To receive full credit you have to provide a detailed explanation of your answers.

1. **(20 points)** Specify proper boundary conditions along the boundary segments AB, BC, CD, and DA in Figure 1.

   **Solution:** The segments AB and BC are no-flow boundaries. The segments CD and DA represent the water table; you can also prescribe an additional flux due to recharge.

2. **(80 points)** Consider steady-state flow in a confined aquifer of hydraulic conductivity 10 cm/s. The flow is driven by natural hydraulic head gradient $J = 0.1$ (i.e., there is no pumping).
   
   (i) The water level in an observation well is 10 m. What is the water level in another observation well located 100 m downstream? *(20 pts)*

   (ii) The aquifer’s thickness is 5 m. Draw the vertical distribution of hydraulic head in the first observation well. *(20 pts)*

   (iii) Draw the corresponding vertical distribution of pressure head. *(20 pts)*

   (iv) Compute the Darcy velocity in the aquifer. *(20 pts)*

   **Solution:**
(i) The water level (hydraulic head) in the first observation well is $h_1 = 10$ m. The second observation well is located downstream, which means that the flow takes place from the first observation well to the second. For this to occur, the water level (hydraulic head) in the second observation well, $h_2$, must be smaller than $h_1$. If the two wells are separated by distance $L = 100$ m and the hydraulic head gradient is $J$, then it follows from $J = (h_1 - h_2)/L$ that $h_2 = h_1 - JL = 10 - 0.1 \times 100 = 0$ m.

(ii) The hydraulic head $h(z)$ is a straight horizontal line $h = 10$ that goes from $z = 0$ to $z = 5$. This is because there is no vertical flow.

(iii) Recall that pressure head is defined as $\psi = p/(\rho g)$. It is related to hydraulic head $h$ by the relation $\psi = h - z$. Since $h = 10$ remains constant, $\psi(z)$ is a straight line that connects the points $\psi(0) = 10$ and $\psi(5) = 5$.

(iv) The Darcy velocity is defined as $q = -KJ$. For the problem under consideration, $q = -10 \times 0.1 = -1.0$ cm/s.