ADVANCED PHYSICS CLUB

APRIL 30, 2023

The updates, homework assignments, and useful links for APC can be found on SchoolNova's web page:
`http://schoolnova.org/nova/classinfo?class_id=adv_phy_club&sem_id=ay2022`
The practical information about the club and contacts can be found on the same web page.

Today's meeting

Today we solved some problems on the second law of thermodynamics. The remaining problems are reassigned, a couple of extra problems on molecular physics are added.

Useful information

You might find some theoretical background about the second law of thermodynamics and Carnot cycle on the following website:
`http://hyperphysics.phy-astr.gsu.edu/hbase/thermo/carnot.html#c2`
For some problems you may need the following integral: $\int_a^b \frac{dx}{x} = log\left(\frac{b}{a}\right)$.

Reassigned Homework

1. During the winter a room is kept warm by using a burner with power 1 kW. With the burner turned on the temperature in the room is 17° C while the outside temperature is −23° C. What power would be required for keeping the same inside temperature if an ideal heat pump was used instead of a burner?

2. A warm object with initial temperature T is used as a hot reservoir for a heat engine. Its' heat capacity does not depend on temperature and is equal to C. As a cold reservoir one uses an infinitely big environment with constant temperature $T_0 < T$. What maximal work can be produced by cooling down the warm object?

***3.** What maximal work can be produced using an iceberg of volume 1 km^3 as the cold reservoir and ocean of temperature 20° C as the hot reservoir for a heat engine? How much time is needed for the Grand Coulee hydroelectric power station (which has power output of about 7000 MW) to produce the same amount of energy?

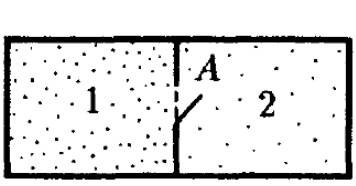
***4.** Find an expression for the entropy of ideal gas. Derive equation of an adiabat of ideal gas using this expression for entropy.

New Homework

1. Estimate the average kinetic energy and root mean square speed of fog droplets of diameter 10μm. Air temperature is 5°C.

2. Consider an ideal pendulum with a ball of mass 1 mg on a thread of length 10 m. Find the mean square deviation from equilibrium position of this pendulum caused by thermal fluctuations. Temperature of the air around is 20° C. *Hint: Use equipartition theorem.*

3. A container is separated in two halves with a wall. Initially, in section 1 there is a mixture of hydrogen and helium gases with equal pressures and in section 2 there is vacuum. For a very brief moment a hole A in the wall is opened and then closed again. Find the ratio of hydrogen pressure to helium pressure in section 2 afterwards. *Hint: Find ratio of average velocities of hydrogen and helium.*



For the next meeting

IMPORTANT: The next club's meeting is at 3:30pm, via Zoom, on Sunday, **May 7**.