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THE TECHNE

Life Without Labor is a Crime, Labor Without Art and the Amenities of Life is Brutality.—Ruskin.

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Sail—sail thy best, ship of Democracy!
Of value is thy freight—'tis not the Present only,
The Past is also stored in thee!
Thou holdest not the venture of thyself alone—not
of the western continent alone;
Earth's résumé entire floats on thy keel, O ship—
is steadied by thy spars;
With thee Time voyages in trust, the antecedent
nations sink or swim with thee,
With all their ancient struggles, martyrs, heroes,
epics, wars, thou bearest the other continents;
Theirs, theirs as much as thine, the destination-port
triumphant;
Steer then with good strong hand and wary eye,
O helmsman—thou carriest great companions,
Venerable, priestly Asia sails this day with thee,
And royal feudal Europe sails with thee...
How can I pierce the impenetrable blank of the
future?
I feel thy ominous greatness, evil as well as good;
I watch thee, advancing, absorbing the present,
transcending the past;
I see they light lighting and they shadow shadow-
ing, as if the entire globe;
But I do not undertake to define thee—hardly to
comprehend thee.

—Walt Whitman

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THE TECHNE publishes, for the most part, papers on educational subjects, though articles on closely related fields are also used. Part of these papers set forth the results of research; others aim at interpretation of current developments. Though some of the discussions will interest the specialist, it is hoped that in every number there will be something useful for the average teacher.

THE TECHNE is sent free to alumni, school officials, libraries, and, on request, to any person interested in the progress of education.

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ORGANIZATION OF THE GENERAL SHOP

E. W. Baxter, Assistant Professor of Industrial Education

The term general shop, is recognized as referring to the school shop equipped and organized to give instruction in two or more types of shop work. This might include work with wood, metal, concrete, electricity, or any other type of shop experience. The general shop is distinctly different from the general wood shop, or the general metal shop, both its organization, management, and method used in accomplishing the objectives. The main objectives are the same in the general shop as in the unit shop, when they are used for general educational purposes. The general shop is usually recognized as the best type of organization, by which a small number of students are to be served. The small school will employ only one shop instructor in most cases. This means that unless the general shop plan is used, the student will experience only one type of shop work, probably wood work.

There exists two types of organization of the general shop. In one the students rotate in the shop from one type of work to another, completing a prescribed number of units in each type of work offered. The other plan of organization is on the general shop project plan. In this plan the course of instruction will follow the type of project in hand. The general shop project will require that instruction and practice in the various types of shop work be given during the construction of the project. In this type of organization the project will involve more than one type of shop experience, also various materials and equipment.

Kilpatrick[1] defines the project as to the elements it should possess. Perhaps chief among them is that a project should represent hearty, purposeful activity on the part of the pupil. He furthermore holds that the hearty purposeful act should be carried on in a social environment. He distinguishes between four types of projects: (1) The producer type; (2) the consumer type; (3) the problem type; and (4) the learning type.

As to instruction sheets Struck[2] states, that any or all instructional material may be used in industry for the primary purpose of getting out production, but under school conditions, education or instruction becomes the major aim, and production when it is involved is merely a means to an end—the end or outcome desired being additional knowledge, skill and mental power on the part of the learner. He classifies the industrial arts education in the junior and senior high school as follows: (1) The unit shop; (2) the general shop; and (3) the modified general shop. In the true general shop as many as four types of industrial arts education are given by the one teacher. Relatively few teachers will undertake so difficult a task. Fortunately we are gradually developing the necessary system and technique which enables teachers by the aid of special devices such as instruction sheets to do creditable work under such conditions. Industrial arts education is an asset of and supplements general

education. Practice and theory go hand-in-hand, each may lead to improvement and refinement in the other.

Through the project method of teaching the hand and head work are correlated. It is easy to stress tool skill at the expense of developing wider interests and appreciations and easy to give information where the pupil should secure it through personal application and effort. The real teacher will see to it that industrial arts education is an education involving both mind and muscle.

The following is a list of some of the major industrial arts aims:

1. To provide exploratory experiences.
2. To provide experiences with various tools and materials.
3. To develop an understanding and appreciation of the world's works.
4. To develop desirable skill and habits.
5. To develop desirable aptitudes and ideals.
6. To utilize the students' interests and to develop desirable permanent interests.
7. To provide an opportunity for intellectual growth through the co-ordination of mental and physical experiences.
8. To provide pre-vocational training through contact with typical elements of trades and occupations.

These skills, habits, attitudes and ideals are learned in a variety of ways: Through participation; through observation; through study; and through inspection trips.

STEPS IN THE ORGANIZATION OF THE GENERAL SHOP

I. Establish clearly defined aims and objectives to be reached through this method of instruction.

II. Determine the experiences to be encountered by the student.

III. Arrange a list of the informational material to be used in the course.

IV. Select a group of problems or projects which will serve as a means of providing the student with the desired experiences.

V. Make an analysis of the problems to determine their order of presentation.

VI. Arrange adequate written instructional material.

VII. Make a list of related material which will make the teaching more effective.

VIII. Make a list of supplementary problems.

IX. Make a reference list of applicable teaching methods.

X. Devise a students' progress chart.

XI. Arrange for permanent class records.

XII. Provide a record system of materials on hand, used, and needed.

XIII. Arrange for testing the student's acquisition and use of subject matter.

[1] Kilpatrick, Wm. H. *The Project Method.* Teachers College, Columbia University, Bureau of Publications (Bulletin 1918).

[2] Struck, F. T. *Methods and Teaching Problems in Industrial Education.* John Wiley & Sons, Inc., New York. 1929.

TRADE AND INDUSTRIAL EDUCATION IN COLORADO

Forrest K. Bryan, Assistant Professor of Industrial Education

(This is a portion of an unpublished master's thesis bearing the same title on file at The Colorado State Teachers College, Greeley, Colorado.)

Vocational training is one of the younger major attempts in education. Its purpose is to fit people of employable age for effective entrance into some gainful manufacturing or mechanical pursuit, or to give extension training along the industrial line in which the individual is employed. Much of our present day education of this type is conducted under regulations as set forth by the National Vocational Educational Act of 1917. Other than yearly reports of the Federal Board for Vocational Education, little study has been made of this education which continues to be a part of our national educational system.

The purpose of this paper is to present two phases of vocational education as it is found in Colorado. They are, (1) the scope of service in the state and (2) the comparison of costs with other forms of education.

State reports to the Federal Board yielded most of the data. Colorado accepted the National Vocational Educational Act in 1917. However, only yearly reports for July 1, 1923 to June 30, 1928 were used. This period was selected to avoid the readjustment following the war and the experimental stage through which each new type of education must pass.

In scope of service, reports revealed that both men and women received training in evening, part-time and general continuation classes. No classes were scheduled entirely for women in day-trade classes. Women were most interested in general continuation courses, Table I, column 4, item 2. This type of training is an attempt to continue where an individual left off in public school life in the grades below the high school.

TABLE I

THE NUMBER OF COURSES OFFERED IN TRADE AND INDUSTRIAL EDUCATION DURING THE PERIOD 1924 TO 1928

Number of Courses for	Evening	Part Time	General Continuation	Day Trade	Total
1	2	3	4	5	6
1. Men	664	41	27	17	749
2. Women	15	11	22	0	48
3. Both Sexes	18	98	23	0	139
4. Total	697	150	72	17	936

Mixed groups ran highest in part-time class work, Table I, column 3, item 3. Part-time training is to aid the young people in attaining trade efficiency in their chosen occupation. Such classes are often organized during "slack seasons" of certain occupations. However,

classes are held for stenographers, bookkeepers and other clerical workers at any time during the year that the need arises.

Men seemed to find evening courses most convenient in a day's program as noted in Table I, column 2, item 1. Evening courses are intended to supplement the daily employment of those sixteen years of age and above who have definitely entered the trade.

Evening and part-time training show the largest number of classes, Table I, column 1, item 4. The growth of these two types in Colorado is comparable to the findings of the Federal Board as expressed in their Twelfth Annual Report for the entire nation. Its statement is as follows, "It is now becoming generally recognized that evening and part-time classes are probably the most efficient forms of trade and industrial education; hence the distinct rise in evening courses and in part-time courses - - - - -"

A glance at Table II gives another view of the service rendered, evening classes showing a pronounced lead in enrollments. One cannot interpret the 31,580 enrollments as being separate individuals for in some cases students enrolled in more than one course during the five year period. But that does not affect the scope of service.

TABLE II

ENROLLMENT IN TYPES OF TRADE AND INDUSTRIAL EDUCATION

1924 TO 1928

Types of Classes	Total Enrollment for the Five Year Period
1	2
1. Evening	19469
2. Part-time	8526
3. Continuation	3318
4. Day-trade	267
5. Total	31580

This study does not include a comparison of vocational education service with the rank in importance of Colorado's industries. However, a glance at Table III, column 1, items 24, 26, 34, 36, 38, 42, 48, 55, 65, 66, 67, 74, 76, 87, 88, and others will show that the various types and phases of mining, sugar manufacture, production of electricity, railroad shop work and other industries have been reached by evening classes. Part-time classes are also connected with major industries as shown by Table IV, column 1, items 6, 7, 9, 10, 11, and others.

TABLE III

COST PER STUDENT HOUR EVENING CLASSES, 1924 TO 1928

Courses	Total Enroll	Total Hours	Total Cost	Cost Stu. Hr.
1	2	3	4	5
1. Acetylene Welding	163	386	912.84	.0145
2. Air Brake	100	180	112.50	.0062

3. Applied Mathematics	32	112	156.00	.0435
4. A. R. A. Rules	100	180	112.50	.0062
5. Architectural Drawing	466	1056	1735.24	.0035
6. Auto Electricity	76	244	390.74	.0210
7. Auto Ignition	57	132	228.00	.0303
8. Auto Mechanics	978	3813	4030.74	.0011
9. Auto Mechanics & Auto Repair	176	760	648.40	.0048
10. Auto Repair	36	48	80.00	.0463
11. Baking	50	290	183.00	.0126
12. Baking (Apprentices)	62	341	544.00	.0257
13. Bakers' Chemistry	26	52	80.00	.0591
14. Battery Work	97	458	432.50	.0097
15. Blue Print Making	20	24	16.00	.0326
16. Blue Print Reading	120	224	354.00	.0131
17. Bookbinding	16	82	228.00	.1737
18. Bricklaying	57	290	137.50	.0083
19. Building Construction	30	30	30.00	.0333
20. Cabinet Making	36	80	110.00	.0382
21. Carpentry	290	486	768.38	.0054
22. Chemistry	23	88	116.00	.0573
23. Chemistry for Welders	177	773	736.50	.0054
24. Chemistry for Zinc Plant Workers	9	40	60.00	.1666
25. Clay Moulding	15	124	217.00	.1666
26. Coal Mining	639	1403	2962.82	.0033
27. Combustion	100	180	112.50	.0062
28. Commercial Illustrating	61	62	108.50	.0287
29. Cooking for Nurses	72	257	438.00	.0236
30. Dietetics	9	48	24.00	.0555
31. Drafting	285	754	642.68	.0029
32. Drafting Mechanics	54	518	339.50	.0121
33. Drafting Sheet Metal Patterns	15	33	33.26	.0675
34. Electricity	1263	3975	5542.04	.0011
35. Electric Battery	18	85	168.00	.1098
36. Electric Theory for Apprentices	76	168	84.00	.0066
37. Electric Welding	53	173	376.00	.0410
38. Electricity for Wiremen	24	53	105.00	.0825
39. Engraving	115	290	1400.00	.0411
40. Estimating	72	89	198.00	.0308
41. First Aid	4344	3182	7110.60	.0005
42. First Aid & Mine Rescue	30	124	441.00	.1185
43. Foremanship Training	709	930	1601.00	.0024
44. Gear Work	10	89	5.60	.0062
45. Ignition	193	942	1444.60	.0079
46. Ignition, Lighting, & Starting	40	168	33.60	.0050
47. Industrial Arithmetic	122	562	719.84	.0104
48. Industrial Chemistry	33	102	188.00	.0558

49. Lathe & Shop Welding	234	888	494.50	.0023
50. Lathe Work	10	40	40.00	.1000
51. Lay-Out Work for Plumbing Apprentices	51	173	281.00	.0318
52. Lead Work for Plumbing Apprentices	48	173	341.00	.0410
53. Lighting	30	196	82.25	.0139
54. Linotyping	26	257	434.00	.0649
55. Locomotive Engineering	552	1704	1892.98	.0020
56. Machine Drawing	173	132	416.12	.0182
57. Machine Shop	1055	3117	4708.36	.0014
58. Math. & Drawing	68	395	495.68	.0184
59. Mechanics	95	487	520.54	.0112
60. Mechanical Drawing	599	1982	2745.80	.0023
61. Mechanics & Electricity	23	90	102.30	.0494
62. Metallurgy	42	240	286.00	.0382
63. Meterman's Course	36	72	104.00	.0401
64. Millinery	291	576	1697.24	.0100
65. Mine Mechanics	153	436	692.36	.0103
66. Mine Rescue	181	364	1487.50	.0225
67. Mine Electricity	111	328	466.32	.0128
68. Mining Mathematics	52	84	104.00	.0238
69. Nurses' Chemistry	21	196	50.00	.0121
70. Paper Hanging	16	140	200.00	.0892
71. Plan Reading	433	1025	1090.36	.0024
72. Plumbing	409	2437	2885.36	.0029
73. Printing	215	519	921.12	.0082
74. Power Plant Electricity	19	40	60.00	.0789
75. Radio Repair	25	124	192.00	.0619
76. Safety Lamps	12	40	60.00	.1250
77. Sewing	253	387	796.12	.0081
78. Sheet Metal	103	231	379.74	.0159
79. Sheet Metal Drawing	110	164	510.24	.0283
80. Shop Mathematics	205	1029	1336.40	.0063
81. Shop Mechanics (Elec)	35	85	24.50	.0082
82. Show Card	46	172	240.00	.0303
83. Steam Engine	123	247	707.12	.0232
84. Steel Square	92	636	756.00	.0129
85. Stone Carving	10			
86. Sub-station Work	60	138	96.00	.0115
87. Sugar Factory Mechanics	216	140	580.00	.0191
88. Sugar Technology	328	380	570.00	.0045
89. Technology of Welding	40	259	343.00	.0331
90. Theory of Plumbing for Apprentices	68	199	221.50	.0164
91. Theory of Welding	275	336	508.00	.0054
92. Trade Mathematics	80	200	320.00	.0200

93. Welding	761	1769	2417.62	.0018
94. Woodshop	72	220	304.00	.0191

TABLE IV

COST PER STUDENT HOUR
FOR PART-TIME CLASSES

1924 TO 1928

Courses 1	Total Enrollm't 2	Total Hours 3	Total Cost 4	Cost Stu. Hr. 5
1. Auto Mechanics	403	7385	11736.62	.0039
2. Baking	145	2250	3025.00	.0092
3. Beauty Parlor	770	10370	10541.50	.0013
4. Bookbinding	16	1140	290.88	.0169
5. Bricklaying	172	3303	3241.88	.0056
6. Electricity	206	3330	5552.76	.0080
7. First Aid	4438	13698	9099.56	.0001
8. Linotype	30	1140	480.00	.0140
9. Machine Shop	128	4370	4134.36	.0074
10. Math. For Apprentices	27	3132	100.00	.0012
11. Math. and Drawing	43	576	666.66	.0269
12. Millinery	651	8565	8970.08	.0016
13. Printing	83	1140	1387.70	.0134
14. Training for Apprentices	43	240	500.00	.0484
15. Training in Drawing for apprentices	43	576	25.00	.0010
16. Vulcanizing	127	3000	4532.84	.0119
17. Welding	193	5490	5967.06	.0056

In making a comparison of costs, the same formula was applied to trade and industrial classes as that used in several studies in secondary education.[1] The formula used is, "To find the cost of salary for teaching one pupil for a year is to divide the yearly salary of one teacher among the different classes taught in proportion to the periods devoted to each, and to divide the total amount so obtained for each subject by the number of pupils in average daily attendance studying that subject." The foregoing formula excludes practically all variable influences and gives something more nearly tangible with which to study comparisons. Nevertheless, to compare secondary and vocational education there are a few differences to be noted. One is that cost per student hour in vocational work is figured on enrollment, while in secondary education subjects, cost is figured on average daily attendance. The other difference to be noted is that due to Federal and State aid, the cost to school districts for vocational work is only one-half that shown in the tables, while the entire costs of secondary education devolve upon the school districts. It should also be kept in mind that vocational education is

conducted on a clock-hour basis while "hours" in secondary education vary greatly. These differences were ignored because of the impossibility of bringing them into the formula.

A resumé of cost studies in secondary schools of various sections of the nation was used as a basis of comparison.[2] This resumé was reduced to student-hour basis as found in Table V. Evening courses range from .0005 to .1737 in cost per student hour according to Table III, column 5, items 41 and 17. The nearest approach to .0005 in cost in secondary education is English instruction in high schools of a population of 1 to 50 in South Dakota, which, according to Table V, column 3, item 1, costs .0450. Science in high schools of 200 population and up, costs .0013 more than 'Bookbinding' the most expensive evening course offered in the state. Table IV, column 5, item 7, shows that in part-time classes, 'First Aid' costs .0001 per student hour, while 'Training for Apprentices' in the same type of vocational education costs .0484. In this instance, we have the most expensive part-time course costing slightly over three mills more than the least expensive secondary school subject. Government reports classify all general continuation subjects under one heading, 'Related Academic Subjects,' which, according to Table VI, column 5, item 1, cost .0004 per student hour. Table VII, column 5, item 6, shows that the least expensive day-trade course is 'Related Drawing,' and that 'General Machine Trades' is the most expensive. Further comparisons might be drawn but results would continue to show that trade and industrial training is markedly lower in cost per student hour than secondary education.

TABLE V

INSTRUCTION COSTS OR COSTS PER STUDENT HOUR*

1. English	NY	.1300	.0700	.0530	.0640
	SD	.0450	.0500	.0700	
	C		.1350	.1050	.0950
2. Latin	NY	.2200	.1700	.1100	.1200
	SD	.0600	.0590	.0770	
	C		.3230	.1900	.1400
3 Modern Languages	NY	.3030	.3880	.2100	.1050
	SD	.0730	.0680	.1390	
	C		.1800	.1540	.1100
4. Mathematics	NY	.1080	.0630	.0500	.1260
	SD	.0510	.0670	.0830	
	C		.1540	.1350	.0900
5. Science	NY	.1550	.0870	.0850	.0920
	SD	.0580	.0660	.0840	

	C		.2700	.1800	.1750
6. History	NY	.2420	.1160	.0550	.0720
	SD	.0510	.0780	.1060	
	C		.1600	.1050	.0850
7. Home Economics	NY	.0570	.0670	.0690	.1300
	C		.3250	.2500	.1950
8. Commercial Courses	NY	.0640	.0690	.1220	.1000
	C		.2200	.1600	.1350

Legend: 'NY' represents the result of two studies on New York state high schools; 'SD' represents a study of several South Dakota high schools; and 'C' represents a study of a number of California high schools. Decimals show cost per student hour.

*This table is based on: Foster, Herbert H. *High School Administration*, p. 477, Table 6, The Century Company, New York, 1928.

TABLE VI

COST PER STUDENT HOUR FOR CONTINUATION CLASSES
1924 TO 1928

1. Related Academic Subjects*	3308	24884	30614.28	.0004

*Although listed as "Related Academic Subjects" in state reports, most of the courses are similar to the basic elementary school subjects. Insofar as possible, they are made to apply directly to the occupations of the students.

TABLE VII

COST PER STUDENT HOUR FOR DAY-TRADE CLASSES 1924 TO 1928

Courses 1	Total Enroll 2	Total Hours 3	Total Cost 4	Cost Stu. Hr. 5
1. Auto Mechanics	112	4550	6567.74	.0128
2. Auto Repair	54	2280	2267.20	.0184
3. Carpentry and Mill Work	6		500.00	
4. Mill Work	12	1620	800.50	.0411
5. General Machine Trades	15	720	960.42	.0889
6. Related Drawing	6	540	32.50	.0100
7. Related Mathematics	14	570	173.60	.0217
8. Related Math. and Drawing	24	1836	506.78	.0115
9. Related Science	14	190	121.52	.0456
10. Welding	10	1080	277.39	.0256

[1] Foster, Herbert H. *High School Administration*, pp. 475-486. The Century Company, New York, 1928.
[2] Foster, Herbert H. *Op. Cit.*, p. 477.

OXIDATION-REDUCTION REACTIONS

W. B. Parks, Professor of Chemistry

Metathetical as well as oxidation-reductions are both of prime importance to the analytical chemist. Certain reactions of the latter class are given consideration in this article. Oxidation is no longer defined as merely the increase of the percentage of oxygen in the substance oxidized. In the light of modern theories, as to the structure of matter, the oxidized substance loses electrons and the reduced one gains them. There can be no oxidation without an accompanying reduction. Oxidation-reduction therefore consists in the transfer of electrons from the oxidized substance to the one reduced. Recent electro-chemical theories bearing upon chemical combination are largely indebted to the early work[1] of Berezelius in the development of his dualistic theory.

In a recent article by William T. Hall[2] credit is given to Otis Coe Johnson for leading the way, in 1880, to change of valence method of writing oxidation-reduction equations. This method in some form has almost superceded the dualistic method. The electron concept has clarified many of our hazy ideas as to oxidation-reduction reactions and simplified our operations in writing equations. The trend of opinion among teachers, as to the importance attached to this concept, is seen in the increased emphasis given to it by recent writers of text books of chemistry and by the many excellent papers upon the subject appearing in current chemical literature. Dr. Whitmore, of Pennsylvania State College, not long ago stated that his first sentence in his first lecture to freshmen each year is that matter is made up of protons and electrons. About twenty per cent of his lectures deal with the electron theory in some form. Dr. Kendall, in the preface to the latest edition of The Smith-Kendall General Chemistry, says: "Our ultimate ambition, we are free to confess, is to develop atomic structure in Chapter I and to build up the whole science on the basis of protons and electrons." The subject of atomic structure has actually been introduced in Chapter I of The Principles of General Chemistry by Dr. Stuart R. Brinkley, of Yale.

All matter has an ultimate electrical structure[3] consisting of protons and electrons. The neutral hydrogen atom is composed of one proton and one electron, respective units of positive and negative charges. All other atoms are complex bodies consisting also of a positive nucleus and outside electrons sufficient, electrically, to neutralize the central positive charge. In the outside shell, or energy level of electrons, are found the valence electrons upon which depend all chemical and physical properties of the atom, exclusive of mass. When, in the neutral atom, the outside shell consists of eight electrons or is compelte, we have such stability as that shown by the inert gases of the zero group of elements. Certain elements, as a rule the metals, show a tendency to lose electrons, thus manifesting the property of a reducing agent; others, the non-metals, show a tendency to gain electrons, manifesting the property of an oxidizing agent.

While much remains to be done on the subject of valence[4], in order to bring about complete agreement in the ranks of chemists, yet valence change, or something corresponding to it in dealing with oxidation-reduction, is used by all. In writing the equations of these reactions one of two schemes[5], or some modification of one of them, is generally called into service at the present time. One of these schemes is designated the ion-electron method, the other the atom-valence method. In the ion-electron method used by Jette and LaMer[6] the gain or loss of electrons is referred to the ions, whereas in the atom-valence method used by Dr. Brinkley of Yale, in his paper cited above, the electronic changes are referred to specific atoms in the oxidizing and reducing agents. The latter method is very simple and is probably used by a majority of teachers today.

An equation is the representation of what takes place in the reaction. In writing the oxidation-reduction equations which follow, examples are chosen from reactions involving electrolysis, displacement of ions in solution, interaction of an element and a compound, and interaction of compounds. These types of reaction, as suggested by Dr. Brinkley's paper already twice cited, may serve as a graded series for presenting the subject to freshmen. Each of the types in the foregoing list is represented by one or more equations below, balanced by the atom-valence change method.

The electric current used in electrolysis is caused by a flow of electrons through the wire connecting the plates of the bath. If the solution is one of hydrochloric acid the chloride ions are attracted to the anode, give up their electrons to join with those flowing through the wire, and become elementary chlorine. The hydrogen ions with positive charges are attracted to the cathode where they are discharged by taking on electrons from the current, and are liberated in the form of elementary hydrogen. In a sense the chloride ions serve as the reducing agent, the hydrogen ions as the oxidizing agent. The current transfers electrons from the reducing agent (Cl^-) to the oxidizing agent (H^+).

Valence change: (1) $Cl^- - (-) \rightarrow Cl^\circ$; (2) $H^+ + (-) \rightarrow H^\circ$.

As the products are elementary chlorine and hydrogen each of the partial equations (1) and (2) is multiplied by two; these partial equations are then combined to give equation (3) below, which represents the oxidation-reduction reaction as a whole.

(3) $2Cl^- + 2H^+ = Cl^\circ_2 + H^\circ_2$.

One of our most valuable reference tables is that of the electrochemical series. At a glance we recognize the displacement order of the elements. Certain ions in a solution may be displaced by choosing a suitable displacing agent, thus involving oxidation-reduction. Merely placing a bright piece of iron into a solution of copper sulphate illustrates the reaction. Iron passes into the solution as ions and copper is displaced.

Valence change: (1) $Fe^{\circ} - 2\ (-) \rightarrow Fe^{++}$;
(2) $Cu^{++} + 2\ (-) \rightarrow Cu^{\circ}$.
Combining partial equations (1) and (2) we get (3) below.
(3) $Fe^{\circ} + Cu^{++} = Cu^{\circ} + Fe^{++}$.

Iron as a reducing agent loses electrons and copper as an oxidizing agent gains them.

In dealing with certain oxidation-reduction reactions the following rules have been found helpful in writing their equations:

(1) Write the skeleton equation representing all interacting substances.

(2) Indicate the valence changes in the oxidizing and reducing substances.

(3) Write, for the coefficient of the oxidizing agent that number representing the number of electrons lost by one mole of the reducing agent, and for the coefficient of the reducing agent that number representing the number of electrons gained by one mole of the oxidizing agent.

(4) Balance the equation in accordance with the law of the conservation of mass.

Elementary hydrogen is a reducing agent; elementary chlorine is an oxidizing agent. When these elements are brought together under suitable conditions reaction results. Hydrogen chloride is the product. Chlorine has gained the electron lost by the hydrogen.

(1) Skeleton equation: $Cl^{\circ}_2 + H^{\circ}_2 \rightarrow HCl$.

(2) Valence change: $Cl^{\circ}_2 + 2\ (-) \rightarrow 2\ Cl^-$; $H^{\circ}_2 - 2\ (-) \rightarrow 2\ H^+$.

(3) Coefficients: $2\ Cl^{\circ}_2 + 2\ H^{\circ}_2 \rightarrow HCl$.

(4) Balanced equation: $2\ Cl^{\circ}_2 + 2\ H^{\circ}_2 = 4HCl$.

It is well understood that conditions largely determine reactions and must, therefore be under control. The nitrogen of nitric acid may be reduced to that of nitrogen in any one of its lower oxides, i. e. those from N_2O_4 down to N_2O inclusive, depending upon conditions. Copper will react with concentrated nitric acid to liberate nitrogen tetroxide; with dilute nitric acid nitric oxide is liberated. These are familiar illustrations of the interaction of an element with a compound. The products from the action of the dilute acid upon copper are copper nitrate, nitric oxide, and water. The latter is always formed in the presence of H^+ in case the oxygen of the oxidizing agent is in excess of that of the reduced product.

(1) Skeleton equation: $Cu + HNO_3 \rightarrow Cu\ (NO_3)_2 + NO + H_2O$.

(2) Valence change: $N^{5+} + 3\ (-) \rightarrow N^{++}$; $Cu^{\circ} + 2\ (-) \rightarrow Cu^{++}$.

(3) Coefficients: $3\ Cu + 2\ HNO_3 \rightarrow Cu(NO_3)_2 + NO + H_2O$.

In order to write the molecular equation additional nitric acid is needed.

(4) Balanced equation: $3\ Cu + 2HNO_3 + 6\ HNO_3 = 3\ Cu(NO_3)_2 + 2\ NO + 8\ H_2O$.

Potassium dichromate as an oxidizing agent reacts, with ferrous sulphate as a reducing agent in the presence of sulphuric acid, to give potassium sulphate, chromic sulphate, ferric sulphate, and water. Here the oxidizing, also the reducing agent, is a compound.

(1) Skeleton equation: $K_2Cr_2O_7 + FeSO_4 + H_2SO_4 \rightarrow Fe_2(SO_4)_3 + K_2SO_4 + Cr_2(SO_4)_3 + H_2O$.

(2) Valence change: $2\ Cr^{6+} + 6(—) \rightarrow 2\ Cr^{+++}; Fe^{++} — (—) \rightarrow Fe^{+++}$.

(3) Coefficients: $1\ K_2Cr_2O_7 + 6\ FeSO_4 + H_2SO_4 \rightarrow Fe_2(SO_4)_3 + K_2SO_4 + Cr_2(SO_4)_3 + H_2O$.

In writing the molecular equation the needed hydrogen and sulphate ions are supplied by the sulphuric acid added.

(4) Balanced equation: $K_2Cr_2O_7 + 6\ FeSO_4 + 7H_2SO_4 = 3\ Fe_2(SO_4)_3 + K_2SO_4 + Cr_2(SO_4)_3 + 7H_2O$.

In the reduction of potassium permanganate by oxalic acid in the presence of sulphuric acid, is found another case in which the oxidizing, also the reducing agent, is a compound. The products of the reaction are the sulphates of manganese and potassium, carbon dioxide, and water. Potentially, the valence of each of the carbon atoms in oxalic acid is three, though the structural formula[7] usually assigned suggests that one atom may have a valence of two positive charges, and the other a valence of four positive charges. From a mathematical view point the valence change is from 3 to 4 for each atom.

(1) Skeleton equation: $C_2H_2O_4 . 2H_2O + KMnO_4 + H_2SO_4 \rightarrow K_2SO_4 + CO_2 + H_2O + MnSO_4$.

(2) Valence change: $Mn^{7+} + 5(\_\_) \rightarrow Mn^{++}$; $2C^{+++} — (—) \rightarrow 2C^{4+}$.

(3) Coefficients: $5\ H_2C_2O_4 . 2H_2O + 2KMnO_4 + H_2SO_4 \rightarrow K_2SO_4 + MnSO_4 + CO_2 + H_2O$.

(4) Balanced equation: $5\ H_2C_2O_4 . 2\ H_2O + 2\ KMnO_4 + 3\ H_2SO_4 = K_2SO_4 + 2\ MnSO_4 + 10\ CO_2 + 28\ H_2O$.

Certain elements of variable valance, i. e. chlorine, may exist in an intermediate stage of valence in a compound, which looked at from one point of view appears as a reducing agent, from another point of view it appears to be an oxidizing agent. Sodium hypochlorite is an example of such a compound. Chlorine is most stable in the chlorides, the neutral atom having gained one electron to attain this state. In the chlorates the neutral atom has lost five electrons and attained

a positive valence of five. In sodium hypochlorite the chlorine has an intermediate valence of plus one and may therefore be oxidized by losing electrons, or reduced by gaining electrons. The products formed on heating an acid solution of sodium hypochlorite are sodium chloride and sodium chlorate.

(1) Skeleton equation: NaClO oxidizing agent + NaClO reducing agent → NaCl + $NaClO_3$.

(2) Valence change: Cl^+ oxidizing agent + 2(—) → Cl^-: Cl^+ reducing agent — 4(—)→Cl^{5+}.

(3) Coefficients: 4 NaClO oxidizing agent + 2 NaClO reducing agent →NaCl + $NaClO_3$.

(4) Balanced equation: 4 NaClO oxidizing agent + 2 NaClO reducing agent = 4 NaCl + 2 $NaClO_3$.

[1] *History of Chemistry*—Venable. [2] *J. Chem. Ed.*, Vol. VI, No. 3, p. 479.
[2] *J. Chem. Ed.*, Vol. VI, No. 3, p. 479.
[3] *Smith's College Chemistry*—Kendall, p. 384.
[4] Reinmuth, *J. Chem. Ed.*, Vol. V, No. 11, p. 1476: ibid Vol. VII, No. 7, p. 1688.
[5] Brinkley, *J. Chem. Ed.*, Vol. VI, No. 11, p. 1897.
[6] Jette and La Mer, *J. Chem. Ed.*, Vol. IV, No. 8, p. 1021.
[7] *Chemical Calculations*—Hamilton and Simpson p. 126.

BOOK NOTES

BUCHHOLZ, H. E. *Fads and Fallacies in Present-Day Education.* New York: The Macmillan Company, 1931. xiiii+200 pp.

This book will jar any reader sufficiently to compel him to do some more thinking about the public schools of the United States. Mr. Buchholz uses the satirical method for pointing out some of the ills in education, and he does it so well that one concludes that he really knows a great deal about the subject. He has been writing on educational matters under the pen name of Ezekiel Cheever for many years. In the "Foreword" of the book William C. Bagley says this about the author's method: "The initiated will not be deceived by these heightened color effects, but the layman should be frankly warned that here and there the picture is a bit distorted."

The story of Horatio Bump with his new science of education which he calls "Petology" is absurd, and yet it is too much like a few of "activity schools" to be wholly ignored. It is perhaps true that some of our school people are prone to test any school innovation by "its promise to afford the pupil pleasure" rather than by "its possible utilitarian worth to the adult."

The arguments which are given in favor of a department of education with a secretary in the President's cabinet are certainly incom-

plete; while the arguments given in opposition to it would probably apply with equal force toward the abolishment of all the other departments and their secretaries which we now have. The chapter called "More Money for Less Educaion" should cause school people to more carefully justify school costs. But should we not expect as careful an accounting and justification of all other public costs?

The author asks whether we can expect school people to be effective teachers of citizenship in a democracy when all too often they work within a school system which is itself undemocratic. The individual teacher often fears to raise a protest against anything that his superintendent or principal wishes done for fear of his job. If he is fortunate in his immediate superiors, he still has "civic bodies, and patriotic societies, no less than machine politicians" who stand "ready to knock all affection for real democracy out of him."

Some light is shed upon two additional problems in education: that of school books, and that of teachers' salaries. Many will take issue with all or part of the conclusion that: "The child requires creditable male instructors; male instructors of equal worth to female pedagogues cannot be hired at the same salary; therefore, whenever the equal salary scale is put into effect it means either the men teachers will be driven out of the system or that male pedagogues of low grade will be recruited."

The book is certain to find a following among those who seek wholesale criticism of our school system. Such readers are, moreover, likely to forget Mr. Bagley's warning. Like most satirical writers, Mr. Buchholz points out many things that are wrong, but pertinent suggestions for their improvement are lacking.

RALPH A. FRITZ

BAGLEY, WILLIAM C. *Education, Crime, and Social Progress.* New York: The Macmillan Company, 1931. xvi+150 pp., $1.20.

When Dr. Bagley speaks either upon the rostrum or in print they who know him are in quiet expectation. They are seldom, if ever, disappointed. In this time of social unrest this book will be a needed stimulant for a keener evaluation of certain over-publicized educational practices and tendencies. Teachers who read this book considerately will less likely gulp down "new-fangled" educational notions, shibboleths and slogans without due consideration. After reading this book, those of us who have been disposed to let the child follow his own bent with the least possible restraint will begin to wonder whether this general attitude has not been a contributor to the proper lack of respect to authority and law.

The range of Dr. Bagley's discussions will be indicated by the chapter headings: Two Outstanding Problems of American Educa-

tion, Some Handicaps of Character Education in the United States, Discipline and Dogma, Shibboleths and Slogans in Educational Reform, Playing at the Work of Education, Through Discipline to Freedom, Emergent Idealism, Education and Adaptibility.

The book is worthy of a place in every educator's library.

EDGAR MENDENHALL.

MORRILL, ABBIE A., BESSEY, MABLE A., WALSH, JOHN V. *Applied Office Practice.* New York: D. C. Heath and Company, 1931. vii+376 pp.

The authors of this text have set forth in a clear and concise manner many of the essentials required of the office assistant. The development of the proper relationship between employer and employee is given careful consideration.

The text is arranged so as to serve in the capacity of an office manager, giving instructions for performing the various tasks found in the average office. The work of the assistant is taken up step by step. The plan is much the same as found in the office where the assistant starts with some of the minor duties but his advance to the more difficult and technical tasks is systematically developed.

The relation of the office to the outside world is carefully studied and analyzed. The functions of the bank, telephone and telegraph systems, postal system, modern office appliances, and papers used in connection with these are emphasized by the use of numerous exercises where the different business forms and papers give the desired training along the practical side of office work. One of the outstanding features of the text is the numerous exercises which provide for actual research on the part of the student.

J. U. MASSEY.