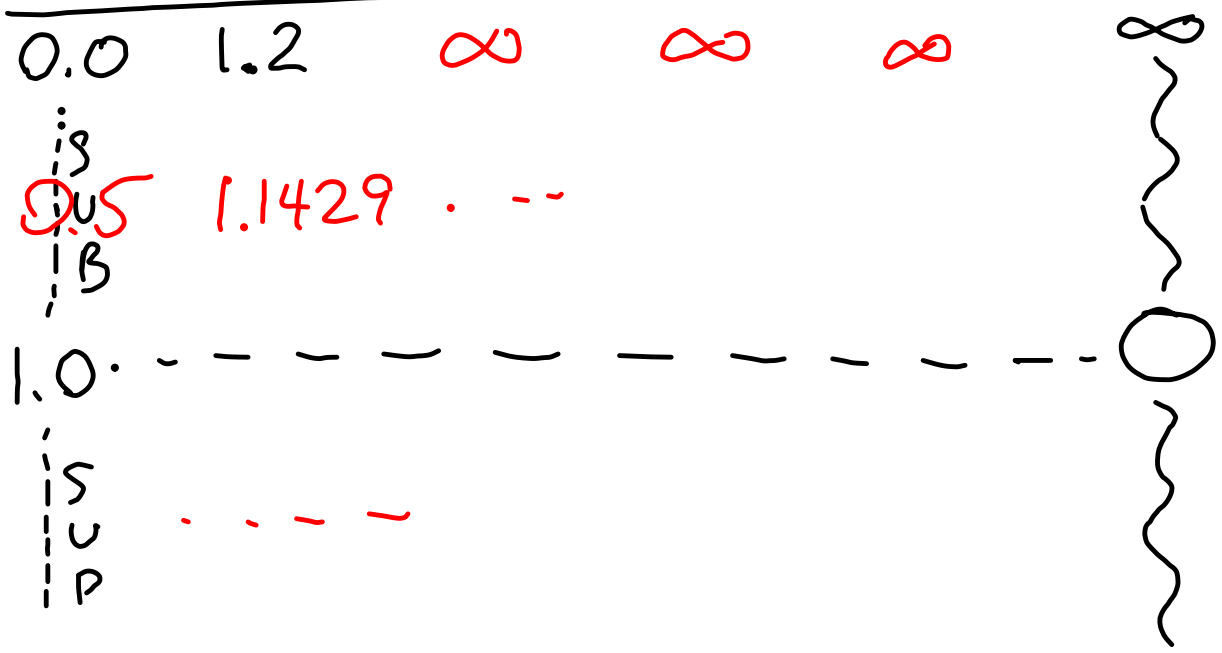
Lecture 23

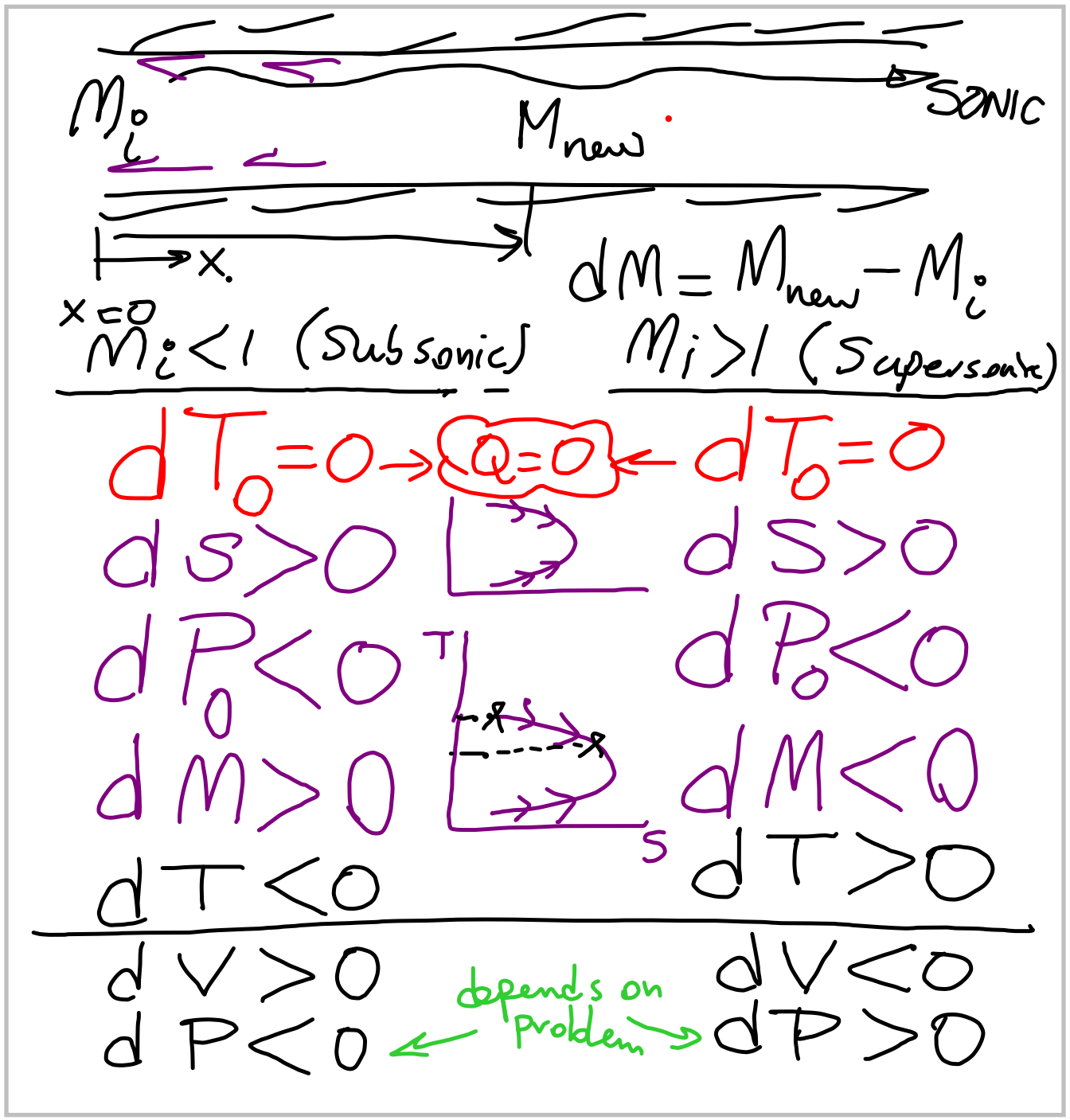
* 8 lectures (4 before & 4 after Thanksgiving)
* Exam 2 (this Th, 11/8 on campus)
* HW 10 (Ch. 9; due next Tu 11/13)

* Tu Th (Dec. 4 & 6) ⇒ Presentations

App. F (Fanno flow)

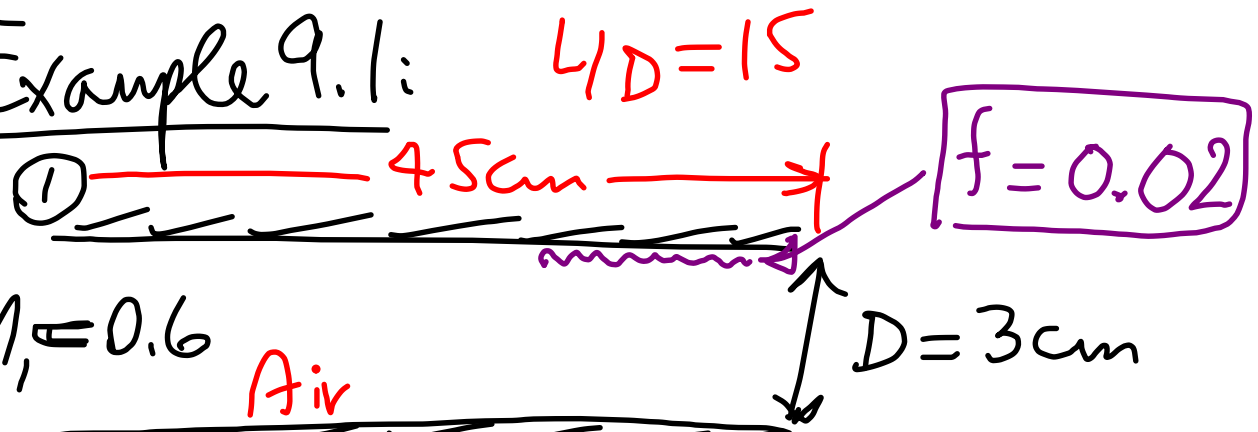
M	T/T^*	P/P^*	P_t/P_t^*	ρ/ρ^*	fL_{max}/D
0.0	1.2	∞	∞	∞	∞
0.5	1.1429 . . .				
1.0					




M_i
M_{new}
SONIC
x
$dM = M_{new} - M_i$
x=0
$M_i < 1$ (Subsonic)
$M_i > 1$ (Supersonic)
$dT_0 = 0$
Q=0
$dT_0 = 0$
$ds > 0$
$ds > 0$
$dP_0 < 0$
$dP_0 < 0$
$dM > 0$
$dM < 0$
$dT < 0$
$dT > 0$
T
s
$dV > 0$
$dP < 0$
depends on problem
$dV < 0$
$dP > 0$

Example 9.1:

$L/D = 15$



$M_1 = 0.6$

Air

$P_1 = 150\,kPa\,abs.$

$T_1 = 300\,K$

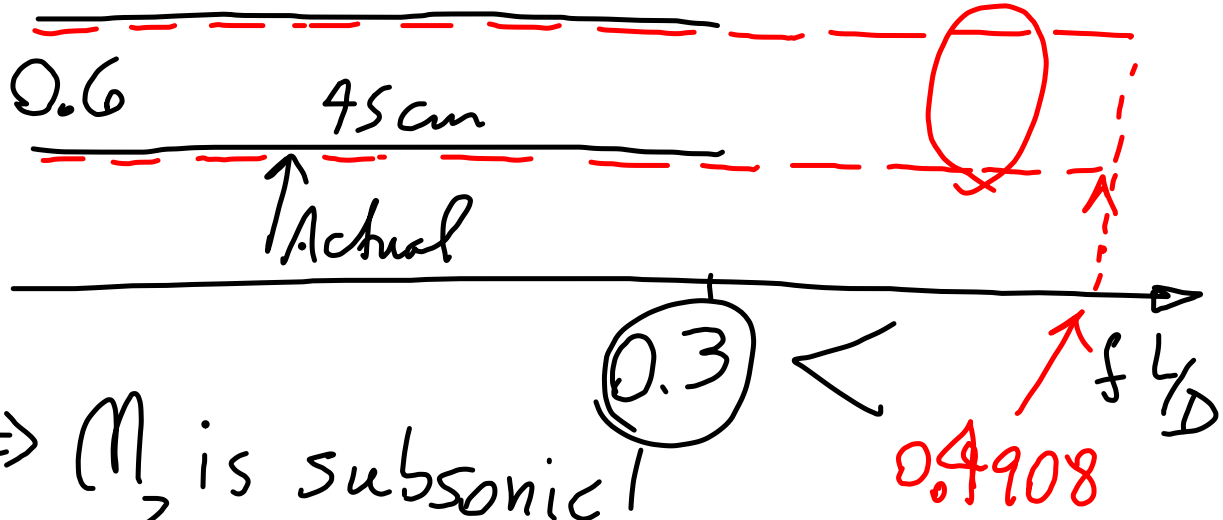
$M_2, P_2, T_2 = ?$

UG Incompressible fluid flow:

$Re \rightarrow f \rightarrow$ Energy Eq. $\Rightarrow \left(\frac{P}{\rho} + \alpha\frac{V^2}{2} + \ldots\right) \equiv f\frac{L}{D}\frac{V^2}{2}$

$$\Rightarrow f\frac{L}{D}\Big|_{actual} = (0.02)\frac{45}{3} = 0.3$$

App. F with $M_1 = 0.6 \Rightarrow f\frac{L_{max}}{D} = 0.4908$

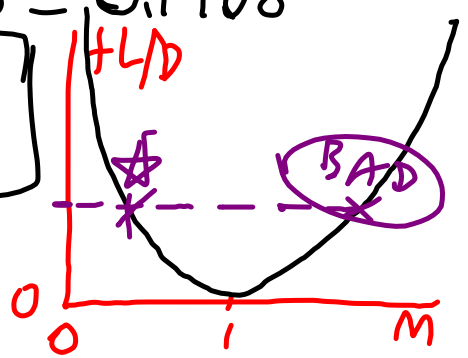


$\Rightarrow M_2$ is subsonic!

$$\left.\frac{fL_{max}}{D}\right|_2 = \left.\frac{fL_{max}}{D}\right|_1 - \left.\frac{fL}{D}\right|_{actual}$$

$$= 0.4908 - 0.3 = 0.1908$$

App. F $\Rightarrow$ $\boxed{M_2 = 0.71}$



$$\frac{P_2}{P_1} = \frac{P_2/p^*}{P_1/p^*} = \frac{1.4728}{1.7634} = 0.835$$

$$\Rightarrow P_2 = 125.3 \text{ kPa}$$

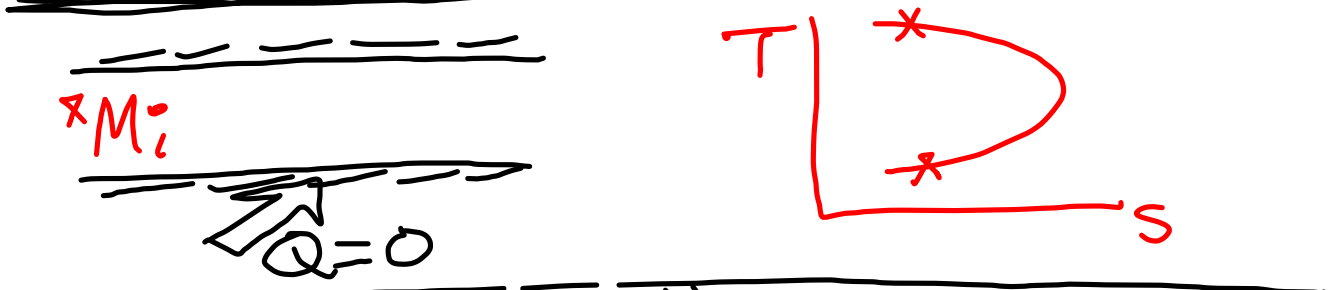
P_1 was 150 kPa!

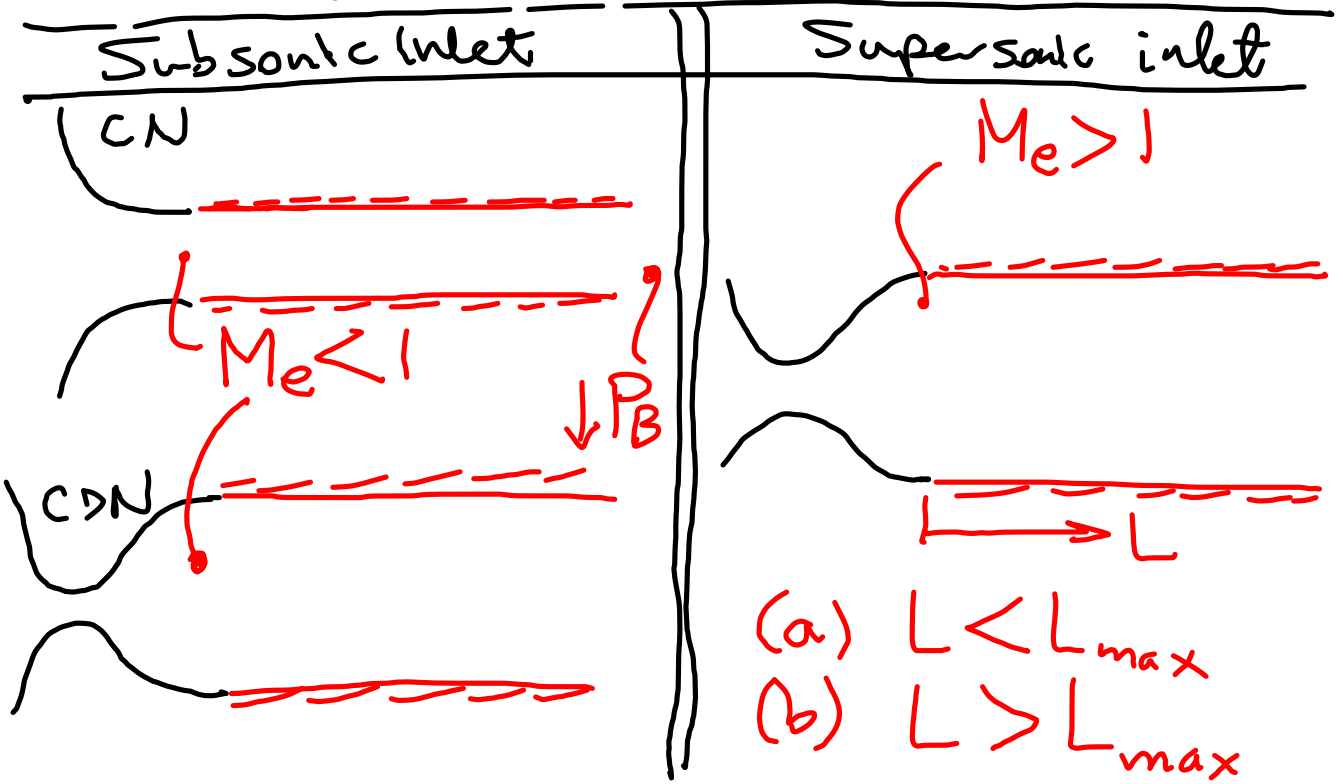
$$\Rightarrow T_2/T_1 = 0.974 \Rightarrow T_2 = 292.2 \text{ K}$$

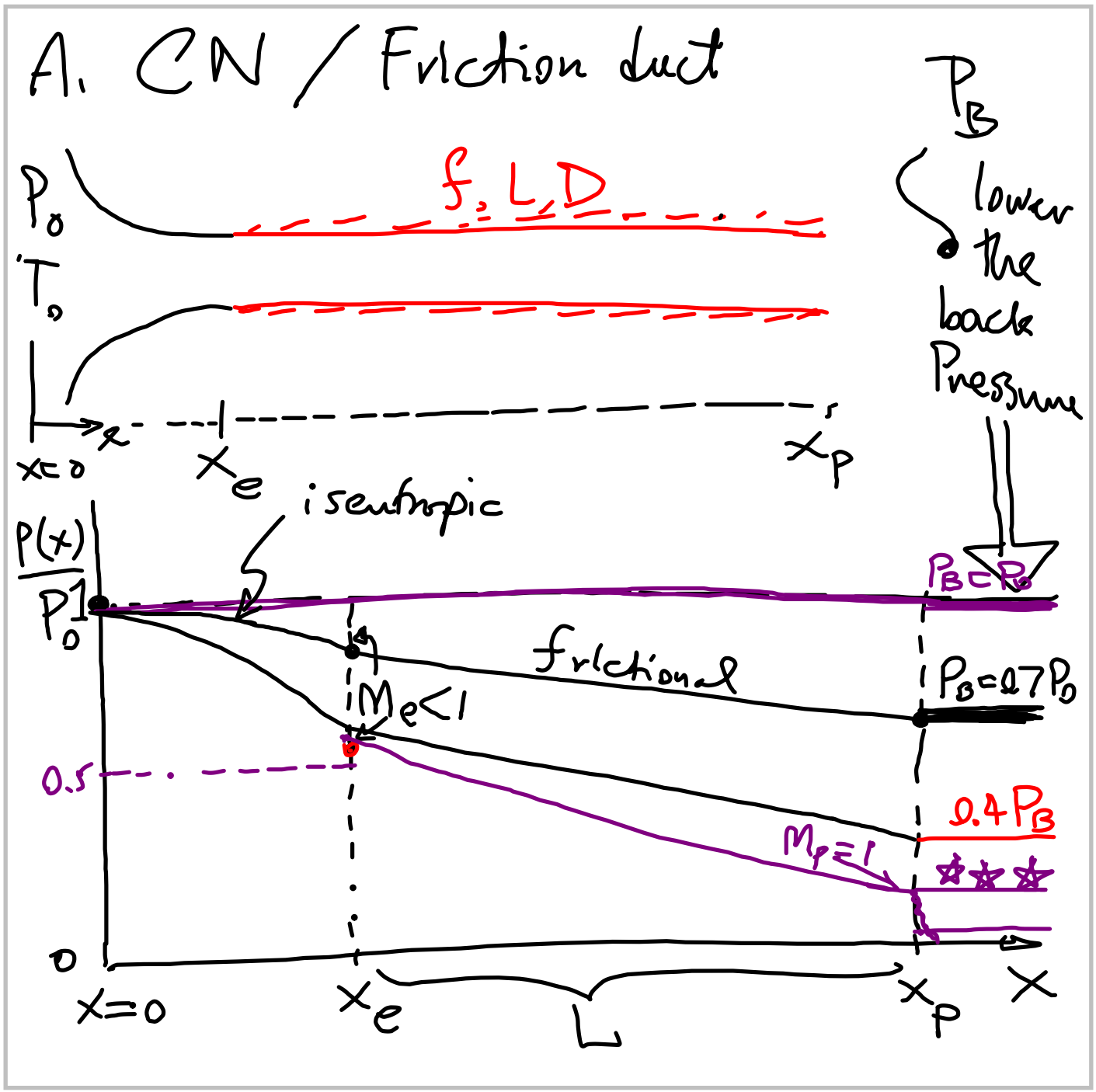
Material above will be on Exam 2, Th 11/8!

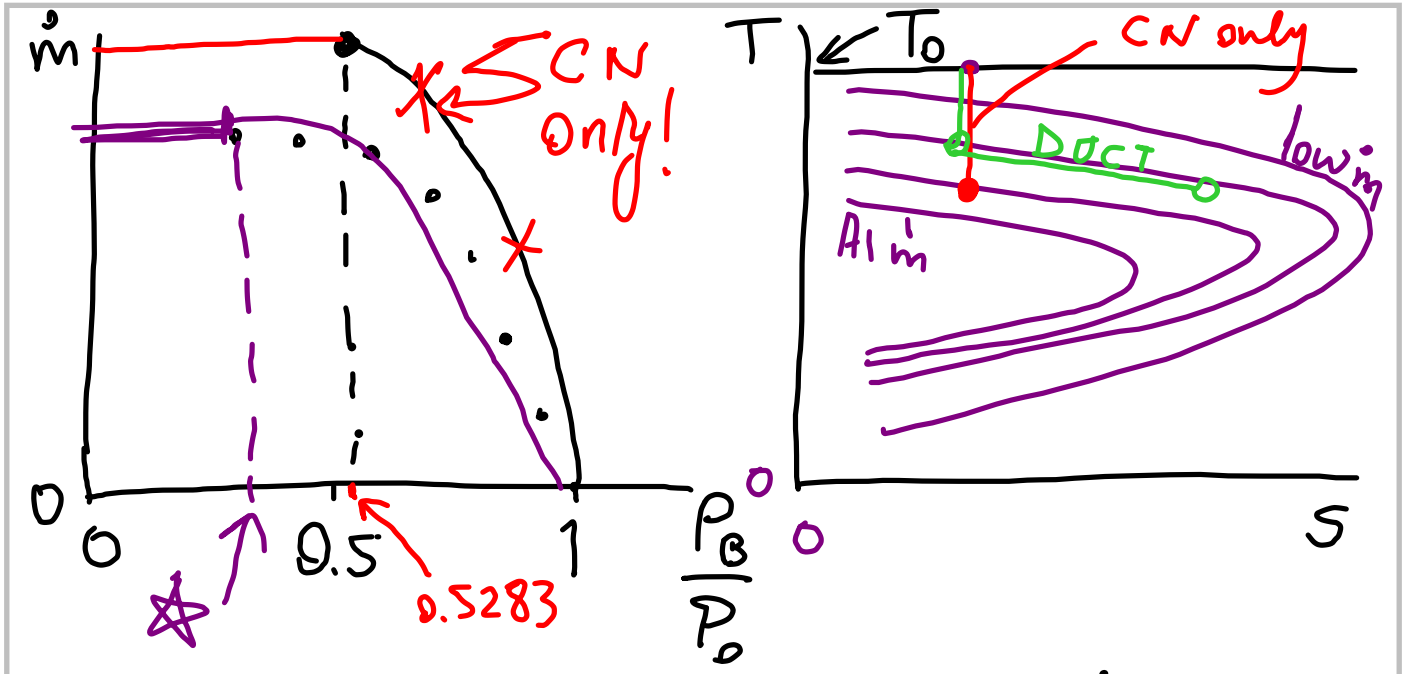
9.3 Flow Through a Composite

NOZZLE / Frictional Duct



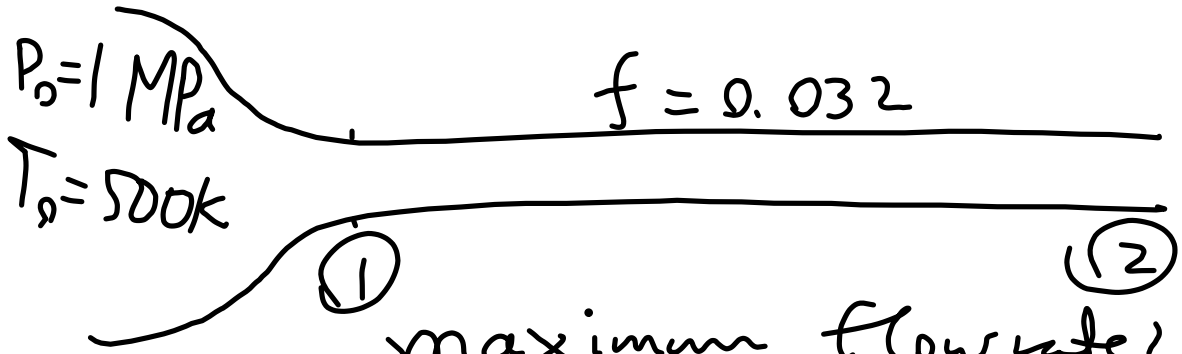



A. CN / Friction duct
P_B
P_0
f, L, D
lower the back Pressure
T_0
x
x=0
x_e
x_p
isentropic
P(x)
P_0
$P_B = P_0$
frictional
$M_e < 1$
$P_B = 0.7 P_0$
0.5
$0.4 P_B$
$M_p = 1$
0
x=0
x_e
L
x_p
X



- Subsonic in the CN at all time
- M_e of CN is subsonic
- System can be choke BY THE DUCT & not the nozzle $P_B/P_0 < 0.5283$

Ex. $L = 20\,cm$, $D = 2\,cm$



- maximum flowrate?
- range of P_B for max in?

$\Rightarrow M_2 = 1 \Rightarrow$ max in!

$M_1 < 1$ subsonic

$$\left.\frac{fL}{D}\right|_{actual} = 0.032 \cdot \left(\frac{20}{2}\right) = 0.32$$

$\Rightarrow$ App. F $\Rightarrow$ $M_1 = 0.652$.

Isentropic flow in the CV

App. A $\frac{P_1}{P_0} = 0.7515$, $\frac{T_1}{T_0} = 0.9217$

$\Rightarrow$ $P_1 = 751.5$ kPa abs., $T_1 = 460.9$ K

$\dot{m}_{max} = \rho_1 A_1 V_1 = 0.5009$ kg/s

$\dot{m}$ without duct $= 0.5679$

$\frac{P_2}{P_1} = \frac{P^*}{P_1} = \frac{1}{1.6130} \Rightarrow P^* = P_2 = \frac{P_1}{1.6130}$

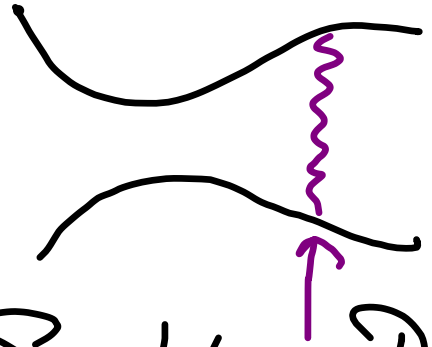
$P^* = 465.9$ kPa abs. $\geq P_B \geq 0$

Exam #2

60 min

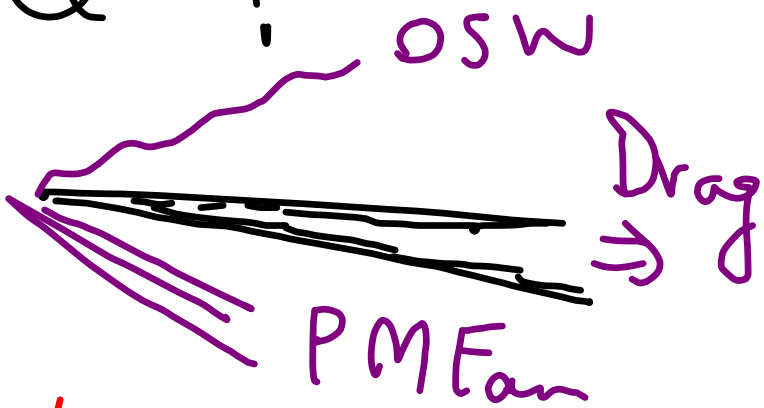
- Closed Book & Notes
- Blue Sheet Tables
- CDN chart

1. CDN with NSW



2. Sudden Discharge
   Q = ?

3.



4. Ch. 9 (Today)