TABLE I

Run	HEAD Inches(a)	ORIFICE Diam. Inches	ACTUAL READING		TEMPERATURES			AS READ(b)		T ₈
			Volts	Amperes	T ₁	T ₂	T ₃	T ₄	T ₅	
1	0	0	68.8	5.22	14	327	675	673	338	14
2	0.083	3/32	68	5.0	7	348	656	586	275	7
3	0	0	72	5.5	10	345	711	711	359	10
4	0.18	3/32	72	5.4	6	378	680	591	282	6
5	0.08	3/32	72	5.4	6	376	693	616	292	6
6	0	0	73	5.5	11	349	719	718	367	12
7	0.035	3/32	73	5.4	7	378	708	650	309	7
8	0.035	3/32	63	4.75	7	311	586	535	250	7
9	0	0	63	4.75	14	293	576	507	239	7
10	0.085	3/32	63	4.8	7	315	538	455	216	6
11	0.18	3/32	62	4.7	6	297	528	522	262	10
12	0	0	57	4.38	10	257	465	401	192	7
13	0.180	3/32	57	4.38	7	262	465	401	192	7
14	1.0	1/4	56	4.38	7	210	322	257	129	7
15	0	0	49	3.75	15	208	420	416	207	15
16	1.18	1/4	48	3.75	6	161	247	190	102	7
17	0	0	49	3.75	12	205	412	410	205	12
18	0.3	3/8	47	3.75	7	160	238	187	100	7
19	0	0	60	4.75	13	284	563	564	286	13
20	0.6	3/8	61	4.75	12	234	327	251	137	12
21	0.6	3/8	72	5.5	8	301	431	345	179	8
22	0.6	3/8	83	6.38	8	376	546	438	231	8
23	0.6	3/8	91.5	6.9	11	444	644	517	276	11
24	0.3	3/8	95	6.95	11	480	718	599	316	11
25	0.75	3/8	60	5.0	10	139	146	112	92	10
26	0.75	3/8	53	4.42	19	122	127	98	82	19
27	0.75	3/8	68	5.5	22	177	188	142	120	22
28	0.75	3/8	96	7.5	15	306	347	255	201	15
29	0.83	1/2	59	5.0	13	117	120	91	90	13
30	0.83	1/2	70	5.75	12	148	151	116	114	12
31	0.83	1/2	99	7.9	15	260	270	214	196	15
32	0.83	1/2	86.5	6.95	12	212	216	160	159	12
33	0.15	1/2	85	6.75	13	279	317	242	188	13
34	0.15	1/2	57.5	4.75	13	144	159	118	102	13
35	0.15	1/2	103	7.95	13	368	424	309	253	13
36	0	0	21	1.88	14	55	104	104	55	14
37	0	0	35.5	2.83	15	124	236	236	122	15

(a) Runs 1 to 24 in inches of Liquid; Runs 25 to 37 in inches of Mercury.

(b) T₂ to T₈, as read by thermal-couples; T₁ and T₈, temperatures of water bath at opposite ends of the furnace.

through each square foot of section, the section being taken at right angles to both heating surface and direction of flow of the air. The expression is apparently independent of temperature up to 750° F.

In the derivation of this formula we have expressed velocities as lbs. of air per sq. ft. of section of path per second. Our reason is that otherwise velocity past various points in the path of flow is a variable

TABLE II

Group	Run	Area Sq. in.	Av. Ht. In.	Av. Temp. ° C.	CORRECTED		
					Volts	Amperes	WATTS
A1.....	33	18.20	2.43	243	83.3	6.65	554
	34	8.72	1.16	116	55.5	4.60	255
	35	24.32	3.24	324	101.3	7.85	795
A2.....	2	37.48	4.99	499	66.0	4.87	321
	10	32.80	4.37	437	61.5	4.65	286
	5	39.75	5.30	530	70.0	5.28	370
B1.....	29	6.64	8.85	885	57.3	4.80	275
	30	8.71	1.16	116	68.0	5.65	385
	31	16.07	2.14	214	97.3	7.75	755
B2.....	32	12.67	1.69	169	84.7	6.85	580
	20	17.65	2.35	235	59.0	4.60	271
	21	24.00	3.20	320	70.0	5.40	378
C1.....	22	29.92	3.99	399	81.2	6.28	510
	23	36.05	4.81	481	89.3	6.80	608
	25	8.33	1.11	111	58.0	4.87	282
C2.....	26	6.55	8.73	873	51.0	4.30	218
	27	10.05	1.34	134	66.0	5.40	356
	28	19.38	2.58	258	94.3	7.42	700
D1.....	18	12.96	1.73	173	45.0	3.55	160
	24	41.19	5.49	549	93.3	6.85	639
	14	17.65	2.35	235	53.5	4.23	227
D2.....	16	13.50	1.80	180	46.0	3.55	163
	4	38.79	5.17	517	71.0	5.28	375
	11	29.84	3.98	398	60.0	4.55	273
Blanks.....	13	26.07	3.48	348	55.0	4.23	233
	1	40.36	5.38	538	67.0	5.10	342
	3	43.03	5.74	574	70.0	5.40	378
	6	43.59	5.81	581	71.0	5.40	383
	9	35.45	4.73	473	61.0	4.60	281
	12	31.58	4.21	421	65.0	4.23	233
	15	24.78	3.31	331	47.5	3.54	166
	17	24.46	3.26	326	47.0	3.55	167
	19	33.95	4.53	453	58.0	4.60	267
	36	5.41	0.72	72	18.9	1.65	31
	37	14.37	1.91	191	33.5	2.63	88

quantity owing to the expansion of the gas in heating. On the assumption that the resistance to flow of heat from a solid to air is due to a surface film of gas around the solid and that the increase in heat conductivity with increasing velocity is caused by the ripping off

TABLE III.

Av. Temp. of Furnace	Input Net Watts	Temp. Exit Gas	Average Temp. Difference	Value of "K".
111	253	80.7	53.3	3.84
161	380	108.7	87.5	3.52
211	523	140.0	119.0	3.56
261	662	171.0	151.0	3.54
311	804	202.0	183.0	3.56
361	925	229.0	218.0	3.44

of this film, the shearing effect upon this film should be determined by the mass of gas passing the heating surface in unit time rather than by its linear velocity, and the use of the above unit of velocity is rational. The constancy of the results of our calculations by this method are, however, its best justification.

We believe that the above equation represents the best figure which is at present available to employ

for the value of *K* from solids to air and feel that it is decidedly preferable to the figure of Richards, the one hitherto most frequently employed, because Richards' formula indicates indefinitely high values at high velocities, whereas our formula indicates, as the experimental results show, that at high velocities the value of *K* reaches a limiting value beyond which it cannot rise.

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LABORATORY PROBLEMS IN INDUSTRIAL CHEMISTRY

By H. K. BENSON

Received March 23, 1916

The field of industrial chemistry is so large that the planning of courses in this subject involves many factors. It has been the experience of the writer that instructors in industrial chemistry formulate their courses largely from the standpoint of their previous personal experience. It is believed that an exchange of views detailing the practice followed by various instructors would prove of great value to individuals as well as be an aid in standardizing the subject matter and in working towards some degree of uniformity.

With this end in view a series of problems are here outlined showing the character of training furnished by such problems. Such a course is not to be regarded as ideal but rather is proposed as an aid to a discussion that might be of value to those who are feeling their way along paths that are not as yet well defined.

The problems were assigned to chemistry students of Junior standing. They had completed courses in general inorganic chemistry, qualitative analysis, quantitative analysis, and were taking organic chemistry coincident with industrial chemistry. The general plan followed was the statement of the problem by

the instructor after which the student was expected to devise his own methods for solution. The instructor answered specific questions but refused to suggest an outline or general plan of procedure, requiring the student to work out his own methods from the literature. A full discussion and exchange of methods among the students in the laboratory was, however, encouraged. Experience has shown that students attack such problems in a wide variety of ways and frequently with varying results. These are criticized and amended in class discussions at the end of each semester.

PROBLEM I—Given a sample of crude California petroleum, obtain the yield of kerosene oil which complies with the requirements of the state law.

Requirements: An examination of the state law, reference to the literature of petroleum refining and familiarity of the student with the varying effects of the rate of distillation, the design of distilling apparatus, the effects of acid and alkali treatment, the removal of water from oily distillates, and the various forms of oil testing apparatus.

PROBLEM II—Given a sample of coal-gas tar at a local cost of 6 cents per gallon, determine the yield of creosote complying with the specifications of the city of Seattle and the cost per gallon, f. o. b. plant, of the creosote.

Requirements: The specifications of the city for creosote, the distillation of the coal tar, computation of fractions and the derivation of the process of distillation, the analysis of the creosote by the official method, a study of the uses and values of the by-products such as light oil and pitch, the selection of a unit charge for commercial operation, a field study of a Barrett plant, and itemization of costs of production.

PROBLEM III—Prepare a bituminous enamel containing 20–35 per cent carbonaceous matter insoluble and 55–65 per cent ash, with physical properties specified by the United States War Department.

Requirements: A study of the commercial pitches, methods of analysis of bituminous materials and selection of a paint filler.

PROBLEM IV—Determine which one of two commercial boiler compounds shall be selected to prevent scale formation in the University Power Station.

Requirements: Analysis of scale, of feed water and of the boiler compounds; a study of the causes and prevention of scale formation and the application of the data to the given case. A description of the problem has already been published in *THIS JOURNAL*, 8 (1916), 435.

PROBLEM V—Determine the effect of blending Portland cement with Washington tufa.

Requirements: Reference to the literature of blended cement products; testing of cement by standard methods; and a study of cement specifications.

PROBLEM VI—Determine the proportion of cement, sand and gravel in concrete.

Requirements: Method of mechanical analysis; grading of aggregate; specific gravity determinations; chemical analysis of cement; and computations.

PROBLEM VII—Determine the effect of adding lime and sand to a plastic red burning clay.

Requirements: Methods of clay testing; study of range of vitrification; grinding and mixing operations.

PROBLEM VIII—Classify the oil obtained from samples of Philippine nuts.

Requirements: Extraction of oil from nuts; comparison with the known constants of fatty oils; and the relation of constants to uses of the oil.

PROBLEM IX—Determine the yield of rosin in western yellow pine.

Requirements: Methods of sampling; extraction by various solvents; and efficiency of commercial solvents.

PROBLEM X—Determine the efficiency of the recovery of ammonia in the extraction of rosin from Douglas fir.

Requirements: Separation of rosin and humus; Kjeldahl determinations; removal of ammonia from wood; and computations.

PROBLEM XI—Devise a method for the extraction of cedar oil from the destructive distillation of Port Orford cedar and determine the nature and probable uses of the residues of the distillate.

Requirements: Methods of steam distillation and of vacuum distillation; study of literature relating to Port Orford cedar oil; determination of constants of oil; study of wood tars and their uses.

PROBLEM XII—Prepare a rosin paint drier soluble in raw linseed oil.

Requirements: Preparation of metallic resins; methods of paint testing; and commercial requirements of driers.

During the present year similar problems dealing with the study of cactus, wood humus, potash salts, recovery of iodine, cost of manufacture of hypochlorites, etc., have been undertaken. It is apparent that the problems are capable of great diversification, which adds to the interest. The chief objects in view are to throw the student upon his own resources, make him acquainted with chemical literature and force him to make use of the tools of knowledge already in his possession.

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AN UNUSUAL EXPLOSION IN CONNECTION WITH POTASSIUM CHLORATE

By FLOYD E. ROWLAND

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There was nothing unusual about the explosion itself, but the manner in which it occurred is well worth mentioning and bringing to the attention of all who have occasion to use pestles which have wooden handles.

Everyone knows that disaster is sure to follow when potassium chlorate and sulfur are ground together; but to have a perfectly clean mortar and pestle suddenly explode with great violence, when one is grinding an inert substance like pumice stone, makes one pause and wonder why.

A pestle and an 8-inch mortar were thoroughly cleaned and about fifteen pounds of potassium chlorate were ground with no disastrous results. The mortar