

~~It is strongly recommended that you read about a subject before it is covered in lectures.~~

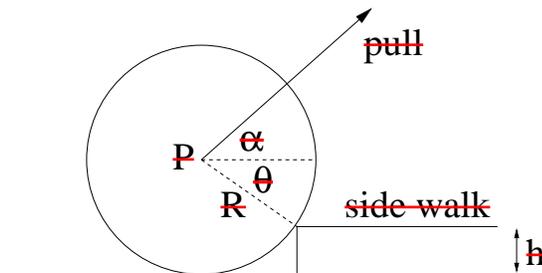
<del>Lecture Date</del>	<del>Material Covered</del>	<del>Reading</del>
<del>#33 Fri 12/3</del>	<del>Kinetic Gas Theory - Ideal Gas Law PIVoT Isothermal Atmosphere Phase Diagrams - Phase Transitions</del>	<del>Page 494 - 504 <b>Take Notes!</b></del>
<del>#34 Mon 12/6</del>	<del>The Wonderful Quantum World Breakdown of Classical Mechanics</del>	<del><b>Take Notes!</b></del>
<del>#35 Wed 12/8</del>		<del>Bring a Friend</del>

~~There is no due date for this assignment, and it will not be graded.~~

~~Solutions will be posted on Dec 10.~~

### ~~10.1 Lifting a Drum up the Sidewalk~~

~~A cylinder of mass  $M$  and radius  $R$  is lying on the street against the sidewalk. The height of the sidewalk is  $h$ . A rope is attached to the axis at each end (point P and Q) of the cylinder (we only show point P in the figure). We pull on the ropes (with equal force) perpendicular to the axis at an angle  $\alpha$  with a horizontal plane so as to just lift the cylinder off the street.~~



- ~~What is the ratio of this force (2 ropes combined) to the weight of the cylinder? Express your answer in terms of  $\alpha$ ,  $\theta$ ,  $M$ , and  $g$ .~~
- ~~At what angle of  $\alpha$  is the ratio as described under a) a minimum, and at what angle is it a maximum? Use  $\theta = 30^\circ$ .~~

### ~~10.2 Strain, Stress and Oscillations~~

~~A mass of 400 kg is hanging from a nylon rope of length 5 m and diameter 1 cm. We pull the mass down from its equilibrium position over a distance of 3 cm. (The stress is proportional to the strain.) Since the mass of the rope is much less than 400 kg you may neglect it.~~

- ~~Calculate the force needed to do this.~~
- ~~The mass is now released and it starts to oscillate vertically. Is the motion a SHO? What is the period of one oscillation?~~
- ~~We now pull the mass down 10 cm from equilibrium and we release it. The stress is still proportional to the strain. Is the motion now a SHO?~~
- ~~How much mass can we hang on the rope before it breaks? Any idea how long the rope then is?~~

### ~~10.3 Archimede's Principle~~

~~A uniform block of wood floats in water with two-thirds of its volume submerged. In oil it has 90% of its volume submerged. What is the density of the wood and of the oil?~~

~~$x = -0.07$  m at which point the rope will start to go slack and there will be no restoring force, only the force of gravity. The motion will no longer be completely simple harmonic motion.~~

~~(d) The ultimate tensile strength is given by Table 14.1 on page 366 as  $\left(\frac{F}{A}\right)_{\max} = 3.2 \times 10^8$  N/m<sup>2</sup>. The maximum mass will then be~~

~~$$M_{\max} = \frac{A}{g} \left(\frac{F}{A}\right)_{\max} \approx 2.6 \times 10^3 \text{ kg}$$~~

~~You can only calculate a conservative lower limit to the amount by which the rope will stretch. As we have seen in lectures, Hooke's law (thus  $\frac{\Delta L}{L} = \frac{F}{YA}$ ) no longer holds near the breaking point. The lower limit would be~~

~~$$\Delta L = \frac{L}{Y} \left(\frac{F}{A}\right)_{\max} \approx 0.44 \text{ m}$$~~

~~Thus a conservative lower limit for the length of the rope is 5.44 m.~~

### Problem 10.3

Let  $\rho = 1$  gm/cm<sup>3</sup> be the density of water,  $\rho_W$  be the density of the wood,  $\rho_O$  be the density of the oil, and  $V$  be the volume of wood. For the water,

$$\rho \cdot \frac{2}{3}V = \rho_W \cdot V \quad \implies \quad \rho_W = \frac{2}{3} \cdot \rho \approx 0.67 \text{ gm/cm}^3$$

For the oil,

$$\rho_O \cdot 0.9 \cdot V = \rho_W \cdot V \quad \implies \quad \rho_O = \frac{1}{0.9} \cdot \rho_W \approx 0.74 \text{ gm/cm}^3$$

### Problem 10.4

~~Let  $p_0$  be atmospheric pressure,  $\rho = 10^3$  kg/m<sup>3</sup> the density of water,  $M$  the mass of the rod,  $A$  its cross section area,  $d = 3$  m its equilibrium depth, and  $x$  its displacement down from its equilibrium depth. The equilibrium depth is given by~~

~~$$Mg = \rho g d A$$~~

~~The force equation is~~

~~$$p_0 A + Mg - (p_0 + \rho g(d + x))A = M\ddot{x}$$~~

~~where  $p_0 + \rho g(d + x)$  is the pressure at the bottom of the rod. If we use the expression  $Mg = \rho g d A$  in the above equation we have~~