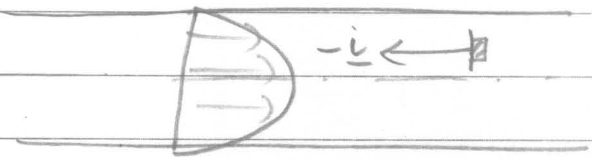
ES0212 QUIZ 2 PAPER A

SOLUTION KEY

(1)



The unit normal to the surface is in the $-\underline{i}$ direction. The relevant shear stress is $\tau_{xy} = \tau_{yx} = \mu \frac{du}{dy}$. $\frac{du}{dy}$ is $-ve$.

So $\tau_{xy} = -ve$ ⇒ direction of force & direction of unit normal are of opposite signs.

Since direction of unit normal is $-ve$

⇒ direction of force due to viscous shear stress is $+ve$ y ⇒ $+\underline{j}$. Correct Answer (B)

(2) given $u = x^2 - axy$ $\quad v = bxy - y^2/2$

$$\frac{\partial u}{\partial x} = 2x - ay \; ; \; \frac{\partial v}{\partial y} = bx - y$$

Incompr ⇒ $\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} = 0$ ⇒ $2x + bx - ay - y = 0$

$x(b+2) - y(a+1) = 0$

⇒ $\boxed{b = -2, \quad a = -1}$

correct Ans (C)

(3) friction factor $f = fn.(Re, \epsilon/D)$ only. So if L is doubled f will remain the same

correct Ans (B)

(4) given $F = fn.(U, D, \mu)$

$\Rightarrow g(F, \mu, D, U) = 0$. $n = 4$, $r = 3$

$\Rightarrow n - r = 1$ dimensionless group

Dimensional anal $\Rightarrow \left(\frac{F}{\mu U D}\right)$ is the dimensionless group

$\Rightarrow \frac{F}{\mu U D} = \text{Const}$ as there is no other parameter

(or) $F \propto \mu U D$ correct Ans (D)

(5) Force balance $\Rightarrow$ $Mg\sin\theta = \tau_w A$

$\tau_w = \frac{\mu V}{h}$; $Mg\sin\theta = \frac{\mu V}{h} A$

$\Rightarrow V = \frac{Mgh\sin\theta}{\mu A}$

$V = \frac{6 \times 9.8 \times 10^{-3} \times \sin(45^\circ)}{1 \times 40 \times 10^{-4}}$

Correct Ans (C)

$= 10.394$ m/s