of free radicals in Table II. In the corrected molecular orbital calculations, S was assumed to have the rounded-off value of 0.25. It is seen that the agreement of the various calculations with experiment and with each other is excellent in most cases, as is shown by the approximate constancy of the values of J, γ and β, and of the ratios J/β and β/γ. The discrepancies with butadiene (Table I) are presumably due to the fact that, with such a small effect, the complications arising from further factors, such as a lack of constancy of the integrals J, α, β, γ and S, the alterations in bond distances, etc., are relatively very important. The obviously impossible result that the resonance energy of cyclobutadiene is negative (Table I), which is obtained in the corrected molecular orbital calculation, is to be related to the fact, previously pointed out,[6] that the molecular orbital treatment of this molecule does not take into account the resonance between the two Kekulé-like structures. With the free radicals (Table II) the calculated orders of increasing free radical resonance energy are in most cases the same as the observed order of increasing dissociation of the corresponding ethanes. While the valence bond treatment seems to reproduce the experimental order somewhat more satisfactorily in some regards than either of the molecular orbital treatments, there are too many further, unconsidered factors, such as solvent effects, entropy changes, steric effects, etc., to permit a judgment as to which of the three treatments is really the most accurate. This is especially true in view of the smallness of the differences involved. It is interesting that none of the methods accounts for the observed greater dissociating effect of the *m*-biphenyl group[7] as compared with the phenyl group.

The conclusion to be reached from the above discussion is that, in cases like those considered, the explicit inclusion of the integral S in the molecular orbital treatment makes no significant difference in the self-consistency of the calculations of resonance energies of molecules, or of free radical resonance energies of radicals. There is no assurance, however, that the same will be true in the calculations of any other properties, especially in those cases in which the integrals α, β, γ and S cannot be considered constant. In fact, Mulliken and Rieke[1] have found that the explicit inclusion of S does materially improve the agreement of the calculations with the spectroscopic data. The fact that the value of the integral β is about twice that of γ also seems to be an improvement, since the old figure of $\gamma \cong -20$ kcal. per mole was hard to reconcile either with the known bond energies or with the ultraviolet absorption spectra of the molecules.

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[6] G. W. Wheland, *Proc. Roy. Soc.* (London), **A164**, 397 (1938).

[7] C. S. Marvel, E. Ginsberg and M. B. Mueller, THIS JOURNAL, **61**, 77 (1939).

NEW COMPOUNDS

α-Guanido-γ-methylmercaptobutyric Acid (Guanidomethionine)

The method employed for the preparation of this compound was similar to that reported for guanidocystine.[1,2] To a solution of 0.74 g. of *dl*-methionine in 10 cc. of 0.5 N potassium hydroxide was added 1.04 g. of methyl-isothiourea hydriodide. The solution was put into a vacuum desiccator which was then evacuated for five hours. After a total of fourteen hours in the desiccator under reduced pressure the dried crystals were dissolved in 10 cc. of water. As before, this solution was slowly brought to dryness in the vacuum desiccator. The dried crystals were rubbed well with 30 cc. of acetone containing 6 drops of concentrated ammonia. Potassium iodide is soluble in acetone in the presence of ammonia. The crystals were filtered off, washed with two 5-cc. portions of ammoniacal acetone, then with plain acetone and air dried. The crude guanidomethionine was obtained as white crystals in about 92% yield. The Sakaguchi reaction was positive. After 3 recrystallizations from boiling water it was obtained as six-sided plates; dried in an Abderhalden apparatus, m. p. 193–194°.

Anal. Calcd. for $C_6H_{13}N_3SO_2$: N, 21.99. Found: N, 21.78.

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[1] J. Kapfhammer and H. Müller, *Z. physiol. Chem.*, **225**, 1 (1934).

[2] Jesse P. Greenstein, *J. Biol. Chem.*, **112**, 35 (1935–1936).

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5-Iodo-7-bromoisatin and 2-Amino-3-bromo-5-iodobenzoic Acid

5-Iodo-7-bromoisatin.—A solution of 3 g. of 5-iodoisatin in 100 ml. of ethyl alcohol was heated to boiling under reflux and 5 g. of bromine added slowly. The reaction mixture was maintained at reflux temperature for eight hours, after which most of the alcohol was removed. The product was collected and crystallized from ethyl alcohol, from which it separated as long narrow orange colored plates, m. p. 247–248°. The yield was 2.8 g. or 75%.

Anal. Calcd. for $C_8H_3O_2NBrI$: N, 3.98. Found: N, 4.02, 4.15.

Repeated attempts to prepare 5-bromo-7-iodoisatin by the action of iodine monochloride on 5-bromoisatin resulted only in the recovery of 5-bromoisatin. This is in accord with the previous observation that iodine cannot be introduced directly into the isatin nucleus in position 7.[1]

2-Amino-3-bromo-5-iodobenzoic Acid.—This compound was obtained when the solution resulting from the addition of 3% hydrogen peroxide to an alkaline solution of 5-iodo-7-bromoisatin was rendered acidic. The compound crystallized from ethyl alcohol as colorless needles, m. p. 226–227°.

The same compound was prepared by the action of bromine on an alcoholic solution of 2-amino-5-iodobenzoic acid. The identity of the two preparations was established by melting point methods.

Anal. Calcd. for $C_7H_5O_2NBrI$: N, 4.10. Found: N, 4.23, 4.33.

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[1] Sumpter and Amundsen, THIS JOURNAL, **54**, 1917 (1932).

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Methylneopentylacetic Acid (2,4,4-Trimethylpentanoic Acid), its Methyl Ester, Amide and Acetanilide

1. Methylneopentylacetic acid obtained in 6% yield by the oxidation of 160 moles of diisobutylene[1] with sodium dichromate and sulfuric acid, was purified by repeated refractionation through a column of 15 theoretical plates until constant index material was obtained. The **methyl ester**, prepared by treating the acid with an excess of methanol saturated with hydrogen chloride, on fractionation gave material $n^{20}\mathrm{D}$ 1.4124 (Valentine), b. p. 162.25° at 730 mm. (Cottrell), d^{20} 0.8706.

The **methylneopentylacetic acid** obtained by saponification of the ester, on fractionation gave $n^{20}\mathrm{D}$ 1.4233 (Valentine), b. p. 217.40° at 730 mm. (Cottrell), d^{20} 0.9028.

Anal. Calcd. for $C_8H_{16}O_2$: C, 66.6; H, 11.1. Found: C, 66.5; H, 11.5.

2. Neopentylethylene, prepared by the addition of *t*-butylmagnesium chloride to a cold ether solution of allyl bromide, was treated with hydrogen bromide in the presence of an antioxidant, diphenylamine, to give 4,4-dimethyl-2-bromopentane, b. p. 56–60° at 29–39 mm., $n^{20}\mathrm{D}$ 1.4460. This was caused to react with magnesium in anhydrous ether in 66.6% yield. The Grignard reagent was cooled in a salt–ice-bath and saturated with carbon dioxide. On decomposition and fractionation, methylneopentylacetic acid was obtained in 51.6% yield, distilling at 108° at 14 mm., $n^{20}\mathrm{D}$ 1.4228–1.4230.

3. Methylneopentylcarbinol, b. p. 136–136.5° at 730 mm., $n^{20}\mathrm{D}$ 1.4180–1.4186, was treated with anhydrous hydrogen chloride under pressure for twenty-two weeks. The oil layer obtained was washed with water and 10% potassium carbonate solution, then dried over anhydrous potassium carbonate and fractionated through the 15-plate column. The methylneopentylcarbinyl chloride, b. p. 63–65° at 85 mm., $n^{20}\mathrm{D}$ 1.4178–1.4187, was treated with magnesium in anhydrous ethyl ether, and the cooled Grignard reagent was saturated with carbon dioxide. On decomposition and fractionation, the yield of methylneopentylacetic acid b. p. 109° at 14 mm., $n^{20}\mathrm{D}$ 1.4233, was 50% based on the chloride.

4. **Methylneopentylacetamide** was prepared by thionyl chloride followed by treatment of an ether solution of the acid chloride with anhydrous ammonia. On recrystallization from petroleum ether the derivative gave m. p. 123°. No depression in m. p. was shown by mixtures with the amides from the oxidation and synthetic acids.

Anal. Calcd. for $C_8H_{17}ON$: N, 9.80. Found: N, 9.68.

5. **Methylneopentylacetanilide** was prepared by adding a solution of aniline in benzene to methylneopentylacetyl chloride, washing with dilute hydrochloric acid and carbonate solution, and recrystallizing from a mixture of petroleum ether and benzene, m. p. 117.5°; mixed melting points showed no depression.

Anal. Calcd. for $C_{14}H_{21}ON$: N, 6.40. Found: N, 6.60.

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[1] *Cf.* Whitmore and co-workers, THIS JOURNAL, **53**, 3137 (1931); **54**, 3707 (1932); **56**, 1397 (1934).

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