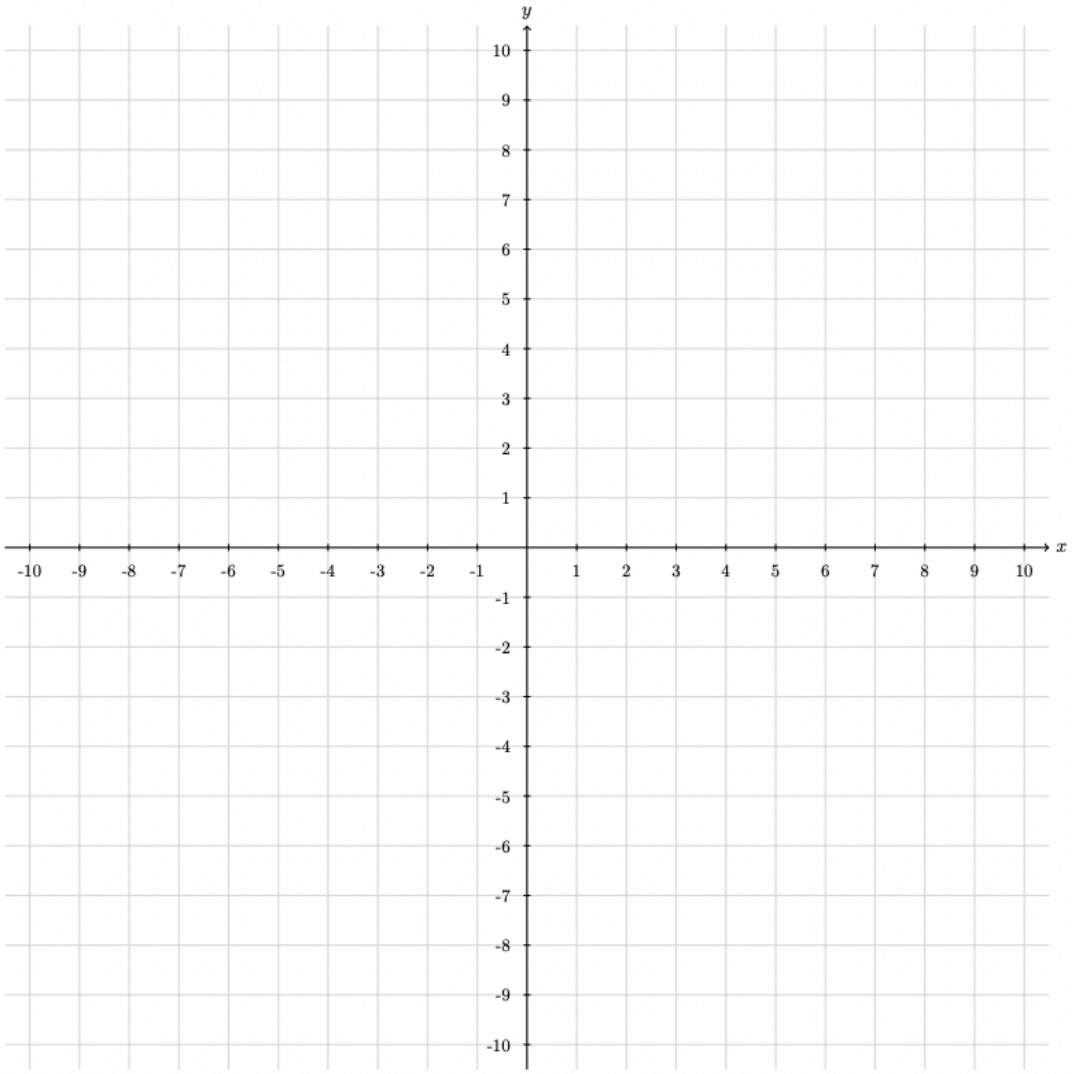
(2b) [6 points] Using unmodified explicit Euler's method, calculate the position over time of a particle with unit mass in a vector field (external force) defined by force$(x, y) = (-2, -y/2)$ starting at time $t = 0$ with position $(-2, 2)$ and velocity $(2, -2)$. Start at $t = 0$ and end at $t = 4$, with time-step $\Delta t = 2$. Draw the positions of the particle on each time step on the graph below.



6. (Total : 14 points) Animation: Kinematics, Motion Capture, Physical Simulation

(6a) (5 points) Imagine you have a one-dimensional system consorting of a single spring and single mass point. One end of the spring is attached to "ground" at $x = 0$ and the other end is attached to the mass point. The mass of the point is $m = 0.5$Kg, and the spring follows Hook's law with $k = 4.0N/m$. The rest length of the spring is zero.

If the system initial starts with the mass at rest at $x = 2.0$ and the simulation takes steps of $\Delta t = 0.5$ using Forward Euler integration, then write the resulting position, velocity, and acceleration for the first 8 time steps.

Hint: The numbers are such that computing by hand is reasonable, but free to write a little program or set up spreadsheet to compute it for you.

$x_0 =$ 2.0	$v_0 =$ 0.0	$a_0 =$
$x_1 =$	$v_1 =$	$a_1 =$
$x_2 =$	$v_3 =$	$a_2 =$
$x_3 =$	$v_3 =$	$a_3 =$
$x_4 =$	$v_4 =$	$a_4 =$
$x_5 =$	$v_5 =$	$a_5 =$
$x_6 =$	$v_6 =$	$a_6 =$
$x_7 =$	$v_7 =$	$a_7 =$
$x_8 =$	$v_8 =$	$a_8 =$

(6b) (1 point) What problem do these numbers demonstrate?

(6c) (1 point) How could you fix the problem?

(6d) (3 points) Fluid Simulation

Imagine that you have a job at a company that designs acoustic devices. Your team lead wants to build a computer simulation to model sound propagation through the air as a way of testing different device designs. They suggest using the "Stable Fluids" fluid simulation method discussed in class.

Do you think the Stable Fluids method is appropriate for this situation? Why or why not? (Hint: This question can be answered in one or two sentences. If you are writing an long essay then you are probably on the wrong track.)

(6e) (4 points) Kinematics

Consider the following code:

```
VecN SimpleIK(const KinematicObject arm, const VecN startConfig, const Vec3 goal) {
     static const float TOLERANCE = 0.010;
     static const float MINSTEP   = 0.001;
     VecN config = startConfig;
     float dist = arm.forwardKinematics(config).distance_from(goal);
     bool giveup = false;
     while ( (dist > TOLERANCE) && (!giveup) ) {
         giveup = true;
         VecN grad =
          normalize(arm.forwardKinematics(config).distance_gradient(goal));
         for ( float alpha = 1.0 ; alpha > MINSTEP ; alpha *= 0.5  ) {
             float testConfig = config - (M_PI/180.0) * alpha * grad;
             float testDist
                  = arm.forwardKinematics(testConfig).distance_from(goal);
             if ( testDist < dist ) {
                 config = testConfig;
                 dist   = testDist;
                 alpha = 1.0;
                 giveup = false;
             }
         }
     }
     return config;
 }
```

This code has an error, something is either incorrect or missing. What is the problem and what a simple way to correct it?