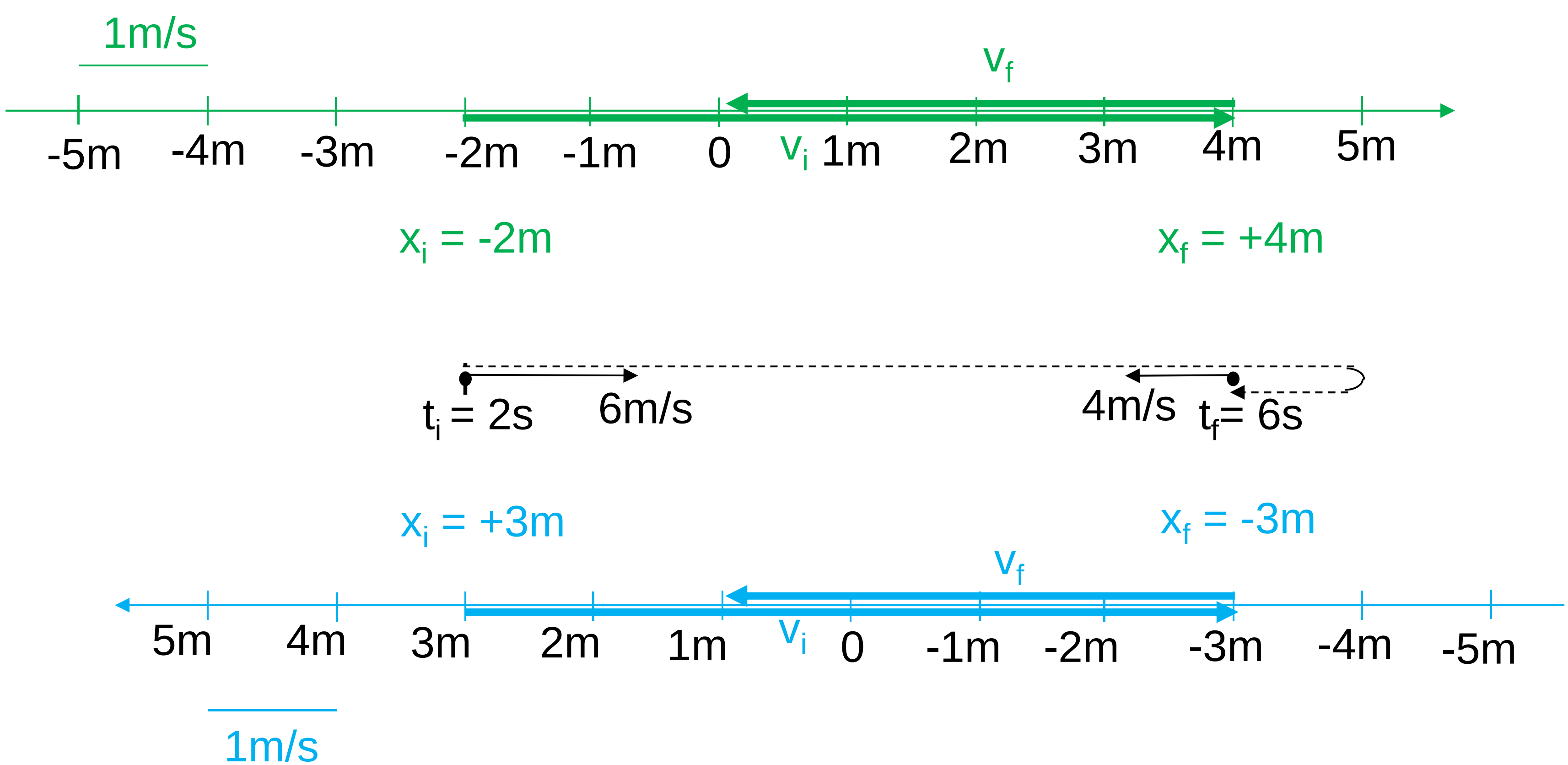
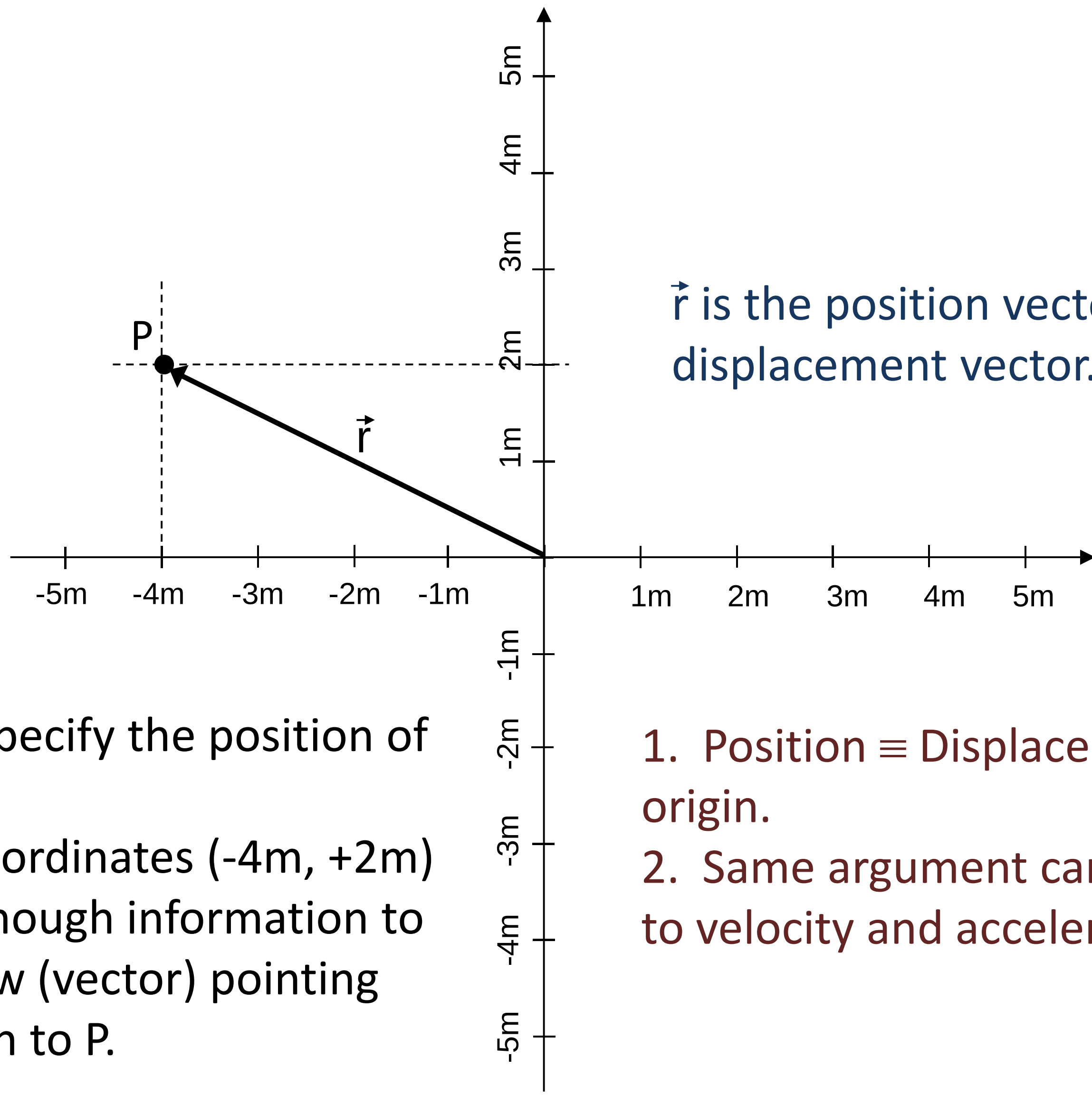
Class 6: Vector and scalar, components

Mapping velocity and acceleration on a real number line (1D)



Velocity and acceleration can now add like real numbers on the number line. There is no confusion because we only add or subtract physical quantities of the same kind. The "coordinate" of the velocity and acceleration are now called "component".

Extending 1D motion to 2D and 3D motions



$\vec{r}$ is the position vector, or displacement vector.

Two ways to specify the position of point P:

1. Give the coordinates (-4m, +2m)
2. Give you enough information to draw the arrow (vector) pointing from the origin to P.

1. Position ≡ Displacement from origin.
2. Same argument can be applied to velocity and acceleration.

"Business as usual" along the x- and y- axis independently, but simultaneously.

Vector and scalar

Physical quantities that can be represented by coordinates like position are called vectors. Physical quantities that cannot be represented by coordinates like position are called vectors.

Examples of vector:

Displacement
Velocity
Acceleration

Force
Weight
Momentum

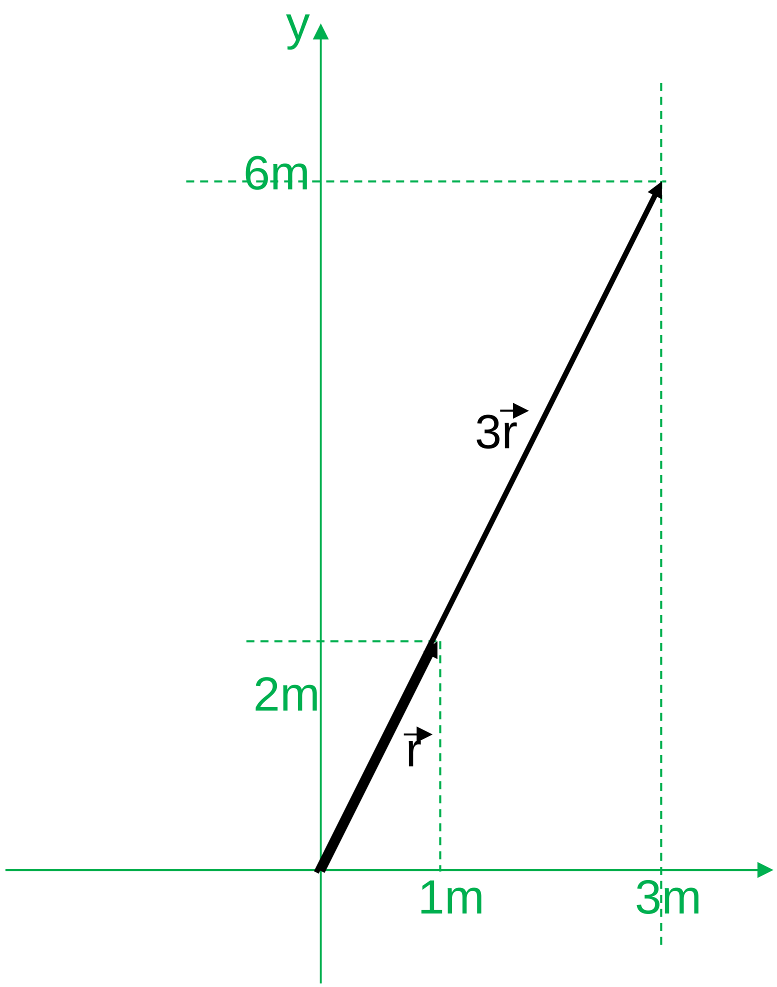
Examples of scalar:

Distance
Speed

Mass
Temperature
Energy

Scalar × Vector → Vector
Scalar × Scalar → Scalar
Vector × Vector → Complicated

Multiplying a vector with a scalar



$$(m\vec{r})_x = m\, r_x$$

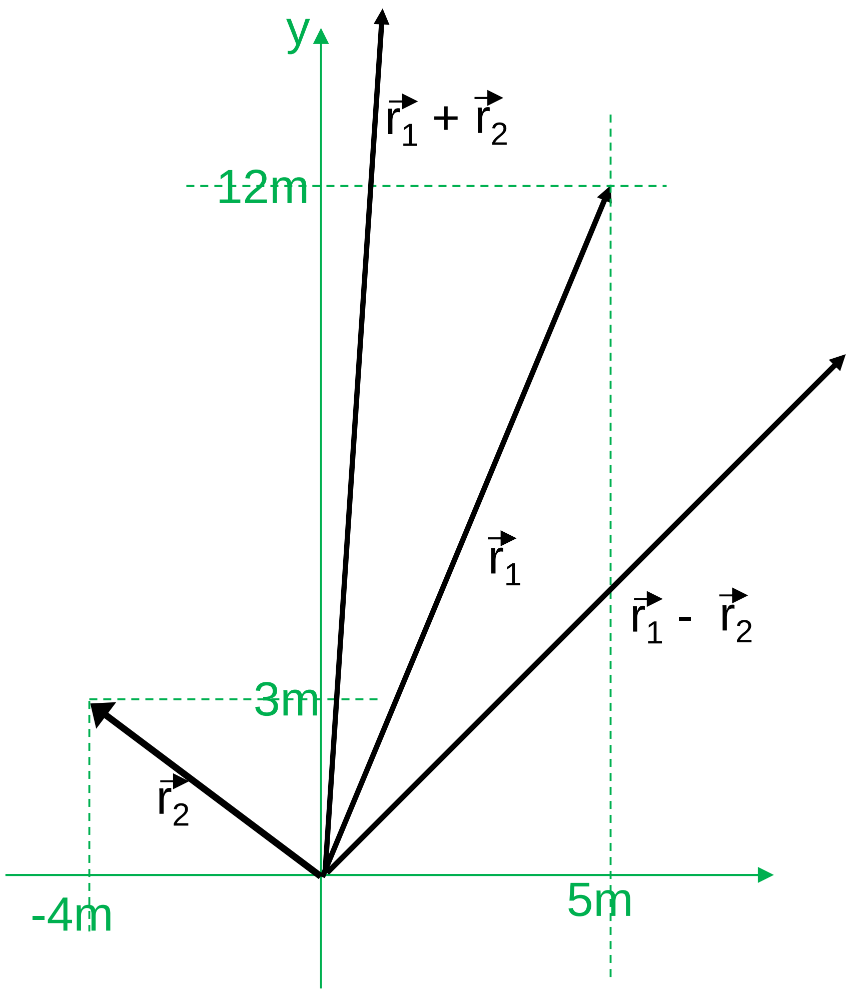
$$(m\vec{r})_y = m\, r_y$$

"Business as usual" along the x- and y- axis independently, but simultaneously.

Same for other kinds of vectors, including velocity and acceleration.

Addition and subtraction of vectors

Only vectors of the same kind (hence same unit) can be added or subtracted.



$$(\vec{r}_1+\vec{r}_2)_x = r_{1x} + r_{2x}$$

$$(\vec{r}_1+\vec{r}_2)_y = r_{1y} + r_{2y}$$

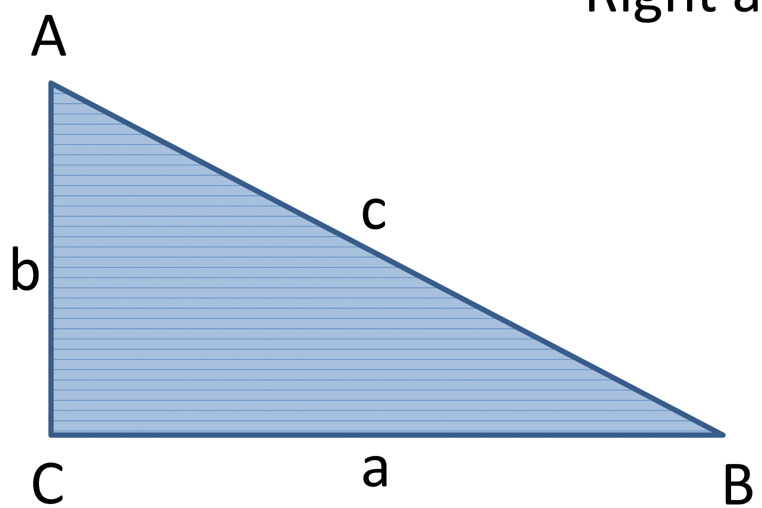
$$(\vec{r}_1-\vec{r}_2)_x = r_{1x} - r_{2x}$$

$$(\vec{r}_1-\vec{r}_2)_y = r_{1y} - r_{2y}$$

"Business as usual" along the x- and y- axis independently, but simultaneously.

Same for other kinds of vectors, including velocity and acceleration.

Right angled triangle



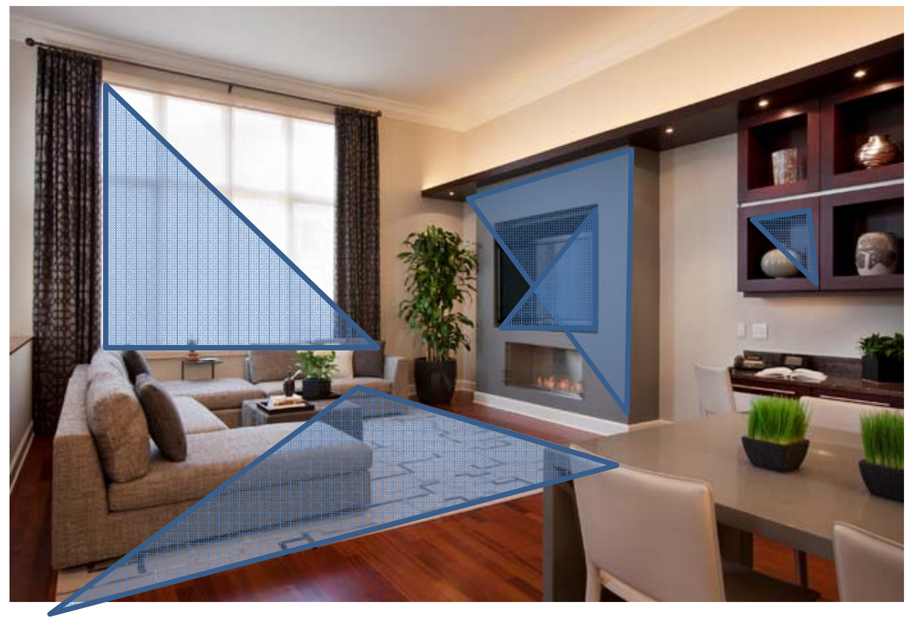
$$a^2 + b^2 = c^2 \quad (\text{or } \sin^2\theta + \cos^2\theta = 1)$$

$$\sin\theta = \frac{\text{opposite side}}{\text{hypotenuse}}$$

$$\cos\theta = \frac{\text{adjacent side}}{\text{hypotenuse}}$$

$$\tan\theta = \frac{\text{opposite side}}{\text{adjacent side}} = \frac{\sin\theta}{\cos\theta}$$

$$\angle A + \angle B = 90^\circ$$



If you know two sides, or one side and one angle, you know everything about the right angled triangle.