TABLE I. Input data for shock temperature calculations.

Quantity	Units	Carbon tetrachloride	Ref.	Nitromethane	Ref.	Water	Ref.
$(\partial p/\partial T)_v$	10^7 dyn $cm^{-2}\cdot deg^{-1}$	1.14	9	1.637[f]	2c	4.04	h
Sound speed	10^5 cm sec^{-1}	0.926[c]	d	1.30	2c	1.48	h
Specific volume at $p=0$	cc g^{-1}	0.631	9	0.884	2c	1.002	h
Temp. at $p=0$ and $v=v_0$	°K	298		298		293	
First volume point on Hugoniot[a]	cc g^{-1}	0.631		0.884		0.819	
Temp. at first volume point on Hugoniot	°K	298		298		323	
Molecular wt	g mol^{-1}	153.84		61		18.02	
C_v (constant)	cal $mol^{-1}\cdot deg^{-1}$	21.7	9	17.8	2c	14.07	h
C_v fit:[b]			e		g		
B		−75 415.8		1.23375×10^6			
C		−2 109.31		−9956.86			
D		8.10247		17.3573			
E		-8.64548×10^{-4}		8.09421×10^{-3}			
F		1.12516×10^{-7}		-2.24624×10^{-6}			

[a] Integration starts from the first volume point on the Hugoniot and the volume increment is −0.01 cc g^{-1}.

[b] $C_v(T)$ is given by C_v (constant) $+(B/T^2)+(C/T)+D+E\times T+F\times T^2$.

[c] Sound speed calculated from the data in Ref. 9 is 0.922×10^5 cm sec^{-1}.

[d] *Handbook of Chemistry and Physics* (Chemical Rubber, Cleveland, Ohio, 1968–1969), 49th ed., p. E-38.

[e] *JANAF Thermochemical Tables* (Dow Chemical, Midland, Mich., 1961).

[f] Calculated from $(\partial p/\partial T)_v=\alpha C_v c_0^2/v_0 C_v$ where α is the coefficient of expansion.

[g] J. P. McCullough, D. W. Scott, R. E. Pennington, I. A. Hossenlopp, and G. Waddington, J. Am. Chem. Soc. **76**, 4791 (1954).

[h] N. E. Dorsey, *Properties of Ordinary Water Substance* (Reinhold, New York, 1940).

constants, and U_s, u_p, and c_0 denote shock velocity, particle velocity, and sound speed in unshocked material.[6] Equation (1) was integrated step by step with a Runge–Kutta program written by S. P. Gill, and the integral in Eq. (4) was evaluated with a program based on a trapezoidal approximation written by B. Y. Lew. As expected, both methods of calculation are found to be consistent. Shock temperatures for carbon tetrachloride calculated with the Runge–Kutta scheme are in excellent agreement with those calculated with the trapezoidal method as shown in Table II. In addition, shock temperatures calculated for copper by Walsh and Christian[1] and for nitromethane by Mader[8] are in good agreement with our values calculated with the same input data and the trapezoidal method.

However, comparison of calculated shock temperatures of carbon tetrachloride with experimental brightness temperatures[3,4] (Fig. 1) demonstrates the inadequacy of applying the Walsh–Christian method to liquids. The poor agreement between the calculated and experimental results indicates that the Walsh–Christian method gives an upper estimate for shock temperature in liquids. Our extension of their method to liquids will take into consideration the sensitivity of calculated shock temperature to choice of the parameters $F(v)$, $(\partial p/\partial T)_v$, and C_v. But since calculations for carbon tetrachloride (Fig. 2) show that the shock temperature vs shock pressure relationship is insensitive to changes of the order of 10% in the constants in the U_s vs u_p

TABLE II. Comparison of shock temperatures for carbon tetrachloride calculated from Eq. (4) by trapezoidal evaluation of the integral and shock temperatures calculated by a Runge–Kutta integration of Eq. (1).

p (kbar)	v (cc g^{-1})	T Eq. (4) Trapezoidal (°K)	T Eq. (1) Runge–Kutta (°K)
0	0.631	298	298
29	0.431	661	662
49	0.401	980	980
73	0.381	1401	1402
113	0.361	2198	2198
144	0.351	2866	2867
188	0.341	3857	3857
253	0.331	5385	5386