Table 2. Constants of the Given Equation for H_2O and CO_2. The calculations were made with eight numbers in order to obtain suitable results also for lower pressures

Const.	H_2O	CO_2
k	$1{\cdot}3805361 \times 10^{-16}$	$1{\cdot}3805376 \times 10^{-16}$
f_1	$1{\cdot}0866111 \times 10^{-27}$	$7{\cdot}744018 \times 10^{-27}$
f_2	$5{\cdot}2229157 \times 10^{-39}$	$7{\cdot}682670 \times 10^{-39}$
a	$7{\cdot}8147519 \times 10^{-4}$	$6{\cdot}8015095 \times 10^{-4}$
n	0·0	1·4229
J_{min}	$2{\cdot}5087014 \times 10^{-9}$	$2{\cdot}5295745 \times 10^{-9}$

The values of the constants of Table 2 were calculated by the given form of the equation which, of course, is only an approximate one on several grounds. We will always be forced to use approximate expressions for such complicated processes of short-range molecular forces, the values of the constants being dependent therefore not only on the conceptual approximation of the problem, and even on the selected points of the liquid state used for the calculation, but also on the selected form of simplification.

The position of the points on the experimental curves used for the calculation of the constants (Fig. 1) leaves no doubt that the equation gives good to excellent results for these broad ranges of liquid states. This surprising fact means that the given relatively simple three-term equation, in comparison with the two-constant—two-term and even the more complicated formulae mentioned here, seems to contain some appropriate new step as to equations of state. Also the calculated points of the saturated vapour state, obtained, of course, with the same constants, are favourable or acceptable ones; this is especially so when it is taken into account that this is only the first stage in a new direction. The greatest divergence of the calculated pressure values is about 10 per cent for water and about 20 per cent for carbon dioxide near the critical point, generally rapidly decreasing at greater vapour volumes, and finally scarcely differing from the experimental data. The same equation, evidently, can represent the corresponding volume values of liquids with a considerably increased precision.

The essentially increased applicability of the formula presented here gives the impression that the modifications incorporated could also be of theoretical significance. Improvements and applications of the solution given and the possible or probable theoretical background will be reported separately.

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Organochlorine Pesticides in the Atmospheric Environment

Pollution of the environment has long been a subject of public concern and much attention has been paid recently to the new ecological factors introduced by the wide agricultural usage of pesticidal chemicals. Contamination of soil and crops has often featured in environmental studies of these pesticides, but so far little attention has been given to atmospheric pollution, although, as long ago as 1961, Harris and Lichtenstein[1] showed that the loss by volatilization of aldrin, dieldrin, heptachlor and gamma-benzene hexachloride was a major factor in their disappearance from soils treated with these compounds. Later, in the United States, the President's Science Advisory Committee drew attention to the fact that inhalation of air contaminated with pesticides might present a hazard to man[2] and recommended that air should be continuously monitored for pesticide residue levels. In 1965, an Advisory Committee of the United States Food and Drug Administration referred to studies which showed the presence of up to 0·075 p.p.m. of dieldrin in total diets[3] and considered the possibility that half as much again could be absorbed from "air or other exposures".

Little practical work seems to have been undertaken to determine pesticide residues in the atmospheric environment, but in the United Kingdom, Wheatley and Hardman[4] recently reported indications of the presence of organochlorine insecticides in rain-water collected in an agricultural area at Wellesbourne in Warwickshire. Steps were therefore taken at this Laboratory to examine rain-water collected in the Metropolitan area.

Two collecting stations were set up in Central London, one being on the roof of the Laboratory of the Government Chemist in Lambeth, S.E.1, and approximately 20 m above ground-level. The other was set up, with the co-operation of the Meteorological Office, at the London Weather Centre's station on the roof of Stato House, High Holborn, W.C.1, some 53 m above ground-level and about 1·45 km distant from the other station, across the River Thames. At these two stations, rain was collected in all-glass apparatus, with amber-coloured receiving vessels to reduce the incidence of photochemical degradation[5]. Samples were removed monthly for examination.

The organochlorine pesticides in the water were determined by a gas-liquid chromatographic method using electron-capture detection and silicone and 'Apiezon' columns as described by de Faubert Maunder *et al.*[6]. The limits of detection by this method were 5 parts per million-million for the isomers of benzene hexachloride (BHC) and 10 parts per million-million for the other organochlorine pesticides in general use in the United Kingdom.

The results for the months of February to July 1965, expressed in parts per million-million, are given in Table 1. Because of the small amounts of rain collected and the low levels of the pesticides found, it was not possible to confirm the results obtained for the individual samples by an alternative technique. However, at the end of the 6 months, the combined residues from each station were examined by thin-layer chromatography on silica-gel plates with hexane : acetone, 99 : 1, as mobile phase.

The appropriate areas of the chromatoplates were eluted and the separate eluates individually re-injected on to the gas-liquid chromatograph in columns. In this way, the presence of dieldrin, *pp'*-DDT and the α- and γ-isomers of BHC was confirmed for both stations. The identity of the *pp'*-DDT from both stations was further confirmed by conversion to *pp'*-DDE by treatment with ethanolic potassium hydroxide[7]. The *pp'*-DDE formed by this reaction was identified and determined by gas-liquid chromatography.

Insufficient quantities of the residues were available to confirm the presence of β-BHC, *pp'*-TDE and *pp'*-DDE

Table 1. Organochlorine Pesticide Residue Levels in London Rain-water

(Parts per million-million)

Station—Cornwall House, London, S.E.1

Month 1965	α-BHC	β-BHC	γ-BHC	HEOD (dieldrin)	*pp'*-DDE	*pp'*-TDE	*pp'*-DDT
Feb.	40	90	90	60	70	—	400
Mar.	15	—	60	60	20	—	115
Apr.	30	—	80	50	—	—	300
May	20	65	70	95	—	—	190
June	30	—	65	25	—	15	70
July	25	—	40	10	15	85	85

Station—State House, High Holborn, London, W.C.1

Month 1965	Rain (mm)	α-BHC	β-BHC	γ-BHC	HEOD (dieldrin)	*pp'*-DDE	*pp'*-TDE	*pp'*-DDT
Mar.	33·4	10	—	20	20	—	—	—
Apr.	37·3	20	—	70	70	—	100	140
May	35·0	20	25	65	50	—	—	220
June	36·2	20	—	155	20	—	50	125
July	78·0	30	—	70	15	10	20	80

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by alternative techniques or to make an infra-red study of any of the residues[8].

Some individual rain-water samples which had been taken between September 1964 and January 1965 at a number of other places in the British Isles were also examined. The collecting sites ranged from Stornaway in the Outer Hebrides to Camborne in Cornwall, and the samples showed residues of organochlorine pesticides in amounts similar to those found in London rain-water. Samples of snow collected in different suburban areas within 25 km of London gave similar results. The size of these other samples, and the low levels found, again precluded the application of any confirmatory technique to the individual samples, but by appropriate building of the residues it was possible to confirm, by thin-layer chromatography, the presence, in the rain-water and in the snow, of dieldrin, *pp'*-DDT and the α- and γ-isomers of BHC.

The levels at which these pesticides have been detected are extremely low, near to the limits of sensitivity of the delicate electron-capture detection system used. Strict precautions were taken throughout to ensure that no fortuitous contamination of samples or extracts occurred within the Laboratory. Two samples taken from remote areas of Scotland during periods of heavy rainfall showed practically no residue content and these results suggest that adventitious contamination of samples in the Laboratory was negligible.

Present results suggest that the atmosphere carries, either as vapour or by occlusion on dust particles, small amounts of the organochlorine pesticides in common use in the United Kingdom and that they are 'scrubbed out' by rain and snow.

Work is now proceeding to determine the residue levels in air samples, and preliminary results show the presence of organochlorine pesticides in the range of 10–20 parts per million-million. Most of these residues appear to be associated with particulate matter. These experiments may eventually make it possible to determine the respiratory intake by man and to compare the result with his intake from certain foods of known pesticide-levels[8].

We thank the Director-General of the Meteorological Office for permission to quote from the London Weather Centre's records of the rainfall on the roof of State House.

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BIOCHEMISTRY

Separation of High-molecular Deoxyribonucleic Acid and Ribonucleic Acid

So far there has been no really satisfactory method for the quantitative separation in high-molecular form of a mixture of DNA and RNA isolated from cells. The procedure based on the different solubility of DNA and RNA in salt solutions of varying concentration[1–3] is quantitatively unsatisfactory. Another method uses chromatographic separation on methylated albumin[4–7], but involves a series of steps which entail the danger of degradation in the recovery of the macromolecule. Specifically, single-stranded DNA cannot be quantitatively recovered without loss of its high-molecular character, because complete elution occurs only at strongly alkaline *p*H. Nygaard and Hall[8] have recently described a micro-method for the detection of DNA/RNA hybrids based on their adsorption on membrane filters of nitrocellulose containing material.

On the basis of the selective adsorption of single-stranded DNA on nitrocellulose fibres of a certain nitration degree (the most satisfactory preparation proved to be 'Nitrocell', supplied by the Servo Laboratories, Heidelberg), we have developed a simple method for the quantitative separation, in high-molecular form, of the two components from a nucleic acid mixture. While RNA and double-stranded DNA (dissolved in 2 × standard saline citrate (SSC), *p*H 6·7) pass through such a column (Fig. 1), single-stranded DNA is quantitatively retained. Elution occurs only with very diluted solutions at *p*H > 9 (Fig. 2). The fact that the sedimentation constant (S_{20} = 23·6) of a single-stranded DNA from bacteriophage *FD* (courtesy of Prof. H. Hoffmann-Berling, Max-Planck Institut für Medizinische Forschung, Heidelberg) remained unchanged (S_{20} = 22·1) proves that the molecule size is not altered during the adsorption and elution steps.

For the isolation of the nucleic acids, approximately 6 × 10⁹ HeLa cells, cultivated in Hanks's solution with the addition of lactalbumin hydrolysate and calf serum, were washed and gently disintegrated by repeated freezing and thawing; during the last thawing, dodecylsulphate *tris*-buffered to *p*H 7 was added (final concentration 0·5 per cent). The resulting viscous solution was diluted and deproteinized in the usual way by treating it twice with phenol[9]. After two-fold precipitation by 67 per cent alcohol, the nucleic acids were dissolved in 0·1 × SSC, dialysed against SSC, and centrifuged for 10 min at

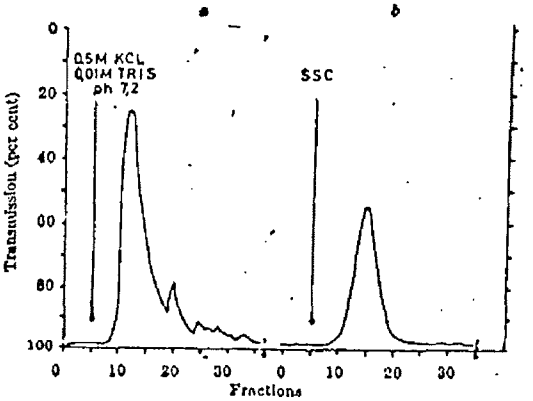


Fig. 1. *a*, Elution diagram of high-molecular RNA from yeast; *b*, that of a double-stranded DNA isolated from thymus. Optical densities were measured with the Uvicord (LKB, Stockholm)

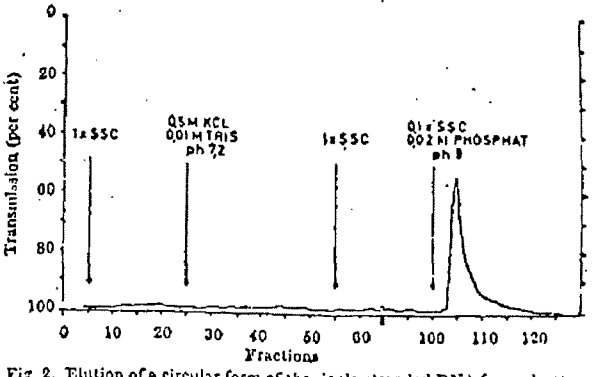


Fig. 2. Elution of a circular form of the single-stranded DNA from phage, dependent on the eluting agent

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