TRANSPORT PROCESSES

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

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

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

4. What is the difference between diffusivity and a mass transfer coefficient?

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

6. What is the Sherwood number?

7. Do Neon and Argon have the same atomic radius? If not, which is larger? Which has the larger (a) diffusivity; (b) viscosity; (c) heat capacity; and (d) Prandtl number?

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

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

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

11. What is an NTU and how do you calculate it?

12. Describe the use of a McCabe-Thiele diagram.

13. 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

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

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

16. Derive the boundary-layer equations.

17. Sketch the governing diagrams for a stripper and an absorber

18. Describe the friction factor (drag coefficient) vs. Re relation for a (a) pipe, (b) sphere, (c) flat plate, etc.

19. Sketch the shear stress profile for a pipe.

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

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

22. How are the diffusivity and viscosity of a mixture determined?

23. Sketch the temperature profile in a heat exchanger.

24. What phenomena are important during an underground explosion? (e.g. bulk flow, diffusion, etc.)

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

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

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

28. 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?

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

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

31. Given two temperatures and a knowledge of all the fluids' properties in a double pipe countercurrent heat exchanger, how do you calculate the other two temperatures?

32. Derive equations describing the wet-bulb/dry-bulb psychrometer. Obtain a relation between the wet-bulb temperature and air humidity in terms of dimensionless groups.

33. Is the heat flux from a liquid into a gas usually higher or lower if the gas is insoluble (versus soluble) in the liquid? This compares "diffusion through a stationary component" with the extreme case of "equimolar counterdiffusion".

34. The Chilton-Colburn j-factor for heat transfer is proportional to h, the convective heat transfer coefficient. Why is j proportional to $(Pr)^{-1/3}$? Why is j only a fraction of Re? Why does j decrease as Re increases?

35. O_2 and N_2 leaks from pressurized tanks are often considered less dangerous than

H_2 leaks. Why? (Answer is best described using Joule-Thompson coefficient).

36. How would you separate oxygen from salt water? Suppose you were processing fairly large volumes so that energy efficiency is a strong consideration. What thermodynamic variables affect solubility? Where is the mass transfer resistance? What type of unit operation would you use? How would you design it?

37. What area is used when defining friction factor for a wetted wall column?

38. What is the Lewis relation? Is it dependent on the gas phase velocity? Why or why not?

39. Why are analogies between mass and heat transfer much more straightforward to use than analogies between mass and momentum transfer?

40. Given a CSTR at temperature T with no reaction what would happen if the inlet temperature were suddenly increased?

41. Analogies between heat, mass and momentum transport are important. Give examples of when they don't hold.

42. What is the theoretical basis for all the "famous" analogies between heat, mass and momentum transport? What are the mass and heat transfer equivalents of the momentum transport equation?

43. What is the difference between skin friction drag and form drag?

44. How would you determine a mass transfer coefficient experimentally?

45. Why does frost not form under a tree when it is on the ground all around the tree?

46. Draw a McCabe-Thiele diagram for a distillation column that uses a reacting absorbent.

47. What are the most commonly used (3) correlations describing heat and mass transfer?

48. Give:
a. Newton's law
b. Fick's law
c. Fourier's law

49. Give the equations describing flow in a packed bed.

50. Derive the equations for gas undergoing an isentropic expansion.

51. What is inside a light bulb, and why?

52. Why do you have to whirl a wet-bulb / dry-bulb psychrometer in the air prior to reading it?

53. In which direction is the momentum flux from a fluid flowing over a flat plate?

54. How does a lawn sprinkler work?

55. Consider firefighters holding a high pressure hose, must they pull or push the hose? Why?

56. For a double plate window with insulating gas between the panes draw the temperature profile from inside the warm room, through the windows and to the outdoors. Allow for natural convection both in the room and in the gas between the two plates. What gas would you recommend using and why?

57. Consider the department store ping-pong ball "floating" above a vacuum cleaner discharge. What determines how high the ball will be? What keeps the ball from moving laterally out of the path of the air? What does the velocity profile look like close to, around and above the ball? What determines whether the ball will fall to the ground if the jet is pointing at an angle rather than straight up?