**Task.** Write the equation of motions of simple harmonic oscillator which has an amplitude of 5 cm and it executes 150 oscillation in 5 minutes with an initial phase of 45 degree also obtain the value of its maximum velocity.

**Solution.** The equation of a simple harmonic oscillation has the following form

$$x(t) = A\cos(\omega t + \phi)$$

where $A$ is the amplitude, $\omega$ is the angular frequency, and $\phi$ is the phase.

Its velocity is then given by the formula:

$$v(t) = x'(t) = (A\cos(\omega t + \phi))' = -A\omega\sin(\omega t + \phi).$$

Hence the maximum of velocity is equal to

$$\max v(t) = A\omega.$$

In our case $A = 5\ cm$, and $\phi = 45^\circ = \frac{\pi}{4}$. Also, by assumption the oscillator executes 150 oscillation in 5 minutes. So its frequency is

$$\nu = \frac{150}{5\ min} = \frac{150}{5 * 60\ sec} = \frac{150}{300\ sec} = 0.5\ sec^{-1},$$

whence the angular frequency is

$$\omega = 2\pi\nu = 2\pi * 0.5\ sec^{-1} = \pi\ rad/sec.$$

Therefore the equation of motion for this oscillator is the following one:

$$x(t) = 5\cos(\pi t + \tfrac{\pi}{4})\ cm$$

and the maximum of velocity is equal to

$$\max v(t) = A\omega = 5\ cm * \pi\ rad/sec = 5\pi\ rad\,cm/sec.$$

**Answer.** $x(t) = 5\cos(\pi t + \frac{\pi}{4})\ cm$, $\max v = A\omega = 5\pi$ rad·cm/sec.