11α-hydroxy group.[1] This method, coupled with our observation that the 11α-hydroxyl group is not oxidized readily by N-bromoacetamide, has made possible the preparation of Δ^4-pregnen-11α,17α,-21-triol-3,20-dione 11,21-diacetate (11-epi-Compound F Diacetate).

Etiocholan-3α-ol-11,17-dione[2] was reduced with sodium in refluxing *n*-propyl alcohol in excellent yield to etiocholan-3α,11α,17β-triol (I), m.p. 245–247°, $[\alpha]^{25}\text{D}$ +13° (0.5% in ethanol). *Anal.* Calcd. for $C_{19}H_{32}O_3$: C, 73.98; H, 10.46. Found: C, 73.82; H, 10.72. The configuration of the 11-hydroxyl group was inferred from the acetylation of I, which gave a triacetate, m.p. 161–162°, $[\alpha]^{25}\text{D}$ −2° (0.9% in ethanol). *Anal.* Calcd. for $C_{25}H_{38}O_6$: C, 69.09; H, 8.81. Found: C, 69.31; H, 8.94. Oxidation of I with excess N-bromoacetamide (NBA) in aqueous methanol–acetone solution at room temperature gave, in good yield, etiocholan-11α-ol-3,17-dione (II), m.p. 143–144°, $[\alpha]^{25}\text{D}$ +72° (1% in acetone). *Anal.* Calcd. for $C_{19}H_{28}O_3$: C, 74.96; H, 9.27. Found: C, 74.87; H, 9.24. The structure of II was established by independent synthesis from I. Oxidation of I with chromic anhydride in aqueous acetic acid at room temperature afforded etiocholan-3,11,17-trione (III),[3] m.p. 135–136°, $[\alpha]^{23}\text{D}$ +151° (1% in acetone). Upon refluxing III with ethylene glycol and *p*-toluenesulfonic acid in benzene solution, there was obtained etiocholan-3,11,17-trione 3,17-bisdioxolane (IV), m.p. 122–123°, $[\alpha]^{26}\text{D}$ +30° (1% in chloroform). *Anal.* Calcd. for $C_{23}H_{34}O_5$: C, 70.73; H, 8.77. Found: C, 70.75; H, 9.07. Reduction of IV with sodium in refluxing *n*-propyl alcohol, followed by hydrolysis of the product with methanol–hydrochloric acid, yielded II, identical in all respects with the sample from NBA oxidation of I.

Sodium and *n*-propyl alcohol reduction of pregnan-3α,17α-diol-11,20-dione 20-dioxolane[4] yielded the corresponding 11α-hydroxy compound (V), m.p. 213.2–214.0°, $[\alpha]\text{D}$ −13° (1% in acetone). *Anal.* Calcd. for $C_{23}H_{38}O_5$: C, 70.01; H, 9.71. Found: C, 69.70; H, 9.74. Hydrolysis of V with aqueous methanol–hydrochloric acid gave pregnan-3α,11α,17α-triol-20-one (VI) as the monohydrate, $[\alpha]\text{D}$ +25° (0.5% in acetone). *Anal.* Calcd. for $C_{21}H_{34}O_4 \cdot H_2O$: C, 68.44; H, 9.85. Found: C, 68.14; H, 10.07. Bromination of VI in chloroform at C-21 followed by acetoxylation according to the method of Gallagher[5] yielded an oil which was not further purified, but was oxidized at C-3 with NBA and then acetylated at C-11 to give pregnan-11α,-17α,21-triol-3,20-dione 11,21-diacetate (VII), m.p. 232–233° dec., $[\alpha]^{25}\text{D}$ +44° (1% in dioxane). *Anal.* Calcd. for $C_{25}H_{36}O_7$: C, 66.94; H, 8.09. Found: C, 66.59; H, 8.29. Bromination at C-4 followed by semicarbazone formation, elimination of HBr and acid hydrolysis of the semicarbazone[6] gave Δ^4-pregnen-11α,17α,21-triol-3,20-dione 11,21-diacetate (11-epi-compound F diacetate), m.p. 223.0–225.8, $[\alpha]\text{D}$ +116° (1% in dioxane), $\epsilon_{240}^{\text{alc}}$ 16,800. *Anal.* Calcd. for $C_{25}H_{34}O_7$: C, 67.24; H, 7.68. Found: C, 67.12; H, 7.85.

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[1] F. Sondheimer, R. Yashin, G. Rosenkranz and C. Djerassi (THIS JOURNAL, **74**, 2696 (1952)) noted that the carbonyl group and the double bond conjugated with it in Δ^8-22-isoallospirosten-3β-ol-11-one propionate are both reduced to yield the saturated 11α-ol with the aid of lithium, liquid ammonia and alcohol.

[2] L. H. Sarett, *ibid.*, **70**, 1454 (1948).

[3] S. Lieberman and K. Dobriner, *J. Biol. Chem.*, **166**, 773 (1946).

[4] The preparation of the various pregnane dioxolanes will be the subject of another paper.

[5] T. H. Kritchevsky, D. L. Garmaise and T. F. Gallagher, THIS JOURNAL, **74**, 483 (1952).

[6] V. R. Mattox and E. C. Kendall, *J. Biol. Chem.*, **188**, 287 (1951); B. Koechlin, T. Kritchevsky and T. F. Gallagher, *ibid.*, **184**, 393 (1950); E. B. Hershberg, *J. Org. Chem.*, **13**, 542 (1948).

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RECEIVED JUNE 9, 1952

THE ION-EXCHANGE SEPARATION OF ISOMERIC DINITROTETRAMMINECOBALT(III) IONS[1]

Sir:

Recently it has been shown that the octahedral complex ions $Cr(H_2O)_6^{+++}$, $Cr(SCN)(H_2O)_5^{++}$, and $Cr(SCN)_2(H_2O)_4^{+}$ are readily separated by an ion-exchange technique.[2] The possibility of using this same technique to separate the isomeric *cis* and *trans* complexes having the general formula $MA_4B_2^{+n}$ was suggested at that time. The isomeric dinitrotetramminecobalt(III) ions have been prepared,[3] and their elution characteristics have been studied. An elution curve of a mixture of the two complex ions is shown in Fig. 1. Since the absorption spectra of these complex ions are different,[4] it is convenient to make use of the spectra in following the elution and identifying the eluted species. The more easily eluted ion is the *trans* complex.

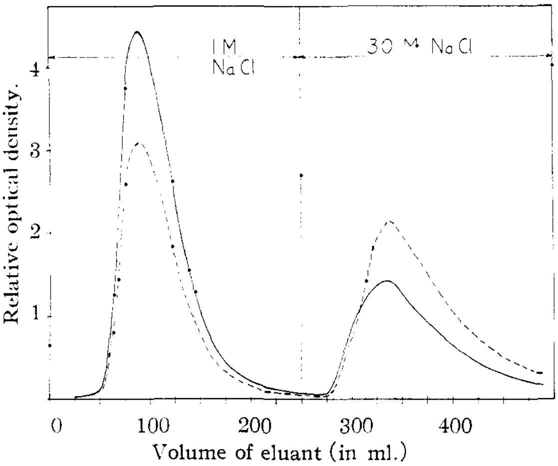

Fig. 1.—Relative optical density of eluant *versus* volume of eluant (in ml.). —350 mμ, - - - - - 325 mμ. For *trans* complex $\epsilon_{350} > \epsilon_{325}$. For *cis* complex $\epsilon_{325} > \epsilon_{350}$. Notice that the relative optical densities in the first part of the second peak indicate that the *trans* complex had not been completely eluted when the eluting agent was changed. Individual portions of eluant were 12.5 ml.

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[1] This work has been supported in part by a grant from the U. S. Atomic Energy Commission.

[2] E. L. King and E. B. Dismukes, THIS JOURNAL, **74**, 1674 (1952).

[3] *cis:* H. Biltz and W. Biltz, "Laboratory Methods of Inorganic Chemistry," John Wiley and Sons, New York, N. Y., 1928, p. 179. *trans:* S. M. Jorgensen, *Z. anorg. Chem.*, **17**, 469 (1898).

[4] F. Basolo, THIS JOURNAL, **72**, 4393 (1950).

In an octahedral complex of the composition $Ma_4B_2^{+n}$, the *trans* isomer has no net dipole moment while the *cis* isomer does. It seems reasonable for the polar ion to be more strongly held in the resin phase than the non-polar ion of the same composition and charge. Since the nitro group is one of the most polar groups, the system studied here may prove to be the one in which the separation of isomers by this method is most easily accomplished.

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THE ISOMERIZATION OF CYCLOPROPANE—A QUASI-UNIMOLECULAR REACTION

Sir:

In 1942 Pease[1] concluded that with the possible exception of the thermal isomerization of cyclopropane investigated by Chambers and Kistiakowsky,[2] there was no case of quasi-unimolecular reaction known, which provided unequivocal confirmation of the theory of unimolecular reactions proposed by Lindemann, Hinshelwood, Rice, Ramsperger, Kassel[3] and others. Later Corner and Pease[4] reinvestigated the isomerization of cyclopropane to propylene and concluded that as the addition of unreactive gases had little effect, the fall-off of the apparent first-order rate constant was more reasonably explained by a complex reaction mechanism than by an energy transfer process.

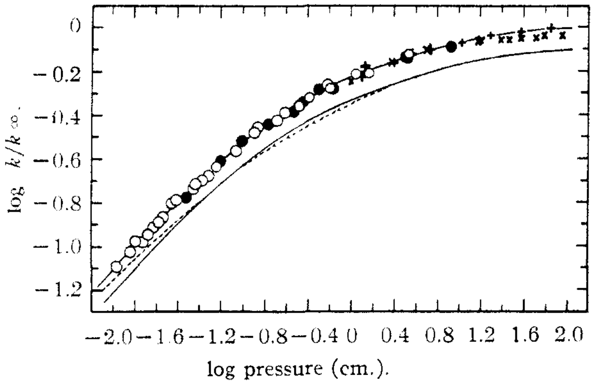

Fig. 1.

There now appear to be two well-established cases of the falling-off of unimolecular rate constants in the decomposition of nitrogen pentoxide[5] and nitrous oxide.[6] We have reinvestigated the isomerization of cyclopropane at 492° in a 2-l. Pyrex reaction vessel extending the measurements below the 10 mm. pressure limit of previous workers down to 0.1 mm. The reaction was followed by the analysis of the cyclopropane–propylene mixture for olefin content on a Blacet–Leighton[7] apparatus using a mercuric acetate bead.[8] There is good evidence that no side-reactions occurred for in an aged reaction vessel no condensation took place and no products non-condensable in liquid nitrogen were formed. Our results are shown together with those of other workers in Fig. 1. The theoretical curve, following Chambers and Kistiakowsky,[2] is calculated from Kassel's[3] equation using a collision diameter of 3.9 Å., 13 oscillators and a value of k_∞, the rate at infinite pressure, given by

$$\log k_\infty = 15.17 - \frac{65{,}000}{2.3RT}$$

Furthermore we have investigated the effect of added hydrogen on the rate constant at low cyclopropane pressures. The hydrogen causes a marked increase in the rate constant and is about one-fifth as efficient as cyclopropane or propylene in restoring the rate constant. The comparatively low efficiency of hydrogen is evidently the reason why Corner and Pease could find no effect which in their case would have been 4%, for this is the order of their experimental error. Accordingly it seems that this reaction is a clear cut case of the falling-off of the rate of a unimolecular gas reaction with pressure.

We are now investigating the effect of the addition of a number of non-reacting gases to the system and hope to publish the results in detail when a full survey has been completed.

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(1) R. N. Pease, "Equilibrium and Kinetics of Gas Reactions," Princeton, N. J., 1942, p. 147.

(2) T. S. Chambers and G. B. Kistiakowsky, THIS JOURNAL, **56**, 399 (1934).

(3) L. S. Kassel, "Kinetics of Homogeneous Gas Reactions," Chemical Catalog Co., New York, N. Y., 1932, p. 93.

(4) E. S. Corner and R. N. Pease, THIS JOURNAL, **67**, 2067 (1945).

(5) H. S. Johnston and R. L. Perrine, *ibid.*, **73**, 4782 (1951).

(6) H. S. Johnston, *J. Chem. Phys.*, **19**, 663 (1951).

(7) F. E. Blacet and P. A. Leighton, *Ind. Eng. Chem., Anal. Ed.*, **3**, 266 (1931).

(8) R. Pyke, A. Cahn and D. J. LeRoy, *Anal. Chem.*, **19**, 65 (1947).

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EFFECT OF PURINES ON A SUCCINYLSULFATHIAZOLE (SST)-INDUCED DEFICIENCY IN MICE

Sir:

The addition of succinylsulfathiazole (SST) to a purified diet having a low fat content was reported to cause a retardation of growth in weanling mice.[1] This effect on growth was prevented if such materials as fat, a defatted cottonseed meal, or rolled oats were added to the basal diet. Whereas whole liver was found to be without effect it has since been found that a water extracted liver residue is also effective. It was tentatively concluded in this earlier report that fat *per se* is an essential nutrient for animal growth. It was further suggested that in the absence of adequate quantities of dietary fat a factor, or factors, synthesized by SST-susceptible intestinal microorganisms is essential for fat synthesis by the animal. This factor, or factors, was postulated to be present in those fat-free natural materials that are capable of preventing the SST-induced growth retardation.

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(1) D. K. Bosshardt, W. J. Paul, R. H. Barnes and J. W. Huff, *Proc. Soc. Exptl. Biol. Med.*, **75**, 722 (1950).