Quantum Lab Teacher's Notes

Main Topic	Measurement
Subtopic	Modern Physics
Learning Level	High
Technology Level	Low
Activity Type	Student

Description: Use a quantum model to indirectly determine the mass of a penny, just as Planck and Einstein did for photon energies.

Required Equipment	Film canisters, pennies (newer than 1982), tape, electronic balance
Optional Equipment	Triple-beam balance

Educational Objectives

- Use a quantum model to determine the mass of a penny indirectly, just as Planck and Einstein did for Photon energies.

Concept Overview

Something that is **quantized** exists in multiples of a set quantity. Examples are **charge [1.6 x 10^{-19}C]** or **quantum energies of photons**. **Planck and Einstein** predicted that light existed as discrete bundles called photons. Since they could not see a unit of photon energy, this lab constructs a **model of how quanta was derived** and visualized by scientists. Money is **quantized** into pennies, nickels, dimes, etc. There are **NO** 2-cent or 8-cent coins!

In this inquiry lab, students will develop their own method for finding the pennies' mass.

Lab Tips

Prepare the film canisters using pennies newer than 1982. Before 1982, pennies were 95% copper and 5% zinc. Since 1982, they are 97.6% zinc and 2.4% copper. New pennies have a mass of 2.5 grams. (Older ones have a mass of 3.1 grams.)

If students have already learned about the quantization of energy and the Planck constant, the optional Questions section provides a review of this topic. The important relationship is

$$E = h\nu$$

Where E is the photon energy, h is the Planck constant (4.14 x 10^{-15} eV•s) and ν is the frequency of the light emitted. In the case of a green laser, as in the question, the frequency is 523nm.

Acknowledgement

This lab was contributed by Dwight "Buzz" Putnam, physics teacher, Whitesboro High School, NY.

Quantum Lab Name: _____

Class: _____

Goal:

Use a quantum model to determine the mass of a penny indirectly, just as Planck and Einstein did for Photon energies.

Materials:

8 pre-made canisters containing unknown numbers of identical pennies, electronic balance.

Procedure:

1. Obtain **8 film canisters**. **DO NOT OPEN THE CANISTERS!**
2. Each sample has the **mass of the empty canister** written on it. Record this and the canister # in **Table #1** below.
3. Devise a method to find the mass of each penny. Use the data table as needed. The pennies are all identical in mass, and each can contains an unknown number.
4. After you have determined the mass of each penny, calculate the number of pennies in each can.

Canister #	Mass of empty can (gms)				# of pennies in can

Quantum Lab

Name: _____

Class: _____

Questions:

1. Find the Quantum Energy [in eV's] for a **green** LASER.

2. If a photon has a Quantum Energy of 250 eV's, find the wavelength and type of photon from the Reference Table.