(1) Liquid water slowly evaporates into surrounding air from a <u>spherical drop</u> maintained at constant temperature and pressure. If the <u>mole fraction of water vapor in the surrounding air is increased</u>, it will

(a) increase driving force for water evaporation	(b) decrease driving force for water evaporation
(c) not affect driving force for water evaporation	(d) no relationship with driving force

(2) Liquid water slowly evaporates into surrounding air from a <u>spherical drop</u> maintained at constant temperature and pressure. If the <u>humidity</u> of the surrounding air is <u>increased</u>, it will

(a) increase the water evaporation rate	(b) decrease the water evaporation rate
(c) not change the water evaporation rate	(d) no relationship with water evaporation rate

(3) The molecular diffusivity of gas mainly depends upon

(a) the temperature only	(b) the pressure only
(c) both temperature and pressure	(d) temperature, pressure and concentration

(4) A 100% increase in the temperature of a binary gas mixture from 20 C to 40 C will increase the diffusion coefficient by

(a) less than 10%	(b) more than 10% and less than 100%
(c) 100%	(d) more than 100%

(5) A 100% increase in the pressure of a binary gas mixture from 1 atm to 2 atm will decrease the diffusion coefficient by

(a) less than 10%	(b) more than 10% and less than 100%
(c) 100%	(d) more than 100%

(6) The molecular diffusivity is a function of concentration (or partial pressure) for

(a) both gas and liquid phases	(b) both gas and solid phases
(c) both liquid and solid phases	(d) solid phase only

(7) In order to increase the flux of species A diffusing from Point 1 to Point 2 through a membrane of vulcanized rubber, one should

(a) increase the pressure at both Points 1 and 2	(b) decrease the pressure at both Points 1 and 2
(c) decrease the pressure at Point 1 and increase pressure at Point 2	(d) increase the pressure at Point 1 and decrease pressure at Point 2

(8) The permeability of a species in a membrane of vulcanized rubber/nylon depends upon its

(a) solubility only	(b) molecular diffusivity only
(c) both solubility and diffusivity	(d) no effect of either solubility or diffusivity

(9) For the diffusion of gases A and B, the flux of A is given by $N_A = -cD_{AB}\frac{d(x_A)}{dz} + \frac{c_A}{c}(N_A + N_B)$. For the diffusion of gas B through the stagnant non-diffusing gas C, the flux of B (N_B) is given by,

(a) $\quad -cD_{BC}\frac{d(x_B)}{dz} + \frac{c_B}{c}(N_B)$	(b) $\quad -cD_{BC}\frac{d(x_B)}{dz} + \frac{c_B}{c}(N_C)$
(c) $\quad -cD_{BC}\frac{d(x_C)}{dz} + \frac{c_B}{c}(N_C)$	(d) $\quad -cD_{BC}\frac{d(x_C)}{dz} + \frac{c_B}{c}(N_B)$

(10) During the diffusion of species A through a liquid B, increasing the pressure by 100% will cause an increase in the diffusion coefficient by

(a) more than 100%	(b) 100%
(c) more than 10% and less than 100%	(d) almost no effect

Answers

1	2	3	4	5	6	7	8	9	10								
b	b	c	b	b	c	d	c	a	d								

The molecular diffusivity can be predicted using,

$$D_{AB} = \frac{1.0 \times 10^{-7} T^{1.75}}{[(\sum v_A)^{1/3} + (\sum v_B)^{1/3}]^2 P} \left(\frac{1}{M_A} + \frac{1}{M_B}\right)^{1/2}$$

Here, A and B are two kinds of molecules present in the gaseous mixture, D_{AB} is the diffusivity (m²/s), T is the absolute temperature (K), M is the molar mass (kg/ kg mol), P is the pressure (atm), and $\sum v_A$=sum of structural volume increments. Prediction accuracy of the above equation is about 8% up to about 1000 K. Using the given relationship, D_{AB1} is evaluated at temperature T_1 K and P_1 atm pressure.

For dilute solutes in liquids (Eq. 6.3-8 in C. J. Geankoplis):

$$D_{AB} = \frac{9.96 \times 10^{-16}}{V_A^{1/3}} (T) \left(\frac{1}{\mu}\right)$$

where, A is solute molecule present in low concentration in solvent B, D_{AB} is the diffusivity (m²/s), T is the absolute temperature (K), μ is the viscosity (Pa·s or kg/(m·s)) and V_A is the solute molar volume at its normal boiling point ($m^3/kg\ mol$). This equation give good predictions for very large un-hydrated and spherical-like solute molecules of molecular weight more than 1000 or where $V_A > 0.5\ m^3/kg\ mol$ in aqueous solution. For smaller solute molar volume, the Wike-Chang correlation can be used (Eq. 6.3-9 in C. J. Geankoplis):

$$D_{AB} = 1.173 \times 10^{-16} (\varphi M_B)^{1/2} \left(\frac{T}{\mu_B V_A^{0.6}}\right)$$

where, A is solute molecule present in low concentration in solvent B, D_{AB} is the diffusivity (m²/s), T is the absolute temperature (K), μ is the viscosity (Pa·s or kg/(m·s)) and V_A (see Table 6.3-2) is the solute molar volume at its normal boiling point ($m^3/kg\ mol$). φ is an association parameter of the solvent.

$$N_A = \frac{D_{AB}}{(z_2 - z_1)}(c_{A1} - c_{A2}) = \frac{D_{AB}}{(z_2 - z_1)}\left(\frac{Sp_{A1}}{22.4} - \frac{Sp_{A2}}{22.4}\right) = \frac{D_{AB}S(p_{A1} - p_{A2})}{22.4(z_2 - z_1)} = \frac{P_M(p_{A1} - p_{A2})}{22.4(z_2 - z_1)}$$

$$= \frac{P_M}{L}\frac{(p_{A1} - p_{A2})}{22.4} = \frac{(p_{A1} - p_{A2})}{22.4\left(\frac{L}{P_M}\right)}$$

For a tube of constant cross-sectional area, the total time of evaporation for the change in level from z_0 to z_F:

$$t_F = \frac{\rho_A}{M_A}\frac{(z_F^2 - z_0^2)}{2D_{AB}}\left(\frac{P}{RT}\frac{p_{A1} - p_{A2}}{p_{BM}}\right)^{-1}$$

For a sphere, for the complete evaporation of initial radius r_1:

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(c) $\quad -cD_{BC}\frac{d(x_C)}{dz} + \frac{c_B}{c}(N_C)$	(d) $-cD_{BC}\frac{d(x_B)}{dz} + \frac{c_B}{c}(N_B)$

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