Appendix A: Student Assignments

Assignment Card (1): Automatically mix two or more dyes (diffusion).

This is the most common situation in chemistry, from fuel injectors to paint color mixing, you have to be able to add exact amounts of two or more solutions or liquids together. Your job is to design a device that has inlets for at least two liquids and one outlet for the mixture.

Things to consider:

1) Your device has no moving parts so the liquids need to mix as they move through the device on their own (gravity flow).

2) Consider that you somehow need to mix the liquids over a short distance to try and achieve a homogeneous mixture that the outlet (if your mixing channel is too short the liquids won't mix enough and if it's too long, it won't be efficient enough for the real world).

3) You need to track the mixing.

4) You need a negative control device (one in which you are sure the liquids won't mix), a positive control device (if you can design one) and at LEAST two different experimental devices of different designs (similar but not identical) to ask a question about how your device can mix the dyes.

5) Sketch your designs on the back of this handout.

Appendix A: Student Assignments

Assignment Card (2): Automatically neutralize an acid and a base and let you know it (diffusion & titration)

This is a common situation in chemistry, from making batteries for cars to producing liquid plumber to unclog your sinks, you have to be able to add exact amounts of and acid and a base together to produce an exact concentration of H^+ or H_3O^+. This is known as pH. You have an advantage because color indicators (dyes) can be added to a solution that will turn an exact color depending on the pH. Your job is to design a device that has inlets for at least two liquids (an acid and a base) and one outlet for the mixture. ALSO, you need to be able to determine the pH of the final mixture.

Things to consider:

1) Your device has no moving parts so the acid and base need to titrate as they move through the device on their own (gravity flow).

2) You should have a negative control device that shows the acid and the base indicator colors without mixing.

3) You should have a positive control of the ideal acid/base pH you wish to achieve (color of the indicator that you can try and match with your device).

4) You should have at LEAST two different devices (similar but not identical) that you can test ways to titrate your acid and base to achieve the pH you are after.

5) Sketch your device on the back of this handout.

Appendix A: Student Assignments

Assignment Card (3): Separate a suspension from a liquid (sedimentation).

A-a-a-h! You just had a refreshing drink from your purified water tap at home. Most of these water purifiers use a conventional filter to get rid of suspended particulates (sediments). These filters, however, get full quickly if the water isn't very pure to begin with. So, more and more filters are adding a flow sedimentation stage to separate large particles from liquids by changing the speed of the flow and allowing gravity to pull out the particles.

Microfluidic sedimentation
United States Patent Application 200201605
(public domain)

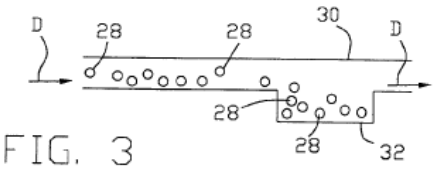

FIG. 3

Your job is to design a device that has inlets for at least two liquids, one with suspended particulates (either 1 mm or 0.5 mm) and one outlet for the "purified" water. ALSO, you need to be able to determine the amount of particulates at the start and end of your purification.

Things to consider:

1) Your device has no moving parts so the particulates need to settle as they move through the device on their own (gravity flow).

Note: This is the only device where I will allow you to manipulate the flow with a syringe or by vibration, etc.

2) Consider that you somehow need to sediment the particles over a short distance to try and achieve a purified solvent at the outlet (if your sedimentation channel is too short the particles won't settle enough and if it's too long, it won't be efficient enough for the real world).

3) You need to track the loss of your particulates.

4) You need a negative control device (one in which you are sure the particles won't disappear), a positive control device (with no particles) and at LEAST two different experimental devices of different designs (similar but not identical) to ask a question about how your device can sediment the particulates.

5) Sketch your designs on the back of this handout.

Appendix A: Student Assignments

Assignment Card (4): Separate immiscible liquids from each other.

Sounds easy, but… The problem is that you often get micelle formation (emulsions) of oil in water (add some vegetable oil to water & shake, you get clouding and bubbles that often take hours to disappear). We often can't wait for this to happen, for example in using pressurized steam to get more oil out of a well. So, just how can we separate the water from the oil, methodically and continuously? Your job is to construct a device that can allow oil and water to flow together to mix but then separate them into two separate outlets. That's right, yours will be the only device that has two inlets and two outlets!!

Things to consider:

1) Your device has no moving parts so the oil and water need to mix and then separate as they move through the device on their own (gravity flow).

2) Consider that you somehow need to separate the liquids over a short distance to try and achieve two separate liquids at the outlets (if your separation channel is too short the liquids won't separate enough and if it's too long, it won't be efficient enough for the real world).

3) You need to track the separation of the two liquids.

4) You need a negative control device (one in which you are sure the particles won't separate), a positive control device (where you know the liquids are separate) and at LEAST two different experimental devices of different designs (similar but not identical) to ask a question about how your device can separate the two liquids.

5) Sketch your designs on the back of this handout.

Appendix A: Student Assignments

Assignment Card (5): Keep two *solutions* separated while flowing TOGETHER (This is hard but can be done by YOU)!

Often, we encounter a situation in which we have two solutions with different dissolved substances but using the same solvent. We need to have both solutions move through one pipe but not mix significantly and separate at the end of the pipe. This is particularly true in biological separations where we want to separate clotting platelets from red blood cells and from white blood cells. The problem is, we only have a single tube/pipe. Hint: Remember that solutions with different densities of dissolved solutes don't mix as readily as solutions that have solutes of nearly the same density. Your job is to construct a device in which two different solutions (each with a unique solute – prepared by your teacher) will enter the device from two different inlets and stay separated until they flow through the outlets.

Things to consider:

1) Your device has no moving parts so the two solutions need to move and stay separate as they move through the device on their own (gravity flow).

2) Consider that you somehow need to keep the solutions separate from the inlets and achieve two separate liquids at the outlets (if your separation channel is too short the solutions may actually mix due to flow rate and if it's too long, the solutions may mix due to diffusion).

3) You need to track the separation of the two solutions.

4) You need a negative control device (one in which you are sure the solutions have NOT stayed separate), a positive control device (where you know the solutions HAVE stayed separate) and at LEAST two different experimental devices of different designs (similar but not identical) to ask a question about how your device can keep the two solutions separate.

5) Sketch your designs on the back of this handout.