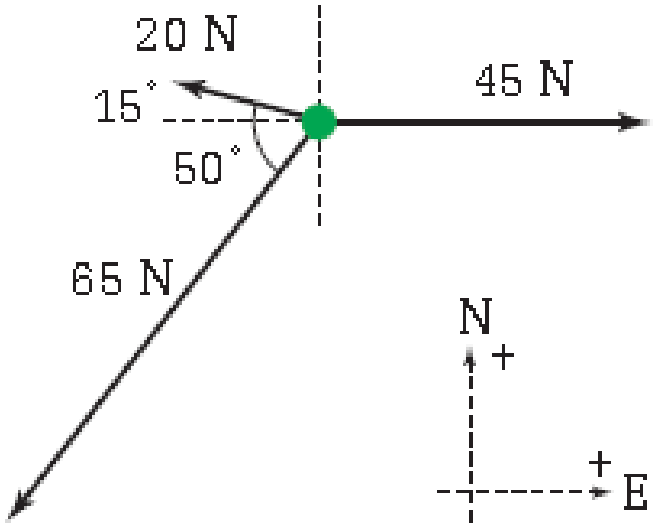
Three children are each pulling on their older sibling, who has a mass of 65 kg. The forces exerted by each child are listed below. Use vector components to find the acceleration of the older sibling.

$\vec{F}_1 = 45$ N[E] $\vec{F}_2 = 65$ N[S40°W] $\vec{F}_3 = 20$ N[N75°W]



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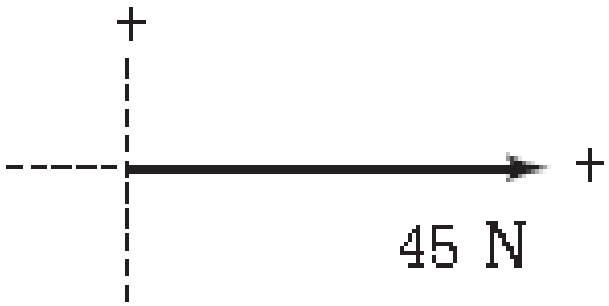
Solution

- Determine the algebraic sum of the X and Y components of each vector to determine the resultant force vector

F₁



$F_{1x} = 45$ N $F_{1y} = 0.0$ N

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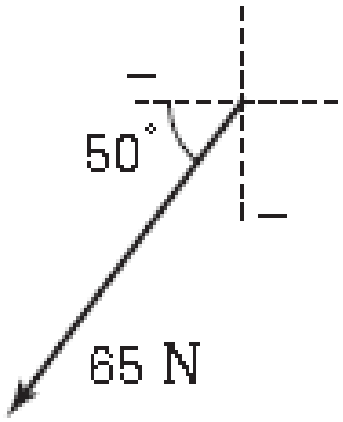
F_2



$$F_{2x} = -|\vec{F}_2| \cos 50^\circ$$
$$F_{2x} = -(65\text{ N})(0.6428)$$
$$F_{2x} = -41.78\text{ N}$$

$$F_{2y} = -|\vec{F}_2| \sin 50^\circ$$
$$F_{2y} = -(65\text{ N})(0.7660)$$
$$F_{2y} = -49.79\text{ N}$$

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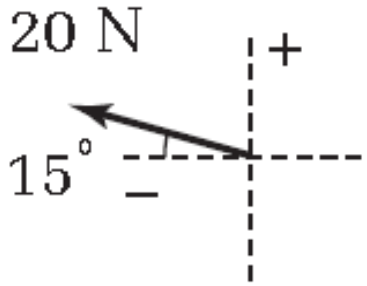
F_3



$$F_{3x} = -|\vec{F}_3| \cos 15^\circ$$
$$F_{3x} = -(20\text{ N})(0.9659)$$
$$F_{3x} = -19.32\text{ N}$$

$$F_{3y} = |\vec{F}_3| \sin 15^\circ$$
$$F_{3y} = (20\text{ N})(0.2588)$$
$$F_{3y} = 5.176\text{ N}$$

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Collect Components in a table

Vector	*x*-component	*y*-component
$\vec{F}_1$	45 N	0.0 N
$\vec{F}_2$	−41.78 N	−49.79 N
$\vec{F}_3$	−19.32 N	5.176 N
$\vec{F}_{\text{net}}$	−16.1 N	−44.614 N

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Magnitude

$$|\vec{F}_{\text{net}}|^2 = (F_{\text{x net}})^2 + (F_{\text{y net}})^2$$

$$|\vec{F}_{\text{net}}|^2 = (-16.1\ \text{N})^2 + (-44.614\ \text{N})^2$$

$$|\vec{F}_{\text{net}}|^2 = 259.21\ \text{N}^2 + 1990.41\ \text{N}^2$$

$$|\vec{F}_{\text{net}}|^2 = 2249.62\ \text{N}^2$$

$$|\vec{F}_{\text{net}}| = 47.430\ \text{N}$$

Direction

$$\tan\theta = \frac{-44.614\ \text{N}}{-16.1\ \text{N}}$$

$$\tan\theta = 2.7711$$

$$\theta = \tan^{-1} 2.7711$$

$$\theta = 70.16^\circ$$

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Recall

Use vector components to find the acceleration of the older sibling.

$$\vec{a} = \frac{\vec{F}}{m}$$

$$\vec{a} = \frac{47.43\ \text{N}[\text{S}20^\circ\text{W}]}{65\ \text{kg}}$$

$$\vec{a} = 0.72969\ \frac{\cancel{\frac{\text{kg}\cdot\text{m}}{\text{s}^2}}}{\cancel{\text{kg}}}[\text{S}20^\circ\text{W}]$$

$$\vec{a} = 0.79269\ \frac{\text{m}}{\text{s}^2}[\text{S}20^\circ\text{W}]$$

The acceleration of the older sibling is $0.73\ \frac{\text{m}}{\text{s}^2}[\text{S}20^\circ\text{W}]$.

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