

Physics I

Vectors

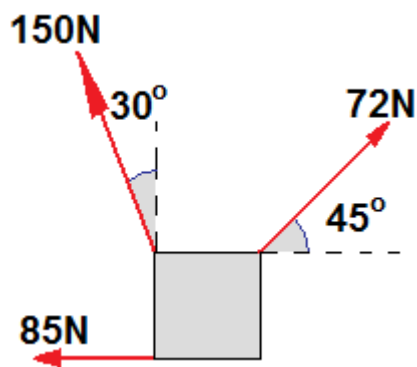
Magnitude of a vector:

$$\text{In 2-D: } |\vec{V}| = \sqrt{V_x^2 + V_y^2} \quad \text{In 3-D: } |\vec{V}| = \sqrt{V_x^2 + V_y^2 + V_z^2}$$

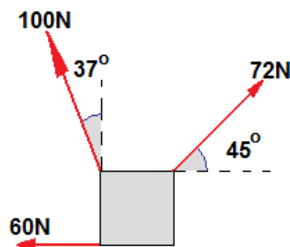
Angle of a vector with respect to the horizontal:

$$\theta = \tan^{-1}\left(\frac{V_y}{V_x}\right) \quad [\text{Watch out for quadrants II and III where you need to add } 180^\circ]$$

Problem 1.- The figure below shows three forces acting on an object. Calculate the sum of the forces. Answer with magnitude and angle.



Problem 1a.- Calculate the sum of the three forces. Answer with magnitude and angle.



Problem 2.- A car is driven 200 km west, then 400 km north and finally 283 km southeast. Draw a vector diagram “head to tail” and find the displacement of the car in km.

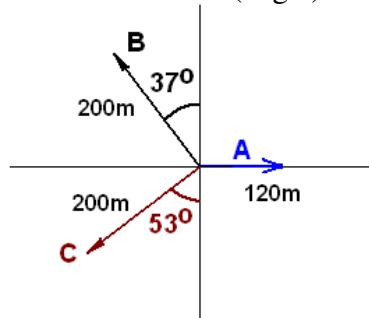
Problem 3.- Transversal velocity is the name given by astronomers to the motion of a star against the background of other farther stars. It can be measured by careful observation over long periods. Radial velocity is the velocity of the star along our line of sight, and it can be calculated by measuring the “red-shift” or “blue-shift” of its light.

Sirius, the brightest star in the night sky, has a transversal velocity of 16 km/s and a radial velocity of -8 km/s (minus sign because it is going away from us). Find the magnitude of its velocity.

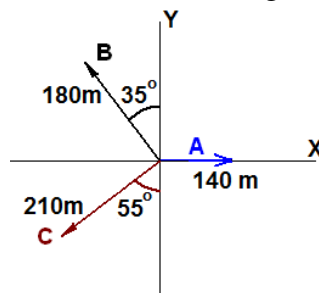
Problem 4.- What is the y component of a vector (in the xy plane) whose magnitude is 250 m and whose x component is 240m?

Problem 4a.- What is the y component of a vector (in the xy plane) whose magnitude is 410 m and whose x component is 400m?

Problem 5.- Calculate the magnitude and direction (angle) of the vector $\vec{A} + \vec{B} + \vec{C}$:



Problem 6a.- Calculate the magnitude and direction (angle) of the vector $\vec{A} + \vec{B} + \vec{C}$:



Problem 7.- A plumber steps out of his truck, walks 25 m east and 50 m south, and then takes an elevator 11 m down into the basement of a building where a bad leak is occurring. What is the magnitude of his displacement?

Problem 8.- A car is driven 200 km west and then 141 km southeast. What is the displacement of the car from the point of origin (magnitude and direction)? Draw a diagram.

Problem 9.- A map shows that the summit of a mountain is 635m north and 845m west of your location (base camp). If the summit is 2,210 m higher than base camp, what is the straight distance between base camp and the summit?

Problem 10.- Calculate the angle between the vectors $\vec{A} = 3i + 4j$ and $\vec{B} = -i + j$

Problem 11.- Calculate the angle between the vectors $\vec{A} = (1, 1, 1)$ and $\vec{B} = (1, -1, 2)$

Problem 12.- A delivery truck follows a route that goes north for 5.0 miles, then east for 10.0 miles and finally north-east for 14.2 miles. Calculate the magnitude and direction (angle) of the total displacement.

Problem 13.- A car is driven 200 km west, then 100 km north and finally 283 km southeast. Draw a diagram and find the displacement of the car from the point of origin (magnitude and direction).

Problem 14.- A car is driven 200 km west and then 141 km southeast. What is the displacement of the car from the point of origin (magnitude and direction)? Draw a diagram.