1. **Elimination of the pressure term** *(5 points)*
   Assume a 2D flow without non-linear terms and friction, where the equations reduce to:

$$\rho \frac{\partial u}{\partial t} = -\frac{\partial p}{\partial x} \tag{1}$$
$$\rho \frac{\partial v}{\partial t} = -\frac{\partial p}{\partial y} \quad . \tag{2}$$

   a) Eliminate the pressure in (1,2) .

   b) Show: Defining the stream function ψ through

$$u = -\frac{\partial \psi}{\partial y} \quad ; \quad v = \frac{\partial \psi}{\partial x} \tag{3}$$

   (mass continuity being unconditionally satisfied), the dynamics degrade into one equation:

$$\partial_t \left(\nabla^2 \psi \right) = 0 \tag{4}$$

   c) We now consider the rotating framework and add the Coriolis terms $-\rho f v$ and $\rho f u$ to the left hand sides of (1,2). Show that (4) changed into

$$\partial_t \left(\nabla^2 \psi \right) + \beta v = 0 \tag{5}$$

   d) Consider the non-linear case, is the following correct ?

$$D_t \left(\nabla^2 \psi \right) + \beta v = 0 \tag{6}$$

Notes on submission form of the exercises: *Working in study groups is encouraged, but each student is responsible for his/her own solution. The answers to the questions can be send until the due date (12:00) to Fernanda Matos (Fernanda.Matos@awi.de), Ahmadreza Masoum (Ahmadreza.Masoum@awi.de).*