

Exam 1

Name: _____

CM3110

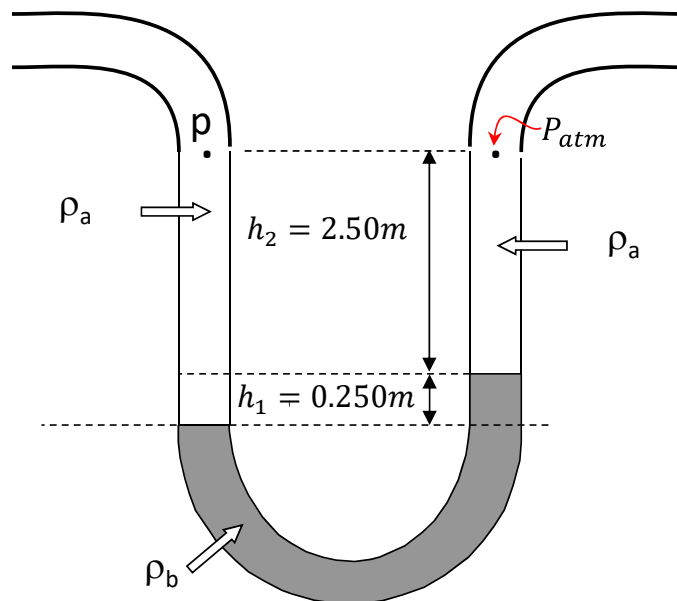
Tuesday 10 September 2019

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| 2. | /20 |
| 3. | /20 |
| 4. | /20 |
| <u>5.</u> | <u>/20</u> |

Instructions:

- Closed book, closed notes. One 8.5" by 11" study sheet allowed, double sided; you may use a calculator; you may not use the internet or a cell phone. All work on the exam must be your own.
- Write your solution on one side of the page only. Do not write on the back of any pages.
- Please be neat. Only neat answers will be granted partial credit.
- Significant figures always count.**
- Please box your final answers.

- (20 points) Water (25°C) flows steadily in a horizontal smooth tube (inner tube diameter is 0.542 inches; tube length is 38 feet). If the water flows at 4.1 gpm (gallons per minute) what is the average velocity of the fluid in the pipe? Give your answer in units of ft/s.
- (20 points) Fluid (a) and fluid (b) are used in a manometer as shown below; the pressure on the top of the right side is $p_{atm} = 1.00\text{ atm}$. The density of fluid (a) is 1.000 g/cm^3 and the density of fluid b is 13.60 g/cm^3 . What is the pressure p ? Please give your answer in atm.



Note: the inner diameter of the manometer tube is 11.2 mm.

3. (20 points) For the vectors \underline{v} and \underline{a} and matrix \underline{M} given below, calculate the four indicated quantities. Show your work. Note that for the kinds of vectors we use (physical vectors), we may express them equivalently either as column vectors (3×1 vectors) or row vectors (1×3 vectors).

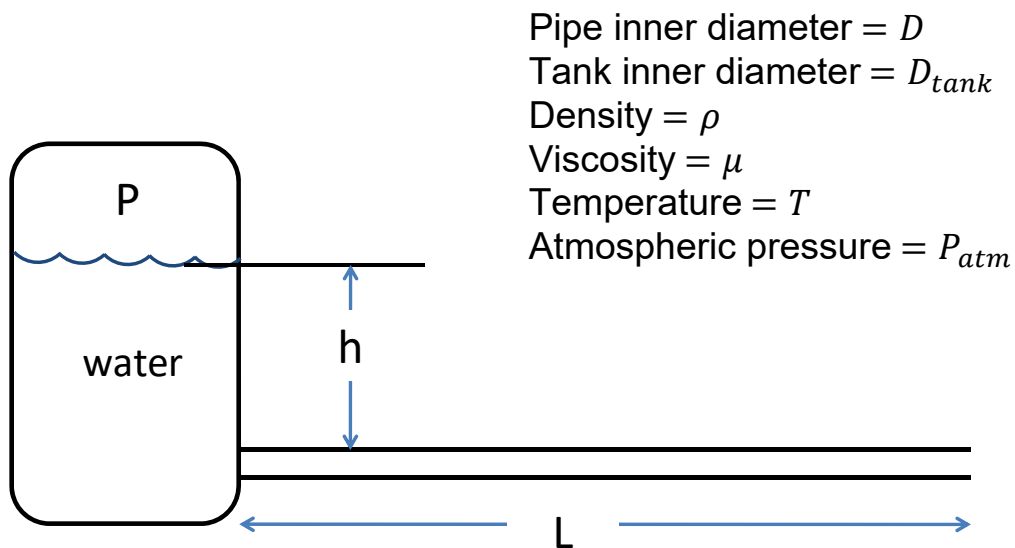
$$\underline{v} = \begin{pmatrix} 2 \\ 1 \\ -1 \end{pmatrix}_{xyz} = (2 \ 1 \ -1)_{xyz}$$

$$\underline{a} = \begin{pmatrix} 1 \\ 2 \\ 2 \end{pmatrix}_{xyz} = (1 \ 2 \ 2)_{xyz}$$

$$\underline{M} = \begin{pmatrix} 0 & 2 & 2 \\ -1 & 1 & 3 \\ 2 & 0 & 5 \end{pmatrix}_{xyz}$$

- $\underline{v} \cdot \underline{a}$
- $|\underline{v}|$ (the magnitude of \underline{v})
- $\underline{M} \cdot \underline{a}$
- Calculate $\frac{d}{dr} \left(4r^2 - \frac{2}{r} \right)$

4. (20 points) For the large tank with piping system sketched below, what is the equation for the average fluid velocity at the pipe discharge? Please write your answer in terms of the variables defined in the figure. You may neglect friction in your solution. The tank is not open to the atmosphere; the pipe discharges fluid to the atmosphere. P is the absolute pressure inside the vapor space over the water in the tank. The flow may be assumed to be steady and turbulent over the time-span of interest.



5. (20 points) The surface area of a sphere (sphere radius = R) may be calculated from the integral below, carried out in spherical coordinates. What are the correct limits to use in the integrals? Carry out the integration and obtain the surface area of a sphere. The spherical coordinate system is shown below and is also discussed in the formula sheets provided.

$$\text{surface area} = \int_{?}^{?} \int_{?}^{?} R^2 \sin \theta d\theta d\phi$$

