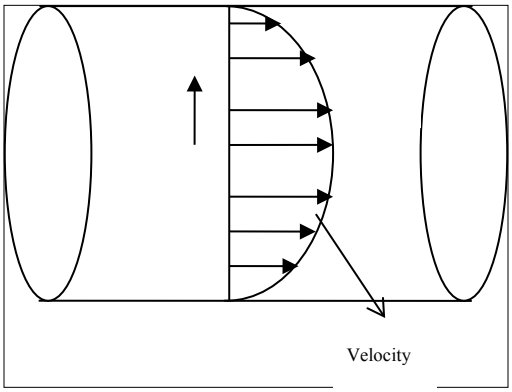
TOPIC

Fluids – Section X – Question 4

QUESTION



The velocity of water out of the pipe of inner radius 0.5 m, varies over the radial location in the pipe and is given below

$$V(r) = 10\left(1 - \frac{r^2}{0.5^2}\right),$$

where

V is given in m/s, and

r is in m.

The flow rate in m^3/s of the water out of the pipe is most nearly

(A) 3.333

(B) 3.927

(C) 5.890

(D) 7.854

HINT

$$Q = \int_0^a 2\pi r\ V(r)\ dr$$

SOLUTION

The velocity is maximum at the center of the pipe, that is, $r = 0$, and is zero at the wall, that is $r = 0.5m$

The flow rate of the water out of the pipe is given by

$$Q = \int_0^a 2\pi r\ V(r)\ dr$$

$$= \int_0^{0.5} 2\pi r \left[10\ \left(1 - \frac{r^2}{0.5^2}\right)\right] dr$$

$$= 20\pi \int_0^{0.5} \left(r - \frac{r^3}{0.25}\right) dr$$

$$= 20\pi \left[\frac{r^2}{2} - \frac{r^4}{4\times 0.25}\right]_0^{0.5}$$

$= 3.927 \ \frac{m^3}{s}$

ANSWER
(B)

CONTRIBUTOR
Autar Kaw