ADVANCED PHYSICS CLUB
FEBRUARY 6, 2022

Useful resources

Today's meeting

Our new topic will be oscillations, we also have two unfinished problems from the previous assignments.

Remaining from previous homeworks

*1. In a very dense fog lots of tiny water droplets "float" with negligible speed. If one of the droplets for some reasons gets a bit larger, it starts falling and absorbs the other droplets it meets on the way. Assuming this droplet stays spherical during the fall, it turns out that it falls with constant acceleration despite air resistance, which is proportional to the speed of the droplet squared and its' cross section area. Find the maximal possible acceleration of such a droplet.

*2. A Slinky is a spring with very small spring constant and non-negligible mass. Consider a Slinky of mass m which initially was fully contracted and lying on a desk. Then we extend it by pulling one end up, until all Slinky is in the air with its lower end almost touching the desk. At this state the total length of the Slinky is L and it is much larger than its' length in the contracted state. Find

    (a) What work had to be done to raise the Slinky above the desk as described?

    (b) If the Slinky is released, how will it move? What will be the speed of its' lower end right before it hits the desk?

    (c) How long does it take for Slinky to fall on the desk?
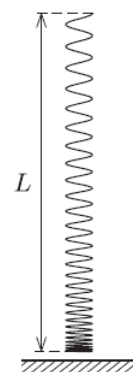
New Homework

1. A block hanging still on a vertical spring extends it by length l. Find the period of small vertical oscillations of the suspended block.

2. A heavy cart is moving with acceleration a downwards on an inclined plane making angle α with the horizon. Find the period of oscillations of a pendulum of length l mounted on the cart.
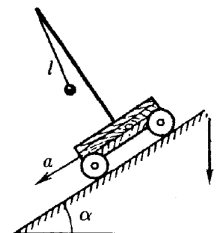
3. Imagine there is a straight tunnel dug through the Earth from one pole to the other. What time would it take a stone to fly from one end to the other? Neglect air resistance, assume the Earth density to be constant. Earth's radius is 6400 km.
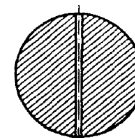
4. Four beads of mass m are connected by four identical springs with spring constant k and make a square. All beads are simultaneously push towards the center of the square so that they start moving with equal speeds. In what time after that will the springs be a) the most contracted b) the most elongated ?
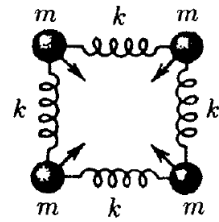
5. A pendulum with length l is hung on a slightly inclined wall. The pendulum was deflected from the vertical to a small angle which is twice the angle of the wall's incline to the vertical. Then the pendulum was released. Find the period of its' oscillations if collisions with the wall are absolutely elastic.
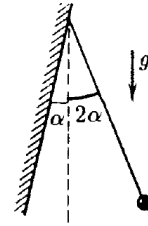
*6. A horizontal cylinder is closed from both ends. A piston of mass M can move along the cylinder without friction and it has an equilibrium position at the center of the cylinder. Two small balls of the same mass m $(m \ll M)$ are flying (parallel to the cylinder's axis) between the piston and ends of the cylinder. Collisions of the balls with the piston and the cylinder ends are completely elastic. When the piston is in equilibrium, frequency of collisions of each ball with the piston is f. If the piston is slowly moved a small distance out of equilibrium it will start oscillating. Show that these oscillations are harmonic and find their period.
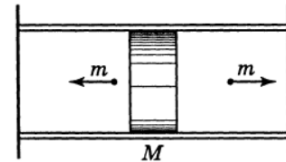
FOR THE NEXT MEETING

IMPORTANT: The next club's meeting is at 3:00pm, via Zoom, on Sunday, **February 13**.