ES0212 Quiz 1. Paper B Solution Key.

1. P: A stream line is parallel to the local velocity vector in the fluid ⇒ True.

Q: Pathlines and streaklines could be different in an unsteady flow ⇒ True

R: Streaklines are produced by instantaneously injecting dye at a point ⇒ False

S: Streamlines and streak lines could be different in a steady flow. ⇒ False

P & Q are true ⇒ Correct Ans: (A)

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(2) $\underline{v} = 2xz\,\underline{i} + 5t\,\underline{j} + ty\,\underline{k}$.

$$\underline{a} = \frac{D\underline{v}}{Dt} = \frac{\partial \underline{v}}{\partial t} + v_x \frac{\partial \underline{v}}{\partial x} + v_y \frac{\partial \underline{v}}{\partial y} + v_z \frac{\partial \underline{v}}{\partial z}$$

$$\frac{\partial \underline{v}}{\partial t} = 5\,\underline{j} + y\,\underline{k}.$$

$$\frac{\partial \underline{v}}{\partial x} = 2z\,\underline{i}\,; \quad v_x \frac{\partial \underline{v}}{\partial x} = 4xz^2\,\underline{i}$$

$$\frac{\partial \underline{v}}{\partial y} = t\,\underline{k}\,; \quad v_y \frac{\partial \underline{v}}{\partial y} = 5t^2\,\underline{k}$$

$$\frac{\partial \underline{v}}{\partial z} = 2x\,\underline{i}\,; \quad v_z \frac{\partial \underline{v}}{\partial z} = 2xyt\,\underline{i}$$

$$\underline{a} = 4xz^2\,\underline{i} + (5\,\underline{j}) + (5t^2+y)\,\underline{k} + 2xyt\,\underline{i}$$

$$= (4xz^2 + 2xyt)\,\underline{i} + 5\underline{j} + (5t^2+y)\,\underline{k}$$

$$\underline{a}\Big|_{\substack{x=1\\y=1\\z=-1\\t=2}} = (+4+4)\,\underline{i} + 5\underline{j} + (21)\,\underline{k}$$

$$= 8\,\underline{i} + 5\,\underline{j} + 21\,\underline{k}.$$

$\Rightarrow$ Correct Ans : (B)

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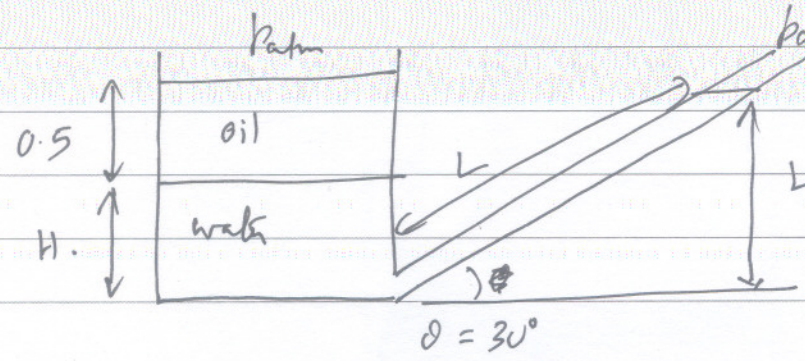
(3)



$L = 2m$

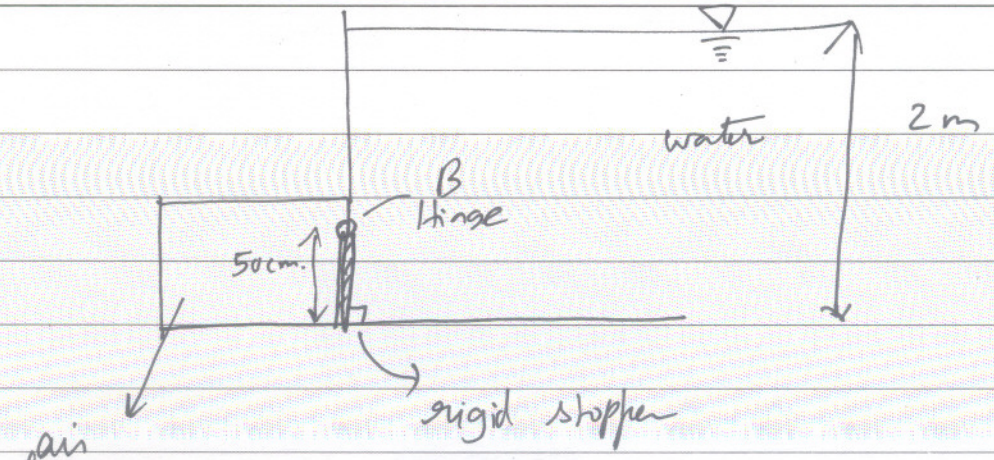
$$P_{atm} + 800\times9.8\times0.5 + 1000\times9.8\times H = \cancel{P_{atm}} + 1000\times9.8\times\frac{L}{2}$$

$$\Rightarrow \quad 0.8\times0.5 + H = 1$$

$$\Rightarrow H = 0.6m.$$

$\Rightarrow$ Correct Ans : (D)

(4)



Moment due to air pressure: (about B)

$$\left(P_{gage} \times 0.5 \times 0.6\right) \times 0.25 \quad \text{——} (1)$$

Moment due to water pressure about B:

$$= 0.6 \int_0^{0.5} \rho_w g \,(1.5 + y)\, y \, dy$$

$$= 10^3 \times 0.6 \times 9.8 \left[1.5 \frac{y^2}{2} + \frac{y^3}{3} \right]_0^{0.5}$$

$$= 10^3 \times 0.6 \times 9.8 \left[1.5 \times \frac{0.5^2}{2} + \frac{0.5^3}{3} \right] \quad \text{——} (2)$$

Equate (1) + (2) $\Rightarrow$ $\boxed{P_{gage} \leq 17.97 \text{ kPa}}$

$\Rightarrow$ Correct Ans: (C)