Massachusetts Institute of Technology - Physics Department

Physics - 8.01 **Assignment #9** November 17, 1999.

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

Lecture Date	Material Covered	Reading
#29 Fri 11/19	Exam Review	Lectures 16 thru 24
Mon 11/22	**Exam #3**	**Handout of 11/15**
#30 Wed 11/24	Simple Harmonic Oscillations - Energy Considerations	Page 389 – 395
	Torsional Pendulum	Page 396 – 397
#31 Mon 11/29	Forced Oscillations - Normal Modes - Resonance	Page 399 – 403
	Natural Frequencies - Musical Instruments	Page 438 – 445
		Take Notes!
#32 Wed 12/1	Heat - Thermal Expansion - Conductivity	Page 515 – 527

Due Wednesday, Dec 1, before 4 PM in 4-339B.

9.1 *Short Questions*

a) A car accelerates. Treating the car (including the tires) as one system, what force causes the system to accelerate (i.e., what force equals Ma)?
(i) The force of friction, (ii) the force of the motor, (iii) none of the above.

b) The kinetic energy of the car increases as it accelerates, so work is being done on the car. What force is doing this work?
(i) The force of friction, (ii) the force of the motor, (iii) none of the above.

c) John is holding a computer monitor, with a mass of 25 kg, at a constant height. He complains that he is becoming exhausted. Nancy tells him that since there is no displacement in the direction of the applied force, he is not doing any work, and therefore should not be tired. Who is right and why?

d) Mary is riding an elevator wearing a backpack of mass M. Between the 5th and the 6th floor the elevator is moving at constant speed through a distance l. Joan, argues that since the velocity of Mary's backpack is constant, the total force on the backpack must be zero, and therefore Mary is applying an upward force, Mg, just enough to cancel that of gravity. Since the displacement is upward over a distance l, the work that Mary has done on the backpack is Mgl. Mary, on the other hand, points out that the weight she feels is just the same as it would be if she were stationary on the sidewalk, in which case there would be no displacement and therefore no work. Since she is burning no more calories than she would if she were on the sidewalk, and thus she is doing no work on the backpack. Who is right and why?

e) Joe, on a frictionless ice rink, is initially stationary. Holding onto a rope attached to the wall, he gives a yank and starts himself moving towards the wall. Jean who is watching, tells Joe that since his kinetic energy has increased, work must have been done. It was the rope that applied the force, Jean explains, so it was the rope that did the work on Joe. Joe argues that ropes can't do work. Ropes don't have any source of energy, obviously it was he who did the work. Mary argues that Joe could not possibly exert a force on himself. Who is right here and why?

f) A fly is resting on the bottom of a closed jar. The jar is placed on a very accurate balance, and there is equilibrium. The fly starts flying. Will there be equilibrium again?

g) Same question, but now with the jar open.

h) You are in orbit around the Earth. Your orbit is very elliptical. You are running very very low in fuel, and it is touch and go whether you will have enough fuel left to reenter and return to Earth. When should you fire your rockets for reentry, when you are farthest away from Earth or when you are very close? Explain your answer.

i) I am sitting in a boat in a swimming pool. There is a heavy rock in my boat. I carefully mark the water line on the tiles of the swimming pool. I then throw the rock over board. Will the water line go up, or down, or will it stay the same? Give your reasoning. ***PIVoT***

j) A block of pure ice is floating in a swimming pool. I mark the water line of the swimming pool, as above. The ice melts. What will happen with the water line? Give your reasoning.

9.2 *Delicate Balance* – page 372, problem 16

9.3 *An Overhang of Books* – page 372, problem 18

9.4 *Compression of a Femur* – page 377, problem 50

9.5 *A Torsional Pendulum in a Watch* – page 408, problem 31

9.6 *High Blood Pressure?* – page 488, problem 17

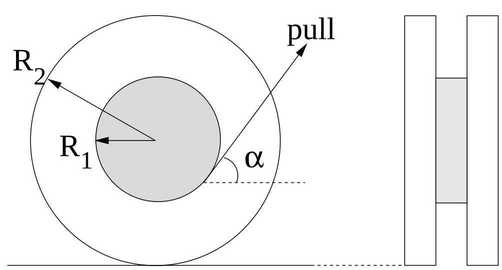
9.7 *A Suction Pump* – page 489, problem 18

9.8 *Dangerous Icebergs* – page 489, problem 24

9.9 *A Submerged Block of Wood* – page 491, problem 35

9.10 *A Hole in a Water Tank* – page 493, problem 50 ***PIVoT***

9.11 A cylindrical container of length L is full to the brim with a liquid which has mass density ρ. It is placed on a weigh-scale; the scale reading is W. A light ball which would float on the liquid if allowed to do so, of volume V and mass m is pushed gently down and held beneath the surface of the liquid with a rigid rod of negligible volume as shown on the left.



a) What is the mass M of liquid which overflowed while the ball was being pushed into the liquid?

b) What is the reading of the scale when the ball is fully immersed?

c) If instead of being pushed down by a rod, the ball is held in place by a thin string attached to the bottom of the container as shown on the right. What is the tension T in the string, and what is the reading on the scale?