ADVANCED PHYSICS CLUB

MAY 2, 2021

Useful resources

The updates, homework assignments, and useful links for APC can be found on SchoolNova's web page:
https://schoolnova.org/nova/classinfo?class_id=adv_phy_club&sem_id=ay2020
The practical information about the club and contacts can be found on the same web page.

Today's meeting

Today's homework is about some advanced topics of thermodynamics: thermal motion and vaporization.
You may find the following links useful for a review of these concepts:
http://hyperphysics.phy-astr.gsu.edu/hbase/Kinetic/eqpar.html
http://hyperphysics.phy-astr.gsu.edu/hbase/Kinetic/vappre.html

Homework

1. What maximal amount of work can be done using an iceberg of volume 1 km^3 as the cold reservoir and ocean of temperature $20°$ C as the hot reservoir? 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?

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.*
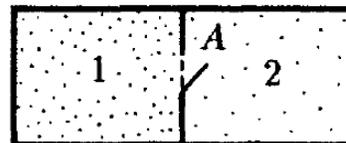
4. A cylinder with cross section $A = 20$ cm^2 is split in two halves by a piston with mass 5 kg. Initially in the lower half of the cylinder there is water and the upper part is evacuated. The piston is connected to the cylinder by a spring with spring constant 15 N/m, which is initially not deformed. Find the mass of steam created during heating the water from $0°$C to $100°$C. Friction is negligible. *Hint: Saturated water steam pressure at $100°$C is 100 kPa.*
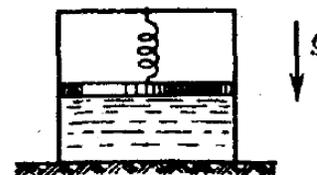
5. There are two immiscible liquids in a glass: water and carbon tetrachloride CCl_4. At normal atmospheric pressure water boils at $100°$C and CCl_4 at $76.7°$C. When the glass with mixture is uniformly heated, boiling at the interface of the two liquids starts at $65.5°$C. Find which liquid evaporates faster and how many times faster (by mass) during this "interface" boiling. Saturated water steam pressure at $65.5°$C is 25.6 kPa.

For the next meeting

IMPORTANT: The next club's meeting is at 3:00pm, via Zoom, on Sunday, **May 9**.