

## 1 Test case motivation

Five Riemann problems are selected to test the performance of the Riemann solver and the influence of the initial guess for pressure. The tests are also used to illustrate some typical wave patterns resulting from the solution of the Riemann problem. Table 4.1 shows the data for all five tests in terms of primitive variables. In all cases the ratio of specific heats is  $\gamma = 1.4$ . The source code for the exact Riemann solver, called HE-EIRPEXACT, is part of the library NUMERICA [519]; a listing is given in Sect. 4.9. Test 1 is the so called Sod test problem [453]; this is a very mild test and its solution consists of a left rarefaction, a contact and a right shock. Fig. 4.7 shows solution profiles for density, velocity, pressure and specific internal energy across the complete wave structure, at time  $t = 0.25$  units. Test 2, called the 123 problem, has solution consisting of two strong rarefactions and a trivial stationary contact discontinuity; the pressure  $p^*$  is very small (close to vacuum) and this can lead to difficulties in the iteration scheme to find  $p^*$  numerically. Fig. 4.8 shows solution profiles. Test 2 is also useful in assessing the performance of numerical methods for low density flows, see Einfeldt et. al. [182]. Test 3 is a very severe test problem, the solution of which contains a left rarefaction, a contact and a right shock; this test is actually the left half of the blast wave problem of Woodward and Colella [584], Fig. 4.9 shows solution profiles. Test 4 is the right half of the Woodward and Colella problem; its solution contains a left shock, a contact discontinuity and a right rarefaction, as shown in Fig. 4.10. Test 5 is made up of the right and left shocks emerging from the solution to tests 3 and 4 respectively; its solution represents the collision of these two strong shocks and consists of a left facing shock (travelling very slowly to the right), a right travelling contact discontinuity and a right travelling shock wave. Fig. 4.11 shows solution profiles for Test 5.

## 2 Test case description and setting

Current test case composed of five independent tests.

## 3 Expected result and scoring procedure