

Monday warm-up: Kinematics III, and Forces I

Prof. Jordan C. Hanson

September 17, 2025

1 Memory Bank

1. $\vec{r}_{PS} = \vec{r}_{PS'} + \vec{r}_{S'S}$... Relative positions
2. $\vec{v}_{PS} = \vec{v}_{PS'} + \vec{v}_{S'S}$... Relative velocities
3. $\sum_i \vec{F}_i = \vec{F}_{\text{net}}$... The net force
4. $\vec{F}_{\text{net}} = \vec{0} \rightarrow$ constant velocity ... Newton's First Law
5. $\vec{F}_{\text{net}} = m\vec{a}$... Newton's Second Law

does it experience (in vector form)? (d) What are the magnitude and direction of the acceleration?

2 Chapter 4 - Relative Motion

1. Two speedboats are traveling at the same speed relative to the water in opposite directions in a moving river. An observer on the riverbank sees the boats moving at 4.0 m/s and 5.0 m/s. (a) What is the speed of the boats relative to the river? (b) How fast is the river moving relative to the shore?

3. Two forces of 25 and 45 N act on an object. Their directions differ by 70 degrees. The resulting acceleration has a magnitude of 10.0 m s^{-2} . What is the mass of the object?

3 Chapter 5 - Forces

1. (a) Find the net force, if each of the following forces act on a system: $\vec{F}_1 = -2.50\hat{i} - 2.5\hat{j}$ N, $\vec{F}_2 = -2.50\hat{i} + 2.5\hat{j}$ N, $\vec{F}_3 = 2.50\hat{i} - 2.5\hat{j}$ N, and $\vec{F}_4 = 2.50\hat{i} + 2.5\hat{j}$ N. (b) Is the system accelerating?

4. (a) Find an equation to determine the magnitude of the net force required to stop a car of mass m , given that the initial speed of the car is v_0 and the stopping distance is Δx . (b) Find the magnitude of the net force if the mass of the car is 1050 kg, the initial speed is 40.0 km hr^{-1} , and the stopping distance is 25.0 m.

2. Two small forces, $\vec{F}_1 = -2.50\hat{i} - 10.0\hat{j}$ N, and $\vec{F}_2 = 10.0\hat{i} - 2.50\hat{j}$ N, are exerted on a rogue asteroid by a pair of space tractors. (a) Find the net force. (b) What are the magnitude and direction of the net force? (c) If the mass of the asteroid is 125 kg, what acceleration