1. (14 pts) A 1000 kg car is subjected to a variable force given by the equation:
\[ y = -15N + (25 N/m) \cdot x \]
When the car had traveled 26 m, its velocity was 15 m/s. What was the car's speed when it traveled 5 m?

2. (14 pts) A 1350 lb roller coaster starting from rest at point A is subjected to a constant friction force of 120 lb over the entire run. Assuming that at point B the coaster's speed is 18 ft/s, what is the length of the track between points A and B?

\[ \frac{1}{2} \cdot 1350 \cdot (115 ft - 88 ft) = \frac{1}{2} \cdot 1350 \cdot (18 ft + 120 ft + 2) \]

\[ X = \frac{347.2 ft}{10} \]

\[ X = \frac{347.2 ft}{10} \]
3. A 40 lb box of candy is sliding across the floor. The box is moving with an unknown initial speed \( v \) when it contacts an initially uncompressed spring with stiffness of 300 lb/ft. There is a friction force of 33 lb between the box and floor. If the spring is compressed 0.7 ft when the box comes to a stop, what is the initial speed \( v \)?

![Image]

\[ 12.5 \text{ ft/s} \]

Point A: Spring uncompressed

Point B: Spring compressed 0.7 ft

\[ \frac{1}{2} m v_A^2 = \frac{1}{2} k x_A^2 + V_f \]

\[ \frac{1}{2} m v_A^2 = \frac{1}{2} k x_B^2 + V_f \text{ friction} \]

\[ \frac{1}{2} m \cdot 40 \text{ lb} = \frac{1}{2} \cdot 400 \text{ lb/ft} \cdot (0.7 \text{ ft})^2 + \frac{0.7 \text{ ft} \cdot 33 \text{ lb}}{2} \]

\[ v_A = 12.47 \text{ ft/s} \]

4. (14 pts) Three identical masses move as depicted in the picture. Mass 1 moves with an initial velocity of 3.5 ft/s at 40\(^\circ\) below the x-axis. Mass 2 moves with an initial velocity of 3 ft/s along the x-axis, and mass 3 moves with an initial velocity of 3.5 ft/s at 40\(^\circ\) above the x-axis. When they collide all three masses stick together. What is the final velocity (magnitude and direction) of the combined masses?

\[ 4.1 \text{ ft/s} \]

5. (14 pts) A 3 kg mass moving at -8 m/s collides with a 4 kg mass moving at -6 m/s. If the collision is perfectly elastic, determine the velocity of the 3 kg mass after the collision.

\[ v_1 = \frac{8}{\sqrt{13}} \text{ m/s} \]

\[ v_2 = \frac{6}{\sqrt{13}} \text{ m/s} \]

\[ m_1 v_1 + m_2 v_2 = m_1 v_1' + m_2 v_2' \]

\[ \frac{3 \cdot 8 \text{ m/s} + 4 \text{ m/s} \cdot (-6 \text{ m/s})}{3 \text{ kg}} = 3 \text{ kg} \cdot v_1' + 4 \text{ kg} \cdot v_2' \]

\[ 3 v_1' + 4 v_2' = 0 \]

From I + II: \( v_1' = -8 \text{ m/s} \)

\( v_2' = +6 \text{ m/s} \)

6. (10 pts) A professor, whose mass is 75 kg, is sliding on a 120 kg sled with a constant velocity of 5 m/s. After 6 seconds, he decides to jump off the sled. His velocity (relative to the ground) is 1.5 m/s in the opposite direction of the sled. What is the sled's velocity after the professor has jumped off of it?

\[ 4.06 \text{ m/s} \]

\[ 1.5 \text{ m/s} \]

\[ 5 \text{ m/s} \]

\[ (m_p \cdot m_s) v = m_p \cdot v_p' + m_s \cdot v_s' \]

\( (75 + 120) \text{ m/s} \cdot 5 \text{ m/s} = 75 \text{ kg} \cdot (-1.5 \text{ m/s}) + 120 \text{ kg} \cdot v_s' \)

\[ v_s' = 9.06 \text{ m/s} \]
7. (10 pts) A ball is dropped to the floor from a height of 2 meters. The coefficient of restitution between the ball and the floor is 0.8. What is the speed of the ball just after it bounces off the floor?

\[ v_f = \sqrt{2gh_a} = \sqrt{2 \times 9.81 \text{ m/s}^2 \times 2 \text{ m}} = -6.36 \text{ m/s} \]

\[ e = \frac{v_f}{v_i} \Rightarrow v_i = e \cdot v_f = 0.8 \times (-6.36) = -5.08 \text{ m/s} \]

8. (10 pts) A crane lifts a 1700 lb weight over a height of 30 ft in 10 seconds. What is the average power of the crane (in hp)?

\[ P = \frac{W}{t} = \frac{1700 \text{ lb} \cdot 30 \text{ ft}}{10 \text{ sec} \cdot 550 \text{ ft/lb}} = 9.27 \text{ hp} \]

Please remain seated if there are less than 5 minutes to go in the exam so as not to disturb those still trying to finish. If you finish early you should go back and check your work.