## Short and Multiple Choice Questions

1. What are the three types of frames of reference used in mass transfer calculations?
2. What is Fick's first law of molecular diffusion in fluids? What are the other laws similar to this law?
3. Under what condition is the approximate form of Fick's law $N_A = -D_{AB}\left(\frac{dc_A}{dz}\right)$ valid?
4. Under what condition, the rates of equal molal counter-diffusion of two gases and diffusion of one gas through a stagnant layer of the other gas become almost equal?
5. For what kind of mixture or solution $D_{AB} = D_{BA}$?
6. Why molecular diffusion in liquids is very slow compared to that in gases?
7. How does binary diffusivity for molecular diffusion in liquids vary with temperature?
8. Molecular diffusivity in a binary gas mixture is related to the temperature ($T$) as
   (a) $D \propto T$ (b) $D \propto T^{0.5}$ (c) $D \propto T^{1.5}$ (d) $D \propto T^{-1}$
9. Molecular diffusivity in a binary gas mixture varies with total pressure ($P$) as
   (a) $D \propto P^{0.5}$ (b) $D \propto P^{1.5}$ (c) $D \propto P^{-0.5}$ (d) $D \propto P^{-1}$
10. The unit of volumetric diffusivity is
    (a) cm/s (b) cm$^2$/s (c) cm$^3$/s (d) cm$^2$/s$^2$.
11. Molecular diffusion is caused by
    (a) kinetic energy of the molecules
    (b) activation energy of the molecules
    (c) potential energy of the molecules
    (d) none of these.
12. Which of the following has the same dimension as that of molecular diffusivity?
    (a) momentum flux (b) thermal conductivity (c) kinematic viscosity (d) none of these
13. The steady-state gas phase reaction $3A + B = C + 2D$ takes place on a catalyst surface. What will be the value of the flux ratio $N_A/N_D$?
    (a) −2 (b) −0.5 (c) −1.5 (d) 2
14. Steady-state equimolal counter-diffusion occurs in
    (a) absorption of $NH_3$ from air by water
    (b) separation of a binary mixture by distillation
    (c) liquid-liquid extraction
    (d) leaching of solids
15. The binary diffusivity of gases at atmospheric conditions are approximately
    (a) $10^{-9}$ cm/s (b) $10^{-1}$ cm$^2$/s (c) $10^{-1}$ cm/s (d) $10^{-4}$ cm$^2$/s
16. Binary diffusivities in gases do not depend on the
    (a) pressure (b) temperature
    (c) nature of components (d) none of these
17. Component $A$ of a binary gas mixture is diffusing from point 1 to point 2. The total pressure is doubled by keeping all other parameters including mole fraction of $A$ at points 1 and 2 constant. How will the rate of diffusion change?

(a) it will be doubled
(b) it will be halved
(c) it will remain unchanged
(d) none of these

18. Molecular diffusivity, thermal diffusivity and eddy momentum diffusivity are the same for
(a) Pr = Sc = 0
(b) Pr = Sc = 0.5
(c) Pr = Sc = 1
(d) Pr = Sc = 10

19. Diffusivity in concentrated solutions differs from that in dilute solutions because of changes in
(a) viscosity
(b) degree of ideality
(c) both (a) and (b)
(d) neither (a) nor (b)

20. Knudsen diffusivity is proportional to
(a) $T^{0.5}$
(b) $T$
(c) $T^2$
(d) $T^4$

21. Liquid phase diffusivity varies with the viscosity of the solution as
(a) $D_{AB} \propto \mu^{0.5}$
(b) $D_{AB} \propto \mu$
(c) $D_{AB} \propto \mu^{-1}$
(d) $D_{AB} \propto \mu^2$

22. Two large bulbs containing mixtures of gases $A$ and $B$ at different proportions but at the same pressure are connected by a tapered tube 10 cm long and end diameters of 2 cm and 4 cm. At which point will the flux of $B$ be maximum?
(a) at the smaller diameter end
(b) at the larger diameter end
(c) at the middle of the tube.
(d) none of these

23. The diffusivity of methane in air at 0°C and 1 atm pressure is 0.196 cm²/s. What will be the diffusivity of air in methane at 50°C and 2.5 atm pressure?
(a) 0.196 $cm^2/s$
(b) 0.10 $cm^2/s$
(c) 0.078 $cm^2/s$
(d) none of these

8. Write Gilliland's equation for mass transfer in fluids flowing through pipes.

9. Schmidt Number is defined as

(a) $\mu/D_{AB}$ (b) $\mu/\rho D_{AB}$ (c) $\rho\mu/D_{AB}$ (d) $\mu D_{AB/}\rho$

10. Eddy momentum diffusivity, thermal diffusivity and mass diffusivity are the same for

(a) Pr = Sc = 0.7 (b) Pr = Sc = 7.0 (c) Pr = Sc = 1.0 (d) Pr = Sc = 700.

11. Lewis number of a mixture is defined as

(a) Pr·Sc (b) Pr/Sc (c) Sc/Pr (d) $C_S$(Sc/Pr)

12. Lewis Number is the ratio of

(a) thermal diffusivity to mass diffusivity

(b) mass diffusivity to momentum diffusivity

(c ) mass diffusivity to thermal diffusivity

(d) momentum diffusivity to thermal diffusivity

13. For water at 20°C, Prandtl Number is

(a) 0.702 (b) 7.02 (c) 70.2 (d) none of these

14. The probable value of Schmidt number (Sc) for diffusion of ammonia in air at 0°C is

(a) 0.35 (b) 0.665 (c) 0.015 (d) none of these

15. Rates of mass transfer are directly affected by

(a) diffusivity (b) hydrodynamic conditions

(c) interfacial area of contact (d) all of these

16. Sherwood number (Sh)

(a) increases with friction factor, $f$

(b) increases with Reynolds Number, Re

(c) decreases with Reynolds Number, Re

(d) decreases with friction factor, $f$

17. Stanton number for mass transfer $(St)_M$ is expressed as

(a) $\dfrac{Sh}{Re\,Sc}$ (b) $\dfrac{Sh}{Re\,Sc^{1/3}}$ (c) $\dfrac{Sh}{Re^{1/2}\,Sc^{1/2}}$

18. Peclet number (Pe) is defined as

(a) Pe = Re Sc (b) Pe = Re/Sc (c) Pe = $Re^{1/2}\,Sc^{1/3}$ (d) Pe = $Re^{1/3}Sc^{1/2}$

19. If Lewis number is 1, then

(a) Pr = Sc (b) Pr = Re (c) Sc = Re (d) Sh = Re Sc

20. According to Chilton–Colburn analogy for heat and mass transfer

(a) Sh $Sc^{1/3}$ = $f/8$ (b) Sh $Sc^{2/3}$ = $f/2$

(c) Sh $Sc^{3/2}$ = $f/2$ (d) Sh $Sc^{2/3}$ = $f/8$

21. Sherwood number (Sh) is defined as

(a) $\dfrac{D_{AB}}{k'_C d}$ (b) $\dfrac{k'_C}{d D_{AB}}$ (c) $\dfrac{k'_C D_{AB}}{d}$ (d) $\dfrac{k'_C d}{D_{AB}}$

22. For pure air at atmospheric conditions, Schmidt number (Sc) is

(a) < 1 (b) = 1 (c) > 1 (d) >> 1

23. For ideal gases, the different mass transfer coefficients are related as

(a) $k'_C = k_G RT = k'_y RT/P$ (b) $k'_C = k_G/RT = k'_y P/RT$

(c) $k'_C = k_G RT/P = k'_y RT$ (d) $k'_C = k_G = k'_y$

24. For flow through pipes, Reynolds analogy is valid for

(a) Pr = 1, Sc = 1 (b) Pr > 1, Sc > 1

(c) Pr < 1, Sc < 1 (d) Pr < 1, Sc > 1

25. The Colburn factor for mass transfer, $J_D$ can be expressed as

(a) $\frac{Sh}{Re\, Sc^{1/3}}$ (b) $\frac{Sh}{Re\, Sc}$ (c) $\frac{St}{Sc^{1/3}}$ (d) $\frac{St}{Re^{1/3}}$

26. In forced mass convection through a tube, Gilliland and Sherwood suggested the relation $Sh = 0.023\,(Re)^{0.83}\,(Sc)^{0.44}$ for

(a) 2000 < Re < 35000

(b) 0.06 < Sc < 2.5

(c ) 200 < Re < 35000 and 0.06 < Sc < 2.5

(d) none of these