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Problem 1

20 pts

a) The position of a particle is given by \( s = 5t^2 + 3t - 8 \) m. What is the velocity of the particle when \( t = 1 \) s.

b) A force acts on a particle giving it an acceleration, \( a = 3x^2 \). What is the velocity of the particle when \( x = 1 \) m.

c) An elevator and its passengers weighs 3220 pounds (\( m = 100 \) slugs). Assuming that the elevator is supported by four cables, what is the tension in each cable after the elevator starts to move up at 5 m/s\(^2\)?

d) Two 5 kg monkeys are climbing on a rope as shown. Monkey A is traveling at 2 m/s down and monkey B is traveling at 1 m/s up. What is the linear momentum of the system at this instant?

e) For the blocks shown below having masses \( m_A \) and \( m_B \) draw a free body diagram of object B labeling all the unknowns quantities.
f) An impact occurs as shown below (the primes denote the velocities after the impact). If B has a mass of 10 kg what is the average impulse between the two objects during the impact?

\[
\begin{align*}
A & \quad v_A = 3 \text{ ft/s} \\
\quad v'_A = 2 \text{ ft/s} \\
B & \quad v_B = 2 \text{ ft/s} \\
\quad v'_B = 1 \text{ ft/s}
\end{align*}
\]

\[ g) \text{ What is the mass of object A in problem 1f)?} \]

\[ h) \text{ The planets rotating about the sun can be considered particles for the purpose of many orbital mechanics calculations. What is the angular momentum of the planet A (assume the planet has a mass m) about the sun for the position shown below.} \]

\[ g) \text{ An aquarium has a 0.6m by 5 m view window as shown below. What is the magnitude of the resultant force due to the water acting on the window. } y_{H,O} = 9.81 \text{ KN} / \text{m}^3 \]

\[
\begin{align*}
\text{Window} & \quad 0.3 \text{ m} \\
0.6 \text{ m} & \quad 1.8 \text{ m} \\
\text{Water} &
\end{align*}
\]
Arm AB of a classifying accelerometer has a weight of 0.25 lbf with a mass center at G had is pivoted freely to the frame F at A. The torsional spring at A is set to preload the arm with an applied-clockwise moment of 2 lb-in. Determine the downward acceleration $a$ of the frame at which the contacts at B will separate and break the electrical circuit.
A test vehicle designed for impact studies has a mass of 1400 kg and is accelerated from rest by the impingement of a high-velocity water jet upon its curved surface as shown. The water leaving the water supply has velocity of 150 m/s and a mass flow rate of 4500 kg/s. Friction acting on the vehicle, which can be treated as a particle, is assumed to be a constant 1000 N. Determine:

a) the initial acceleration of the vehicle (35 pts)
b) the velocity of the vehicle after 3 seconds (5 pts)