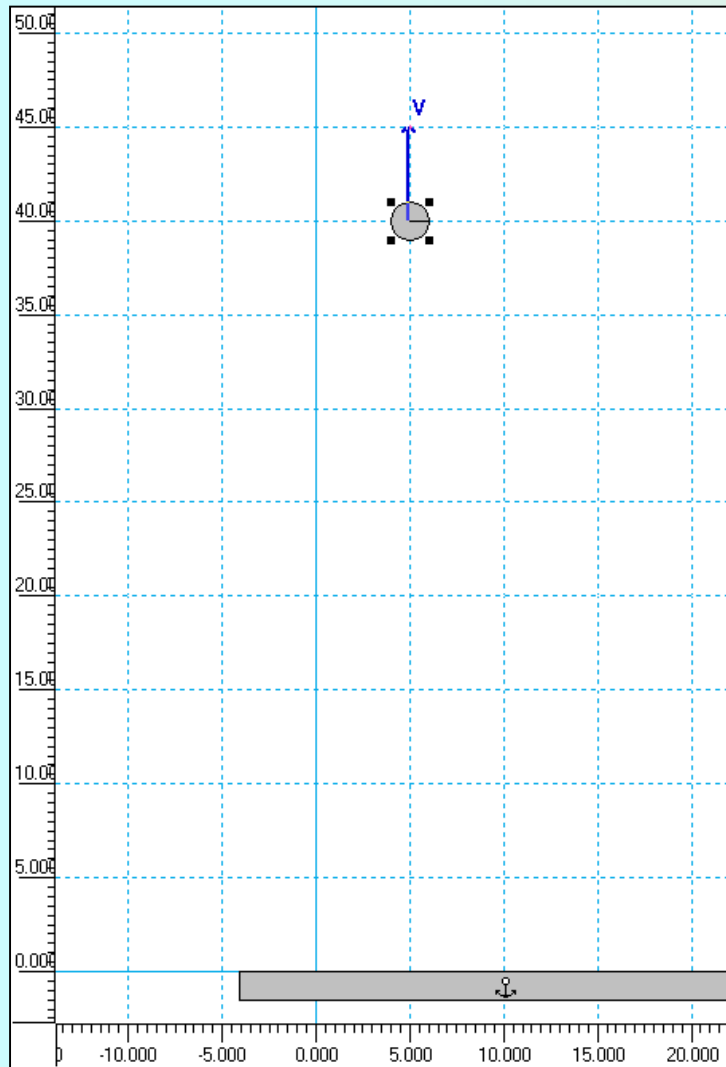


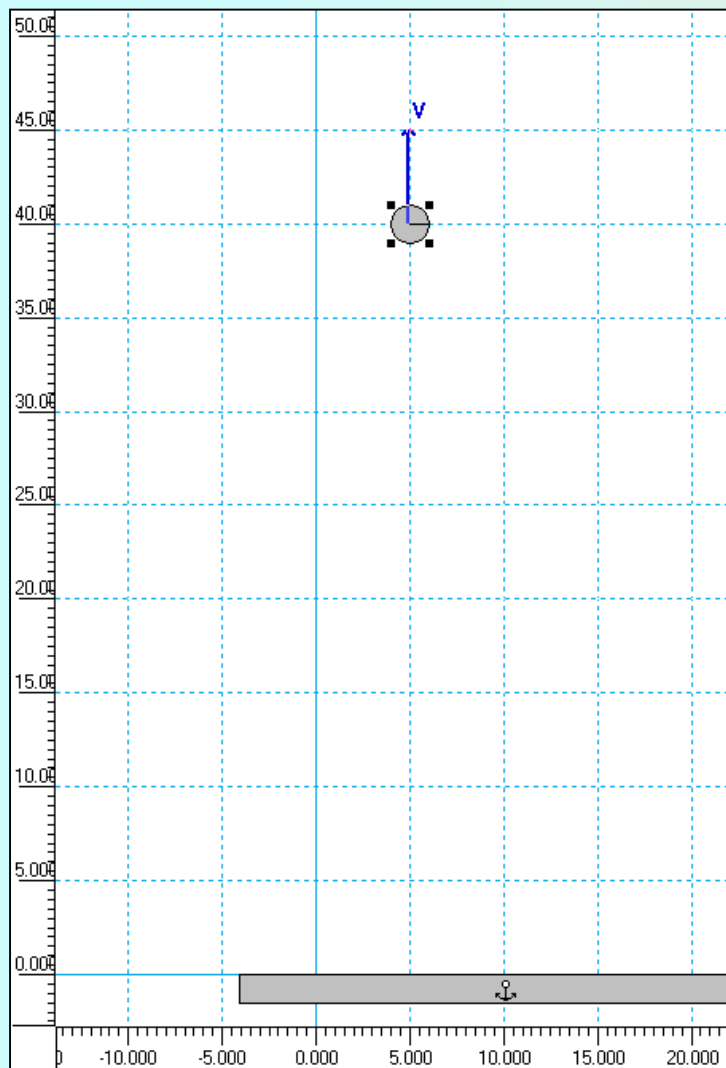
## Free fall: problem



A body is thrown upwards with an initial velocity of  $+25 \text{ m/s}$  and from a point  $40 \text{ m}$  above the origin. Determine:

- the equation of the position vector
- the equation of the velocity
- the maximum height reached by the body
- the moment when the body hits the floor
- the velocity when the body hits the floor
- the velocity when the height is  $h=20 \text{ m}$

## Free fall: problem



A body is thrown upwards with an initial velocity of +25 m/s and from a point 40 m above the origin. Determine:

**a- the equation of the position vector**

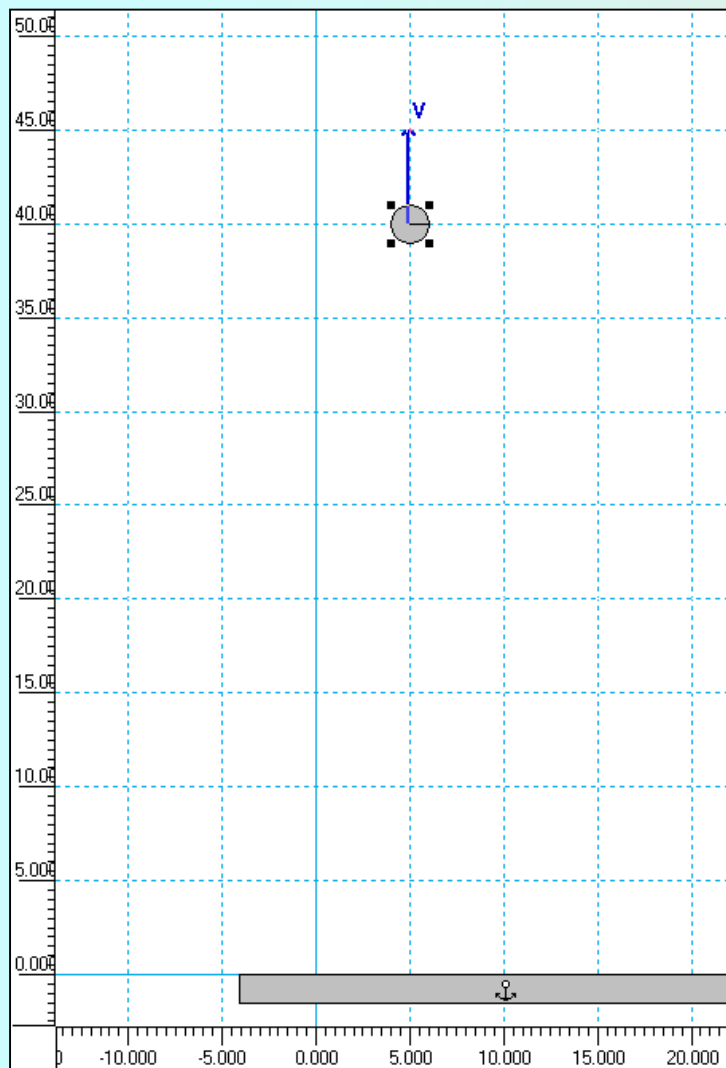
$$\vec{r} = (40 + 25 * t - 5 * t^2) \vec{j} \quad (\text{m})$$

**b- the equation of the velocity**

By differentiation of the equation of the position vector we get the equation of velocity

$$\vec{v} = (25 - 10 * t) \vec{j} \quad (\text{m/s})$$

## Free fall: problem



A body is thrown upwards with an initial velocity of +25 m/s and from a point 40 m above the origin. Determine:

**c- the maximum height reached by the body**

First, we have to calculate the moment in which the maximum height is reached

**Condition:** maximum height  $\longrightarrow$  **Expression:**  $v = 0$

$$\vec{v} = (25 - 10 * t) \vec{j} = 0$$

$$25 - 10 * t = 0 \rightarrow t = \frac{25}{10} = 2.5 \text{ s}$$

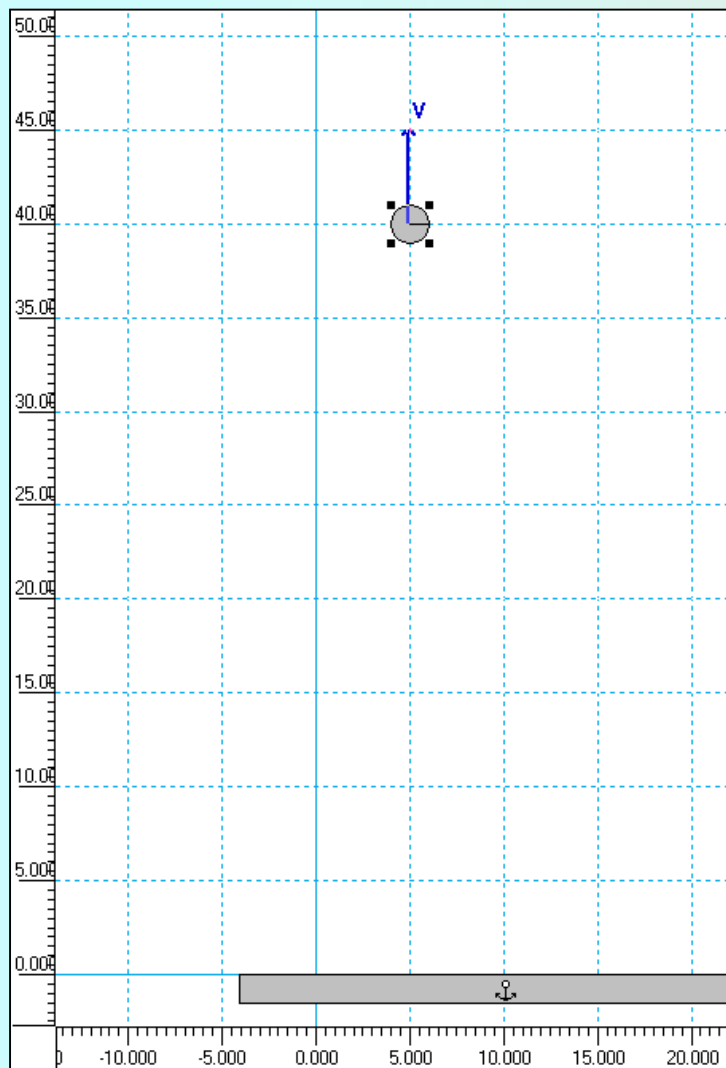
Then, we calculate the height using the equation of the position vector:

$$y = 40 + 25 * t - 5 * t^2$$

$$y = 40 + 25 * 2.5 - 5 * (2.5)^2$$

$$y = 71.25 \text{ m}$$

## Free fall: problem



A body is thrown upwards with an initial velocity of +25 m/s and from a point 40 m above the origin. Determine:

**d- the moment when the body hits the floor**

Condition: it hits the floor  $\longrightarrow$  Expression:  $y = 0$

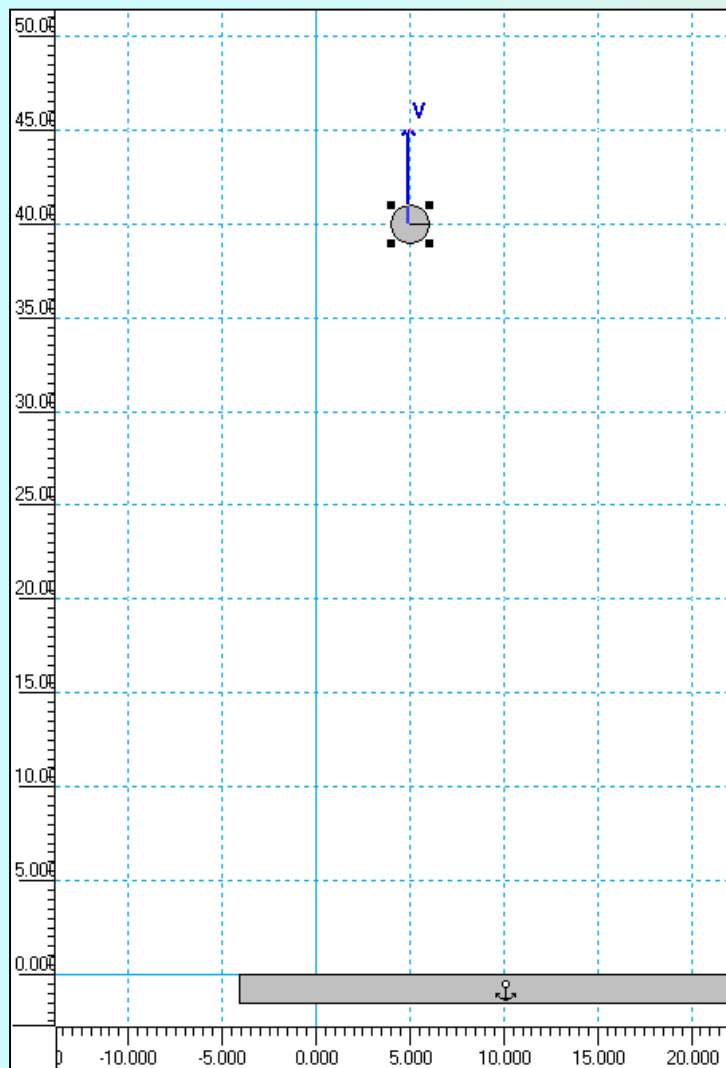
$$y = 40 + 25 * t - 5 * t^2 = 0$$

$$t^2 - 5 * t - 8 = 0$$

$$t = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} = \frac{5 \pm \sqrt{25 + 32}}{2}$$

$$t = 6.27 \text{ s}$$

## Free fall: problem



A body is thrown upwards with an initial velocity of +25 m/s and from a point 40 m above the origin. Determine:

**e- the velocity when the body hits the floor**

**Condition:** it hits the floor  $\longrightarrow$  **Expression:**  $y = 0$

$$t = 6.27 \text{ s}$$

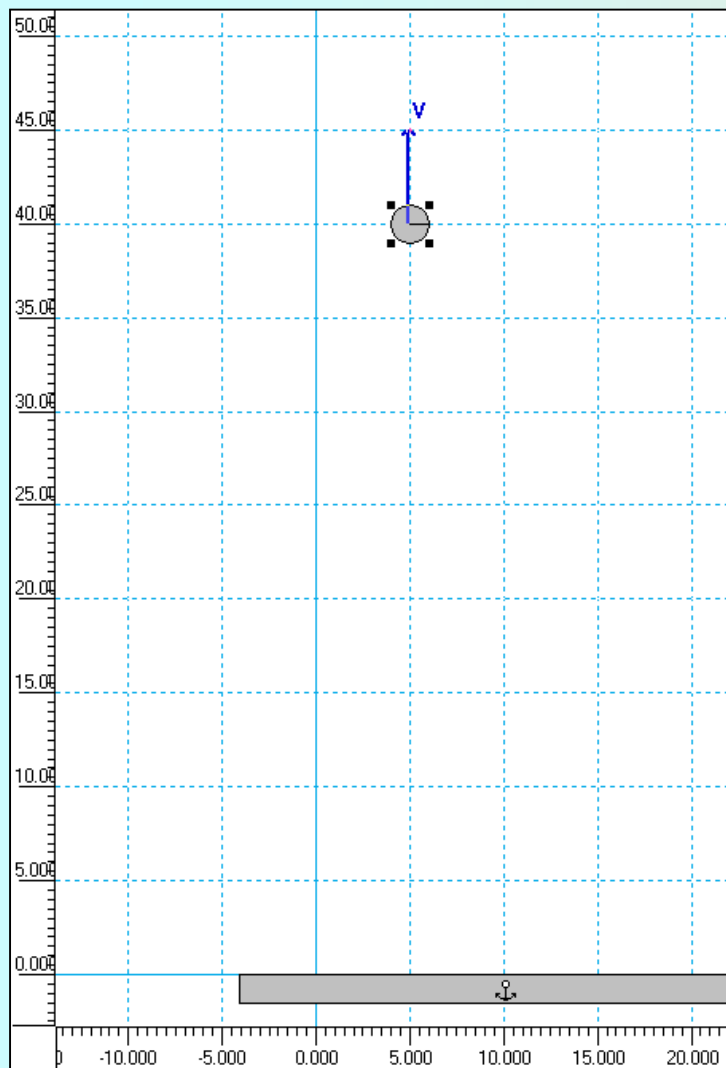
The velocity is:

$$\vec{v} = (25 - 10 * t) \vec{j} \text{ (m/s)}$$

$$\vec{v} = (25 - 10 * 6.27) \vec{j} \text{ (m/s)}$$

$$\vec{v} = -37.7 \vec{j} \text{ (m/s)}$$

## Free fall: problem



A body is thrown upwards with an initial velocity of +25 m/s and from a point 40 m above the origin. Determine:

**f - the velocity when the height is  $h=20$  m**

First, we have to calculate the moment in which the height is 20 m

Condition: height is 20 m  $\longrightarrow$  Expression:  $y = 20$

$$y = 40 + 25 * t - 5 * t^2 = 20$$

$$t^2 - 5 * t - 4 = 0$$

$$t = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} = \frac{5 \pm \sqrt{25 + 16}}{2}$$

$$t = 5.7 \text{ s}$$

Then, we calculate the velocity:

$$\vec{v} = (25 - 10 * t) \vec{j} \text{ (m/s)}$$

$$\vec{v} = (25 - 10 * 5.7) \vec{j} \text{ (m/s)}$$

$$\vec{v} = -32 \vec{j} \text{ (m/s)}$$