

## #2800 Smoking Experiment

This kit provides materials for a series of demonstrations or small group experiments for secondary students. The materials provided will allow the investigation of smoke content, cigarette tar comparisons, filter efficiencies, length of an efficient filter, and tar content of the first and last half of a cigarette. The demonstrations (5 in all) can be completed in about two class periods, but may be spread out to cover more time. Please note that various types and brands of cigarettes are required for this experiment and are not supplied in the kit. You may wish to review the lab procedures before purchasing or collecting cigarettes.

### Contents:

Filter Holder with Tubing (1)  
Aspirator Bulb with Fitting (1)  
Filters (25)  
Color Chart (1)

Teacher Manual (1)

### Additional Required Materials:

20 - 40 cigarettes of various brands, filtered & unfiltered of each brand  
Scale  
Ruler

### TO CLEAN -

**PULL VALVES FROM BLACK RUBBER BULB**

**NOTE ORIENTATION OF VALVES**

**THEY ARE BOTH ONE-WAY VALVES.  
CLEAN IN ALCOHOL WHEN DIRTY.**

**PRY SECTIONS OF SMOKING CHAMBER  
APART WITH A SCREWDRIVER OR COIN.**

## Introduction

Cigarette smoking has been linked to many diseases such as heart disease, lung cancer, emphysema, chronic bronchitis, Buerger's disease, cancer of the larynx (voice box), cancer of the esophagus and cancer of the mouth.

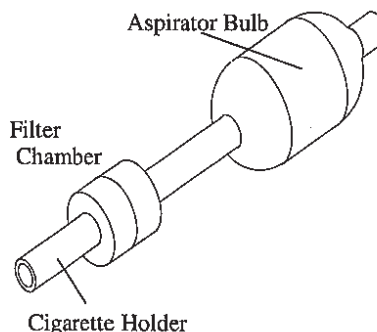
There is a definite connection between the quantity of cigarettes smoked and the amount of smoke ingested and the disease rate for the above ailments. It is important therefore to find out just how much smoke (tar) is generated by a cigarette and also to determine how efficient the various cigarette filters actually are.

This experimental manual is designed to allow the student to visually, as well as quantitatively, determine the various parameters concerning cigarette smoking.

### A. How Much Smoke Is In A Cigarette?

Prepare the smoking experiment apparatus as shown in the diagram. Make certain that the filter holder is securely wedged against the filter to prevent any smoke from leaking past the filter. Mark an unfiltered cigarette with a ball point pen exactly 1 1/4" from the end. Put the cigarette into the holder (open-ended rubber tubing).

Light the cigarette with a match by squeezing the rubber aspirator bulb once and releasing it slowly to create a suction on the cigarette. Each squeeze of the bulb approximates one puff of a cigarette. To closely simulate a smoker, take a "puff" about once every thirty seconds. Closely observe the filter in the holder.



- A. 1
  - a) Why doesn't any smoke pass through the filter?
  - b) Where is the smoke?
  - c) Record your observations.

Smoke the cigarette down to the ink mark which was put on the cigarette earlier. Carefully remove the cigarette from the holder and dispose of it in a safe manner. Open the filter holder carefully.

- 2 What does the filter look like? Smell like?

Compare the filter color with that of the color chart supplied in the kit. The quantity of material collected by the filter is approximately represented by this matching color. If the color on the filter disc appears to be between two adjoining colors on the chart, use a value mid-way between the values stated for each color.

- 3 What is the filter paper value?

This value is a close approximation of the quantity of smoke generated by the cigarette and also that amount which would have been ingested by a person had he/she been actually smoking the cigarette.

Repeat this experiment and compare the results with the first test.

An average human adult breaths 22,000 times per day, with an average volumetric intake of 13,200 liters of air per day, or 0.60 liters of air per breath. In a polluted atmosphere, the air may contain as much as 300 micrograms of dust per cubic meter.

- 4
- Calculate the total intake of pollutants by weight for an average adult over a 24 hour period in a polluted atmosphere.
  - Calculate the total intake of smoke by an adult who smokes one pack (20) of cigarettes per day, using the value obtained from the color chart.
  - Compare this result with the quantity of pollutants ingested by an adult in the polluted atmosphere. Which is more dangerous?

Note that the color chart need not be used and may be replaced by the more accurate technique of pre-weighing the filter discs on any analytical balance and re-weighing them after filtering the cigarette smoke. The filter discs must be desiccated before weighing because they tend to absorb moisture from the atmosphere, altering weight slightly. Secondly, and more importantly, one of the products of tobacco combustion is water, which must be removed from the filter disc either by heating gently or by drying with a desiccant for periods of no less than thirty minutes, and preferably overnight.

## **B. Which Cigarette Has The Lowest Smoke (Tar) Content?**

Take several (5-6) different brands of cigarettes, both filtered and unfiltered, all of the same length, and “smoke” them in the smoking experiment apparatus as described in Part A. Note that the ball point pen mark is to be placed on the cigarette exactly 1 1/4" from the end of the cigarette which has the filter tip.

- 1
- Using the color chart, record the weight of smoke generated by each different brand.
  - Do the weights differ? Why?

- c) Which cigarette has the highest smoke content? Which has the lowest?
  - d) In general, what can be said about the unfiltered cigarettes?
- 2
- a) Take unused filter tipped cigarettes (same brands as above) and carefully remove the filters. Weigh the filter tips. Record these weights.
  - b) Remove the filters from the used cigarettes and weigh them.
  - c) Record any weight differences between the used and unused filter tips of the same brands.
  - d) Is this difference only due to the trapped smoke particles?
- 3
- How does the weight of a clean filter tip correlate with the quantity of smoke collected on the filter disc for each cigarette?
- 4
- How does the length of the filter tip compare with the quantity of smoke collected on the filter discs?

### C. Efficiency of Different Cigarette Filters

Set up the smoking experiment apparatus as described in Part A. Take two filter tipped cigarettes (same brand; any length) and carefully remove the filter from one of the cigarettes. Put a ball point pen mark 1½" from the end of the filter tipped cigarette (tipped end) a 1½" from the end of the unfiltered cigarette. Smoke both cigarettes as described in Part A. Remove the filter discs from the filter holders very carefully.

- 1
- a) Which disc is darker? Why?
  - b) Record the quantity of smoke (tar) collected by each filter disc using the color chart.
  - c) Calculate the filter tip efficiency (the efficiency of smoke removal by the filter tip).

Sample Calculations:

Filter disc #1 contains 40 milligrams (mg) of collected smoke particulate matter (color chart value).  
 Filter disc #2 contains 30 mg of smoke particulate matter (color chart value).

Therefore, the quantity of smoke collected by the cigarette filter is 40mg - 30mg = 10mg.

$$\text{Cigarette filter tip efficiency} = \frac{\text{Quantity collected by filter tip}}{\text{Total Potential Quantity}} \times 100\% = \frac{10}{40} \times 100\% = 25\%$$

#### **D. Length Of An Efficiently Filtered Cigarette**

Set up the smoking experiment apparatus as described in Part A. Remove the filter tip from any cigarette and smoke it as in Part A.

- 1 Record the amount collected on the filter disc by comparing it to the stains on the color chart.
- 2 Smoke a filter tipped cigarette of the same brand in the apparatus. Record the amount collected on the filter disc.
- 3 Take the filter tip, which was removed from the first cigarette and place it in series with a filter tipped cigarette of the same brand using a piece of rubber tubing. Smoke the cigarette with these two filter tips. Record the amount of smoke collected.
- 4 Repeat the previous steps, only using two extra filter tips, totaling three filter tips in a series. Amount of smoke collected?
- 5 Continue adding filter tips until the stain on the filter disc is equal to the first color on the chart. How many filter tips are required?

Repeat this experiment using the so called "low tar" cigarettes and see how many of those filter tips are required to lower the smoke content of a cigarette to the low level achieved in the previous step.

#### **E. "Tar" Content Of The First And Second Half Of A Cigarette**

Set up the smoking experiment as described in Part A. Mark a filter tipped cigarette 1 1/4" from the end which has the filter tip. Insert the tip into the apparatus. Place a second mark on the exact middle of the remaining section of the cigarette. Smoke the cigarette up to the first mark and then carefully stub it out in an ashtray. Remove the filter from the holder and replace it with a new one. Reinsert the cigarette into the apparatus and re-light it. Smoke the cigarette down to the original mark.

- 1 Compare the two filters by appearance and by color chart values. Which one is darker? Why?
- 2 Repeat this experiment with an unfiltered cigarette. What are the results compared with the filter tipped cigarette?