1. [10 points]
The angular position of a 3.7 kg disk is given by $\theta(t) = (6t^3 - 8t^2 + 5)$ rad, where $t$ is in s. What is its angular velocity at $t = 2.14$ s?

2. [10 points]
A 3.75 kg mass is hung on a spring. If the spring is stretched 12.3 cm when the system reaches equilibrium, what is the spring constant of this spring?

3. [25 points]
An 11.8 kg box is pushed by an 86.1 N force (acting at $\theta = 17.4^\circ$ below horizontal) as shown. The coefficient of friction between the box and the surface is $\mu = 0.297$.

(A) Draw a free-body diagram for the box showing all forces in terms of their $x$ and $y$ components:

(B) Calculate the acceleration of the box.

(C) How much work is done by gravity if it was pushed 3.3 m to the right by $F$?
4. [15 points]
A 63 kg astronaut drifting with a velocity of \(( 3.64 \hat{i} - 7.44 \hat{j} )\) m/s is holding a 17.6 kg module for the space station. She throws the module to another astronaut at a velocity of \((-1.35 \hat{i} - 3.64 \hat{j})\) m/s. Find the (vector) velocity of the first astronaut after she threw the module.

5. [10 points]
Calculate the velocity required for a satellite of mass 675 kg to be in a circular orbit that is 3473 km above the surface of the earth. (The other data you need are on the front page of the exam.)

6. [20 points]
Given that \(\vec{F}_1 = (-51.4 \hat{i} + 32.2 \hat{j})\) N and \(\vec{F}_2 = (24.1 \hat{i} + 13.4 \hat{j})\) N act on a 5.67 kg mass that is initially moving at \(\vec{v} = (9.87 \hat{i} - 7.44 \hat{j})\) m/s,

(A) calculate the acceleration of the mass

(B) calculate the time when the x component of its velocity is zero.

7. [15 points]
A wind-up toy car with a mass of 1.39 kg is released from the top of a ramp that is 0.876 m high. It rolls down the ramp and across a carpeted floor, stopping after traveling 2.68 m. If there is a 9.89 N force of friction from the carpet, how much work was done by the windup motor in the car?