

GUJARAT TECHNOLOGICAL UNIVERSITY

BE-7 SEMESTER – OLD PAPER – S22 TO S25 – QUESTION BANK

Subject Name & Code:

Transport Phenomena- 3170511

Unit 1: Introduction to Transport Phenomena

Repeated Questions:

1. **Compare/State the general equations/expression that govern any transport process.**
 - Appeared in: W23 (Q1a, 03 marks), SUM 25 (Q1a, 03 marks)
2. **Discuss the significance of momentum, thermal and mass diffusivities.**
 - Appeared in: S22 (Q1a, 03 marks), W23 (Q4a, 03 marks)
3. **Compare Scalar, Vector and Tensor. / Differentiate between Cartesian, cylindrical and spherical coordinate systems.**
 - Appeared in: S24 (Q1a, 03 marks), WIN 24 (Q1a, 03 marks)
4. **Explain momentum diffusivity. / Write the significance of momentum diffusivity.**
 - Appeared in: W22 (Q1a, 03 marks), S23 (Q1b, 04 marks)
5. **Find which of the following velocity fields are irrotational/have zero divergence.**
 - Appeared in: S24 (Q1b, 04 marks), S22 (Q1b, 04 marks), S23 (Q1c, 07 marks)
6. **Discuss the three levels at which the transport phenomena is studied. / State and discuss the various levels of transport phenomena studies in detail.**
 - Appeared in: W22 (Q1b, 04 marks), W23 (Q1c, 07 marks)

Other Important Questions:

1. **Cite the reasons for studying Transport Phenomena.**
 - Appeared in: W23 (Q1b, 03 marks)
2. **Compute the mean molecular velocity and the mean free path for a given gas (e.g., oxygen) at specified conditions.**
 - Appeared in: SUM 25 (Q1b, 04 marks)
3. **Write the expression for:**
 - Dot product of two vectors
 - Cross product of two vectors
 - Multiplication of a Tensor by a Scalar
 - Addition of two vectors
 - Appeared in: WIN 24 (Q1b, 04 marks)

4. **Compare Newton's Law of viscosity with Fourier's Law of heat conduction and Fick's of mass diffusion for their analogies.**
 - Appeared in: S22 (Q1c, 07 marks)
5. **Discuss in details the Newton's law of viscosity and write its equation in three dimensions.**
 - Appeared in: W22 (Q1c, 07 marks)
6. **Estimate the thermal conductivity of a gas mixture from given data on the pure components.**
 - Appeared in: S24 (Q1c, 07 marks) (*Numerical*)
7. **For a steady-state axial flow in a circular pipe with a given momentum flux profile, find the velocity profile, max velocity, average velocity, mass flow rate, and force on solid surfaces.**
 - Appeared in: SUM 25 (Q1c, 07 marks) (*Numerical*)
8. **For steady-state axial flow of an incompressible liquid in an annular region, with a given velocity profile, find the max velocity, average velocity, mass flow rate, and force on solid surfaces.**
 - Appeared in: WIN 24 (Q1c, 07 marks) (*Numerical*)
9. **Compute the steady-state momentum flux τ_{yx} between two parallel plates.**
 - Appeared in: W23 (Q2a, 03 marks), W22 (Q3b, 04 marks) (*Numerical*)
10. **Discuss about the conservation laws.**
 - Appeared in: W23 (Q2b, 04 marks)
11. **Find $\tau \cdot v$ (dot product) and $\tau \times v$ (cross product) where τ is a tensor and v is a vector.**
 - Appeared in: S24 (Q2b, 04 marks)
12. **Prove that for incompressible fluids divergence of velocity vector is zero i.e. $\nabla \cdot \vec{v} = 0$.**
 - Appeared in: S22 (Q2c, 07 marks), W22 (Q2c, 07 marks)
13. **Derive equation of motion from momentum balance and modify it to the Navier-Stoke's equation.**
 - Appeared in: S22 (Q2c, 07 marks)
14. **Derive equation for momentum for a Newtonian incompressible fluid.**
 - Appeared in: W22 (Q2c, 07 marks) (OR)
15. **Discuss with appropriate equation and schematic representation about the molecular transport of momentum.**
 - Appeared in: W23 (Q2c, 07 marks)

Unit 2: Momentum Transport

Repeated Questions:

1. **State and explain the general shell momentum balance equation. / Write general shell momentum balance equation.**
 - Appeared in: S24 (Q3a, 03 marks), W22 (Q3a, 03 marks)
2. **Explain Newton's Law of Viscosity. / Define Newton's Law of Viscosity.**
 - Appeared in: S24 (Q3a, 03 marks), S23 (Q5a, 03 marks) (OR)
3. **Derive the velocity profile and mass flow rate for flow of a falling film. / Find Velocity distribution for a liquid flowing down an inclined flat plate.**
 - Appeared in: S22 (Q3c, 07 marks), W22 (Q3c, 07 marks), S24 (Q3c, 07 marks) (OR)
4. **Derive the relation for velocity distribution for flow through a circular tube. / Derive the expression for max velocity, avg. velocity and mass flow rate for a flow through circular pipe system.**
 - Appeared in: W23 (Q2c, 07 marks) (OR), S24 (Q2c, 07 marks)
5. **Derive velocity profile and shear stress profile for flow through a narrow slit/parallel plates.**
 - Appeared in: S22 (Q3c, 07 marks), S24 (Q2c, 07 marks) (OR)
6. **What are the commonly used boundary conditions of shell momentum balance?**
 - Appeared in: S22 (Q3a, 03 marks)
7. **Discuss the general trends of viscosity with temperature and pressure for ordinary fluids. / Discuss in brief pressure and temperature dependence of viscosity.**
 - Appeared in: S22 (Q3a, 03 marks), W23 (Q3c, 07 marks)

Other Important Questions:

1. **Compare and contrast the molecular and convective momentum transport.**
 - Appeared in: S23 (Q2b, 04 marks)
2. **Explain the molecular momentum flux and write the components of the molecular momentum flux tensor.**
 - Appeared in: S22 (Q3b, 04 marks), W22 (Q3b, 04 marks)
3. **Develop the shear stress and velocity distribution profile for the laminar flow through the annulus.**
 - Appeared in: SUM 25 (Q2c, 07 marks)
4. **Develop the shear stress and velocity distribution profile for the laminar flow through the circular pipe.**
 - Appeared in: WIN 24 (Q2c, 07 marks)
5. **For the downward laminar flow on an inclined plane, develop the velocity distribution profile for a Newtonian fluid.**
 - Appeared in: WIN 24 (Q2c, 07 marks) (OR)

6. **A cylindrical rod moves axially with velocity $v_z = v_0$ along the axis of a cylindrical cavity. Find the velocity distribution in the narrow annular region.**
 - **Appeared in:** S23 (Q4c, 07 marks) (OR) (*Numerical*)
7. **Derive the equation for pressure drop for laminar flow of a Newtonian, incompressible fluid through a circular pipe.**
 - **Appeared in:** W22 (Q3c, 07 marks) (OR)
8. **State and discuss the procedure for setting up and solving viscous flow problems with reference to velocity distributions in laminar flow.**
 - **Appeared in:** W23 (Q3c, 07 marks) (OR)
9. **Glycerine is flowing through a horizontal tube. From the given flow data, find the viscosity of glycerine.**
 - **Appeared in:** S22 (Q3b, 04 marks) (*Numerical*)
10. **Oil has a kinematic viscosity and density given. For a falling film of a given thickness on a vertical wall, calculate the mass rate of flow of the liquid.**
 - **Appeared in:** S23 (Q4b, 04 marks), S24 (Q2a, 03 marks) (*Numerical*)
11. **Calculate the radius of a capillary from the given flow data.**
 - **Appeared in:** S23 (Q4b, 04 marks) (OR) (*Numerical*)
12. **Define Reynolds's number.**
 - **Appeared in:** W22 (Q3a, 03 marks) (OR)
13. **Give the significance of Total time derivative, Partial time derivative and Substantial time derivative with example.**
 - **Appeared in:** S24 (Q3b, 04 marks)
14. **Develop an expression for the equation of continuity involving cylindrical coordinates.**
 - **Appeared in:** SUM 25 (Q2c, 07 marks) (OR)

Unit 3: Steady State Heat Transport

Repeated Questions:

1. **State and explain Fourier's Law of heat conduction. / Write the equation for Fourier's law of heat conduction.**
 - **Appeared in:** SUM 25 (Q2b, 03 marks), W22 (Q4a, 03 marks) (OR), S24 (Q4a, 03 marks)
2. **Define thermal diffusivity. / Define thermal diffusivity and Prandtl number.**
 - **Appeared in:** SUM 25 (Q3b, 04 marks), S22 (Q2a, 03 marks)
3. **Discuss about temperature and pressure dependency of thermal conductivity. / Explain how thermal conductivity is affected by temperature for gases, liquids, and solids.**
 - **Appeared in:** S22 (Q2b, 04 marks), W22 (Q2b, 04 marks), SUM 25 (Q3a, 03 marks) (OR)
4. **Derive the temperature distribution and heat flux for heat conduction with an electrical heat source.**
 - **Appeared in:** S22 (Q4c, 07 marks), S23 (Q2c, 07 marks) (OR), S24 (Q4c, 07 marks) (OR)
5. **Derive the temperature distribution and heat flux for heat conduction with a nuclear heat source.**
 - **Appeared in:** SUM 25 (Q3c, 07 marks), W23 (Q4c, 07 marks)
6. **Develop the temperature distribution for heat conduction due to viscous heat dissipation for flow between two concentric cylinders.**
 - **Appeared in:** S22 (Q4b, 04 marks), S23 (Q5c, 07 marks) (OR)
7. **What are the commonly used boundary conditions for energy transport? / Write the common boundary conditions used in shell energy balance.**
 - **Appeared in:** SUM 25 (Q2a, 03 marks), W22 (Q4b, 04 marks) (OR), S24 (Q4b, 04 marks) (OR)

Other Important Questions:

1. **Define/Explain molecular, convective, and total heat flux.**
 - **Appeared in:** S22 (Q4a, 03 marks), S24 (Q4a, 03 marks) (OR)
2. **Compare thermal conductivity, thermal diffusivity and heat capacity.**
 - **Appeared in:** W23 (Q3a, 03 marks)
3. **Compute the thermal conductivity of a gas (e.g., oxygen) at low pressure using given Lennard-Jones constants.**
 - **Appeared in:** W23 (Q4a, 04 marks) (*Numerical*)
4. **The wall of an industrial furnace is constructed from a thick brick. Given temperatures and thermal conductivity, what is the rate of heat loss?**
 - **Appeared in:** SUM 25 (Q3b, 04 marks) (*Numerical*)
5. **Calculate the heat loss per m² for an insulating wall, given thickness, temperatures, and thermal conductivity.**
 - **Appeared in:** W23 (Q4b, 04 marks) (*Numerical*)

6. **A copper wire has a given radius and length. For what voltage drop would the temperature rise at the wire axis be a specified value?**
 - **Appeared in:** S22 (Q4b, 04 marks), W22 (Q4b, 04 marks) (*Numerical*)
7. **An oil is acting as a lubricant for concentric cylinders. Develop a temperature profile and find the maximum temperature.**
 - **Appeared in:** SUM 25 (Q3c, 07 marks) (*Numerical*)
8. **Develop the heat flux and temperature distribution profile for heat conduction in a rectangular fin. / Construct the expression of effectiveness of a Cooling Fin.**
 - **Appeared in:** WIN 24 (Q3c, 07 marks), S24 (Q4c, 07 marks)
9. **Derive the equation for temperature distribution for chemical reaction as a heat source.**
 - **Appeared in:** W22 (Q4c, 07 marks) (OR)
10. **Derive the equation of energy for pure Newtonian incompressible fluids with constant thermal conductivity.**
 - **Appeared in:** S23 (Q2c, 07 marks)
11. **Why is the thermal conductivity of a solid generally larger than that of a liquid or gas?**
 - **Appeared in:** WIN 24 (Q3a, 03 marks)
12. **Compare and contrast the molecular and convective mechanisms for heat transport.**
 - **Appeared in:** WIN 24 (Q3a, 03 marks)
13. **For a given insulation, calculate the heat flux and rate of heat transfer.**
 - **Appeared in:** WIN 24 (Q3b, 04 marks) (*Numerical*)
14. **For a fixed-bed axial flow reactor, derive/find the steady-state axial temperature distribution.**
 - **Appeared in:** S23 (Q5c, 07 marks), WIN 24 (Q5c, 07 marks) (OR)
15. **A copper wire with a voltage drop and heat transfer coefficient is given. Find the maximum temperature in the wire.**
 - **Appeared in:** S23 (Q5b, 04 marks) (*Numerical*)
16. **Calculate the thermal conductivity of a plastic panel from given heat rate and temperature data.**
 - **Appeared in:** S23 (Q5b, 04 marks) (OR) (*Numerical*)
17. **Write an expression for:**
 - Convective energy flux vector
 - Molecular work flux vector
 - Molecular heat flux vector
 - **Appeared in:** SUM 25 (Q3a, 03 marks)

Unit 4: Mass Transport

Repeated Questions:

1. **Define/Explain Fick's law of binary diffusion. / State and explain Fick's law of binary diffusion.**
 - Appeared in: S23 (Q3b, 04 marks), S24 (Q5a, 03 marks)
2. **Define/Explain Mass and Molar Concentrations, Mass Average and Molar Average Velocities.**
 - Appeared in: S22 (Q5a, 03 marks), W22 (Q5a, 03 marks), S24 (Q5b, 04 marks) (OR), WIN 24 (Q4a, 03 marks)
3. **Explain temperature and pressure dependency of diffusivity.**
 - Appeared in: S22 (Q5b, 04 marks), W22 (Q5b, 04 marks), S24 (Q5a, 03 marks) (OR)
4. **Show that for equimolar counter diffusion $D_{AB} = D_{BA}$.**
 - Appeared in: W23 (Q5a, 03 marks), S22 (Q5c, 07 marks)
5. **Derive an equation of molar flux for steady state diffusion of one gaseous component through a stagnant non-diffusing second component. / Develop the mass flux equation for steady-state diffusion of A through stagnant B.**
 - Appeared in: S22 (Q5c, 07 marks) (OR), S23 (Q3c, 07 marks), S24 (Q5c, 07 marks)
6. **With a neat diagram, derive an equation of molar flux for diffusion with a heterogeneous chemical reaction.**
 - Appeared in: S23 (Q3c, 07 marks) (OR), W22 (Q5c, 07 marks) (OR)
7. **Develop the mass flux equation for diffusion into a falling liquid film (Gas Absorption).**
 - Appeared in: S24 (Q5c, 07 marks) (OR), WIN 24 (Q5c, 07 marks)

Other Important Questions:

1. **Define the following:**
 - Molecular mass flux
 - Convective mass flux
 - Appeared in: SUM 25 (Q4a, 03 marks) (OR)
2. **Write in brief about Mass average and molar average velocity.**
 - Appeared in: SUM 25 (Q4a, 03 marks), WIN 24 (Q4a, 03 marks)
3. **What is the role of boundary conditions in shell mass balance? State the common boundary conditions.**
 - Appeared in: SUM 25 (Q4b, 04 marks) (OR), WIN 24 (Q4b, 04 marks) (OR)
4. **Define and explain binary Diffusivity.**
 - Appeared in: S23 (Q3a, 03 marks), W22 (Q5a, 03 marks) (OR)
5. **Explain molecular diffusion in gases at low density. / Shortly explain the theory of diffusion in gases at low density.**
 - Appeared in: S22 (Q5b, 04 marks) (OR), W22 (Q5b, 04 marks) (OR)
6. **A tank containing CO₂ is connected to another tank via a connection line. Calculate the initial rate of mass transfer of CO₂ (assuming equimolar counter diffusion).**
 - Appeared in: SUM 25 (Q4c, 07 marks) (Numerical)
7. **A graduated cylinder containing chloropicrin is placed in a hood. Estimate the substance diffusivity in air from the liquid level drop data.**
 - Appeared in: SUM 25 (Q4c, 07 marks) (Numerical)
8. **Estimate the diffusion coefficient for acetone in water using the Wilke-Chang equation.**
 - Appeared in: W23 (Q5b, 04 marks) (Numerical)

9. **Discuss equilibrium counter diffusion.**
 - **Appeared in:** S23 (Q4a, 03 marks)
10. **Explain Knudsen diffusivity.**
 - **Appeared in:** S23 (Q4a, 03 marks) (OR)
11. **Derive an equation for diffusion with a homogeneous chemical reaction.**
 - **Appeared in:** W23 (Q5c, 07 marks)
12. **Distinguish between homogeneous and heterogeneous reactions. Discuss the phenomenon of a diffusion-controlled reaction.**
 - **Appeared in:** SUM 25 (Q5c, 07 marks) (OR)
13. **Discuss in brief about diffusion with homogeneous catalytic reaction.**
 - **Appeared in:** WIN 24 (Q5b, 04 marks) (OR)
14. **How does the equation of change differ in single-component and multicomponent systems?**
 - **Appeared in:** SUM 25 (Q5b, 04 marks), WIN 24 (Q5a, 03 marks) (OR)
15. **Define the following:**
 - Self-diffusion
 - Biot Number
 - Lewis number
 - Brinkman Number
 - Thiele modulus
 - Schmidt Number
 - **Appeared in:** SUM 25 (Q5a, 03 marks), SUM 25 (Q5a, 03 marks) (OR), WIN 24 (Q5a, 03 marks)
16. **Define Thiele modulus. What is its significance?**
 - **Appeared in:** WIN 24 (Q5b, 04 marks)
