1. [20 points]
A 13.6 kg mass traveling in the \(+\hat{i}\) direction at 4 m/s explodes into two pieces. One piece with mass 5.7 kg ends up traveling in the \(+\hat{j}\) direction at 6 m/s.

Find the (vector) velocity of the other mass, which has a mass of 7.9 kg. You can ignore gravity. Give your answer using components.

2. [10 points]
The angular position of a 5.1 kg disk is given by \(\theta(t) = (5t^3 - 33t^2)\) rad, where \(t\) is in s. What is its angular velocity at \(t = 2.4\) s?

3. [15 points]
A spring-loaded gun is used to launch a 0.129 kg projectile straight up in the air. The spring (with a force constant of 7620 N/m) is initially compressed 9.13 cm. If you observe that the projectile only rises 19.1 m, how much work was done by air drag and friction?

4. [20 points]
The 19.2 kg mass shown at right is accelerating at 1.90 m/s\(^2\) up the ramp, which is at a 12.5 deg angle. The force \(F\) is 95.3 N, and there is friction.

Draw your free-body diagram here:

What is the coefficient of kinetic friction, \(\mu\)?
5. [20 points]
A projectile is launched from the origin at an angle of 41.4 degrees above horizontal (above the x axis) with a speed $v = 41.7$ m/s.

Assume that the only force acting on it is gravity.

Let $t = 0$ when the projectile is launched from the origin.

A) At what time $t$ does it reach the highest point above the ground?

B) How far downrange (distance along the x axis) is it at this time?

6. [5 points]
An archer shoots an arrow. Consider the action force to be the bowstring against the arrow. The 3rd law reaction to this force is the

A) friction of the ground against the archer’s feet.
B) weight of the arrow.
C) forward movement of the arrow.
D) grip of the archer’s hand on the bow.
E) arrow’s push against the bowstring.

7. [15 points]
A mass requires 8.1 s to slide 61.8 m. During this time it is subject to a constant acceleration of $-23$ m/s$^2$. Find its initial velocity.

Give your well-organized calculation below.
Do not assume that the final velocity is zero.