



# Interdisciplinary Education Group

## *“Smart” Paper Activity – Detailed Instructions*

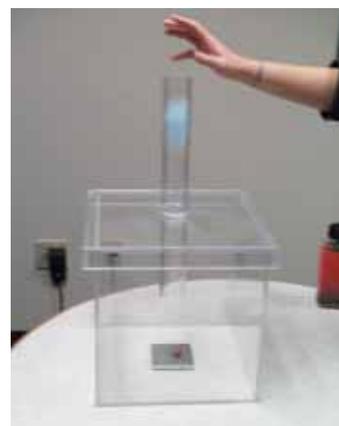
### **Introduction**

Hand out absorbent paper, lemon juice and cotton swabs. Have students write their name on the top corner of the page in regular ink, and then ask them to write a message or draw a picture on the paper in lemon ink. Have students set the paper aside until later. You should also write two messages and set them aside.



The weights, bath beads, and paints balls used in the splatter box.

Give all students 3 sheets of carbonless copy paper labeled A, B, and C. Guide students to write on the top sheet and observe what happens to the bottom two. Instruct students to try different orders of the sheets: ACB, CAB, BAC, and CBA. CBA will give the desired result, copying from the top sheet to the other two. Ask the students to flip the middle B sheet so that the B faces down instead of up have them



Notice that the weight is in mid-fall in the splatter box. It will hit the paint ball at the bottom of the box, in the center of the aluminum square.

write on the top sheet again (no copying will occur).

Two discussions can be lead: How does this paper work? and Is this paper advantageous to use and why/not?

Have a volunteer help with the next demonstration. Give him/her a sheet of plain white computer paper and white thermal paper. Ask if s/he can see any ink on the paper. Then have them hold the iron on top of the thermal paper and computer paper for a few seconds. CAUTION: clothing irons can get very hot, so warn students to avoid burns. Hold up both sheets of paper; the thermal paper will have an ink mark on it where the heat touched the paper.

### **Microcapsules**

#### **Intro Questions**

Ask students: What is the smallest thing you have seen with your eyes? What is the smallest thing you cannot see with your eyes, but you know exists?

Mention that the paper they were just playing with contains tiny capsules they cannot see, called “microcapsules.” These microcapsules hold invisible ink. Ask students what they think a microcapsule is. If they need ideas, ask what something micro is and what a capsule is used for.

#### **Demonstration Procedures**

Ask for different examples of capsules we use every day that are intended to contain liquids or solids and release them in a certain way: M&M’s, eggs, gushers, paintballs, Tylenol gel caps, and bath beads. Talk about the different ways that you can break the capsules discussed, and what is actually being used to rupture the shell. Bring up “melts in your mouth” (i.e. heat transfer), or cracking an egg (i.e. mechanical pressure or force), and scratching and dissolving (medicine)

Ask what would happen if you could put ink into a tiny capsule? What would you put it on? How would you release the ink?



Another photograph of the splatter box, including the weights, paint balls and bath beads.

Ask for a volunteer. Give the student the lightest cylinder and discuss differences between that and the stainless steel cylinder. Ask which cylinders the student thinks will break the paintball and why. Have a different student drop the lightest cylinder, which should not break the paintball. Ask students what they think will happen when the heavier cylinders are dropped. Have them test their ideas. While they are doing this, ask the students to observe any differences in noise, splatter, etc.

Explain that this splatter box experiment was a model for the mechanical force carbonless copy paper encounters during its lifetime. The lighter cylinders were analogies to regular handling of paper, etc., and the heavier cylinders represented the mechanical pressure they put on the paper when writing on it.

Explain that the model is not exactly like smart paper because it is not the breaking of the capsules in the paper that creates the image. Rather, it is the reaction that occurs when the ink inside the capsule comes in contact with other chemicals in the paper that brings out the color. Briefly explain that a reaction is when two things interact and change each other, like a baking soda volcano or other similar phenomenon.

Ask students what problems they see with putting tiny capsules on paper that can be broken, and how they think paper makers get around these problems. Have students try and break a bath bead, ask why it would not always be a good thing to be able to break a capsule.

Bring up the other methods discussed earlier for breaking a microsphere, stressing heat. Ask if a similar method could be used (only with heat) for releasing ink.

Introduce thermal paper as being similar to carbonless, but with different types of spheres all over, sensitive to heat not pressure. Ask, how we could use this technology to print? Could we develop something similar to the printer we have on our computer?

Have the students to draw an analogy to the splatter box: what would we use to represent the printer instead of a heavy cylinder? (iron, hot metal rod of some sort) Ask about advantages of having the ink inside the paper, where only heat is needed to develop an image.

Again stress that it is a multi-step process. The capsule walls are broken (either with heat or force), which releases the ink inside, which combines with other chemicals in the paper to form an image.

### ***Invisible ink***

Have students inspect the absorbent paper that they wrote on with lemon juice and ask them if they can see the lemon juice ink. Explain that the lemon juice is like invisible ink, similar to the ink in the smart paper microcapsules. Like the microcapsule ink, the lemon juice ink becomes visible when it mixes with something else, like red cabbage juice, and reacts with it.

Spray red cabbage juice on your sheet of absorbent paper with lemon ink (in a tray or on newspaper) and show the students. Have all the students spray their own sheet of paper (in trays or on newspaper).

You can also demonstrate that heat (using an iron) can also turn the lemon ink colors.

Another reaction demonstration is the glow stick. Have a student start the stick by bending it. Explain that this breaks the capsule inside the stick and allows the chemicals to interact and react.

### **Testing for Smart Paper**

Have students work in groups, if desired. Hold a discussion centered on the following questions: Where might they have seen smart paper before? What are the advantages of having the ink already in the paper? What are the disadvantages of smart paper? What are some possible uses for this technology?

Hold up various examples of “smart” and “dumb” paper, such as airline tickets, concert tickets, lottery tickets, and grocery receipts. Have the students vote yes or no on whether they think microspheres are in the paper. Ask them if they noticed anything about how frequently smart paper is used; comment on how often they “see” this technology without even realizing it



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Encourage the students to quiz their mom or dad at home: ask parents for a grocery receipt, and whether they think ink is in the paper. Then tell them to lightly iron the paper and see what happens. Demonstrate for the class.

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