Comp Astro Assignment 1

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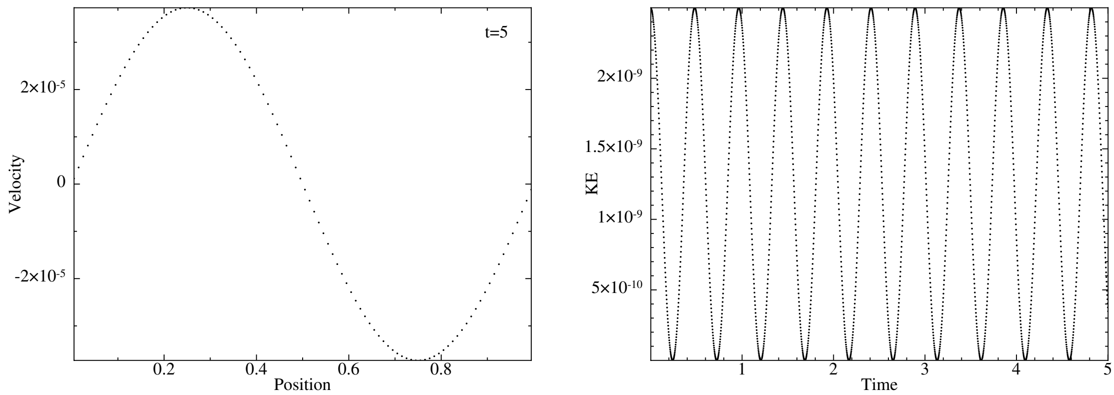
Steps

1. Done, see main.f90.
2. Done, see subroutine setup in init.f90.
3. Done, see subroutine output in outputs.f90.
4. Done, see subroutines get_density and kernal in derivs.f90.
5. Done, see subroutine set_ghosts in edges.f90.
6. Done, see subroutine equation_of_state in derivs.f90.
7. Done, see subrotines get_accel and derivs in derivs.f90.
8. Done, see subroutines leapfrog and timestepping in evolution.f90.
9. Done, see Figure 1(a) for the Velocity as a function of position at time $t = 5$, and Figure 1(b) for the total kinetic energy as a function of time. From the total Kinetic Energy, we find that we get five waves (ten waves of kinetic energy) at $t = 4.82$, which gives a wave period of $t = 0.964$. The error with respect to the expected period ($t = 1$) is therefore 0.036.
10. Done, see get_smoothing_length and get_derivs in derivs.f90.
11. Done. We find that we get five waves at $t = 4.945$, which gives a wave period of $t = 0.989$. The error with respect to the expected period is therefore 0.011.
12. Done, see subroutines viscosity and equation_of_state in derivs.f90, and Figure 2.
13. Done, see subroutine isothermal_setup in init.f90 and isothermal.f90.
14. Done, see set_boundary in edges.f90.
15. Done, see Figure 3.
16. Done, see subroutine leapfrog in evolution.f90 and subroutine get_accel in derivs.f90.
17. Done, see subroutine equation_of_state in derivs.f90.
18. Done, see sod_shock.f90 and subroutine sod_setup in init.f90.
19. Done, see Figure 4.
20. Done, see Figures 5(a), 5(b) and 5(c). The artifical viscosity parameters, when used, are able to capture the shock at the discontinuities.



(a) (b)

Figure 1: (a) Velocity of the particles at $t = 5$. (b) Total Kinetic Energy (KE) of particles as a function of time.

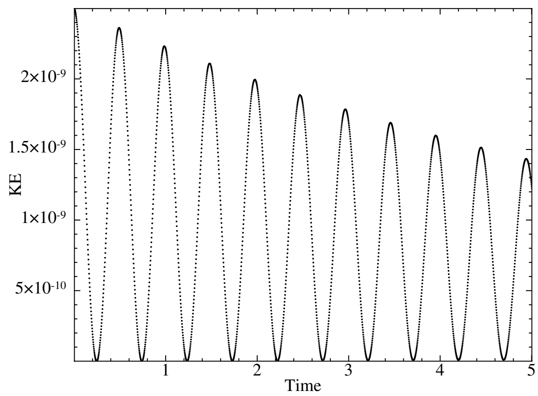


Figure 2: Total Kinetic energy (KE) of the particles as a function of time, with artificial viscosity.

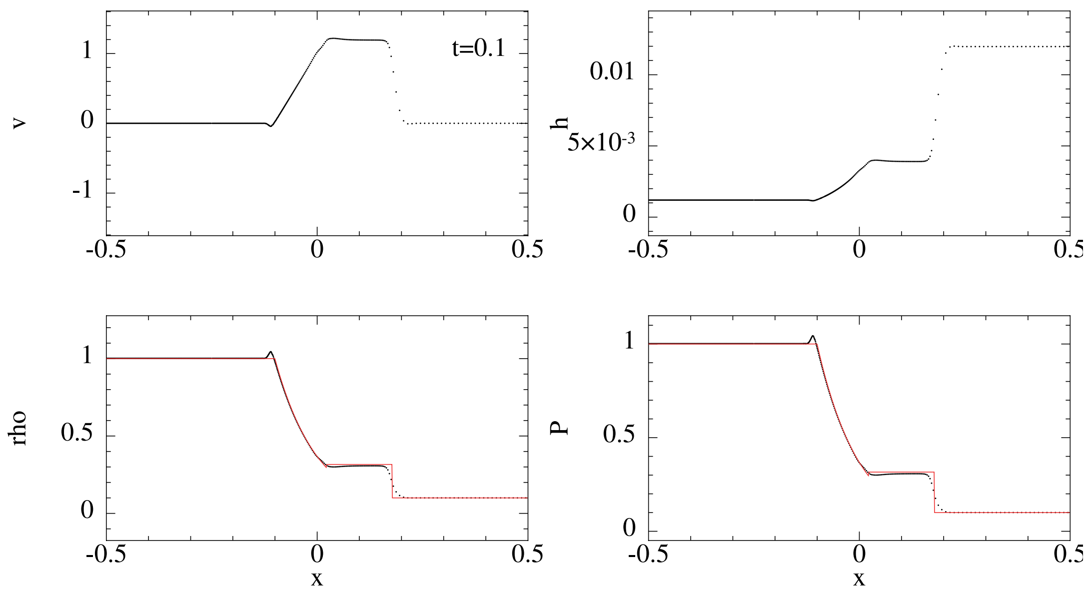


Figure 3: Clockwise from the top left: the velocity (v), the smoothing length (h), the pressure (P) and the density (rho), all as a function of position. For the density and pressure, the exact solution is plotted in red.

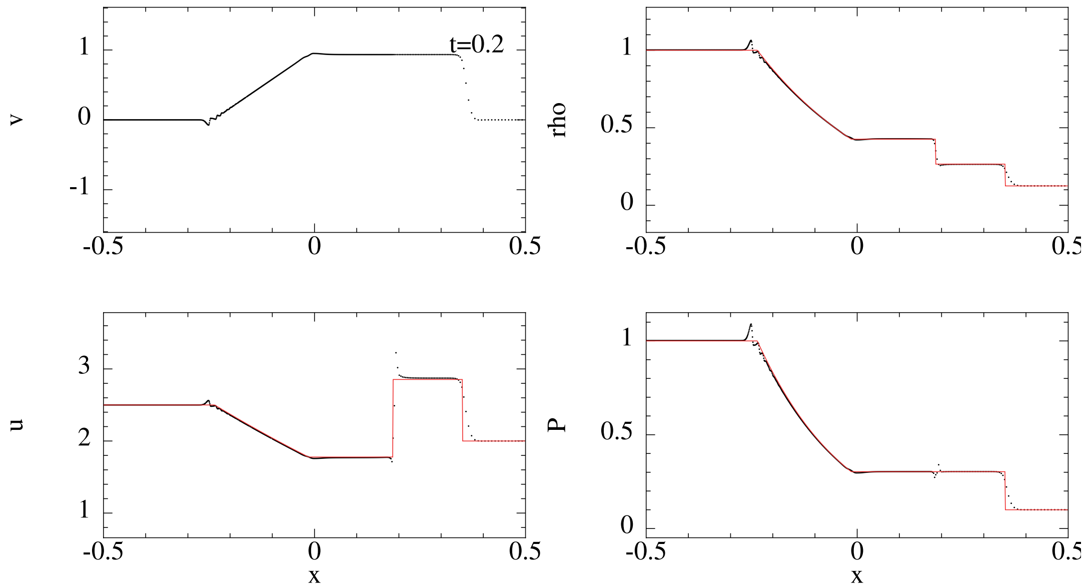
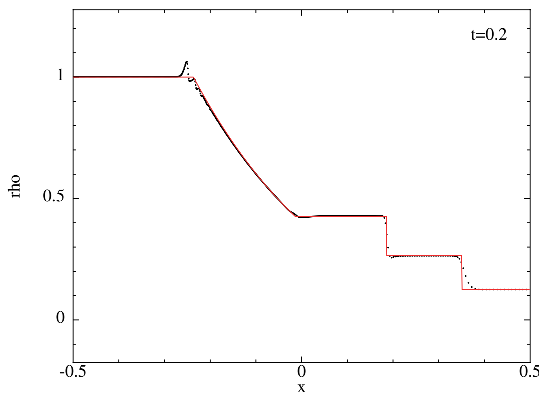
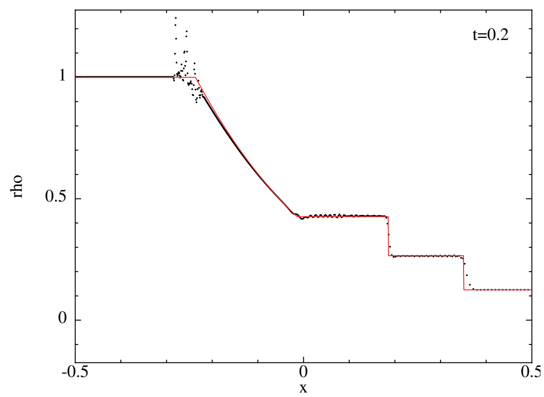


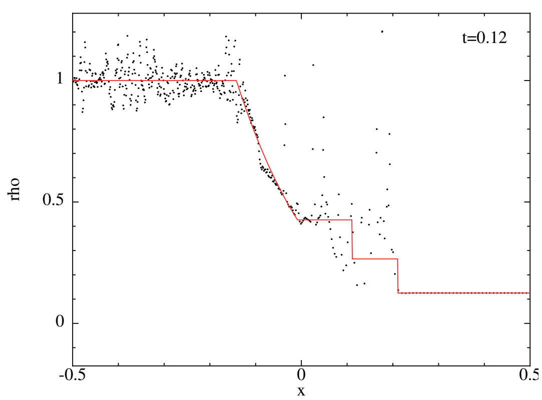
Figure 4: Clockwise from the top left: the velocity (v), the density (rho), the pressure (P) and the internal energy (u), all as a function of position. For the density, pressure and internal energy, the exact solution is plotted in red.



(a)



(b)



(c)

Figure 5: A plot of the density as a function of position of viscosity parameters: $\alpha = 1$, $\beta = 2$ (a), $\alpha = 0$, $\beta = 2$ (b) and $\alpha = \beta = 0$ (c)

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