

Homework Set 2

Due: Thursday, September 1 (sections 001, 003, and 004)/Friday, September 2 (section 002)

This assignment is to be completed individually. The number in parentheses next to each problem shows how many points the problem is worth in the overall assignment. Please show all work and use correct significant figures to receive full credit. Be sure to follow the problem formatting instructions to avoid unnecessary deductions. If you use an equation-solving tool (calculator, APEx, Solver, MATLAB), write out the equation(s) and note the tool that you used; otherwise, show all hand calculations used to solve any equations.

- (5 pts)** Take the Learning Styles inventory at <http://www.engr.ncsu.edu/learningstyles/ilsweb.html> and read the description at <http://www4.ncsu.edu/unity/lockers/users/f/felder/public/ILSdir/styles.htm>. State your learning style and discuss how you're going to approach this class based on your learning style to maximize success. This should be typewritten on white paper.
- (10 pts)** Since the 1960s, the Free Expression Tunnel at North Carolina State University has been the University's way to combat graffiti on campus. The tunnel is painted almost daily by various student groups to advertise club meetings, praise athletic accomplishments, and declare undying love. You and your engineering classmates decide to decorate the tunnel with chemical process flowcharts and key equations found in your favorite text, so you purchase a can of spray paint. The label indicates that the can holds nine fluid ounces, which should cover an area of approximately 25 ft².

(a) You measure the tunnel and find that it is roughly 8 feet wide, 12 feet high, and 148 feet long (assume it's rectangular). Based on the stated coverage, how many cans of spray paint would it take to apply one coat to the walls and ceiling of the tunnel?

(b) Having just heard a lecture on process safety in your engineering class, you want to take appropriate safety precautions while painting the tunnel. One useful source for this type of information is the Safety Data Sheet (SDS), a document used in industry to provide workers and emergency personnel with procedures for safely handling or working with a specified chemical. Other sources of information about hazardous substances can be found in handbooks, and some countries, including the United States, have laws that require employers to provide their employees with Safety Data Sheets. Besides composition information, the SDS contains information such as physical properties (melting point, boiling point, flash point, etc.), other threats to health and safety, recommended protective equipment, and recommended procedures for storage, disposal, first aid, and spill handling. The SDS can typically be found online for most common substances.

(i) Search the web for "spray paint SDS" and find a representative SDS for a typical spray paint product. Print the SDS you found and include it with your homework.

(ii) Based on the document you find, list the top three hazards that you might encounter during your tunnel painting project.

(iii) Suggest one safety precaution for each listed hazard.
- (10 pts)** Limestone (calcium carbonate) particles are stored in 50-L bags. The void fraction of the particulate matter is 0.30 (liter of void space per liter of total volume) and the specific gravity of solid calcium carbonate is 2.93.

(a) Estimate the bulk density of the bag contents (kg CaCO₃/liter of total volume).

(b) Estimate the weight (*W*) of the filled bags. State what you are neglecting in your estimate.

(c) The contents of three bags are fed to a ball mill, a device something like a rotating clothes dryer containing steel balls. The tumbling action of the balls crushes the limestone particles and turns them into a powder. (See pp. 21-64 of *Perry's Chemical Engineers' Handbook*, 8th ed.) The limestone coming out of the mill is put back into 50-L bags. Would the limestone (i) just fill

three bags, (ii) fall short of filling three bags, or (iii) fill more than three bags? Briefly explain your answer.

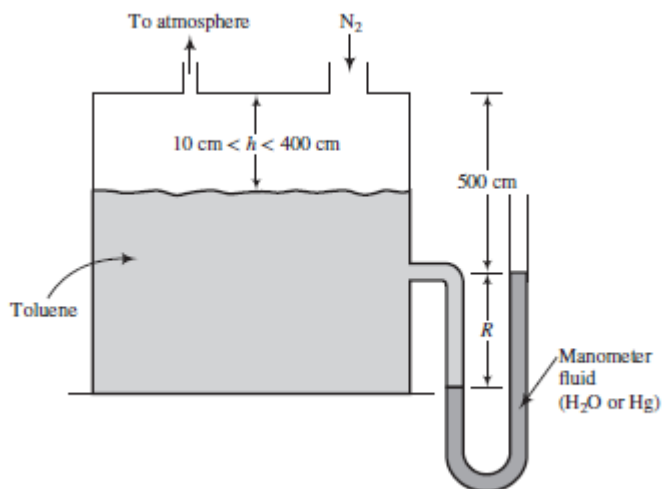
4. (10 pts) In the movie, *Willy Wonka and the Chocolate Factory*, Augustus Gloop leans over the chocolate river to get a drink and falls in. He is sucked through the pipe leading to the fudge room where he is saved by the Oompa Loompa workers. Unfortunately, real-life accidents do not always have such happy endings, even when they involve chocolate. In a tragic 2009 accident, a worker suffered fatal injuries after falling into a cylindrical mixing vat that had an 8-ft diameter and was 8 ft tall. At the time of the accident, the vat was full of molten chocolate.

(a) What was the total weight (lb_f) of chocolate in the vat? The specific gravity of chocolate is approximately 1.24.

(b) Determine the pressure (psig) at the bottom of the tank.

(c) Speculate on whether a person would float or sink in the vat and list two possible causes of the worker's death.

5. (15 pts) The level of toluene (a flammable hydrocarbon) in a storage tank may fluctuate between 10 and 400 cm from the top of the tank. Since it is impossible to see inside the tank, an open-end manometer with water or mercury as the manometer fluid is to be used to determine the toluene level. One leg of the manometer is attached to the tank 500 cm from the top. A nitrogen blanket at atmospheric pressure is maintained over the tank contents.



(a) When the toluene level in the tank is 150 cm below the top ($h = 150$ cm), the manometer fluid level in the open arm is at the height of the point where the manometer connects to the tank. What manometer reading, R (cm), would be observed if the manometer fluid is (i) mercury, (ii) water? Which manometer fluid would you use, and why?

(b) Briefly describe how the system would work if the manometer were simply filled with toluene. Give several advantages of using the fluid you chose in Part (a) over using toluene.

(c) What is the purpose of the nitrogen blanket?

(50 pts) The remainder of the assignment (5 problems) will be completed online using WileyPLUS. *You do not have to turn in any paperwork with this portion of the assignment.* Use the link for your class on the Moodle site, and then you can access the Assignment within WileyPLUS. The due date for the WileyPLUS completion is the same as for the homework assignment – the beginning of your class period. Note that the WileyPLUS assignment cannot be submitted late.

Challenge Problem for Honors contract: FR&B 3.51