QUANTUM PHYSICS AT HOME

A Star Research Notebook

Your mission: use ordinary objects to explore probability, waves and light, then investigate what these models can - and cannot - tell us about the quantum world.

A curious researcher asks good questions

Quantum physics describes how very small things, such as atoms and particles of light, behave. We cannot see those tiny things directly at home, but we can explore related ideas through simple activities and careful research.

Research honesty: these activities are models and demonstrations. A coin, water ripple or pair of sunglasses is not a quantum particle, and these activities do not prove quantum physics. They help us ask better questions about probability, waves and measurement.

Researcher name

Date and place

My starting question about the quantum world:

Investigation 1: chance and patterns

You need: one coin, paper and a pencil. **Question:** what pattern appears when a fair coin is tossed many times?

Important comparison: coin tossing is classical chance. The coin follows ordinary physical rules, even if its exact motion is hard to predict. Quantum theory also uses probabilities, but this coin experiment is only an analogy - it is not a quantum experiment.

Make a prediction: if you toss the coin 20 times, how many heads do you expect? Why?

Try it. Toss the coin 20 times. Record each result with a tally, then count heads and tails.

Heads	Tails

My result: heads ___ tails ___ total ___

What surprised me? What would I expect if I repeated the test?

Research link: scientists use probability to predict patterns when outcomes cannot be stated with certainty. In quantum physics, probabilities are part of the theory itself.

Investigation 2: waves meet waves

You need: a shallow tray or bowl with a little water, and two pencils. Ask an adult before using water near electrical devices.

Try it. Put the tray on a steady surface. Gently tap the water in two places at the same time with the pencil tips. Watch where the ripples meet. If the tray is too small, tap one place, then the other, and compare the patterns.

Look for: places where ripples seem to grow stronger, and places where they seem to flatten. When waves overlap, they can add together or partly cancel. This is called interference.

Draw the pattern you noticed. Label where the ripples met.

What changed when I tapped in two places instead of one?

Quantum connection: quantum experiments can produce interference patterns. Water ripples are much larger and behave according to classical wave physics. They help us picture interference, but they do not show how a single quantum particle behaves.

New question to research: how can individual particles build up a pattern that looks wave-like?

Investigation 3: light and direction

You need: a phone or tablet with a bright white screen and polarised sunglasses. If you do not have polarised sunglasses, skip this activity. Never look at the Sun through sunglasses or any other object.

Try it. Open a white screen. Look at it through the sunglasses and slowly rotate the glasses. Notice whether the screen changes brightness. Try turning the device too. Results vary between screens and sunglasses.

What is happening? Some screens and polarised lenses filter light according to its direction of vibration. Polarisation is a property of light. Quantum physics also describes light in terms of photons, which have polarisation states.

What did I see as I rotated the glasses?

What might affect the result? Think about the screen, glasses, angle or room light.

Quantum connection: measuring a photon's polarisation is a quantum measurement. This activity uses bright light containing enormous numbers of photons; it does not measure one photon at a time. It is a starting point for research, not a test of quantum behaviour.

Research prompt: what does a polarising filter do? Find one reliable explanation and write it in your own words.

Source or website title:

My explanation:

Become a quantum research detective

Choose one question. Use a book, museum, university or science organisation website to investigate it. Write down where your information came from.

Pick a question:

■ What is an atom made of? ■ What is a photon? ■ What does “superposition” mean? ■ What is quantum entanglement? ■ Why do scientists use probability in quantum physics?

My question (or one of your own):

What I found out - in my own words:

Source: author or organisation, title, and web address or book details

Check your source

■ Who wrote it? ■ Is it from a trusted science or education source? ■ Does it explain evidence, or make a claim without showing evidence? ■ Can I find the same idea in another reliable source?

One fact I feel confident about, and why:

Plan your own safe mini investigation

Choose a question you can explore safely - perhaps by repeating a coin toss or finding out how light changes through household filters. Do not take appliances apart, use lasers, stare at bright lights, or mix household chemicals.

My question and prediction:

What I did and what I observed:

What I can conclude - and what I still do not know:

Final thought: a good researcher can change their mind when evidence points somewhere new. Keep wondering, keep checking, and explain the difference between what you observed and what you think it might mean.