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SOLA-STAR:
A One-Dimensional
ICED-ALE Hydrodynamics Program for
Spherically Symmetric Flows

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SOLA-STAR: A ONE-DIMENSIONAL, ICED-ALE HYDRODYNAMICS
PROGRAM FOR SPHERICALLY SYMMETRIC FLOWS

by

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ABSTRACT

This report describes a simple, general-purpose, and efficient algorithm for solving one-dimensional spherically symmetric, transient fluid-dynamics problems using a variation of the ICED-ALE technique. Included are the finite difference equations, three test problems that illustrate various capabilities of the program, and a complete code description, including a listing, sample data decks and output, a summary of important variable names, and hints for conversion to other operating systems.

I. INTRODUCTION

Several years ago we reported a technique for implementing the ICED-ALE methodology in a form suitable for numerically simulating a wide variety of spherically symmetric fluid flows.¹ An experimental computer program, VEGA, was written to test this methodology and was applied to the star formation problem. Although that technique was designed for astrophysical applications, it is by no means limited to them. In the interim, Group T-3 has developed the SOLA series of simplified numerical fluid dynamics programs^{2,3} specifically for public distribution. In response to requests for copies of the VEGA program, we are presenting a simplified version, SOLA-STAR, in this report. This code follows the philosophy of the SOLA series inasmuch as the code is easy to understand and use, it can be used by persons with little numerical fluid dynamics experience, it is easily modified to include more complicated physics, and it is useful both as a teaching device and a serious research tool.

The numerical algorithm used in the present program is basically the same as reported in Ref. 1, so no derivation of the difference equations will be presented in this report. The derivation is based on a volume integration of the governing equations, and the interested reader can find the details in Refs. 1 and 4-6. The algorithm consists of two phases. Phase I is a partially implicit Lagrangian time step. In Phase II, the solution is rezoned (if desired) in a physically motivated manner that conserves mass, momentum, and internal energy. The only stability requirement is that

$$\frac{|u| \delta t}{\delta r} < 1 \quad (1)$$

everywhere on the mesh, where u is the velocity, δt is the time step, and δr is the width of a computational mesh cell. This limit requires that the fluid moves less than one cell width each computational cycle. Observance of this limit, proper choice of the donor cell parameter α (to be described later), and choosing the time step such that no variable changes its value by more than some small amount, say 20%, has been sufficient to achieve numerical stability for all of the problems that we have run. A more detailed discussion of stability of the method (and of many other aspects of the method) can be found in Ref. 1.

II. EQUATIONS FOR SPHERICALLY SYMMETRIC FLOWS

To simplify the program and minimize both computing time and core requirements, SOLA-STAR assumes a single-component ideal gas. The differential equations that we model are

$$\frac{\partial \rho}{\partial t} + \frac{1}{r^2} \frac{\partial}{\partial r} (r^2 \rho u) = 0 \quad , \quad (2)$$

$$\begin{aligned} \frac{\partial \rho u}{\partial t} + \frac{1}{r^2} \frac{\partial}{\partial r} (r^2 \rho u^2) = & - \rho g - \frac{\partial p}{\partial r} + \frac{1}{r^2} \frac{\partial}{\partial r} \left(r^2 (2\mu + \lambda) \frac{\partial u}{\partial r} \right) - \frac{2u(2\mu + \lambda)}{r^2} \\ & + \frac{2u}{r} \frac{\partial \lambda}{\partial r} \quad , \end{aligned} \quad (3)$$

and

$$\begin{aligned} \frac{\partial \rho I}{\partial t} + \frac{1}{r} \frac{\partial}{\partial r} (r^2 \rho u I) = - p \frac{1}{r} \frac{\partial}{\partial r} (r^2 u) + \frac{1}{r} \frac{\partial}{\partial r} \left(r^2 K \frac{\partial T}{\partial r} \right) + 2\mu \left[\left(\frac{\partial u}{\partial r} \right)^2 \right. \\ \left. + \frac{2u^2}{r^2} \right] + \lambda \left[\frac{1}{r} \frac{\partial}{\partial r} (r^2 u) \right]^2, \end{aligned} \quad (4)$$

where t is time, r is radius, ρ is the density, u is the radial velocity, p is the pressure, μ is the coefficient of viscosity, λ is the second coefficient of viscosity, g is the gravitational acceleration, I is the specific internal energy, K is the conductivity, and T is the temperature. Normally we use

$$\lambda = -\frac{2}{3} \mu, \quad (5)$$

which is accurate for an ideal monatomic gas. If experimental values of λ are available for polyatomic gases, they can be used. However, the program will need modification. The gravitational acceleration is computed from a difference approximation to

$$g = \frac{4\pi G}{r} \int_0^r \rho x^2 dx, \quad (6)$$

where G is the gravitational constant. This procedure is more accurate than solution of the Poisson equation for the gravitational potential. The set of equations is closed by the equation of state, which we assume to be

$$p = (\gamma - 1) \rho I, \quad (7)$$

where γ is the ratio of specific heats.

III. DIFFERENCE EQUATIONS

The SOLA-STAR difference equations are written in terms of the primitive variables p , ρ , I , r , and u . Furthermore, simple averages are used to find values of variables at points other than those where they are defined. Transformations of variables are frequently advocated as a means of achieving better accuracy on a given computational mesh. However, as discussed in the SOLA-ICE report,³ this approach has a number of disadvantages and pitfalls for general-purpose programs. First, it is much easier to create conservative difference schemes in the primitive variables. Second, transformations commonly introduce transcendental functions such as square roots and exponentials into the equations, and these functions are expensive to compute. Third, the transformed equations are usually more complicated, resulting in more debugging effort and increased execution time. Fourth, the transformation that gives the best accuracy is problem dependent and, in general, unknown. Heuristic arguments that lead to particular transformations are at best unreliable. Finally, if good resolution is used, all well-behaved transformations will give the same results as the primitive variables.

Advancement of the variables in time is accomplished in two phases. Phase I consists of a partially implicit Lagrangian time step, and Phase II consists of the rezoning procedure. The velocity is defined at cell edges, (or vertices) as shown in Fig. 1, and all other quantities are defined at cell centers.

Fig. 1.

The SOLA-STAR computing mesh. Cell centers have integer subscripts, and cell edges have half-integer subscripts. We specify the cell edge positions and define the cell center positions by $r_i = 0.5 * (r_{i+\frac{1}{2}} + r_{i-\frac{1}{2}})$. Cells 1 and $N+1$ are fictitious cells.

The spatial difference approximations for Phase I are derived by integrating the dynamical equations over a control volume taken to be a spherical shell coincident with the computational mesh. This procedure has been adequately described elsewhere,^{1,4,5,6} so it will not be repeated here. The equations are written as fully implicit, and then they are made linear in the advanced time quantities. The linearization is illustrated by the equation of state:

$$p_j^{n+1} = (\gamma-1)_j^{n+1} \rho_j^{n+1} I_j^{n+1} \doteq (\gamma-1)_j^n \left(\rho_j^{n+1} I_j^n + \rho_j^n I_j^{n+1} - \rho_j^n I_j^n \right) \quad (8)$$

where the superscript denotes the time level, and the subscript denotes the spatial computational cell. We have computed protostellar models through central hydrogen dissociation and ionization (where the γ of the gas changes radically) with no sign of instability from the use of the explicit value of γ . In such a case we define γ not as the ratio of specific heats, but as $\gamma-1 \equiv P/\rho I$. The function $\gamma-1$ is constant over much of the (ρ, T) plane, so a bilinear interpolation is accurate. In the regions of the (ρ, T) plane where $(\gamma-1)$ is not constant, this interpolation scheme may be preferred over many of the higher order schemes advocated in the literature, including both second and third order polynomials and splines. Indiscriminant use of some of these schemes can introduce spurious oscillations into $\gamma-1$, leading to inaccurate numerical solutions.

Let us write the continuity equation as

$$\frac{d\rho}{dt} + \rho D = 0 \quad , \quad (9)$$

where

$$D = \frac{1}{r} \frac{\partial}{\partial r} (r^2 u) \quad . \quad (10)$$

Define the quantity

$$d_j^n = - \frac{\delta t}{1 + \delta t D_j^n} , \quad (11)$$

where

$$D_j^n = \frac{u_{j+\frac{1}{2}}^n - u_{j-\frac{1}{2}}^n}{r_{j+\frac{1}{2}} - r_{j-\frac{1}{2}}} + 2 \frac{u_{j+\frac{1}{2}}^n + u_{j-\frac{1}{2}}^n}{r_{j+\frac{1}{2}} + r_{j-\frac{1}{2}}} \quad (12)$$

Then Eq. (9) is approximated by

$$\rho_j^{n+1} - d_j^n \rho_j^n D_j^{n+1} = \rho_j^n , \quad (13)$$

which may be expanded to

$$\rho_j^{n+1} - u_{j+\frac{1}{2}}^{n+1} \rho_j^n d_j^n \left(\frac{2}{r_{j+\frac{1}{2}} + r_{j-\frac{1}{2}}} + \frac{1}{r_{j+\frac{1}{2}} - r_{j-\frac{1}{2}}} \right) - u_{j-\frac{1}{2}}^{n+1} \rho_j^n d_j^n \left(\frac{2}{r_{j+\frac{1}{2}} + r_{j-\frac{1}{2}}} - \frac{1}{r_{j+\frac{1}{2}} - r_{j-\frac{1}{2}}} \right) = \rho_j^n . \quad (14)$$

As with all our difference equations, the geometric quantities (that is, r , A , and V) are the old-time values. The left-hand side of Eq. (9) is differenced directly because the control volume integration procedure would provide no immediate information on new densities. It would merely give us the trivial fact that the mass in a cell does not change. The advanced-time cell volume, necessary to compute the advanced time density from the cell mass, is not directly available.

The equation for the specific internal energy may be written as

$$\frac{\partial \rho I}{\partial t} + \frac{1}{r^2} \frac{\partial}{\partial r} (r^2 \rho u I) = - p D + \frac{1}{r^2} \frac{\partial}{\partial r} \left(r^2 K \frac{\partial T}{\partial r} \right) + \Phi \quad . \quad (15)$$

For numerical reasons we have found it expedient to define the flux

$$F = K \frac{\partial T}{\partial r} = K \frac{\partial}{\partial r} \left(\frac{I}{c_v} \right) \quad , \quad (16)$$

and carry along this extra equation. For normal gases, $K = \mu c_p / Pr$, where Pr is the Prandtl number and c_p is the specific heat at constant pressure. For stellar problems where we are modeling radiation diffusion, K is the radiative conductivity. The quantity c_v is defined as I/T , so it is not always the usual specific heat. It is tabulated and treated numerically the same as $\gamma-1$ for the general case. Incidentally, the turbulent conductivity defined by Eq. (28) of Ref. 1 did not work well and was replaced by an estimate based on the mixing length theory. The diffusion term in Eq. (15) is replaced by

$$\frac{1}{r^2} \frac{\partial}{\partial r} (r^2 F) \quad .$$

Carrying the additional flux equation is necessary wherever $\chi \equiv \log_{10}(K \delta t / \rho c_v \delta r^2)$ approaches or exceeds the number of digits carried in the calculation, because the coefficient matrix has a term like $1 + 2 \times 10^\chi$. The one gets lost in round off if χ is too large, and the matrix package cannot successfully recover the one in the course of solving the linear system.

The expression for the viscous dissipation term in Eq. (15) is

$$\phi \equiv 2\mu \left[\left(\frac{\partial u}{\partial r} \right)^2 + \frac{2u^2}{r^2} \right] + \lambda \left[\frac{1}{r^2} \frac{\partial}{\partial r} (r^2 u) \right]^2 . \quad (17)$$

The difference approximation to Eq. (15) is derived by integrating over the spherical shell between $r = r_{j-\frac{1}{2}}$ and $r = r_{j+\frac{1}{2}}$, using the procedure described in Ref. 1. Define normalized cells volumes

$$V_{c,j} \equiv r_{j+\frac{1}{2}}^3 - r_{j-\frac{1}{2}}^3 , \quad (18)$$

and normalized vertex areas

$$A_{j-\frac{1}{2}} = 3r_{j-\frac{1}{2}}^2 . \quad (19)$$

Then

$$\begin{aligned} I_j^{n+1} = I_j^n + \delta t \left\{ \frac{V_{c,j}}{M_{c,j}} \phi_j + \frac{1}{M_{c,j}} \left[A_{j+\frac{1}{2}} F_{j+\frac{1}{2}}^{n+1} - A_{j-\frac{1}{2}} F_{j-\frac{1}{2}}^{n+1} \right] \right. \\ \left. - \frac{1}{2M_{c,j}} \left[p_j^{n+1} \left(A_{j+\frac{1}{2}} u_{j+\frac{1}{2}}^n - A_{j-\frac{1}{2}} u_{j-\frac{1}{2}}^n \right) + p_j^n \left(A_{j+\frac{1}{2}} u_{j+\frac{1}{2}}^{n+1} \right. \right. \right. \\ \left. \left. \left. - A_{j-\frac{1}{2}} u_{j-\frac{1}{2}}^{n+1} \right) \right] \right\} , \quad (20) \end{aligned}$$

where

$$M_{c,j}^n = \rho_j^n v_{c,j} \quad , \quad (21)$$

and

$$\begin{aligned} \Phi_j = & \mu_j^n \left\{ 2 \left[2 \left(u_{j+\frac{1}{2}}^{n+1} - u_{j-\frac{1}{2}}^{n+1} \right) \left(u_{j+\frac{1}{2}}^n - u_{j-\frac{1}{2}}^n \right) - \left(u_{j+\frac{1}{2}}^n - u_{j-\frac{1}{2}}^n \right)^2 \right] \left(r_{j+\frac{1}{2}} - r_{j-\frac{1}{2}} \right)^{-2} \right. \\ & + 2 \left[4 \left(u_{j+\frac{1}{2}}^{n+1} + u_{j-\frac{1}{2}}^{n+1} \right) \left(u_{j+\frac{1}{2}}^n + u_{j-\frac{1}{2}}^n \right) - 2 \left(u_{j+\frac{1}{2}}^n + u_{j-\frac{1}{2}}^n \right)^2 \right] \left(r_{j+\frac{1}{2}} + r_{j-\frac{1}{2}} \right)^{-2} \\ & - \frac{2}{3(v_{c,j})^2} \left[2 \left(A_{j+\frac{1}{2}} u_{j+\frac{1}{2}}^{n+1} - A_{j-\frac{1}{2}} u_{j-\frac{1}{2}}^{n+1} \right) \left(A_{j+\frac{1}{2}} u_{j+\frac{1}{2}}^n - A_{j-\frac{1}{2}} u_{j-\frac{1}{2}}^n \right) \right. \\ & \left. \left. - \left(A_{j+\frac{1}{2}} u_{j+\frac{1}{2}}^n - A_{j-\frac{1}{2}} u_{j-\frac{1}{2}}^n \right)^2 \right] \right\} . \quad (22) \end{aligned}$$

The viscous dissipation term is positive-definite if all velocities are at the same time level, but we lose this physical characteristic by using velocities from a mixture of time levels. This is probably not serious, but it should be noted.

The flux equation is

$$F_{j+\frac{1}{2}}^{n+1} = \frac{2K_{j+\frac{1}{2}}^n}{r_{j+2/3} - r_{j-\frac{1}{2}}} \left(\frac{I_{j+1}^{n+1}}{c_{v,j+1}^n} - \frac{I_j^{n+1}}{c_{v,j}^n} \right) . \quad (23)$$

The momentum equation is given by

$$\begin{aligned} \frac{\partial \rho u}{\partial t} + \frac{1}{r} \frac{\partial}{\partial r} (r^2 \rho u^2) = & - \rho g - \frac{\partial p}{\partial r} + \frac{1}{2} \frac{\partial}{\partial r} \left[r^2 (2\mu + \lambda) \frac{\partial u}{\partial r} \right] \\ & - \frac{2u(2\mu + \lambda)}{r^2} + \frac{2u}{r} \frac{\partial \lambda}{\partial r} . \quad (24) \end{aligned}$$

The Lagrangian form of Eq. (24) is differenced by integrating over a spherical shell (momentum control volume) between $r_{j-1} = 0.5(r_{j-3/2} + r_{j-1/2})$ and $r_j = 0.5(r_{j+1/2} + r_{j-1/2})$.

$$\begin{aligned}
\frac{M_{v,j-1/2}^n}{\delta t} (u_{j-1/2}^{n+1} - u_{j-1/2}^n) = & -M_{v,j-1/2}^n g_{j-1/2} - 2V_{v,j-1/2} \frac{(p_j^{n+1} - p_{j-1}^{n+1})}{r_{j+1/2} - r_{j-3/2}} \\
& + \frac{4}{3} \left[A_j u_j^n \frac{u_{j+1/2}^{n+1} - u_{j-1/2}^{n+1}}{r_{j+1/2} - r_{j-1/2}} \right. \\
& \left. - A_{j-1} \mu_{j-1}^n \frac{u_{j-1/2}^{n+1} - u_{j-3/2}^{n+1}}{r_{j-1/2} - r_{j-3/2}} \right] \\
& - \frac{4}{3} V_{v,j-1/2} \left[\frac{u_{j-1/2}^{n+1}}{r_{j-1/2}} 2 \left(\frac{\mu_j^n - \mu_{j-1}^n}{r_{j+1/2} - r_{j-3/2}} \right. \right. \\
& \left. \left. + \frac{\mu_j^n + \mu_{j-1}^n}{r_{j-1/2}} \right) \right] , \tag{25}
\end{aligned}$$

where the vertex masses and vertex volumes are given by

$$M_{v,j-1/2} = (M_{c,j} + M_{c,j-1})/2 , \tag{26}$$

$$V_{v,j-1/2} = r_j^3 - r_{j-1}^3 . \tag{27}$$

The shell areas, A_j , are defined at cell centers, as indicated by the integral subscripts. To obtain the gravitational acceleration, we perform the sum

$$g_{j-1/2} = \frac{4\pi G}{3r_{j-1/2}^2} \sum_{i=2}^{j-1} M_{c,i} . \tag{28}$$

The equations form a banded linear system in the advanced time quantities, so they may be solved by a banded matrix package, such as the one by Hindmarsh.⁷ The left element of each row of the band is stored in the computer with an index of 1. A simple mnemonic display of the subscripting scheme is given in the program listing in Appendix A.

In Phase II we are modeling the convection term

$$\iint_S \rho Q (\underline{u}_g - \underline{\tilde{u}}) \cdot \hat{n} \, ds \quad , \quad (29)$$

where $\underline{u}_g$ is the grid velocity and $\underline{\tilde{u}}$ is the fluid velocity at the end of Phase I. We define the difference velocity for our one-dimensional problems, $w_{j-\frac{1}{2}} \equiv u_{g,j-\frac{1}{2}} - \tilde{u}_{j-\frac{1}{2}}$, which is the velocity of the mesh relative to the fluid. Then $w_{j-\frac{1}{2}} A_{j-\frac{1}{2}} \delta t$ is the volume relative to the fluid that is swept out by the moving grid point. One might be tempted to take for, say the density, simply an average of the densities on either side of the moving mesh point. This is called centered differencing, and it is unstable. For this reason we use a mixture of centered differencing and donor cell differencing. The donor cell component adds a strong stabilizing diffusional truncation error that compensates for the destabilizing diffusional error of centered differencing.

Define the donor cell parameter, $\alpha_{j+\frac{1}{2}}$, by

$$\alpha_{j+\frac{1}{2}} = -\bar{\alpha} \operatorname{sgn}(w_{j+\frac{1}{2}}) \quad , \quad (30)$$

where the function sgn is the sign of the argument, and $\bar{\alpha}$ is a constant, $0 \leq \bar{\alpha} \leq 1$. As an example of the difference form of the convection term for a cell centered quantity,

$$\begin{aligned} M_{c,j}^{n+1} = M_{c,j}^n - \frac{\delta t}{2} \left\{ w_{j-\frac{1}{2}} A_{j-\frac{1}{2}} \left[(1 + \alpha_{j-\frac{1}{2}}) \tilde{\rho}_{j-1} + (1 - \alpha_{j-\frac{1}{2}}) \tilde{\rho}_j \right] \right. \\ \left. - w_{j+\frac{1}{2}} A_{j+\frac{1}{2}} \left[(1 + \alpha_{j+\frac{1}{2}}) \tilde{\rho}_j + (1 - \alpha_{j+\frac{1}{2}}) \tilde{\rho}_{j+1} \right] \right\} \quad . \end{aligned} \quad (31)$$

The tildes denote results from Phase 1. This is a straightforward approximation to Eq. (29) for $Q = 1$. The density is obtained by calculating volumes from the new mesh position

$$r_{j-\frac{1}{2}}^{n+1} = r_{j-\frac{1}{2}}^n + u_{g,j-\frac{1}{2}} \delta t \quad . \quad (32)$$

Then

$$\rho_j^{n+1} = \frac{M_{c,j}^{n+1}}{V_{c,j}^{n+1}} \quad , \quad (33)$$

which ensures mass conservation. The convection of internal energy is handled in exactly the same manner.

For momentum the control volume runs from cell center to cell center, and a slight modification is necessary. The difference velocity must be obtained by averaging the difference velocities of the neighboring vertices. This leads to

$$\begin{aligned} u_{j-\frac{1}{2}}^{n+1} = \frac{1}{M_{v,j-\frac{1}{2}}^{n+1}} & \left\{ M_{v,j-\frac{1}{2}}^n u_{j-\frac{1}{2}}^n - \frac{\delta t}{4} \left[\tilde{\rho}_{j-1} (w_{j-\frac{1}{2}} + w_{j-3/2}) A_{j-1} ((1+\alpha_{j-1}) \tilde{u}_{j-3/2} \right. \right. \\ & + (1-\alpha_{j-1}) \tilde{u}_{j-\frac{1}{2}}) - \tilde{\rho}_j (w_{j-\frac{1}{2}} + w_{j+\frac{1}{2}}) A_j ((1+\alpha_j) \tilde{u}_{j-\frac{1}{2}} \\ & \left. \left. + (1-\alpha_j) \tilde{u}_{j+\frac{1}{2}}) \right] \right\} \quad , \quad (34) \end{aligned}$$

where

$$\alpha_j = -\bar{\alpha} \operatorname{sgn} (w_{j-\frac{1}{2}} + w_{j+\frac{1}{2}}) \quad . \quad (35)$$

It is not necessary to use the same $\bar{\alpha}$ in the momentum equation as in the equation for the mass or energy. We have found empirically that we need more donor cell in the mass and energy equations to keep cells from emptying out in the neighborhood of steep gradients.

For problems with strong shocks, an explicit artificial viscous pressure is helpful in attaining numerical stability and accurate jump conditions. The form we have chosen is

$$q_j^n = -\Lambda \rho_j^n (x_{j+\frac{1}{2}} - x_{j-\frac{1}{2}})^2 D_j^n \min(0, D_j^n) \quad , \quad (36)$$

where Λ is a constant of order unity. To the right side of Eq. (20), we add $-\delta t q_j^n D_j^n$. To the right side of Eq. (25), we add $2V_{v,j-\frac{1}{2}} (q_{j-1}^n - q_j^n) / (r_{j+\frac{1}{2}} - r_{j-\frac{3}{2}})$. In regions of expansion, q vanishes. In regions of compression, the q terms provide velocity diffusion in the momentum equation and "viscous" conversion of kinetic energy to thermal energy in the I equation. These terms have an effective kinematic viscosity that is roughly the fluid velocity times a mesh cell size in the neighborhood of a shock. The artificial viscous effects are concentrated in the regions of strongest compression, precisely where they are needed the most. For problems with no shocks, $\Lambda = 0$ is recommended.

IV. NUMERICAL EXAMPLES

This section contains three numerical examples that illustrate the kinds of problems that may be solved with SOLA-STAR. The first example provides a test problem to be used to check out new copies of the code. These examples are crude simulations of physical problems, and are not intended to be compared to observations without some refinement. The first problem is the early collapse phase of a protostellar cloud. This is basically the same problem solved by Larson.⁸ The second test problem is a simple blast wave for which there is an analytical solution. The third problem is the solar wind solution by Hundhausen and Gentry.⁹ They considered the effects of transients imposed on a steady state solar wind.

A. Collapse Of a Protostellar Cloud

The first numerical fluid dynamics calculation of the collapse of a dense interstellar cloud to form a protostar was published by Larson.⁸ His initial condition was an isothermal cloud of uniform density that was just unstable to inward gravitational collapse according to the Jeans criterion. The outer boundary condition was $u=0$ at just under the Jeans' radius. Larson's solution for a one solar mass cloud was confirmed by Ruppel and Cloutman,¹ and the results

presented in this subsection and the code listing and output in Appendix A are for a similar one solar mass cloud.

Since some results of VEGA calculations were described fully and compared to Larson's results in reference 1, we will limit the present discussion to the use of this problem as a test case for new copies of the program. Appendix A provides the actual computer output at 0, 1, 500, and 3000 cycles. The following physical events can be seen in the solution as it develops. First, a rarefaction is created at the outer boundary at $t = 0$ by the collapse of the cloud. It travels inward at the speed of sound. The density is spatially constant but temporally increasing inside the rarefaction, and it falls off as $1/r^2$ outside. This behavior is illustrated in figure 2 with the curve from cycle 300 ($t = 2.981 \times 10^{12}$ s). The velocity profile consists of two linear segments with the minimum at the rarefaction, as illustrated in figure 3. The material is isothermal at 10 K. When the rarefaction reaches the center, the embryonic star is formed. The density becomes peaked at the center, forming a body nearly in hydrostatic equilibrium, surrounded by an accretion shock. The central body contains roughly 10^{-3} solar masses and has a radius of about 10^{14} cm. Upon its creation, the protostar may oscillate briefly. Cloud material falls supersonically to the accretion shock, is decelerated, and added to the protostar. The central density continues to rise. When it reaches about 10^{-13} g/cm³, the central temperature also begins to rise. This phase is illustrated in figures 2 and 3 with the curves from cycle 900 ($t = 8.578 \times 10^{12}$ s). When the central temperature reaches 2000 K, the calculation is terminated. Figure 4 shows the structure at 3500 cycles ($t = 8.653 \times 10^{12}$ s), shortly before termination. Real gas physics is needed to go farther because of the importance of H₂ dissociation. This has been done in VEGA by making tables of $(\gamma-1) \equiv p/\rho I$ and $c_v \equiv I/T$ using the equation of state in Paczynski's stellar envelope program.^{10v} This pseudo- γ and pseudo-specific heat are easy to insert into the code, and they need to be evaluated only at time level n for use in the coefficient matrix. In addition, they are constant over large parts of the ρ - T plane, so bilinear interpolation is sufficiently accurate.

B. Spherical Blast Wave

The spherical blast wave is a classical test problem for numerical fluid dynamics codes, and it is a much more severe test than piston-driven shocks or shock tubes. In these latter cases, the solutions are piece-wise constant except for the expansion wave in a shock tube, which generally has only modest

Fig. 2.

Runs of density at cycles 300 and 900 in the protostar calculation.

Fig. 3.

Runs of velocity at 300 and 900 cycles in the protostar calculation.

Fig. 4.

The protostar solution at 3500 cycles. The vertical axis runs from -3×10^5 to 0 cm-s^{-1} for the radial velocity (u), 0 to $1.5 \times 10^{-8} \text{ g-cm}^{-3}$ for the density (ρ), and 0 to 10^{11} for the specific internal energy (I).

curvature. On the other hand, the blast wave solution is sharply peaked, presenting a real challenge for finite difference methods.

The sample problem discussed in this section is based on a 10^{51} erg point explosion in a 10,000 K and $\rho = 2.4 \times 10^{-9}$ g/cm³ ambient medium with $\gamma = 5/3$. Appendix B gives UPDATE modifications and the data deck.

Figure 5 shows the numerical solution for the density at two different times. The solid curves are for $\alpha = 1.0$ (pure donor cell transport) and the dashed curve is for $\alpha = 0.6$. Note that decreasing α reduces the numerical diffusion, thereby sharpening the peaks. Note also the improvement in the density jump condition as the wave progresses. This is due to two phenomena. First, the initial condition is not the Taylor-Sedov solution, toward which the solution evolves. Second, and more importantly, the resolution of the sharp self-similar peak improves as the radius of the shock grows to include more cells.

C. Solar Wind

A simple solar wind model is presented to illustrate use of the code with inflow and outflow boundaries. It also has the left-most vertex away from the

Fig. 5.

Runs of density for blast wave solutions. The solid curves are for $\alpha = 1.0$ at 150 cycles ($t \approx 96.5$ s) and 300 cycles ($t = 216.5$ s). The dashed curve is for $\alpha = 0.6$ at 300 cycles ($t = 212.3$ s). The peak of the analytical solution is 9.6×10^{-9} g cm⁻³ at $r = 7.2 \times 10^{12}$ cm at 300 cycles.

origin. This feature is also useful for running a Cartesian problem merely by making $X(2)$ much larger than the total width of the mesh.

The sample solutions presented here are repetitions of solutions by Hundhausen and Gentry (HG).⁹ The first step in this problem is to find a steady state solar wind solution. This could be accomplished by letting the program go through a transient phase. However, the computational effort was minimized by using an inviscid analytical solution as the initial condition. Then transient disturbances were introduced into the solution to represent perturbations by solar flares, and their propagation was followed.

The initial condition is an inviscid adiabatic radial expansion of an ideal gas:

$$p = (\gamma - 1)\rho I = C_1 \rho^\gamma, \quad (37)$$

$$r^2 \rho u = C_2, \quad (38)$$

and

$$u \frac{du}{dr} + \frac{1}{\rho} \frac{dp}{dr} + \frac{GM}{r^2} = 0, \quad (39)$$

where M is the mass of the sun. Substituting (37) into (39) and integrating, we find

$$I + \frac{1}{2} u^2 + \frac{p}{\rho} - \frac{GM}{r} = C_3, \quad (40)$$

which is the Bernoulli equation for this problem. The constants C_1 , C_2 , and C_3 are evaluated by specifying the values of all variables at $r = 1.25 \times 10^{12}$ cm, which is outside the critical point of the inviscid solar wind. Elimination of all dependent variables except ρ leads to a transcendental equation for ρ :

$$\rho^2 \left(C_3 + \frac{GM}{r} - \frac{\gamma C_1}{\gamma - 1} \rho^{\gamma - 1} \right) = \frac{C_2^2}{2r^4} \quad (41)$$

This form is solved iteratively by the program, and then the other variables are found trivially by using equations (37) and (38).

The inflow boundary at the left is straightforward, as can be seen from the UPDATE modifications given in the appendix C. However, outflow boundaries are always more troublesome. One simple form that is frequently useful is the continuative boundary, where all gradients are set to zero on the boundary. This procedure is often adequate for supersonic flows, but can reflect unwanted signals into the mesh for subsonic flows. We use an alternate approach, the radiation condition

$$\frac{\partial c}{\partial t} + u \frac{\partial c}{\partial r} = 0 \quad , \quad (42)$$

where c is one of the flow variables, in place of the continuative boundary. A small bump in the velocity at the right end of the mesh is strictly a numerical artifact of the outflow boundary. It is slightly smaller using equation (42) than the continuative boundary, and the supersonic outflow prevents it from propagating into the mesh. The user may have to develop a better outflow boundary condition for some problems.

The first numerical solution we ran was the generation of a steady state solution. The analytic solution from equations (37), (38), and (41) was used as the initial condition. The parameters of HG were used. The problem was run beyond the time it takes an element of fluid to cross the mesh, and the numerical and analytic steady states were compared. During the transient, the interface between the fluid originally in the mesh and the fluid that subsequently flowed into the mesh propagated to the right, showing a small disturbance of increasing amplitude that exited the mesh without reflection. Comparison of the computer-generated plots shows the analytic and computational solutions are almost indistinguishable. Examination of the numerical output shows that the worst errors are near the left boundary where gradients of the variables are the largest. The mesh has been compressed in this region to reduce the error, which has a maximum of 4% in the pressure. The other variables are computed more accurately, and the accuracy of all variables improves at larger r .

The second numerical solution was the same as the transient shock problem solved by HG. A disturbance lasting 2.1 hours was introduced into the mesh at

$t_0 = 2 \times 10^5$ s. This initial period was introduced to allow the inner boundary perturbation to propagate well into the mesh where it could be ignored. This procedure is probably not necessary. Figure (6) corresponds to figures (1)-(3) of HG, and the interested reader is invited to compare the results. The top row of figure 6 shows the solution at 2.0 hrs. after t_0 . The analytical solution has a velocity of 1570 km/s just behind the shock, in good agreement with our calculation. The velocity jump in HG's figure 1 is a bit too high. Our velocity profile has a spike behind the shock. As we are running with $\alpha = 0.5$, this feature is probably a dispersive truncation error. HG show no spike, suggesting that perhaps their solution was obtained using full donor cell transport ($\alpha = 1$). However, Gentry (private communication) has pointed out that at least part of the HG work was done with a scheme that was more closely related to the truncation error cancellation technique of Rivard and collaborators,¹¹ which is similar in principle to locally computing and applying the minimum α needed in each cell to get numerical stability. This procedure often allows significant dispersive errors to occur, especially near a strong shock, so it is not clear what differencing scheme HG used to obtain their published results.

An unexpected feature of the numerical solutions is the density jump across the shock. The analytic value is a factor of four. Our solution gives a factor of seven, and HG's jump is about the same in spite of the label on their graph showing good agreement with a factor of four jump. The explanation may be that the density gradient is quite large in this region, so shocked material compressed by the correct amount is more than four times as dense as the material ahead of the shock, several cells away.

The second row of figure 6 is taken at $t_0 + 4.3$ hr. The agreement with HG is better than at $t_0 + 2.1$ hr, especially in the velocity field. The density jump in the SOLA-STAR solution is still apparently a bit higher than expected.

The bottom row of figure 6 was taken at $t_0 + 20.1$ hr, as was HG's figure 3. HG's velocity curve is slightly broader and smoother. Their density jump and ours now are close to the desired factor of four, but the velocity and density profiles differ somewhat in detail. Although our solution is in qualitative agreement with that of HG, it is clear that some unanswered questions about these solar wind solutions remain.

Fig. 6.

Fig. 6 (con't)
The solar wind solution at 2.0 hr.,
4.3 hr., and 20.1 hr. after beginning
the shock wave inflow for the top,
middle, and bottom rows of figures re-
spectively. Dashed lines indicate the
steady state solar wind.

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APPENDIX A

SAMPLE PROBLEM

This appendix provides a listing of SOLA-STAR, a list of main variables, and some information to help the new user convert the code to a non-LASL operating system. We begin by noting that, for the most part, the code is written in ANSI-standard FORTRAN. The CDC computers carry approximately 13 digits, which has proved adequate. However for machines with a short word length, such as IBM, it will be necessary to use double precision throughout the code. This is good practice for any hydrodynamics program, but especially so for SOLA-STAR with its large linear system solver.

SOLA-STAR can be used on quite modest computers. This version of SOLA-STAR requires 77 K₈ words of memory. However, this number can be reduced if necessary by adjusting the size of dimensioned arrays or by sacrificing the plotting capability. The arrays B and AA are dimensioned for a maximum of JBAR = 150 real cells. The grind time, that is the time required to complete one time step for one cell, is 5.3 ms on a CDC 6400. This is approximately a factor of 10 longer than for a CDC 7600 and a factor of 2 larger than for a CDC 6600.

The main system-dependent feature is the graphics package. Logical unit 7 is the film file, and it can be eliminated if graphics output is not desired. The following is a list of graphical output routines used by SOLA-STAR. These routines will have to be replaced by the non-LASL user's local equivalent or deleted from the program.

1. CALL ADV(NF): If $1 \leq NF \leq 21$, the film is advanced NF frames. Otherwise, the call is ignored.
2. CALL EMPTY: Empty the FILM file buffer onto disk. Unless the run is unexpectedly aborted, this routine is superfluous.
3. CALL LINCNT(N): N is modulo 64. The next line of output directed to the film file is directed to the Nth line.
4. CALL SPLØT(IØP,N,X,Y,ICHAR,IØN): Standardized plot routine. Four types of grid: IØP = 1, 2, 3, or 4 gives linear-linear, linear-log, log-linear, or log-log plots respectively. N successive points are plotted from the tables X and Y (abscissas and ordinates respectively). ICHAR is a code number for a character to be plotted at each point

(ICHAR = 42 is a dot). If ICØN ≠ 0, the points are connected by straight lines.

5. CALL WLCH(IX,IY,CN,NCH,NS): Writes large horizontal characters beginning with SC 4020 coordinates (IX,IY). SC 4020 coordinates define a location on the film frame, with (0,0) at the upper left hand corner and (1023,1023) at the lower right hand corner. NC is the number of characters to be written beginning with the variable NCH. NS is an integer character size parameter, $1 \leq NS \leq 5$.

The sample problems in the Appendixes require minor changes to the basic code, and it is convenient to specify the changes in CDC UPDATE format, even though many users will not have this software. A statement of the form *INSERT SV.n means insert the FØRTTRAN statements between the *INSERT card and the next statement beginning with an * behind statement number SV.n The card *DELETE SV.m,SV.n means delete statements SV.m through SV.n and replace them with any statements between the *DELETE and the next * card. The *IDENT statement merely specifies a name to be associated with the set of modifications and may be ignored by users not using the UPDATE utility.

Table I lists the major program variables and their definitions. The remainder of this appendix is a program listing and sample output suitable for testing new SOLA-STAR decks. It is recommended that the new user try these problems to become thoroughly familiar with this code before embarking on his or her own research program.

TABLE I

DEFINITION OF SOLA-STAR VARIABLES

	<u>Definition</u>
AA	Coefficient matrix (band only) of the linear system.
AJ	Areas of cell faces.
B	Right hand side of the linear system.
CND	Thermal conductivity.
DØNM	Donor cell parameter α for the ρ and I equations.
DØNMØM	Donor cell parameter for the u equation.
DT	Time step.
DTK	Maximum allowed value of $ u\delta t/\delta x $, normally about 0.25.
DTMAX	Maximum value of DT allowed in the run.
DX	Width of the innermost two real cells and left hand fictitious cell.
EI	Specific internal energy I.
EM	Vertex masses.
EMC	Cell masses.
FMASS	Total mass of the system.
FMOØM	Total momentum of the system.
FOURPI	Four times π .
G	Gravitational constant.
GAMMA	γ , the ratio of specific heats.
GRDVL	Velocity of grid points as fraction of fluid velocity; zero for Eulerian run, unity for Lagrangian calculation. Can also be fractional or SUBRØUTINE GRID can be rewritten to provide an arbitrary, user-chosen grid motion.
JBAR	Number of real cells.
JP1	JBAR + 1.
JP2	JBAR + 2.
JP3	JBAR + 3.
KPR	Get one line summary print every KPR cycles.
LFILM	Get film output every LFILM cycles.
MUVISC	Coefficient of viscosity μ .

NDIM	Dimension of B and first dimension of AA. Must be at least NEQ * JP2.
NDIM2	Second dimension of AA.
NDT	Number of time steps.
NEQ	Number of dependent variables in the linear system.
NM	Get full printout every NM cycles.
P	Pressure p.
PDVCEN	Time centering parameter for $p \nabla \cdot \vec{u}$ in the I equation.
RCV	Reciprocal of the specific heat, T/I.
RH0	Density ρ .
RHOL	Density at the end of Phase I.
RMAX	Coordinate r of the right hand boundary.
RMIN	Coordinate r of the left hand boundary.
RSAB	Central density (RHO(2)) as a function of t. Saved for plotting purposes only.
T	Time t.
TIM	Array containing t for use in plotting RSAB.
U	Fluid velocity $u_{j-\frac{1}{2}}$.
UD	Difference velocity $w_{j-\frac{1}{2}}$.
UG	Grid velocity.
UTL	Fluid velocity at the left boundary.
UTMAX	Fluid velocity at the right boundary.
VJC	Cell volumes.
VJV	Vertex volumes.
VLAM	Λ , the artificial viscosity parameter.
UT	Velocity after Phase I.
X	Vertex positions $r_{j-\frac{1}{2}}$.

PROGRAM VEGA (OUTPUT=100,TAPE5=100,TTY,TAPE59=TTY,	SV	2
\$ TAPE5=100)	SV	3
REAL MUWISC	SV	4
COMMON /A1/JBAR,JP1,JP2,JP3,DT,T,N,NDT,FMASS,FMM,ET,EINT,NM,LFILMSV	SV	5
COMMON /A2/ EM(200),X(200),U(200),MUWISC(200)	SV	6
COMMON /3/ EI(200),E(200),DTMAX,VLAM,DTK	SV	7
COMMON /4/ RHJ(200),EMC(200),P(200),RHJL(200)	SV	8
COMMON /45/ UT(200),JD(200)	SV	9
COMMON /12/ GAMMA,UT1,UTMAX,DONM,DONMM,GRDVEL	SV	10
COMMON /A14/ EMCT(200),UG(200),DPHI(200)	SV	11
COMMON /A15/ RCV(200),CND(200),R2DR(200),TNJT4	SV	12
COMMON /A40/FOURPI,AJ(200),XMR(160)	SV	13
COMMON /TIMEV/ RSAV(2000),TIM(2000),ITIME	SV	14
COMMON LA,LB,AA(770,16),JBNEQ,NDIM,IP(770)	SV	15
DIMENSION ZNU(200),THE(200),ALF(200),BET(200),ZKAP(200),TAU(200)	SV	16
DIMENSION B(770),RM(200),RDX(200),AJC(200)	SV	17
DIMENSION RJC(200),VJC(200),RRJC(200),PHI(200),ZJ(200),	SV	18
1 ZN(200),RA(200),RB(200),RC(200),RD(200),VJV(200)	SV	19
DATA T,N/D.,O/	SV	20
DATA FOURPI,G/12.56537062,5.63E-8/	SV	21
DATA PD/CEN/1./	SV	22
DATA LFILM,KPR,NM/25,1,50/	SV	23
C ***	SV	24
C *** SET UP	SV	25
C ***	SV	26
CALL INPUT	SV	27
GM1=GAMMA-1.	SV	28
TNJT4=(EI(JP1)*RCV(JP1))**4	SV	29
WRITE (5,230) TNJT4	SV	30
WRITE (7,230) TNJT4	SV	31
C *** LA IS NUMBER OF ELEMENTS TO LEFT OF DIAGONAL, LB TO RIGHT	SV	32
LA=5	SV	33
LB=5	SV	34
NEQ=5	SV	35
NDIM=770	SV	36
NDIM2=16	SV	37
JBNEQ=JP1*NEQ	SV	38
DO 10 J=2,JP2	SV	39
RDX(J)=1./(X(J+1)-X(J))	SV	40
RJC(J)=.5*(X(J)+X(J+1))	SV	41

AJC(J)=3.*RJC(J)*RJC(J)	SV	42
RRJC(J)=0.5/RJC(J)	SV	43
RA(J)=RDX(J)+2.*RRJC(J)	SV	44
RB(J)=RDX(J)-2.*RRJC(J)	SV	45
RC(J)=(RDX(J)+RRJC(J))*RRJC(J)	SV	46
RD(J)=(RDX(J)-RRJC(J))*RRJC(J)	SV	47
VJC(J)=X(J+1)**3-X(J)**3	SV	48
EMC(J)=R4D(J)*VJC(J)	SV	49
10 CONTINUE	SV	50
RJC(1)=0.5*(X(1)+X(2))	SV	51
C *** R2DR(2)=0 TO MAKE DI/DR=0 AT ORIGIN	SV	52
R2DR(2)=0.	SV	53
DO 20 J=3,JP2	SV	54
R2DR(J)=1./(X(J+1)-X(J-1))	SV	55
AJ(J)=3.*X(J)*X(J)	SV	56
VJV(J)=RJC(J)**3-RJC(J-1)**3	SV	57
20 EM(J)=0.5*(EMC(J-1)+EMC(J))	SV	58
AJ(2)=3.*X(2)*X(2)	SV	59
AJ(JP3)=3.*X(JP3)*X(JP3)	SV	60
VJV(2)=RJC(2)**3-X(2)**3	SV	61
EM(2)=0.5*EMC(2)	SV	62
CALL CONDUCT	SV	63
CALL OUTPUT	SV	64
DTT=DT	SV	65
ITIME=0	SV	66
C ***	SV	67
C *** HYDRODYNAMICS LOOP	SV	68
C ***	SV	69
DO 200 N=1,NDT	SV	70
ITIME=ITIME+1	SV	71
IF (ITIME.GT.500) ITIME=1	SV	72
DT=AMIN1(DTT,1.1*DT)	SV	73
T=T+DT	SV	74
TEMPE=EI(2)*RCV(2)	SV	75
IF (MJD(N,KPR).EQ.0) WRITE (6,220) DT,T,N,R4D(2),U(15),TEMPE	SV	76
IF (MJD(N,KPR).EQ.0) WRITE (7,220) DT,T,N,RHO(2),U(15),TEMPE	SV	77
IF (TEMPE.GT.3000.) CALL EXIT	SV	78
JBM=JBA2-1	SV	79
SET(2)=0.	SV	80
SET(JP2)=X(JP2)**2*RDX(JP1)	SV	81

	DPHI(2)=0.	SV	82
	SUM=0.	SV	83
	DUG=FJURPI*G/3.	SV	84
	DO 30 J=3,JP1	SV	85
	3ET(J)=X(J)*X(J)/(RJC(J)-RJC(J-1))	SV	86
	SUM=SUM+EMC(J-1)*DUG	SV	87
	DPHI(J)=SUM/(X(J)*X(J))	SV	88
30	CONTINUE	SV	89
	DPHI(JP2)=(SUM+EMC(JP1)*DUG)/(X(JP2)*X(JP2))	SV	90
	GMAX=ABS(DPHI(JP2))	SV	91
	CALL CONDUCT	SV	92
	R2DR(JP3)=0.	SV	93
	DO 80 J=2,JP2	SV	94
	T1=U(J+1)-U(J)	SV	95
	T2=U(J+1)+U(J)	SV	96
	T3=0.	SV	97
	IF (J.NE.JP2) T3=DT/EMC(J)	SV	98
	ZD=T1*RDX(J)+2.*T2*RRJC(J)	SV	99
	T4=-DT/(1.+DT*ZD)	SV	100
	T5=2.*T1*RDX(J)**2	SV	101
	T6=4.*T2*RRJC(J)**2	SV	102
	3ET(J)=(T1*RDX(J))**2+2.*(T2*RRJC(J))**2	SV	103
	ZNU(J)=0.5*T3	SV	104
	ALF(J)=2.*T3*4JVISI(J)*VJC(J)	SV	105
	THE(J)=U(J+1)*AJ(J+1)-U(J)*AJ(J)	SV	106
	ZKAP(J)=T5+T6	SV	107
	TAU(J)=T5-T6	SV	108
	RM(J)=DT/EM(J)	SV	109
	PHI(J)=T4*R4D(J)	SV	110
80	CONTINUE	SV	111
C	*** MATRIX STRUCTURE	SV	112
C	***	SV	113
C	*** FORMAT BLOCK	SV	114
C	***	SV	115
C		SV	116
C		SV	117
C	P	SV	118
C		SV	119
C	U	SV	120
C		SV	121

30	C	RHD	K+2,L-2	SV	122
	C			SV	123
	C	FLUX	<+3,L+1	SV	124
	C			SV	125
	C	EI	K+4,L-1	SV	126
	C			SV	127
		DO 90 I=1,NDIM		SV	128
		DO 90 J=1,NDI42		SV	129
		90 AA(I,J)=0.		SV	130
		AA(2,6)=1.		SV	131
		AA(4,7)=1.		SV	132
		K=1-NEQ		SV	133
		L=LA+1		SV	134
		DIVR=0.		SV	135
		ARTPP=0.		SV	136
		DO 120 J=2,JP2		SV	137
		K=K+NEQ		SV	138
		AA(<,L)=-GM1*EI(J)		SV	139
		AA(K,L+2)=1.		SV	140
		AA(K,L+3)=-GM1*RHJ(J)		SV	141
		JIVL=DIVR		SV	142
		DIVR=J.		SV	143
		IF (J .LT. JP2) DIVR=(AJ(J+1)*U(J+1)-AJ(J)*U(J))/VJC(J)		SV	144
		IF (DIVR .GT. 0.) DIVR=0.		SV	145
		ARTPM=ARTPP		SV	146
		ARTPP=VLAM*RHJ(J)*DIVR*DIVR/(RDX(J)*RDX(J))		SV	147
		IF(J .EQ. 2) GO TJ 100		SV	148
		AA(K+1,L-5)=-4.*VJV(J)*RM(J)*MUVISC(J-1)*(R2DR(J)*RDX(J-1)-RC(J-1))		SV	149
		1)		SV	150
		AA(K+1,L-4)=-RM(J)*AJ(J)		SV	151
		AA(K+1,L)=1.+4.*VJV(J)*RM(J)*(MUVISC(J)*(R2DR(J)*RDX(J)+RC(J))		SV	152
		1 +MUVISC(J-1)*(R2DR(J)*RDX(J-1)-RD(J-1)))		SV	153
		AA(<+1,L+1)=RM(J)*AJ(J)		SV	154
		AA(K+1,L+5)=-4.*VJV(J)*RM(J)*MUVISC(J)*(R2DR(J)*RDX(J)+RD(J))		SV	155
		AA(<+3,L-5)=2.*CND(J)*RCV(J)*R2DR(J)		SV	156
		AA(<+3,L+1)=1.		SV	157
		AA(<+3,L)=-2.*CND(J)*RCV(J+1)*R2DR(J)		SV	158
		100 AA(<+4,L-3)=ALF(J)*TAU(J)-PDVCEN*ZNU(J)*P(J)*AJ(J)*2.		SV	159
		AA(<+4,L-2)=2.*ZNU(J)*THE(J)		SV	160
		5 *PDVCEN		SV	161

AA(K+4,L-1)=1.	SV	162
IF (J.EQ.JP2) GO TO 110	SV	163
AA(K+4,L)=2.*ZNU(J)*AJ(J)	SV	164
AA(K+4,L+5)=-2.*ZNU(J)*AJ(J+1)	SV	165
110 CONTINUE	SV	166
AA(K+4,L+2)=2.*PDVCEN*ZNJ(J)*P(J)*AJ(J+1)-ALF(J)*ZKAP(J)	SV	167
AA(K+2,L-2)=1.	SV	168
AA(K+2,L-1)=PHI(J)*RB(J)	SV	169
AA(K+2,L+4)=-PHI(J)*RA(J)	SV	170
B(K)=-341*RHO(J)*EI(J)	SV	171
B(K+1)=U(J)	SV	172
IF (J.GT.2) B(K+1)=B(K+1)+RM(J)*AJ(J)*(ARTPM-ARTPP)	SV	173
B(K+1)=B(K+1)-DT*DPHI(J)	SV	174
B(K+2)=RHJ(J)	SV	175
B(K+3)=0.	SV	176
B(K+4)=EI(J)-ALF(J)*BET(J)-DT*ARTPP*DIVR/RHO(J)	SV	177
\$ +2.*(2.*PDVCEN-1.)*ZNU(J)*THE(J)*P(J)	SV	178
120 CONTINUE	SV	179
AA(K+1,L-5)=0.	SV	180
AA(K+1,L-4)=0.	SV	181
AA(K+1,L+1)=0.	SV	182
AA(K+1,L+5)=0.	SV	183
AA(K+1,L)=1.	SV	184
B(K+1)=0.	SV	185
AA(K,L)=0.	SV	186
AA(K,L+3)=0.	SV	187
AA(K,L-3)=-1.	SV	188
B(K)=0.	SV	189
AA(K+2,L-1)=0.	SV	190
AA(K+2,L+4)=0.	SV	191
CALL DECB (IER)	SV	192
CALL SOLB (B)	SV	193
K=1-NEQ	SV	194
GO 130 J=2,JP2	SV	195
K=K+NEQ	SV	196
RHOL(J)=B(K)	SV	197
UT(J)=B(K+1)	SV	198
P(J)=B(K+2)	SV	199
EI(J)=B(K+3)	SV	200
DPHI(J)=B(K+4)	SV	201

130	CONTINUE	SV	202
	JT(2)=UT1	SV	203
	RHQL(1)=RHQL(2)	SV	204
	RHQL(JP2)=RHQL(JP1)	SV	205
C ***		SV	206
C ***	REZONE SECTION	SV	207
C ***		SV	208
	CALL GRID	SV	209
	DO 150 J=2,JP1	SV	210
	DUB1=-ABS(DONM)*SIGN(1.,UD(J))	SV	211
	DUB2=-ABS(DONM)*SIGN(1.,UD(J+1))	SV	212
	EMCT(J)=EMC(J)-0.5*DT*(UD(J)*AJ(J)*((1.+DUB1)*RHQL(J-1)+(1.-DUB1)*SV	SV	213
	1RHQL(J))-JD(J+1)*AJ(J+1)*((1.+DUB2)*RHQL(J)+(1.-DUB2)*RHQL(J+1)))	SV	214
	E(J)=(EI(J)*EJC(J)-.5*DT*(JD(J)*AJ(J)*((1.+DUB1)*RHQL(J-1)*EI(J-1)SV	SV	215
	1+(1.-DUB1)*RHQL(J)*EI(J))-UD(J+1)*AJ(J+1)*((1.+DUB2)*RHQL(J)*EI(J)SV	SV	216
	2+(1.-DUB2)*RHQL(J+1)*EI(J+1))))/EMCT(J)	SV	217
150	CONTINUE	SV	218
	EMCT(JP2)=EMC(JP2)	SV	219
	E(JP2)=EI(JP2)	SV	220
	DO 160 J=3,JP2	SV	221
	DUB1=-ABS(DONM)*SIGN(1.,UD(J)+UD(J-1))	SV	222
	DUB2=-ABS(DONM)*SIGN(1.,UD(J)+UD(J+1))	SV	223
	U(J)=EM(J)*UT(J)-.25*DT*(RHQL(J-1)*(JD(J)+UD(J-1))*AJC(J-1)*((1.+SV	SV	224
	1DUB1)*UT(J-1)+(1.-DUB1)*JT(J))-RHQL(J)*(UD(J)+UD(J+1))*AJC(J)*SV	SV	225
	2(1.+DUB2)*UT(J)+(1.-DUB2)*UT(J+1)))	SV	226
160	CONTINUE	SV	227
	U(JP2)=0.	SV	228
	DPHI(2)=0.	SV	229
	DO 170 J=2,JP2	SV	230
	RDX(J)=1./(X(J+1)-X(J))	SV	231
	RJC(J)=.5*(X(J)+X(J+1))	SV	232
	AJC(J)=3.*RJC(J)*RJC(J)	SV	233
	RRJC(J)=0.5/RJC(J)	SV	234
	RA(J)=RDX(J)+2.*RRJC(J)	SV	235
	RB(J)=RDX(J)-2.*RRJC(J)	SV	236
	RC(J)=(RDX(J)+RRJC(J))*RRJC(J)	SV	237
	RD(J)=(RDX(J)-RRJC(J))*RRJC(J)	SV	238
	VJC(J)=X(J+1)**3-X(J)**3	SV	239
	EMC(J)=EMCT(J)	SV	240
	RHJ(J)=EMC(J)/VJC(J)	SV	241

EI(J)=E(J)	SV	242
170 CONTINUE	SV	243
RJC(1)=0.5*(X(1)+X(2))	SV	244
DTT=DTMAX	SV	245
DO 180 J=3,JP2	SV	246
R2DR(J)=1./(X(J+1)-X(J-1))	SV	247
AJ(J)=3.*X(J)*X(J)	SV	248
VJV(J)=RJC(J)**3-RJC(J-1)**3	SV	249
EM(J)=0.5*(EMC(J-1)+EMC(J))	SV	250
U(J)=U(J)/EM(J)	SV	251
IF (U(J).NE.0.) DTT=AMIN1(DTT,DTK*(X(J+1)-X(J))/ABS(U(J)))	SV	252
180 CONTINUE	SV	253
VJV(2)=RJC(2)**3-X(2)**3	SV	254
AJ(2)=3.*X(2)*X(2)	SV	255
AJ(JP3)=3.*X(JP3)*X(JP3)	SV	256
EM(2)=0.5*EMCT(2)	SV	257
U(2)=UT1	SV	258
RHO(1)=RHO(2)	SV	259
RHO(JP2)=RHO(JP1)	SV	260
EI(1)=EI(2)	SV	261
C ***	SV	262
C *** TIME ACCOUNTING	SV	263
C ***	SV	264
IF (MOD(N,NM).NE.0 .AND. MJD(N,LFILM).NE.0 .AND. N.GT.1)	SV	265
\$ GO TO 192	SV	266
ET=0.	SV	267
EINT=0.	SV	268
FMAS=0.	SV	269
FMOM=0.	SV	270
DO 190 J=2,JP2	SV	271
FMOM=FMOM+EM(J)*UT(J)	SV	272
ET=ET+0.5*EM(J)*UT(J)*UT(J)	SV	273
IF (J .EQ. JP2) GO TO 190	SV	274
ET=ET+EMC(J)*EI(J)	SV	275
EINT=EINT+EMC(J)*EI(J)	SV	276
FMAS=FMAS+EMC(J)	SV	277
FMOM=FMOM+EM(J)*UT(J)	SV	278
190 CONTINUE	SV	279
ET=ET*FOURPI/3.	SV	280
EINT=EINT*FOURPI/3.	SV	281

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FMAS=FMASS*FOURPI/3.
FMOM=FMOM*FOURPI/3.
192 CONTINUE
      RSV(IIME)=ALGLO(RHO(2))
      TIM(IIME)=T
      IF (N.EQ.1) CALL OUTPUT
      IF (MOD(N,N4).EQ.0.JR.MOD(N,LFILM).EQ.0) CALL OUTPUT
200 CONTINUE
      CALL EXIT
C ***
C ***
C ***
      FORMAT BLOCK
220 FORMAT (2X,4HDT =,1PE17.8,2X,3HT =,E17.8,I5,3E13.5)
230 FORMAT (1X,1PE20.8)
      END
      SUBROUTINE INPUT
      COMMON /A1/JBAR,JP1,JP2,JP3,DT,T,N,NDT,FMASS,FMOM,ET,EINT,NM,LFILM
      COMMON /A2/ EM(200),X(200),U(200),MUVISC(200)
      COMMON /A3/ EI(200),E(200),DTMAX,VLAM,DTK
      COMMON /A4/ RHJ(200),EMC(200),P(200),RHL(200)
      COMMON /A5/ UT(200),JD(200)
      COMMON /A6/ ITITLE(8)
      COMMON /A7/ GAMMA,UT1,UTMAX,DONM,DONMOM,GRDVEL
      COMMON /A14/ EMCT(200),J3(200),DPHI(200)
      COMMON /A15/ RCV(200),CND(200),R2DR(200),TNJ14
      REAL MUVISC
      DATA (EM(J),J=1,200)/200*0./
      DATA (MUVISC(J),J=1,200)/200*0./
      DATA (UT(J),J=1,200)/200*0./
      DATA (U(J),J=1,200)/200*0./
      DATA (UG(J),J=1,200)/200*0./
      DATA (RCV(J),J=1,200)/200*1.911098562E-08/
C ***
C ***
C ***
      READ DATA DECK
      READ (5,50) (ITITLE(J),J=1,8)
      WRITE (6,50) (ITITLE(J),J=1,8)
      WRITE (7,50) (ITITLE(J),J=1,3)
      READ (5,60) JBAR,NDT
      WRITE (6,60) JBAR,NDT

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WRITE (7,60) JBAR,NDT
JP1=JBAR+1
JP2=JP1+1
JP3=JP2+1
READ (5,70) DT,DX,GROVEL
WRITE (6,70) DT,DX,GROVEL
WRITE (7,70) DT,DX,GROVEL
READ (5,70) RMIN,RMAX
WRITE (6,70) RMIN,RMAX
WRITE (7,70) RMIN,RMAX
READ (5,70) DONM,DONMOM
WRITE (6,70) DONM,DONMOM
WRITE (7,70) DONM,DONMOM
READ (5,70) GAMMA,UTL,UTMAX
WRITE (6,70) GAMMA,UTL,UTMAX
WRITE (7,70) GAMMA,UTL,UTMAX
READ (5,70) VLAM,DTMAX,DTK
WRITE (6,70) VLAM,DTMAX,DTK
WRITE (7,70) VLAM,DTMAX,DTK
U(2)=UTL
U(JP2)=UTMAX

C ***
C *** SET U MESH
C ***

X(2)=RMIN
RMLJ=0.5
RMHI=2.
RATIO=1.
DR8=DX
10 CONTINUE
DX=DR8
DO 20 J=3,JP3
IF (J.GT.4.AND.J.LT.JBAR) DX=DX*RATIO
X(J)=X(J-1)+DX
20 CONTINUE
WRITE (6,80) RATIO,X(JP2),DX
IF (RATIO.GT.2.95.AND.X(JP2).LT.RMAX) CALL EXIT
IF (ABS((X(JP2)-RMAX)/RMAX).LT.1.E-4) GO TO 30
IF (X(JP2).GT.RMAX) RMHI=RATIO
IF (X(JP2).LE.RMAX) RMLJ=RATIO

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36	RATIO=0.5*(RMLO+RMHI)	SV	362
	GO TO 10	SV	363
30	CONTINUE	SV	364
	X(1)=2.*X(2)-X(3)	SV	365
C ***		SV	366
C ***	INITIALIZE DEPENDENT VARIABLES	SV	367
C ***		SV	368
	DO 40 J=1,JP2	SV	369
	RHO(J)=1.10E-19	SV	370
	RHO(J)=1.26E-19	SV	371
	P(J)=3.696E-11	SV	372
	P(J)=4.39758E-11	SV	373
	U(J)=0.	SV	374
	EI(J)=P(J)/((GAMMA-1.)*RHO(J))	SV	375
40	CONTINUE	SV	376
	U(2)=UT1	SV	377
	U(JP3)=U(JP2)	SV	378
	UD(JP3)=0.	SV	379
	UT(JP3)=0.	SV	380
	CALL SETKAP	SV	381
	RETURN	SV	382
C		SV	383
	50 FORMAT (B410)	SV	384
	60 FORMAT (10H ,I10,10H ,I10)	SV	385
	70 FORMAT (10H ,E10.3,10H ,E10.3,10H ,	SV	386
	1 E10.3)	SV	387
	80 FORMAT (1X,*RATIO, RMAX FROM MESH GEN*,1P3E16.8)	SV	388
	END	SV	389
	SUBROUTINE SETKAP	SV	390
	COMMON/KAPA/KAP(51,31),XMF,YMF,ZMF	SV	391
	REAL KAP	SV	392
C ***		SV	393
C ***	READS G08 OPACITY DECK	SV	394
C ***		SV	395
	READ (5,100) XMF,YMF	SV	396
100	FORMAT (10F8.5)	SV	397
	ZMF=1.-XMF-YMF	SV	398
	I=0	SV	399
	K2=0	SV	400
300	CONTINUE	SV	401

I=I+1	SV	402
IF (I .GT. 51) GO TO 304	SV	403
301 FORMAT (1X,I5,14F5.2)	SV	404
K2=K2+1	SV	405
READ (5,301) K1, (KAP(I,J), J=1,14)	SV	406
IF (K1 .NE. K2) GO TO 302	SV	407
K2=K2+1	SV	408
READ (5,301) K1, (KAP(I,J), J=15,29)	SV	409
IF (K1 .NE. K2) GO TO 302	SV	410
K2=K2+1	SV	411
READ (5,301) K1, (KAP(I,J), J=29,31)	SV	412
IF (K1 .NE. K2) GO TO 302	SV	413
GO TO 300	SV	414
302 CONTINUE	SV	415
303 FORMAT (1X,21HWRONG CAPACITY CARD,K=I3)	SV	416
WRITE (6,303) K2	SV	417
CALL EXIT	SV	418
304 CONTINUE	SV	419
RETURN	SV	420
END	SV	421
SUBROUTINE OUTPUT	SV	422
REAL MUWISC	SV	423
COMMON /A1/ JBAR, JP1, JP2, JP3, DT, T, N, NDT, FMASS, FMOM, ET, EINT, NM, LFIL	SV	424
COMMON /A2/ EM(200), X(200), U(200), MUWISC(200)	SV	425
COMMON /A3/ EI(200), E(200), DTMAX, VLAM, DT	SV	426
COMMON /A4/ RHQ(200), EMC(200), P(200), RHQL(200)	SV	427
COMMON /A5/ UT(200), UD(200)	SV	428
COMMON /A6/ ITITLE(8)	SV	429
COMMON /A7/ GAMMA, JT1, UTMAX, DONM, DONMOM, GRDVEL	SV	430
COMMON /A8/ EMCT(200), JG(200), DPHI(200)	SV	431
COMMON /A9/ RCV(200), CND(200), RZDR(200), TNOT4	SV	432
COMMON /A10/ FJURPI, AJ(200), XMR(160)	SV	433
COMMON /TIMEV/ RSV(2000), TIM(2000), ITIME	SV	434
DIMENSION AL(200), BL(200), CL(200)	SV	435
DIMENSION XC(200), TEM(200)	SV	436
DATA UTITLE/10HX-VELOCITY/	SV	437
DATA (DPHI(J), J=1,200)/200*0./	SV	438
DATA PTITLE/8HPPRESSURE/	SV	439
DATA (XMR(J), J=1,160)/160*0./	SV	440
DATA RHDTITL/7HDENSITY/	SV	441
DATA XITL/3HSIE/	SV	442

38	C ***	SV	443
	C *** BCD OUTPUT	SV	444
	C ***	SV	445
	DD 25 J=2,JP2	SV	446
	IF (J .GT. 2) XMR(J)=XMR(J-1)+FOURPI*FMC(J-1)/3.	SV	447
	DPHI(J)=-FOURPI*AJ(J)*DPHI(J)/3.	SV	448
	TEM(J)=EI(J)*RCV(J)	SV	449
	25 CONTINUE	SV	450
	IUMIN=6	SV	451
	IUMAX=7	SV	452
	IF (N.LE.1) GO TO 10	SV	453
	IF (MOD(N,NM).NE.0) IUMIN=7	SV	454
	IF (MOD(N,LFILM).NE.0) IUMAX=6	SV	455
	IF (IUMIN.GT.IUMAX) IUMAX=7	SV	456
	10 DO 20 IU=IUMIN,IUMAX	SV	457
	WRITE (IU,40) EINT,ET,FMASS,FMOM,N	SV	458
	IF (IU.EQ.7) CALL ADV (1)	SV	459
	WRITE (IU,50)	SV	460
	WRITE (IU,60)(I,X(I),U(I),RHO(I),EI(I),P(I),CND(I),DPHI(I),	SV	461
	1 XMR(I),TEM(I),I=2,JP2)	SV	462
	20 CONTINUE	SV	463
	C ***	SV	464
	C *** GRAPHICAL OUTPUT	SV	465
	C ***	SV	466
	IF (IUMAX .EQ. 6) RETURN	SV	467
	CALL SPLDT (1,JP1,X(2),U(2),42,1)	SV	468
	CALL WLCH (0,0,56,ITITLE,2)	SV	469
	CALL WLCH (0,25,10,UTITLE,1)	SV	470
	CALL LINCNT (60)	SV	471
	WRITE (7,70)T,N	SV	472
	DO 30 J=2,JP1	SV	473
	XC(J)=.5*(X(J)+X(J+1))	SV	474
	AL(J)=ALOG10(RHO(J))	SV	475
	BL(J)=ALOG10(EI(J))	SV	476
	CL(J)=ALOG10(P(J))	SV	477
	30 CONTINUE	SV	478
	CALL SPLDT (1,JP1-1,XC(2),P(2),42,1)	SV	479
	CALL WLCH (0,0,56,ITITLE,2)	SV	480
	CALL WLCH (0,25,8,PTITLE,1)	SV	481
	CALL LINCNT (60)	SV	482

WRITE (7,70)T,N	SV	483
CALL SPLOT (1,JP1-1,XC(2),EI(2),42,1)	SV	484
CALL WLC4 (0,0,56,ITITLE,2)	SV	485
CALL WLC4 (0,25,3,XITLE,1)	SV	486
CALL LINCNT (60)	SV	487
WRITE (7,70)T,N	SV	488
CALL SPLOT (1,JP1-1,XC(2),RHJ(2),42,1)	SV	489
CALL WLC4 (0,0,56,ITITLE,2)	SV	490
CALL WLC4 (0,25,7,RHOTITL,1)	SV	491
CALL LINCNT (60)	SV	492
WRITE (7,70)T,N	SV	493
CALL SPLOT (1,JP1-1,XC(2),CND(2),42,1)	SV	494
CALL WLC4 (0,0,56,ITITLE,2)	SV	495
CALL WLC4 (0,25,3,3HCND,1)	SV	496
CALL LINCNT (50)	SV	497
WRITE (7,70)T,N	SV	498
IF (N.GT.10) CALL SPLOT (2,ITIME,TIM,RSAY,42,1)	SV	499
IF (N.GT.10) CALL WLC4 (0,25,8,8HRHD VS T,1)	SV	500
CALL LINCNT (60)	SV	501
WRITE (7,70)T,N	SV	502
JBAR=JP1-1	SV	503
CALL SPLOT (2,JBAR,XC(2),AL(2),42,1)	SV	504
CALL WLC4(0,25,7,RHOTITL,1)	SV	505
CALL SPLOT (2,JBAR,XC(2),BL(2),42,1)	SV	506
CALL WLC4(0,25,3, XITLE,1)	SV	507
CALL SPLOT (2,JBAR,XC(2),CL(2),42,1)	SV	508
CALL WLC4(0,25,8,PTITLE,1)	SV	509
XJCL=1.E-3*X(JP2)	SV	510
DO 7000 J=2,JP1	SV	511
JCL=J	SV	512
IF (X(J) .GT. XJCL) GO TO 7001	SV	513
7000 CONTINUE	SV	514
7001 CONTINUE	SV	515
IF (JCL .EQ. JP1 .OR. JCL .LT. 3) GO TO 7002	SV	516
CALL SPLOT(1,JCL,X(2),U(2),42,1)	SV	517
CALL WLC4(0,25,10,UTITLE,1)	SV	518
CALL SPLOT(1,JCL-1,XC(2), P(2),42,1)	SV	519
CALL WLC4(0,25,8,PTITLE,1)	SV	520
CALL SPLOT(1,JCL-1,XC(2), EI(2),42,1)	SV	521
CALL WLC4(0,25,3, XITLE,1)	SV	522

CALL SPLOT(1,JCL-1,XC(2),RHO(2),42,1)	SV	523
CALL WLC4(0.25,7,RHDTITL,1)	SV	524
7002 CONTINUE	SV	525
WRITE (59,70) T,N	SV	526
IF (ITEM(2) .GT. 2000.) CALL EXIT	SV	527
RETURN	SV	528
C ***	SV	529
C *** FORMAT BLOCK	SV	530
C ***	SV	531
40 FORMAT (1X,17HINTERNAL ENERGY =,1PE13.6,	SV	532
1 15H TITAL ENERGY =,E13.6,7H MASS =,E13.6,11H MOMENTUM =,E13.6,	SV	533
1 8H CYCLE =,I7)	SV	534
50 FORMAT (4X,1HJ,7X,1HX,12X,1HU,11X,3HRHO,10X,2HEI,11X,1HP,	SV	535
5 10X,3HCND,11X,1HL,10X,2HMR,11X,1HT)	SV	536
60 FORMAT (1X,I3,1P9E13.5)	SV	537
70 FORMAT (5H TIME =,1PE10.3,7H CYCLE =,I5)	SV	538
END	SV	539
SUBROUTINE GRID	SV	540
REAL MUVISC	SV	541
COMMON /A1/ J9AR,JP1,JP2,JP3,DT,T,N,NDT,FMASS,FMDM,ET,EINT,NM,LFIL	SV	542
COMMON /A2/ EM(200),X(200),U(200),MUVISC(200)	SV	543
COMMON /A5/ UT(200),UD(200)	SV	544
COMMON /I2/ GAMMA,UT1,UTMAX,DONM,DONMDM,GRDVEL	SV	545
COMMON /A14/ EMCT(200),UG(200),DPHI(200)	SV	546
C ***	SV	547
C *** DEFINE GRID VELOCITY UG, REZONE (DIFFERENCE) VELOCITY UD,	SV	548
C *** AND NEW VERTEX POSITIONS X.	SV	549
C *** GRDVEL = 0., EULERIAN. GRDVEL = 1., LAGRANGIAN.	SV	550
C ***	SV	551
DO 10 J=2,JP2	SV	552
UG(J)=GRDVEL*U(J)	SV	553
UD(J)=UG(J)-UT(J)	SV	554
X(J)=X(J)+DT*UG(J)	SV	555
10 CONTINUE	SV	556
X(JP3)=2.*X(JP2)-X(JP1)	SV	557
X(1)=2.*X(2)-X(3)	SV	558
RETURN	SV	559
END	SV	560
REAL FUNCTION KAPPA(RD1,TE)	SV	561
C *** T LIMITS IF TABLE ARE LOG(T)=3.3 AND 3.2	SV	562

C *** RHJ TABLE LIMITS ARE 1.E-12 AND 1000.	SV	563
COMMON/KAPA/KAP(51,31),XMF,YMF,ZMF	SV	564
REAL KAP,KAPP	SV	565
INTEGER DI,TI	SV	566
DATA DUSTK/0.15/	SV	567
C *** DUST OPACITY ONLY	SV	568
KAPPA=DUSTK	SV	569
IF (TE .LE. 1500.) RETURN	SV	570
C *** GAS OPACITY	SV	571
RD=RD1	SV	572
D=2.0*ALOG10(RD)+25.0	SV	573
DI=INT(D)	SV	574
D=D-DI	SV	575
T=20.*ALOG10(TE)-65.	SV	576
IF (T .GT. 35.) T=35.+(T-35.)*0.25	SV	577
TI=INT(T)	SV	578
T=T-TI	SV	579
IF (DI .GE. 1) GO TO 30	SV	580
DI=1	SV	581
D=0.	SV	582
30 CONTINUE	SV	583
IF (DI .LE. 30) GO TO 31	SV	584
DI=30	SV	585
D=1.	SV	586
31 CONTINUE	SV	587
IF (TI .GE. 1) GO TO 32	SV	588
TI=1	SV	589
T=0.	SV	590
32 CONTINUE	SV	591
IF (TI .LE. 50) GO TO 33	SV	592
TI=50	SV	593
T=1.	SV	594
33 KAPP=(1.-T)*((1.-D)*KAP(TI,DI)+D*KAP(TI,DI+1))+	SV	595
1 T*((1.-D)*KAP(TI+1,DI)+D*KAP(TI+1,DI+1))	SV	596
KAPPA=EXP(2.3026*KAPP)	SV	597
IF (TE .GE. 2000.) RETURN	SV	598
C *** DUST PLUS GAS OPACITIES	SV	599
T=(2000.-TE)*0.002	SV	600
KAPPA=T*DUSTK+(1.-T)*KAPPA	SV	601
RETURN	SV	602

END	SV	603
SUBROUTINE CONDUCT	SV	604
REAL KAPPA,MUVISC	SV	605
COMMON /A1/ JBAR,JP1,JP2,JP3,DT,T,N,NDT,FMASS,FMDM,ET,EINT,NM,LFILMSV	SV	606
COMMON /A2/ E1(200),X(200),U(200),MUVISC(200)	SV	607
COMMON /A3/ EI(200),E(200),DTMAX,VLAM,DT	SV	608
COMMON /A4/ RHO(200)	SV	609
COMMON /A15/ RCV(200),CND(200),R2DR(200),TNOT4	SV	610
DATA PR/1.0/	SV	611
C ***	SV	612
C *** COMPUTE CONDUCTIVITY CND AND VISCOSITY MUVISC.	SV	613
C ***	SV	614
DO 10 J=2,JP1	SV	615
TEM=EI(J)*RCV(J)	SV	616
MUVISC(J)=7.15E-05*SQRT(TEM)	SV	617
TEM=0.5*(TEM+EI(J-1)*RCV(J-1))	SV	618
RDE=0.5*(RHO(J)+RHO(J-1))	SV	619
AA=RDE*TEM*KAPPA(RDE,TEM)	SV	620
TGRAD=2.*(RCV(J)*EI(J)-EI(J-1)*RCV(J-1))*R2DR(J)	SV	621
CND(J)=3.02383E-04*(TEM**4-TNOT4)/((1.-4.*TGRAD/(3.*AA))*AA)	SV	622
CND(J)=3.02383E-04*TEM*TEM*(RDE*KAPPA(RDE,TEM))	SV	623
CND(J)=0.5*(MUVISC(J)+MUVISC(J-1))/PR	SV	624
10 CONTINUE	SV	625
MUVISC(1)=MUVISC(2)	SV	626
MUVISC(JP2)=MUVISC(JP1)	SV	627
CND(JP1)=CND(JP1-1)	SV	628
CND(JP1+1)=CND(JP1)	SV	629
RETURN	SV	630
END	SV	631
SUBROUTINE DECB(IER)	SV	632
COMMON ML,MU,3(770,15),N,NDI1,IP(770)	SV	633
C	SV	634
C LU DECOMPOSITION OF BAND MATRIX A.. L*U=P*A, WHERE P IS A	SV	635
C PERMUTATION MATRIX, L IS A UNIT LOWER TRIANGULAR MATRIX,	SV	636
C AND U IS AN UPPER TRIANGULAR MATRIX.	SV	637
C N = ORDER OF MATRIX.	SV	638
C B = N BY (2*ML+MU+1) ARRAY CONTAINING THE MATRIX A ON INPUT	SV	639
C AND ITS FACTORED FORM ON OUTPUT.	SV	640
C ON INPUT, B(I,K) (1.LE.I.LE.N) CONTAINS THE K-TH	SV	641
C DIAGONAL OF A, OR A(I,J) IS STORED IN B(I,J-I+ML+1).	SV	642

C	ON OUTPUT, B CONTAINS THE L AND U FACTORS, WITH	SV	643
C	U IN COLUMNS 1 TO ML+MU+1, AND L IN COLUMNS	SV	644
C	ML+MU+2 TO 2*ML+MU+1.	SV	645
C	ML,MU= WIDTHS OF THE LOWER AND UPPER PARTS OF THE BAND, NOT	SV	646
C	COUNTING THE MAIN DIAGONAL. TOTAL BANDWIDTH IS ML+MU+1.	SV	647
C	NDIM = THE FIRST DIMENSION (COLUMN LENGTH) OF THE ARRAY B.	SV	648
C	NDIM MUST BE . GE. N.	SV	649
C	IP = ARRAY OF LENGTH N CONTAINING PIVOT INFORMATION.	SV	650
C	IER = ERROR INDICATOR..	SV	651
C	= 0 IF NO ERROR,	SV	652
C	= K IF THE K-TH PIVOT CHOSEN WAS ZERO (A IS SINGULAR).	SV	653
C	CAUTION.. IF ML=0, THIS ROUTINE CONTAINS EMPTY DO-LOOPS	SV	654
C	WHICH MUST BE COMPILED CORRECTLY (I.E.NO ACTION TAKEN).	SV	655
C	THE INPUT ARGUMENTS ARE NDIM,N,ML,MU,B.	SV	656
C	THE OUTPUT ARGUMENTS ARE B,IP,IER.	SV	657
C		SV	658
	IER=0	SV	659
	LL=ML+MU+1	SV	660
	N1=N-1	SV	661
	DO 3 I=1,ML	SV	662
	II=MU+I	SV	663
	K=ML+1-I	SV	664
	DO 1 J=1,II	SV	665
1	B(I,J)=B(I,J+K)	SV	666
	K=II+1	SV	667
	DO 2 J=K,LL	SV	668
2	B(I,J)=0.	SV	669
3	CONTINUE	SV	670
	LR=ML	SV	671
	DO 9 NR=1,N1	SV	672
	NP=NR+1	SV	673
	IF(LR.NE.N) LR=LR+1	SV	674
	MX=NR	SV	675
	XM=ABS(B(NR))	SV	676
	DO 4 I=NP,LR	SV	677
	IF(ABS(B(I)).LE.XM)GO TO 4	SV	678
	MX=I	SV	679
	XM=ABS(B(I))	SV	680
4	CONTINUE	SV	681
	IP(NR)=MX	SV	682

IF(IP(NR).EQ.NR)GO TO 1	SV	723
J=IP(NR)	SV	724
XX=Y(NR)	SV	725
Y(NR)=Y(J)	SV	726
Y(J)=XX	SV	727
KK=MI,G(N-NR,ML)	SV	728
DO 2 I=1,KK	SV	729
Y(NR+I)=Y(NR+I)+Y(NR)*B(NR,LL+I)	SV	730
CONTINUE	SV	731
LL=LL-1	SV	732
Y(N)=Y(N)*B(N)	SV	733
KK=0	SV	734
DO 5 NB=1,N1	SV	735
NR=N-N3	SV	736
IF(KK.NE.LL)KK=KK+1	SV	737
DP=0.	SV	738
DO 4 I=1,KK	SV	739
DP=DP+B(NR,I+1)+Y(NR+I)	SV	740
Y(NR)=(Y(NR)-DP)*3(NR)	SV	741
RETURN	SV	742
END	SV	743
SUBROUTINE UNDRQP	SV	744
CALL GFR80(1HU,4HVEGA,4,3H1J5,5HT3LDC,4HKEEP)	SV	745
CALL GRPHLUN(7)	SV	746
CALL LIB4020	SV	747
CALL GRPHFTN	SV	748
CALL SETFLSH	SV	749
RETURN	SV	750
END	SV	751

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*IOENT FIX
*DELETE SV.23
  DATA LFIL 4,KPR,NM/130,5,500/
*INSERT SV.371
  IF (J.LE. 5) RHO(J)=RHO(J)*FLOAT(10-MAY0(2,J))*0.25
*INSERT SV.26
  CALL UNDROP

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1	10/26/77	EXPJRT	V604	BASE	CASE				
2	JBAR	120	NDT						
3	DT	1.000E+010DX		3.000E+012	GRDVL		0.0		
4	RMIN	0.000E+000	RMAX	1.560E+017					
5	DONR	MASS	1.0	QTR	MDM	1.0			
6	GAMMA			1.667UTL		UTMAX			
7	VLAY	0.	DI	MAX	+1.000E+10	DIK	0.20		
8		.70000	.27000						
9		1-4	41-3	50-3	20-2	35-2	72-2	67-2	64-2
10		2-2	50-2	59-2	58-2	54-2	52-2	49-2	45-2
11		3-4	59-4	69-4	59				
12		4-4	73-4	71-4	69-4	14-3	52-3	04-2	80-2
13		5-2	59-2	52-2	49-2	44-2	39-2	33-2	26-2
14		6-4	41-4	41-4	41				
15		7-4	53-4	51-4	45-4	41-4	29-4	05-3	60-3
16		8-2	43-2	35-2	29-2	20-2	09-1	98-1	85-1
17		9-4	23-4	23-4	23				
18		10-4	44-4	41-4	38-4	31-4	21-4	08-3	90-3
19		11-2	01-1	63-1	73-1	71-1	43-1	28-1	12
20		12-4	05-4	05-4	05				
21		13-4	31-4	29-4	12				
22		14-1	45-1	27-1	09				
23		15-3	87-3	87-3	87				
24		16-4	13-4	14-4	25				
25		17	-93	-75	-53	-30	-08	.15	.38
26		18-3	70-3	70-3	70				
27		19-3	95-3	93-4	03-3	12-3	71-3	33-3	03-2
28		20	-60	-35	-06	.21	.47	.74	1.01
29		21-3	52-3	52-3	52				
30		22-3	41-3	40-4	50-3	52-3	37-3	12-2	52-2
31		23	-24	.05	.35	.01	.89	1.17	1.46
32		24-3	34-3	34-3	34				
33		25-2	63-2	77-2	95-2	93-2	78-2	55-2	28-1
34		26	.03	.37	.60	.95	1.25	1.54	1.83
35		27-3	15-3	16-3	16				
36		28-1	90-2	05-2	24-2	37-2	39-2	27-2	06-1
37		29	.36	.57	.98	1.27	1.60	1.91	2.22
38		30-2	98-2	95-2	98				
39		31-1	27-1	59-1	49-1	51-1	66-1	56-1	39-1
40		32	.53	.97	1.23	1.58	1.89	2.18	2.47

41	33-2.80-2.80-2.80	-0.79	-0.50	-0.73	-0.62	-0.47	-0.30	-0.10	.11	.33	.56	.81
42	34 -0.79 -0.79 -0.77	1.55	2.12	2.33	2.64	2.76	1.71	3.11	-2.62	-2.62	-2.62	-2.62
43	35 1.05 1.32 1.29	-0.15	-0.08	-0.01	.07	.19	.33	.49	.57	.85	1.05	1.29
44	36-2.62-2.62-2.62	2.25	2.69	2.73	2.95	3.01	1.82	-2.89	-2.44	-2.44	-2.44	-2.44
45	37 -0.40 -0.42 -0.23	.18	.42	.59	.74	.85	.97	1.10	1.24	1.39	1.55	1.76
46	38 1.52 1.76 2.01	2.02	2.33	3.05	3.25	3.19	1.92	-2.66	-2.25	-2.25	-2.25	-2.25
47	39-2.44-2.44-2.44	.22	.55	.39	1.19	1.39	1.54	1.65	1.77	1.90	2.05	2.21
48	40 -0.44 -0.25 -0.07	2.97	3.17	3.36	3.52	3.35	2.02	-2.44	-2.03	-2.03	-2.03	-2.03
49	41 1.97 2.16 2.40	.01	.43	.55	1.25	1.62	1.90	2.09	2.24	2.37	2.50	2.63
50	42-2.26-2.26-2.25	3.31	3.49	3.67	3.80	3.49	2.12	-2.22	-1.90	-1.90	-1.90	-1.90
51	43 -0.47 -0.23 -0.03	-0.18	.24	.63	1.14	1.59	2.00	2.31	2.56	2.74	2.83	3.01
52	44 2.33 2.53 2.73	3.00	3.73	3.97	4.07	3.62	2.23	-2.00	-1.72	-1.72	-1.72	-1.72
53	45-2.03-2.03-2.03	-0.26	.09	.49	.93	1.42	1.90	2.33	2.59	2.96	3.16	3.32
54	46 -0.47 -0.40 -0.31	3.37	4.04	4.23	4.30	3.73	2.33	-1.78	-1.54	-1.54	-1.54	-1.54
55	47 2.73 2.95 3.12	-0.30	-0.04	.29	.70	1.19	1.71	2.22	2.68	3.04	3.32	3.54
56	48-1.90-1.90-1.90	4.12	4.28	4.43	4.43	3.80	2.43	-1.56	-1.36	-1.36	-1.36	-1.36
57	49 -0.47 -0.47 -0.48	-0.35	-0.15	.15	.53	1.01	1.53	2.07	2.53	3.01	3.37	3.66
58	50 3.14 3.25 3.44	4.35	4.50	4.57	4.49	3.55	2.52	-1.34	-1.19	-1.19	-1.19	-1.19
59	51-1.72-1.72-1.72	-0.39	-0.23	.03	.36	.83	1.34	1.89	2.43	2.91	3.33	3.71
60	52 -0.47 -0.47 -0.47	4.53	4.70	4.70	4.53	3.92	2.62	-1.12	-1.01	-1.01	-1.01	-1.01
61	53 3.45 3.58 3.72	-0.40	-0.26	-0.04	.27	.59	1.18	1.73	2.28	2.79	3.26	3.69
62	54-1.54-1.54-1.54	4.73	4.92	4.94	4.72	4.02	2.72	-0.90	-0.83	-0.83	-0.83	-0.83
63	55 -0.47 -0.47 -0.47	-0.40	-0.23	-0.10	.17	.26	1.04	1.57	2.13	2.65	3.17	3.64
64	56 3.71 3.85 3.98	4.94	5.11	5.14	4.87	4.11	2.82	-0.58	-0.65	-0.65	-0.65	-0.65
65	57-1.36-1.36-1.35	-0.41	-0.29	-0.14	.09	.45	.91	1.43	1.99	2.53	3.05	3.56
66	58 -0.47 -0.47 -0.47	5.05	5.27	5.32	5.00	4.19	2.93	-0.46	-0.47	-0.47	-0.47	-0.47
67	59 3.33 3.57 4.21	-0.47	-0.47	-0.47	-0.47	-0.47	-0.47	-0.47	-0.47	-0.47	-0.47	-0.47
68	60-1.19-1.19-1.19	4.07	4.24	4.41	4.07	3.54	2.44	-0.83	-0.83	-0.83	-0.83	-0.83
69	61 -0.47 -0.47 -0.47	4.07	4.24	4.41	4.07	3.54	2.44	-0.83	-0.83	-0.83	-0.83	-0.83
70	62 4.02 4.24 4.41	4.07	4.24	4.41	4.07	3.54	2.44	-0.83	-0.83	-0.83	-0.83	-0.83
71	63-1.01-1.01-1.01	4.07	4.24	4.41	4.07	3.54	2.44	-0.83	-0.83	-0.83	-0.83	-0.83
72	64 -0.47 -0.47 -0.47	4.07	4.24	4.41	4.07	3.54	2.44	-0.83	-0.83	-0.83	-0.83	-0.83
73	65 4.02 4.24 4.41	4.07	4.24	4.41	4.07	3.54	2.44	-0.83	-0.83	-0.83	-0.83	-0.83
74	66 -0.33 -0.33 -0.33	4.07	4.24	4.41	4.07	3.54	2.44	-0.83	-0.83	-0.83	-0.83	-0.83
75	67 -0.47 -0.47 -0.47	4.07	4.24	4.41	4.07	3.54	2.44	-0.83	-0.83	-0.83	-0.83	-0.83
76	68 4.02 4.24 4.41	4.07	4.24	4.41	4.07	3.54	2.44	-0.83	-0.83	-0.83	-0.83	-0.83
77	69 -0.50 -0.50 -0.50	4.07	4.24	4.41	4.07	3.54	2.44	-0.83	-0.83	-0.83	-0.83	-0.83
78	70 -0.47 -0.47 -0.47	4.07	4.24	4.41	4.07	3.54	2.44	-0.83	-0.83	-0.83	-0.83	-0.83
79	71 4.02 4.24 4.41	4.07	4.24	4.41	4.07	3.54	2.44	-0.83	-0.83	-0.83	-0.83	-0.83
80	72 -0.47 -0.47 -0.47	4.07	4.24	4.41	4.07	3.54	2.44	-0.83	-0.83	-0.83	-0.83	-0.83

81	73	-.47	-.47	-.47	-.42	-.32	-.18	.03	.38	.82	1.33	1.88	2.42	2.95	3.46
82	74	3.95	4.40	4.79	5.11	5.35	5.41	5.08	4.27	3.03	-.24	-.29	-.29	-.29	-.29
83	75	-.29	-.29	-.29	-.44	-.35	-.23	-.02	.32	.75	1.26	1.80	2.33	2.85	3.38
84	76	-.47	-.47	4.76	5.10	5.34	5.39	5.09	4.33	3.12	-.01	-.11	-.11	-.11	-.11
85	77	3.88	4.34	4.76	5.10	5.34	5.39	5.09	4.33	3.12	-.01	-.11	-.11	-.11	-.11
86	78	-.11	-.11	-.11	-.45	-.40	-.28	-.07	.26	.68	1.18	1.72	2.24	2.76	3.28
87	79	-.47	-.47	4.63	5.05	5.30	5.32	5.07	4.38	3.22	.21	.07	.07	.07	.07
88	80	3.74	4.25	4.63	5.05	5.30	5.32	5.07	4.38	3.22	.21	.07	.07	.07	.07
89	81	.07	.07	.07	-.47	-.44	-.32	-.12	.20	.60	1.10	1.53	2.14	2.65	3.16
90	82	-.47	-.47	4.53	4.95	5.20	5.22	5.00	4.42	3.32	.43	.25	.25	.25	.25
91	83	3.57	4.15	4.53	4.95	5.20	5.22	5.00	4.42	3.32	.43	.25	.25	.25	.25
92	84	.25	.25	.25	-.49	-.47	-.35	-.16	.14	.52	1.00	1.52	2.02	2.52	3.04
93	85	-.47	-.47	4.44	4.86	5.11	5.13	4.91	4.33	3.25	.43	.25	.25	.25	.25
94	86	3.54	4.11	4.44	4.86	5.11	5.13	4.91	4.33	3.25	.43	.25	.25	.25	.25
95	87	.43	.43	.43	-.49	-.47	-.35	-.16	.14	.52	1.00	1.52	2.02	2.52	3.04
96	88	-.47	-.47	4.30	4.72	5.07	5.09	4.87	4.29	3.21	.43	.25	.25	.25	.25
97	89	3.39	3.97	4.30	4.72	5.07	5.09	4.87	4.29	3.21	.43	.25	.25	.25	.25
98	90	.61	.61	.61	-.49	-.47	-.35	-.16	.14	.52	1.00	1.52	2.02	2.52	3.04
99	91	-.47	-.47	4.14	4.56	4.91	4.93	4.71	4.13	3.05	.80	1.31	1.82	2.34	2.87
100	92	3.22	3.71	4.14	4.56	4.91	4.93	4.71	4.13	3.05	.80	1.31	1.82	2.34	2.87
101	93	.79	.79	.79	-.49	-.47	-.35	-.16	.14	.52	1.00	1.52	2.02	2.52	3.04
102	94	-.47	-.47	4.07	4.49	4.84	4.86	4.64	4.06	2.98	.87	1.38	1.89	2.40	2.91
103	95	3.04	3.52	4.07	4.49	4.84	4.86	4.64	4.06	2.98	.87	1.38	1.89	2.40	2.91
104	96	.97	.97	.97	-.49	-.47	-.35	-.16	.14	.52	1.00	1.52	2.02	2.52	3.04
105	97	-.47	-.47	3.90	4.32	4.67	4.69	4.47	3.89	2.81	.95	1.46	1.97	2.48	2.99
106	98	2.82	3.30	3.90	4.32	4.67	4.69	4.47	3.89	2.81	.95	1.46	1.97	2.48	2.99
107	99	1.15	1.15	1.15	-.49	-.47	-.35	-.16	.14	.52	1.00	1.52	2.02	2.52	3.04
108	100	-.47	-.47	3.73	4.15	4.50	4.52	4.30	3.72	2.64	.98	1.49	2.00	2.51	3.02
109	101	2.54	3.17	3.73	4.15	4.50	4.52	4.30	3.72	2.64	.98	1.49	2.00	2.51	3.02
110	102	1.32	1.32	1.32	-.49	-.47	-.35	-.16	.14	.52	1.00	1.52	2.02	2.52	3.04
111	103	-.47	-.47	3.56	3.98	4.33	4.35	4.13	3.55	2.47	.98	1.49	2.00	2.51	3.02
112	104	2.43	2.96	3.56	3.98	4.33	4.35	4.13	3.55	2.47	.98	1.49	2.00	2.51	3.02
113	105	1.20	1.20	1.20	-.49	-.47	-.35	-.16	.14	.52	1.00	1.52	2.02	2.52	3.04
114	106	-.47	-.47	3.39	3.81	4.16	4.18	3.96	3.38	2.30	.98	1.49	2.00	2.51	3.02
115	107	1.53	2.22	2.75	3.21	3.54	3.56	3.34	2.76	1.68	.98	1.49	2.00	2.51	3.02
116	108	-.70	-.70	-.70	-.49	-.47	-.35	-.16	.14	.52	1.00	1.52	2.02	2.52	3.04
117	109	-.47	-.47	3.22	3.64	3.99	4.01	3.79	3.21	2.13	.98	1.49	2.00	2.51	3.02
118	110	.83	1.35	1.91	2.39	2.77	2.79	2.57	1.99	.89	.98	1.49	2.00	2.51	3.02
119	111	-.19	-.19	-.19	-.49	-.47	-.35	-.16	.14	.52	1.00	1.52	2.02	2.52	3.04
120	112	-.47	-.47	3.05	3.47	3.82	3.84	3.62	3.04	1.96	.98	1.49	2.00	2.51	3.02

10/26/77 EXPJRT VISA BASE CASE

JBAK 120 NDT 4000
 DT .130E+11 AX .300E+13 GROVEL 0.
 RMIM 0. RMAX .156E+13
 DJNR MASS .100E+01 DJNR NUM .100E+01
 GAMMA .167E+01 DTI 0. UTMAX 0.
 VLAM 0. DTMAX .100E+11 DTK .200E+00

RATIO	RMAX	FROM	MESH	GEN	1.00000000E+00	3.60000000E+14	3.00000000E+12
RATIO	RMAX	FROM	MESH	GEN	1.00000000E+00	3.20000000E+13	5.34091967E+32
RATIO	RMAX	FROM	MESH	GEN	1.20000000E+00	3.34095987E+24	4.16574484E+23
RATIO	RMAX	FROM	MESH	GEN	1.12000000E+00	2.74689621E+19	2.28908193E+18
RATIO	RMAX	FROM	MESH	GEN	1.00250000E+00	6.39254202E+16	3.19852101E+15
RATIO	RMAX	FROM	MESH	GEN	1.00370000E+00	1.31528711E+18	8.96806708E+16
RATIO	RMAX	FROM	MESH	GEN	1.07812500E+00	2.87955631E+17	1.71423233E+16
RATIO	RMAX	FROM	MESH	GEN	1.07031250E+00	1.35305050E+17	7.42745396E+15
RATIO	RMAX	FROM	MESH	GEN	1.07213750E+00	1.97281857E+17	1.12923683E+16
RATIO	RMAX	FROM	MESH	GEN	1.07220563E+00	1.63356036E+17	9.15999748E+15
RATIO	RMAX	FROM	MESH	GEN	1.07124906E+00	1.48664504E+17	8.24875514E+15
RATIO	RMAX	FROM	MESH	GEN	1.07177734E+00	1.55335727E+17	8.69254737E+15
RATIO	RMAX	FROM	MESH	GEN	1.07202143E+00	1.57951199E+17	8.92323859E+15
RATIO	RMAX	FROM	MESH	GEN	1.07184941E+00	1.57652425E+17	8.80714425E+15
RATIO	RMAX	FROM	MESH	GEN	1.07183333E+00	1.56756333E+17	8.74965983E+15
RATIO	RMAX	FROM	MESH	GEN	1.07180766E+00	1.56295346E+17	8.72105726E+15
RATIO	RMAX	FROM	MESH	GEN	1.07174260E+00	1.56055366E+17	8.70679675E+15
RATIO	RMAX	FROM	MESH	GEN	1.07178497E+00	1.55950504E+17	8.69956617E+15
RATIO	RMAX	FROM	MESH	GEN	1.07178379E+00	1.56007424E+17	8.70322774E+15

1.00000420E+04

INTERNAL ENERGY =		-I TOTAL ENERGY =		-I MASS =		-I MOMENTUM =		-I CYCLE =		0	
J	X	U	R4D	EI	P	CND	L	MR	T		
2	0.	0.	2.00000E-19	2.61630E+08	4.39758E-11	-1.49992E+19	0.	0.	5.00001E+00		
3	3.00000E+12	0.	2.00000E-19	2.99000E+08	4.39758E-11	8.74058E+12	0.	2.85000E+19	5.71429E+00		
4	6.00000E+12	0.	1.39000E-19	3.48340E+08	4.39758E-11	6.31347E+12	0.	2.03000E+20	6.66667E+00		
5	9.21537E+12	0.	1.07500E-19	4.18000E+08	4.39758E-11	4.02691E+12	0.	6.51630E+20	8.00001E+00		
6	1.26616E+13	0.	1.26000E-19	5.23260E+08	4.39758E-11	1.39212E+12	0.	1.47448E+21	1.00000E+01		
7	1.63552E+13	0.	1.26000E-19	5.23260E+08	4.39758E-11	0.	0.	2.71215E+21	1.00000E+01		
8	2.03139E+13	0.	1.26000E-19	5.23260E+08	4.39758E-11	0.	0.	4.82740E+21	1.00000E+01		
9	2.45268E+13	0.	1.26000E-19	5.23260E+08	4.39758E-11	0.	0.	8.21902E+21	1.00000E+01		
10	2.91044E+13	0.	1.26000E-19	5.23260E+08	4.39758E-11	0.	0.	1.34149E+22	1.00000E+01		
11	3.39734E+13	0.	1.26000E-19	5.23260E+08	4.39758E-11	0.	0.	2.11078E+22	1.00000E+01		
12	3.92023E+13	0.	1.26000E-19	5.23260E+08	4.39758E-11	0.	0.	3.22007E+22	1.00000E+01		
13	4.48012E+13	0.	1.26000E-19	5.23260E+08	4.39758E-11	0.	0.	4.78632E+22	1.00000E+01		
14	5.08021E+13	0.	1.26000E-19	5.23260E+08	4.39758E-11	0.	0.	6.96027E+22	1.00000E+01		
15	5.72337E+13	0.	1.26000E-19	5.23260E+08	4.39758E-11	0.	0.	9.93530E+22	1.00000E+01		
16	6.41271E+13	0.	1.26000E-19	5.23260E+08	4.39758E-11	0.	0.	1.39589E+23	1.00000E+01		
17	7.15153E+13	0.	1.26000E-19	5.23260E+08	4.39758E-11	0.	0.	1.93447E+23	1.00000E+01		
18	7.94340E+13	0.	1.26000E-19	5.23260E+08	4.39758E-11	0.	0.	2.64935E+23	1.00000E+01		
19	8.79211E+13	0.	1.26000E-19	5.23260E+08	4.39758E-11	0.	0.	3.59109E+23	1.00000E+01		
20	9.70174E+13	0.	1.26000E-19	5.23260E+08	4.39758E-11	0.	0.	4.82361E+23	1.00000E+01		
21	1.06757E+14	0.	1.26000E-19	5.23260E+08	4.39758E-11	0.	0.	6.42748E+23	1.00000E+01		
22	1.17216E+14	0.	1.26000E-19	5.23260E+08	4.39758E-11	0.	0.	8.50408E+23	1.00000E+01		
23	1.28416E+14	0.	1.26000E-19	5.23260E+08	4.39758E-11	0.	0.	1.11807E+24	1.00000E+01		
24	1.40419E+14	0.	1.26000E-19	5.23260E+08	4.39758E-11	0.	0.	1.46169E+24	1.00000E+01		
25	1.53234E+14	0.	1.26000E-19	5.23260E+08	4.39758E-11	0.	0.	1.96127E+24	1.00000E+01		
26	1.67074E+14	0.	1.26000E-19	5.23260E+08	4.39758E-11	0.	0.	2.46177E+24	1.00000E+01		
27	1.81351E+14	0.	1.26000E-19	5.23260E+08	4.39758E-11	0.	0.	3.17442E+24	1.00000E+01		
28	1.97071E+14	0.	1.26000E-19	5.23260E+08	4.39758E-11	0.	0.	4.07815E+24	1.00000E+01		
29	2.14658E+14	0.	1.26000E-19	5.23260E+08	4.39758E-11	0.	0.	5.22146E+24	1.00000E+01		
30	2.32863E+14	0.	1.26000E-19	5.23260E+08	4.39758E-11	0.	0.	6.65480E+24	1.00000E+01		
31	2.52365E+14	0.	1.26000E-19	5.23260E+08	4.39758E-11	0.	0.	8.48330E+24	1.00000E+01		
32	2.73256E+14	0.	1.26000E-19	5.23260E+08	4.39758E-11	0.	0.	1.07734E+25	1.00000E+01		
33	2.95669E+14	0.	1.26000E-19	5.23260E+08	4.39758E-11	0.	0.	1.36422E+25	1.00000E+01		
34	3.19079E+14	0.	1.26000E-19	5.23260E+08	4.39758E-11	0.	0.	1.72429E+25	1.00000E+01		
35	3.43412E+14	0.	1.26000E-19	5.23260E+08	4.39758E-11	0.	0.	2.17511E+25	1.00000E+01		

36	3.729394E+14	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	2.75087E+25	1.00000E+01
37	4.02525E+14	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	3.44303E+25	1.00000E+01
38	4.34234E+14	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	4.32105E+25	1.00000E+01
39	4.66117E+14	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	5.41637E+25	1.00000E+01
40	5.03453E+14	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	6.78037E+25	1.00000E+01
41	5.45360E+14	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	8.47820E+25	1.00000E+01
42	5.85411E+14	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	1.05887E+26	1.00000E+01
43	6.30221E+14	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	1.32111E+26	1.00000E+01
44	6.78249E+14	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	1.64675E+26	1.00000E+01
45	7.29745E+14	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	2.05036E+26	1.00000E+01
46	7.84935E+14	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	2.55208E+26	1.00000E+01
47	8.44932E+14	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	3.17342E+26	1.00000E+01
48	9.09702E+14	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	3.94329E+26	1.00000E+01
49	9.79328E+14	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	4.89679E+26	1.00000E+01
50	1.04613E+15	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	6.07723E+26	1.00000E+01
51	1.12616E+15	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	7.53304E+26	1.00000E+01
52	1.20979E+15	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	9.34540E+26	1.00000E+01
53	1.29942E+15	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	1.15801E+27	1.00000E+01
54	1.39545E+15	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	1.43430E+27	1.00000E+01
55	1.49746E+15	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	1.77579E+27	1.00000E+01
56	1.60631E+15	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	2.19774E+27	1.00000E+01
57	1.72709E+15	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	2.71899E+27	1.00000E+01
58	1.85336E+15	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	3.36274E+27	1.00000E+01
59	1.98974E+15	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	4.15763E+27	1.00000E+01
60	2.13245E+15	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	5.13894E+27	1.00000E+01
61	2.27144E+15	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	6.35017E+27	1.00000E+01
62	2.44273E+15	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	7.84493E+27	1.00000E+01
63	2.63802E+15	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	9.68931E+27	1.00000E+01
64	2.83301E+15	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	1.15687E+28	1.00000E+01
65	3.03614E+15	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	1.477715E+28	1.00000E+01
66	3.22689E+15	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	1.82334E+28	1.00000E+01
67	3.44368E+15	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	2.25027E+28	1.00000E+01
68	3.74706E+15	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	2.77671E+28	1.00000E+01
69	4.01845E+15	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	3.42580E+28	1.00000E+01
70	4.31013E+15	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	4.22602E+28	1.00000E+01
71	4.62234E+15	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	5.21244E+28	1.00000E+01
72	4.95695E+15	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	6.42841E+28	1.00000E+01
73	5.31554E+15	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	7.92710E+28	1.00000E+01
74	5.69988E+15	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	9.77444E+28	1.00000E+01
75	6.11176E+15	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	1.20504E+29	1.00000E+01
76	6.55331E+15	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	1.48553E+29	1.00000E+01
77	7.02676E+15	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	1.83116E+29	1.00000E+01
78	7.53332E+15	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	2.25701E+29	1.00000E+01
79	8.07703E+15	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	2.78171E+29	1.00000E+01
80	8.65030E+15	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	3.42813E+29	1.00000E+01
81	9.25443E+15	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	4.22431E+29	1.00000E+01
82	9.892413E+15	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	5.20557E+29	1.00000E+01
83	1.06713E+16	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	6.41411E+29	1.00000E+01
84	1.14404E+16	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	7.90280E+29	1.00000E+01
85	1.22865E+16	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	9.73653E+29	1.00000E+01
86	1.31477E+16	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	1.19952E+30	1.00000E+01
87	1.40743E+16	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	1.47712E+30	1.00000E+01
88	1.51089E+16	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	1.82038E+30	1.00000E+01
89	1.61904E+16	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	2.24243E+30	1.00000E+01
90	1.73617E+16	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	2.76216E+30	1.00000E+01
91	1.865110E+16	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	3.40259E+30	1.00000E+01
92	1.994499E+16	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	4.19055E+30	1.00000E+01
93	2.138489E+16	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	5.16153E+30	1.00000E+01
94	2.297229E+16	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	6.35716E+30	1.00000E+01
95	2.455712E+16	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	7.82960E+30	1.00000E+01
96	2.63330E+16	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	9.64284E+30	1.00000E+01
97	2.81214E+16	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	1.16704E+31	1.00000E+01
98	3.02610E+16	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	1.46254E+31	1.00000E+01

J	X	U	RH	FI	P	CND	L	MM	T
99	3.24332E+16	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	1.00114E+31	1.00000E+01
100	3.47575E+16	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	2.21010E+31	1.00000E+01
101	3.76302E+16	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	2.73153E+31	1.00000E+01
102	3.97431E+16	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	3.36375E+31	1.00000E+01
103	4.23176E+16	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	4.14252E+31	1.00000E+01
104	4.59910E+16	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	5.10085E+31	1.00000E+01
105	4.9184E+16	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	6.28122E+31	1.00000E+01
106	5.27222E+16	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	7.73465E+31	1.00000E+01
107	5.65099E+16	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	9.2429E+31	1.00000E+01
108	6.05694E+16	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	1.17279E+32	1.00000E+01
109	6.49204E+16	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	1.44412E+32	1.00000E+01
110	6.9648E+16	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	1.7721E+32	1.00000E+01
111	7.49319E+16	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	2.18957E+32	1.00000E+01
112	7.9936E+16	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	2.6400E+32	1.00000E+01
113	8.5530E+16	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	3.13973E+32	1.00000E+01
114	9.13340E+16	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	4.08761E+32	1.00000E+01
115	9.8424E+16	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	5.0330E+32	1.00000E+01
116	1.05493E+17	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	6.19721E+32	1.00000E+01
117	1.13075E+17	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	7.63055E+32	1.00000E+01
118	1.21195E+17	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	9.39236E+32	1.00000E+01
119	1.2989E+17	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	1.15683E+33	1.00000E+01
120	1.3860E+17	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	1.40828E+33	1.00000E+01
121	1.4733E+17	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	1.68698E+33	1.00000E+01
122	1.5600E+17	0.	1.25000E-19	5.23260E+08	4.39758E-11	0.	0.	2.00401E+33	1.00000E+01
INTERNAL ENERGY = 1.043010E+42 TOTAL ENERGY = 1.046018E+42 MASS = 2.004007E+33 MOMENTUM = -1.47758E+35 CYCLE = 1									
2	3.00000E+12	0.	1.2333E-19	4.46002E+08	4.40257E-11	-1.49992E+19	0.	0.	8.52333E+00
3	3.00000E+12	7.70026E+01	1.46873E-19	4.46002E+08	4.40257E-11	8.74058E+12	-8.75720E+17	2.2500E+19	8.52333E+00
4	3.00000E+12	1.1704E+02	1.46018E-19	4.46002E+08	4.3984E-11	6.31337E+12	-5.15902E+18	1.51042E+20	8.52333E+00
5	1.65616E+13	7.60428E+01	1.47936E-19	4.46002E+08	4.39436E-11	4.02691E+12	-1.23488E+19	9.9916E+20	8.52333E+00
6	1.65625E+13	4.49413E+03	1.46000E-19	5.23261E+08	4.39700E-11	1.39212E+12	-1.60365E+19	1.26248E+21	8.52766E+00
7	2.03139E+13	-6.22790E-01	1.26001E-19	5.23261E+08	4.39704E-11	0.	0.	2.71622E+21	1.00000E+01
8	2.45504E+13	-4.28598E-01	1.26001E-19	5.23261E+08	4.39764E-11	0.	0.	4.8347E+21	1.00000E+01
9	2.91044E+13	-3.08167E-01	1.26001E-19	5.23261E+08	4.39765E-11	0.	0.	8.22311E+21	1.00001E+01
10	3.3734E+13	-2.29401E-01	1.26001E-19	5.23261E+08	4.39765E-11	0.	0.	1.34190E+22	1.00001E+01
11	3.76203E+13	-1.7647E-01	1.26001E-19	5.23261E+08	4.39765E-11	0.	0.	2.11120E+22	1.00001E+01
12	4.08012E+13	-1.04013E-01	1.25001E-19	5.23261E+08	4.39765E-11	0.	0.	3.22050E+22	1.00001E+01
13	4.38021E+13	-9.5574E-02	1.25001E-19	5.23261E+08	4.39765E-11	0.	0.	4.76677E+22	1.00001E+01
14	4.67271E+13	-8.22330E-02	1.26001E-19	5.23261E+08	4.39765E-11	0.	0.	6.90074E+22	1.00001E+01
15	4.941271E+13	-7.28607E-02	1.26001E-19	5.23261E+08	4.39765E-11	0.	0.	9.9357E+22	1.00001E+01
16	5.17153E+13	-6.50971E-02	1.26001E-19	5.23261E+08	4.39765E-11	0.	0.	1.35591E+23	1.00001E+01
17	5.37211E+13	-5.19598E-02	1.26001E-19	5.23261E+08	4.39765E-11	0.	0.	1.93531E+23	1.00001E+01
18	5.54176E+13	-4.04123E-02	1.26001E-19	5.23261E+08	4.39766E-11	0.	0.	2.64442E+23	1.00001E+01
19	5.69767E+13	-3.08167E-02	1.26001E-19	5.23261E+08	4.39766E-11	0.	0.	3.59116E+23	1.00001E+01
20	5.841271E+13	-2.29401E-02	1.26001E-19	5.23261E+08	4.39766E-11	0.	0.	4.82369E+23	1.00001E+01
21	5.9767E+13	-1.542E-02	1.26001E-19	5.23261E+08	4.39766E-11	0.	0.	6.42759E+23	1.00001E+01
22	6.10713E+13	-0.65939E-02	1.26001E-19	5.23261E+08	4.39766E-11	0.	0.	8.50421E+23	1.00001E+01
23	6.2354E+13	-0.40131E-02	1.26001E-19	5.23261E+08	4.39766E-11	0.	0.	1.11809E+24	1.00001E+01
24	6.3637E+13	-0.24043E-02	1.26001E-19	5.23261E+08	4.39766E-11	0.	0.	1.46171E+24	1.00001E+01
25	6.49204E+13	-0.1421E-02	1.26001E-19	5.23261E+08	4.39766E-11	0.	0.	1.90129E+24	1.00001E+01
26	6.6203E+13	-8.2233E-03	1.26001E-19	5.23261E+08	4.39766E-11	0.	0.	2.46180E+24	1.00001E+01
27	6.7484E+13	-4.4941E-03	1.26001E-19	5.23261E+08	4.39766E-11	0.	0.	3.1746E+24	1.00001E+01
28	6.8721E+13	-2.29401E-03	1.26001E-19	5.23261E+08	4.39766E-11	0.	0.	4.07819E+24	1.00001E+01
29	6.9957E+13	-1.04013E-03	1.26001E-19	5.23261E+08	4.39766E-11	0.	0.	5.22152E+24	1.00001E+01
30	7.1193E+13	-0.65939E-03	1.26001E-19	5.23261E+08	4.39766E-11	0.	0.	6.66471E+24	1.00001E+01
31	7.2429E+13	-0.40131E-03	1.26001E-19	5.23261E+08	4.39766E-11	0.	0.	8.48339E+24	1.00001E+01
32	7.3665E+13	-0.24043E-03	1.26001E-19	5.23261E+08	4.39766E-11	0.	0.	1.07705E+25	1.00001E+01
33	7.4901E+13	-0.1421E-03	1.26001E-19	5.23261E+08	4.39766E-11	0.	0.	1.36424E+25	1.00001E+01
34	7.6137E+13	-8.2233E-04	1.26001E-19	5.23261E+08	4.39766E-11	0.	0.	1.7231E+25	1.00001E+01
35	7.7373E+13	-4.4941E-04	1.26001E-19	5.23261E+08	4.39766E-11	0.	0.	2.1701E+25	1.00001E+01
36	7.8609E+13	-2.29401E-04	1.26001E-19	5.23261E+08	4.39766E-11	0.	0.	2.73889E+25	1.00001E+01
37	7.9845E+13	-1.04013E-04	1.26001E-19	5.23261E+08	4.39766E-11	0.	0.	3.44307E+25	1.00001E+01
38	8.1081E+13	-0.65939E-04	1.26001E-19	5.23261E+08	4.39766E-11	0.	0.	4.32169E+25	1.00001E+01

39	9.011776e+14	-1.178277e-01	1.25001e-19	5.23263e+03	4.39766e-11	0.	5.41693e+25	1.00001e+01
40	5.043941e+14	-1.178277e-01	1.25001e-19	5.23263e+08	4.39766e-11	0.	6.78097e+25	1.00001e+01
41	5.043942e+14	-1.178277e-01	1.25001e-19	5.23263e+03	4.39766e-11	0.	8.47829e+25	1.00001e+01
42	5.043941e+14	-1.178277e-01	1.25001e-19	5.23263e+08	4.39766e-11	0.	1.05889e+26	1.00001e+01
43	6.322211e+14	-2.23353e-01	1.25001e-19	5.23263e+03	4.39766e-11	0.	1.32113e+26	1.00001e+01
44	6.322210e+14	-2.23353e-01	1.25001e-19	5.23263e+08	4.39766e-11	0.	1.64677e+26	1.00001e+01
45	7.272726e+14	-2.43920e-01	1.25001e-19	5.23263e+03	4.39766e-11	0.	2.05388e+26	1.00001e+01
46	7.843926e+14	-2.76732e-01	1.25001e-19	5.23263e+08	4.39766e-11	0.	2.52111e+26	1.00001e+01
47	8.460285e+14	-2.97521e-01	1.25001e-19	5.23263e+03	4.39766e-11	0.	3.17435e+26	1.00001e+01
48	9.074325e+14	-3.19951e-01	1.25001e-19	5.23263e+08	4.39766e-11	0.	3.94334e+26	1.00001e+01
49	9.721328e+14	-3.43683e-01	1.25001e-19	5.23263e+03	4.39766e-11	0.	4.89685e+26	1.00001e+01
50	1.048313e+15	-3.69493e-01	1.25001e-19	5.23263e+08	4.39766e-11	0.	6.07722e+26	1.00001e+01
51	1.126010e+15	-3.97053e-01	1.25001e-19	5.23263e+03	4.39766e-11	0.	7.53612e+26	1.00001e+01
52	1.203779e+15	-4.26325e-01	1.25001e-19	5.23263e+08	4.39766e-11	0.	9.34501e+26	1.00001e+01
53	1.293742e+15	-4.58134e-01	1.25001e-19	5.23263e+03	4.39766e-11	0.	1.15802e+27	1.00001e+01
54	1.395495e+15	-4.92062e-01	1.25001e-19	5.23263e+08	4.39766e-11	0.	1.43432e+27	1.00001e+01
55	1.498468e+15	-5.28303e-01	1.25001e-19	5.23263e+03	4.39766e-11	0.	1.77581e+27	1.00001e+01
56	1.603311e+15	-5.67210e-01	1.25001e-19	5.23263e+08	4.39766e-11	0.	2.19777e+27	1.00001e+01
57	1.727092e+15	-6.08911e-01	1.25001e-19	5.23263e+03	4.39766e-11	0.	2.71902e+27	1.00001e+01
58	1.878187e+15	-6.53632e-01	1.25001e-19	5.23263e+08	4.39766e-11	0.	3.36277e+27	1.00001e+01
59	1.937776e+15	-6.91563e-01	1.25001e-19	5.23263e+03	4.39766e-11	0.	4.15767e+27	1.00001e+01
60	2.135366e+15	-7.32051e-01	1.25001e-19	5.23263e+08	4.39766e-11	0.	5.13894e+27	1.00001e+01
61	2.297144e+15	-7.75078e-01	1.25001e-19	5.23263e+03	4.39766e-11	0.	6.35023e+27	1.00001e+01
62	2.456736e+15	-8.20787e-01	1.25001e-19	5.23263e+08	4.39766e-11	0.	7.84501e+27	1.00001e+01
63	2.634321e+15	-8.69657e-01	1.25001e-19	5.23263e+03	4.39766e-11	0.	9.68941e+27	1.00001e+01
64	2.830136e+15	-9.20069e-01	1.25001e-19	5.23263e+08	4.39766e-11	0.	1.18649e+28	1.00001e+01
65	3.053148e+15	-9.70743e-01	1.25001e-19	5.23263e+03	4.39766e-11	0.	1.47717e+28	1.00001e+01
66	3.295836e+15	-1.07426e+00	1.25001e-19	5.23263e+08	4.39766e-11	0.	1.82336e+28	1.00001e+01
67	3.493343e+15	-1.13167e+00	1.25001e-19	5.23263e+03	4.39766e-11	0.	2.25029e+28	1.00001e+01
68	3.747028e+15	-1.23210e+00	1.25001e-19	5.23263e+08	4.39766e-11	0.	2.77674e+28	1.00001e+01
69	4.018845e+15	-1.31503e+00	1.25001e-19	5.23263e+03	4.39766e-11	0.	3.42583e+28	1.00001e+01
70	4.310131e+15	-1.38196e+00	1.25001e-19	5.23263e+08	4.39766e-11	0.	4.22606e+28	1.00001e+01
71	4.622316e+15	-1.42507e+00	1.25001e-19	5.23263e+03	4.39766e-11	0.	5.21253e+28	1.00001e+01
72	4.956935e+15	-1.45275e+00	1.25001e-19	5.23263e+08	4.39766e-11	0.	6.42348e+28	1.00001e+01
73	5.315935e+15	-1.47404e+00	1.25001e-19	5.23263e+03	4.39766e-11	0.	7.92718e+28	1.00001e+01
74	5.697746e+15	-1.48708e+00	1.25001e-19	5.23263e+08	4.39766e-11	0.	9.77424e+28	1.00001e+01
75	6.119851e+15	-2.15802e+00	1.25001e-19	5.23263e+03	4.39766e-11	0.	1.20502e+29	1.00001e+01
76	6.553512e+15	-2.31023e+00	1.25001e-19	5.23263e+08	4.39766e-11	0.	1.48554e+29	1.00001e+01
77	7.026706e+15	-2.43748e+00	1.25001e-19	5.23263e+03	4.39766e-11	0.	1.83117e+29	1.00001e+01
78	7.533947e+15	-2.54224e+00	1.25001e-19	5.23263e+08	4.39766e-11	0.	2.25704e+29	1.00001e+01
79	8.077636e+15	-2.62524e+00	1.25001e-19	5.23263e+03	4.39766e-11	0.	2.78174e+29	1.00001e+01
80	8.660306e+15	-3.05131e+00	1.25001e-19	5.23263e+08	4.39766e-11	0.	3.42017e+29	1.00001e+01
81	9.284801e+15	-3.42734e+00	1.25001e-19	5.23263e+03	4.39766e-11	0.	4.22455e+29	1.00001e+01
82	9.95413e+15	-3.75094e+00	1.25001e-19	5.23263e+08	4.39766e-11	0.	5.20563e+29	1.00001e+01
83	1.06718e+16	-3.92331e+00	1.25001e-19	5.23263e+03	4.39766e-11	0.	6.41617e+29	1.00001e+01
84	1.14404e+16	-4.03340e+00	1.25001e-19	5.23263e+08	4.39766e-11	0.	7.90288e+29	1.00001e+01
85	1.226493e+16	-4.32300e+00	1.25001e-19	5.23263e+03	4.39766e-11	0.	9.73664e+29	1.00001e+01
86	1.314747e+16	-4.63340e+00	1.25001e-19	5.23263e+08	4.39766e-11	0.	1.19953e+30	1.00001e+01
87	1.409443e+16	-4.96313e+00	1.25001e-19	5.23263e+03	4.39766e-11	0.	1.47774e+30	1.00001e+01
88	1.510391e+16	-5.32506e+00	1.25001e-19	5.23263e+08	4.39766e-11	0.	1.82039e+30	1.00001e+01
89	1.619547e+16	-5.71325e+00	1.25001e-19	5.23263e+03	4.39766e-11	0.	2.2442e+30	1.00001e+01
90	1.736192e+16	-6.12115e+00	1.25001e-19	5.23263e+08	4.39766e-11	0.	2.76219e+30	1.00001e+01
91	1.860110e+16	-6.56129e+00	1.25001e-19	5.23263e+03	4.39766e-11	0.	3.40623e+30	1.00001e+01
92	1.991797e+16	-7.03351e+00	1.25001e-19	5.23263e+08	4.39766e-11	0.	4.19069e+30	1.00001e+01
93	2.131496e+16	-7.54921e+00	1.25001e-19	5.23263e+03	4.39766e-11	0.	5.16129e+30	1.00001e+01
94	2.282236e+16	-8.08175e+00	1.25001e-19	5.23263e+08	4.39766e-11	0.	6.35725e+30	1.00001e+01
95	2.445712e+16	-8.64292e+00	1.25001e-19	5.23263e+03	4.39766e-11	0.	7.82969e+30	1.00001e+01
96	2.623301e+16	-9.24590e+00	1.25001e-19	5.23263e+08	4.39766e-11	0.	9.64291e+30	1.00001e+01
97	2.816315e+16	-9.89360e+00	1.25001e-19	5.23263e+03	4.39766e-11	0.	1.18759e+31	1.00001e+01
98	3.026105e+16	-1.05889e+01	1.25001e-19	5.23263e+08	4.39766e-11	0.	1.46256e+31	1.00001e+01
99	3.253621e+16	-1.13358e+01	1.25001e-19	5.23263e+03	4.39766e-11	0.	1.80165e+31	1.00001e+01
100	3.478752e+16	-1.21271e+01	1.25001e-19	5.23263e+08	4.39766e-11	0.	2.21012e+31	1.00001e+01
101	3.728024e+16	-1.31307e+01	1.25001e-19	5.23263e+03	4.39766e-11	0.	2.73155e+31	1.00001e+01

102	3.494943E+16	-1.433294E+04	1.26001E-19	5.23263E+08	4.39766E-11	0.	0.	3.36477E+31	1.00001E+01
103	4.25119E+16	-1.433294E+04	1.26001E-19	5.23263E+08	4.39766E-11	0.	0.	4.14229E+31	1.00001E+01
104	4.58311E+16	-1.61795E+01	1.26001E-19	5.23263E+08	4.39766E-11	0.	0.	5.10091E+31	1.00001E+01
105	4.72224E+16	-1.73323E+01	1.26001E-19	5.23263E+08	4.39766E-11	0.	0.	6.20129E+31	1.00001E+01
106	5.21722E+16	-1.55574E+04	1.26001E-19	5.23263E+08	4.39766E-11	0.	0.	7.73473E+31	1.00001E+01
107	5.65039E+16	-1.49233E+01	1.26001E-19	5.23263E+08	4.39766E-11	0.	0.	9.52439E+31	1.00001E+01
108	6.02649E+16	-2.1355E+01	1.26001E-19	5.23263E+08	4.39766E-11	0.	0.	1.17280E+32	1.00001E+01
109	6.4208E+16	-2.24833E+01	1.26001E-19	5.23263E+08	4.39766E-11	0.	0.	1.44414E+32	1.00001E+01
110	7.45319E+16	-2.4527E+01	1.26001E-19	5.23263E+08	4.39766E-11	0.	0.	2.14960E+32	1.00001E+01
111	7.87319E+16	-2.62047E+01	1.26001E-19	5.23263E+08	4.39766E-11	0.	0.	3.1976E+32	1.00001E+01
112	7.99339E+16	-2.81303E+01	1.26001E-19	5.23263E+08	4.39766E-11	0.	0.	2.14960E+32	1.00001E+01
113	9.52039E+16	-3.02371E+01	1.26001E-19	5.23263E+08	4.39766E-11	0.	0.	3.03765E+32	1.00001E+01
114	9.18340E+16	-3.23773E+01	1.26001E-19	5.23263E+08	4.39766E-11	0.	0.	5.03114E+32	1.00001E+01
115	9.16249E+16	-3.47025E+01	1.26001E-19	5.23263E+08	4.39766E-11	0.	0.	6.19727E+32	1.00001E+01
116	1.05423E+17	-3.71949E+01	1.26001E-19	5.23263E+08	4.39766E-11	0.	0.	7.63063E+32	1.00001E+01
117	1.13075E+17	-3.94663E+01	1.26001E-19	5.23263E+08	4.39766E-11	0.	0.	9.39544E+32	1.00001E+01
118	1.21149E+17	-4.27249E+01	1.26001E-19	5.23263E+08	4.39766E-11	0.	0.	1.15685E+33	1.00001E+01
119	1.26849E+17	-5.57774E+01	1.26001E-19	5.23263E+08	4.39766E-11	0.	0.	1.40529E+33	1.00001E+01
120	1.36631E+17	-6.84558E+01	1.26001E-19	5.23263E+08	4.39766E-11	0.	0.	1.68694E+33	1.00001E+01
121	1.47439E+17	-5.18874E+01	1.26001E-19	5.23263E+08	4.39766E-11	0.	0.	2.00000E+01	1.00000E+01
122	1.50000E+17	0.	1.26001E-19	5.23263E+08	4.39766E-11	0.	0.	2.00000E+01	1.00000E+01
01	3.41591E+09	1.	3.5039979E+10	5	1.2601E-19	-4.96740E-01	1.00000E+01		
02	1.0000000E+10	1.	3.5039979E+10	10	1.26037E-19	-1.43313E-01	1.00000E+01		
03	1.0000000E+10	1.	1.3036797E+11	15	1.26105E-19	-2.44042E-01	1.00000E+01		
04	1.0000000E+10	1.	1.0036797E+11	20	1.26205E-19	-3.4504E-01	1.00000E+01		
05	1.0000000E+10	1.	2.3036797E+11	25	1.26339E-19	-4.46531E-01	1.00000E+01		
06	1.0000000E+10	1.	3.0036797E+11	30	1.26504E-19	-5.47830E-01	1.00000E+01		
07	1.0000000E+10	1.	3.0036797E+11	35	1.26710E-19	-6.49581E-01	1.00000E+01		
08	1.0000000E+10	1.	3.0036797E+11	40	1.26946E-19	-7.51577E-01	1.00000E+01		
09	1.0000000E+10	1.	3.0036797E+11	45	1.27217E-19	-8.54008E-01	1.00000E+01		
10	1.0000000E+10	1.	3.0036797E+11	50	1.27522E-19	-9.56817E-01	1.00000E+01		
11	1.0000000E+10	1.	3.0036797E+11	55	1.27863E-19	-1.06002E+00	1.00000E+01		
12	1.0000000E+10	1.	3.0036797E+11	60	1.28240E-19	-1.16178E+00	1.00000E+01		
13	1.0000000E+10	1.	3.0036797E+11	65	1.28653E-19	-1.26804E+00	1.00000E+01		
14	1.0000000E+10	1.	3.0036797E+11	70	1.29103E-19	-1.37300E+00	1.00000E+01		
15	1.0000000E+10	1.	3.0036797E+11	75	1.29589E-19	-1.47855E+00	1.00000E+01		
16	1.0000000E+10	1.	3.0036797E+11	80	1.30114E-19	-1.58486E+00	1.00000E+01		
17	1.0000000E+10	1.	3.0036797E+11	85	1.31241E-19	-1.69192E+00	1.00000E+01		
18	1.0000000E+10	1.	3.0036797E+11	90	1.31424E-19	-1.79935E+00	1.00000E+01		
19	1.0000000E+10	1.	3.0036797E+11	95	1.31424E-19	-1.90357E+00	1.00000E+01		
20	1.0000000E+10	1.	3.0036797E+11	100	1.32699E-19	-2.01627E+00	1.00000E+01		
21	1.0000000E+10	1.	1.0635680E+12	105	1.33335E-19	-2.12898E+00	1.00000E+01		
22	1.0000000E+10	1.	1.0635680E+12	110	1.34105E-19	-2.24076E+00	1.00000E+01		
23	1.0000000E+10	1.	1.1308569E+12	115	1.34919E-19	-2.35368E+00	1.00000E+01		
24	1.0000000E+10	1.	1.1308569E+12	120	1.35778E-19	-2.46777E+00	1.00000E+01		
25	1.0000000E+10	1.	1.2335680E+12	125	1.36684E-19	-2.58317E+00	1.00000E+01		
26	1.0000000E+10	1.	1.3005680E+12	130	1.37534E-19	-2.69936E+00	1.00000E+01		
27	1.0000000E+10	1.	1.3005680E+12	135	1.38041E-19	-2.81779E+00	1.00000E+01		
28	1.0000000E+10	1.	1.3308569E+12	140	1.39694E-19	-2.93769E+00	1.00000E+01		
29	1.0000000E+10	1.	1.4308569E+12	145	1.40802E-19	-3.05876E+00	1.00000E+01		
30	1.0000000E+10	1.	1.6035680E+12	150	1.41953E-19	-3.18159E+00	1.00000E+01		
31	1.0000000E+10	1.	1.7035680E+12	155	1.44454E-19	-3.30612E+00	1.00000E+01		
32	1.0000000E+10	1.	1.0308569E+12	160	1.45789E-19	-3.43248E+00	1.00000E+01		
33	1.0000000E+10	1.	1.0308569E+12	165	1.47137E-19	-3.56074E+00	1.00000E+01		
34	1.0000000E+10	1.	1.1008569E+12	170	1.48640E-19	-3.69103E+00	1.00000E+01		
35	1.0000000E+10	1.	1.7035680E+12	175	1.50177E-19	-3.82339E+00	1.00000E+01		
36	1.0000000E+10	1.	1.4035680E+12	180	1.51776E-19	-3.95798E+00	1.00000E+01		
37	1.0000000E+10	1.	1.0308569E+12	185	1.53466E-19	-4.09489E+00	1.00000E+01		
38	1.0000000E+10	1.	1.0308569E+12	190	1.55145E-19	-4.23415E+00	1.00000E+01		
39	1.0000000E+10	1.	1.1035680E+12	195	1.56921E-19	-4.37602E+00	1.00000E+01		
40	1.0000000E+10	1.	1.1035680E+12	200	1.57021E-19	-4.52054E+00	1.00000E+01		
41	1.0000000E+10	1.	2.0335680E+12	205	1.57305E-19	-4.66736E+00	1.00000E+01		
42	1.0000000E+10	1.	2.0335680E+12	210	1.59025E-19	-4.81811E+00	1.00000E+01		

5	7.001330e+13	-0.21725e+00	1.00000e+01	3.25037e+14	2.57997e+15	7.25231e+21	1.00005e+01
6	1.250125e+13	-0.13570e+00	1.00000e+01	3.56030e+14	6.75104e+14	1.12288e+22	1.00005e+01
7	7.003325e+13	-0.21317e+01	1.00006e+01	3.16036e+14	1.49431e+14	2.50413e+22	1.00006e+01
8	2.003330e+13	-0.13570e+00	1.00006e+01	3.17335e+14	2.17034e+14	4.05249e+22	1.00006e+01
9	2.003330e+13	-0.13570e+00	1.00006e+01	3.20334e+14	5.07101e+14	8.50234e+22	1.00006e+01
10	2.003330e+13	-0.13570e+00	1.00006e+01	3.20334e+14	8.44243e+14	1.43239e+23	1.00006e+01
11	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	1.49431e+14	2.24940e+23	1.00006e+01
12	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	2.06107e+20	3.50701e+23	1.00006e+01
13	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	4.65579e+20	7.36064e+23	1.00006e+01
14	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	6.01398e+13	1.09198e+24	1.00006e+01
15	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	1.25249e+21	1.25249e+24	1.00006e+01
16	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	1.71630e+21	2.91928e+24	1.00006e+01
17	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	3.12695e+21	3.92594e+24	1.00006e+01
18	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	4.61734e+21	5.33870e+24	1.00006e+01
19	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	5.21485e+21	7.06867e+24	1.00006e+01
20	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	7.25137e+21	9.34031e+24	1.00006e+01
21	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	9.30731e+21	1.24334e+25	1.00006e+01
22	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	1.23320e+22	1.61626e+25	1.00006e+01
23	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	1.23320e+22	2.09770e+25	1.00006e+01
24	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	2.05923e+22	2.71625e+25	1.00006e+01
25	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	2.05923e+22	3.25080e+25	1.00006e+01
26	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	2.05923e+22	3.44997e+25	1.00006e+01
27	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	3.16733e+22	5.70164e+25	1.00006e+01
28	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	4.32359e+22	7.33433e+25	1.00006e+01
29	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	4.32359e+22	9.35111e+25	1.00006e+01
30	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	5.03221e+22	1.13649e+26	1.00006e+01
31	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	6.04695e+22	1.36495e+26	1.00006e+01
32	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	8.04731e+22	1.50239e+26	1.00006e+01
33	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	1.11822e+23	1.90271e+26	1.00006e+01
34	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	1.11822e+23	2.40017e+26	1.00006e+01
35	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	1.77657e+23	3.00217e+26	1.00006e+01
36	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	2.30257e+23	3.79218e+26	1.00006e+01
37	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	2.30257e+23	4.70088e+26	1.00006e+01
38	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	2.30257e+23	5.97707e+26	1.00006e+01
39	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	4.37601e+23	7.43545e+26	1.00006e+01
40	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	6.06611e+23	9.35011e+26	1.00006e+01
41	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	8.06611e+23	1.15330e+27	1.00006e+01
42	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	8.06611e+23	1.45754e+27	1.00006e+01
43	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	1.36761e+24	1.81681e+27	1.00006e+01
44	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	1.32944e+24	2.26251e+27	1.00006e+01
45	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	1.55422e+24	2.81371e+27	1.00006e+01
46	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	2.02651e+24	3.20625e+27	1.00006e+01
47	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	2.55495e+24	4.34454e+27	1.00006e+01
48	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	3.17207e+24	5.40094e+27	1.00006e+01
49	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	4.01037e+24	6.31257e+27	1.00006e+01
50	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	5.04856e+24	7.60232e+27	1.00006e+01
51	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	6.32594e+24	8.31257e+27	1.00006e+01
52	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	7.92242e+24	1.00006e+01	1.00006e+01
53	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	9.92242e+24	1.26888e+28	1.00006e+01
54	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	1.26888e+24	1.57105e+28	1.00006e+01
55	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	1.61981e+25	2.04170e+28	1.00006e+01
56	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	1.75941e+25	2.39237e+28	1.00006e+01
57	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	2.15940e+25	2.79354e+28	1.00006e+01
58	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	3.00787e+25	3.70354e+28	1.00006e+01
59	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	3.90471e+25	5.05011e+28	1.00006e+01
60	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	5.04971e+25	6.69346e+28	1.00006e+01
61	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	6.69346e+25	8.93491e+28	1.00006e+01
62	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	8.93491e+25	1.18230e+29	1.00006e+01
63	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	1.18230e+25	1.58491e+29	1.00006e+01
64	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	1.58491e+25	2.10491e+29	1.00006e+01
65	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	2.10491e+25	2.80491e+29	1.00006e+01
66	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	2.80491e+25	3.70491e+29	1.00006e+01
67	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	3.70491e+25	4.90491e+29	1.00006e+01
68	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	4.90491e+25	6.50491e+29	1.00006e+01
69	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	6.50491e+25	8.60491e+29	1.00006e+01
70	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	8.60491e+25	1.14049e+30	1.00006e+01
71	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	1.14049e+25	1.51049e+30	1.00006e+01
72	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	1.51049e+25	1.98049e+30	1.00006e+01
73	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	1.98049e+25	2.64049e+30	1.00006e+01
74	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	2.64049e+25	3.54049e+30	1.00006e+01
75	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	3.54049e+25	4.74049e+30	1.00006e+01
76	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	4.74049e+25	6.34049e+30	1.00006e+01
77	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	6.34049e+25	8.54049e+30	1.00006e+01
78	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	8.54049e+25	1.14404e+31	1.00006e+01
79	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	1.14404e+25	1.54404e+31	1.00006e+01
80	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	1.54404e+25	2.04404e+31	1.00006e+01
81	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	2.04404e+25	2.74404e+31	1.00006e+01
82	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	2.74404e+25	3.64404e+31	1.00006e+01
83	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	3.64404e+25	4.84404e+31	1.00006e+01
84	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	4.84404e+25	6.44404e+31	1.00006e+01
85	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	6.44404e+25	8.64404e+31	1.00006e+01
86	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	8.64404e+25	1.15440e+32	1.00006e+01
87	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	1.15440e+25	1.55440e+32	1.00006e+01
88	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	1.55440e+25	2.05440e+32	1.00006e+01
89	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	2.05440e+25	2.75440e+32	1.00006e+01
90	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	2.75440e+25	3.65440e+32	1.00006e+01
91	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	3.65440e+25	4.85440e+32	1.00006e+01
92	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	4.85440e+25	6.45440e+32	1.00006e+01
93	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	6.45440e+25	8.65440e+32	1.00006e+01
94	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	8.65440e+25	1.15544e+33	1.00006e+01
95	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	1.15544e+25	1.55544e+33	1.00006e+01
96	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	1.55544e+25	2.05544e+33	1.00006e+01
97	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	2.05544e+25	2.75544e+33	1.00006e+01
98	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	2.75544e+25	3.65544e+33	1.00006e+01
99	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	3.65544e+25	4.85544e+33	1.00006e+01
100	3.347343e+13	-0.21317e+01	1.00006e+01	3.56033e+14	4.85544e+25	6.45544e+33	1.00006e+01

69	3.77736E+17	-2.31527E+03	1.37047E-13	5.23291E+03	4.78431E-10	3.56936E+14	1.70076E+26	3.03955E+29	1.00000E+01
69	4.01834E+15	-2.23141E+03	1.35755E-13	5.23241E+03	4.77418E-10	3.57084E+14	2.15550E+26	3.74550E+29	1.00006E+01
70	4.31131E+15	-2.33721E+03	1.36417E-13	5.23291E+03	4.78261E-10	3.57291E+14	2.66055E+26	4.61401E+29	1.00006E+01
71	4.62234E+15	-2.35277E+03	1.35033E-13	5.23291E+03	4.78930E-10	3.57532E+14	3.26722E+26	5.68262E+29	1.00006E+01
72	4.93037E+15	-2.72602E+03	1.35741E-13	5.23291E+03	4.78343E-10	3.57812E+14	4.00927E+26	6.74480E+29	1.00006E+01
73	5.31559E+15	-2.91515E+03	1.35101E-13	5.23291E+03	4.77110E-10	3.58135E+14	4.91587E+26	8.60764E+29	1.00006E+01
74	5.69933E+15	-3.11275E+03	1.34535E-13	5.23291E+03	4.69767E-10	3.58510E+14	6.02215E+26	1.05881E+30	1.00006E+01
75	6.11190E+15	-3.32177E+03	1.33933E-13	5.23291E+03	4.67550E-10	3.58942E+14	7.37014E+26	1.30185E+30	1.00006E+01
76	6.55341E+15	-3.54257E+03	1.33105E-13	5.23291E+03	4.65035E-10	3.59441E+14	9.01011E+26	1.57992E+30	1.00006E+01
77	7.02676E+15	-3.77514E+03	1.32340E-13	5.23291E+03	4.62186E-10	3.60015E+14	1.10013E+27	1.96520E+30	1.00006E+01
78	7.53344E+15	-4.01444E+03	1.31405E-13	5.23290E+03	4.58466E-10	3.60674E+14	1.34163E+27	2.41248E+30	1.00006E+01
79	8.07703E+15	-4.27582E+03	1.30377E-13	5.23290E+03	4.55333E-10	3.61432E+14	1.53368E+27	2.95470E+30	1.00006E+01
80	8.66530E+15	-4.56577E+03	1.29175E-13	5.23290E+03	4.51243E-10	3.62301E+14	1.78614E+27	3.62848E+30	1.00006E+01
81	9.28480E+15	-4.82660E+03	1.27847E-13	5.23290E+03	4.46650E-10	3.63295E+14	2.41042E+27	4.44492E+30	1.00006E+01
82	9.95413E+15	-5.11900E+03	1.26351E-13	5.23290E+03	4.41505E-10	3.64432E+14	2.91974E+27	5.44037E+30	1.00006E+01
83	1.05715E+16	-5.42255E+03	1.24701E-13	5.23289E+03	4.35759E-10	3.65730E+14	3.52928E+27	6.55236E+30	1.00006E+01
84	1.14404E+16	-5.73645E+03	1.22855E-13	5.23289E+03	4.29364E-10	3.67210E+14	4.25634E+27	8.12571E+30	1.00006E+01
85	1.22654E+16	-6.05002E+03	1.20909E-13	5.23289E+03	4.22270E-10	3.68894E+14	5.12047E+27	9.91368E+30	1.00006E+01
86	1.31477E+16	-6.39211E+03	1.18550E-13	5.23289E+03	4.14432E-10	3.70807E+14	6.14353E+27	1.20793E+31	1.00006E+01
87	1.40943E+16	-6.73117E+03	1.16066E-13	5.23288E+03	4.05911E-10	3.72797E+14	7.34954E+27	1.46968E+31	1.00005E+01
88	1.51089E+16	-7.07735E+03	1.13346E-13	5.23288E+03	3.96372E-10	3.75429E+14	8.76488E+27	1.78532E+31	1.00005E+01
89	1.61954E+16	-7.43717E+03	1.10397E-13	5.23287E+03	3.86090E-10	3.78196E+14	1.04177E+28	2.16497E+31	1.00005E+01
90	1.73619E+16	-7.77941E+03	1.07158E-13	5.23287E+03	3.74954E-10	3.81310E+14	1.23377E+28	2.62034E+31	1.00005E+01
91	1.86113E+16	-8.13142E+03	1.03743E-13	5.23286E+03	3.62964E-10	3.84801E+14	1.45555E+28	3.16440E+31	1.00005E+01
92	1.99497E+16	-8.49231E+03	1.00061E-13	5.23285E+03	3.50138E-10	3.88704E+14	1.71018E+28	3.81399E+31	1.00005E+01
93	2.13844E+16	-8.82794E+03	9.61513E-14	5.23285E+03	3.36513E-10	3.93051E+14	2.00063E+28	4.58500E+31	1.00005E+01
94	2.29222E+16	-9.15591E+03	9.20312E-14	5.23284E+03	3.22142E-10	3.97871E+14	2.32969E+28	5.49741E+31	1.00005E+01
95	2.455712E+16	-9.49304E+03	8.77270E-14	5.23283E+03	3.07102E-10	4.03195E+14	2.69975E+28	6.57288E+31	1.00005E+01
96	2.63334E+16	-9.83591E+03	8.32507E-14	5.23282E+03	2.91466E-10	4.09047E+14	3.11270E+28	7.83527E+31	1.00004E+01
97	2.82315E+16	-1.01500E+04	7.85434E-14	5.23281E+03	2.75406E-10	4.15430E+14	3.56972E+28	9.31060E+31	1.00004E+01
98	3.02610E+16	-1.03737E+04	7.33541E-14	5.23280E+03	2.58988E-10	4.22219E+14	4.07112E+28	1.10270E+32	1.00004E+01
99	3.24362E+16	-1.06209E+04	6.92042E-14	5.23279E+03	2.42370E-10	4.29665E+14	4.61615E+28	1.30143E+32	1.00004E+01
100	3.47675E+16	-1.08375E+04	6.44409E-14	5.23278E+03	2.25998E-10	4.38088E+14	5.20288E+28	1.53044E+32	1.00004E+01
101	3.72562E+16	-1.10192E+04	5.97063E-14	5.23277E+03	2.09119E-10	4.46790E+14	5.82803E+28	1.77302E+32	1.00003E+01
102	3.99443E+16	-1.11614E+04	5.57416E-14	5.23275E+03	1.92779E-10	4.56020E+14	6.48693E+28	2.09261E+32	1.00003E+01
103	4.28146E+16	-1.12796E+04	5.04862E-14	5.23275E+03	1.76818E-10	4.65773E+14	7.17349E+28	2.43269E+32	1.00003E+01
104	4.58940E+16	-1.13591E+04	4.53764E-14	5.23274E+03	1.61362E-10	4.75987E+14	7.88020E+28	2.81679E+32	1.00003E+01
105	4.91833E+16	-1.13959E+04	4.16442E-14	5.23273E+03	1.46527E-10	4.86533E+14	8.59835E+28	3.24843E+32	1.00003E+01
106	5.27222E+16	-1.13951E+04	3.73170E-14	5.23272E+03	1.32409E-10	4.97455E+14	9.31814E+28	3.73111E+32	1.00002E+01
107	5.65537E+16	-1.11233E+04	3.40167E-14	5.23271E+03	1.19087E-10	5.08456E+14	1.00290E+29	4.26824E+32	1.00002E+01
108	6.05694E+16	-1.09387E+04	3.04603E-14	5.23270E+03	1.06618E-10	5.19395E+14	1.07198E+29	4.86316E+32	1.00002E+01
109	6.48294E+16	-1.06974E+04	2.71530E-14	5.23269E+03	9.50413E-11	5.29772E+14	1.13794E+29	5.51910E+32	1.00002E+01
110	6.93833E+16	-1.03642E+04	2.41151E-14	5.23268E+03	8.43752E-11	5.39356E+14	1.19968E+29	6.23920E+32	1.00002E+01
111	7.42531E+16	-9.93161E+03	2.13303E-14	5.23268E+03	7.46178E-11	5.48560E+14	1.25614E+29	7.02650E+32	1.00002E+01
112	7.93938E+16	-9.52375E+03	1.87392E-14	5.23267E+03	6.57474E-11	5.57437E+14	1.30627E+29	7.88398E+32	1.00001E+01
113	8.48630E+16	-9.09242E+03	1.65040E-14	5.23266E+03	5.77237E-11	5.59825E+14	1.34897E+29	8.81446E+32	1.00001E+01
114	9.08303E+16	-8.63835E+03	1.44429E-14	5.23255E+03	5.04837E-11	5.60605E+14	1.38301E+29	9.82055E+32	1.00001E+01
115	9.74246E+16	-8.04401E+03	1.25833E-14	5.23254E+03	4.39790E-11	5.56798E+14	1.40886E+29	1.09043E+33	1.00001E+01
116	1.03490E+17	-7.88192E+03	1.09411E-14	5.23264E+03	3.81269E-11	5.46560E+14	1.41876E+29	1.20669E+33	1.00001E+01
117	1.13079E+17	-7.96674E+03	9.41377E-15	5.23263E+03	3.28858E-11	5.27299E+14	1.41694E+29	1.33081E+33	1.00001E+01
118	1.21119E+17	-7.91453E+03	8.05050E-15	5.23262E+03	2.82362E-11	4.94115E+14	1.40029E+29	1.46267E+33	1.00001E+01
119	1.27894E+17	-7.73270E+03	6.94449E-15	5.23262E+03	2.42632E-11	4.39006E+14	1.36757E+29	1.60210E+33	1.00000E+01
120	1.33601E+17	-7.52653E+03	5.97923E-15	5.23261E+03	2.09391E-11	3.46242E+14	1.32346E+29	1.73911E+33	1.00000E+01
121	1.47309E+17	-7.12767E+03	5.19016E-15	5.23260E+03	1.81424E-11	3.46242E+14	1.26855E+29	1.87321E+33	1.00000E+01
122	1.56039E+17	0	5.19116E-15	5.23260E+03	1.81424E-11	3.46242E+14	1.20534E+29	2.00401E+33	1.00000E+01
01	1.00000000E+10	f	5.03095690E+12	505	1.48831E-18	-3.23444E+01	1.00000E+01		
01	1.30000000E+10	f	5.03095690E+12	516	1.6147E-18	-3.19941E+01	1.00007E+01		
01	1.50000000E+10	f	5.13035690E+12	515	1.75990E-18	-3.12620E+01	1.00007E+01		
01	1.00000000E+10	f	5.14065690E+12	520	1.90680E-18	-3.01547E+01	1.00007E+01		
01	1.00000000E+10	f	5.23085630E+12	525	2.05937E-18	-2.87269E+01	1.00007E+01		
01	1.00000000E+10	f	5.23095690E+12	530	2.21491E-18	-2.70540E+01	1.00008E+01		
01	1.00000000E+10	f	5.33095690E+12	535	2.37111E-18	-2.52254E+01	1.00008E+01		
01	1.00000000E+10	f	5.33095690E+12	546	2.52586E-18	-2.33319E+01	1.00008E+01		

61	2.291944E+15	-4.47049E+04	3.32038E-16	7.54106E+03	1.09233E-07	2.68998E+15	4.67901E+32	8.95125E+31	1.43029E+01
62	2.45873E+15	-4.46849E+04	2.83330E-16	7.42922E+03	1.42904E-07	2.63576E+15	4.67984E+32	9.34515E+31	1.41980E+01
63	2.51302E+15	-4.47001E+04	2.50215E-16	7.23152E+03	1.20712E-07	2.69551E+15	4.67887E+32	9.76720E+31	1.38202E+01
64	2.630318E+15	-4.47177E+04	2.18701E-16	7.04752E+03	1.02037E-07	2.63071E+15	4.67846E+32	1.02191E+32	1.34685E+01
65	3.03614E+15	-4.46259E+04	1.83091E-16	6.87074E+03	8.2887E-08	2.63661E+15	4.67823E+32	1.07025E+32	1.31421E+01
66	3.45936E+15	-3.39301E+04	1.52466E-16	6.71689E+03	7.30318E-08	2.65668E+15	4.67807E+32	1.12193E+32	1.28401E+01
67	3.74705E+15	-3.30617E+04	1.42077E-16	6.57288E+03	6.18575E-08	2.68232E+15	4.67786E+32	1.17716E+32	1.25614E+01
68	4.01084E+15	-3.73935E+04	1.22074E-16	6.43575E+03	5.24333E-08	2.71699E+15	4.67765E+32	1.23608E+32	1.23051E+01
69	4.31013E+15	-3.59913E+04	1.03267E-16	6.31563E+03	4.4493E-08	2.76112E+15	4.67744E+32	1.29897E+32	1.20702E+01
70	4.55223E+15	-3.50077E+04	9.12578E-17	6.20347E+03	3.77675E-08	2.81518E+15	4.67724E+32	1.36603E+32	1.18554E+01
71	4.75653E+15	-3.29132E+04	8.06973E-17	6.11111E+03	3.27023E-08	2.87964E+15	4.67704E+32	1.43748E+32	1.16598E+01
72	5.03259E+15	-3.2917E+04	7.3773E-17	5.99239E+03	2.7216E-08	2.94988E+15	4.67684E+32	1.51338E+32	1.14822E+01
73	5.30938E+15	-3.25563E+04	6.7129E-17	5.86749E+03	2.3270E-08	3.04169E+15	4.67667E+32	1.59406E+32	1.13213E+01
74	5.61113E+15	-3.2835E+04	6.133E-17	5.7757E+03	1.9783E-08	3.14028E+15	4.67650E+32	1.68074E+32	1.11176E+01
75	6.05231E+15	-3.2125E+04	5.76987E-17	5.71913E+03	1.6502E-08	3.25123E+15	4.67634E+32	1.77235E+32	1.09379E+01
76	7.02676E+15	-3.14784E+04	5.2427E-17	5.66309E+03	1.2702E-08	3.37509E+15	4.67619E+32	1.86971E+32	1.07287E+01
77	7.53399E+15	-3.10740E+04	4.7764E-17	5.61305E+03	1.04763E-08	3.51238E+15	4.67605E+32	1.97312E+32	1.05227E+01
78	8.07703E+15	-3.05511E+04	4.3054E-17	5.57002E+03	8.9457E-09	3.63664E+15	4.67593E+32	2.08291E+32	1.03278E+01
79	8.66030E+15	-2.9837E+04	3.92730E-17	5.53623E+03	7.6478E-09	3.82946E+15	4.67582E+32	2.20941E+32	1.01728E+01
80	9.28449E+15	-2.8937E+04	3.5936E-17	5.49541E+03	6.5906E-09	4.01040E+15	4.67571E+32	2.34228E+32	1.00449E+01
81	9.92849E+15	-2.8127E+04	3.3238E-17	5.45961E+03	5.5907E-09	4.20709E+15	4.67561E+32	2.48300E+32	1.05702E+01
82	1.05671E+16	-2.7410E+04	3.1193E-17	5.4300E+03	4.78201E-09	4.42015E+15	4.67551E+32	2.62928E+32	1.04038E+01
83	1.12404E+16	-2.6758E+04	2.923E-17	5.4130E+03	4.09117E-09	4.64832E+15	4.67541E+32	2.73994E+32	1.03427E+01
84	1.19404E+16	-2.6107E+04	2.7424E-17	5.40251E+03	3.50304E-09	4.89832E+15	4.67531E+32	2.89570E+32	1.03465E+01
85	1.26805E+16	-2.5507E+04	2.59770E-17	5.39300E+03	3.0304E-09	5.14421E+15	4.67521E+32	3.06058E+32	1.03056E+01
86	1.34177E+16	-2.5462E+04	2.47701E-17	5.38360E+03	2.69561E-09	5.44950E+15	4.67510E+32	3.23505E+32	1.02695E+01
87	1.41509E+16	-2.5415E+04	2.37400E-17	5.37421E+03	2.46337E-09	5.75462E+15	4.67500E+32	3.41935E+32	1.02376E+01
88	1.48949E+16	-2.5373E+04	2.2817E-17	5.36491E+03	2.2597E-09	6.03025E+15	4.67490E+32	3.61489E+32	1.02095E+01
89	1.56344E+16	-2.5337E+04	2.2011E-17	5.35571E+03	1.87723E-09	6.42704E+15	4.67480E+32	3.82005E+32	1.01845E+01
90	1.63813E+16	-2.5311E+04	2.1317E-17	5.3467E+03	1.6050E-09	6.75551E+15	4.67470E+32	4.03875E+32	1.01626E+01
91	1.713610E+16	-2.5291E+04	2.0730E-17	5.3375E+03	1.37302E-09	7.18619E+15	4.67460E+32	4.26880E+32	1.01433E+01
92	1.79139E+16	-2.5274E+04	2.0238E-17	5.3286E+03	1.17471E-09	7.59919E+15	4.67450E+32	4.51160E+32	1.01263E+01
93	1.87139E+16	-2.5258E+04	1.98447E-17	5.32075E+03	1.00397E-09	8.03454E+15	4.67440E+32	4.7671E+32	1.01111E+01
94	1.95428E+16	-2.5243E+04	1.94947E-17	5.31300E+03	8.5734E-10	8.43206E+15	4.67430E+32	5.03786E+32	1.00976E+01
95	2.04112E+16	-2.5229E+04	1.92480E-17	5.30540E+03	7.3151E-10	8.97159E+15	4.67420E+32	5.32199E+32	1.00861E+01
96	2.13303E+16	-2.5216E+04	1.9018E-17	5.29776E+03	6.23197E-10	9.47434E+15	4.67410E+32	5.62104E+32	1.00758E+01
97	2.22823E+16	-2.5204E+04	1.8794E-17	5.29045E+03	5.29800E-10	9.99325E+15	4.67400E+32	5.93207E+32	1.00666E+01
98	2.32602E+16	-2.5193E+04	1.8574E-17	5.28322E+03	4.49112E-10	1.05539E+16	4.67390E+32	6.26447E+32	1.00589E+01
99	2.42730E+16	-2.5183E+04	1.8361E-17	5.27604E+03	3.79287E-10	1.11635E+16	4.67380E+32	6.60746E+32	1.00514E+01
100	2.53175E+16	-2.5174E+04	1.8151E-17	5.26947E+03	3.18698E-10	1.17921E+16	4.67370E+32	6.95748E+32	1.00439E+01
101	2.63962E+16	-2.5166E+04	1.7943E-17	5.26348E+03	2.66370E-10	1.24212E+16	4.67360E+32	7.3638E+32	1.00393E+01
102	2.75162E+16	-2.5158E+04	1.7735E-17	5.25748E+03	2.22512E-10	1.30292E+16	4.67350E+32	7.71853E+32	1.00347E+01
103	2.86716E+16	-2.5151E+04	1.7527E-17	5.25192E+03	1.8523E-10	1.42575E+16	4.67340E+32	8.11108E+32	1.00304E+01
104	2.985910E+16	-2.5145E+04	1.7327E-17	5.24660E+03	1.54603E-10	1.52943E+16	4.67330E+32	8.51375E+32	1.00268E+01
105	3.10735E+16	-2.5139E+04	1.7134E-17	5.24149E+03	1.29072E-10	1.65161E+16	4.67320E+32	8.93517E+32	1.00236E+01
106	3.23222E+16	-2.5134E+04	1.6946E-17	5.23646E+03	1.09435E-10	1.79300E+16	4.67310E+32	9.3933E+32	1.00208E+01
107	3.36039E+16	-2.5129E+04	1.6760E-17	5.23146E+03	9.30786E-11	1.87820E+16	4.67300E+32	9.8933E+32	1.00183E+01
108	3.49204E+16	-2.5125E+04	1.6582E-17	5.22649E+03	7.9562E-11	1.99733E+16	4.67290E+32	1.02634E+33	1.00162E+01
109	3.62734E+16	-2.5121E+04	1.6413E-17	5.22149E+03	6.8723E-11	2.11589E+16	4.67280E+32	1.07355E+33	1.00145E+01
110	3.76638E+16	-2.5117E+04	1.6253E-17	5.21649E+03	5.0567E-11	2.23136E+16	4.67270E+32	1.12734E+33	1.00127E+01
111	3.90948E+16	-2.5113E+04	1.6091E-17	5.21149E+03	3.75170E-11	2.34945E+16	4.67260E+32	1.18221E+33	1.00115E+01
112	4.05693E+16	-2.5109E+04	1.5936E-17	5.20649E+03	3.22902E-11	2.46338E+16	4.67250E+32	1.24038E+33	1.00098E+01
113	4.20830E+16	-2.5105E+04	1.5787E-17	5.20149E+03	2.7736E-11	2.57257E+16	4.67240E+32	1.30210E+33	1.00081E+01
114	4.36340E+16	-2.5101E+04	1.5644E-17	5.19649E+03	2.38315E-11	2.75771E+16	4.67230E+32	1.36755E+33	1.00077E+01
115	4.52244E+16	-2.5097E+04	1.5506E-17	5.19149E+03	2.0303E-11	2.80915E+16	4.67220E+32	1.43692E+33	1.00067E+01
116	4.68424E+16	-2.5093E+04	1.5373E-17	5.18649E+03	1.74610E-11	2.70846E+16	4.67210E+32	1.51036E+33	1.00058E+01
117	4.84944E+16	-2.5089E+04	1.5244E-17	5.18149E+03	1.4968E-11	2.4389E+16	4.67200E+32	1.58799E+33	1.00053E+01
118	5.01854E+16	-2.5085E+04	1.5119E-17	5.17649E+03	1.2908E-11	2.13836E+16	4.67190E+32	1.66762E+33	1.00048E+01
119	5.19164E+16	-2.5081E+04	1.5000E-17	5.17149E+03	1.11890E-11	1.8150E+16	4.67180E+32	1.75156E+33	1.00043E+01
120	5.36864E+16	-2.5077E+04	1.4886E-17	5.16649E+03	1.11890E-11	1.3150E+16	4.67170E+32	1.84068E+33	1.00038E+01
121	5.54964E+16	-2.5073E+04	1.4777E-17	5.16149E+03	1.11890E-11	1.3150E+16	4.67160E+32	1.93335E+33	1.00033E+01
122	5.73464E+16	-2.5069E+04	1.4673E-17	5.15649E+03	1.11890E-11	1.3150E+16	4.67150E+32	2.03041E+33	1.00028E+01

APPENDIX B

```
*IDENT FIX
*DELETE SV.23
  DATA LFILM,KPR,NM/10,1,20/
*DELETE SV.313
  DATA (RCV(J),J=1,200)/200*8.02232E-09/
*DELETE SV.370,SV.373
  RHO(J)=2.4E-09
  P(J)=1.79543E+03
  IF (J.LE. 5) P(J)=5.37152E+14
*DELETE SV.513,SV.624
  CND(J)=0.5*(MUVISC(J-1)+MUVISC(J))/PR
*DELETE SV.611
  DATA PR/100./
*DELETE SV.616,SV.617
  MUVISC(J)=2.4E+07
*DELETE SV.527
*DELETE SV.78
*INSERT SV.509
  IF (IUMAX.GT. -1) RETURN
*INSERT SV.26
  G=0.
*DELETE SV.22
  DATA PDVCEN/0.51/
*INSERT SV.26
  CALL UNDROP
```

1	10/26/77	EXPORT	VEGA	BLAST	HAVE			
2	JBAR	60	NDT			300		
3	DT	4.000E-001	DX	1.667E+011	GRDVEL	0.0		
4	RMIN	0.000E+000	RMAX	9.000E+012				
5	DONR	MASS	1.00	DONR	MDM	1.00		
6	GAMMA						UTMAX	
7	VLAM	0.2	DTMAX	+8.000E-01	DTK	0.20		
8		.70000	.27000					
9		1-4.48-3.30-3.20-2.86-2.72-2.67-2.64-2.63-2.63-2.62-2.62-2.62-2.61-2.60						
10		2-2.60-2.59-2.58-2.55-2.54-2.52-2.49-2.46-2.42-5.54-4.59-4.59-4.59						
11		3-4.59-4.59-4.59						
12		4-4.73-4.71-4.59-4.14-3.52-3.04-2.80-2.69-2.55-2.53-2.61-2.60-2.59-2.57						
13		5-2.55-2.52-2.49-2.44-2.39-2.33-2.26-2.13-2.09-5.32-4.41-4.41-4.41						
14		6-4.41-4.41-4.41						
15		7-4.53-4.51-4.48-4.41-4.29-4.05-3.60-3.12-2.83-2.69-2.62-2.57-2.53-2.48						
16		8-2.43-2.36-2.29-2.20-2.09-1.98-1.85-1.72-1.58-5.09-4.23-4.23-4.23						
17		9-4.23-4.23-4.23						
18		10-4.44-4.41-4.38-4.31-4.21-4.08-3.90-3.64-3.28-2.90-2.60-2.41-2.25-2.13						
19		11-2.01-1.88-1.73-1.59-1.43-1.28-1.12-.96-.80-4.87-4.05-4.05-4.05						
20		12-4.05-4.05-4.05						
21		13-4.31-4.29-4.32-4.24-4.10-3.92-3.68-3.39-3.05-2.72-2.38-2.07-1.82-1.62						
22		14-1.45-1.27-1.08-.90-.71-.52-.33-.14-.00-4.65-3.87-3.87-3.87						
23		15-3.87-3.87-3.87						
24		16-4.13-4.14-4.23-4.12-3.94-3.68-3.37-3.04-2.69-2.35-2.03-1.72-1.44-1.20						
25		17-.98-.76-.53-.30-.08.15.38.61.66-4.43-3.70-3.70-3.70						
26		18-3.70-3.70-3.70						
27		19-3.96-3.99-4.03-3.92-3.71-3.39-3.03-2.69-2.35-2.04-1.73-1.43-1.13-.86						
28		20-.60-.33-.06.21.47.74 1.01 1.26 1.06-4.21-3.52-3.52-3.52						
29		21-3.52-3.52-3.52						
30		22-3.31-3.40-3.56-3.52-3.37-3.12-2.82-2.51-2.17-1.82-1.47-1.13-.80-.51						
31		23-.24.05.33.61.89 1.17 1.46 1.72 1.25-3.99-3.34-3.34-3.34						
32		24-3.34-3.34-3.34						
33		25-2.63-2.79-2.95-2.98-2.93-2.78-2.55-2.28-1.96-1.59-1.21-.84-.50-.20						
34		26.08.37.66.96 1.25 1.54 1.83 2.08 1.39-3.77-3.16-3.16-3.16						
35		27-3.16-3.16-3.16						
36		28-1.90-2.06-2.24-2.37-2.39-2.27-2.06-1.81-1.53-1.23-.91-.58-.26.05						
37		29.35.67.98 1.29 1.60 1.91 2.22 2.45 1.51-3.55-2.38-2.98-2.98						
38		30-2.98-2.98-2.98						
39		31-1.27-1.39-1.49-1.61-1.66-1.56-1.34-1.18-.96-.72-.47-.20.09.38						
40		32.68.97 1.23 1.58 1.88 2.18 2.47 2.65 1.61-3.33-2.80-2.80-2.80						

[illegible]

81	73	-0.47	-0.47	-0.47	-0.42	-0.32	-0.18	.03	.38	.82	1.33	1.88	2.42	2.95	3.46
82	74	3.95	4.40	4.79	5.11	5.35	5.41	5.08	4.27	3.03	-0.24	-0.29	-0.29	-0.29	-0.29
83	75	-0.29	-0.29	-0.29	-0.42	-0.36	-0.23	-0.02	.32	.75	1.26	1.80	2.33	2.85	3.38
84	76	-0.47	-0.47	-0.47	-0.44	-0.36	-0.23	-0.02	.32	.75	1.26	1.80	2.33	2.85	3.38
85	77	3.88	4.34	4.76	5.10	5.34	5.39	5.09	4.33	3.12	-0.01	-0.11	-0.11	-0.11	-0.11
86	78	-0.11	-0.11	-0.11	-0.45	-0.40	-0.28	-0.07	.26	.68	1.18	1.72	2.24	2.75	3.28
87	79	-0.47	-0.47	-0.47	-0.45	-0.40	-0.28	-0.07	.26	.68	1.18	1.72	2.24	2.75	3.28
88	80	3.78	4.26	4.68	5.05	5.30	5.32	5.07	4.38	3.22	.21	.07	.07	.07	.07
89	81	.07	.07	.07	-0.47	-0.44	-0.32	-0.12	.20	.60	1.10	1.63	2.14	2.65	3.16
90	82	-0.47	-0.47	-0.47	-0.47	-0.44	-0.32	-0.12	.20	.60	1.10	1.63	2.14	2.65	3.16
91	83	3.67	4.15	4.58	4.95	5.20	5.22	5.00	4.42	3.32	.43	.25	.25	.25	.25
92	84	.25	.25	.25	-0.49	-0.47	-0.35	-0.16	.14	.52	1.00	1.52	2.02	2.52	3.04
93	85	-0.47	-0.47	-0.47	-0.49	-0.47	-0.35	-0.16	.14	.52	1.00	1.52	2.02	2.52	3.04
94	86	3.54	4.01	4.44	4.82	5.07	5.06	4.88	4.43	3.41	.65	.43	.43	.43	.43
95	87	.43	.43	.43	-0.49	-0.47	-0.35	-0.16	.14	.52	1.00	1.52	2.02	2.52	3.04
96	88	-0.47	-0.47	-0.47	-0.49	-0.47	-0.35	-0.16	.14	.52	1.00	1.52	2.02	2.52	3.04
97	89	3.39	3.87	4.30	4.67	4.92	4.93	4.81	4.45	3.51	.87	.61	.61	.61	.61
98	90	.61	.61	.61	-0.49	-0.47	-0.35	-0.16	.14	.52	1.00	1.52	2.02	2.52	3.04
99	91	-0.47	-0.47	-0.47	-0.49	-0.47	-0.35	-0.16	.14	.52	1.00	1.52	2.02	2.52	3.04
100	92	3.22	3.71	4.14	4.50	4.75	4.80	4.73	4.46	3.60	1.09	.79	.79	.79	.79
101	93	.79	.79	.79	-0.48	-0.47	-0.44	-0.36	-0.22	.01	.39	.87	1.39	1.94	2.50
102	94	-0.47	-0.47	-0.47	-0.48	-0.47	-0.44	-0.36	-0.22	.01	.39	.87	1.39	1.94	2.50
103	95	3.04	3.54	3.97	4.34	4.59	4.68	4.66	4.47	3.69	1.31	.97	.97	.97	.97
104	96	.97	.97	.97	-0.48	-0.47	-0.44	-0.36	-0.22	.01	.39	.87	1.39	1.94	2.50
105	97	-0.47	-0.47	-0.47	-0.48	-0.47	-0.44	-0.36	-0.22	.01	.39	.87	1.39	1.94	2.50
106	98	2.85	3.36	3.81	4.19	4.47	4.58	4.59	4.44	3.77	1.53	1.15	1.15	1.15	1.15
107	99	1.15	1.15	1.15	-0.47	-0.47	-0.46	-0.41	-0.30	-0.09	.25	.68	1.18	1.72	2.29
108	100	-0.47	-0.47	-0.47	-0.47	-0.47	-0.46	-0.41	-0.30	-0.09	.25	.68	1.18	1.72	2.29
109	101	2.64	3.17	3.65	4.05	4.35	4.49	4.52	4.39	3.82	1.75	1.32	1.32	1.32	1.32
110	102	1.32	1.32	1.32	-0.47	-0.47	-0.47	-0.44	-0.35	-0.17	.12	.51	.98	1.50	2.07
111	103	-0.47	-0.47	-0.47	-0.47	-0.47	-0.47	-0.44	-0.35	-0.17	.12	.51	.98	1.50	2.07
112	104	2.43	2.98	3.48	3.91	4.23	4.39	4.43	4.30	3.84	1.97	1.50	1.20	.71	-0.27
113	105	-1.20	-2.29	-3.39	-0.47	-0.47	-0.49	-0.47	-0.39	-0.23	.01	.34	.78	1.29	1.85
114	106	-0.47	-0.47	-0.47	-0.47	-0.47	-0.48	-0.49	-0.46	-0.40	-0.30	-0.13	.16	.56	1.07
115	107	1.63	2.22	2.76	3.21	3.54	3.74	3.82	3.79	3.65	2.79	2.20	1.75	1.19	.24
116	108	-0.70	-1.77	-2.86	-0.47	-0.47	-0.47	-0.47	-0.47	-0.47	-0.47	-0.47	-0.47	-0.47	-0.47
117	109	-0.47	-0.47	-0.47	-0.47	-0.47	-0.47	-0.47	-0.47	-0.47	-0.47	-0.47	-0.47	-0.47	-0.47
118	110	.83	1.36	1.91	2.39	2.77	3.01	3.15	3.18	3.18	3.11	2.78	2.27	1.67	.74
119	111	-0.19	-1.25	-2.33	-0.47	-0.47	-0.47	-0.47	-0.47	-0.47	-0.47	-0.47	-0.47	-0.47	-0.47
120	112	-0.47	-0.47	-0.47	-0.47	-0.47	-0.47	-0.47	-0.47	-0.47	-0.47	-0.47	-0.47	-0.47	-0.47

121	113	.13	.54	1.02	1.53	1.99	2.31	2.54	2.64	2.71	2.83	2.91	2.69	2.15	1.25
122	114	.32	-.74	-1.81	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.41
123	115	-.47	-.47	-.47	-.47	1.17	1.60	1.96	2.19	2.35	2.52	2.70	2.81	2.55	1.74
124	116	-.29	-.06	.27	.70	1.17	1.60	1.96	2.19	2.35	2.52	2.70	2.81	2.55	1.74
125	117	.31	-.24	-1.29	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.46
126	118	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.46
127	119	-.42	-.36	-.22	.06	.43	.92	1.40	1.77	2.06	2.23	2.36	2.52	2.57	2.12
128	120	1.29	.26	-.79	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47
129	121	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47
130	122	-.47	-.45	-.39	-.25	-.03	.34	.77	1.23	1.54	1.89	2.05	2.16	2.24	2.22
131	123	1.70	.75	-.30	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47
132	124	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47
133	125	-.47	-.47	-.44	-.40	-.30	-.10	.19	.59	1.01	1.31	1.53	1.65	1.74	1.89
134	126	1.84	1.18	.19	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47
135	127	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47
136	128	-.48	-.48	-.47	-.47	-.43	-.37	-.23	.01	.30	.59	.85	1.01	1.15	1.33
137	129	1.50	1.41	.65	-.48	-.48	-.48	-.48	-.48	-.48	-.48	-.48	-.48	-.48	-.48
138	130	-.48	-.48	-.48	-.48	-.48	-.48	-.48	-.48	-.48	-.48	-.48	-.48	-.48	-.48
139	131	-.43	-.48	-.48	-.48	-.48	-.47	-.44	-.35	-.21	-.02	.20	.39	.57	.74
140	132	.93	1.15	.97	-.48	-.48	-.48	-.48	-.48	-.48	-.48	-.48	-.48	-.48	-.48
141	133	-.43	-.48	-.48	-.48	-.48	-.48	-.48	-.48	-.48	-.48	-.48	-.48	-.48	-.48
142	134	-.49	-.48	-.48	-.43	-.48	-.48	-.47	-.46	-.43	-.35	-.24	-.09	.07	.22
143	135	.41	.66	.80	-.49	-.49	-.49	-.49	-.49	-.49	-.49	-.49	-.49	-.49	-.49
144	136	-.49	-.49	-.49	-.49	-.49	-.49	-.49	-.49	-.49	-.49	-.49	-.49	-.49	-.49
145	137	-.49	-.49	-.49	-.49	-.49	-.49	-.49	-.49	-.49	-.49	-.49	-.49	-.49	-.49
146	138	-.01	.20	.43	-.49	-.49	-.49	-.49	-.49	-.49	-.49	-.49	-.49	-.49	-.49
147	139	-.50	-.50	-.50	-.50	-.50	-.50	-.50	-.50	-.50	-.50	-.50	-.50	-.50	-.50
148	140	-.50	-.50	-.50	-.50	-.50	-.50	-.50	-.50	-.50	-.50	-.50	-.50	-.50	-.50
149	141	-.23	-.14	.03	-.50	-.50	-.50	-.50	-.50	-.50	-.50	-.50	-.50	-.50	-.50
150	142	-.51	-.51	-.51	-.51	-.51	-.51	-.51	-.51	-.51	-.51	-.51	-.51	-.51	-.51
151	143	-.51	-.51	-.51	-.51	-.51	-.51	-.51	-.51	-.51	-.51	-.51	-.51	-.51	-.51
152	144	-.44	-.36	-.26	-.53	-.53	-.53	-.53	-.53	-.53	-.53	-.53	-.53	-.53	-.53
153	145	-.53	-.53	-.53	-.53	-.53	-.53	-.53	-.53	-.53	-.53	-.53	-.53	-.53	-.53
154	146	-.53	-.53	-.53	-.53	-.53	-.53	-.53	-.53	-.53	-.53	-.53	-.53	-.53	-.53
155	147	-.51	-.49	-.43	-.56	-.56	-.56	-.56	-.56	-.56	-.56	-.56	-.56	-.56	-.56
156	148	-.56	-.56	-.56	-.56	-.56	-.56	-.56	-.56	-.56	-.56	-.56	-.56	-.56	-.56
157	149	-.56	-.56	-.56	-.56	-.56	-.56	-.56	-.56	-.56	-.56	-.56	-.56	-.56	-.56
158	150	-.56	-.55	-.53	-.61	-.61	-.61	-.61	-.61	-.61	-.61	-.61	-.61	-.61	-.61
159	151	-.61	-.61	-.61	-.61	-.61	-.61	-.61	-.61	-.61	-.61	-.61	-.61	-.61	-.61
160	152	-.61	-.61	-.61	-.61	-.61	-.61	-.61	-.61	-.61	-.61	-.61	-.61	-.61	-.61
161	153	-.61	-.60	-.60	-.61	-.61	-.61	-.61	-.61	-.61	-.61	-.61	-.61	-.61	-.61

APPENDIX C

```

1 *IDENT PROB
2 *DELETE SV.23
3     DATA LFILM,KPR,NM/50,5,200/
4 *DELETE SV.313
5     DATA (RCV(J),J=1,200)/200*4.E-09/
6 *DELETE SV.259
7     U(JP2)=U(JP1)+DELU
8     U(JP3)=U(JP2)+DELU
9     RHO(1)=3.674E-21
10    EI(JP2)=2.*EI(JP1)-EI(JBAR)
11 *DELETE SV.261
12    EI(1)=2.65E+14
13 *DELETE SV.370,SV.373
14    RHO(J)=3.674E-21
15    EI(J)=2.65E+14
16    P(J)=(GAMMA-1.)*RHO(J)*EI(J)
17 *DELETE SV.375
18 *DELETE SV.618,SV.624
19    CND(J)=0.5*(MUUVISC(J)+MUUVISC(J-1))/PR
20 *DELETE SV.180
21    AA(K+1,L-5)=-1.
22 *DELETE SV.78
23 *DELETE SV.527
24 *DELETE SV.228
25 *DELETE SV.374
26    U(J)=UT1
27 *DELETE SV.87
28    SUM=1.33E+26
29 *DELETE SV.90
30    DPHI(JP2)=SUM/X(JP2)**2
31 *DELETE SV.204
32    RHOL(1)=3.674E-21
33    EI(1)=2.65E+14
34    UT(JP2)=UT(JP1)+DELU
35    UT(JP3)=UT(JP2)+DELU
36    EI(JP2)=2.*EI(JP1)-EI(JBAR)
37 *DELETE SV.552
38    DO 10 J=2,JP3
39 *INSERT SV.296
40    SUBROUTINE ASULN(X,P,EI,RHO,U,GAMMA,JP1)

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```

41     DIMENSION X(1),P(1),FI(1),RHO(1),U(1)
42     JP2=JP1+1
43     GNOT=1.33E+26
44     ANA=RHO(1)*U(2)*X(2)*X(2)
45     ANB=EI(1)+0.5*U(2)*U(2)+P(1)/RHO(1)-GNOT/X(2)
46     ANC=P(1)/RHO(1)**GAMMA
47     D2=GAMMA*ANC/(GAMMA-1.)
48     D3=GAMMA-1.
49     D4=SQRT(ANA**2*0.5)
50     WRITE (6,6) ANA,ANB,ANC,D2,D3,D4
51 6   FORMAT (1X,*A AND D*,7E15.6)
52     DO 1 J=3,JP2
53     ROLD=RHO(J)
54     DO 2 IT=1,200
55     RHO(J)=D4/(X(J)*X(J)*SQRT(ANB-D2*RHO(J)**D3+GNOT/X(J)))
56     IF (ABS(RHO(J)-ROLD) .LE. 1.E-10*ROLD) GO TO 3
57     ROLD=RHO(J)
58 2   CONTINUE
59     WRITE (6,4) J,ROLD,RHO(J)
60 4   FORMAT (1X,*ITER FAILURE*,I5,2E15.6)
61 3   CONTINUE
62     P(J)=ANC*RHO(J)**GAMMA
63     EI(J)=P(J)/(D3*RHO(J))
64     U(J)=ANA/(X(J)*X(J)*RHO(J))
65     WRITE (6,5) J,RHO(J),P(J),EI(J),U(J)
66 5   FORMAT (1X,*A SOLN*,I5,4E13.6)
67     END FILE 6
68 1   CONTINUE
69     RETURN
70     END
71 *INSERT SV.376
72     CALL ASOLN (X,P,EI,RHO,U,GAMMA,JP1)
73 *DELETE SV.511
74     DATA PR/1.E+05/
75 *INSERT SV.27
76     DELU=U(JP2)-U(JP1)
77 *DELETE SV.185
78     B(K+1)=DELU
79 *INSERT SV.617
80     $ *1.E-12

```

```

81 *DELETE SV.132
82     AA(4,7)=X(2)*X(2)
83     AA(4,12)=-X(3)*X(3)
84 *DELETE SV.229
85 *INSERT SV.210
86     RHOT=RHOL(J)
87     EIT=EI(J)
88     IF (J.NE. 2) GO TO 151
89     RHOT=RHOL(1)
90     EIT=EI(1)
91     151 CONTINUE
92 *DELETE SV.214
93     1RHOT=UD(J+1)*AJ(J+1)*((1.+DUB2)*RHOL(J)+(1.-DUB2)*RHOL(J+1))
94 *DELETE SV.215
95     1+(1.-DUB1)*RHOT*EIT)-UD(J+1)*AJ(J+1)*((1.+DUB2)*RHOL(J)*EI(J)
96 *IDENT SHOK
97 *INSERT PR08.10
98     IF (T.LT.TSHOK .OR. T.GE.TSHOK+7560.) GO TO 1006
99     RHOL(1)=RHOL(1)*3.364
100    EI(1)=EI(1)*25.47
101    UT(2)=1.57E+08
102    1006 CONTINUE
103 *INSERT PR08.26
104     IF (T.LT.TSHOK .OR. T.GE.TSHOK+7560.) GO TO 1007
105     RHOL(1)=RHOL(1)*3.364
106     EI(1)=EI(1)*25.47
107     U(2)=1.57E+08
108    1007 CONTINUE
109 *INSERT SV.22
110     DATA TSHOK/2.E+05/
111 *IDENT RADCO
112 *DELETE PR08.22,PR08.23
113     U(JP3)=U(JP2)
114 *DELETE PR08.11,PR08.12
115     UT(JP3)=UT(JP2)
116 *DELETE PR08.7
117     AA(K+1,L-5)=-DT*U(JP2)/(X(JP2)-X(JP1))
118 *DELETE SV.184
119     AA(K+1,L)=1.-AA(K+1,L-5)
120 *DELETE PR08.8

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```
121      B(K+1)=('JP2)
122 *INSERT SV.26
123      CALL UNDRJP
```



```

1 10/26/77 EXPORT VEGA SOLAR WIND
2 JBAR      140      NDT      5000
3 DT        1.000E+002 DX      1.500E+010 GRDVEL      0.0
4 RMIN      1.250E+012 RMAX      2.000E+013
5 DDNR MASS 0.50      DDNR MOM 0.50
6 GAMMA     1.667 UT1      +3.140E+07 UTMAX
7 VLAM      0.2      DTMAX      +1.000E+04 DTK      0.20
8 .70000 .27000
9 1-4.48-3.80-3.20-2.85-2.72-2.67-2.64-2.63-2.63-2.62-2.62-2.62-2.61-2.60
10 2-2.60-2.59-2.58-2.56-2.54-2.52-2.49-2.46-2.42-2.54-4.59-4.59-4.59-4.59
11 3-4.59-4.59-4.59
12 4-4.73-4.71-4.59-4.14-3.52-3.04-2.80-2.69-2.65-2.63-2.61-2.60-2.59-2.57
13 5-2.55-2.52-2.49-2.44-2.39-2.33-2.26-2.18-2.09-5.32-4.41-4.41-4.41-4.41
14 6-4.41-4.41-4.41
15 7-4.53-4.51-4.48-4.41-4.29-4.05-3.60-3.12-2.83-2.69-2.62-2.57-2.53-2.48
16 8-2.43-2.36-2.29-2.20-2.09-1.98-1.85-1.72-1.58-5.09-4.23-4.23-4.23-4.23
17 9-4.23-4.23-4.23
18 10-4.44-4.41-4.38-4.31-4.21-4.08-3.90-3.54-3.28-2.90-2.60-2.41-2.25-2.13
19 11-2.01-1.88-1.73-1.59-1.43-1.28-1.12 -.96 -.80-4.87-4.05-4.05-4.05-4.05
20 12-4.05-4.05-4.05
21 13-4.31-4.29-4.32-4.24-4.10-3.92-3.68-3.39-3.06-2.72-2.38-2.07-1.82-1.62
22 14-1.45-1.27-1.08 -.90 -.71 -.52 -.33 -.14 .00-4.65-3.87-3.87-3.87-3.87
23 15-3.87-3.87-3.87
24 16-4.13-4.14-4.23-4.12-3.94-3.68-3.37-3.04-2.69-2.35-2.03-1.72-1.44-1.20
25 17 -.98 -.76 -.53 -.30 -.08 .15 .38 .61 .66-4.43-3.70-3.70-3.70-3.70
26 18-3.70-3.70-3.70
27 19-3.96-3.99-4.03-3.92-3.71-3.39-3.03-2.69-2.35-2.04-1.73-1.43-1.13 -.86
28 20 -.60 -.33 -.06 .21 .47 .74 1.01 1.26 1.06-4.21-3.52-3.52-3.52-3.52
29 21-3.52-3.52-3.52
30 22-3.31-3.40-3.56-3.52-3.37-3.12-2.82-2.51-2.17-1.82-1.47-1.13 -.80 -.51
31 23 -.24 .05 .33 .61 .89 1.17 1.46 1.72 1.25-3.99-3.34-3.34-3.34-3.34
32 24-3.34-3.34-3.34
33 25-2.63-2.79-2.95-2.98-2.93-2.78-2.55-2.28-1.96-1.59-1.21 -.84 -.50 -.20
34 26 .08 .37 .66 .96 1.25 1.54 1.83 2.08 1.39-3.77-3.16-3.16-3.16-3.16
35 27-3.16-3.16-3.16
36 28-1.90-2.06-2.24-2.37-2.39-2.27-2.06-1.81-1.53-1.23 -.91 -.58 -.26 .05
37 29 .35 .57 .98 1.29 1.60 1.91 2.22 2.45 1.51-3.55-2.98-2.98-2.98-2.98
38 30-2.98-2.98-2.98
39 31-1.27-1.39-1.49-1.61-1.66-1.56-1.39-1.18 -.96 -.72 -.47 -.20 .09 .38
40 32 .63 .97 1.28 1.58 1.88 2.18 2.47 2.65 1.61-3.33-2.80-2.80-2.80-2.80

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81	73	-.47	-.47	-.47	-.42	-.32	-.18	.03	.38	.82	1.33	1.88	2.42	2.95	3.46
82	74	3.95	4.40	4.79	5.11	5.35	5.41	5.08	4.27	3.03	-.24	-.29	-.29	-.29	-.29
83	75	-.29	-.29	-.29											
84	76	-.47	-.47	-.47	-.44	-.36	-.23	-.02	.32	.75	1.26	1.80	2.33	2.86	3.38
85	77	3.83	4.34	4.75	5.10	5.34	5.39	5.09	4.33	3.12	-.01	-.11	-.11	-.11	-.11
86	78	-.11	-.11	-.11											
87	79	-.47	-.47	-.47	-.46	-.40	-.28	-.07	.26	.68	1.18	1.72	2.24	2.75	3.28
88	80	3.78	4.26	4.68	5.05	5.30	5.32	5.07	4.38	3.22	.21	.07	.07	.07	.07
89	81	.07	.07	.07											
90	82	-.47	-.47	-.47	-.47	-.44	-.32	-.12	.20	.60	1.10	1.53	2.14	2.65	3.16
91	83	3.67	4.15	4.58	4.95	5.20	5.22	5.00	4.42	3.32	.43	.25	.25	.25	.25
92	84	.25	.25	.25											
93	85	-.47	-.47	-.47	-.49	-.47	-.36	-.16	.14	.52	1.00	1.52	2.02	2.52	3.04
94	86	3.54	4.01	4.44	4.82	5.07	5.06	4.83	4.43	3.41	.55	.43	.43	.43	.43
95	87	.43	.43	.43											
96	88	-.47	-.47	-.47	-.49	-.48	-.39	-.23	.01	.35	.80	1.31	1.82	2.34	2.87
97	89	3.39	3.87	4.30	4.67	4.92	4.93	4.81	4.45	3.51	.87	.61	.61	.61	.61
98	90	.61	.61	.61											
99	91	-.47	-.47	-.47	-.49	-.48	-.42	-.20	-.11	.17	.60	1.10	1.61	2.15	2.70
100	92	3.22	3.71	4.14	4.50	4.76	4.90	4.73	4.46	3.50	1.09	.79	.79	.79	.79
101	93	.79	.79	.79											
102	94	-.47	-.47	-.47	-.48	-.47	-.44	-.36	-.22	.01	.39	.87	1.39	1.94	2.50
103	95	3.04	3.54	3.97	4.34	4.59	4.58	4.66	4.47	3.69	1.31	.97	.97	.97	.97
104	96	.97	.97	.97											
105	97	-.47	-.47	-.47	-.48	-.47	-.46	-.41	-.30	-.09	.25	.58	1.18	1.72	2.29
106	98	2.85	3.35	3.81	4.19	4.47	4.58	4.59	4.44	3.77	1.53	1.15	1.15	1.15	1.15
107	99	1.15	1.15	1.15											
108	100	-.47	-.47	-.47	-.47	-.47	-.47	-.44	-.35	-.17	.12	.51	.95	1.50	2.07
109	101	2.54	3.17	3.65	4.05	4.35	4.44	4.52	4.39	3.82	1.75	1.32	1.32	1.32	1.32
110	102	1.32	1.32	1.32											
111	103	-.47	-.47	-.47	-.47	-.47	-.49	-.47	-.39	-.23	.01	.34	.78	1.29	1.85
112	104	2.43	2.98	3.48	3.91	4.23	4.39	4.43	4.30	3.34	1.97	1.50	1.20	.71	-.27
113	105	-1.20-2.29-3.39													
114	106	-.47	-.47	-.47	-.47	-.47	-.48	-.49	-.46	-.40	-.30	-.13	.15	.56	1.07
115	107	1.53	2.22	2.76	3.21	3.54	3.74	3.82	3.79	3.65	2.79	2.20	1.75	1.19	.24
116	108	-1.70-1.77-2.85													
117	109	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.44	-.37	-.22	.02	.38
118	110	.83	1.36	1.91	2.39	2.77	3.01	3.15	3.18	3.18	3.11	2.73	2.27	1.67	.74
119	111	-1.13-1.25-2.33													
120	112	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.48	-.48	-.48	-.46	-.42	-.31	-.14

121	.13	.54	1.02	1.53	1.99	2.31	2.54	2.64	2.71	2.83	2.91	2.69	2.15	1.25
122	.32	-.74	-1.81											
123	-.47	-.67	-.67	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.45	-.41
124	-.29	-.06	.27	.70	1.17	1.60	1.96	2.19	2.36	2.52	2.70	2.81	2.55	1.74
125	.81	-.24	-1.29											
126	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.46	-.46
127	-.42	-.35	-.22	.06	.43	.92	1.40	1.77	2.06	2.23	2.36	2.52	2.57	2.12
128	1.29	.26	-.79											
129	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47
130	-.47	-.45	-.39	-.26	-.03	.34	.77	1.23	1.64	1.89	2.05	2.16	2.24	2.22
131	1.73	.75	-.30											
132	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47
133	-.47	-.47	-.44	-.40	-.30	-.10	.19	.59	1.01	1.31	1.53	1.65	1.74	1.89
134	1.84	1.18	.19											
135	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47	-.47
136	-.48	-.48	-.47	-.47	-.43	-.37	-.23	.01	.30	.59	.85	1.01	1.15	1.33
137	1.50	1.41	.65											
138	-.48	-.48	-.48	-.48	-.48	-.48	-.48	-.48	-.48	-.48	-.48	-.48	-.48	-.48
139	-.48	-.43	-.48	-.48	-.48	-.47	-.44	-.35	-.21	-.02	.20	.39	.57	.74
140	.93	1.15	.97											
141	-.48	-.48	-.48	-.48	-.48	-.48	-.48	-.48	-.48	-.48	-.48	-.48	-.48	-.48
142	-.48	-.48	-.48	-.48	-.48	-.48	-.47	-.46	-.43	-.35	-.24	-.09	.07	.22
143	.41	.66	.86											
144	-.49	-.49	-.49	-.49	-.49	-.49	-.49	-.49	-.49	-.49	-.49	-.49	-.49	-.49
145	-.49	-.49	-.49	-.49	-.49	-.49	-.49	-.49	-.49	-.47	-.43	-.35	-.26	-.15
146	-.01	.20	.43											
147	-.50	-.50	-.50	-.50	-.50	-.50	-.50	-.50	-.50	-.50	-.50	-.50	-.50	-.50
148	-.50	-.50	-.50	-.50	-.50	-.50	-.50	-.50	-.50	-.50	-.50	-.50	-.50	-.50
149	-.28	-.14	.03											
150	-.51	-.51	-.51	-.51	-.51	-.51	-.51	-.51	-.51	-.51	-.51	-.51	-.51	-.51
151	-.51	-.51	-.51	-.51	-.51	-.51	-.51	-.51	-.51	-.52	-.52	-.52	-.50	-.48
152	-.44	-.36	-.25											
153	-.53	-.53	-.53	-.53	-.53	-.53	-.53	-.53	-.53	-.53	-.53	-.53	-.53	-.53
154	-.53	-.53	-.53	-.53	-.53	-.53	-.53	-.53	-.53	-.53	-.53	-.53	-.53	-.53
155	-.51	-.49	-.43											
156	-.55	-.55	-.56	-.56	-.56	-.56	-.56	-.56	-.56	-.56	-.56	-.56	-.56	-.56
157	-.55	-.56	-.56	-.56	-.56	-.56	-.56	-.56	-.56	-.56	-.56	-.56	-.56	-.56
158	-.55	-.55	-.53											
159	-.61	-.61	-.61	-.61	-.61	-.61	-.61	-.61	-.61	-.61	-.61	-.61	-.61	-.61
160	-.61	-.61	-.61	-.61	-.61	-.61	-.61	-.61	-.61	-.61	-.61	-.61	-.61	-.61
161	-.61	-.60	-.60											