**Exercise 3**

A sub-sea pipeline connects a well-head cluster to a process plant on land, a length of 20 km. Pipe inner diameter is: 400 mm. The pipe runs horizontally the first 15 km. The last 5km approaching shore it slopes: 5o upwardly. Consider the pipeline flow conditions:

Gas superficial velocity: 2 m/s

Liquid flowing fraction: l=0.01

Gas density: 100kg/m3

Liquid density: 900kg/m3

The following friction factors have been estimated

Gas against pipe wall: 0.02

Gas against liquid layer: 0.04

Liquid against pipe wall: 0.012

**Task 1**

1. Estimate the liquid layer height in the horizontal section
2. Estimate the liquid layer height in the upward sloping section

**Task 2**

1. Estimate pressure drop along the horizontal section
2. Estimate pressure drop along the upward sloping section
3. Discuss the validity of your pressure drop estimates above