2.2 Tiny particles

At the end of this activity students will be able to:

- use the kinetic theory (particle model) to explain the behaviour of particles in each state of matter.
- use the particle model to explain the phenomenon of Brownian motion.

What ideas might your students already have?

Students will be familiar with the concept of the particle model, but have had very few opportunities to see direct evidence of it.

Equipment list

Each GROUP will require:

- access to **Student Digital**
- microscope, slides and cover slips
- small quantity of milk diluted approximately 1 in 4.
- pipette
- tissues for drying slides

Each STUDENT will require:

- ***Notebook***

Things to consider and hints for success

Milk is an emulsion of mostly droplets suspended in water. The fat droplets have a variety of sizes that are appropriate for the observation of Brownian motion. Observing Brownian motion is difficult because it requires the compound microscope to be well focused under 400 X magnification. Students consistently have problems getting microscopes to work to this level, and may need some direct assistance in setting this up.

The phenomenon is quite underwhelming to students until you impress on them that the small jiggling of particles that they observer is due to collisions with water molecules in the milk. As they get used to the phenomenon it becomes more obvious. It should be possible to focus on a couple of specks that a close to each other and observe them wandering around in a ‘random walk’ due to their random collisions with the water molecules around them.

There is something of a misconception that Einstein received one of two Nobel Prizes for his analysis of Brownian motion. However, he only received one Nobel prize (for his analysis of the photoelectric effect).

Teacher content information:

The particle model (or kinetic theory) of matter is one of the most important scientific ideas that students learn. And yet it is one of the most difficult to demonstrate directly at a macroscopic level. This activity provides an opportunity for students to consider the particle model and its ramifications, as well as making some direct observations that provide evidence of particles in constant motion.

The position and motion of particles in different states.

State	Position and motion of particles
Solid	The particles are in fixed positions in a lattice structure. They are tightly packed together and can only vibrate within a particular position.
Liquids	Particles clump together but are not locked into fixed positions. The clumps are always large enough to fall to the bottom of any container due to gravity. They are close together.
Gases	Particles move quickly. They travel in straight lines until they hit another particle. They are widely spaced and do not interact except through collisions.

Brownian motion

Einstein's mathematical analysis of Brownian motion was important in providing direct evidence for the particle (kinetic) theory of matter. Although not as well-known as his work on relativity and the photoelectric effect this research was one of the important pieces of early work that propelled him into a career as a theoretical physicist.

Lesson plan

Step 1: Students observe the movement of particles in each state of matter using the learning object, then answer Question 1 in their ***Notebooks***.

Step 2: Students complete the remaining questions in their ***Notebooks***.

Step 3: Students then move on to the activity of observing Brownian motion in milk. Spend time ensuring that students are able to focus on their slides using 400X magnification.

Discussion Questions

You should observe the fatty droplets in the milk jiggling around.

1. You will notice both large and small droplets. Do you observe any difference between the jiggling motion of the large and small droplets?
2. Why do you think there is a difference?
3. How do your observations support the idea that water is made of tiny particles in constant motion?