# PHYS 1511 Discussion Section: Week 11

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# Review

Chapter 11: Fluids

-Gauge pressure vs absolute pressure

-Bernoulli's Equation

Chapter 12: Temperature and Heat

-Temperature Scales (Fahrenheit, Celsius, Kelvin)

-Linear Thermal Expansion

-Volume Thermal Expansion

-Specific Heat Capacity

-Latent Heat/Phase Changes

-Sign convention for heat transfer ( (+Q) flow in, (-Q) flow out)

# Relevant Equations

Chapter 11:

$$P_1 + \frac{1}{2}\rho v_1^2 + \rho g h_1 = P_2 + \frac{1}{2}\rho v_2^2 + \rho g h_2 \qquad \text{(Bernoulli's Eqn)} \tag{1}$$

Chapter 12:

$$T_k = T_c + 273.15 \qquad \text{(Kelvin} \rightleftarrows \text{Celsius)} \tag{2}$$

$$T_F = \frac{9}{5} T_c + 32 \qquad \text{(Fahrenheit} \rightleftarrows \text{Celsius)} \tag{3}$$

$$\Delta L = \alpha L_0 \Delta T \qquad \text{(Linear Thermal Expansion)} \tag{4}$$

$$\Delta V = \beta V_0 \Delta T \qquad \text{(Volume Thermal Expansion)} \tag{5}$$

$$Q = mc\Delta T \qquad \text{(Temperature Change w/ specific heat capacity )} \tag{6}$$

$$Q = mL \qquad \text{(Latent Heat)} \tag{7}$$

# Question #1

## Bernoulli's Conundrum

Water is circulating through a closed system of pipes in a two-floor apartment. On the first floor, the water has a gauge pressure of $3.4 \times 10^5$Pa and a speed of 2.1 m/s. However, on the second floor, which is 4.0m higher, the speed of the water is 3.7m/s. The speeds are different because the pipe diameters are different. What is the gauge pressure of the water on the second floor? (The density of water is $\approx$1000 kg/m$^3$)

# Question #2

## Useful Physics

Because of differing measurement systems, every person should know how some basic information on temperature scales. Answer the following:

**(a)** You're talking to your friend from India on the phone and they tell you its 4°C in New York City. **Without using a calculator** estimate what the temperature is in Fahrenheit. (you might need to do this one day in a conversation)

**(b)** Repeat (a) using a calculator

**(c)** As of science in 2019, it is impossible for any observable matter to reach something called **absolute zero** ($T_k = 0$), what is this temperature in Fahrenheit?

# Question #3

## Engineering Issues

A steel bridge is built in several segments, each 20 m long. The gap between segments is 4 cm at 18°C. What is the maximum temperature (in Celsius) that the bridge can manage before buckling? (The coefficient of thermal expansion for steel is $12 \times 10^{-6} \frac{m}{mK}$)

# Question #4

## Physics above

The roof tiles of Van Allen are square and are often seen bent upward at the perimeter toward the sky (see figure below). They are seen to fit snug against one another with one side faced toward the sun and the other face against the lower temperature roof.

**(a)** Offer a possible explanation as to why the tiles curve upward

**(b)** If the dimensions of the tiles when brand new are (0.91m by 0.91m by 1.5cm) what is the volume of the top half?

**(c)** The average daily temperature change in Iowa City is about 13°C. Assuming the tiles have a coeffcient of thermal expansion of $4 \times 10^{-5} \frac{1}{K}$ and the top half undergoes this temperature change, what is total change in volume of the top half of the tiles?

# Question #5

## Snow Problem

A snow maker at a resort pumps 130 kg of lake water per minute and sprays it into the air above a ski run. The water droplets freeze in the air and fall to the ground, forming a layer of snow. If all the water pumped into the air turns into snow, and the snow cools to the ambient air temperature of -7.0°C, how much heat does the snow-making process release each minute given the following:

$T_0 = 12.0°\text{C}$ (initial temperature of lake water)

$c_w = 2.00 \times 10^3 \text{J}/(\text{kg C})$ (specific heat of lake water)

$c_s = 2.09 \times 10^3 \text{J}/(\text{kg C})$ (specific heat of snow)

$L_f = 3.33 \times 10^5 \text{J}/\text{kg}$ (latent heat of fusion water)