

Acoustics Exercise 3. To be returned on Friday 3.4.2009

- (1) Show that the convective derivative of volume element $\delta V = dx dy dz$ is proportional to the divergence of the velocity field

$$\frac{D\delta V}{Dt} = \delta V \nabla \cdot \mathbf{v}$$

- (2) Calculate how the speed of sound depends on the temperature for an ideal gas that obeys

$$P = \rho \frac{k_B T}{m}$$

- (3) A gas with a virial coefficient $B(T)$ has:

$$P = \rho \frac{k_B T}{m} (1 + \rho B(T))$$

How does the speed of sound on temperature in this case? Apply this to Van der Waals gas

$$P = \rho \frac{k_B T}{m} \left(1 + \rho \left(b - \frac{a}{k_b T}\right)\right)$$

- (4) Prove, that the function

$$p(r) = \frac{f(r - ct)}{r} + \frac{g(r + ct)}{r}$$

is a solution for a three dimensional wave equation. What is the particle velocity for this solution at distance $r = a$. What is the volume velocity (the change of volume caused by given particle velocity on a surface) for a ball of radius a . How does this depend on the radius a ?