Transport

1 Write down the molecular transport equations (constitutive equations) for mass, momentum, and heat transfer.

2 Several years ago there was a report of a boiler explosion in a church. When interviewed, the janitor explained that he lit the gas flame in the boiler; after a time he noticed the pressure gauge readings were way too high. He immediately extinguished the burners. Five minutes later the boiler blew up.
Why?

3 Given two temperatures and all fluid properties in a double-pipe heat, counter current heat exchanger, how do you calculate the other two temperatures?

How is the overall heat transfer coefficient for a heat exchanger found?

4 Derive the steady state momentum balance for fully developed, laminar flow in a pipe.

6 Sketch the temperature profiles in a counter current heat exchanger.

7 Estimate the number of diameters required to achieve fully developed flow in a pipe.

8 Write the equations describing a wet bulb thermometer.
How would you find the unknowns in these equations?

9 Discuss boundary layer theory.

10 Explain the different means of molecular transport.
Are these the only means of transport?
What are some of the differences?

11 Given a double-pipe heat exchanger and all properties of the pipe, the fluids flowing and the flow rates, and also the temperatures at one end, could the other two temperatures be found?
How would you estimate the overall heat transfer coefficient?
What is the overall heat transfer coefficient?
Could the various analogies between transport processes be used to determine individual heat transfer coefficients?
What dimensionless parameters would be involved in correlations for the heat transfer coefficient?

12 You are pumping a fluid to an elevated tank. How would you go about sizing the pump to do this?

13 Explain the lost work term in Bernoulli's Equation.
What is it made up of?
What is the friction factor in a pipe?

14 What phenomena are important during an underground explosion?

15 What is the Re vs friction factor curve like for a sphere, a pipe and a flat plate?

16 Discuss the analogies among momentum, heat and mass transfer.
Name some examples of when they don't hold.

17 Why does frost not form under a tree when it is on the grass all around the tree?

14 What is the difference between:
a. heat and mass transfer?
b. heat and momentum transfer?
c. mass and momentum transfer?

Set up the equations to describe:
a. the wet bulb thermometer
b. an iceberg being towed in the ocean
c. a burning carbon particle

Will heat transfer affect the friction factor?
In what way?

What is the difference between diffusivity and a mass transferee coefficient?

Why is the Prandtl number greater for liquids than for gases?

What is the Sherwood number?

Do Neon and Argon have the same atomic radius?
If not, which is larger?
Which one has a larger diffusivity; viscosity; heat capacity; Prandtl number?

Consider the problem of pumping oil down the Alaskan pipeline. Given the pipe diameter and length and the properties of oil, how would you calculate the (a) pump size; (b) heat loss and (c) the temperature profile?

Describe and give the governing equations for (a) and orifice meter; (b) a venturi meter; and (c) the pitot tube.

Give the following:
a. Bernoulli's equation
b. Hagen-Poiseuille law;
c. Stokes law;
d. Continuity equation;
e. Navier stokes equation.

What is an NTU and how do you calculate it?

Describe the use of a McCabe-Thiele diagram.

How do the following vary with temperature and pressure?
a. diffusivity;
b. dynamic viscosity;
c. thermal conductivity;
d. heat capacity;
e. heat transfer coefficient;
f. kinematic viscosity.

What is the Reynolds analogy?
What is the Chilton-Colburn analogy?

What is the friction factor?
What is the coefficient of friction?

Derive the boundary layer equations.

Sketch the operating diagrams for a stripper and an absorber.

Sketch the shear stress profile for a pipe.

Define the most commonly used dimensionless parameters and describe their significance.

Given a pool of organic liquid (such as from a spill), how would you estimate its evaporation rate?

How are the diffusivity and viscosity of a mixture determined?

Sketch the temperature profile in a heat exchanger.

Consider a drop falling down a tower, initial temperature and tower temperature are given. How does the drop temperature change as it falls?

What is the angular dependence for the Nusselt number for a falling drop?

Draw the boiling curve and describe the physical phenomena responsible for the observed behavior. Draw and explain the similar curve for condensation.

given the free stream velocity and particle diameter, calculate the boundary layer thickness at a 45 degree angle. What is the pressure at the forward and backward stagnation points? What causes the difference?

Derive the steady-state momentum balance for fully developed, laminar flow in a pipe.

How is the overall heat transfer coefficient for a heat exchanger found?

There are several analogies between mass, heat, and momentum transfer. How do they arise? Why are those between mass and heat transfer easier to use than mass and momentum?

Is the mass flux from a liquid into a gas higher or lower if the gas is soluble in the liquid (as compared to as insoluble gas)?

Derive the mass transfer boundary layer equation.

How does upstream pressure relate to velocity of the jet in a discharging gas cylinder? (assume μ_{JT} = zero)

Derive an equation describing;
a. losses in a sudden expansion;
b. pressure drop across a jet ejector pump;
c. flow rate through an orifice;
d. pitot tube velocity measurement;
e. diameter of a free jet (laminar flow)

A sphere of ice is inserted into a bath of 50 F water of infinite dimensions.
a. How far will the sphere travel before it melts and how long will it take?
b.What is the terminal velocity?
c. How does friction factor depend on Renolds number?
d. Draw a temperature profile from the sphere center in the radial direction.
e. What does the heat transfer coefficient depend on?
f. Construct an energy balance for the system.

Determine the time required for a liquid to drain from a tank.

Upon pricking a soap film with a pin, the film breaks and retracts. Calculate the velocity of the receding film boundary.

Draw the transient velocity profiles associated with laminar flow down a pipe. What is important in determining how far down the pipe a fully developed profile will occur (both laminar and turbulent)?

Draw a plot of friction factor vs Reynolds number.
What is k/D?
Why do such small values of k/D greatly affect *f*?

Draw the boiling curve.

A hot metal sphere falls through the air. How would you calcutate the sphere's temperature after it has fallen a given distance?