AE111 QUIZ 1

1. a) chord, velocity $\frac{1}{2}+\frac{1}{2}$
   b) roll. 1
   c) lift, drag, velocity $(\frac{1}{2}, \frac{1}{2})+\frac{1}{2}$
   d) Camber. 1
   e) flap 1
   f) increase in drag, lose of lift (1, 1)
   g) rudder 1
   h) stagnation point 1
   i) kinematic similarity 1
   j) gravitational constant. 1

— x —

2. $\frac{u}{U} = 2\frac{y}{h} - y^2/h^2$.

(1/2) $$\frac{du}{dy} = U\left[\frac{2}{h} - \frac{2y}{h^2}\right]$$

$$= 2\left[\frac{2}{0.1} - \frac{2y}{0.01}\right] = 4\left[10 - 100y\right]$$

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

$$= 0.798\times10^{-5}\times4\left[10 - 100y\right]$$

(1/2) $$\tau\Big|_{@y=0} = 4\times0.798\times10^{-4} \left(\frac{N\cdot s}{m^2}\cdot\frac{m/s}{m}\right) N/m^2$$

$$= 3.192\times10^{-4}\ N/m^2$$

(1) Direction – along the wall.

3.

a) $E_v = +\dfrac{dp}{d\rho/\rho}$. $\frac{1}{2}$ (4)

$$\int_0^{p} dp = E_v \int_{\rho_0}^{\rho} \frac{d\rho}{\rho}$$

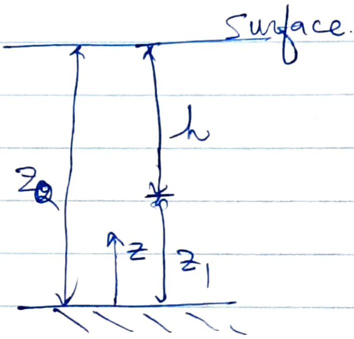
$\rho = \rho_0$ at $p = 0$.

$$p = E_v \ln\left(\frac{\rho}{\rho_0}\right)$$

$$\rho = \rho_0 e^{(p/E_v)} \quad \text{—(A)}$$

$\frac{1}{2}$ $\dfrac{dp}{dz} = -\gamma = -\rho g$

$$\frac{dp}{\rho} = -g\,dz \quad \text{—(B)}$$



Using (A) in (B)

$$\int_{p_1}^{0} \frac{dp}{\rho_0 e^{(p/E_v)}} = -g \int_{z_1}^{z_0} dz$$

$$= \int_{p_1}^{0} \frac{dp}{e^{(p/E_v)}} = -\rho_0 g \int_{z_1}^{z_0} dz$$

L.H.S $= \displaystyle\int_{p_1}^{0} e^{-p/E_v}\,dp = -E_v \left[e^{-p/E_v}\right]_{p_1}^{0}$

$$= -E_v\left[1 - e^{-p_1/E_v}\right]$$

R.H.S $= -\rho_0 g\left[z_0 - z_1\right] = -\rho_0 g h$.

$$-E_v\left[1-e^{-p_1/E_v}\right] = -\rho_o g h$$

$$1-e^{-p_1/E_v} = \rho_o g h / E_v.$$

$$1-\rho_o g h/E_v = e^{-p_1/E_v}.$$

$$-\frac{p_1}{E_v} = \ln\left[1-\frac{\rho_o g h}{E_v}\right]$$

(3) $$p_1 = -E_v \ln\left[1-\frac{\rho_o g h}{E_v}\right]$$

b) $h = 6\,km. = 6\times10^3\,m.$

$E_v = 2.3\times10^9\,Pa.$; $\rho = 1030\,kg/m^3.$

$$p_1 = -2.3\times10^9 \times\left[\ln\left(1-\frac{1.03\times10^3\times9.81\times6\times10^3}{2.3\times10^9}\right)\right]$$

$= 61439143.53142\ Pa.$

(1) $= 61.43914\ MPa.$

(1) Constant density $p = \rho g h.$

$= 1.03\times10^3\times9.81\times6\times10^3$

$= 60625800\ Pa$

$= 60.625\ MPa.$

— x —

4. 80 kg $\quad V = 1200\ m^3$.

$\rho_{He} = 0.18\ kg/m^3 \qquad \rho_{air} = 1.30\ kg/m^3$.

(1) $L = \rho_{atm} \cdot V \cdot g \left(1 - \frac{\rho_{gas}}{\rho_{atm}}\right)$.

$= 1.30 \times 1200 \times 9.81 \left[1 - \frac{0.18}{1.30}\right]$

(½) $L = 13184.64\ N$.

(½) Ballon weight = $80 \times 9.81 = 784.~~532~~8\ N$.

(1) Payload $= 13184.64 - 784.8$
$= 12399.84\ N$.

— x —

5. $R_H = 4157\ J/(kg \cdot K) \qquad g_{Jupiter} = 24.9\ m/s^2$

T = Constant = 150 K.

(½) Pressure above the surface, where pressure = ½ surface pressure.

for Isothermal layer.

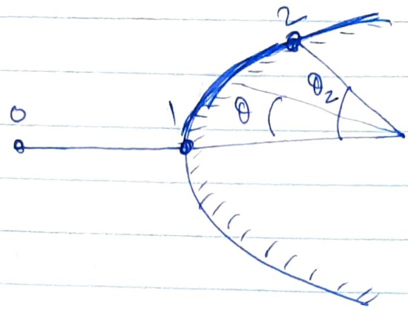
(1) $$\frac{P}{P_1} = e^{-[g_0/RT](h - h_1)}$$

$$\frac{1}{2} = e^{-[24.9/(4157 \times 150)]\Delta h}$$

(3) $$\ln\left(\frac{1}{2}\right) = \frac{-24.9}{4157 \times 150} \times \Delta h.$$

$\Delta h = 17357.90861\ m. = 17.357\ km.$

6.



Applying Bernoulli's equation along the streamline (incompressible)

2 $$p_0 + \frac{1}{2}\rho V_0^2 = p_1 + \frac{1}{2}\rho V_1^2 = p_2 + \frac{1}{2}\rho V_2^2$$

$$V_1 = 0$$

$$\Rightarrow p_0 + \frac{1}{2}\rho V_0^2 = p_1 = p_2 + \frac{1}{2}\rho V_2^2.$$

$$p_1 - p_2 = \frac{1}{2}\rho V_2^2 = \frac{1}{2}\rho V_0^2.$$

1 $$\therefore V_2 = V_0.$$

$$V = 2V_0 \sin\theta \quad \Rightarrow V_0 = 2V_0\sin\theta.$$

$$\frac{1}{2} = \sin\theta.$$

1 $$\theta = 30^\circ$$