Tutorial questions

1. A shock wave travels along a copper bar with a velocity of 5km/s.
   (a) Determine the sound speed in the copper bar, before and after the shock.
   (b) Determine the pressure in the bar after the shock.
   (c) Determine the particle velocity in the bar after the shock.

You may need the following data. For copper, the shock velocity *D* is linearly related to the particle velocity *u* as

$$D = c_0 + su ,$$

where $c_0 = 3.940\text{km/s}$, $s = 1.489$. The Young's modulus and the density of the copper at rest are 120GPa and 8.930g/cm^3, respectively.

2. A slab made of aluminum (flying in the air at 2km/s) strikes the slab made of copper (at rest), and keeps pressing to sustain the pressure. Calculate
   (a) the particle velocity and pressure at the interface between aluminum and copper slabs;
   (b) the velocity of the shock wave generated in the aluminum slab;
   (c) the velocity of the shock wave generated in the copper slab.

You may need the following data. For aluminum, $c_0 = 5.328\text{km/s}$, $s = 1.338$. The density at rest is $2.785\times10^3\text{kg/m}^3$.

3. A slab made of copper (flying in the air at 2km/s) strikes the slab made of aluminum copper (at rest), and keeps pressing to sustain the pressure. Calculate
   (a) the particle velocity and pressure at the interface between aluminum and copper slabs;
   (c) the velocity of the shock wave generated in the aluminum slab;
   (d) the velocity of the shock wave generated in the copper slab.

4. An explosive of 500kg TNT charge detonates at 60m underwater. Can this be treated as a deep underwater explosion? Estimate the maximum bubble diameter and oscillation period for the first bubble pulsation cycle, assuming 50% of the explosive energy contributes to the bubble expansion.

You may need the following data. The atmospheric pressure is $1atm = 1.01\times10^5\text{Pa}$. The energy available in the TNT is $4.84\times10^6\text{J/kg}$. 1kg = 2.2 lb. 1meter = 3.28 ft.