没有喷发的火山，和第二次机会

白醋倒进去的那一刻，我们全组都屏住了呼吸。可是杯子里只冒出几颗细小的泡泡，没有泡沫涌出来，更没有顺着山坡往下流。前排有人小声说：失败了。我盯着那座捏了半节课的火山，指尖还沾着没干的浆糊。

火山模型是上午做的。我们先用报纸团出一个瘦高的锥形骨架，一层层缠上胶带，再糊上从花坛边挖来的黏土。我负责山顶，把杯口修成一个规整的圆，用湿黏土把杯壁和山坡之间的缝抹严实。同桌笑我抹得认真，我说，火山漏气就不是火山了。黏土糊得厚薄不均，干下去以后裂了几道细缝，我们又拿湿泥补了一遍，等到表面发白才敢往里面放东西。

加小苏打的时候大家都想抢那把勺子。最后按人头发，一人一勺，五勺倒进杯底，粉末堆成小小的一座白雪山。我顺手捏了一小撮红色颜料粉按在顶上，想着等它喷出来，颜色要像真的岩浆。

问题出在倒醋上。第一次是组长倒的，他手快，半瓶醋一口气冲下去，又高又急。我后来蹲下去看杯子里的情况：粉末被冲得贴在杯壁上，醋积在杯底，安安静静地冒泡，像一杯放久了的汽水。我忽然想起科学老师提过一句，反应要攒够了气才有劲。我们把杯里的残液小心倒掉，重新加了两勺小苏打。这一次我扶着瓶口，先沿着杯壁慢慢渗进去一点，等杯里滋滋响起来、顶起一层白沫，再把剩下的醋全部倒下去。

泡沫是从山顶鼓出来的，先是一个圆顶，然后裂开，红色的沫子一股一股往外涌，顺着黏土的山坡淌下来，淌过我们画的那条小河。教室里炸开了，我们组叫得最响。科学老师走过来，看了一眼表，说从第一次失败到喷发，你们用了四分钟。

后来我常在想，如果第一次没喷出来我们就把杯子收走，那座火山在成绩单上就只是一次失败。可动手实践本来就不是照着步骤走一遍就算完。气要攒够才会喷，这句话我记住了，不只是说给小苏打和醋听的。

The Volcano That Did Not Erupt, and the Second Chance

The moment the vinegar went in, our whole group held its breath. But only a few tiny bubbles rose inside the cup. No foam surged out, and nothing ran down the slope. Someone in the front row whispered: it failed. I stared at the volcano we had shaped for half a class period, paste still drying on my fingertips.

We built the model in the morning. First we crumpled newspaper into a tall, narrow cone, wrapped it layer by layer with tape, then coated it with clay dug from the edge of the flower bed. I was in charge of the summit. I trimmed the rim of the cup into a neat circle and sealed the gap between the cup wall and the slope with wet clay. My deskmate laughed at how careful I was. I said a leaking volcano is no volcano at all. The clay dried unevenly and cracked in a few thin lines, so we

patched it with wet mud again and waited until the surface turned pale before we dared to put anything inside.

Everyone wanted the spoon when it came time to add the baking soda. In the end we went by turns, one spoonful each, five spoonfuls piled into the bottom of the cup like a small white snow mountain. I pressed a pinch of red pigment powder on top, thinking that when it erupted, the color should look like real lava.

The problem was in how we poured the vinegar. Our group leader poured the first time. He was in a hurry and dumped half the bottle in one go, high and fast. Later I crouched down to look inside the cup: the powder had been washed flat against the wall, the vinegar pooled at the bottom, bubbling quietly like a soda left out too long. It suddenly hit me that our science teacher had once said a reaction needs to gather enough gas before it can push hard. We carefully poured out the leftover liquid and added two more spoonfuls of baking soda. This time I held the bottle at the rim and let the vinegar seep slowly down the inner wall first. When the cup began to hiss and a white foam lifted on top, I poured in the rest.

The foam bulged out of the summit, first as a round dome, then it split, and red froth pushed out in waves, running down the clay slope, running over the little river we had painted on it. The classroom erupted. Our group shouted the loudest. The science teacher walked over, glanced at his watch, and said: from the first failure to the eruption, you took four minutes.

I often think about it since. If we had cleared the cup away after the first failure, that volcano would have been nothing but a failure on the record. But hands-on practice was never about following the steps once and calling it done. Gas must gather before it can erupt. I remember that sentence, and it is not only about baking soda and vinegar.

阳台上的火山喷发

弟弟五岁，是我这场实验唯一的观众。他蹲在阳台地砖上，两只手撑着膝盖，眼睛瞪得圆圆的，盯着那座我们花了一下午做出来的火山。我举着白醋的瓶子，手心里全是汗——课上的实验是小组五个人分担的，这一次，模型是我一个人做的，喷不喷得起来，没人帮我找原因。

模型是用一个旧水泥花盆做的。花盆倒扣过来当底座，中间立一只喝空的酸奶杯，杯口和花盆之间塞满揉皱的旧报纸，再在外面糊上一层装修剩下的腻子粉。我按着课上抹黏土的样子，把山坡修得一边高一边低，老师说真实的火山都不是对称的。腻子粉干得慢，我在阳台上守了两个小时，中间忍不住伸手按了三次，指印留在山坡上，只好再补一层。弟弟在旁边帮忙递胶带，递错了七次，但态度是认真的。

加小苏打是弟弟抢着做的。他从袋子里舀，一勺，两勺，数到第五勺洒出去小半勺，他紧张地看我，我说没关系，山脚也是山的一部分。红色的食用色素滴进去四滴，粉末变成淡淡的粉，像还没睡醒的岩浆。

倒白醋的时候我学乖了。课上那次失败我记到现在：醋要慢，要贴着杯壁。我把瓶口压在杯沿上，一线醋慢慢渗下去。第一秒没有声音，第二秒杯底传来滋滋的响，像谁在杯子底下煮一小锅水。然后白沫顶上来，托着粉色，涌出杯口，顺着腻子粉的山坡往下漫。弟弟猛地站起来，喊了一声：它活了！接着他问了一句我完全没准备的话：哥，它肚子里的气是从哪儿来的？

我答不上来。那天晚上我翻课本、查资料，才知道小苏打和醋碰在一起会生成二氧化碳，气在杯子里攒着，攒得越来越多，顶得泡沫往外跑。第二天我做了第二个实验：把喷出的气体引到一只点燃的蜡烛前，火苗歪了一下，灭了。弟弟鼓着掌，我以为他是在为火山鼓掌，后来他说他是为火苗鼓掌。

作业只要求拍一段喷发的视频。可我交上去的那份里多了一张照片：蜡烛灭了的那一瞬。科学老师回了我一行批语：你比你弟弟问的问题还深一点。其实不是。是弟弟先问出口，我才敢往下查。动手实践这件事，手先动起来，问题才会跟着冒出来，就像气顶着泡沫，泡沫顶着颜色，一层推着一层，直到涌出山顶。

Volcano Eruption on the Balcony

My brother is five. He was the only audience for this experiment. He squatted on the balcony tiles, knees propped by his hands, eyes round as plates, staring at the volcano we had spent a whole afternoon building. I held the vinegar bottle, my palm slick with sweat. In class the experiment was shared among five of us; this time I had built the model alone, and if it failed to erupt, there would be no one to help me find out why.

The model started from an old cement flower pot. We turned it upside down as the base, stood an empty yogurt cup in the middle, stuffed the space between the cup and the pot with crumpled newspaper, then coated the outside with the putty powder left over from renovations. I shaped the slope high on one side and low on the other, the way our teacher said real volcanoes never come out symmetrical. The putty dried slowly. I guarded it on the balcony for two hours and pressed it with my finger three times along the way, leaving fingerprints on the slope that had to be patched over. My brother helped by handing me tape. He handed me the wrong thing seven times, but his attitude was serious.

Adding the baking soda was his fight to win. He scooped it from the bag: one spoon, two, and on the fifth he spilled about half a spoon out. He looked at me nervously. I said it is fine, the foot of the mountain is still part of the mountain. Four drops of red food coloring went in, and the powder turned a pale pink, like lava

that had not fully woken up.

When it came to the vinegar, I had learned my lesson. I still remember the failure in class: the vinegar must go in slowly, along the cup wall. I pressed the bottle mouth against the rim and let a thin line of vinegar seep down. The first second was silent. In the second second a hissing sound rose from the bottom of the cup, like someone boiling a tiny pot of water under it. Then white foam pushed up, carrying the pink with it, spilling over the rim and running down the putty slope. My brother jumped to his feet and shouted: it is alive! Then he asked the one question I had no answer ready for: big brother, where does the air inside it come from?

I could not answer. That night I went through the textbook and looked things up, and learned that baking soda and vinegar together produce carbon dioxide; the gas gathers inside the cup, more and more, until it pushes the foam outward. The next day I ran a second experiment: I guided the erupted gas toward a lit candle. The flame leaned sideways and went out. My brother clapped. I thought he was clapping for the volcano, but later he said he was clapping for the flame.

The assignment only asked for a video of the eruption. But the file I handed in carried one extra photo: the instant the candle went out. Our science teacher wrote one line back: you are asking a question even deeper than your little brother. That is not true. He asked first, and only then did I dare to dig. With hands-on work, once the hands start moving, the questions follow, like gas pushing foam, foam pushing color, layer upon layer, until everything spills over the summit.

一杯醋的量，我们测了三回

科学节报名单上，我们小组填的项目是火山喷发。班主任签字的时候抬了一下眼皮：这个节目去年就有班做过，你们有什么不一样的？组长说：我们打算把喷发测出来。班主任把笔递回来，签了。

说不清楚从哪一刻起，我们不再把这件事当成一个节目，而当成一个问题。区别在于：别人只要火山喷起来，我们要回答的是，怎样喷得最高、最久。而这个问题，课本上没有现成的答案，只能自己做。

模型照旧做：报纸骨架，胶带缠绕，外面糊黏土，山顶立一只统一的量杯。这一部分没人偷懒，因为喷发高度跟山顶的口径直接相关，杯口大了气跑得快，小了又容易从半腰胀裂。我们把杯口定在四厘米，用黏土把接缝全部封死，等它干透。

第一次正式测试，小苏打五勺，白醋半杯，喷发高度用直尺量，泡沫最高顶到杯口上方十一厘米。数据记在硬纸板上。问题跟着就来了：是醋越多喷得越高吗？第二次我们加到一杯醋，结

果反而只有九厘米——醋倒得太满，把粉末压死了，气顶不动。第三次我们反过来减醋，四勺小苏打配小半杯醋，喷到十四厘米，而且喷得慢，前后持续了四十多秒。

那几天课间我们组四个人围着硬纸板吵。有人主张继续加小苏打，有人坚持先固定小苏打只调醋。最后定下的办法最笨也最稳：小苏打锁死五勺，醋从三十毫升起，每次加十毫升，各测一遍。注射器是医务室借的，直尺贴在模型侧面。测到第七组数据，曲线自己现出了形状：醋在七十毫升附近，喷发最高，二十八厘米；再多，高度往下掉。原来不是料越多越好，是两样东西要刚好赶上彼此。

科学节那天，台下坐着两百多人。我们按第七组的配比操作：五勺小苏打落进杯底，红色的醋沿着杯壁渗下去，滋滋声从杯底一路顶上来，泡沫冲出口沿，直尺上的白沫线爬到三十厘米才停。台下安静了一秒，然后鼓掌。主持人问我们凭什么跟去年那班不一样，组长把硬纸板举起来，上面是七组数据。

后来我把那块硬纸板留了下来。它提醒我一件事：喷出来，只是实验的开始；把喷出来这件事量清楚，才是科学探究的开始。动手的价值不在于手动了，而在于手动过之后，问题有没有跟着变清楚。

How Much Vinegar: We Measured It Three Times

On the science festival sign-up sheet, our group entered volcano eruption. When our homeroom teacher signed, she looked up for a moment: a class did this last year. What will you do differently? Our group leader said: we plan to measure the eruption. She handed the pen back and signed.

None of us can say exactly when the project stopped being a show for us and became a question. The difference is this: everyone else only needs the volcano to erupt. What we wanted to answer was how to make it erupt the highest and the longest. And that question had no ready answer in the textbook. We could only find it ourselves.

The model followed the usual method: a newspaper frame, wrapped in tape, coated with clay, with a standard measuring cup set at the summit. Nobody slacked off on this part, because eruption height is tied directly to the mouth of the cup. Too wide and the gas escapes too fast; too narrow and the slope splits at the middle. We fixed the mouth at four centimeters and sealed every seam with clay, then let it dry through.

In the first formal test: five spoonfuls of baking soda, half a cup of vinegar, height measured with a ruler. The foam topped out eleven centimeters above the rim. We wrote the number on a piece of cardboard. The question came right with it: does more vinegar mean a higher eruption? The second time we used a full cup of vinegar,

and the result was only nine centimeters. Too much vinegar pressed the powder flat, and the gas could not push. The third time we went the other way and cut the vinegar down: four spoonfuls of soda with a scant half cup of vinegar. It reached fourteen centimeters, and it erupted slowly, lasting over forty seconds.

For days we argued around that cardboard between classes. One of us wanted to keep adding baking soda; another insisted on fixing the soda and adjusting only the vinegar. The method we finally chose was the dumbest and the steadiest: lock the soda at five spoonfuls, start the vinegar at thirty milliliters, add ten milliliters each round, and test every combination once. We borrowed a syringe from the school clinic and taped a ruler to the side of the model. By the seventh set of data, the curve showed its shape on its own: near seventy milliliters of vinegar the eruption peaked at twenty-eight centimeters; past that, the height fell. It turned out more material is not better. The two have to arrive at each other at exactly the right moment.

On festival day, more than two hundred people sat below the stage. We followed the seventh set of proportions: five spoonfuls of baking soda fell into the cup, the red vinegar seeped down the inner wall, the hissing rose from the bottom all the way up, the foam shot over the rim, and the white line on the ruler climbed to thirty centimeters before it stopped. The audience went quiet for one second, then applauded. The host asked what made us different from last year's class. Our group leader held up the cardboard. On it were seven sets of data.

I kept that cardboard afterwards. It reminds me of one thing: an erupting volcano is only the beginning of the experiment; measuring what erupting means, that is where real scientific inquiry begins. The value of hands-on work is not that the hands moved. It is whether the question grew clearer after they did.