Czech Lectures
on
Fluid Mechanics

Homework No. I

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α) Partial pressures at different conditions

Partial pressures of oxygen and carbon dioxide were measured after removing water vapor from the exhaled gas using a water vapor absorber. The measured partial pressures were pO_2 = 15 kPa and pCO_2 = 4.5 kPa. What are the actual/real partial pressures of oxygen and carbon dioxide in the exhaled gas?

β) Air Compressor

A compressor is able to deliver 300 SLPM (standard liters per minute).

What flow rate is able to deliver continuously (expressed in LPM, L/min) with the output pressure of 5 atm?

γ) Humid Air

In the lab, the temperature is 24 °C and the relative humidity φ = 68%. Outside the lab, the temperature is 31 °C and the relative humidity φ = 58%.

1. **Where is more water in the air?**
2. **Where a wet piece of material will be dryied faster?**
3. **Calculate the partial pressure of water vapor in the lab and outside the lab.**

δ) Cooking in the mountains

What is the boiling temperature of water in 5 500 m above sea level and what is the boiling temperature of wate on the top of Mount Everest (8 849 m). The ambient pressure in 5 500 m is ½ of the standard pressure and the ambient pressure on the top of Mt. Everest is 32 kPa.

ε) Breathing in the mountains

What is the partial pressure of oxygen in dry air and what is the partial pressure of oxygen at B.T.P.S. on the top of Mt. Everest? (Use data from the previous task.)

ζ) Compressing air

If you compress air with the relative humidity φ = 40% isotermally at 30 °C (i.e., $t_1 = t_2 = 30°C$) from the initial pressure of 1 atm to:

1) 2 bars

2) 3 bars,

will there be water condensation?

η) Diving

What is the partial pressure of oxygen for divers if normal air is used for diving 20 meters under the water surface of a sweet water lake?

θ) Diving with a ball

A diver will dive 40 meters under the water surface of a sweet water lake with a party ball or children rubber ball filled with air. The diameter of the ball at the water surface is 15 cm.

1) **What will be the diameter of the ball 40m deep?**
2) **What is the original volume of the ball and what will be its volume 40 m deep?**

ı) Bubbles of a diver

A diver releases bubbles of air 90 m below the water surface. The bubbles are 1.5 cm in diameter. What will be the size of the bubbles close to the water surface (approx. 0 m deep)? Please, suppose, that the bubbles will not spread, which is not realistic!)

κ) Funny units of pressure

Derive (no „find on internet“) the conversion factor of the „unusual“ pressure units used on the pressure gauges in the pictures.

Use only definition of pressue (p=F/S where F is force and S is area), gravity force calculation and conversion factors you already know.

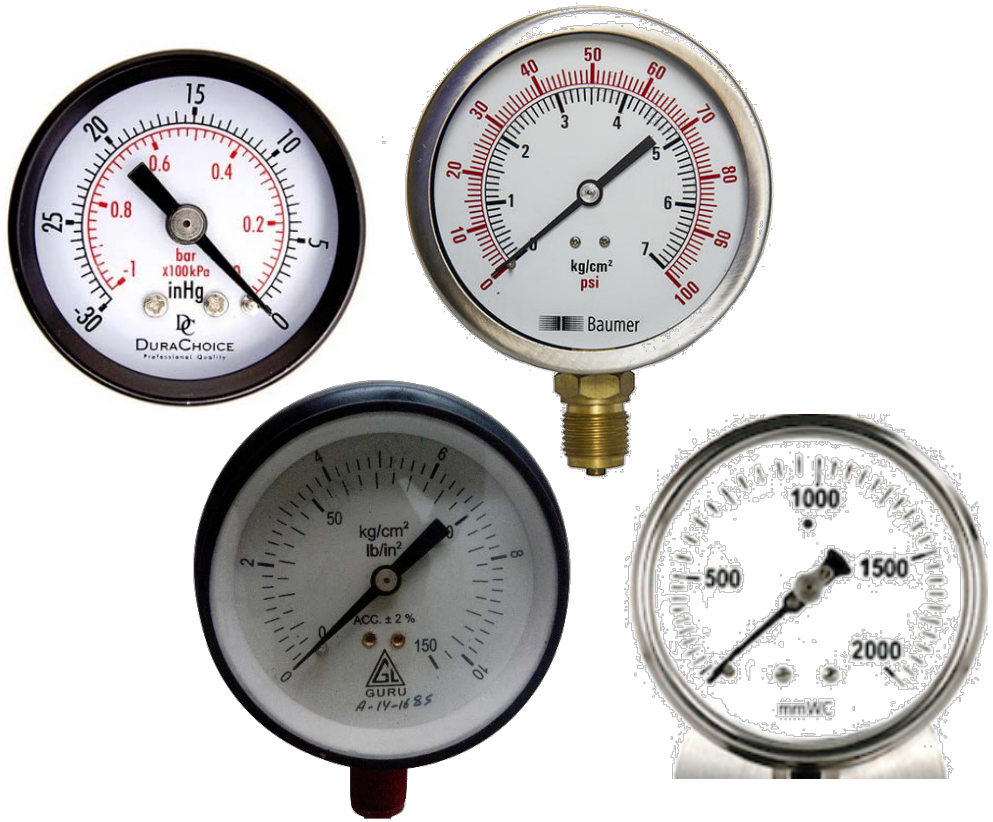
1 in Hg = kPa = cm H_2O = bar

1 kg/cm^2 = kPa = cm H_2O = bar

1 lb/in^2 = kPa = cm H_2O = bar

1 psi = kPa = cm H_2O = bar

1 mmWC = kPa = cm H_2O = bar



λ) Report on an experiment

Please, describe the aim and solution of the experiment with measurement of outside temperature and relative humidity, calculating the dew point temperature and its verification using a glass bottle and ice.

Provide the commented calculations and also the alternative graphical solution using the saturated water vapor curve.