National Higher School of Autonomous Systems Technology
Department of Basic Training, 2nd Year
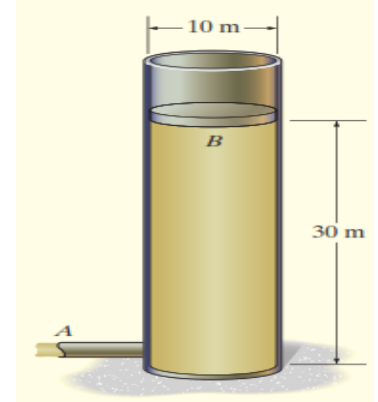University year: 2025/2026
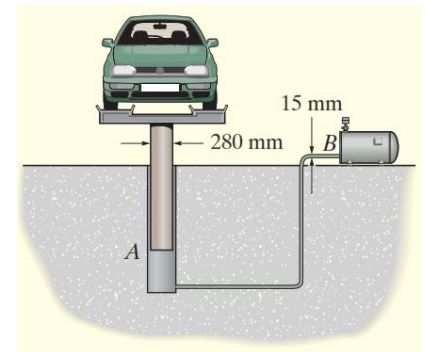
NHSAST

The Second Tutorial in Fluid Mechanics

Exercise 1:

The natural gas in the storage tank is contained within a flexible membrane and held under constant pressure using a weighted top that is allowed to move up or down as the gas enters or leaves the tank, see figure. Determine the required weight of the top if the (gage) pressure at the outlet A is to be 60 kPa in both cases <u>incompressible</u> and <u>compressible</u>. The gas has a constant temperature of 20°C. ρ_g=0.665 kg/m³, rg =518 J/kgK
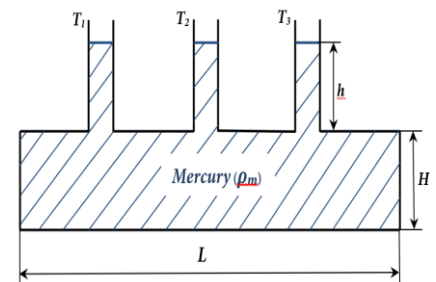

Exercise 2:

A pneumatic jack is used in a service station as shown in Figure. If the car and lift weigh 25 kN, determine the force that must be developed by the air compressor at B to raise the lift at a constant velocity. Air is in the line from B to A. The airline at B has an inner diameter of 15 mm, and the post at A has a diameter of 280 mm.

Exercise 3:

In an empty container, shaped like a rectangular parallelepiped (H=0.4m, L=0.75m) with width w=0.5m; a mass of mercury of 2448kg has been poured. The container is topped with three vertical cylindrical tubes of the same cross-section s=0.02 m². The density of mercury is ρ_m=13,6 g/cm³. **1)** Determine the magnitude of the pressing force exerted on the horizontal bottom of the container. **2)** On top of the mercury, a column of water of height h1=40cm and density ρ_1=1 g/cm³ is poured in T1, then a column of gasoline in T2 and a column of acid in T3 in such a way that free surfaces of water, gasoline and acid have the same level. The values of the gasoline and acid columns are h2=39.1cm and h3=42.9cm . Deduce the densities of the gasoline and acid ρ_2 and ρ_3, respectively.

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Exercise 4

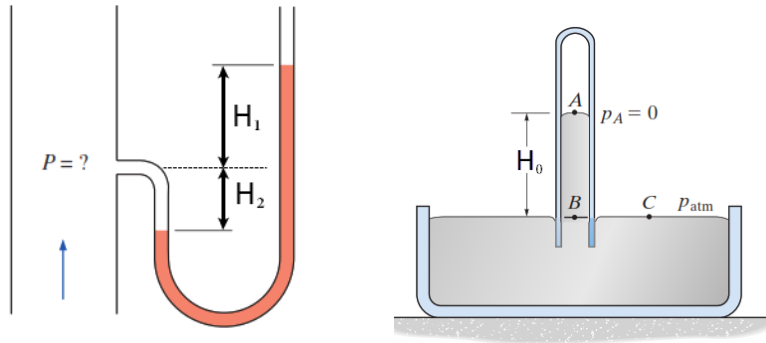If sea-level pressure is 101350 Pa, compute the standard pressure at an altitude of 5000 m, using: (a) the <u>exact formula</u> and (b) an <u>isothermal assumption</u> at a standard sea-level temperature of 15°C. Is the isothermal approximation adequate?   <u>Given data:</u> T0=15°C, β=0.0065 K/m, g/βr=5.26.
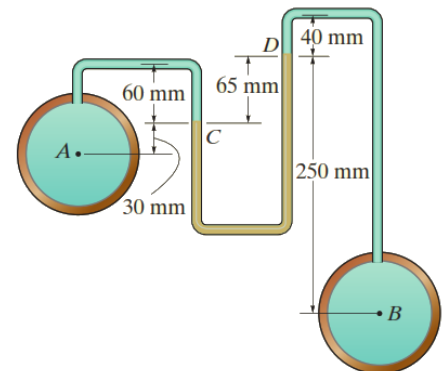
Exercise 5:

To determine the absolute pressure inside a pipe through which a fluid of density ρ flows, a barometer and a manometer filled with mercury (density ρ_0) are placed side by side. The height readings H_0, H_1, and H_2 are taken. Calculate, in bars and Pascals, the pressure along the pipe axis.
<u>Given data:</u> H_0=0.7565 m, H_1=0.3245 m, H_2=0.1925 m, ρ=1000 kg/m³, ρ_0=13590 kg/m³

Exercise 6

Determine the difference in pressure between the centerline points A and B in the two pipelines, in figure alongside, if the manometer liquid CD is at the level shown. The density of the liquid in AC and DB is ρ=800 kg/m³ , and in CD, ρ_{CD}=1100 kg/m³

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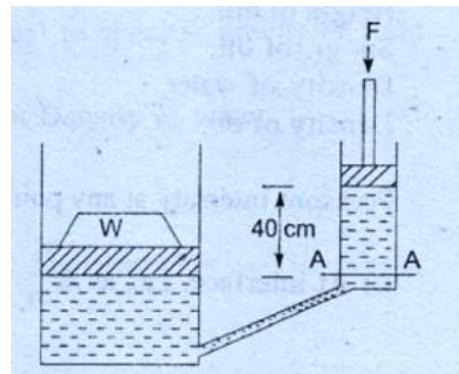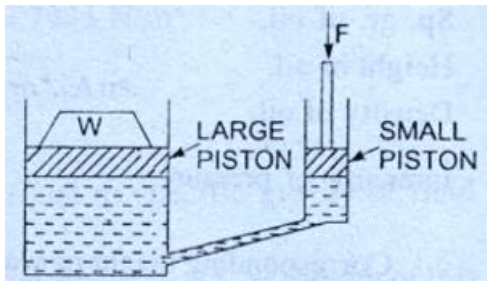Department of Basic Training, 2nd Year
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Supplementary Exercises:

Exo1

The diameters of a small piston and a large piston of a hydraulic jack are 3 cm and 10 cm respectively. A force of. 80 N is applied on the small piston. Find the load lifted by the large piston when: (The density of the liquid in the jack is given as 1000 kg/m^3)

(a) the pistons are at the same level.

(b) small piston is 40 cm above the large piston.

Exo2

A U-shaped tube with a uniform inner cross section s=2cm^2 contains mercury in equilibrium. The air columns above the free surfaces of the mercury have the same length L_0=50cm in both vertical branches B_1 and B_2, which are open to the atmosphere.

1. a) What volume of glycerin must be poured into branch so that the volume of air above the free surface of the mercury in B_2 has a height double that of the air column above the free surface of the glycerin in B_1 ?

b) Then calculate the heights L_1 and L_2 of the air columns and the difference in mercury levels d=2x_0. ρ_g=1250 kg/m^3, ρ_m=13600 kg/m^3, g=9.8m/s^2