Exercise 1. Pressure I

Find the total force exerted on a 10 [cm] by 10 [cm] section of a wall exerted by atmospheric pressure, assumed to be $P = 10^5$ [Pa].

(a) 100 [N]
(b) 1000 [N] ***
(c) 10000 [N]
(d) 100000 [N]

Exercise 2. Pressure II

Find the total force exerted on a 1 [cm] by 10 [cm] strip of a wall exerted by atmospheric pressure, assumed to be $P = 10^5 + 10^3 x$ [Pa], where x ranges from 0 to 10 [cm].

(a) 100.05 [N]***
(b) 1000.5 [N]
(c) 10005 [N]
(d) 100050 [N]

Exercise 3. Pressure III

Find the total force on a 0.1 [m] by 0.1 [m] section of a wall exerted by atmospheric pressure, assumed to be $P = 10^5 + 10^3 \cos(2\pi x/0.1)\cos(2\pi y/0.1)$ [Pa]. Hint: set your origin in the center of the square.

(a) 969 [N]
(b) 1000 [N] ***
(c) 1031 [N]
(d) 1062 [N]

Exercise 4. Submersion I

Find the pressure at the bottom of a 3 [m] deep pool if the pressure at the surface is 10^5 [Pa], the gravitational constant is $g = 10$ [m/s^2], and the density of water is 10^3 [kg/m^3].

(a) 0.7 [bar]
(b) 1.0 [bar]
(c) 1.3 [bar] ***
(d) 1.7 [bar]

Exercise 5. Submersion II

How much work must you do to move 1 [cm^3] of water from the bottom of the pool to the surface?

(a) 0 [J]
(b) 13.0 [J]
(c) 34.5 [J] ***
(d) 39.0 [J]

Exercise 6. Manometer I

Suppose that one end of a mercury manometer (density 13.5 [g/cm^3]) experiences a pressure of 5.063×10^5 [bar] above a dewar of liquid nitrogen, and the other end experiences atmospheric pressure of 1.013 [bar]. Sketch the experimental setup.

Exercise 7. Manometer II

What is the difference in heights?

(a) 3 [m] ***
(b) 0.3 [m]
(c) 0.03 [m]
(d) 0.003 [m]

Exercise 8. Buoyancy I

Suppose that a diver of density 0.85 [g/cm^3] is at a depth of 20 [m] below the surface of the ocean, and 20 [m] above the sea floor. Draw a free body diagram. In which direction is the net force?

Exercise 9. Buoyancy II

How long does it take to reach the surface/bottom by just floating?

(a) 5.60 [s]

(b) 5.16 [s] ***

(c) 4.76 [s]

(d) 4.33 [s]

Exercise 10. Continuity

Suppose that air enters a jet of radius 1 [m] at 10 [m/s], and leaves at a radius of 0.1 [m]. If the engine does no work, what speed does the air leave at?

(a) 10 [m/s]

(b) 100 [J]

(c) 1000 [J] ***

(d) 10000 [J]

Exercise 11. Discontinuity

Now, suppose that the engine does 1000 [J] of work on each kilogram of air. Assuming constant pressure, what speed does the air leave at?

Exercise 12. Conversion I

Suppose that hydrogen peroxide H_2O_2 is generated as a byproduct of a reaction at a rate of 1 [mol/s], and is carried in a tube by 10 [mol/s] of water, H_2O. If the tube has a diameter of 2.54 [cm], and the densities of peroxide and water are 1450 [kg/m^3] and 1000 [kg/m^3] respectively, what is the flow rate? Note: the molar masses of per peroxide and water are 34 [g/mol] and 18 [g/mol] respectively.

Exercise 13. Conversion II

Now suppose that all of the peroxide is reduced on a platinum catalyst in the presence of hydrogen according to the reaction $H_2O_2 + H_2 \rightarrow 2H_2O$. What is the new flow rate? Hint: the number of moles have changed!

Exercise 14. Bernoulli I

Suppose that water enters a tube of 20 [cm] diameter at UCLA (elevation of 96 [m]), and travels to the pier at Santa Monica, 10.4 [km] away. If the water starts at 1 [m/s] how fast is it moving when it reaches the pier?

Exercise 15. Bernoulli II

The Stone Canyon Reservoir is at a height of 258 [m] and provides water to UCLA. If water starts in a tube at rest, and the tube breaks into 10000 faucets each 1 [cm] in diameter, how much power can a hydroelectric motor extract if the water leaves the faucets at 5 [m/s]?