Supplement: Group velocity

- Say a wave-packet starts out at x=0 at t=0.
  - meaning each harmonic component has the same phase there.
- After time t
  - the harmonic component at ω_1 will have changed phase by $\omega_1 t$
  - the harmonic component at ω_2 will have changed phase by $\omega_2 t$
  - The phase difference between these components at x=0 will now be $(\omega_2 - \omega_1)\, t$
    To find the point x where they're in phase, we need to find where the phase difference from moving downstream by x cancels that:
    - $(\omega_2 - \omega_1)\, t = (k_2 - k_1)\, x$ Or for small differences in ω,k: $t d\omega = x dk$

Result

$$v_g = x/t = d\omega/dk$$

In this case $v_g = p/m$