1. Calculate the dissolved oxygen concentration of seawater at 5 and 20 DegC.
   The partial pressure of the contaminant above the liquid
   pp = H . x
   H – Henry's constant
   x – mol fraction of component in liquid phase

   5 DegC – H = 29100 atm/mf
   Partial pressure of oxygen in air = 0.2095 atm
   Therefore, dissolved oxygen x = 0.2095/29100 = 7.2 x 10^{-6} = 7.3 ppm

   20 DegC – H = 40100 atm/mf
   Partial pressure of oxygen in air = 0.2095 atm
   Therefore, dissolved oxygen x = 0.2095/40100 = 5.2 x 10^{-6} = 5.2 ppm

2. A sea water deaeration column utilising gas stripping in a single packed bed is operating with the following conditions.

   Stripping gas is Nitrogen. The oxygen partial pressure contained within the nitrogen at inlet and outlet conditions is 0 and 0.02atm respectively. Seawater counter flows to the Nitrogen. The seawater enters the column with an Oxygen concentration of 8 x 10-6 mol fraction, the sea water leaves the bottom of the column with a concentration of 0.05 x 10-6 mol fraction. The column operates at 10 DegC. The height of the packing is 3.5 m.

   The information is to be used to design a new column to achieve an Oxygen outlet of 0.04 x 10-6 mol fraction. The other conditions for the new column are as above, calculate the packing height which would be required in the new column.

   Henry's constant for seawater can be taken as;

T(ºC)	H_{O2} atm/mol fraction
0	25,500
5	29,100
10	32,700
15	36,400
20	40,100
25	43,800
30	47,500
35	50,700
40	53,500
45	56,300
50	58,800
60	62,900
70	66,300
80	68,700
90	69,900
100	70,100

The number of transfer units for the packing can be calculated from (usual notation);

$NTU = (x_1-x_2)/\Delta x_{lm}$, where $\Delta x_{lm} = ((x - x_e)_1 - (x - x_e)_2)/\ln((x - x_e)_1 / (x - x_e)_2)$

1 is column top, 2 is column bottom

$x_1 = 8 \times 10^{-6}$

$x_2 = 0.05 \times 10^{-6}$

The equilibrium concentration at column top and bottom can be determined from Henry's law;

Partial pressure O2, PPO2 = H.x

At column temperature 10 DegC, H = 32700 atm/mol fct

Hence,

x_{e1} = PPO2/H = 0.02/32700 = 6.12×10^{-7}

x_{e2} = PPO2/H = 0

Substituting into the NTU expression;

NTU = $(x_1-x_2)/\Delta x_{lm}$, where $\Delta x_{lm} = ((x - x_e)_1 - (x - x_e)_2)/\ln((x - x_e)_1 / (x - x_e)_2)$

$\Delta x_{lm} = ((x - x_e)_1 - (x - x_e)_2)/\ln((x - x_e)_1 / (x - x_e)_2)$

$= (8 \times 10^{-6} - 6.12 \times 10^{-7}) - (0.05 \times 10^{-6} - 0)/\ln((8 \times 10^{-6} - 6.12 \times 10^{-7})/ (0.05 \times 10^{-6} - 0))$

$= 1.468 \times 10^{-6}$

Therefore, NTU = $(8 \times 10^{-6} - 0.05 \times 10^{-6})/ 1.468 \times 10^{-6} = 5.41$

Packing height, Z = NTU x HTU

Z = 3.5m

Thus the HTU = 3.5/5.44 = 0.643m

The new packing will have the same HTU

Calculate new NTU, with $x_2 = 0.04 \times 10^{-6}$ mf

NTU(new)

$\Delta x_{lm} = ((x - x_e)_1 - (x - x_e)_2)/\ln((x - x_e)_1 / (x - x_e)_2)$

$= (8 \times 10^{-6} - 6.12 \times 10^{-7}) - (0.04 \times 10^{-6} - 0)/\ln((8 \times 10^{-6} - 6.12 \times 10^{-7})/(0.04 \times 10^{-6} - 0))$

$= 1.408 \times 10^{-6}$

Therefore, NTU(new) = $(8 \times 10^{-6} - 0.04 \times 10^{-6})/1.408 \times 10^{-6} = 5.65$

Z(new) = NTU (new) x HTU = 0.643 x 5.65 = 3.63m