Settling Rate and Layering of Various-Sized Particles

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Topic

Particle size and settling rate

Time

45 minutes

Safety

Please click on the safety icon to view the safety precautions.

Materials

clear plastic tube with inside diameter of approximately 2.5 cm (a 5- to 6-ft tube gives best results, but a 3-ft tube will work.)
test-tube clamp and ring stand
rubber stopper or cork to fit plastic tube
20 solid plastic beads of each of the following sizes: 3 mm, 6 mm, 9 mm (Don't use polypropylene beads or other floating types. The exact size of beads is not as important as relative sizes.)
water
watering can or pitcher
funnel to fit inside plastic tube
index card
jar with mouth approximately the size of the tube mouth
stopwatch
bucket
step stool (if you are using a 6-ft tube)

Procedure

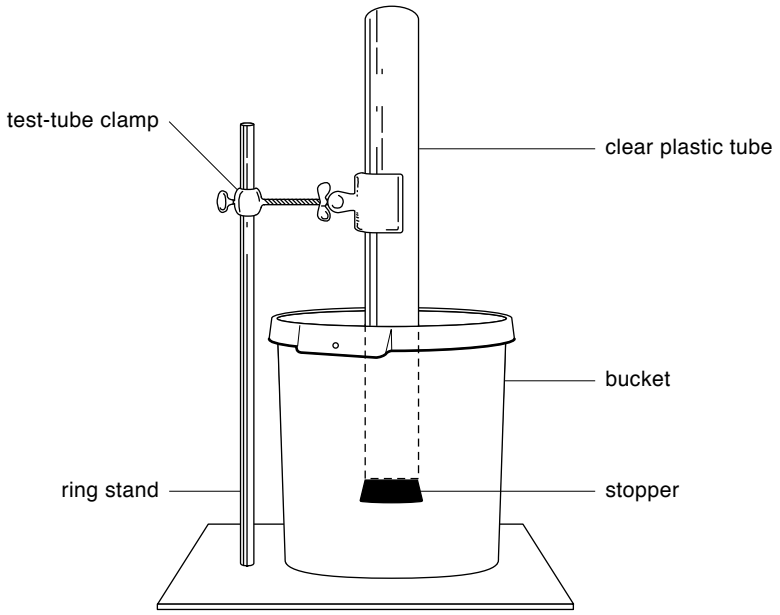
Preparation

1. Hold the clear plastic tube vertically with the test-tube clamp and ring stand or similar mechanism (pliers or C-clamp held in a vise, etc.; see figure 1). The bottom of the tube should be close to the floor.
2. Stopper or plug the bottom of the tube.
3. Place a bucket under the tube so that water leaking or spilled will not reach the floor, where it would create slippery conditions.
4. Carefully using a funnel, fill the tube with water from a plastic pitcher or watering can. If you are using a long tube, use a step stool to reach the top.

Part A

1. Select one of the smallest beads. Hold it just over the top of the tube. Drop it, timing (with the stopwatch) how long it takes to hit the bottom.

Figure 1



2. Record the time on the data table.

DATA TABLE

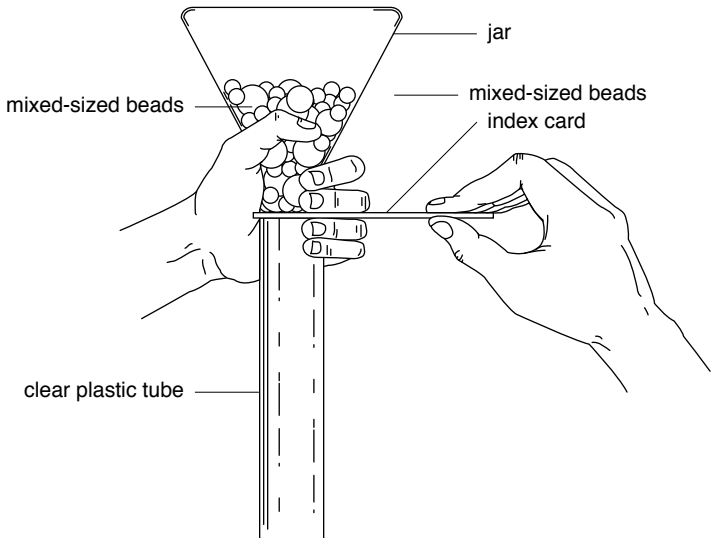
	Time needed to sink (sec)				
Bead size	Trial 1 (1st bead)	Trial 2 (2d bead)	Trial 3 (3d bead)	Total (3 trials)	Average (3 trials)
Small					
Medium					
Large					

3. Repeat steps 1 and 2 twice with two more of the smallest beads.
4. Next, separately time and record the descent of three medium-sized beads.
5. Repeat with three larger beads.
6. Average the time for each size, and complete the data table.

PART B

1. Remove all beads from the tube by slowly easing the stopper out of the tube. Pull the stopper out gradually, allowing the water to drain gradually into the bucket. Since the water is under pressure, it will shoot out forcefully if the stopper is removed quickly.
2. Replace the stopper and refill the tube with water.
3. Mix approximately 20 small beads, 15 medium beads, and 10 large beads together in a jar with a mouth about the same size as the mouth of the tube.
4. Place an index card over the jar mouth, and invert the mouth over the top of the tube. Let it rest there while you hold the jar against the tube neck with one hand and the index card with the other, as shown in figure 2. With a quick movement, pull the card from between the jar and tube to release all the beads into the tube.

Figure 2



5. After they reach the bottom, observe the positions of the small, medium, and large beads. Make an accurate drawing.
6. Which beads sank the fastest? Why?
7. Which beads sank the slowest? Why?
8. If the rate of sinking is consistent for all beads of the same size, then when the mixture is dropped, all the fastest ones should form the bottom layer. Did this occur? Can you explain your results?
9. If a bank of a stream falls into the moving water of the stream itself:
   a. Which size particles will settle to the bottom first?
   b. Which ones as a result of their slower settling will remain in the moving water longer before dropping to the bottom?
   c. What pattern will develop in particle size distribution on the bottom as you go downstream?

What's Going On

The largest beads with the greatest mass should have the fastest times of descent. Accurate start-and-stop timing is the key to good data. Medium-sized beads should be next, and the smallest beads should take the longest to fall. As a result, the drop of mixed sizes should result in well-defined layers, with the largest on the bottom, medium-size in the middle, and the smallest beads in a uniform layer on top. What is horizontal layering in the tube becomes a vertical downcurrent layering in the stream. The large particles travel only a short distance and fall to the bottom, close to the source. Medium particles settle next, and small particles, which stay in the water longest, are carried the farthest downstream.

Connections

Most of the rocks on the earth's surface are sedimentary. They were formed when solid material settled out of ice, air, or water, and accumulated either on dry land or under water. Sedimentary particles are deposited in layers depending on their mass. Objects with greater mass will settle faster than those of lesser mass. Coal is a sedimentary rock, which at times preserves the remains of plant life in the form of fossils.

Safety Precautions

READ AND COPY BEFORE STARTING ANY EXPERIMENT

Experimental science can be dangerous. Events can happen very quickly while you are performing an experiment. Things can spill, break, even catch fire. Basic safety procedures help prevent serious accidents. Be sure to follow additional safety precautions and adult supervision requirements for each experiment. If you are working in a lab or in the field, do not work alone.

This book assumes that you will read the safety precautions that follow, as well as those at the start of each experiment you perform, and that you will *remember* them. These precautions will not always be repeated in the instructions for the procedures. It is up to you to use good judgment and pay attention when performing potentially dangerous procedures. Just because the book does not always say "be careful with hot liquids" or "don't cut yourself with the knife" does not mean that you should be careless when simmering water or stripping an electrical wire. It *does* mean that when you see a special note to be careful, it is extremely important that you pay attention to it. If you ever have a question about whether a procedure or material is dangerous, stop to find out for sure that it is safe before continuing the experiment. To avoid accidents, always pay close attention to your work, take your time, and practice the general safety procedures listed below.

PREPARE

- Clear all surfaces before beginning work.
- Read through the whole experiment before you start.
- Identify hazardous procedures and anticipate dangers.

PROTECT YOURSELF

- Follow all directions step by step; do only one procedure at a time.
- Locate exits, fire blanket and extinguisher, master gas and electricity shut-offs, eyewash, and first-aid kit.
- Make sure that there is adequate ventilation.
- Do not horseplay.
- Wear an apron and goggles.
- Do not wear contact lenses, open shoes, and loose clothing; do not wear your hair loose.
- Keep floor and work space neat, clean, and dry.
- Clean up spills immediately.
- Never eat, drink, or smoke in the laboratory or near the work space.
- Do not taste any substances tested unless expressly permitted to do so by a science teacher in charge.

USE EQUIPMENT WITH CARE

- Set up apparatus far from the edge of the desk.
- Use knives and other sharp or pointed instruments with caution; always cut away from yourself and others.
- Pull plugs, not cords, when inserting and removing electrical plugs.
- Don't use your mouth to pipette; use a suction bulb.
- Clean glassware before and after use.
- Check glassware for scratches, cracks, and sharp edges.
- Clean up broken glassware immediately.

- Do not use reflected sunlight to illuminate your microscope.
- Do not touch metal conductors.
- Use only low-voltage and low-current materials.
- Be careful when using stepstools, chairs, and ladders.

USING CHEMICALS

- Never taste or inhale chemicals.
- Label all bottles and apparatus containing chemicals.
- Read all labels carefully.
- Avoid chemical contact with skin and eyes (wear goggles, apron, and gloves).
- Do not touch chemical solutions.
- Wash hands before and after using solutions.
- Wipe up spills thoroughly.

HEATING INSTRUCTIONS

- Use goggles, apron, and gloves when boiling liquids.
- Keep your face away from test tubes and beakers.
- Never leave heating apparatus unattended.
- Use safety tongs and heat-resistant mittens.
- Turn off hot plates, bunsen burners, and gas when you are done.
- Keep flammable substances away from heat.
- Have a fire extinguisher on hand.

WORKING WITH MICROORGANISMS

- Assume that all microorganisms are infectious; handle them with care.
- Sterilize all equipment being used to handle microorganisms.

GOING ON FIELD TRIPS

- Do not go on a field trip by yourself.
- Tell a responsible adult where you are going, and maintain that route.
- Know the area and its potential hazards, such as poisonous plants, deep water, and rapids.
- Dress for terrain and weather conditions (prepare for exposure to sun as well as to cold).
- Bring along a first-aid kit.
- Do not drink water or eat plants found in the wild.
- Use the buddy system; do not experiment outdoors alone.

FINISHING UP

- Thoroughly clean your work area and glassware.
- Be careful not to return chemicals or contaminated reagents to the wrong containers.
- Don't dispose of materials in the sink unless instructed to do so.
- Wash your hands thoroughly.
- Clean up all residue, and containerize it for proper disposal.
- Dispose of all chemicals according to local, state, and federal laws.

BE SAFETY-CONSCIOUS AT ALL TIMES