Roll No: Quiz 1 (CHE 318) Time Allowed: 30 Min.

(1) At P = 1 atm and T = 25 °C, the molecular diffusivity of 1%-Helium in Nitrogen is given $7 \times 10^{-5}\, m^2/s$, its diffusivity at P= 1 atm and T = 50 °C will be

(a) $7 \times 10^{-5}\, m^2/s$	√ (b) less than 14×10^{-5} and more than $7 \times 10^{-5}\, m^2/s$
(c) $14 \times 10^{-5}\, m^2/s$	(d) more than $14 \times 10^{-5}\, m^2/s$

(2) At P = 1 atm and T = 25 °C, the molecular diffusivity of 1%-Helium in Nitrogen is given $7 \times 10^{-5}\, m^2/s$, its diffusivity at P= 0.5 atm and T = 25 °C will be

(a) $7 \times 10^{-5}\, m^2/s$	(b) less than 14×10^{-5} and more than $7 \times 10^{-5}\, m^2/s$
√ (c) $14 \times 10^{-5}\, m^2/s$	(d) more than $14 \times 10^{-5}\, m^2/s$

(3) At P = 1 atm and T = 25 °C, the molecular diffusivity of 1%-Helium in Nitrogen is given $7 \times 10^{-5}\, m^2/s$. At P = 1 atm and T = 25 °C, molecular diffusivity of 10%-Helium in Nitrogen will be

√ (a) $7 \times 10^{-5}\, m^2/s$	(b) less than 14×10^{-5} and more than $7 \times 10^{-5}\, m^2/s$
(c) $14 \times 10^{-5}\, m^2/s$	(d) more than $14 \times 10^{-5}\, m^2/s$

(4) At P = 1 atm and T = 25 °C, the molecular diffusivity of 1%-Helium in Nitrogen is given $7 \times 10^{-5}\, m^2/s$. At P = 1 atm and T = 25 °C, molecular diffusivity of1%-Nitrogen in Helium will be

√ (a) $7 \times 10^{-5}\, m^2/s$	(b) less than 14×10^{-5} and more than $7 \times 10^{-5}\, m^2/s$
(c) $14 \times 10^{-5}\, m^2/s$	(d) more than $14 \times 10^{-5}\, m^2/s$

(5) At P = 1 atm and T = 25 °C, the molecular diffusivity of air in water vapor is $2.6 \times 10^{-5}\, m^2/s$. At P = 1 atm and T = 25 °C, the molecular diffusivity of air in liquid water is approximately

(a) $2.2 \times 10^{-2}\, m^2/s$	(b) $2.6 \times 10^{-3}\, m^2/s$
(c) $2.6 \times 10^{-5}\, m^2/s$	√ (d) $2.2 \times 10^{-9}\, m^2/s$

(6) At P = 1 atm and T = 25 °C, the molecular diffusivity of air in water vapor is $2.6 \times 10^{-5}\, m^2/s$. At P = 2 atm and T = 25 °C, the molecular diffusivity of air in liquid water is approximately

(a) $2.2 \times 10^{-2}\, m^2/s$	(b) $2.6 \times 10^{-3}\, m^2/s$
(c) $2.6 \times 10^{-5}\, m^2/s$	√ (d) $2.2 \times 10^{-9}\, m^2/s$

(7) At a given temperature and pressure, the complete evaporation of a droplet of liquid of 2 mm diameter takes about 300 s approximately. How much time will approximately be required for the complete evaporation of a droplet of water of diameter = 4 mm.

(a) $150\, s$	(b) $300\, s$
(c) $600\, s$	√ (d) $1200\, s$

Water at 25°C is flowing in a covered irrigation ditch below ground. Every 100 m, there is a vent line 30 mm inside diameter and 1.0 m long to the outside atmosphere at 25°C. There are 10 vents in the 1000-m ditch. The outside air can be assumed to be dry. Calculate the total evaporation loss of water in kg/day. Use the diffusivity data from Table 6.2-1.

$T = 298\,K;\ P = 1.01325 \times 10^5\, Pa;\ D_{AB} = 2.6 \times 10^{-5}\ m^2/s;$

$Area = \pi (30/1000)^2 m^2 = 7.07 \times 10^{-4} m^2$

$p_{A1} =$ 3116 Pa (Vapor pressure of water vapor at 25°C)

$p_{A2} =$ 0 (Assuming dry air, *i.e.* no water vapor)

$p_{B1} = P - p_{A1} = 101.325 \times 10^3 - 3.116 \times 10^3 = 98{,}159$ Pa

$p_{B2} = P - p_{A2} = 101.325 \times 10^5 - 0 = 101{,}325$ Pa

$$p_{BM} = \frac{p_{B2} - p_{B1}}{ln \frac{p_{B2}}{p_{B1}}} = \frac{p_{A1} - p_{A2}}{ln \frac{p_{B2}}{p_{B1}}} = 99734\ Pa$$

When, $p_{B1} \approx p_{B2};\ p_{BM} \cong \frac{p_{B1}+p_{B2}}{2} = 99742\ Pa$

$$N_A = \frac{D_{AB}}{(z_2 - z_1)} \frac{P}{RT} \frac{p_{A1} - p_{A2}}{p_{BM}} = \frac{2.6 \times 10^{-5}}{1.0} \frac{1.01325 \times 10^5}{8314 \times 298} \frac{(3116 - 0)}{99734} = 3.38 \times 10^{-8} \frac{kg\ mol}{m^2 \cdot s}$$

$n_A = N_A \times Area \times MW \times (s/day) \times$ vents

$$= 3.38 \times 10^{-8} \frac{kg\ mol}{m^2 \cdot s} \times 7.07 \times 10^{-4} m^2 \times 18 \frac{kg}{kg\ mol} \times \frac{86400\ s}{day} \times 10$$

$$= 3.71 \times 10^{-4} \frac{kg}{d}$$

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(1) At P = 1 atm and T = 25 °C, the molecular diffusivity of 1%-Helium in Nitrogen is given $7 \times 10^{-5}\, m^2/s$, its diffusivity at P= 0.5 atm and T = 25 °C will be

(a) $7 \times 10^{-5}\, m^2/s$	(b) less than 14×10^{-5} and more than $7 \times 10^{-5}\, m^2/s$
√ (c) $14 \times 10^{-5}\, m^2/s$	(d) more than $14 \times 10^{-5}\, m^2/s$

(2) At P = 1 atm and T = 25 °C, the molecular diffusivity of 1%-Helium in Nitrogen is given $7 \times 10^{-5}\, m^2/s$, its diffusivity at P= 1 atm and T = 50 °C will be

(a) $7 \times 10^{-5}\, m^2/s$	√ (b) less than 14×10^{-5} and more than $7 \times 10^{-5}\, m^2/s$
(c) $14 \times 10^{-5}\, m^2/s$	(d) more than $14 \times 10^{-5}\, m^2/s$

(3) At P = 1 atm and T = 25 °C, the molecular diffusivity of 1%-Helium in Nitrogen is given $7 \times 10^{-5}\, m^2/s$. At P = 1 atm and T = 25 °C, molecular diffusivity of 10%-Helium in Nitrogen will be

(a) $14 \times 10^{-5}\, m^2/s$	(b) less than 14×10^{-5} and more than $7 \times 10^{-5}\, m^2/s$
√ (c) $7 \times 10^{-5}\, m^2/s$	(d) more than $14 \times 10^{-5}\, m^2/s$

(4) At P = 1 atm and T = 25 °C, the molecular diffusivity of 1%-Helium in Nitrogen is given $7 \times 10^{-5}\, m^2/s$. At P = 1 atm and T = 25 °C, molecular diffusivity of1%-Nitrogen in Helium will be

(a) $14 \times 10^{-5}\, m^2/s$	(b) less than 14×10^{-5} and more than $7 \times 10^{-5}\, m^2/s$
√ (c) $7 \times 10^{-5}\, m^2/s$	(d) more than $14 \times 10^{-5}\, m^2/s$

(5) At P = 1 atm and T = 25 °C, the molecular diffusivity of air in water vapor is $2.6 \times 10^{-5}\, m^2/s$. At P = 1 atm and T = 25 °C, the molecular diffusivity of air in liquid water is approximately

(a) $2.2 \times 10^{-2}\, m^2/s$	(b) $2.6 \times 10^{-3}\, m^2/s$
(c) $2.6 \times 10^{-5}\, m^2/s$	√ (d) $2.2 \times 10^{-9}\, m^2/s$

(6) At a given temperature and pressure, the complete evaporation of a droplet of liquid of 2 mm diameter takes about 300 s approximately. How much time will approximately be required for the complete evaporation of a droplet of water of diameter = 4 mm?

(a) $150\, s$	(b) $300\, s$
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(7) At P = 1 atm and T = 25 °C, the molecular diffusivity of air in water vapor is $2.6 \times 10^{-5}\, m^2/s$. At P = 2 atm and T = 25 °C, the molecular diffusivity of air in liquid water is approximately

(a) $2.2 \times 10^{-2}\, m^2/s$	(b) $2.6 \times 10^{-3}\, m^2/s$
(c) $2.6 \times 10^{-5}\, m^2/s$	√ (d) $2.2 \times 10^{-9}\, m^2/s$

Water at 25°C is flowing in a covered irrigation ditch below ground. Every 100 m, there is a vent line 20 mm inside diameter and 0.5-m long to the outside atmosphere at 25°C. There are 10 vents in the 1000-m ditch. The outside air can be assumed to be dry. Calculate the total evaporation loss of water in kg/day. Use the diffusivity data from Table 6.2-1.

$T = 298\, K;\; P = 1.01325 \times 10^5\, Pa;\; D_{AB} = 2.6 \times 10^{-5}\; m^2/s;$

$Area = \pi(20/1000)^2 m^2 = 3.14 \times 10^{-4} m^2$

$p_{A1} = 3116$ Pa (Vapor pressure of water vapor at 25°C)

$p_{A2} = 0$ (Assuming dry air, *i.e.* no water vapor)

$p_{B1} = P - p_{A1} = 101.325 \times 10^3 - 3.116 \times 10^3 = 98{,}159$ Pa

$p_{B2} = P - p_{A2} = 101.325 \times 10^5 - 0 = 101{,}325$ Pa

$$p_{BM} = \frac{p_{B2} - p_{B1}}{ln\frac{p_{B2}}{p_{B1}}} = \frac{p_{A1} - p_{A2}}{ln\frac{p_{B2}}{p_{B1}}} = 99734\; Pa$$

When, $p_{B1} \approx p_{B2};\; p_{BM} \cong \frac{p_{B1}+p_{B2}}{2} = 99742\; Pa$

$$N_A = \frac{D_{AB}}{(z_2 - z_1)}\frac{P}{RT}\frac{p_{A1} - p_{A2}}{p_{BM}} = \frac{2.6 \times 10^{-5}}{0.5}\frac{1.01325 \times 10^5}{8314 \times 298}\frac{(3116 - 0)}{99734} = 6.75 \times 10^{-8}\frac{kg\ mol}{m^2 \cdot s}$$

$$n_A = N_A \times Area \times MW \times (s/day) \times \text{vents}$$

$$= 6.75 \times 10^{-8}\frac{kg\ mol}{m^2 \cdot s} \times 3.14 \times 10^{-4} m^2 \times 18\frac{kg}{kg\ mol} \times \frac{86400\ s}{day} \times 10$$

$$= 3.30 \times 10^{-4}\frac{kg}{d}$$