Week of Oct 17

Reading: Fishbein, Chapters 6, 7, 8.1-8.2

Homework: Due in class Oct 20.

Please solve the following problems. Problems 1-5 are not from the textbook. The others are chosen from chapters 6 and 7 of the 3rd edition of Physics for Scientists and Engineers, authors Fishbane, Gasiorowicz and Thornton.

(1) Consider a block of mass $M = 1kg$ which is pulled along a plane, inclined at an angle $\theta = \pi/6$ to the horizontal, by a rope which exerts a tension force $T$ directed along the plane. The block is also subject to gravitational and frictional forces (see figure).

Assume that there is no friction. Suppose that the tension in the string is initially such that the block is at rest at position $P_1$, and that starting at time $t_1$ the tension in the rope is changed to $T = Mg$. The block begins to accelerate and after 2 seconds has moved to a different position.

(i) Defining work done on the block as the change in the total (kinetic plus potential) energy of the block, compute the work done on the block by the tension in the rope between time $t_1$ and time $t_1 + 2$ sec.
(ii) Defining work done on the block as the change in the kinetic energy of the block, compute the total work done on the block by all of the forces which act on it between time \( t_1 \) and time \( t_1 + 2 \text{ sec} \).

(2) Consider the situation of Problem 1, but now assume that the coefficient of kinetic friction \( \mu = 0.1 \). Suppose that at time \( t_1 \) the block is at position \( P_1 \) and is moving to the right (down the plane) at velocity \( v_1 = 5 \text{ m/sec} \), and suppose that the tension in the rope is such as to keep the block moving at constant velocity. After 2 seconds the block has moved to a different position.

(i) Defining work done on the block as the change in the total (kinetic plus potential) energy of the block, compute the work done on the block between time \( t_1 \) and time \( t_1 + 2 \text{ sec} \).

(ii) Compute the total work done by the tension force in the rope between time \( t_1 \) and time \( t_1 + 2 \text{ sec} \). You should find that this is not equal to the answer you got in part i. Explain the difference.

(3) In class we saw that a mass of approximately 15kG suspended from a point \( \approx 1 \text{ m} \) from the ceiling swung back and forth with a period of \( \approx 4 \text{ sec} \). At its lowest point the mass was \( \approx 1 \text{ m} \) from the floor. Please use this information to determine the height of the ceiling of the classroom above the floor.

(4) Consider a mass \( M = 0.1 \text{kG} \) suspended from a string of length \( L = 2 \text{ m} \) which undergoes circular motion in the \( x-z \) plane with \( z \) being the vertical direction which is subject both to gravity and to a position-independent force \( F = 1 \text{N} \) directed along \( \hat{x} \).

Suppose that at time \( t = 0 \) the mass is hanging vertically down below the suspension point and has some velocity \( v \). Please find the minimum value of \( v \) such that the mass can complete a full circle of rotation.

(5) Consider a mass \( M = 2 \text{kG} \) suspended from a spring of equilibrium length \( L \) and spring constant \( K \) so that its potential energy is

\[
V(z) = \frac{1}{2}K(L-z)^2 + mgz
\]

Suppose that at time \( t = 0 \) the mass is at position \( z = L \) and has zero velocity. The mass will bounce up and down along \( z \). Please find

(a) the lowest point reached by the mass
(b) the velocity, when it is half way to the lowest point
(c) the period (repeat time) of the motion?

(6) Problem 6.56
(7) Problem 6.60
(8) Problem 7.28
(9) Problem 7.46