Note: I have tried to compose this set of problems so that they cover all of the areas already covered on previous tests which are likely to appear on the final. I do not make any promises that this set is inclusive. It is possible that topics not covered in this set will appear on the final. The definitive list of “old material” topics for the final was given in class.

(2.1.10) In the diagram below, each pulley has a mass of 8.0kg, and the platform being supported by the pulley system has a mass of 20kg. Find the tensions $T_A$ and $T_B$. Assume that the strings are massless.

(2.1.60) Helmut holds an eraser of mass $m$ motionless against a wall by pushing on it at an angle $\theta$ above the horizontal. The coefficient of static friction between the eraser and the wall is $\mu_s$. If $P$ is the strength (i.e. magnitude) of the push force, what is the smallest value of $P$ which will prevent $m$ from sliding down the wall? State your answer in terms of $m$, $\theta$, and $\mu_s$.

(4.2.20) A bullet initially travelling at 500m/s strikes a plank of wood which is 5.0cm thick. When the bullet emerges from the other side, its speed is 400m/s. What are the acceleration of the bullet and the time spent in the plank?
(4.1.40) Points A and B are 400m apart. A Porsche leaves point A moving towards point B with a constant speed of 20mi/hr. 5.0s later, a Datsun leaves point B moving towards point A with a constant speed of 20m/s. How far from point A will the two cars collide?
(5.2.10) A box of mass $m$ slides down an incline which makes angle $\theta$ with the horizontal. The coefficient of kinetic friction between the box and the incline is $\mu_k$.

(a) What is the acceleration of the box? Express your answer in terms of the given quantities.
(b) Suppose that $m = 7.0\text{kg}$, $\theta = 30^\circ$, $\mu_k = 0.4$. What is the acceleration of the box?
(c) If the initial speed of the box is 3.0 m/s, how much distance will it slide through before it speeds up to 4.0 m/s?

(5.2.20) A 3800 kg elephant is lifted by two helicopters, as shown below. The elephant accelerates upward at $2.0\text{m/s}^2$. Find the tension in the cables.

![Diagram of an elephant being lifted by two helicopters](image)

Textbook: Chapter 3, Problem 29
Textbook: Chapter 3, Problem 31

(7.2.10) A 6.0 kg box is dragged 4.0 m along a horizontal floor by a string with tension $T = 30.0\text{N}$. The string makes a $40^\circ$ angle with the horizontal. The coefficient of kinetic friction between the box and the floor is $\mu_k = 0.3$. If the initial speed of the box is $2.0\text{m/s}$, what is the final speed? (Try to use the work-kinetic energy theorem to answer this question.)

(7.2.20) A box is released from the top of a $30^\circ$ incline. It slides 1.5 m along a frictionless part of the incline before encountering a region where the coefficient of kinetic friction between the box and the incline is 0.7. Through what distance must the box slide along the frictional part of the incline before coming to rest? (Try to use the work-kinetic energy theorem to answer this question.)

(7.5.10) Water balloons are launched from the top of a dormitory using a spring-loaded water balloon launcher. To launch a balloon, a spring of spring constant 500 N/m is compressed 50 cm, a balloon of mass 0.60 kg is placed against the spring, and the spring is released. The roof of the dormitory is 30 m above the ground. What is the speed of the water balloon when it hits the ground?

(7.5.20) A 2.0 kg mass is dropped onto a vertical spring from a height of 60 cm above the moving end of the spring. When the block is momentarily at rest, the spring has been compressed 20 cm.
(a) What is the spring constant?
(b) What is the speed of the block when the spring is compressed 10 cm?
(7.6.10) In the scenario shown below, the springs are unstretched. Assume that $k_1 = 200\text{N/m}$, $k_2 = 300\text{N/m}$, $m = 0.6\text{kg}$, and the coefficient of kinetic friction between the mass and the horizontal surface beneath it is 0.4. Suppose that the mass is displaced 20cm from its equilibrium position and released. What will be its speed when it again passes through the equilibrium position?

(FOLLOW THE PROCEDURE DISTRIBUTED IN CLASS WHEN DOING THIS PROBLEM)

Textbook:
Chapter 6, Problem 30
Chapter 6, Problem 50