46. Hyoscyamus.—Non-glandular trichomes.
47. Ipecac.—Raphides. Fibrous tissue. Starch.
48. Iris florentina.—Starch. Crystals.
49. Jalap.—Resin-bearing cells. Starch.
50. Kamala.—Glands and trichomes.
51. Krameria.—Bast cells and groups of bast.
52. Lobelia.—Trichomes and groups of fibrous tissue.
53. Lupulin.—Number of glandular structures.
54. Lycopodium.—Number of spores.
55. Mezereum.—Number of bast fragments.
56. Nux vomica.—Trichome fragments and groups of endosperm tissue.
57. Paracoto.—As for coto.
58. Physostigma.—Starch granules.
59. Phytolacca.—Number of raphides.
60. Pimenta.—Groups of sclerenchyma cells and trichomes.
61. Piper, black.—Groups of endosperm cells and of pericarp tissue.
62. Piper, white.—Groups of endosperm cells.
63. Prunus serotina.—Bast and sclerenchyma.
64. Prunus virginiana.—Bast.
65. Pyrethrum flowers.—Pollen grains. Sclerenchyma. Fibrous tissue.
66. Quillaja.—Bast and crystals.
67. Rhamnus purshiana.—Groups of bast and crystal-bearing fibers.
68. Rheum.—Aggregate crystals. Ducts. Colored tissue.
69. Sarsaparilla.—Number of raphides. Ducts. Starch.
70. Sassafras.—Bast. Groups of sclerenchyma cells.
71. Scopola.—As for belladonna leaf and root.
72. Senna.—Trichomes. Neighboring cells.
73. Stramonium.—Non-glandular trichomes.
74. Strophantus.—Trichomes.
75. Tabacum.—Glandular and non-glandular trichomes.
76. Thea.—Trichomes and sclerenchyma cells.
77. Viburnums.—Bast, and bast and sclerenchyma cells.
78. Zingiber.—Starch granules. Cork tissue.

COLLEGE OF PHARMACY,
UNIVERSITY OF NEBRASKA,
    LINCOLN, NEBRASKA,
        April 4th, 1920.

THE CHEMISTRY OF THE HEPTANE SOLUTION.

BY EDWARD KREMERS.

3. PURIFICATION OF HEPTANE AND ITS PHYSICAL CONSTANTS.

BY DR. C. L. SHERK.

(Concluded from November Number, p. 1052.)

II. PHYSICAL CONSTANTS OF PURIFIED HEPTANE.

1. Boiling Point.

For the final determination of the boiling point the constant pressure apparatus constructed by Professor Mathews[24] was used under the direction of Dr. A. E. Koenig.

The boiling point of water as registered by the thermometer employed is 99.96°. Accordingly there is positive correction to be made on all subsequent readings of 0.04°.

Heptane Purified by Iodine.—The run was made on about 300 Cc. in every case and, as this was the first of a series, the heptane was kept boiling gently for one-quarter hour to establish again equilibrium in the thermometer. These five runs were made on the same day and the time in the tables gives the order in which they were actually made. The flask after each determination was emptied and a stream of air passed through to remove vapors. A small quantity of the next sample was used to wash out the flask before the run was made. The distillates were collected for every 0.05° rise in temperature.

The boiling range of this sample was 0.52°. This sample was kept gently boiling for 15 minutes; accordingly there was some loss by vaporization and the amount recovered was somewhat lower than in the other cases where distillation proceeded at once. The run was made on 300 Cc. at 7 amperes.

Time.	Temperature. Degrees.	Remarks.	Volume of distillate.	Time.	Temperature. Degrees.	Remarks.	Volume of distillate.
7:04	. . . . .	Boiling began		7:23	98.30		54
7:05	98.00	Pressure on		7:24	98.30		
7:06	98.10			7:25	98.30		
7:07	98.13			7:26	. . . . .		
7:08	98.16			7:27	98.31		
7:09	98.16			7:28	98.32		
7:10	98.17			7:29	98.32		
7:11	98.18			7:30	98.33		
7:12	98.20		47	7:31	98.34		
7:13	98.20			7:32	98.34		
7:14	98.20			7:33	98.33		
7:15	98.20			7:34	98.35		76
7:16	98.23			7:35	98.36		
7:17	98.25		37	7:36	. . . . .		
7:18	98.25			7:37	98.37		
7:19	98.27			7:38	98.38		
7:20	98.29			7:39	98.38		
7:21	98.29			7:40	98.40		
7:22	98.29			7:41	98.40	Done	37
				7:42			

Recovered, 251

Heptane Purified by Hydrogen Iodide.—This sample had a boiling range of 0.23°. The run was made on 300 Cc. at 7 amperes.

Time.	Temperature. Degrees.	Remarks.	Volume of distillate.	Time.	Temperature. Degrees.	Remarks.	Volume of distillate.
8:06	. . . . .	Boiling began		8:29	98.28		
8:07	97.90	Pressure on		8:30	98.30		70
8:08	. . . . .			8:31	98.30		
8:09	98.07			8:32	98.30		
8:10	98.10			8:33	99.30		
8:11	98.12		25	8:34	98.31		
8:12	98.17			8:35	98.32		
8:13	98.18			8:36	98.32		
8:14	98.19			8:37	98.32		
8:15	98.20		17	8:38	. . . . .		
8:16	98.20			8:39	98.32		
8:17	98.22			8:40	98.33		
8:18	98.22			8:41	98.34		
8:19	98.23			8:42	98.35		80
8:20	98.25		39	8:43	98:36		

8:21	. . . . .		8:44	98.37
8:22	98.24		8:45	98.37
8:23	98.25		8:46	98.38
8:24	98.27		8:47	98.38
8:25	98.28		8:48	98.40	53
8:26	98.28		8:50	Done
8:27	98.29			———
8:28	98.29			Recovered, 284 Cc.

Heptane Purified by Hydrogen Chloride.—This is the first sample the boiling range of which is 0.34°. The run was made on about 300 Cc. and the heptane was kept boiling gently for one-half hour, to establish equilibrium in the thermometer. The run was made on 280 Cc. at 7 amperes.

Time.	Temperature. Degrees.	Remarks.	Volume of distillate.	Time.	Temperature. Degrees.	Remarks.	Volume. of distillate.
2:19	. . . . .	Boiling began		3:18	98.30		
3:00	. . . . .	Pressure on		3:19	98.30		
3:01	98.18			3:20	98.31		
3:02	98.18		8	3:21	98.31		
3:03	98.20		17	3:22	98.33		
3:04	98.22			3:23	98.33		
3:05	98.23			3:24	98.34		
3:06	98.24			3:25	98.34		
3:07	98.24			3:26	98.35		
3:08	98.25		80	3:27	98.34		
3:09	98.26			3:28	98.36		85
3:10	98.27			3:29	98.36		
3:11	. . . . .			3:30	98.36		
3:12	98.28			3:31	98.38		
3:13	98.28			3:32	98.39		
3:14	98.30			3:33	. . . . .		
3:15	98.30		50	3:34	98.40		
3:16	98.30			3:35		Done	
3:17	98.30						———
							Recovered, 230 Cc.

The following table is taken from data on previous runs obtained after the still had been in operation for more than an hour. The sample represents this first purification with hydrogen chloride and the run was made on the usual 300 Cc. at 7 amperes.

Time.	Temperature. Degrees.	Remarks.	Volume of distillate.	Time.	Temperature. Degrees.	Remarks.	Volume of distillate.
4:28	98.00	Pressure on		4:44	98.30		
4:29	98.10		13	4:45	98.30		98
4:30	98.14			4:46	98.32		
4:31	98.16			4:47	98.30		
4:32	98.20		32	4:48	98.32		
4:33	98.20			4:49	98.34		
4:34	98.22		34	4:50	98.30		
4:35	98.25			4:51	98.35		60
4:36	. . . . .			4:52	98.37		
4:37	98.28			4:53	98.38		
4:38	98.29			4:54	98.39		
4:39	98.30			4:55	. . . . .		
4:40	98.30			4:56	98.40		48
4:41	. . . . .			4:57			
4:42	98.30					Done	7
4:43	98.30						———
							Recovered, 292 Cc.

From the tables it becomes apparent that the heptane boils constantly within limits of temperature of 0.10° and the constant temperature, 98.30° in both cases, may be taken as the boiling point of this sample of heptane.

This represents the second sample prepared by this method. It had a boiling range of 0.28°.

Time.	Temperature. Degrees.	Remarks.	Volume of distillate.	Time.	Temperature. Degrees.	Remarks.	Volume of distillate.
3:59	.....	Boiling began		4:20	.....		
4:00	97.90	Pressure on		4:21	98.28		
4:01	97.98			4:22	98.30		40
4:02	98.03			4:23	.....		
3:03	98.07			4:24	98.30		
4:04	98.10			4:25	98.30		
4:05	98.10			4:26	98.30		
4:06	98.12			4:27	98.30		
4:07	98.14			4:28	98.31		
4:08	98.16			4:29	98.31		50
4:09	98.16			4:30	.....		
4:10	98.17			4:31	98.32		
4:11	98.18			4:32	98.32		
4:12	98.20		88	4:33	98.34		
4:13	98.20			4:34	98.34		
4:14	.....			4:35	98.35		52
4:15	98.21			4:36	98.37		
4:16	98.23			4:37	98.38		
4:17	98.25		46	4:38		Done	
4:18	98.27						——
4:19	98.27					Recovered, 276 Cc.	

This sample, taken from a different portion of the original lot, also boils within close limits having a constant value at 98.30°.

Heptane Purified by Antimony Trichloride.—The sample had a boiling range of 0.38°. The run was made on 300 Cc. at 7 amperes.

Time.	Temperature. Degrees.	Remarks.	Volume of distillate.	Time.	Temperature. Degrees.	Remarks.	Volume of distillate.
9:18	.....	Boiling began		9:39	98.30		
9:19	.....	Pressure on		9:40	98.30		
9:20	98.11			9:41	98.30		43
9:21	98.15			9:42	98.31		
9:22	98.18			9:43	98.32		
9:23	98.20		32	9:44	98.32		
9:24	98.20			9:45	98.33		
9:25	98.20			9:46	98.33		
9:26	98.20			9:47	98.34		
9:27	98.22			9:48	98.33		
9:28	98.23			9:49	98.35		55
9:29	98.24			9:50	98.37		
9:30	98.25		55	9:51	98.37		
9:31	98.26			9:52	98.37		
9:32	98.28			9:53	98.38		
9:33	98.28			9:54	98.39		
9:34	.....			9:55	98.40		
9:35	98.29		50	9:56	98.41		55
9:36	98.30			9:57		Done	
9:37	98.30						——
9:38	98.30					Recovered, 290 Cc.	

A previous run made on the same sample of heptane when the still had been in use for hours gave the following table on the usual quantity—300 Cc. at 7 amperes.

Time.	Temperature. Degrees.	Remarks.	Volume of distillate.	Time.	Temperature. Degrees.	Remarks.	Volume of distillate.
5:18	.....	Boiling began		5:32	98.28		
5:19	98.00	Pressure on		5:33	.....		
5:20	98.10		8	5:34	98.29		
5:21	.....			5:35	98.30		
5:22	98.20		13	5:36	98.31		
5:23	98.20			5:37	98.31		
5:24	98.20			5:38	98.31		
5:25	98.20			5:39	98.31		112
5:26	98.21			5:40	98.32		
5:27	98.23			5:41	98.35		
5:28	98.23			5:42	98.38		
5:29	98.24			5:43	98.39		
	98.25		107	5:44	98.40		48
5:30	98.26			5:45	98.42	Done	7
5:31	98.27						‾‾‾

Recovered, 295 Cc.

It will thus be seen that in both cases a very large proportion came over within 0.10° with the temperature remaining constant at 98.30° and 98.31°, respectively.

Heptane Purified by Bromine and Hydrogen Bromide.—This sample is of a much lower degree of purity than any of the preceding and is included here because the values of some of its other physical properties are included in the tables.

The run was made on a portion, having a boiling range, of about 1.0°, and a quantity of 300 Cc. with a current of 7 amperes.

Time.	Temperature Degrees.	Remarks.	Volume of distillate.	Time.	Temperature. Degrees.	Remarks.	Volume of distillate.
4:13	97.90	Pressure on		4:36	98.40		
4:16	98.10		7	4:37	98.40		61
4:20	98.20		32	4:38	98.43		
4:24	98.25		30	4:40	98.45		
4:26	98.30			4:42	98.50		52
4:27	98.30			4:44	98.57		
4:29	98.30		58	4:45	98.62		
4:30	98.32			4:46	98.70		
4:31	98.36			4:47	98.90		
4:33	98.37			4:48	99.15		
4:34	98.39			4:49	100.00		53
4:35	98.39						‾‾‾

Recovered, 293 Cc.

There are indications that with more care in fractionation this sample would have shown the same characteristic boiling temperature as the others.

These results indicate that there is remarkable uniformity in the product obtained by the various methods of purification. In every case there is obtained a constant temperature of 98.30° at which the boiling point remains fixed for minutes at a time. This value becomes 98.34°, when the correction obtained for the boiling point of water is applied.

The following more exact determinations of the boiling point of normal heptane have been made by various observers:

Boiling point.	Observer.	Source.
98.42 to 98.43°[a]	T. E. Thorpe[2,10]	*Pinus Sabiniana.*
98.4°	Sydney Young[11]	Reduction of normal heptyl bromide.
98.25 to 98.45°	Sydney Young[12]	"Petroleum ether" from Am. petroleum.
97.33°[b]	R. E. Kremers[1]	*Pinus Sabiniana.*
98.56 to 98.57°[c]	W. A. Gruse[13]	*Pinus Jeffreyi.*
98.34°[c]	Sherk	*Pinus Jeffreyi.*

[a] Barometric pressure corrected to 760 mm. and temperature reduced to 0° C.

[b] Barometric pressure corrected but not reduced.

[c] Constant pressure apparatus.

2. Density.

In all the density determinations weighings were made with a set of weights which had been calibrated by direct comparison with weights standardized by the Bureau of Standards. The weights were compared on both pans of the balance and calculations made by the method of swings and determination of the sensitiveness of the balance for the several loads.

The pyknometers were of the Ostwald-Sprengel type and comparisons were made with one of a capacity of about 50 Cc. The caps fitted tightly. The pyknometer was carefully cleaned and steamed out. Water which had been distilled from permanganate and condensed in tin was afterwards boiled before using to standardize the pyknometer. All weights are corrected and were made by double weighing using as a tare a pyknometer of equal size. Determinations were made by refilling and checks obtained in the weighings to 2 mg. The tare was treated like the other pyknometer by being introduced into the bath and wiped dry in the same manner and allowed to hang in the balance case the same length of time.

The pyknometer was allowed to remain in the bath one-half hour until all movement of the liquid had ceased. The bath was kept at 20° C. within less than ±0.03°. After cleaning, the pyknometer stood a day to give time for readjustments to take place in the glass. For a change of sample, air filtered through a plug of cotton was aspirated through the pyknometer.

For density determination at 0° the most uniform sample of purified heptane was chosen and only this one value obtained. A bulb was blown in one arm of the pyknometer to allow for expansion. This bulb was so shaped and its outlet so inclined that it readily drained on cooling, and no heptane would rise in the capillary beyond until the bulb filled. The leak was very slight as one determination showed after pyknometer had stood several hours.

For the temperature regulation finely powdered ice was packed into a large funnel and the instrument immersed and left until no movement took place in the capillary tube. The bulb was then completely drained by tilting and final adjustment made.

In the comparative determinations the fractions of heptane chosen are indicated. The heptane was standing over sodium.

The most satisfactory value of the series was that for the purification with

hydrogen chloride; accordingly the density of 20° and 0° was reduced to vacuo by using the formula[14]

$$M\sigma\left(\frac{1}{\Delta} - \frac{1}{p}\right) = MK,$$

where M = apparent mass in grammes of body in air,
   σ = density of air,
   Δ = density of body,
   p = density of weights.

The data used were for heptane at 20°:
   apparent weight of heptane = 35.8320 grammes,
   apparent weight of water = 52.3346 grammes.

The correction (K) is determined for weights used and the density of the substance weighed, but σ is taken as the average density or 0.0012. In the calculations the value of this correction factor (K) was obtained from the actual density[15] of the air at the time of weighing. The following values were obtained:

   corrected weight of heptane = 35.8912 grammes,
   corrected weight of water = 52.4189 grammes.

The density of heptane at 20°/20° is

$$\frac{35.8912}{52.4189} = 0.68469.$$

The. values for two other temperatures were also obtained, reducing the weights to vacuo in each case:

$d_{20°/20°}$............................ 0.68469
$d_{20°/4°}$............................. 0.70075
$d_{0°/4°}$.............................. 0.70192

TABLE OF COMPARATIVE DENSITY.

Heptane purified by	Boiling point, Degrees.	Density at 20°.	Average.
Iodine..................................	98.20 to .35	0.684598	
		0.684586	0.68459
Hydrogen iodide..........................	98.25 to .35	0.684687	
		0.684703	0.68469
Hydrogen chloride........................	98.20 to .30	0.684644	
		0.684627	0.68464
Hydrogen chloride........................	98.25 to .30	0.684687	
		0.684657	0.68467
Antimony trichloride......................	98.25 to .30	0.684722	
		0.684667	0.68469
Bromine and hydrogen bromide............	98.25 to .40	0.684894	
		0.684873	0.68488

The following table gives the results of other observers on the determination of the density of heptane:

	Density.	Observer.	Source.
$d_{0°/0°}$..............	0.70057	Thorpe[2]	*Pinus Sabiniana.*
$d_{0/4}$................	0.70048	Thorpe[10]	*Pinus Sabiniana.*
$d_{15/15}$..............	0.68838	Thorpe[16]	*Pinus Sabiniana.*
$d_{15/15}$..............	0.68851	Perkin[16]	Thorpe's sample.
$d_{25/25}$..............	0.68142	Perkin[18]	Thorpe's sample.
$d_{0/4}$................	0.70048	Young[11]	American petroleum.
$d_{0/4}$................	0.70186	Young[11]	Normal heptyl bromide.
$d_{0/0}$................	0.6984	Kijmer[17]	Oxidation of fatty hydrazine.

	Density.	Observer.	Source.
$d/15$..................	0.6863	Blasdale[18]	*Pinus Jeffreyi.*
$d/15$..................	0.6840	Blasdale[18]	*Pinus Sabiniana.*
$d/20$..................	0.68288	Kremers[1]	*Pinus Sabiniana.*
$d/40$..................	0.66623	Kremers[1]	*Pinus Sabiniana.*
$d_{20/4}$..............	0.6932	Faville[10]	*Pinus Jeffreyi.*

3. Index of Refraction.

This constant was measured by the Pulfrich refractometer. The measurements were made at 20° and at every setting of the instrument a temperature reading was taken. Care is necessary in the adjustment of the temperature because of the high coefficient of expansion of heptane. Water was used as a standard. A quantity prepared for conductivity measurements was used.

Measurements were made on two separate portions of the liquid under examination. The cell was filled with a pipette and readings taken. Then the liquid was withdrawn in the same manner and the cell dried with filter paper. A second portion was introduced and a new series of readings obtained. The sodium flame was used in this determination. Settings were made repeatedly and readings taken until a series of five had been obtained for each portion.

The value obtained for the refractive index for water is $n_{20°} = 1.33279$.

Heptane purified by	Fraction. Degrees.	Angle of refraction.	Refractive index, 20°.
Iodine.................................	98.25 to .35	56° 30.9′	1.38737
Hydrogen iodide........................	98.25 to .35	56° 30.7′	1.38739
Hydrogen chloride......................	98.25 to .30	56° 31.1′	1.38735
Antimony trichloride....................	98.25 to .30	56° 30.6′	1.38740
Bromine and hydrogen bromide..........	98.25 to .40	56° 30.7′	1.38739

In order to determine the effect of such narrow fractionation upon the refractive index, the indices of every fraction obtained from the first sample of hydrogen chloride purification were determined in the same manner; and the following series of results was obtained:

Fraction. Degrees.	Angle of refraction.	Refractive index.
98.10 to .20.................................	56° 31.0′	1.38736
98.20 to .25.................................	56° 31.0′	1.38736
98.25 to .30.................................	56° 30.95′	1.38737
98.30 to .35.................................	56° 31.4′	1.38733
98.35 to .40.................................	56° 30.6′	1.38740

Thus it is apparent that the differences are very slight, and the values obtained for the different methods of purification as well as those for a series of fractions are very nearly constant.

The values which have been obtained by other observers are given below.

	Index of refraction.	Method.	Observer.	Source.
n_D............	1.3879	Horizontal goniometer	Thorpe[2]	*Pinus Sabiniana.*
$n^{15°}$..........	1.3887	....	Blasdale[18]	*Pinus Sabiniana.*
$n^{15°}$..........	1.3905	....	Blasdale[18]	*Pinus Jeffreyi.*
$n^{20°}$..........	1.3895	Abbé	Kremers[1]	*Pinus Sabiniana.*
$n^{20°}_D$..........	1.38776	Pulfrich	Faville[19]	*Pinus Jeffreyi.*

4. Dispersion.

A hydrogen tube was used and settings were made on the (C) and the (G) lines. The distance between the lines was determined by the vernier and settings

were made and readings taken by first rotating the vernier in one direction for one reading and in the reverse direction for the second reading. Thus a series of concordant values for the distance was obtained by taking five or six such alternate readings. The temperature was accurately controlled as in the previous cases at 20° by observing the thermometer at the time of each setting.

Results are calculated on the values obtained for the sample of hydrogen chloride purified heptane boiling between 98.25° and 98.30°. This was again chosen as the most representative sample. However, values for the corresponding fractions of iodine purified heptane and the purification by antimony chloride are included as well, to show that the variations among the samples are very slight.

Sample.	Fraction. Degrees.	Angle for (C) line.	Angle for (G) line.	Difference by vernier.
Hydrogen chloride..............	98.25 to .30	55° 48.8′	58° 6.5′	2° 18.4′
Hydrogen iodide................	98.25 to .30	55° 49.5′	58° 6.5′	2° 18.2′
Antimony trichloride...........	98.20 to .30°	55° 49.5′	58° 6.5′	2° 18.0′

From these results the molecular refractions for the two hydrogen lines are obtained. The values for the sodium line are included here. The calculated values are obtained from the atomic refractions of the elements. The formula of Lorentz and Lorenz was used:

$$\mathrm{M\ R} = \frac{n^2 - 1}{n^2 + 2} \cdot \frac{\mathrm{M}}{\mathrm{d}}$$

where R represents the refractions,

M represents the molecular weight of the substance,

n represents the index of refraction, and

d represents the density of the substance under the conditions of the observations.

Heptane purified by	Molecular refraction. C.	D.	G.	Molecular dispersion.
Hydrogen chloride.....................	34.294	34.395	35.763	1.469
Hydrogen iodide.......................	34.295	34.395	35.763	1.468
Antimony trichloride..................	34.296	34.395	35.763	1.467
Calculated............................	34.203	34.323	35.052	0.849

5. Viscosity.

The method used was that described by Ostwald[20] and is the very familiar method. A definite amount of liquid is allowed to flow through a capillary tube, and the time taken for it to flow between the two marks noted. This time is then compared with the time of outflow of a liquid whose viscosity is known, or whose relative viscosity is taken as unity. Since the height of the column of liquid is the same, correction will have to be made only for the difference in the densities of the two liquids.

Water was used as a standard here, as its absolute viscosity has been carefully measured, and its purity is easily checked. The absolute viscosity of water is taken to be 0.01007 dyne per sq. cm. at 20° C. This value is obtained by interpolation of the results of Thorpe and Rodger[21,22] for the absolute value of the viscosity of water. The relative values obtained by the Ostwald method by taking the viscosity of water as unity are then multiplied by this factor to give the value in absolute units.

Throughout the work the temperature was controlled to within ±0.03° and the thermostat with glass sides was employed as for density determinations, and

was regulated at 20°. Especial care is required in the case of heptane whose thermal expansion is great. The time of outflow was recorded by a stopwatch which could be read to 0.1 of a second. Two types of instrument were used. Tube I was the ordinary open form and tube II was the form arranged for volatile liquids. Exactly 4 Cc. of heptane were measured into the viscosimeter with a pipette. Care was taken to allow the pipette to drain for the same length of time and the heptane was at the temperature of the bath.

Eight to twelve readings were taken for each sample. When one set of readings was finished, the other viscosimeter would be ready. Each was emptied and filled a second time and new readings recorded. For a new sample the tube was aspirated carefully using filtered air and a set of readings taken again until two series checked. At the end of all of the series the first sample of heptane was run again and finally water a second time.

With water the time of outflow at the first and last was for instrument II 112.2 and 112.4 seconds; while heptane purified with hydrogen chloride gave with instrument II 54.8 and 54.8 seconds. For a single series the times of outflow for consecutive readings of instrument II were 54.8, 54.8, 54.8, 54.8, 54,8, 54.8, 54.8, 54.9. With tube I the times of outflow in seconds were: 68.0, 67.9, 67.8, 67.9, 68.1, 68.0, 68.0, 68.0. Each set of readings was averaged and that value taken as correct. The values obtained at different times during the work were also averaged as in the case of water and one heptane sample.

Heptane purified by	Fraction. Degrees.	No. of viscos- imeter.	Time of outflow. Water.	Time of outflow. Heptane.	Sp. gr. at 20°.	Relative viscosity at 20°.	Absolute viscosity. Dynes cm².
Iodine	98.25 to .30	I	112.26	67.94		0.413	0.00416
		II	90.20	54.91	0.68459	0.415	0.00418
Hydrogen iodide	98.25 to .35	I	112.26	67.70		0.414	0.00417
		II	90.20	54.70	0.68469	0.417	0.00420
Hydrogen chloride	98.25 to .30	I	112.26	67.96		0.414	0.00417
		II	90.20	54.80	0.68467	0.416	0.00419
Antimony trichloride	98.25 to .30	I	112.26	67.99	....	0.415	0.00418
		II	90.20	54.78	0.68469	0.416	0.00419

The following values have been obtained by other observers and among them those that are strictly comparable are chosen.

Temperature. Degrees.	Relative viscosity.	Absolute viscosity.	Observer.
20.10	.....	0.004025 dyne.	Thorpe[2]
20.0[a]	.....	0.00410	Thorpe & Rodger[22]
20	0.418	0.00421	Faville[19]
	0.424	0.00426	

[a] The value for this temperature was taken from the curve which accompanied the table.

I wish to express my thanks to Dr. A. E. Koenig for the helpful suggestions which he made in this part of the work.

NOTE ON THE DIELECTRIC CONSTANT.

The value of this constant has been determined for pure heptane by Miss Faville[19] under the direction of Professor Mathews using Drude's second method. The value 1.76 at 20° was obtained compared with benzene which gave a value of 2.258.

Recently Richards and Shipley[23] obtained the value 1.973 for "heptane" compared with that of benzene, 2.286, at 20°. Apparently the authors have attempted to fix the value of this constant by the use of a product derived from petroleum having boiling points anywhere between 96.5° and 100°. They admit, "Probably the result represents an average value for several heptanes;" yet heptane of any desired degree of purity is available for the determination of physical constants and chemical characteristics. The value of the dielectric constant is now being redetermined on pure heptane in Professor Mathews' laboratory.

[1] R. E. Kremers, "A chemical study of Digger's pine oil and of the heptane therefrom." Unpublished thesis, Univ. of Wis., 1915.

[2] *Journ. Chem. Soc.*, 35 (1879), 296.

[8] *Amer. Chem. Journ.*, 20, 202.

[4] W. A. Gruse, unpublished results of the Forest Products Laboratory.

[5] Wm. Rabak, unpublished thesis, Univ. of Wis., 1915, note, p. 14.

[9] Smithsonian Physical Tables, 6th ed., 1914, p. 19.

[10] *Journ. Chem. Soc.*, 37 (1880), 141.

[11] *Ibid.*, 73 (1898), 905.

[12] *Ibid.*, 73 (1898), 917.

[13] Determination by W. A. Gruse; also K. E. Faville, Thesis, Univ. of Wis., 1916.

[14] Kaye and Laby, "Physical and Chemical Constants," p. 19.

[15] Wade and Merriman's Table, *Journ. Chem. Soc.*, 101 (1912), 2429.

[16] By Perkin, *Ibid.*, 45 (1884), 447.

[17] *Journ. f. prakt. Chemie*, 2d Ser., 64 (1901), 127.

[18] *Journ. Am. Chem. Soc.*, 23 (1901), 162.

[19] K. E. Faville, Thesis, Univ. of Wis., 1916.

[20] "Physiko-chemische Messungen," p. 260.

[21] *Proc. Royal Soc.*, 1894.

[22] *Phil. Trans. Roy. Soc.*, 185A (1894), 307.

[23] *Journ. Am. Chem. Soc.*, 41 (1919), 2007.

[24] *Journ. Phys. Chem.*, 22 (1918), 1; see also *Journ. Am. Chem. Soc.*, 36 (1914), 1787; and Richards and Mathews, *Ibid.*, 30 (1908), 1282.

PRACTICAL TESTING OF SPIRIT OF CAMPHOR.

BY A. B. LYONS.

The accurate determination of camphor in an alcoholic solution is not so simple a matter as it would at first appear. If the camphor is of the dextrogyrate variety, the polariscope will quickly solve the problem. But a polariscope does not usually form part of the equipment of a drug store. There is camphor, moreover, that does not affect the polarized ray.

The camphor is easily thrown out of solution by addition of strong saline solutions, and the precipitated camphor is readily taken up by such immiscible solvents as petroleum ether. The amount of camphor is shown by the increase in volume of the solvent. If the quantity of spirit taken for the test is 5 mils, this increase in volume will be, in the case of a standard U. S. P. spirit, 0.5 mil, a quantity not easily read off with an exactness of one part in forty. Every detail of the method as described by Penniman and Randall must be scrupulously adhered to if even this degree of exactness is to be secured, and the method involves the use of a Babcock milk testing outfit. In inexperienced hands, variations considerably greater than 0.25 percent (in a total of 10 percent) may be