Branch: IS (Makro)
Course: Physics
Teaching form: Classes
Semester: 2
Academic Year: 2018/2019

PRACTICE PROBLEMS - SET 5

PHASE TRANSITIONS, GAS PROPERTIES AND LAWS OF THERMODYNAMICS

Problem #1.
You are served tea of volume $V_t = 200\ ml$ in a glass of volume $V_g = 250\ ml$ and mass $m_g = 25\ g$ at the temperature $t_g = 55\ °C$. In order to decrease a temperature of tea in glass the several ice cubes each of mass $m_{ic} = 15\ g$ at a temperature $t_{ic} = -10°\ C$ were dropped into the glass. How many ice cubes would you use to reach the tea temperature $t_t = 30°\ C$? Take the specific heat: $c_{glass} = 840\ J/kg{\cdot}K$, $c_{steam} = 2.0\ kJ/kg{\cdot}K$, $c_{water} = 4.2\ kJ/kg{\cdot}K$, $c_{ice} = 2.0\ kJ/kg{\cdot}K$, and the respective latent heats of ice fusion L_{ice}=$334\ kJ/kg$ and water porization of water L_{water}=$2260\ kJ/kg$. Neglect the effects of thermal conduction between glass and ambience and tea vaporization.

Problem #2.
A block of metal of mass $m_m = 0.5\ kg$ and an initial temperature $t_m = 30\,^{\circ}C$ is dropped into a container holding of water of mass $m_w = 1.12\ kg$ at temperature $t_w = 20\,^{\circ}C$. If the final temperature of block-water system is t_f = 20.4°C, what is the specific heat of the metal? Take the specific heat of water $c_{water} = 4186\ J/\ kg{\cdot}\,^{o}C$. Assume that the thermal parameters of container can be ignored, and that no heat is exchanged with the surroundings.

Problem #3.
Estimate the number of helium atoms *He*, molecular oxygen O_2 and molecular ammonia NH_3 of mass $m = 1\ g$ at room temperature, as well as their average temperature based on kinetic energy at the level of $E_k = 5{\cdot}10^{-21}\ J$.

Problem #4.
A molecular oxygen O_2 is placed in a cylinder with a piston that is allowed to move freely. The initial gas state parameters are following: pressure $p_1 = 85\ kPa$, temperature $t_1 = 12°C$, and a volume $V_1 = 0.6\ L$. Determine its pressure p_2 if the temperature is raised to $t_1 = 30°\ C$ while the volume is fixed, as well as determine its pressure p_3 if its volume is increased to V_2=1.2 L but the temperature is held as before at $t_1 = 12°C$.

Problem #5.
In cylindrical vessel filled with air is closed by the movable piston. After its isobaric heating in temperature range $\Delta T = 300 \div 400\ K$ the piston was shifted by $\Delta h = 2\ cm$. What was its primary height *h* before heating?

Problem #6.
Estimate the difference in respective local pressure and temperature between Zakopane Centre (*900 m osl*) and Świnica peak (*2301 m osl*) taking both places as the isolated systems (adiabatic spacer) without any undesired and unexpected weather effects like wind Foehn.

Problem #7.
A cubical room of volume $V = 250\ m^3$ is filled with molecular nitrogen N_2 at atmospeheric pressure $p = 100\ kPa$ and at room temperature $t = 20\ °C$. Determine the mass of gas in the room? What is an amount of heat needed to increase the temperature in room by $\Delta t = 5\,^{\circ}C$ (if the total heat goes into the gas), and what is a respective variation of its internal energy ΔU? Assume that the heating process is under constant *V* and *p*, respectively.

Problem #8.
In the Carnot engine the ratio of temperature of heating source T_h and cooler T_c, respectively is equal to 4. What is its theoretical efficiency, and what is an amount of mechanical work done by this engine after taking the heat $Q = 200\ J$?

Problem #9.
For a Carnot engine working at temperature of heater $T_h = 600\ K$, the efficiency $\eta = 40\%$. If its efficiency increases to $\eta = 75\%$, what is a respective temperature of heater, when a temperature of cooler kept constant?

in some problems some additional assumption based on the general knowledge may be necessary