

**ASSIGNMENT 2:**  
**Pressure, Ideal Gas**  
**Equation,**  
**First Law of Thermodynamics, Heat Transport.**  
**Calorimetry**

STUDENT #: \_\_\_\_\_

NAME: \_\_\_\_\_

**Released: Sept 21,**

**Due: Sept 28**

**6PM**

**1** Evangelista Torricelli was the first person to realize that we live at the bottom of an ocean of air. He correctly surmised that the pressure of our atmosphere is attributable to the weight of the air. The density of air at  $0^{\circ}\text{C}$  at the Earth's surface is  $1.29\text{ kg/m}^3$ . The density decreases with increasing altitude (as the atmosphere thins). On the other hand, if we assume that the density is constant at  $1.29\text{ kg/m}^3$  up to some altitude  $h$ , and zero above that altitude, then  $h$  would represent the depth of the ocean of air. Use this model to determine the value of  $h$  that gives a pressure of  $1.00\text{ atm}$  at the surface of the Earth. Would the peak of Mount Everest rise above the surface of such an atmosphere?

- 2**
- a) In state-of-the-art vacuum systems, pressures as low as  $10^{-10}\text{ Pa}$  are being attained. Calculate the number of molecules in a  $1.00\text{-m}^3$  vessel at this pressure if the temperature is  $21.0^{\circ}\text{C}$ .
  - b) A copper wire and a lead wire are joined together, end to end. The compound wire has an effective coefficient of linear expansion of  $23.0 \times 10^{-6} (\text{C}^{\circ})^{-1}$ . What fraction of the length of the compound wire is copper?

**3** A diving bell in the shape of a cylinder with a height of  $2.70\text{ m}$  is closed at the upper end and open at the lower end. The bell is lowered from air into sea water ( $\rho = 1.033\text{ g/cm}^3$ ). The air in the bell is initially at  $25.0^{\circ}\text{C}$ . The bell is lowered to a depth (measured to the bottom of the bell) of  $90.0\text{ m}$ . At this depth the water temperature is  $4.0^{\circ}\text{C}$ , and the bell is in thermal equilibrium with the water.

(a) How high does sea water rise in the bell? (b) To what minimum pressure must the air in the bell be raised to expel the water that entered?

**PROVIDE THE FULL SOLUTION ON THE OPPOSITE PAGE**

**ASSIGNMENT 2:CONT**

UNIVERSITY OF OTTAWA  
Principles of Physics  
PHY1321/31 Fall 2018  
*Dr. A. Czaikowski*

STUDENT #: \_\_\_\_\_

NAME: \_\_\_\_\_

- 4 a) A water heater is operated by solar power. If the solar collector has an area of  $8.00 \text{ m}^2$ , and the intensity delivered by sunlight is  $550 \text{ W/m}^2$ , how long does it take to increase the temperature of  $1.00 \text{ m}^3$  of water from  $17.0^\circ\text{C}$  to  $62.0^\circ\text{C}$ ?
- 4 b) The surface of certain star n has a surface temperature of about  $5\,800 \text{ K}$ . The radius of the star is  $9 \times 10^8 \text{ m}$ . Calculate the total energy radiated by this star in each second. Assume that the emissivity is  $0.995$ .

- 5 At high noon, the Sun delivers  $1\,100 \text{ W}$  to each square meter of a blacktop road. If the hot asphalt loses energy only by radiation, what is its equilibrium temperature?

- 6 A  $2 \text{ kg}$  of ice at  $-20^\circ \text{C}$  is added to  $3 \text{ kg}$  of steam at  $140^\circ\text{C}$ . answer the following questions:
- a) What is the phase of the system of ice + steam if no heat escaped from it.
- b) What is the final temperature when the equilibrium is established
- CHECK THE CLASS NOTES FOR THE DISCUSSION OF THIS TYPE OF PROBLEM

**PROVIDE THE FINAL ANSWER HERE:**

(use the opposite side of this page to provide the detailed solution)