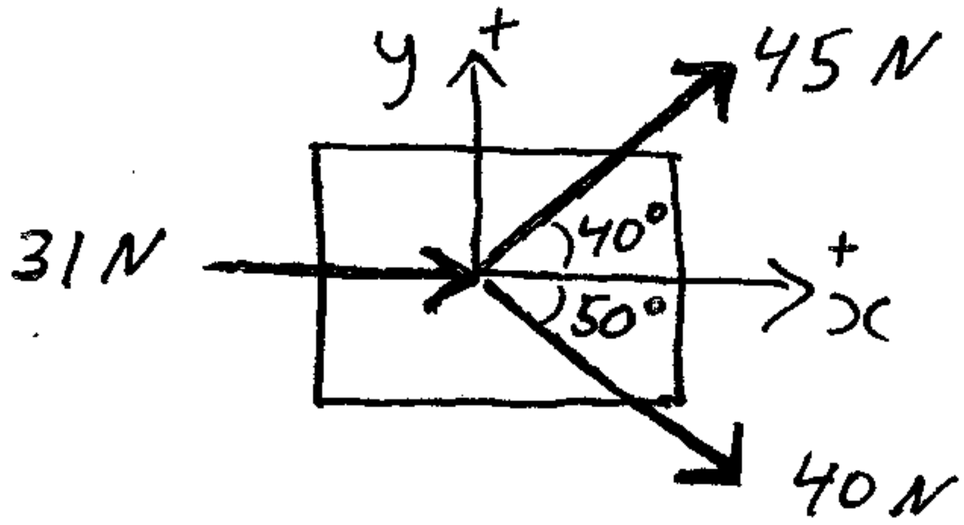
This is a force and motion problem involving Newton's laws.

Three forces are applied to a 2kg slab, as shown. What is the slab's acceleration in unit-vector notation, and expressed as a magnitude and direction?



Solution:

The sum of the forces in the x-direction is:

$$\Sigma F_x = 31 + 45\cos 40° + 40\cos 50° = 91.18\ N$$

The sum of the forces in the y-direction is:

$$\Sigma F_y = 45\sin 40° - 40\sin 50° = -1.72\ N$$

Apply Newton's 2nd law in the x-direction:

$$\Sigma F_x = ma_x \Rightarrow a_x = \frac{\Sigma F_x}{m} = \frac{91.18\ N}{2\ kg} = 45.6\ m/s^2$$

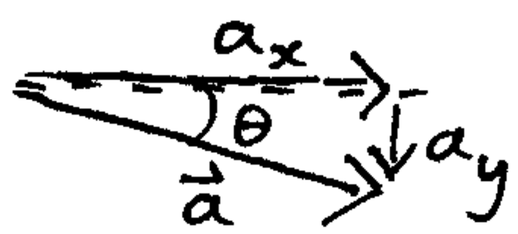
Apply Newton's 2nd law in the y-direction:

$$\Sigma F_y = ma_y \Rightarrow a_y = \frac{\Sigma F_y}{m} = \frac{-1.72\ N}{2kg} = -0.86\ m/s^2$$

The acceleration of the slab in unit-vector notation is:

$$\vec{a} = a_x \hat{i} + a_y \hat{j}$$

$$\vec{a} = 45.6\,\hat{i} - 0.86\,\hat{j} \ m/s^2 \quad \text{(answer)}$$



$$\tan\theta = \frac{a_y}{a_x} = \frac{-0.86}{45.6}$$

$$\theta = \tan^{-1}\left(\frac{-0.86}{45.6}\right)$$

$\theta = -1.08°$ (the negative sign means that $\vec{a}$ is directed below +x-axis)

and $|\vec{a}| = \sqrt{a_x^2 + a_y^2}$

$$|\vec{a}| = 45.61 \ m/s^2$$

The slab's acceleration is:

$a = 45.61 \ m/s^2$ at $1.08°$ below $+x$ (answer)