

UE Problem F4-5

Fall '07

a)	Parameter	Units	
	$\sigma$	kg/m-s <sup>2</sup>	N=5, K=3 (kg, m, s)
	V	m/s	
	$\rho$	kg/m <sup>3</sup>	Expect N-K=5-3=2 Pi groups
	$\mu$	kg/m-s	
	l	m	

$$\pi_1 = \frac{\sigma}{\frac{1}{2}\rho V^2}$$

$$\pi_2 = \frac{\rho V l}{\mu} = Re$$

} other sets are possible, as always

b) Must have  $\pi$ 's match:  $\frac{\sigma_1}{\frac{1}{2}\rho V_1^2} = \frac{\sigma_2}{\frac{1}{2}\rho V_2^2}$ ,  $\frac{\rho V_1 l_1}{\mu} = \frac{\rho V_2 l_2}{\mu}$

From Re match  $V_1 l_1 = V_2 l_2$ ,  $V_2 = V_1 \frac{l_1}{l_2} = 30 \text{ m/s} \cdot \frac{l_1}{l_1/5} = 150 \text{ m/s}$

Then we will have  $\sigma_2 = \sigma_1 \frac{\sqrt{\frac{1}{2}\rho V_2^2}}{\sqrt{\frac{1}{2}\rho V_1^2}} = 25 \sigma_1$

c) Assume  $\mu$  has negligible effect.

Parameter	
$\sigma$	} These will now always appear together as $\rho V^2$ or $\frac{1}{2}\rho V^2$ , so they are really just one significant parameter, say $q = \frac{1}{2}\rho V^2$
$\rho$	
V	
l	

So revised parameter list is

$\sigma$ (Pa)	} N=2, K=1, N-K=1, $\pi_1 = \frac{\sigma}{q}$
q (Pa)	
<del>l</del> (m)	stranded unit

Note: Part c) is a freebie, since this wasn't covered. No points lost.