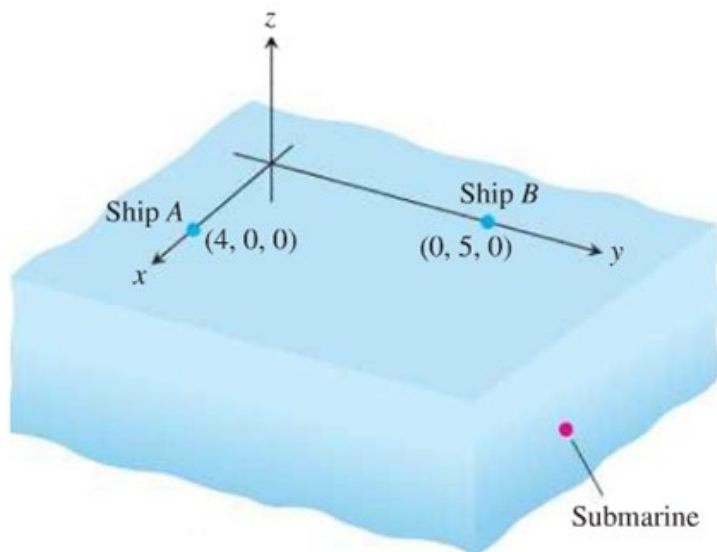
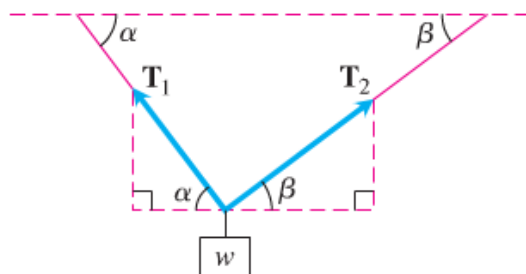


Professor: Fred Khoury

1. Two surface ships on maneuvers are trying to determine a submarine's course and speed to prepare for an aircraft intercept. Ship *A* is located at $(4, 0, 0)$, whereas ship *B* is located at $(0, 5, 0)$. All coordinates are given in thousands of feet. Ship *A* locates the submarine in the direction of the vector $2\hat{i} + 3\hat{j} - \frac{1}{3}\hat{k}$, and ship *B* locates the submarine in the direction of the vector $18\hat{i} - 6\hat{j} - \hat{k}$. Four minutes ago, the submarine was located at $(2, -1, -\frac{1}{3})$. The aircraft is due in 20 min. Assuming that the submarine moves in a straight line at a constant speed, to what position should the surface direct the aircraft?



2. Consider the weight w N suspended by two wires where T_1 and T_2 are force vectors directed along the wires.

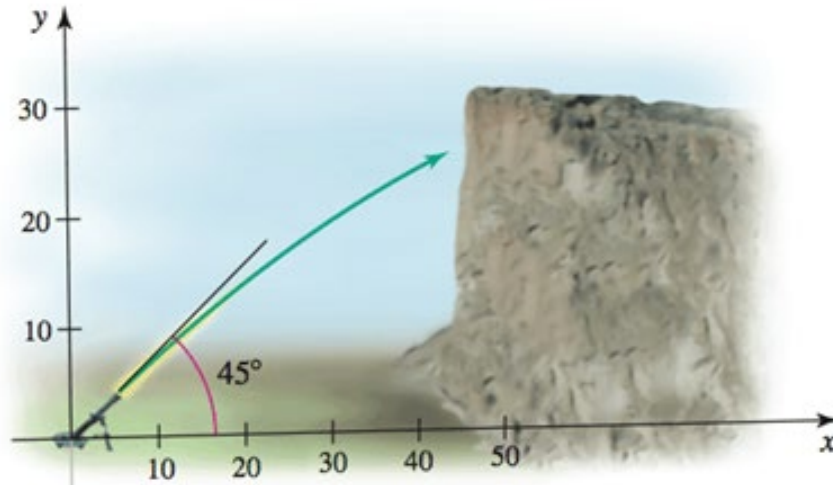


- a) Find the vectors T_1 and T_2 and show that their magnitudes are

$$|T_1| = \frac{w \cos \beta}{\sin(\alpha + \beta)} \quad \text{and} \quad |T_2| = \frac{w \cos \alpha}{\sin(\alpha + \beta)}$$

- b) For a fixed β determine the value of α which minimizes the magnitude $|T_1|$
- c) For a fixed α determine the value of β which minimizes the magnitude $|T_2|$

3. A projectile is launched from the origin, which is a point 50 ft from a 30-ft vertical cliff. It is launched at a speed of $50\sqrt{2}$ ft/s at an angle of 45° to the horizontal. Assume the ground is horizontal on top of the cliff and only the gravitational force affects the motion of the object



- a) Give the coordinates of the landing spot of the projectile on the top of the cliff.
- b) What is the maximum height reached by the projectile?
- c) What is the time of flight?
- d) Write the integral that gives the length of the trajectory.
- e) Approximate the length of the trajectory.
- f) What is the range of launch angles needed to clear the edge of the cliff?