

Vector Word Problems

Problem 1: Adding Forces in Engineering A crane is lifting a heavy load with two cables. The first cable applies a force of 400 N at an angle of 20 degrees to the left of vertical, represented by $\vec{F}_1 = 400\hat{j}$ N. The second cable applies a force at an angle of 30 degrees from the right, with a magnitude of 300 N.

- Sketch a free-body diagram and represent the forces, \vec{F}_1 , \vec{F}_2 , in component form using \hat{i} and \hat{j} .
- Write a formula for the resultant vector \vec{R} in terms of the other vectors. Then calculate the total force exerted by the two cables on the load in component form.
- Determine the magnitude and direction of the total force.

Problem 2: Plane Flying in the Wind A plane aims to fly directly north at an airspeed of 250 km/h. However, there's a wind blowing 32 degrees south of west at 60 km/h.

- Sketch a picture and represent the plane's velocity as a vector, \vec{V}_p , and the wind's velocity as a vector, \vec{V}_w , in component form.
- Write a formula for the plane's actual velocity relative to the ground, \vec{V}_g in terms of the other vectors. Calculate this vector, taking into account the wind's effect.
- Determine the plane's actual speed and direction of travel relative to the ground.

Problem 3: Boat Going Down a River A boat wants to cross a river that is 500 meters wide. The river's current flows southward at a speed of 3 km/h, and the boat can travel at a speed of 8 km/h relative to the water. The boat aims to reach the exact opposite point on the other bank.

- Draw a picture and write the 3 relevant vectors. Express one vector as function of the other two.
- At what angle (to the west of north) must it head?
- Calculate how long it will take for the boat to cross the river and the actual distance downstream it will have landed from its starting point.