0.1 Scalar potential

Given a vector field $\mathbf{F}$ we may be able to identify a scalar field P such that:

$\mathbf{F} = -\nabla P$

0.2 Non-uniqueness of scalar potentials

Scalar potentials are not unique.

If P is a scalar potential of $\mathbf{F}$, then so is $P + c$, where c is a constant.

0.2.1 Conservative vector fields

Not all vector fields have scalar potentials. Those that do are conservative.

For example if a vector field is the gradient of a scalar height function, then the height is a scalar potential.

If a vector field is the rotation of water, there will not be a scalar potential.