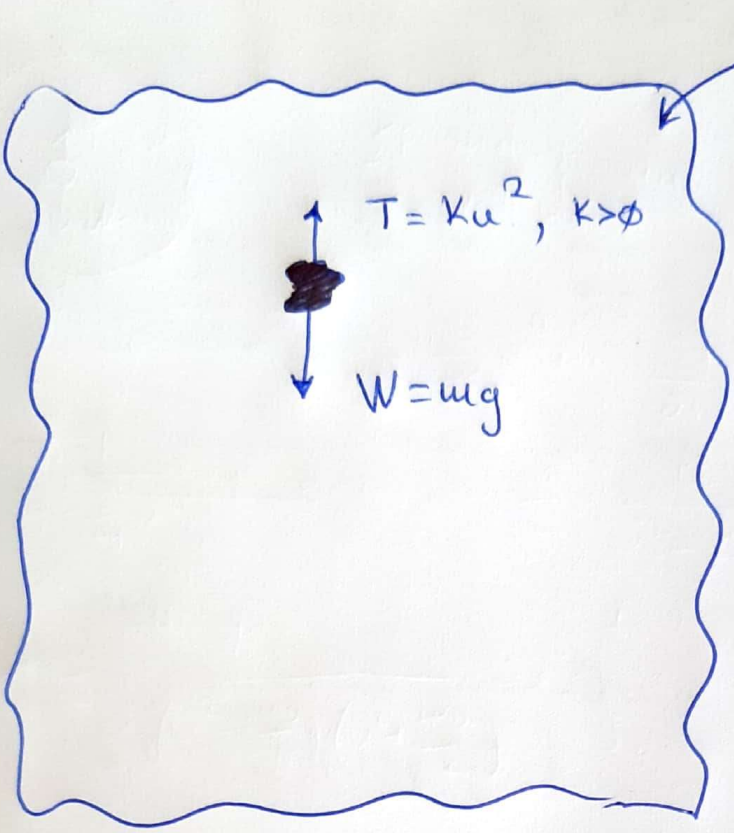


For $t = \emptyset$ sec $u_0 = \emptyset \frac{m}{s}$

T : Fluid friction

Buoyancy $= \emptyset$

(a) $u(t) = ?$

(b) limit speed $= ?$

$$\left.\begin{array}{l}\Sigma F = ma \\ \Sigma F = W - T\end{array}\right\} ma = mg - kv^2 \Leftrightarrow a = g - \frac{k}{m}u^2 \Leftrightarrow$$

$$\Leftrightarrow \frac{\partial u}{\partial t} = g - \frac{k}{m}u^2 \Leftrightarrow \frac{1}{g - \frac{k}{m}u^2}\partial u = \partial t \Leftrightarrow$$

$$\Leftrightarrow -\frac{m}{k}\frac{1}{u^2 - \frac{gm}{k}}\partial u = \partial t \Leftrightarrow -\frac{m}{k}\int_0^u \frac{1}{u^2 - \frac{gm}{k}}\partial u = \int_0^t \partial t \Leftrightarrow$$

$$\Leftrightarrow -\frac{m}{k}\int_0^u \frac{1}{\left(u - \sqrt{\frac{gm}{k}}\right)\left(u + \sqrt{\frac{gm}{k}}\right)}\partial u = \int_0^t \partial t \quad (*)$$

- $$\frac{1}{\left(u - \sqrt{\frac{gm}{k}}\right)\left(u + \sqrt{\frac{gm}{k}}\right)} = \frac{A}{u - \sqrt{\frac{gm}{k}}} + \frac{B}{u + \sqrt{\frac{gm}{k}}} \Leftrightarrow$$

$$\Leftrightarrow 1 = A\left(u + \sqrt{\frac{gm}{k}}\right) + B\left(u - \sqrt{\frac{gm}{k}}\right)$$

For $u = \sqrt{\frac{gm}{k}} \rightsquigarrow A = \frac{1}{2\sqrt{\frac{gm}{k}}}$

For $u = -\sqrt{\frac{gm}{k}} \rightsquigarrow B = -\frac{1}{2\sqrt{\frac{gm}{k}}}$

(*) $\Leftrightarrow -\frac{u}{k}\int_0^u \left( \frac{1}{2\sqrt{\frac{gu}{k}}} \cdot \frac{1}{u-\sqrt{\frac{gu}{k}}} - \frac{1}{2\sqrt{\frac{gu}{k}}} \cdot \frac{1}{u+\sqrt{\frac{gu}{k}}} \right) \partial u = \int_0^t \partial t \quad (\Rightarrow$

$(\Rightarrow -\frac{u}{k} \frac{1}{2\sqrt{\frac{gu}{k}}} \int_0^u \frac{1}{u-\sqrt{\frac{gu}{k}}} \partial u + \frac{u}{k} \frac{1}{2\sqrt{\frac{gu}{k}}} \int_0^u \frac{1}{u+\sqrt{\frac{gu}{k}}} \partial u = \int_0^t \partial t \quad (\Leftrightarrow$

$\Leftrightarrow -\frac{u}{k} \frac{1}{2\sqrt{\frac{gu}{k}}} \left( \ln\left|u-\sqrt{\frac{gu}{k}}\right| \right)_0^u + \frac{u}{k} \frac{1}{2\sqrt{\frac{gu}{k}}} \left( \ln\left|u+\sqrt{\frac{gu}{k}}\right| \right)_0^u = t \quad \Leftrightarrow$

$$\Leftrightarrow -\frac{w}{k}\frac{1}{2\sqrt{\frac{gw}{k}}}\left(\ln\left|u-\sqrt{\frac{gw}{k}}\right|-\ln\left|-\sqrt{\frac{gw}{k}}\right|\right)+\frac{w}{k}\frac{1}{2\sqrt{\frac{gw}{k}}}\left(\ln\left|u+\sqrt{\frac{gw}{k}}\right|-\ln\left|\sqrt{\frac{gw}{k}}\right|\right)=t \Leftrightarrow$$

$$\Leftrightarrow -\frac{w}{k}\frac{1}{2\sqrt{\frac{gw}{k}}}\ln\left|\frac{u-\sqrt{\frac{gw}{k}}}{-\sqrt{\frac{gw}{k}}}\right|+\frac{w}{k}\frac{1}{2\sqrt{\frac{gw}{k}}}\cdot\ln\left|\frac{u+\sqrt{\frac{gw}{k}}}{\sqrt{\frac{gw}{k}}}\right|=t \Leftrightarrow$$

$$\Leftrightarrow \frac{w}{k}\frac{1}{2\sqrt{\frac{gw}{k}}}\left(\ln\left|\frac{u+\sqrt{\frac{gw}{k}}}{\sqrt{\frac{gw}{k}}}\right|-\ln\left|\frac{u-\sqrt{\frac{gw}{k}}}{-\sqrt{\frac{gw}{k}}}\right|\right)=t \Leftrightarrow$$

$$\Leftrightarrow \ln\left|\frac{u+\sqrt{\frac{gu}{k}}}{\sqrt{\frac{gu}{k}}}\right| - \ln\left|\frac{u-\sqrt{\frac{gu}{k}}}{-\sqrt{\frac{gu}{k}}}\right| = \frac{t}{\frac{w}{k}\frac{1}{2\sqrt{\frac{gu}{k}}}} \Leftrightarrow$$

$$\Leftrightarrow \ln\left|\frac{\frac{u+\sqrt{\frac{gu}{k}}}{\sqrt{\frac{gu}{k}}}}{\frac{u-\sqrt{\frac{gu}{k}}}{-\sqrt{\frac{gu}{k}}}}\right| = \frac{t}{\frac{w}{k}\frac{1}{g\sqrt{\frac{gu}{k}}}} \Leftrightarrow$$

$$\Leftrightarrow \frac{\frac{u+\sqrt{\frac{gu}{k}}}{\sqrt{\frac{gu}{k}}}}{\frac{u-\sqrt{\frac{gu}{k}}}{-\sqrt{\frac{gu}{k}}}} = e^{\left(\frac{t}{\frac{w}{k}\frac{1}{2\sqrt{\frac{gu}{k}}}}\right)} \Leftrightarrow$$

$$\Leftrightarrow \frac{\left(u+\sqrt{\frac{g\mu}{k}}\right)\left(-\sqrt{\frac{g\mu}{k}}\right)}{\left(u-\sqrt{\frac{g\mu}{k}}\right)\left(\sqrt{\frac{g\mu}{k}}\right)} = e^{\left(\frac{t}{\frac{u}{k}\frac{1}{2\sqrt{\frac{g\mu}{k}}}}\right)} \Leftrightarrow$$

$$\Leftrightarrow -\frac{u+\sqrt{\frac{g\mu}{k}}}{u-\sqrt{\frac{g\mu}{k}}} = e^{\left(\frac{t}{\frac{u}{k}\frac{1}{2\sqrt{\frac{g\mu}{k}}}}\right)} \Leftrightarrow$$

$$\Leftrightarrow -u+\sqrt{\frac{g\mu}{k}} = e^{(\dots)}\left(u-\sqrt{\frac{g\mu}{k}}\right) \Leftrightarrow -u+\sqrt{\frac{g\mu}{k}} = e^{(\dots)}\cdot u - e^{(\dots)}\cdot\sqrt{\frac{g\mu}{k}} \Leftrightarrow$$

$$\Leftrightarrow e^{(\dots)} \cdot u + u = e^{(\dots)} \cdot \sqrt{\frac{g\mu}{k}} + \sqrt{\frac{g\mu}{k}} \Leftrightarrow u\left(e^{(\dots)} + 1\right) = \left(e^{(\dots)} + 1\right)\sqrt{\frac{g\mu}{k}} \Leftrightarrow$$

$$\Leftrightarrow \boxed{u = \sqrt{\frac{g\mu}{k}}} \rightsquigarrow u = \sqrt{\frac{W}{k}}$$