A gardener waters the plants by a pipe of diameter 1 mm. The water comes out from the pipe at
the rate of 10 cm3/sec. The reactionary force exerted on the hand of the gardener is:

Solution:

$V = 10^{-2}m^3 -$ volume of water for 1 second;

$\Delta t = 1s;$

$D = 10^{-3}m -$ diameter of the pipe;

$F -$ the force with which the water acts on the hand of the gardener ;

$N -$ reactionary force exerted on the hand of the gardener;

$\rho = 1000\frac{kg}{m^3} -$ *water density*;

First we need to find the velocity of the water flow:

$$\vartheta = \frac{V}{S} = \frac{4V}{\pi D^2} \qquad (1)$$

Change of momentum can be found from the formula

$F\Delta t = p_1 - p_2; \quad p_1 = m \cdot \vartheta, p_2 = 0$

$$F\Delta t = m \cdot \vartheta \qquad (2)$$

$$m = \rho \cdot V \qquad (3)$$

$(1)in(2)$:

$$F\Delta t = \rho V \cdot \frac{4V}{\pi D^2} = \rho\frac{4V^2}{\pi D^2}$$

$$F = \rho\frac{4V^2}{\pi D^2 \Delta t}$$

When water exerts a force on a hand, the hand simultaneously exerts a force equal in magnitude and opposite in direction to that of the water.

$$\vec{N} = -\vec{F};\ |\vec{N}| = |\vec{F}|$$

$$x: N = F = \rho\frac{4V^2}{\pi D^2 \Delta t} = 1000\frac{kg}{m^3} \cdot \frac{4 \cdot 10^{-2}m^3}{\pi \cdot 10^{-3}m \cdot 1s^2} = 12.7 \times 10^3 N$$

Answer: the reactionary force exerted on the hand of the gardener is $12.7 \times 10^3 N$