Speed of sound

In air = 343 m/s

$$v_{gasses} = \sqrt{\gamma \frac{P}{\rho}}$$

pressure

gas density

Deegrees of freedom = FD

$$\gamma = \frac{FD+2}{FD} = \frac{7}{5} \text{ for air}$$

$$v_{air} = \sqrt{\frac{7}{5} \cdot \frac{10^5\ Pa}{1{,}2\ kg/m^3}} = 341\ \frac{m}{s}$$

$$VP = R \cdot T$$

Kelvins = 273 + $T_{celsius}$

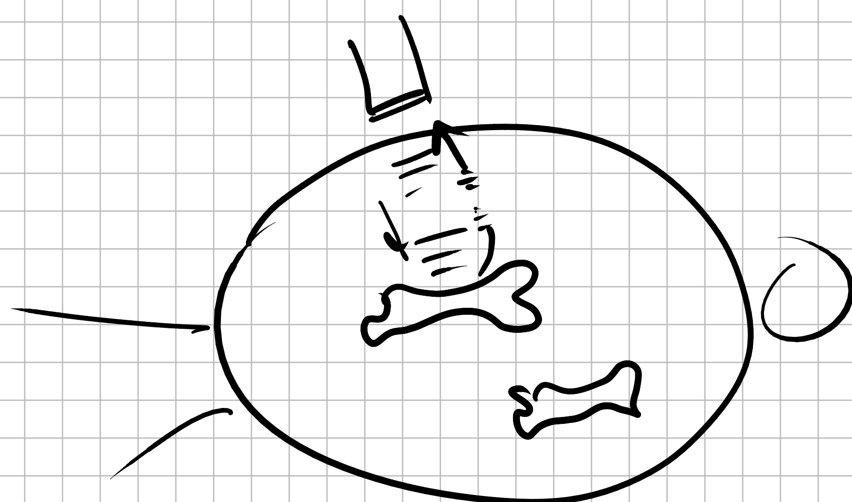
gas constant 8.31 $\frac{J}{K \ldots}$

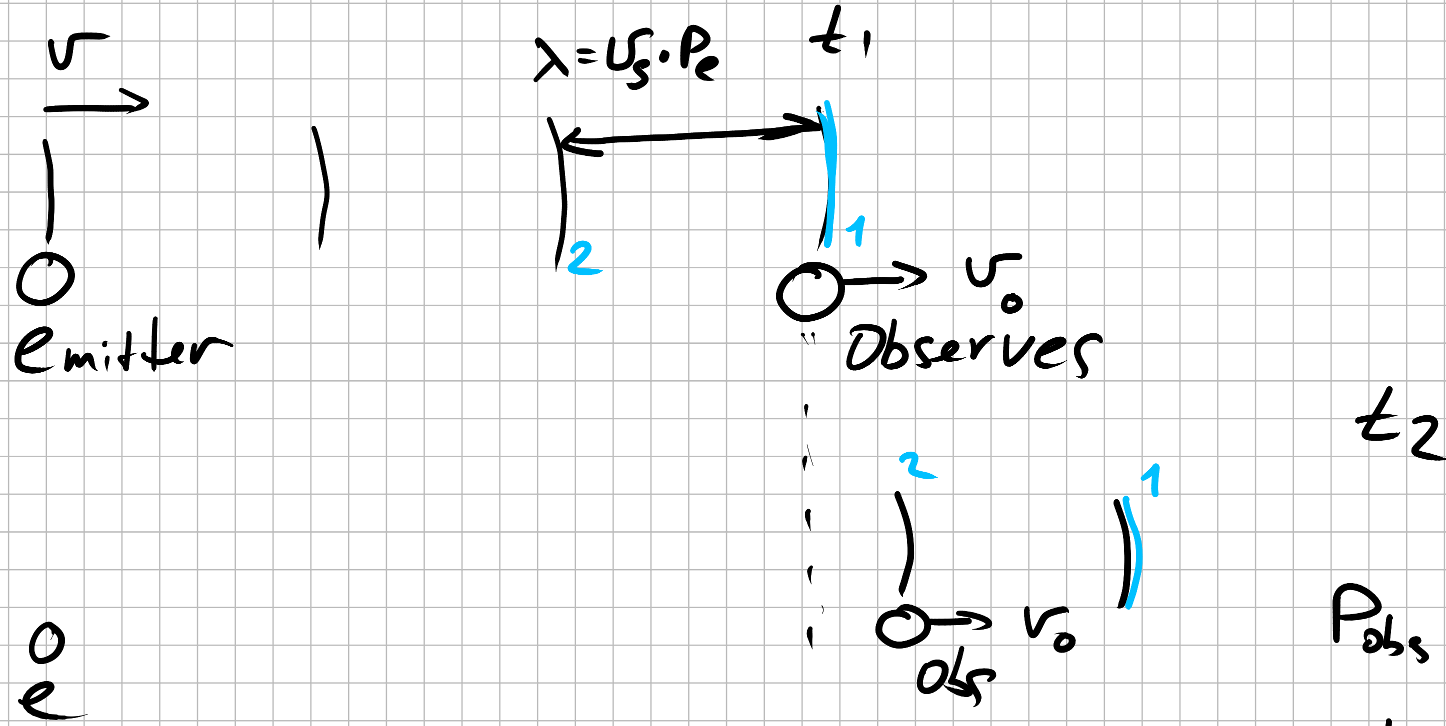
$$p = \frac{R \cdot T}{V} \longrightarrow v = \sqrt{\frac{\gamma p}{\rho}} = \sqrt{\gamma \frac{RT}{V \cdot \rho}} =$$

$$v = \sqrt{\gamma \frac{RT}{M}}$$

molar mass

Ultrasound





$$P_{obs} = t_2 - t_1$$

$$\Delta t = t_2 - t_1$$

Sound position : $-\lambda + v_s \cdot \Delta t = x_s$

$$\shortparallel$$

Observer position : $v_o \cdot \Delta t = x_o$

$$-\lambda + v_s \, \Delta t = v_o \cdot \Delta t$$

$$\Updownarrow$$

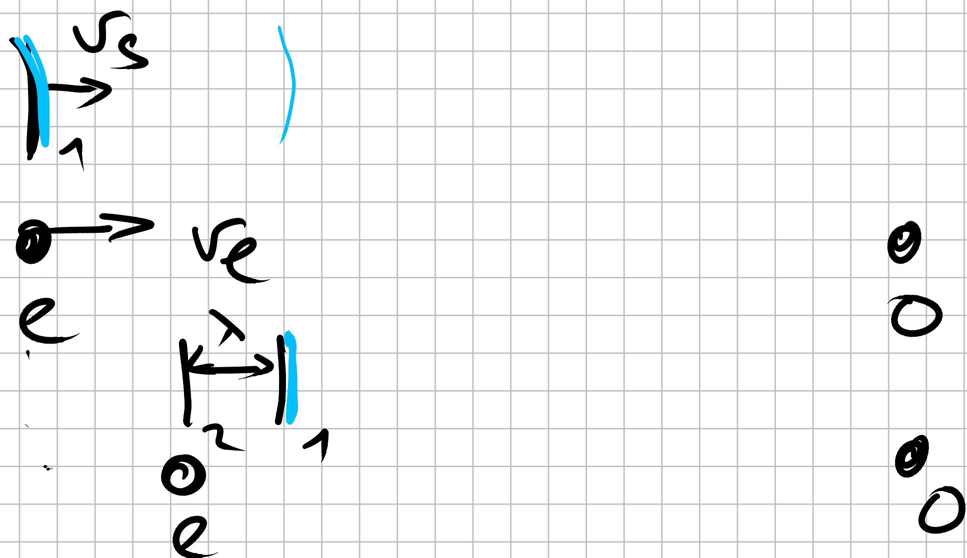
$$-v_s \cdot P_e + v_s \, P_{obs} = v_o \, P_{obs}$$

$$\frac{1}{f_{obs}} = P_{obs} = \frac{v_s \cdot P_e}{-(v_o - v_s)} = \frac{v_s}{v_o - v_s} \, \frac{1}{f_e}$$

$$\boxed{f_{obs} = \frac{v_s - v_o}{v_s} \cdot f_{emitter}}$$

moving observer

Case 2 moving emitter

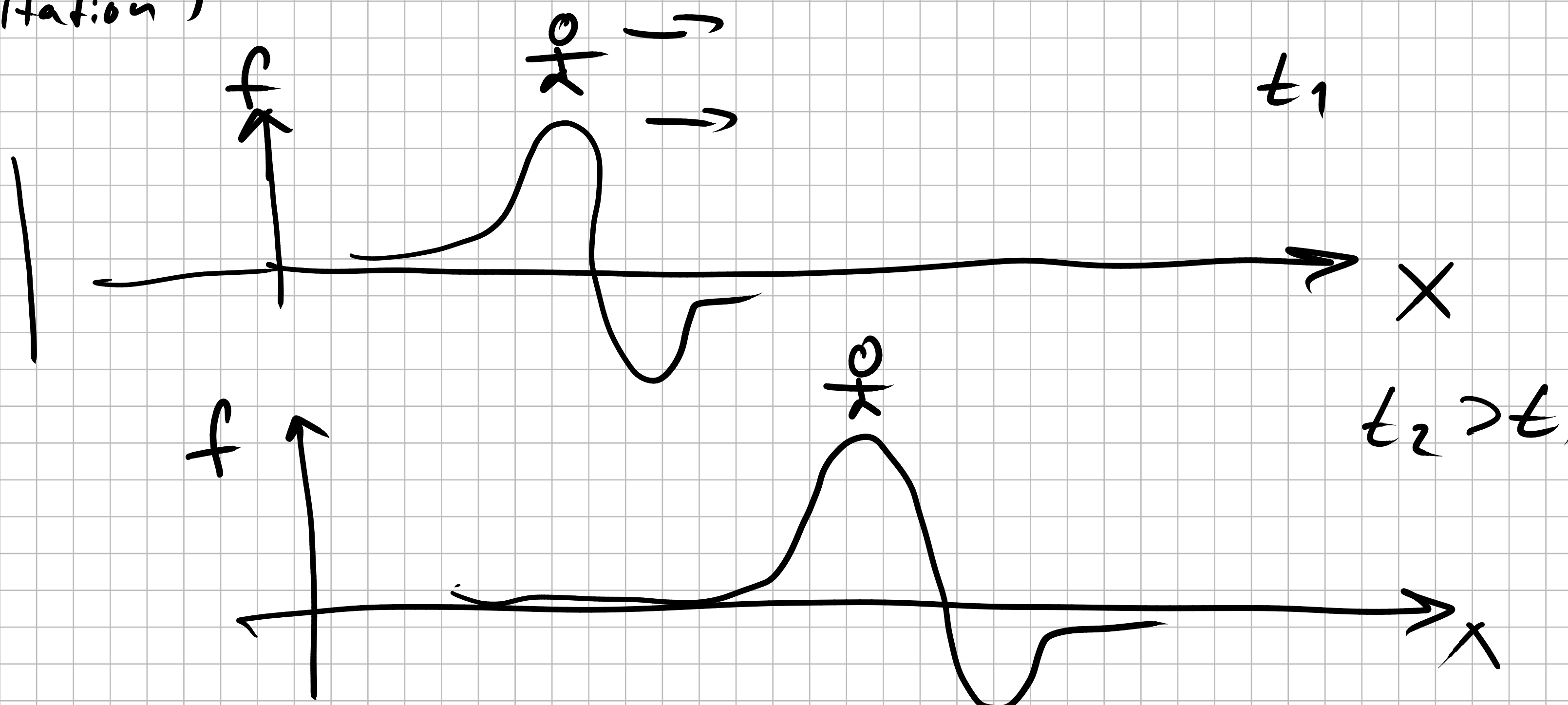


to

$$\boxed{f_o = f_e \frac{v_s}{v_s - v_e}}$$

Pulse propagation

Pulse
Packet
Exitation
$\Bigg\}$ – something which moves through space without changing shape



$$\text{Pulse} = f(x, t)$$

$$f(x, t_2) = f(x - v \cdot \Delta t, t_1) = f(x - v(t_1 - t_1), t_1)$$

$$f(x, t) = f(x - vt)$$

Wave equation

$$\frac{\partial}{\partial x} f(\underbrace{x - vt}_{u}) = \left(\frac{\partial}{\partial u} f\right) \cdot \frac{\partial u}{\partial x} = f' \cdot \frac{\partial (x-vt)}{\partial x}$$

$$f' = \left(\frac{\partial}{\partial u} f\right)$$

$$= f' \cdot 1$$

$$\frac{\partial^2}{\partial x^2} = f'' = \left(\frac{\partial^2}{\partial u^2} f\right)$$

$$\frac{\partial}{\partial t} f(x-vt) = f' \frac{\partial (x-vt)}{\partial t}$$

$$= f'(-v)$$

$$\frac{\partial^2}{\partial t^2} = v^2 f''$$

$$\frac{\partial^2}{\partial x^2} = f''$$