

Phyz Examples: Numerical Vector Arithmetic

$$\begin{aligned} \mathbf{a} &= (7\text{m}, 10\text{m}) \\ \mathbf{b} &= (-2\text{m}, 5\text{m}) \end{aligned}$$

$$\begin{aligned} \mathbf{c} &= (3\text{m}, -1\text{m}) \\ \mathbf{d} &= (-9\text{m}, -5\text{m}) \end{aligned}$$

$$\begin{aligned} \mathbf{e} &= (6\text{m}, -8\text{m}) \\ \mathbf{f} &= (10\text{m}, 2\text{m}) \end{aligned}$$

Vector Addition (Method 1: simultaneous calculations of x - and y - components)

$$1. \mathbf{n} = \mathbf{a} + \mathbf{f}$$

$$\begin{aligned} \mathbf{n} &= (7\text{m}, 10\text{m}) + (10\text{m}, 2\text{m}) \\ \mathbf{n} &= (7\text{m} + 10\text{m}, 10\text{m} + 2\text{m}) \\ \mathbf{n} &= (17\text{m}, 12\text{m}) \end{aligned}$$

$$2. \mathbf{p} = \mathbf{b} + \mathbf{d}$$

$$\begin{aligned} \mathbf{p} &= (-2\text{ m}, 5\text{ m}) + (-9\text{ m}, -5\text{ m}) \\ \mathbf{p} &= [-2\text{ m} + (-9\text{ m}), 5\text{ m} + (-5\text{ m})] \\ \mathbf{p} &= (-11\text{ m}, 0\text{ m}) \end{aligned}$$

Vector Addition (Method 2: separate calculations of x - and y - components)

$$3. \mathbf{q} = \mathbf{c} + \mathbf{d} + \mathbf{e} + \mathbf{f}$$

$$\begin{aligned} \mathbf{q} &= (3\text{m}, -1\text{m}) + (-9\text{m}, -5\text{m}) + (6\text{m}, -8\text{m}) + (10\text{m}, 2\text{m}) \\ q_x &= 3\text{m} + (-9\text{m}) + 6\text{m} + 10\text{m} = 10\text{m} \\ q_y &= -1\text{m} + (-5\text{m}) + (-8\text{m}) + 2\text{m} = -12\text{m} \\ \mathbf{q} &= (10\text{m}, -12\text{m}) \end{aligned}$$

Vector Subtraction

$$4. \mathbf{r} = \mathbf{a} - \mathbf{f}$$

$$\begin{aligned} \mathbf{r} &= (7\text{m}, 10\text{m}) - (10\text{m}, 2\text{m}) \\ \mathbf{r} &= (7\text{m} - 10\text{m}, 10\text{m} - 2\text{m}) \\ \mathbf{r} &= (-3\text{m}, 8\text{m}) \end{aligned}$$

$$5. \mathbf{u} = \mathbf{f} - \mathbf{a}$$

$$\begin{aligned} \mathbf{u} &= (10\text{ m}, 2\text{ m}) - (7\text{ m}, 10\text{ m}) \\ \mathbf{u} &= (10\text{ m} - 7\text{ m}, 2\text{ m} - 10\text{ m}) \\ \mathbf{u} &= (3\text{ m}, -8\text{ m}) \end{aligned}$$

$$6. \mathbf{w} = \mathbf{b} - \mathbf{c} - \mathbf{d} - \mathbf{e}$$

$$\begin{aligned} \mathbf{w} &= (-2\text{m}, 5\text{m}) - (3\text{m}, -1\text{m}) - (-9\text{m}, -5\text{m}) - (6\text{m}, -8\text{m}) \\ w_x &= -2\text{m} - 3\text{m} - (-9\text{m}) - 6\text{m} = -2\text{m} \\ w_y &= 5\text{m} - (-1\text{m}) - (-5\text{m}) - (-8\text{m}) = 19\text{m} \\ \mathbf{w} &= (-2\text{m}, 19\text{m}) \end{aligned}$$

Vector Addition, Subtraction, and Multiplication

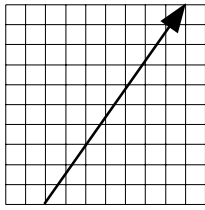
$$7. \mathbf{g} = 2\mathbf{a} - 5\mathbf{c} + (3/2)\mathbf{e}$$

$$\begin{aligned} \mathbf{g} &= 2(7\text{m}, 10\text{m}) - 5(3\text{m}, -1\text{m}) + (3/2)(6\text{m}, -8\text{m}) \\ \mathbf{g} &= (14\text{m}, 20\text{m}) - (15\text{m}, -5\text{m}) + (9\text{m}, -12\text{m}) \\ g_x &= 14\text{m} - 15\text{m} + 9\text{m} = 8\text{m} \\ g_y &= 20\text{m} - (-5\text{m}) - 12\text{m} = 13\text{m} \\ \mathbf{g} &= (8\text{m}, 13\text{m}) \end{aligned}$$

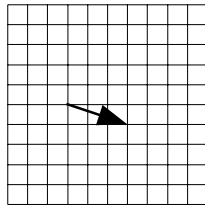
$$8. \mathbf{h} = 2\mathbf{b}/9 + 7\mathbf{f}/6$$

$$\begin{aligned} \mathbf{h} &= 2(-2\text{m}, 5\text{m})/9 + 7(10\text{m}, 2\text{m})/6 \\ \mathbf{h} &= (-0.44\text{m}, 1.1\text{m}) + (11.7\text{m}, 2.3\text{m}) \\ \mathbf{h} &= (-0.44\text{m} + 11.7\text{m}, 1.1\text{m} + 2.3\text{m}) \\ \mathbf{h} &= (11\text{m}, 3.4\text{m}) \end{aligned}$$

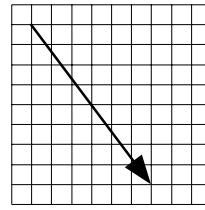
Phyz Examples: Graphical Vector Arithmetic



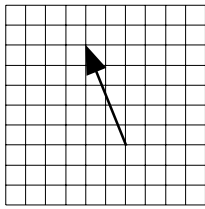
$$\mathbf{a} = (7\text{m}, 10\text{m})$$



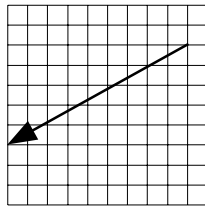
$$\mathbf{c} = (3\text{m}, -1\text{m})$$



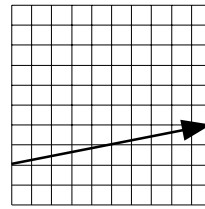
$$\mathbf{e} = (6\text{m}, -8\text{m})$$



$$\mathbf{b} = (-2\text{m}, 5\text{m})$$



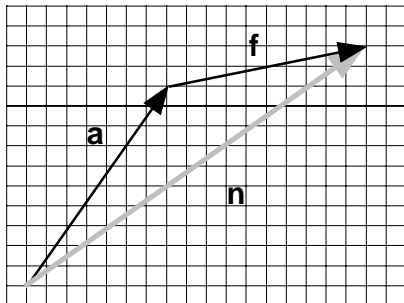
$$\mathbf{d} = (-9\text{m}, -5\text{m})$$



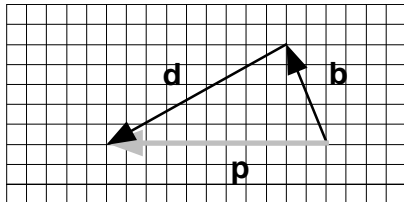
$$\mathbf{f} = (10\text{m}, 2\text{m})$$

Head-to-Tail Methods: Vector Addition

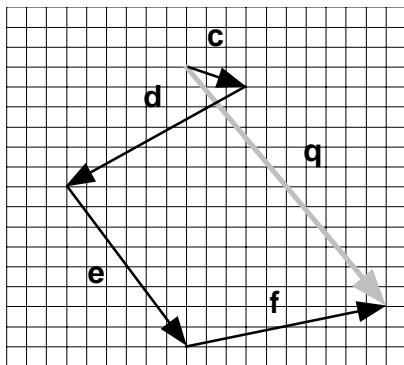
$$1. \mathbf{n} = \mathbf{a} + \mathbf{f}$$



$$2. \mathbf{p} = \mathbf{b} + \mathbf{d}$$

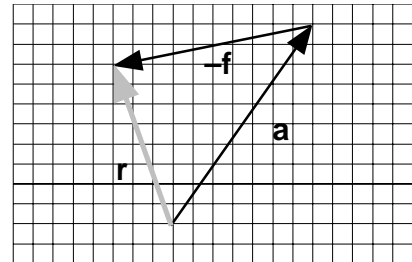


$$3. \mathbf{q} = \mathbf{c} + \mathbf{d} + \mathbf{e} + \mathbf{f}$$

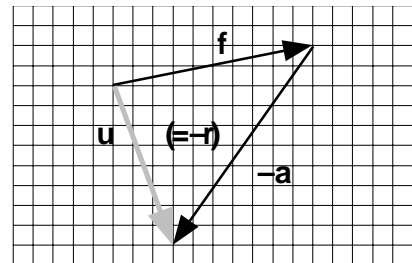


Vector Subtraction

$$4. \mathbf{r} = \mathbf{a} - \mathbf{f}$$



$$5. \mathbf{u} = \mathbf{f} - \mathbf{a}$$



$$6. \mathbf{w} = \mathbf{b} - \mathbf{c} - \mathbf{d} - \mathbf{e}$$

