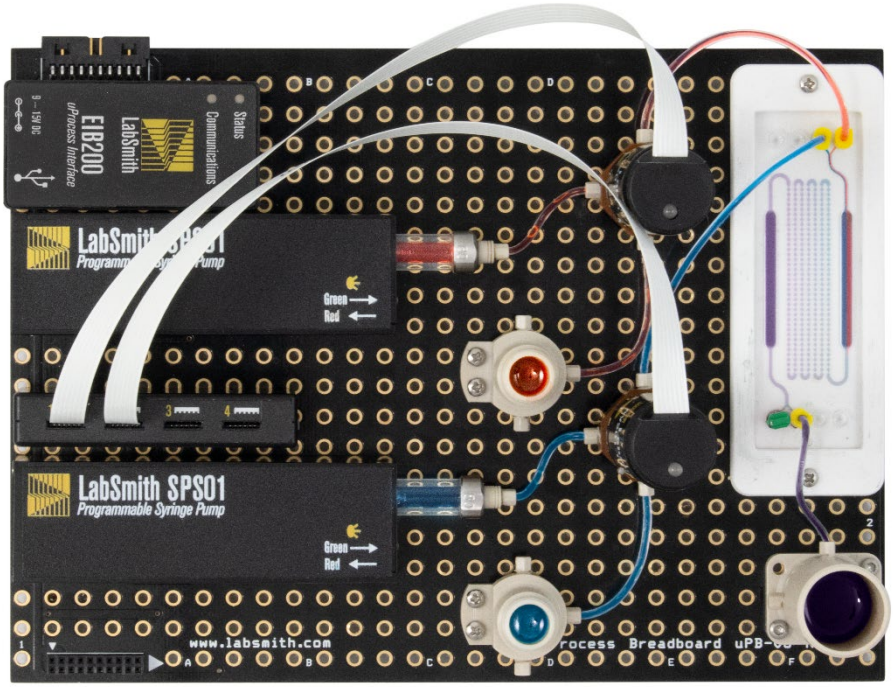
Microfluidic Education Kit – Teacher's Guide



Students will create a microfluidic controller to flow liquids across a microfluidic chip. The exercise will demonstrate a type of extreme laminar flow known as Stokes Flow that is typical in microfluidic systems (see Reynolds Number worksheet). Students will learn engineering, assembly, and computer science skills while becoming familiar with microfluidic systems and principles.

Recommend working group size: 2-4 students
Total lab time: 2-3 hours (can be broken into multiple sessions)

Task	Approximate Time Required	Skills learned
• follow step-by-step instructions to create flow controller sub-assemblies • connect sub-assemblies to breadboard	30 – 60 minutes	• mechanical assembly
• connect to software and manipulate valves and syringe pumps via software control panel • verify proper fluid connections • troubleshoot leaks or clogs	30 – 60 minutes	• basic engineering • troubleshooting
• automate flow controller by following step-by-step instructions to create software script • develop custom software script to create flow patterns	60 minutes	• computer programming

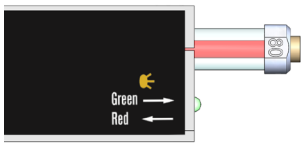
LabSmith
TOOLS FOR SCIENCE

Lab Equipment:

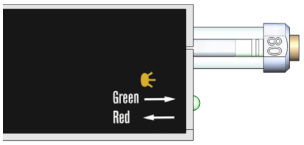
In this lab, you will assemble and automate a flow controller to demonstrate a fundamental property of microfluidics. Each of the individual components assembled on the breadboard has a unique function that helps get to the final goal: to deliver the dye from the 1 mL reservoirs through the chip.

Syringe pump

A syringe pump is used to pull or push a fluid. The syringe pumps in this kit have a glass tube with a plunger inside. The plunger is moved backwards or forwards to fill or empty the syringe pump.



Full Syringe pump



Empty syringe pump

Reservoir

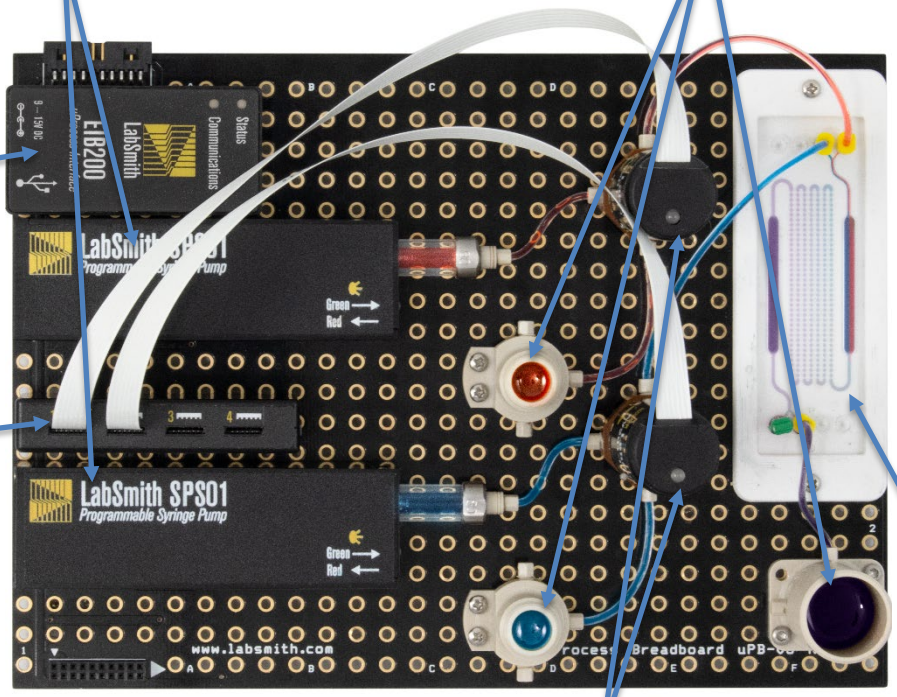
A reservoir is used to hold liquid. In this lab, the small reservoirs (1 mL) are filled with red and blue dye. The large reservoir (5 mL) will store the combined liquid after it goes through the microfluidic chip.

EIB200

The EIB200 connects to power and to the computer so the instruments can be controlled with the software.

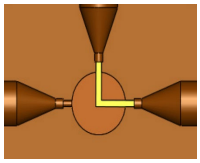
4VM02

The 4VM02 connects to the valves so you can control them using the software.

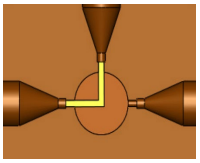


Valve

A valve is used to direct the fluid flow. The valves in this kit have 3 ports and direct the flow from the center-to-left port, or from the center-to-right port.



Valve in Position A



Valve in Position B

Microfluidic Chip

A microfluidic chip is a set of micro-channels etched or molded into a material. In this lab, the microfluidic chip has two input channels that come together in a Y formation.

Pre-Lab Question: In this exercise, the objective is to push the dye from the small reservoirs through the microfluidic chip and into the large reservoir. How would you accomplish this using the syringe pumps and valves?

Kit Contents

Product Name	Product Number	Quantity	Description
Controller	EIB200	1	uProcess USB interface controller. Includes a power supply and USB cable
Valve Manifold	4VM02	1	4-channel valve manifold
Automated Valve	AV201-T116	2	3-port, 2-position automated valve
Syringe Pump	SPS01-080-T116	2	Syringe, including glass and plunger set
Pearl Chain Mixing Chip	10001975	1	Pearl chain mixer microfluidic chip
uProcess Breadboard	uPB-05	1	uProcess breadboard with 5 device connections
1-mL Breadboard Reservoir (with O-ring)	BBRES-T116-1ML	2	1 mL volume reservoir for holding dye liquid
5-mL Breadboard Reservoir	BBRES-T116-5ML	1	5 mL volume reservoir for holding waste liquid
One-Piece Fitting	T116-100	16	Fitting for connecting tubing to component ports
One-Piece Plug	T116-101	7	Plug for closing open ports of components
1 m Tubing	TUBE-116F	1	1/16” outside diameter FEP tubing
Luer Tip Manual Syringe	LS-SYRINGE_LT	1	Cleanup. Interfaces with microfluidic chip
Luer Lock Manual Syringe	LS-SYRINGE_LL	1	Used for degassing the microfluidic system
Luer Lock Adapter	T116-300A	2	Connects Luer Lock syringe to tubing
Also includes custom chip holder, chip connectors and plugs, liquid dispense bottles, waste cups, mounting screws, screwdriver, and hex wrench.			
Detailed assembly instructions and support documentation			

Required Items Not Supplied

Item	Quantity
Computer running Windows	1
Food Coloring	2 different colors – red and blue recommended
Distilled Water	1/2 liter
Scissors/blade (to cut tubing)	1

Setup Instructions

We recommend you install and test the software on your Windows-based computer and prepare the liquid dye prior to starting the classroom lab. Please contact LabSmith (info@labsmith.com) or 925-292-5161 if you have any questions.

Software and Driver Installation:

1. **Install the uProcess software**. The software can be installed from the USB flash drive included in the kit (go to *Software Installation>setup.exe*), or downloaded from our website https://labsmith.com/downloads/download-uprocess-software/ Install the software by running the **setup.exe** file.

   NOTE: If you are not able to load software onto your computer (i.e., because of school/corporate policy or a firewall), the flash drive includes a 'static' version of the uProcess software that can be run directly from the flash drive. To open the software, go to *Software Installation>uProcess Software – Static>uProcess.exe*

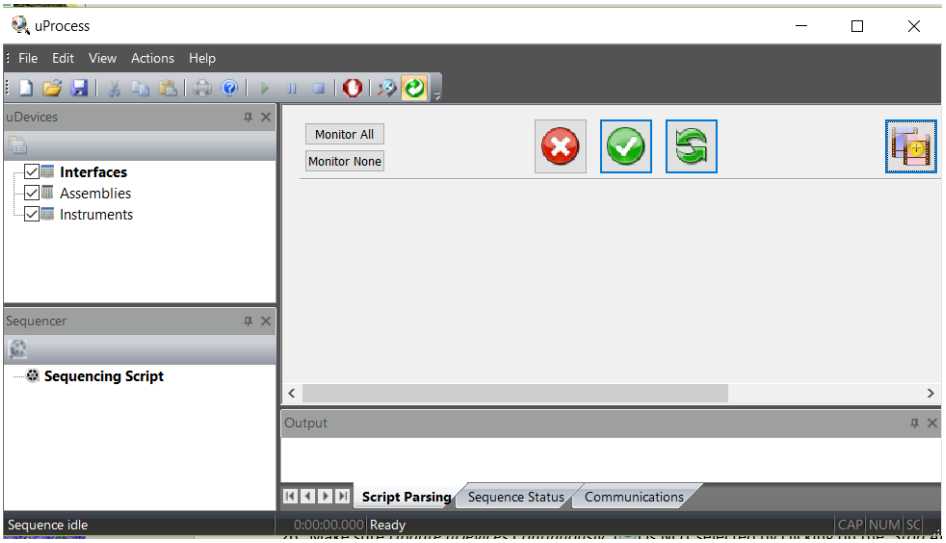
2. **Install the USB driver**. From the flash drive go to *Software Installation>CP210x Windows Drivers* and run one of the following files:
   a. **CP210xVCPInstaller_x64.exe** if you have a Windows x64 computer
   b. **CP210xVCPInstaller_x86.exe** if you have a Windows x32 computer

   NOTE: this step may not be required for newer operating systems. If preferred, you can go on to Step 3 (test the software) and come back to this step if the drivers are not automatically found by your computer.

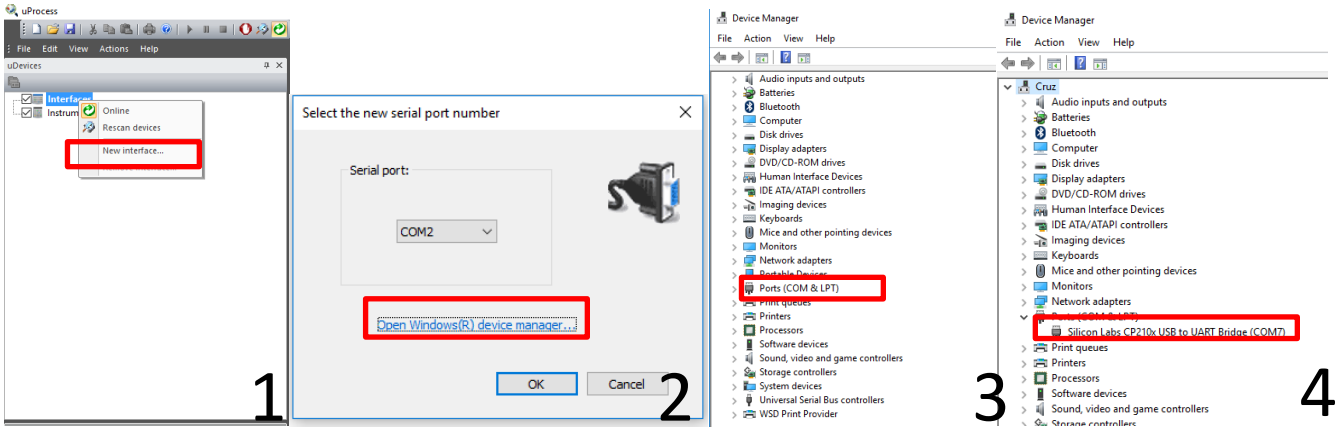
3. **Connect to the EIB200** (to test that the software installation).
   a. Remove the EIB200, micro-USB cable, and power supply from the kit.

   b. Connect the power supply to the EIB200 and to a power outlet.
   c. Connect the micro-USB cable between the EIB200 and a USB port on the computer.
   d. Start the uProcess Software. (If using a version installed on your computer, the icon should be on your desktop. If running the static version from the USB flash drive go to *Software Installation>uProcess Software – Static>uProcess.exe.)*

e. The uProcess software window should open and look similar to:

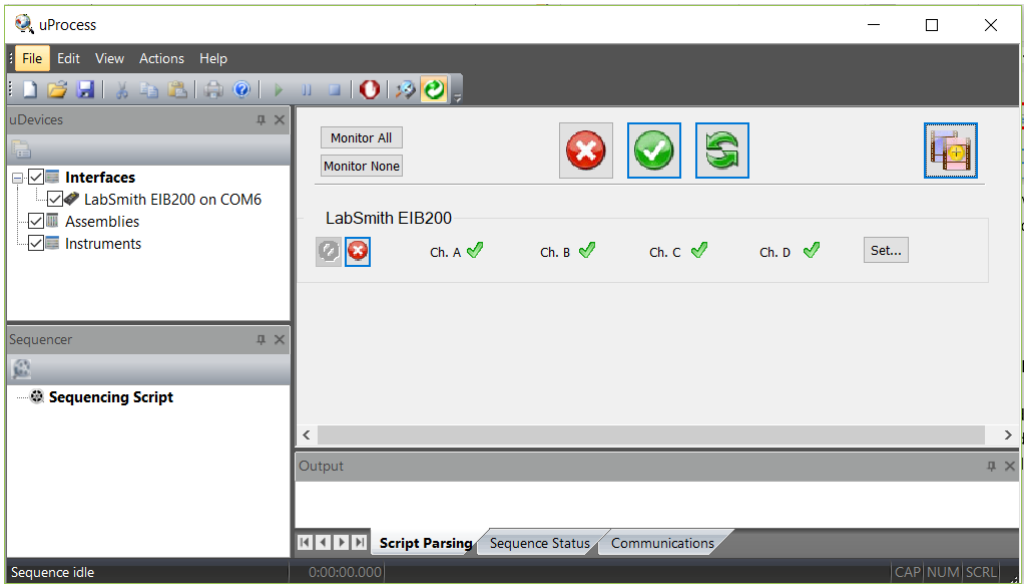


f. Right-click on '*Interfaces*' and select '*New Interface.*' Then select the corresponding COM serial port from the drop-down menu. If the COM port is unknown, click on '*Open Windows device manager…*' and view the Ports list. The correct COM port is listed as '*Silicon Labs CP210x USB to UART Bridge.*' The COM port will be listed at the end of the line.



g. If the COM port is not listed, you will most likely need to install the USB driver as described in Step 2.

h. Once the correct com port is found, the software should look similar to:



The software in now setup and ready for the lab.

Prepare the liquid dispense bottles

1. Fill one bottle with distilled water
2. Fill the other two bottles about half full with distilled water, and add approximately 30 drops of red/blue food coloring to each.

Classroom instructions

Printed assembly and automation instructions are included in the kit packet, along with an electronic copy on the flash drive, and an interactive version on our website at https://labsmith.com/microfluidics-education/demo/.

The flash drive also includes an optional **Reynolds Number Worksheet** and a **Troubleshooting Guide**.

Between lab preparation

The lab instructions include disassembly and cleanup procedures for the students to follow which will get the kit mostly ready for the next class. We advise to check the kits between classes to ensure no components are missing or broken. The following steps are optional:

- Remove the chip from the breadboard and clean off the tape. Add a new piece of chip tape to each kit. This step can be skipped if you want to leave the chip attached to the breadboard for the next class.
- Check each piece of tubing for wear. The clear tubing used for this kit is softer than standard microfluidic tubing, so an overtightened one-piece-fitting can cause an indentation in the tubing that will make reassembly more difficult. In this case, cut off the indented end of the tubing using sharp scissors or a razor blade. Ensure the tubing end is cut straight, not at an angle.