1. Compute Thermodynamic/Transport Properties c_v, k, μ, γ

2. Compute the equilibration pressure with an equation of state (ideal Gas).

$P_{eq} = (\gamma - 1) c_v \rho T$

$c = \sqrt{\frac{dP}{d\rho} + \frac{dP}{de}\frac{P_{eq}}{\rho^2}}$

where $\frac{dP}{d\rho} = (\gamma - 1) c_v T$ and $\frac{dP}{de} = (\gamma - 1)\rho$

set boundary conditions on P_{eq}

3. Compute sources of energy due to chemical reactions $S_{(me)}$

4. Compute the face-centered velocities

$$\vec{U}^{*^f} = \left\langle \frac{\rho\vec{U}}{\rho} \right\rangle^{n^f} - \frac{\Delta t}{<\rho^o>^f} \nabla^f P_{eq} + \Delta t \vec{g}$$
$$= \frac{(\rho\vec{U})_R + (\rho\vec{U})_L}{\rho_R + \rho_L} - \Delta t \frac{2.0(v_L^o v_R^o)}{v_L^o + v_R^o} \left(\frac{P_{eq_R} - P_{eq_L}}{\Delta x} \right) + \Delta t \vec{g}$$

set boundary conditions on $\vec{U}^{*^f}$

5. Compute ΔP

$$\Delta P = \frac{-\Delta t \quad \overbrace{\nabla \cdot \theta \vec{U}^{*^f}}^{\text{Advection}(\theta, \vec{U}^{*^f})}}{\kappa}$$

where $P^{n+1} = P_{eq} + \Delta P$ for a single material $\theta = 1.0$ and $\kappa = \frac{v^o}{c^2}$

set boundary conditions on P^{n+1}

6. Compute the face centered pressure

$$P^{*^f} = \frac{\frac{P}{\rho} + \frac{P_{adj}}{\rho_{adj}}}{\frac{1}{\rho} + \frac{1}{\rho_{adj}}} = \frac{P\rho_{adj} + P_{adj}\rho}{\rho + \rho_{adj}}$$

7. Accumulate sources

$\Delta(m\vec{U}) = -\Delta t V \Delta t \nabla P^{*^f} + \nabla \cdot (\tau^{*^f}) + m\vec{g}\Delta t$

$\Delta(me) = V \kappa P \Delta P - \nabla q^{*^f} + S_{(me)}$

where $q^{*^f} = -k^f \nabla T$

8. Compute Lagrangian quantities

$m^L = \rho V$

$(m\vec{U})^L = (m\vec{U}) + \Delta(m\vec{U})$

$(me)^L = (me) + \Delta(me)$

set boundary conditions on the primative variables $(\vec{U}, \rho, T)$

Evolution of specific volume

$(mv^o)^L = (mv^o) + \Delta t V \nabla \cdot \vec{U}^{*f}$

Note $\Delta t V \nabla \cdot \vec{U}^{*f} = \kappa V \Delta p$

9. <u>Advect and Advance in time</u>

   $m^{n+1} = m^L - \Delta t \text{Advection}(m^L, \vec{U}_m^{*f})$

   $(m\vec{U})^{n+1} = (m\vec{U})^L - \Delta t \text{Advection}((m\vec{U})^L, \vec{U}^{*f})$

   Transport passive scalars

   $(mf)^{n+1} = (mf)^L - \Delta t \text{Advection}((mf)^L, \vec{U}^{*f})$

   Compute $c_v(f)^{n+1}$

   $(me)^{n+1} = (me)^L - \Delta t \text{Advection}((\rho e)^L, \vec{U}^{*f})$

   $(mv^o)^{n+1} = (mv^o)^L - \Delta t \text{Advection}((\rho v^o)^L, \vec{U}^{*f})$

   Backout the primitive variables $(T, \rho, \vec{U}, v^0, f)$

   set boundary conditions on the primitive variables $(\vec{U}, \rho T)$.