1. [15 points]
   A mass M (837 kg) is at the origin and a mass m (372 kg) is located at the point \( x = 0.055 \text{ m}, \ y = 0.037 \text{ m} \) as shown.

   (A) Find the magnitude of the gravitational force between mass M and mass m.

   (B) Specify the vector gravitational force of M on m using components.

2. [10 points]
   A motor in a 5.73 kg cart produces an acceleration of 0.387 m/s\(^2\) when the cart is traveling at 2.87 m/s. Calculate the power being produced by the motor.

3. [20 points]
   Mass B (11.8 kg) is on a frictionless incline as shown, connected by a massless rope to mass A which is hanging from an ideal pulley. The incline is at \( \theta = 41.6^\circ \) above horizontal. Find the mass of A so A accelerates upward at 2.06 m/s\(^2\).

   (Sketch your free-body diagrams below.)

4. [5 points]
   If you double the mass of an object and cut its speed in half, by what factor does the kinetic energy change? (Circle the correct answer.)

   A) 8    B) 4    C) 2    D) 1    E) 1/2    F) 1/4    G) 1/8
5. [20 points]
A 5.37 kg cart is moving at 3.75 m/s at point A. Between B and C it crosses a moving belt that applies the force shown in the graph at right. (Point B is at x = 0 m and C is at x = 3 m and the rest of the surface is frictionless.) It then hits a massless spring that has a force constant of k = 278 N/m. How much is the spring compressed when the cart stops?

![Diagram of cart on a moving belt with forces and position markers]

Show your well-organized calculation below.

6. [15 points]
Two forces, $\vec{F}_1 = (12.1 \hat{i} + 7.6 \hat{j})$ N and $\vec{F}_2 = (6.7 \hat{i} - 37.8 \hat{j})$ N, are the only forces acting on a 3.85 kg mass. If the mass has an initial velocity of $(-7.1 \hat{i} + 9.4 \hat{j})$ m/s, find the (vector) velocity at $t = 2.75$ s.

7. [20 points]
A 2.31 kg cart, initially at rest on a horizontal, frictionless surface, is struck by a 4.72 kg cart moving to the right with a speed of 3.87 m/s. After the collision, the 4.72 kg cart has a velocity of 1.17 m/s to the right.

![Diagram of collision with carts and incline]

(A) Determine the velocity of the 2.31 kg cart right after the collision.

(B) How far up a hill will the 2.31 kg cart go before stopping?
1. [15 points]
A satellite with a 387 kg mass is in a circular orbit at an altitude of 687 km above the surface of the earth. The other data you need are on the front of the exam: \( M_{\text{Earth}} = 5.98 \times 10^{24} \text{ kg} \), \( R_{\text{Earth}} = 6.37 \times 10^6 \text{ m} \).

(A) Calculate the weight of the satellite at that altitude.

(B) Calculate the orbital speed of the satellite.

2. [10 points]
A motor in a 938 kg car produces an acceleration of 2.87 m/s\(^2\) when the car is traveling at 26.4 m/s. Calculate the power being produced by the motor.

3. [20 points]
Mass B (16.5 kg) is on a frictionless incline as shown, connected by a massless rope to mass A which is hanging from an ideal pulley. The incline is at \( \theta = 35.4^\circ \) above horizontal. Find the mass of A so A accelerates downward at 2.36 m/s\(^2\).

(Sketch your free-body diagrams below.)

4. [15 points]
An object is launched at 58.3 m/s at an angle of 57.3° above horizontal. At what time will it be 31.8 m above the launch point and on its way down?
5. [20 points]
A 4.67 kg cart is moving at 3.75 m/s at point A. Between B and C it crosses a moving belt that applies the force shown in the graph at right. (Point B is at x = 0 m and C is at x = 3 m and the rest of the surface is frictionless.) It then hits a massless spring that has a force constant of k = 367 N/m. How much is the spring compressed when the cart stops?

![Graph of force vs. position]

Show your well-organized calculation below.

6. [5 points]
If you double the mass of an object and cut its speed in half, by what factor does the kinetic energy change? (Circle the correct answer.)

A) 8  B) 4  C) 2  D) 1  E) 1/2  F) 1/4  G) 1/8

7. [20 points]
A 3.13 kg cart, initially at rest on a horizontal, frictionless surface, is struck by a 6.62 kg cart moving to the right with a speed of 4.36 m/s. After the collision, the 6.62 kg cart has a velocity of 1.28 m/s to the right.

![Diagram of collision]

(A) Determine the velocity of the 3.13 kg cart immediately after the collision.

(B) How far up a hill will the 3.13 kg cart go before stopping?