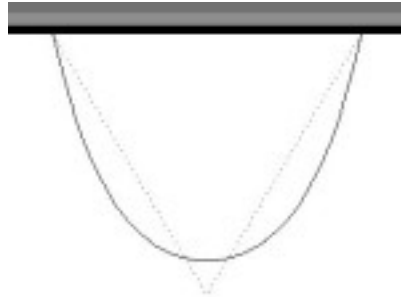


2010-02-28

## Oral Rehearsal Questions for the general doctoral exams retake at Auburn University in 2010

**Question 1.** A string with a mass is suspended at its ends at the same level in the field of gravity as shown in the figure.



What is the curve that it describes? Suppose then that it was pulled down and held at its center in the shape of the dotted line. Whose center of mass is higher – of the solid or dotted curve?

**Question 2.** The relativistic Lagrangian has the form

$$L = -mc^2 \sqrt{1 - \frac{\dot{x}^2}{c^2}}$$

Find the momentum  $p$  and the Hamiltonian  $H$ . Expand the Hamiltonian using the Taylor series and show that it reduces to the non-relativistic Hamiltonian at slow speeds. (Source: <http://www.mit.edu>)

**Question 3.** A rod of mass  $m$  rests on the rough horizontal table with coefficient of friction  $\mu$ . What minimum force applied to one of its ends perpendicular to the rod and parallel to the table is required to move the rod? The acceleration of gravity is  $g$ . (Source: Savchenko, O. Ya. "Zadachi po fizike" ("Problems in physics"), Moscow, 1988; problem 2.8.44)

**Question 4.** Write the equation of state of a van der Waals gas.

**Question 5.** A monoatomic gas obeys the equation  $pV^n = \text{const}$ . Find its specific heat capacity.

**Question 6.** For a two-dimensional gas derive its partition function  $Z$ , Helmholtz free energy  $F$ , and internal energy  $U$ .