry who were paired by divisions.

Likewise, it is found that the mathematics index has significant predictive value in the combined group.

Table 1. Correlation between aptitude test scores and freshman first semester chemistry grades.

Group	With h. s. chem.			Without h. s. chem.		
Test	N	r	P.E.r	N	r	P.E.r
Curriculum - math.	60	.35	.07	60	.25	.08
Division - math.	40	.22	.10	40	.33	.09
Curriculum - div. math.	100	.29	.06	100	.46	.054
Curriculum - gen.	60	.40	.07	60	.43	.067
Division - gen.	40	.28	.09	40	.48	.08
Curriculum - div. gen.	100	.40	.057	100	.29	.06

Table 2. Correlation between aptitude test scores and freshman second semester chemistry grades.

Group	With h. s. chem.			Without h. s. chem.		
Test	N	r	P.E.r	N	r	P.E.r
Curriculum - math.	57	.27	.08	51	.42	.08
Division - math.	31	.52	.088	26	.08	.13
Curriculum - div. math.	88	.27	.066	77	.33	.076
Curriculum - gen.	56	.42	.07	47	.37	.08
Division - gen.	30	.21	.11	26	.23	.12
Curriculum - div. gen.	86	.37	.062	73	.18	.076

Table 3. Distribution of percentile rankings of the 60 pairs in freshman mathematics test for each letter grade in chemistry for first semester.

Grade	Percentile									
	1 - 10	11 - 20	21 - 30	31 - 40	41 - 50	51 - 60	61 - 70	71 - 80	81 - 90	91 - 100
A-with high-school chemistry				3	1	1	2	4	2	5
A-without high-school chemistry								2	2	4
B-with high-school chemistry		1	6	1	3	1	1	1	1	1
B-without high-school chemistry			1		2	1	1	1	4	1
C-with high-school chemistry	2	3	3	2	2	2		1	5	
C-without high-school chemistry	1	1	3	4	5	2	1	2	2	1
D-with high-school chemistry				2	2					
D-without high-school chemistry	2	2	4	3	1	2	1		1	1
F-with high-school chemistry										
F-without high-school chemistry	1				1			1		

Table 4. Distribution of percentile rankings of the 40 pairs in freshman mathematics test for each letter grade in first semester chemistry.

Grade	Percentile									
	1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100
A-with high-school chemistry			1	1	1	1			3	1
A-without high-school chemistry						2				
B-with high-school chemistry		1	3			1	1	1	1	2
B-without high-school chemistry			1	1						1
C-with high-school chemistry	3	2	3	1	1	3	1	1	1	
C-without high-school chemistry		1	1	2	2	5	2	2	4	2
D-with high-school chemistry				1	1	2	2			
D-without high-school chemistry	3	1	2	1	1	2				
F-with high-school chemistry										
F-without high-school chemistry	1		1							1

Table 5. Distribution of percentile rankings of the 40 pairs in freshman general test for each letter grade in first semester chemistry

Grade	Percentile										
	1	11	21	31	41	51	61	71	81	91	
	10	20	30	40	50	60	70	80	90	100	
A-with high-school chemistry		1		1	1		1	6	1	1	
A-without high-school chemistry								1		1	
B-with high-school chemistry		3		1	1		1				
B-without high-school chemistry	1							1			
C-with high-school chemistry	3	3	2	2		1	1	1	2	1	
C-without high-school chemistry		4	2	1	3	3	1	5	3	1	
D-with high-school chemistry	2				2	1		1			
D-without high-school chemistry	1	3	1	2	1			2			
F-with high-school chemistry											
F-without high-school chemistry	2			1							

Table 6. Distribution of percentile rankings of the 60 pairs in freshman general test for each letter grade in first semester chemistry.

Grade	Percentile									
	1	11	21	31	41	51	61	71	81	91
	10	20	30	40	50	60	70	80	90	100
A-with high-school chemistry			1	1	1		3			12
A-without high-school chemistry						1	2			4
B-with high-school chemistry	1	2	1			1	2	2	6	2
B-without high-school chemistry						1	2		3	4
C-with high-school chemistry	1	2	1	2	2	4	2	1		1
C-without high-school chemistry	1	1		2	2	2	3	3	4	5
D-with high-school chemistry		1		1	1	3	1	1		
D-without high-school chemistry	1	4	3	1	2	4		1		1
F-with high-school chemistry										
F-without high-school chemistry					2					1

Further light is thrown upon the significance of the freshman list scores by referring to Tables 3, 4, 5, and 6 in which the percentile ranks on the test are tabulated for each letter grade earned by the groups in freshman chemistry. In all four tables it is clear that only a few students in the upper deciles of the freshman test without high school chemistry succeed in getting A grades in chemistry as compared with a considerable range among those that have had high school chemistry. Further comparisons in these tables follow the same clear trend.

Complete data are available for a total of 203 freshmen chemistry students who had high school chemistry and for 482 who did not have high school chemistry. Disregarding pairings, Figure 1 shows the comparative mean score of the two groups on the freshman mathematics test for each letter grade in chemistry. Figure 2 shows the same thing on the basis of scores in the freshman general ability test. Examination of these graphs shows a clear relation between freshman test scores and first semester freshman chemistry grades. It is also evident in both graphs that it takes a higher ranking on the freshman test without high school chemistry than with it to get a high grade in freshman chemistry.

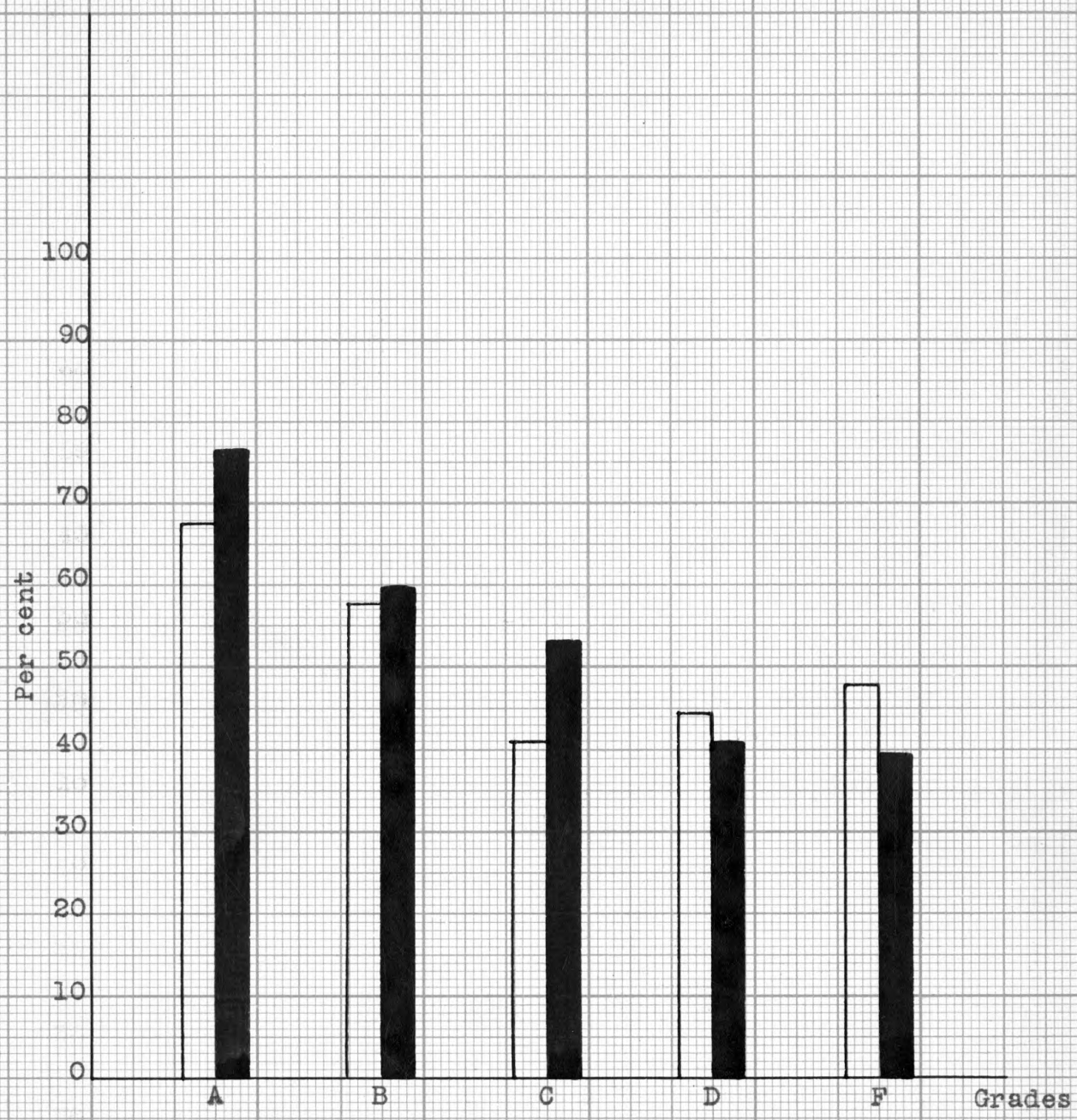

Fig. 1. Means of the mathematics test scores for those receiving the different letter grades the first semester.

□ 203 students with high school chemistry

■ 482 students without high school chemistry

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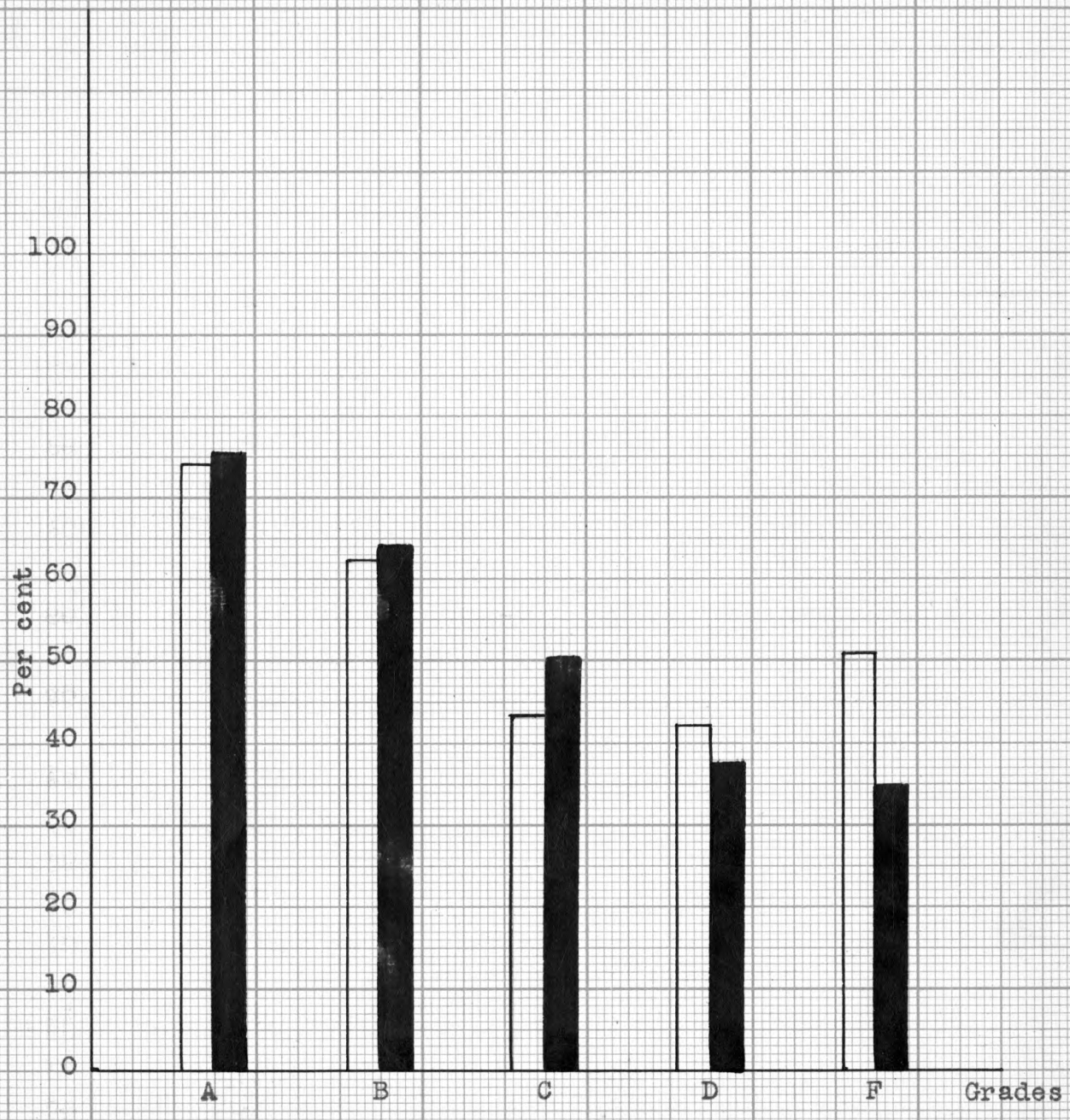

Fig. 2. Means of the general freshman scores for those receiving the different letter grades the first semester.

□ 203 students with high school chemistry

■ 482 students without high school chemistry

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In Tables 7 and 8 is found a really conclusive answer to the question to which this study is directed. Table 7, dealing with the outcome in first semester freshman chemistry, shows that in every arrangement the paired group which has had high school chemistry has made better grades than the one without by a decisive margin. In the case of the 60 pairs matched with respect to scores on the mathematics aptitude test, comparable high schools, type of town and curriculum the difference of mean grades is .70 ± .128 of a letter step with a critical ratio of 5.4. For the 40 pairs, paired by divisions instead of curricula and otherwise as above the difference is .80 ± .126 of a letter step with a critical ratio of 6.3. Since the 60 pair group and the 40 pair group were tabulated on the same scale they may be thrown together and treated as 100 matched pairs. By doing this a difference of .77 ± .095 letter step appears with a critical ratio of 8.1.

In making similar calculations for the groups matched by the freshman general aptitude test scores instead of mathematics aptitude slightly higher differences of the mean are found, the highest of all being for the 40 pairs matched also by divisions, .84 ± .146 letter step with a critical ratio of 5.7.

It will be noticed that these critical ratios range from 5.4 to 8.1. Available tables for interpreting critical ratios run up to 4 only where the chances are 997 out of 1,000. On this basis, therefore, it may be said with assurance that there is practically no chance that students with high school chemistry

will not excel students of equal ability without high school chemistry.

Table 8, for second semester freshman chemistry, naturally, because of the intervening semester of college chemistry does not show such a wide margin of difference but it is still impressive.

Table 7. Mean achievement of matched groups in first semester chemistry.

Group	With h. s. chem.			Without h. s. chem.			Diff. of means		
	N	M	SD	N	M	SD	Md	PEd%M	D/PEd
Curriculum - math.	60	3.82	1.00 ± .087	60	3.12	1.06 ± .094	.70	.128	5.4
Division - math.	40	3.56	.99 ± .086	40	2.76	.86 ± .092	.80	.126	6.3
Curriculum - div. math.	100	3.72	1.01 ± .068	100	2.95	1.00 ± .067	.77	.095	8.1
Curriculum - gen.	60	3.84	1.08 ± .094	60	3.08	1.01 ± .088	.76	.128	5.9
Division - gen.	40	3.61	1.05 ± .112	40	2.77	.88 ± .094	.84	.146	5.7
Curriculum - div. gen.	100	3.75	1.08 ± .073	100	2.95	1.90 ± .128	.80	.147	5.4

Table 8. Mean achievement of matched groups in second semester chemistry.

Group	With h. s. chem.			Without h. s. chem.			Diff. of means		
	N	M	SD	N	M	SD	Md	PEd%M	D/PEd
Curriculum - math.	57	3.41	1.10 ± .098	51	2.98	1.14 ± .107	.43	.144	3.
Division - math.	31	3.20	.94 ± .114	26	2.67	1.24 ± .16	.53	.196	2.7
Curriculum - div. math.	88	3.34	.52 ± .036	77	2.88	1.18 ± .091	.46	.097	4.7
Curriculum - gen.	56	3.33	1.10 ± .099	47	2.97	1.31 ± .128	.36	.162	2.2
Division - gen.	30	3.42	1.15 ± .141	26	2.81	.80 ± .106	.61	.176	3.5
Curriculum - div. gen.	86	3.36	1.11 ± .081	73	2.91	1.17 ± .092	.45	.122	3.7

In order to clarify further the comparative achievement in first semester freshman chemistry of students with and without high school chemistry, graphs as shown in Figures 3 to 9 have been constructed. Figure 3 includes the total unpaired groups of 203 with high school chemistry and 487 without and shows the per cent of each group that received each letter grade. It will be noted that about double the proportion of those with high school chemistry received A and B grades as compared with those without high school chemistry while in the lower grades those without high school chemistry are greatly preponderant.

Figures 4 to 9 deal in similar manner with the paired groups set up as before explained. A study of these graphs reveals in a vivid manner the great preponderance on the upper

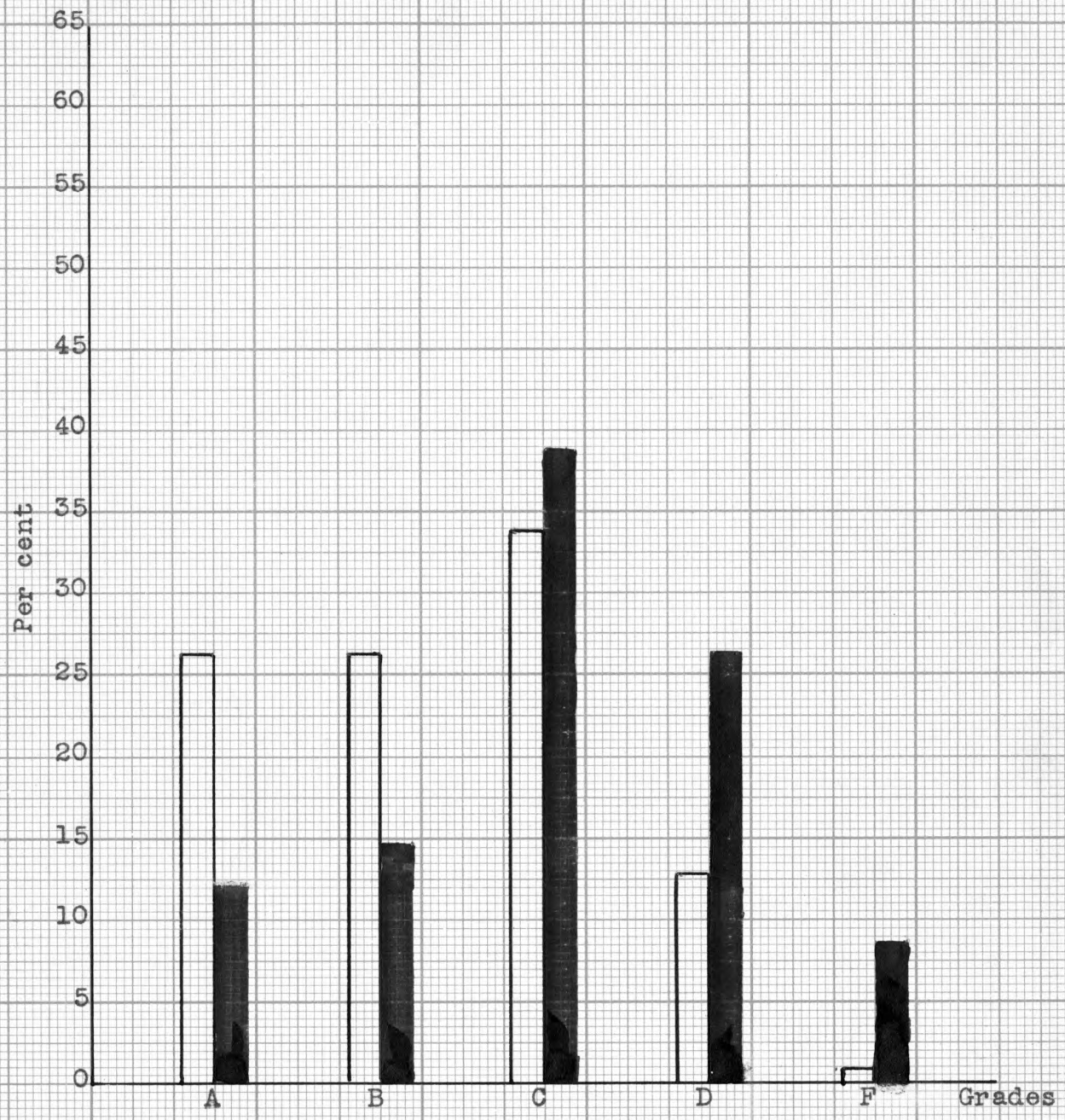

Fig. 3. Per cent of total unpaired groups of students with and without high school chemistry that earned the various letter grades in first semester freshman chemistry.

203 students with high school chemistry

487 students without high school chemistry

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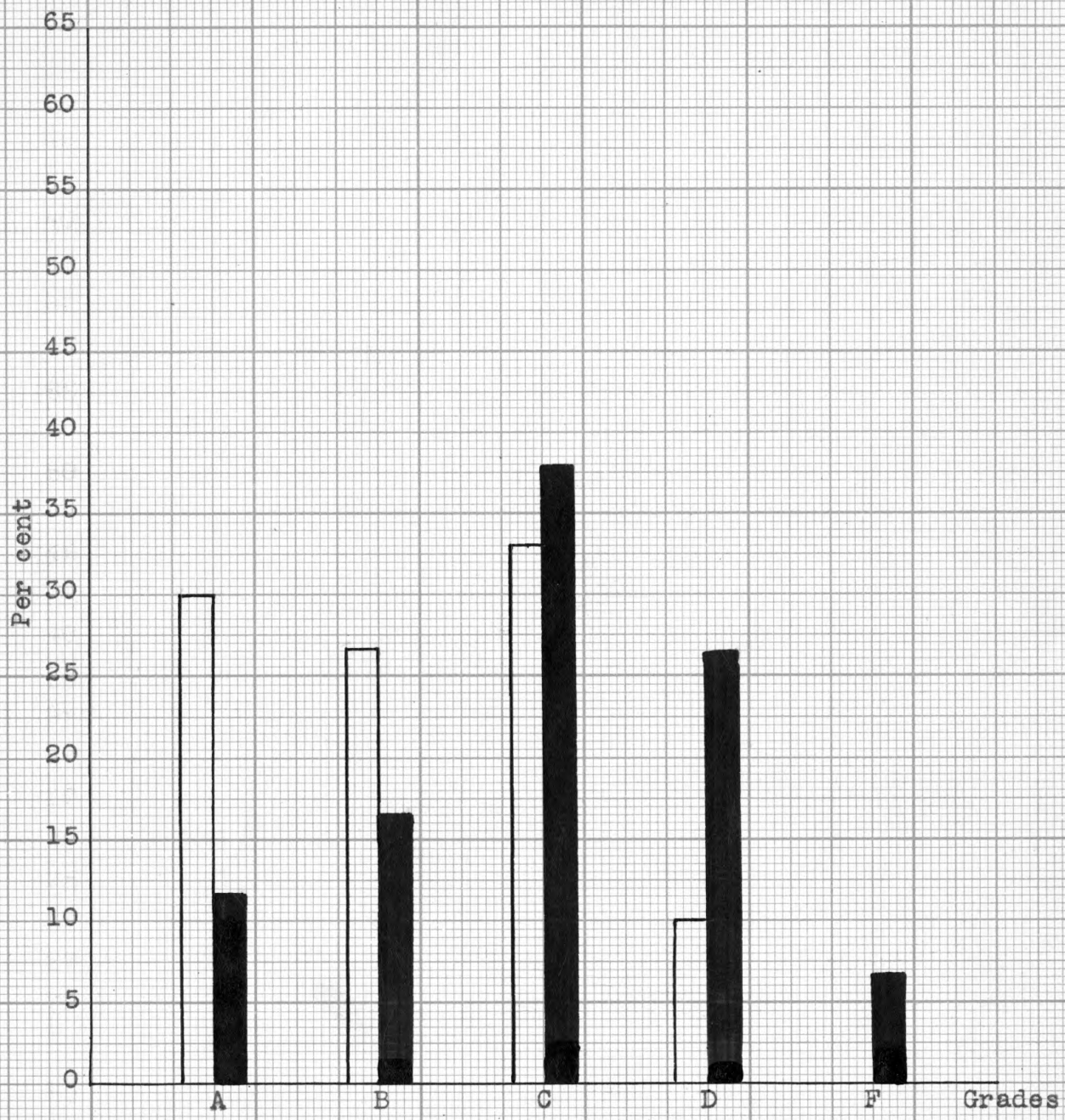

Fig. 4. Per cent of students paired by curriculum and mathematics test score that received the different letter grades in chemistry the first semester.

□ 60 students with high school chemistry

■ 60 students without high school chemistry

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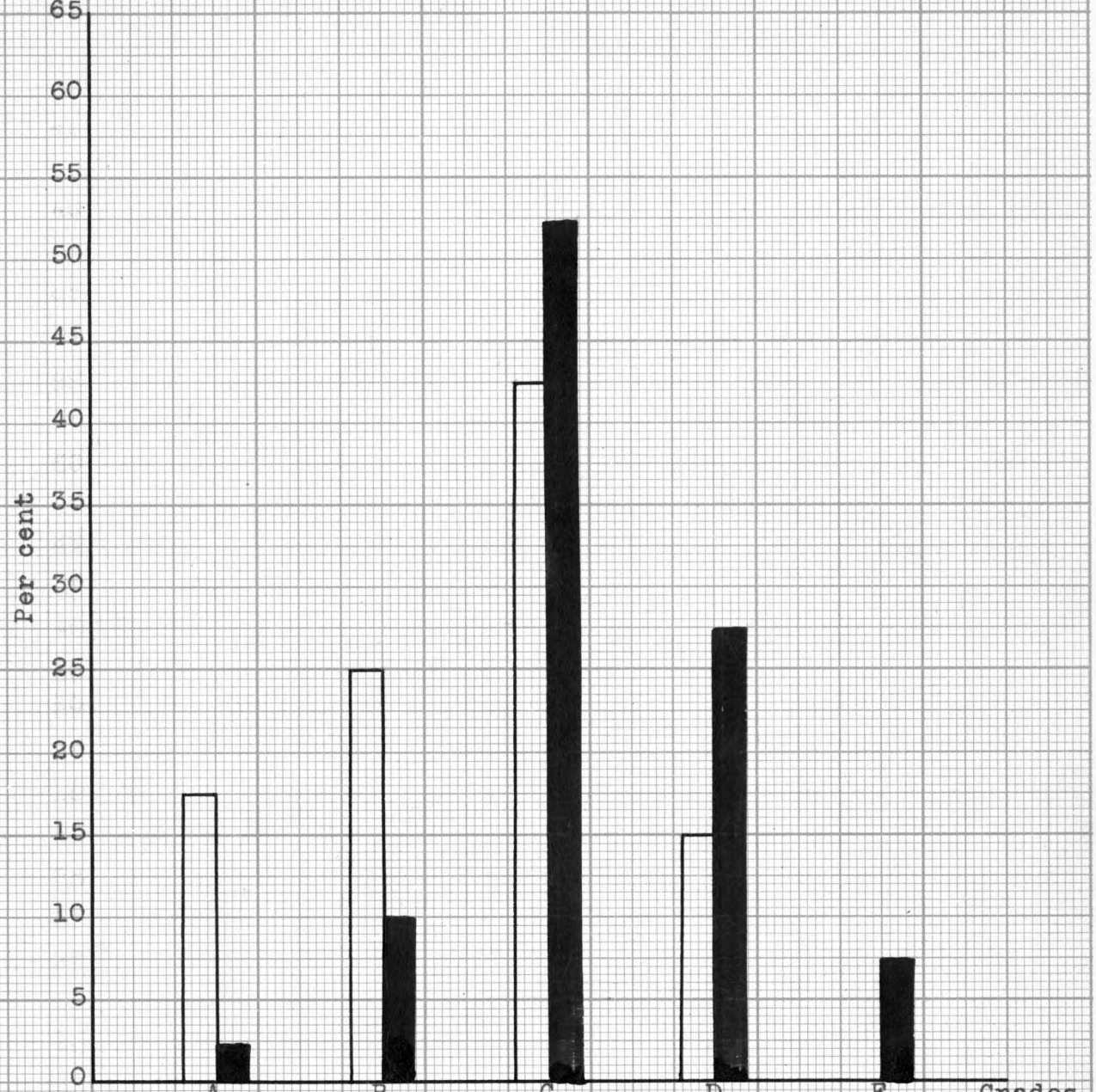

Fig. 5. Per cent of students paired by divisions and mathematics test score that received the different letter grades in chemistry the first semester.

□ 40 students with high school chemistry

■ 40 students without high school chemistry

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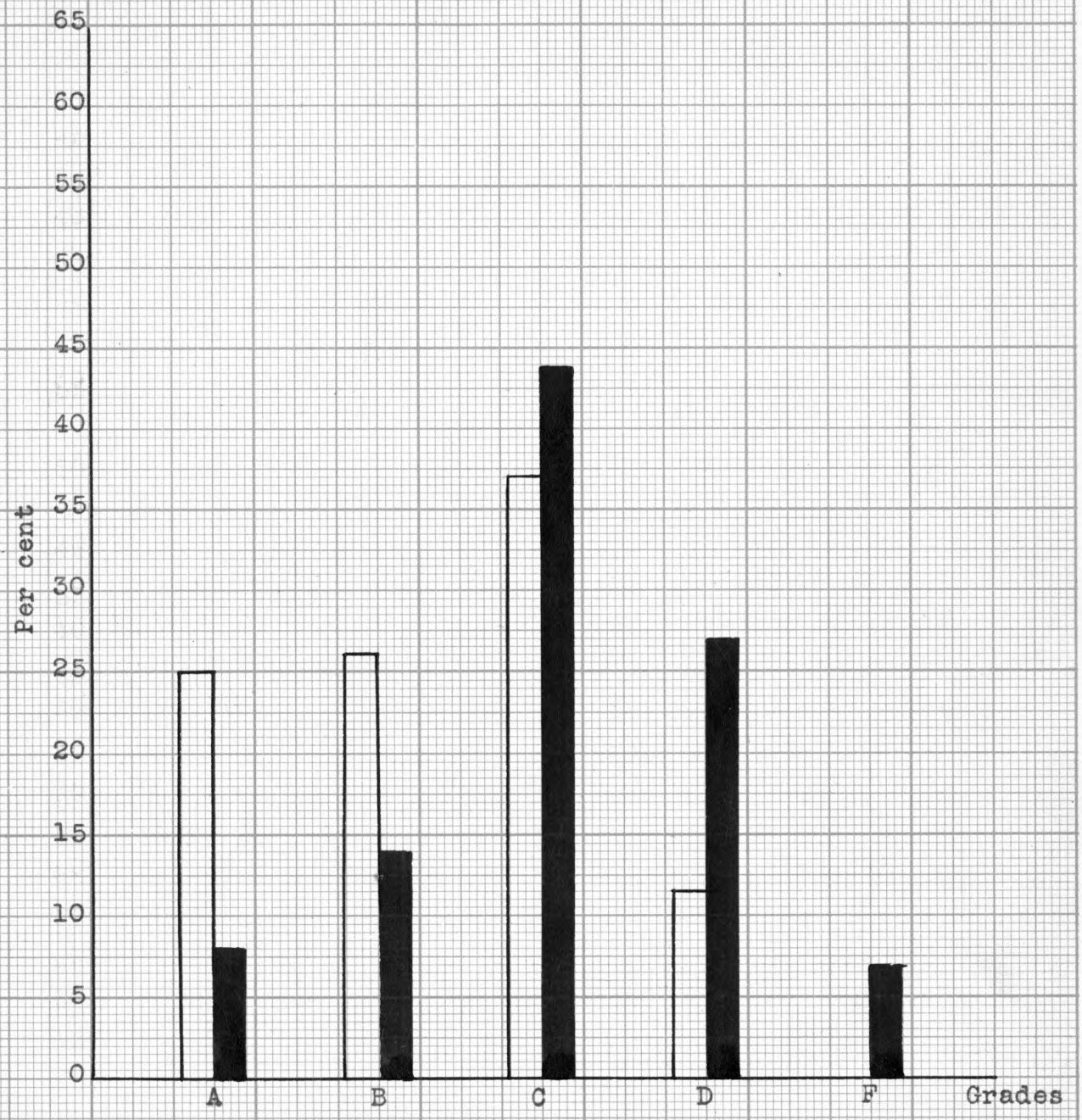

Fig. 6. Per cent of students in the combined group and mathematics test score that received the different letter grades in chemistry the first semester.

□ 100 students with high school chemistry

■ 100 students without high school chemistry

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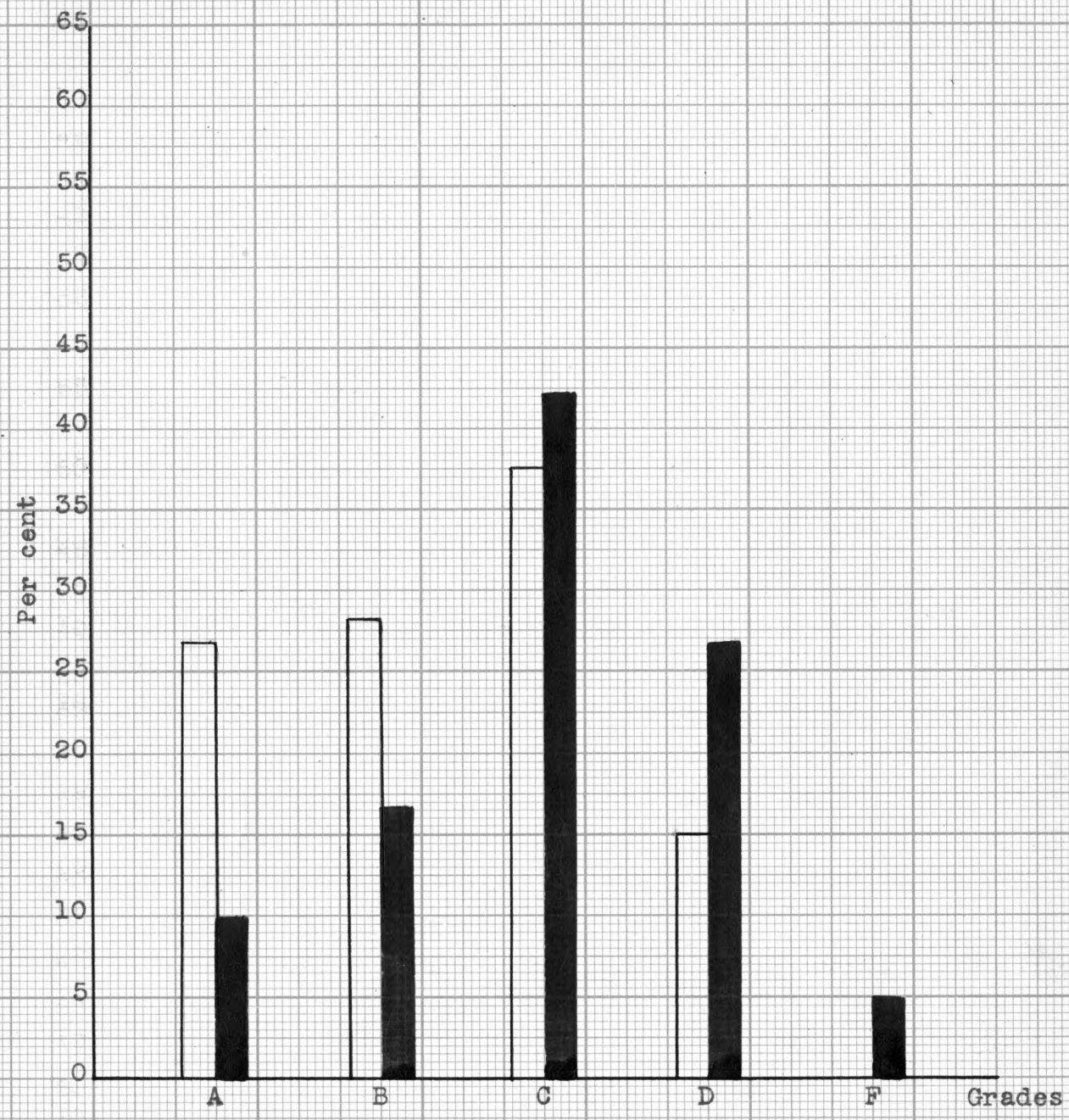

Fig. 7. Per cent of students paired by curriculum and general test score that received the different letter grades in chemistry the first semester.

60 students with high school chemistry

60 students without high school chemistry

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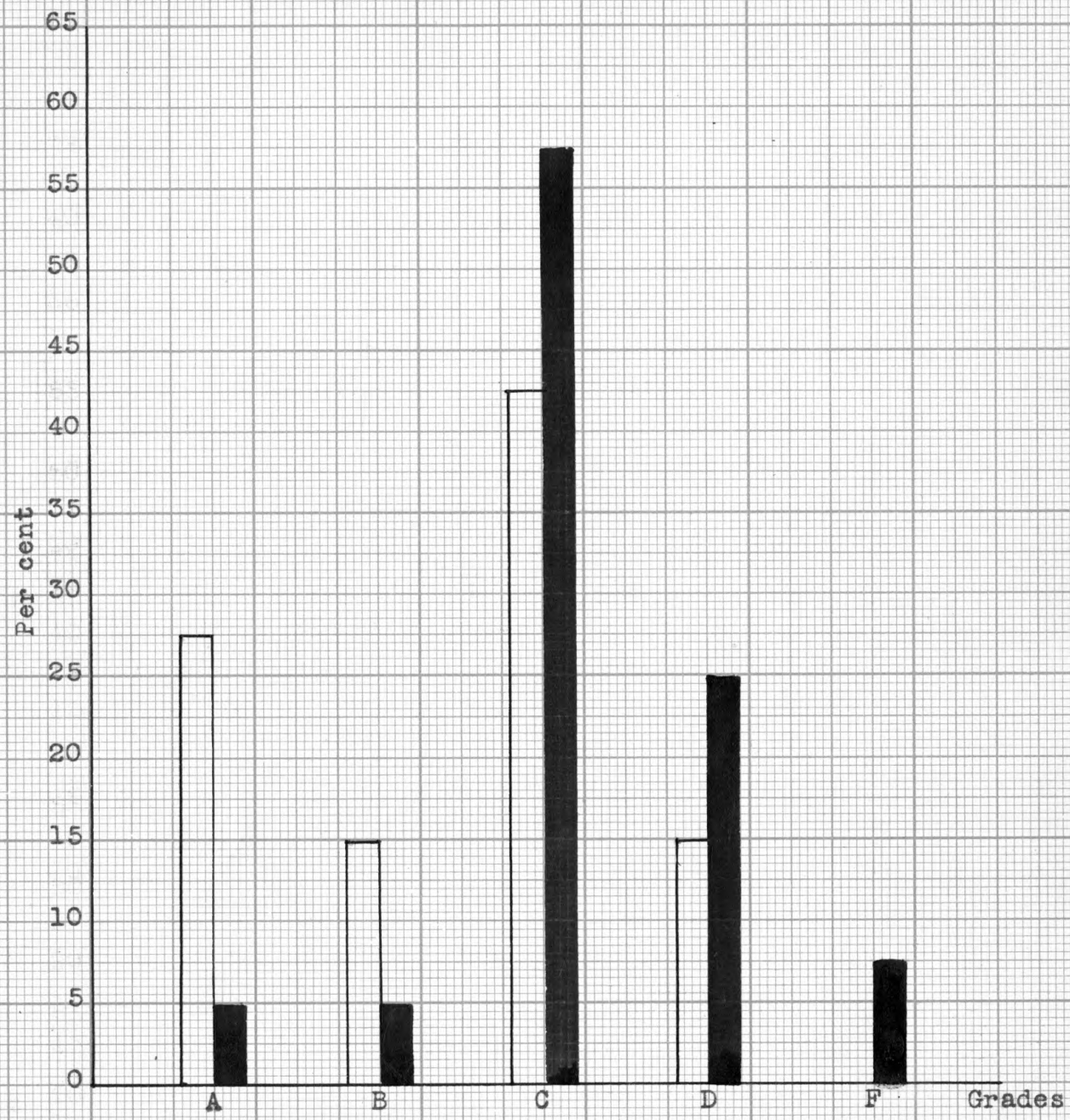

Fig. 8. Per cent of students paired by divisions and general test score that received the different letter grades in chemistry the first semester.

□ 40 students with high school chemistry

■ 40 students without high school chemistry

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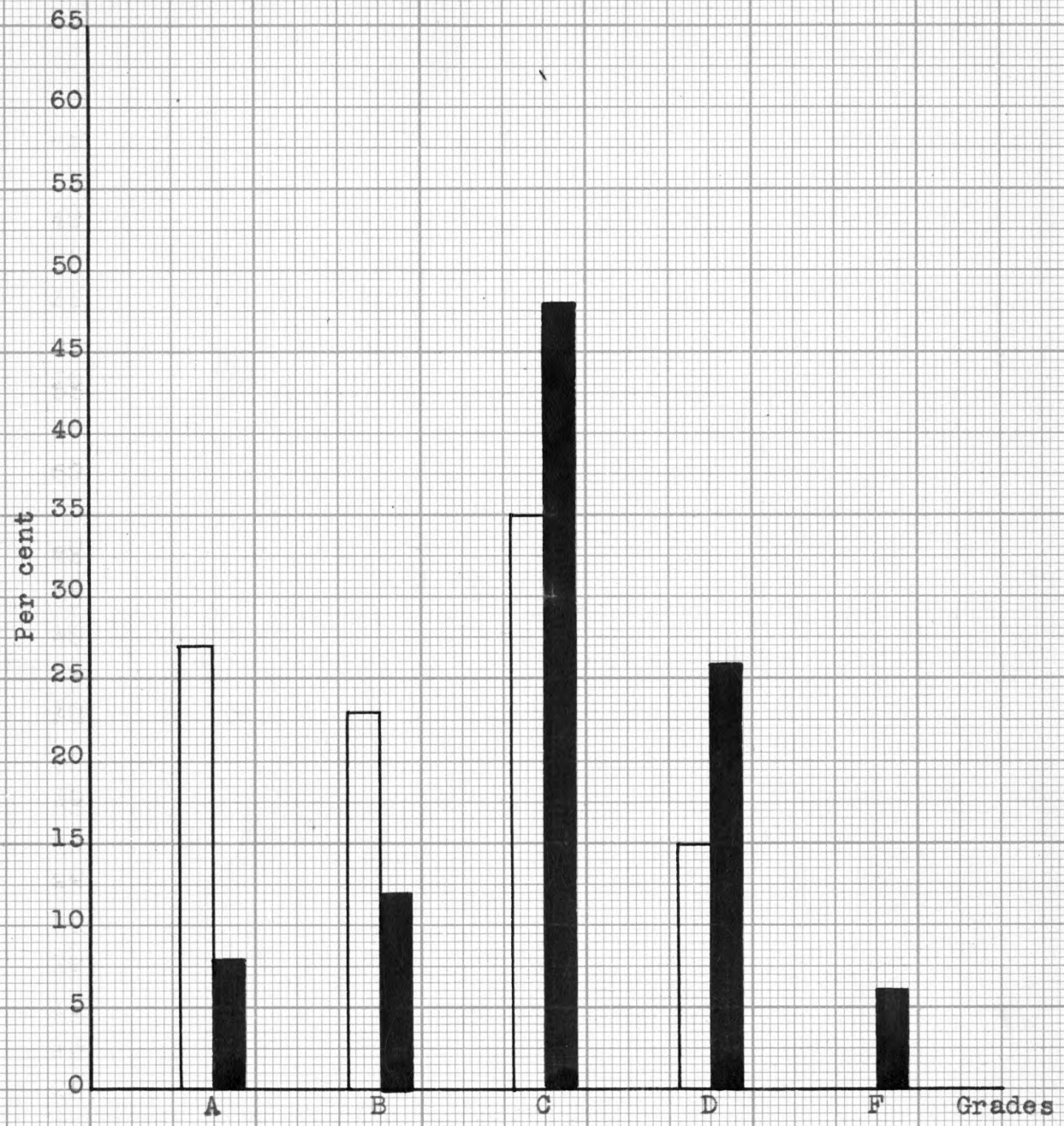

Fig. 9. Per cent of students of the combined group and general test score that received the different letter grades in chemistry the first semester.

□ 100 students with high school chemistry

■ 100 students without high school chemistry

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grade levels of the students who have had high school chemistry and a similar preponderance on the lower grade levels of those who have not had high school chemistry.

Naturally the question arises as to whether the effect of high school chemistry carries over into second semester freshman chemistry. The question is considerably complicated as before explained by the fact that nearly 18 per cent of those with high school chemistry and about 30 per cent of those without high school chemistry dropped out. Neither must we lose sight of the fact that a semester of college chemistry has intervened. For the second semester graphs shown in Figures 10 to 16 have been prepared in identically the same manner as those for the first semester. A perusal of these graphs shows the same trends as in the first semester with somewhat less uniformity and the differences not as large on an average. One particularly striking case comes out with the 21 pairs of students paired by division and general freshman test score among which not a single student without high school chemistry succeeded in getting an A grade.

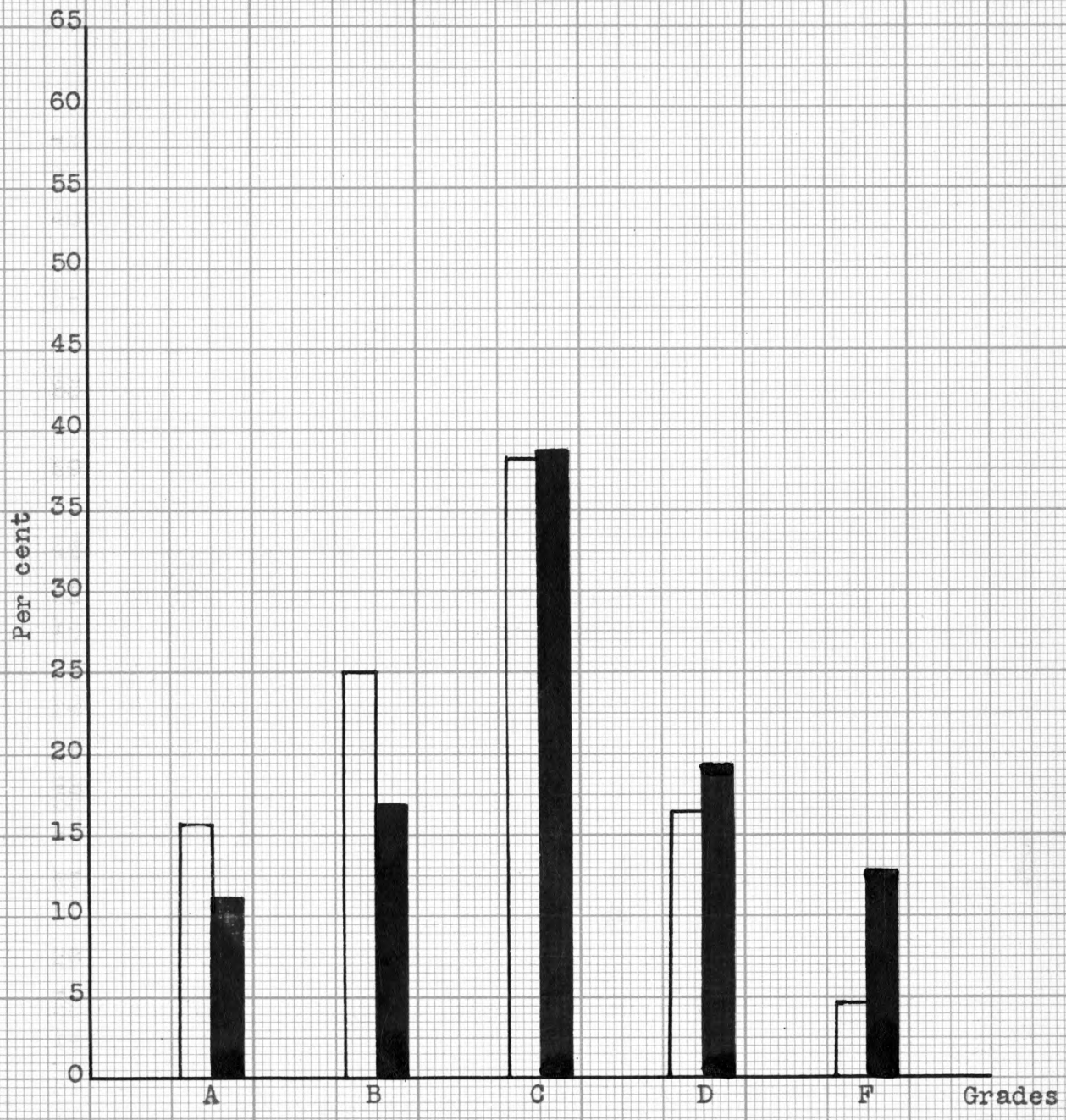

Fig. 10. Per cent of total unpaired groups of students with and without high school chemistry that earned the various letter grades in second semester freshman chemistry.

□ 167 students with high school chemistry

■ 345 students without high school chemistry

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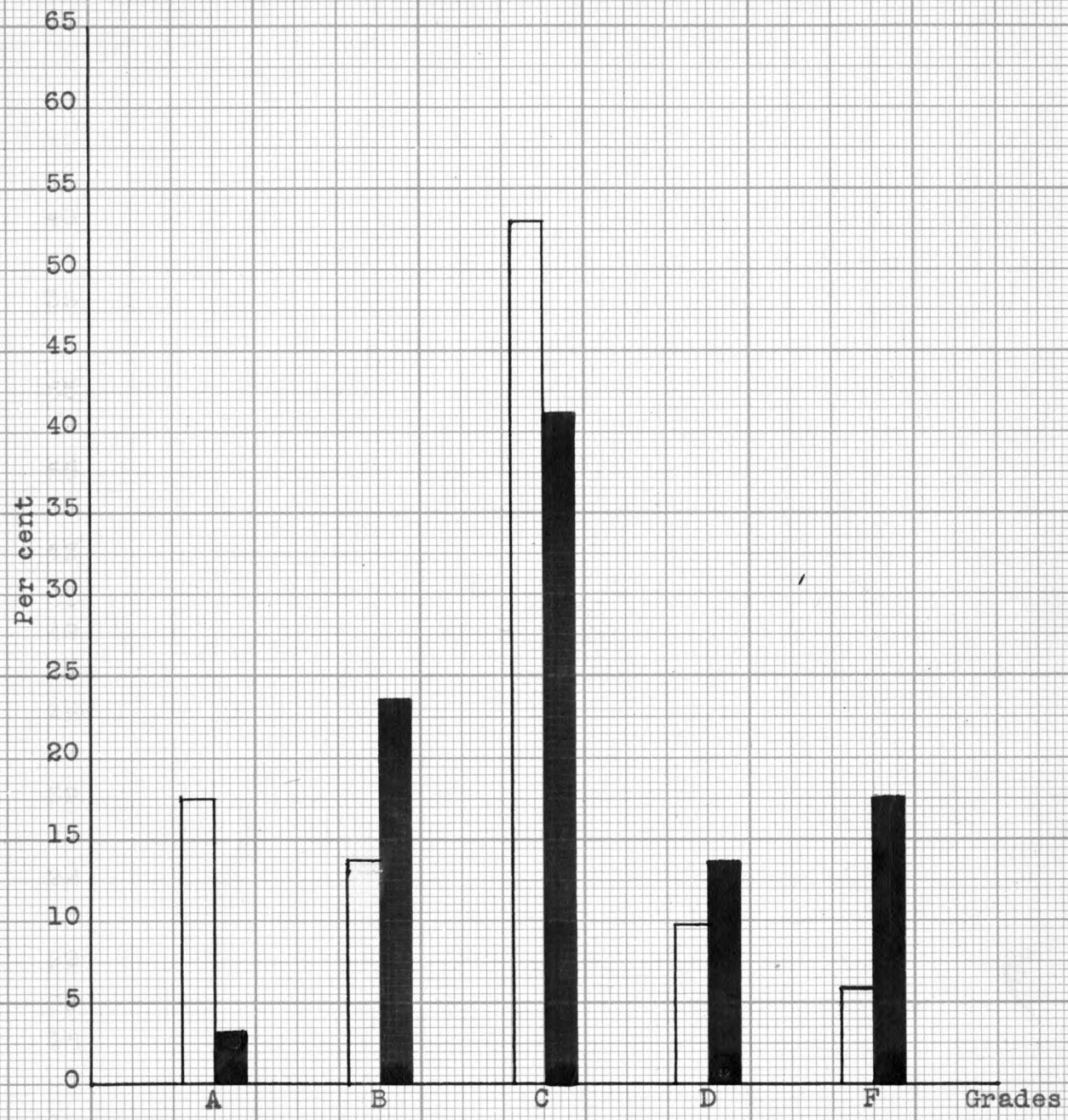

Fig. 11. Per cent of students paired by curriculum and mathematics test score that received the different letter grades in chemistry the second semester.

□ 51 students with high school chemistry

■ 51 students without high school chemistry

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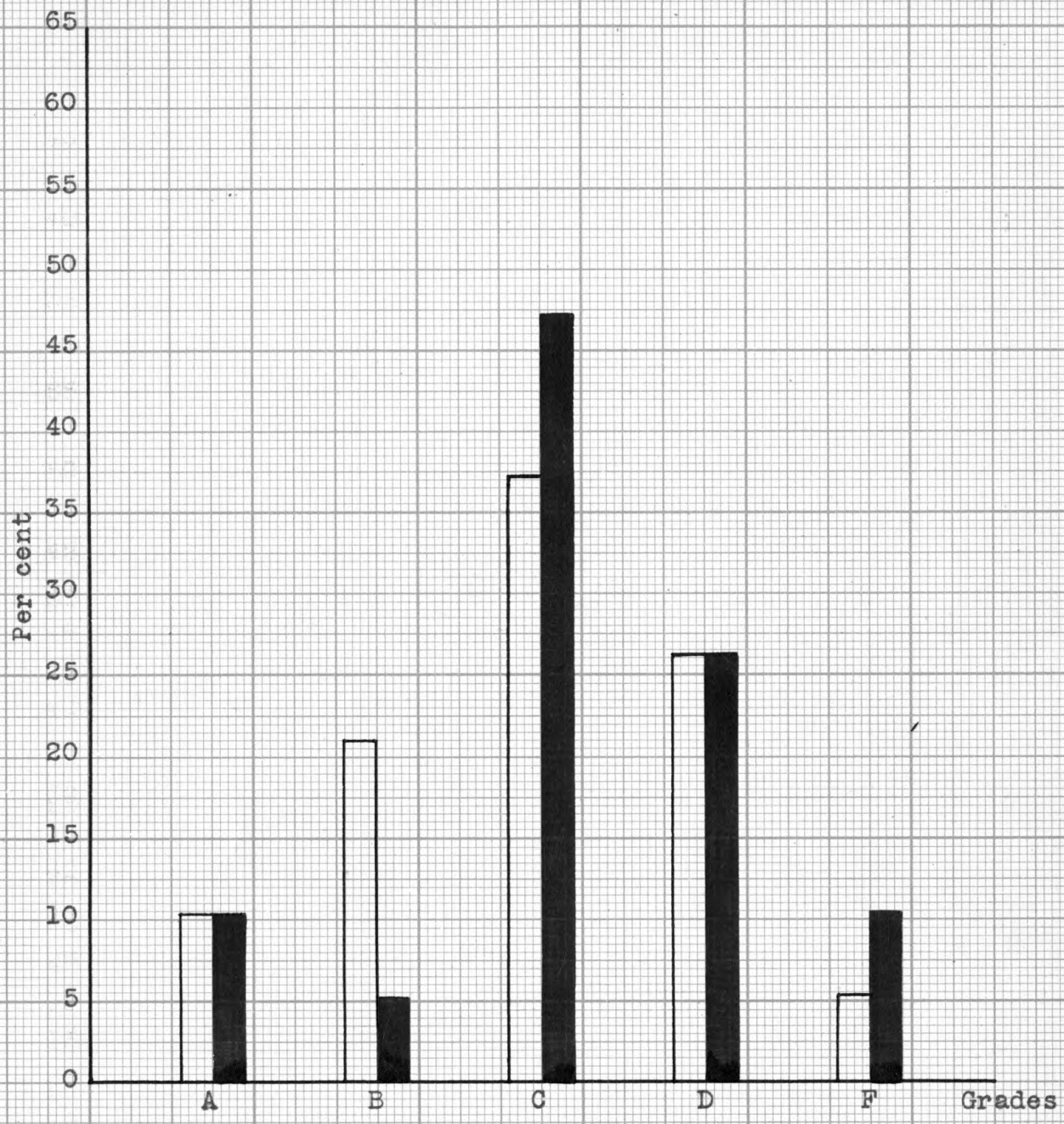

Fig. 12. Per cent of students paired by curriculum and mathematics test score that received the different letter grades in chemistry the second semester.

□ 19 students with high school chemistry

■ 19 students without high school chemistry

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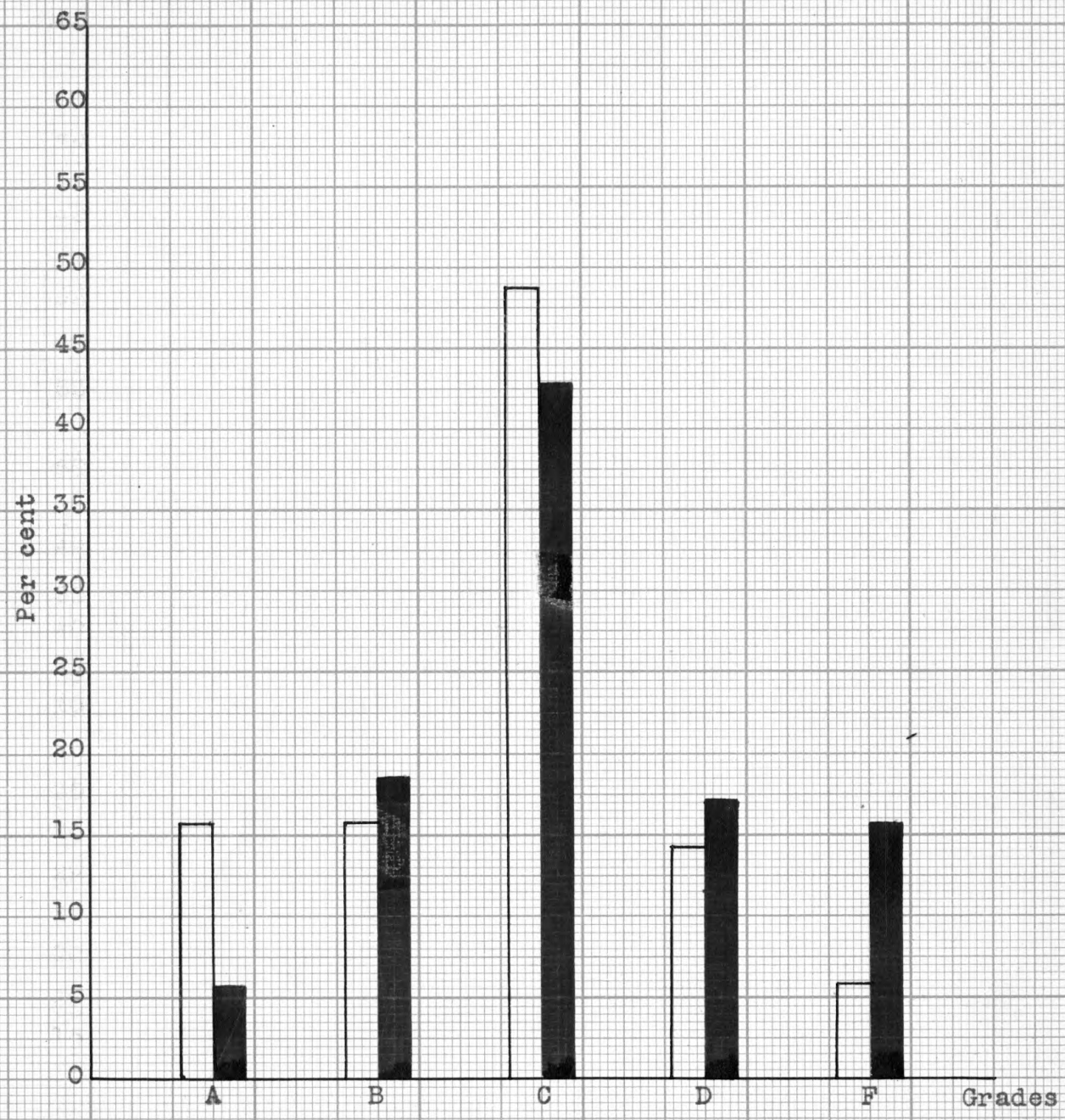

Fig. 13. Per cent of students of the combined group and mathematics test score that received the different letter grades in chemistry the second semester.

□ 70 students with high school chemistry

■ 70 students without high school chemistry

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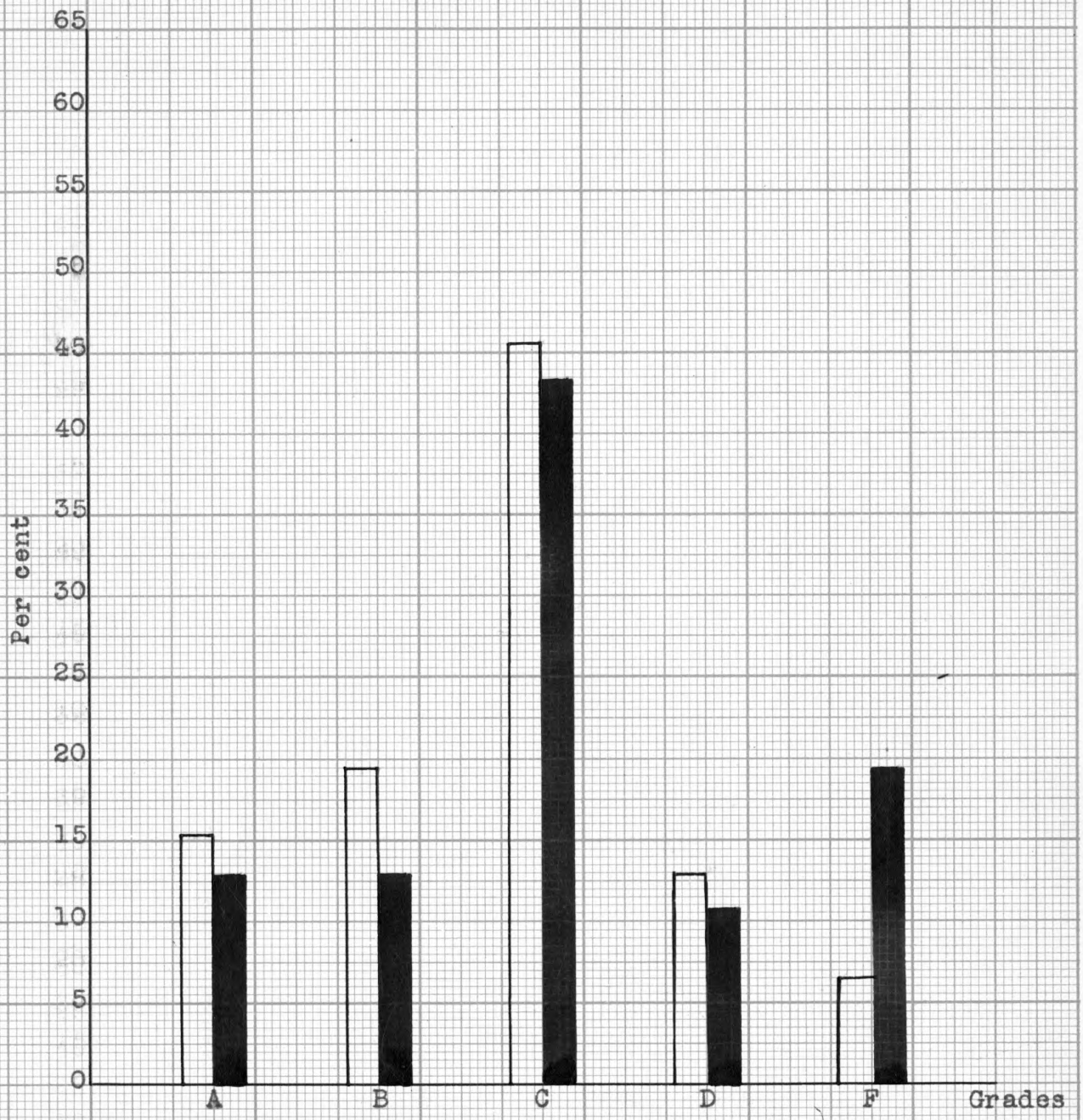

Fig. 14. Per cent of students paired by curriculum and general test score that received the different letter grades in chemistry the second semester.

46 students with high school chemistry

46 students without high school chemistry

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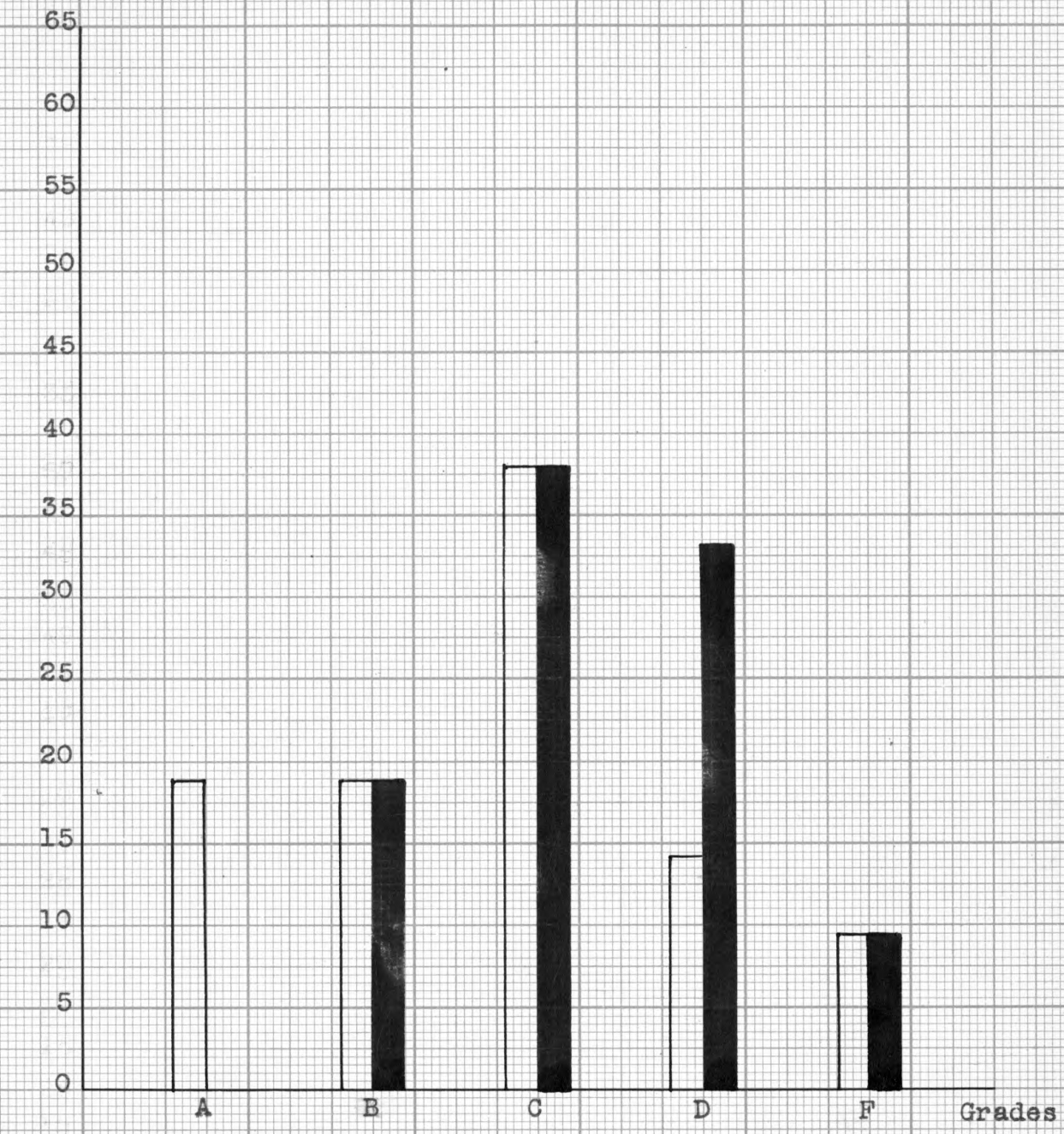

Fig. 15. Per cent of students paired by division and general test score that received the different letter grades in chemistry the second semester.

21 students with high school chemistry

21 students without high school chemistry

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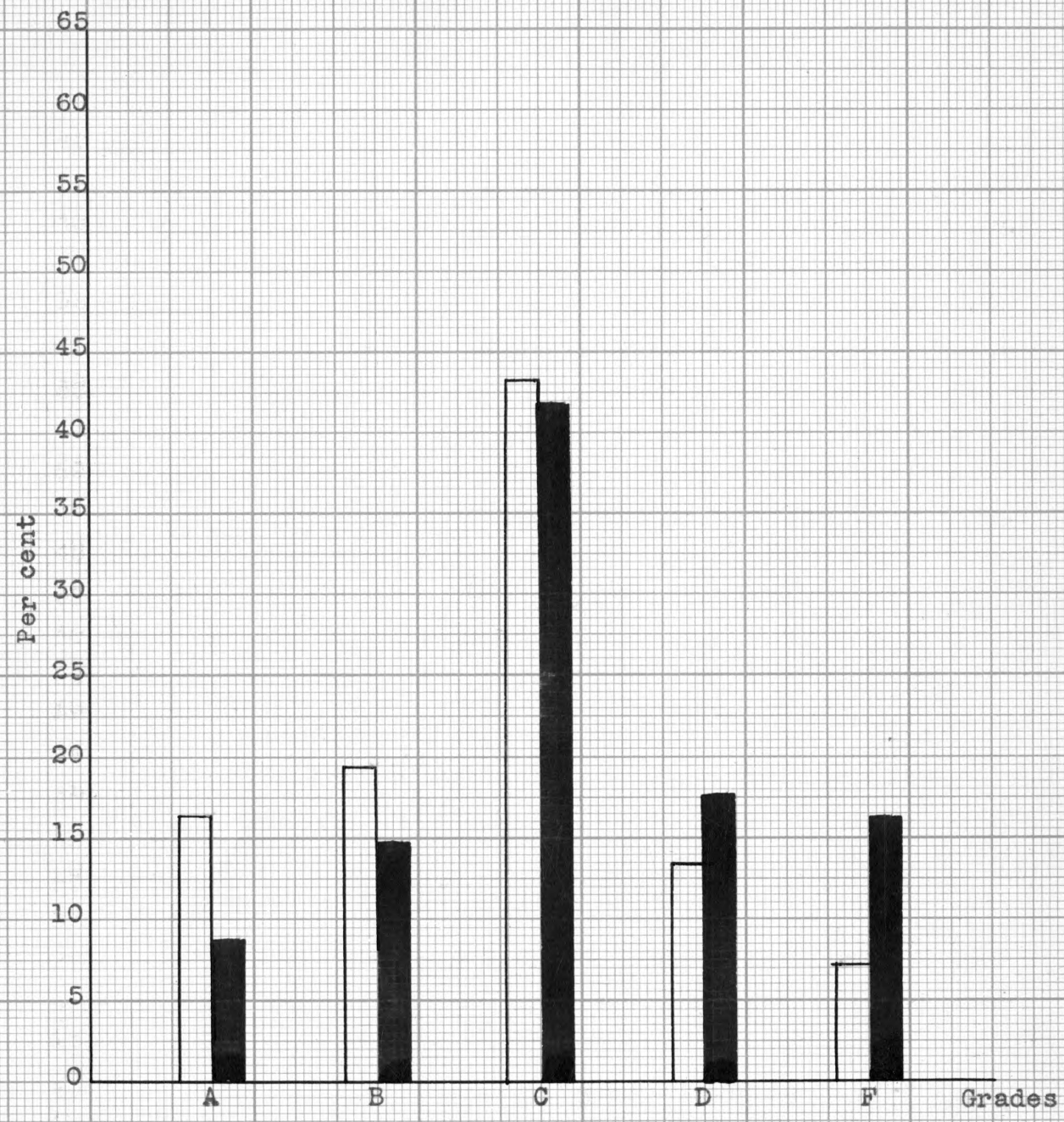

Fig. 16. Per cent of students of the combined group and general test score that received the different letter grades in chemistry the second semester.

67 students with high school chemistry

67 students without high school chemistry

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It is often suggested that the type of school has much to do with the efficiency of its courses and the kind of students produced. With this in mind all the students for which data were gathered have been classified irrespective of pairings by schools in college towns, first class cities, second class cities, third class cities including rural high schools, and one selected second class city of high type. In each case the pupils were divided into two groups, one having had high school chemistry and the other not, and the per cent receiving each letter grade calculated. Results appear in Tables 9 to 13.

Examination of these tables reveals the same trend as all of the other tabulations. Without exception the pupils with high school chemistry have excelled by far those without it, the proportion receiving A and B grades in chemistry ranging from two to nearly five times as large. On the contrary the proportion of those without high school chemistry who received D and F grades ranged from two to 17 times as great. In the selected second class city, of the 44 who had high school chemistry not a single one failed.

Table 9. Students from college towns.

1st Semester	
90 With h. s. chemistry	61 Without h. s. chemistry
24 received A - 26.67 %	6 received A - 9.83 %
20 received B - 22.22 %	4 received B - 6.56 %
36 received C - 40.00 %	20 received C - 32.78 %
9 received D - 10.00 %	24 received D - 39.34 %
1 received F - 1.11 %	7 received F - 11.48 %

2nd Semester	
71 With h. s. chemistry	48 Without h. s. chemistry
11 received A - 15.49 %	2 received A - 4.17 %
16 received B - 22.53 %	5 received B - 10.42 %
28 received C - 39.44 %	16 received C - 33.33 %
13 received D - 18.31 %	18 received D - 37.50 %
3 received F - 4.23 %	7 received F - 14.58 %

Table 10. Students from first class cities.

1st Semester	
63 With h. s. chemistry	57 Without h. s. chemistry
11 received A - 17.45 %	5 received A - 8.77 %
15 received B - 25.00 %	4 received B - 7.02 %
25 received C - 39.68 %	24 received C - 42.11 %
11 received D - 17.45 %	17 received D - 29.82 %
1 received F - 1.61 %	7 received F - 12.28 %

Table 10. Concluded.

2nd Semester	
53 With h. s. chemistry	43 Without h. s. chemistry
7 received A - 13.46 %	0 received A -
13 received B - 25.00 %	5 received B - 11.63 %
17 received C - 32.70 %	16 received C - 37.21 %
11 received D - 21.15 %	13 received D - 30.23 %
4 received F - 7.69 %	9 received F - 20.93 %

Table 11. Students from second class cities.

1st Semester	
113 With h. s. chemistry	103 Without h. s. chemistry
35 received A - 30.97 %	12 received A - 11.65 %
30 received B - 26.55 %	18 received B - 17.48 %
36 received C - 31.86 %	40 received C - 38.83 %
11 received D - 9.73 %	25 received D - 24.27 %
1 received F - .89 %	8 received F - 7.77 %

2nd Semester	
93 With h. s. chemistry	79 Without h. s. chemistry
20 received A - 25.51 %	11 received A - 13.92 %
28 received B - 30.11 %	19 received B - 24.05 %
30 received C - 32.26 %	27 received C - 34.18 %
13 received D - 13.97 %	12 received D - 15.19 %
2 received F - 2.15 %	10 received F - 12.66 %

Table 12. Students from third class city and rural high schools.

1st Semester	
27 With h. s. chemistry	298 Without h. s. chemistry
7 received A - 25.93 %	40 received A - 13.42 %
8 received B - 29.63 %	46 received B - 15.47 %
8 received C - 29.63 %	114 received C - 38.22 %
4 received D - 14.81 %	78 received D - 26.18 %
0 received F - 0.00 %	20 received F - 6.71 %

2nd Semester	
22 With h. s. chemistry	225 Without h. s. chemistry
5 received A - 22.72 %	30 received A - 13.33 %
3 received B - 13.64 %	35 received B - 15.56 %
10 received C - 45.45 %	89 received C - 39.56 %
3 received D - 13.64 %	46 received D - 20.44 %
1 received F - 4.55 %	25 received F - 11.11 %

Table 13. Students from selected second class cities.

1st Semester	
44 With h. s. chemistry	18 Without h. s. chemistry
20 received A - 45.45 %	3 received A - 16.67 %
11 received B - 25.00 %	0 received B - 0.00 %
12 received C - 27.27 %	8 received C - 44.44 %
1 received D - 2.27 %	6 received D - 33.33 %
0 received F - 0.00 %	1 received F - 5.56 %

Table 13. Concluded.

2nd Semester	
35 With h. s. chemistry	13 Without h. s. chemistry
5 received A - 14.29 %	1 received A - 7.69 %
13 received B - 37.14 %	2 received B - 15.38 %
11 received C - 31.43 %	4 received C - 30.77 %
6 received D - 17.14 %	2 received D - 15.38 %
0 received F - 0.00 %	4 received F - 30.77 %

It may be suggested that those who took high school chemistry were a selected group of better ability. Bearing on this point a calculation of the mean freshman test scores for the two groups reveals that on the general aptitude test for those with high school chemistry the mean score was 55.7 and for those without, 51.33. This small difference certainly would not account for the large difference in chemistry outcomes. Furthermore, the mean scores on the freshman mathematics aptitude tests for these two groups were 52.46 and 52.37 respectively, almost identical. It may be remembered in this connection that rather generally the predictive value of the mathematics test proved a trifle better.

The comparisons reveal that seven per cent of the students from first class cities fail, of these 87 per cent did not have chemistry in high school; also that four per cent of the students from second class cities fail, of these 90 per cent did

not have chemistry in high school; and that seven per cent of the students from third class cities and rural high schools fail, of these 97 per cent did not have chemistry in high school.

SUMMARY

1. In order to determine the effects of high school chemistry on success in college freshman chemistry data were collected for 690 freshman students enrolled in college chemistry at Kansas State College, September, 1939. Of these 203 had had high school chemistry and 487 had not.
2. Two paired groups were set up, one of 60 pairs, paired by freshman general aptitude test score, mathematics aptitude, comparable schools and curriculum; and one of 40 pairs by the same criteria except that college divisions were used in the place of curricula. Tabulations were made for the whole group and paired groups and statistical treatment was worked out.
3. Correlation between chemistry grades and freshman test scores proved that these scores have significant predictive value for success in chemistry.
4. Without exception all tabulations and comparisons indicated that freshman chemistry students who had high school chemistry excelled those who did not by a wide margin of statistical significance.
5. Calculation of mean differences and critical ratios

for the various classifications revealed that the student with high school chemistry had from 930 to 997 chances out of 1,000 to get a better freshman chemistry grade.

6. While there were minor variations chemistry training in any type of high school proved highly valuable.
7. Of the freshmen who took chemistry at Kansas State College in 1939, only 29 per cent had high school chemistry.
8. High school students who plan to take college curricula including chemistry should be counseled to take the high school chemistry course.
9. The clearly different levels of achievement of those with and without high school chemistry suggests the advisability of sectioning classes on this basis.
10. Both colleges and high schools should understand clearly the effect of high school chemistry on college success in the subject.
11. Ninety per cent of the failures in college chemistry appeared to be students who had not had high school chemistry.
12. Chemistry merits much more attention in high schools of the state than it is receiving.

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