GED - Assignment - 9 - Questions

(1) $m = 10\,kg$, $x_0 = 10\,m$, $y_0 = 10\,m$, $v = \sqrt{2}\,m/s$, $\alpha_0 = 45°$, $g = 10\,m/s$

$h = 0,5$, (time step)

$\vec{v} = \begin{pmatrix} v_{x_0} \\ v_{y_0} \end{pmatrix}$, $|\vec{v}| = v = \sqrt{2}\,m/s \Rightarrow \sqrt{v_{x_0}^2 + v_{y_0}^2} = \sqrt{2}\,m/s \Leftrightarrow v_{x_0}^2 + v_{y_0}^2 = 2\,m^2/s^2$

$\cos(\alpha) = \frac{v_{x_0}}{v} \Leftrightarrow \cos(\alpha) = \frac{1}{\sqrt{2}} = \frac{v_{x_0}}{\sqrt{2}\,m/s} \Leftrightarrow v_{x_0} = 1\,m/s \Rightarrow v_{x_0}^2 + v_{y_0}^2 = 2\,m/s$

$\Leftrightarrow v_{y_0} = 1\,m/s$, $\vec{v} = \begin{pmatrix} 1\,m/s \\ 1\,m/s \end{pmatrix}$, $v_{0x_0} = 1\,m/s$

Explicit Euler Method: with $v_y(0) = 1\,m/s$:

$v_{y_1} = v_y(h) = v_y(0) + h \cdot (-1) \cdot g$

$= 1\,m/s - 0.5\,s \cdot 10\,m/s^2$

$= -4\,m/s$

$v_{y_2} = v_y(2h) = v_y(h) + h \cdot (-1) \cdot g$

$= -4\,m/s - 0.5\,s \cdot 10\,m/s^2 = -9\,m/s$

with $v_x(0) = 1\,m/s$: (No change to velocity in x)

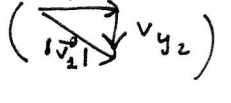
$v_{x_1} = v_x(h) = v_x(0) + h \cdot 0 = 1\,m/s$

$v_{x_2} = v_x(2h) = v_x(h) + h \cdot 0 = 1\,m/s$

After 1 second, the velocity is

$\vec{v}_1 = \begin{pmatrix} v_{x_2} \\ v_{y_2} \end{pmatrix} = \begin{pmatrix} 1\,m/s \\ -9\,m/s \end{pmatrix}$, $|\vec{v}_1| = \sqrt{82}\,m/s$

into a direction of $\alpha_1 = -\arccos\left(\frac{v_{x_2}}{|\vec{v}_1|}\right) \approx -83,66°$



(2) $y_0 = 10\,m$; $x_0 = 10\,m$ $\quad y(0) = y_0$, $x(0) = x_0$

Semi-Explicit Euler Method:

$y_1 = y(h) = y(0) + v_y(h) \cdot h = 10\,m + 0.5\,s \cdot -4\,m/s = 8\,m$

$y_2 = y(2h) = y(h) + h \cdot v_y(2h) = 8\,m - 0,5\,s \cdot 9\,m/s = 3,5\,m$

$x_1 = x(h) = x(0) + h \cdot v_x(h) = 10\,m + 0{,}5\,s \cdot 1\,m/s = 10{,}5\,m/s$

$x_2 = x(2h) = x(h) + h \cdot v_x(2h) = 10{,}5\,m/s + 0.5\,s \cdot 1\,m/s = 11\,m$

- The particle is now at Position ~~(11, 3,5 m~~ (11, 3.5) in meters.