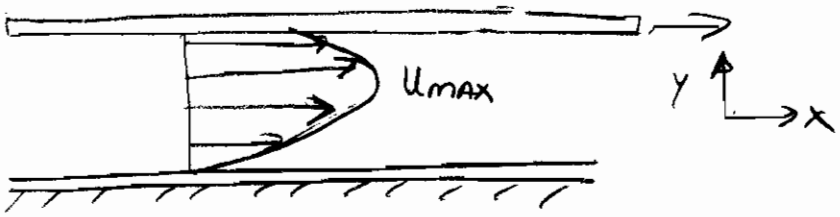
9-5



(a) TRUE $\tau = \mu \frac{du}{dy}$

$\left|\frac{du}{dy}\right|$ IS LARGEST AT THE FIXED PLATE

(b) FALSE

(c) FALSE - MINUMUM OCCURS AT u_{max}

(d) FALSE

(e) TRUE

9.20

GIVEN:

RAIN FALLS ONTO A 15 FT BY 40FT ROOF AT 0.4 IN/HR. SLOPE IN 15 FT DIRECTION IS 10°.

FIND: DEPTH & AVERAGE VELOCITY AT LOWER EDGE OF ROOF

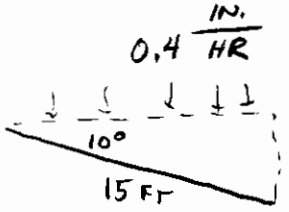
SOLUTION: ASSUME FULLY DEVELOPED FLOW DOWN AN INCLINED PLANE

$$q = \frac{1}{3}\frac{\gamma}{\mu} d^3 \sin\theta$$

q IS THE FLOW PER UNIT FOOT OF ROOF

$$V = \frac{q}{d}$$

OBTAIN q FROM RAIN RATE.



$$q = \left(0.4 \frac{IN.}{HR}\right)\left(\frac{1\ FT}{12\ IN.}\right)\left(\frac{1\ HR}{3600\ S}\right)(15\ FT)\cos 10^{\circ}$$

$$q = 0.000137 \frac{FT^2}{S}$$

$$d = \left(3q\frac{\mu}{\gamma \sin\theta}\right)^{\frac{1}{3}} = \left[3(.000137)\frac{2.73 \times 10^{-5}}{62.4 \sin 10^{\circ}}\right]^{\frac{1}{3}}$$

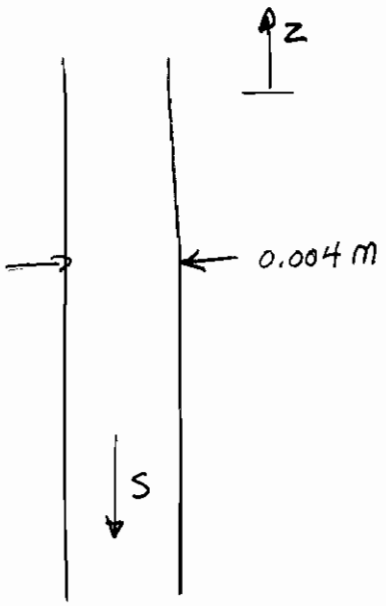
$$d = 0.00101\ FT = 0.0121\ IN.$$

$$V = \frac{q}{d} = 0.136 \frac{FT}{S} = 1.63 \frac{IN}{S.}$$

9.24

GIVEN: GLYCERIN AT 20°C FLOWS DOWNWARD BETWEEN VERTICAL PARALLEL PLATES SEPARATED BY 0.4CM. THE ENDS ARE OPEN.

FIND: q IN m^2/s



SOLUTION: THIS IS "FLOW BETWEEN STATIONARY PARALLEL PLATES" (PAGES 328-329)

$$q = -\left(\frac{B^3}{12\mu}\right)\frac{d}{ds}(p+\gamma z)$$

VERTICAL DOWNWARD FLOW $\Rightarrow$ $s = -z$

$$q = \left(\frac{B^3}{12\mu}\right)\frac{d}{dz}(p+\gamma z)$$

$$q = \frac{B^3}{12\mu}\left(\frac{dp}{dz}+\gamma\right)$$

$\frac{dp}{dz} = 0$ (ENDS ARE OPEN)

$$q = \frac{B^3\gamma}{12\mu}$$

TABLE A.4 $\gamma = 12{,}300 \ \frac{N}{m^3}$, $\mu = 1.41 \ \frac{N\cdot s}{m^2}$

$$q = \frac{(0.004)^3 \ 12{,}300}{12\,(1.41)}$$

$$q = 4.65 \times 10^{-5} \ \frac{m^2}{s}$$