Name _____ Date _____ Period _____

Lab: Free Fall and Air Resistance

CONCEPTUAL PHYSICS: UNIT 1

Questions: Does increased weight overcome the force of air resistance acting on a falling coffee filter?

Materials:

- 24 coffee filters
- Meter stick
- graph paper
- Stopwatch

Goal: Differing numbers of nested coffee filters falling in air readily show a variation in the effects of air resistance on a falling body. We can readily calculate the time to fall a measured distance near the earth due to gravity' acceleration if no air resistance acts. Repeatedly measure the time for differing numbers of coffee filters to fall in air a measured distance using a stopwatch.

Plot time of fall vs. increasing number of nested coffee filters dropped to graphically illustrate the effects of air resistance on increasingly heavier coffee filters falling in air. By nesting coffee filters the surface area of the falling body remains constant as mass is added. We can increase the number of nested filters dropped to change the mass of (and the net force acting on) the falling coffee filters in air.

Procedure:

1. Form groups of 3 students each.

2. Obtain required materials (24 coffee filters, meter stick(s), stopwatch)

3. Have the tallest member of your group hold a coffee filter overhead as high as possible. This will be the same height for every trial. **Use the meter stick** to measure this height from where the tallest student will repeatedly drop the filters from.

Record that distance here = _____meters

4. Calculate the time to <u>free fall</u> this vertical distance from the tallest student's hand held high to the floor. This is the distance the coffee filters fall. Show this calculation in your lab report. Use the equation below to calculate this (Show work below) Use g = 9.8 m/s^2

$$t = \sqrt{\frac{2d}{g}}$$

Record the time to fall here. **Free fall time = _____ seconds**

Assume this time to be the time the filters actually fall freely the distance <u>without</u> effects of air drag.

5. Now drop one, then 2, then 4 (up to 24) nested coffee filters at least three times each while timing the fall using a stopwatch. Nest the filters dropped when more than one filter is used so that **the same surface area is exposed to the air** but also **so the filters fit together and increase the**

weight acting on the falling filters. Repeat each experimental trial 3 times to insure good data. Discard any measurements that may be in error. Record data in data table below.

6. **Graph** the time of fall (dependent variable) on the vertical y-axis vs. the number of falling filters on the horizontal x-axis to show how free fall is achieved as we increase the number of nested, falling, coffee filters (by increasing the mass) falling with a constant surface area.

7. After you have finished graphing your data, answer the conclusion questions.

Data Table for Falling Coffee Filters

	Time (seconds)			
Number of Filters	Trial 1	Trial 2	Trial 3	Average
1				
2				
4				
6				
8				
10				
12				
14				
16				
18				
20				
22				
24				

Questions:

1. Define the meaning of the term **free fall**.

2. What is the:

   a. **dependent** variable in this experiment?

   b. **Independent** variable in this experiment?

   c. **Controlled** variables in this experiment?

3. Explain why the time to fall decreases as the number of filters dropped increases.

4. Explain in your own words what the graph shows.

5. Determine the **average speed** of the first filter dropped. Is this an example of free fall? (Show your work)

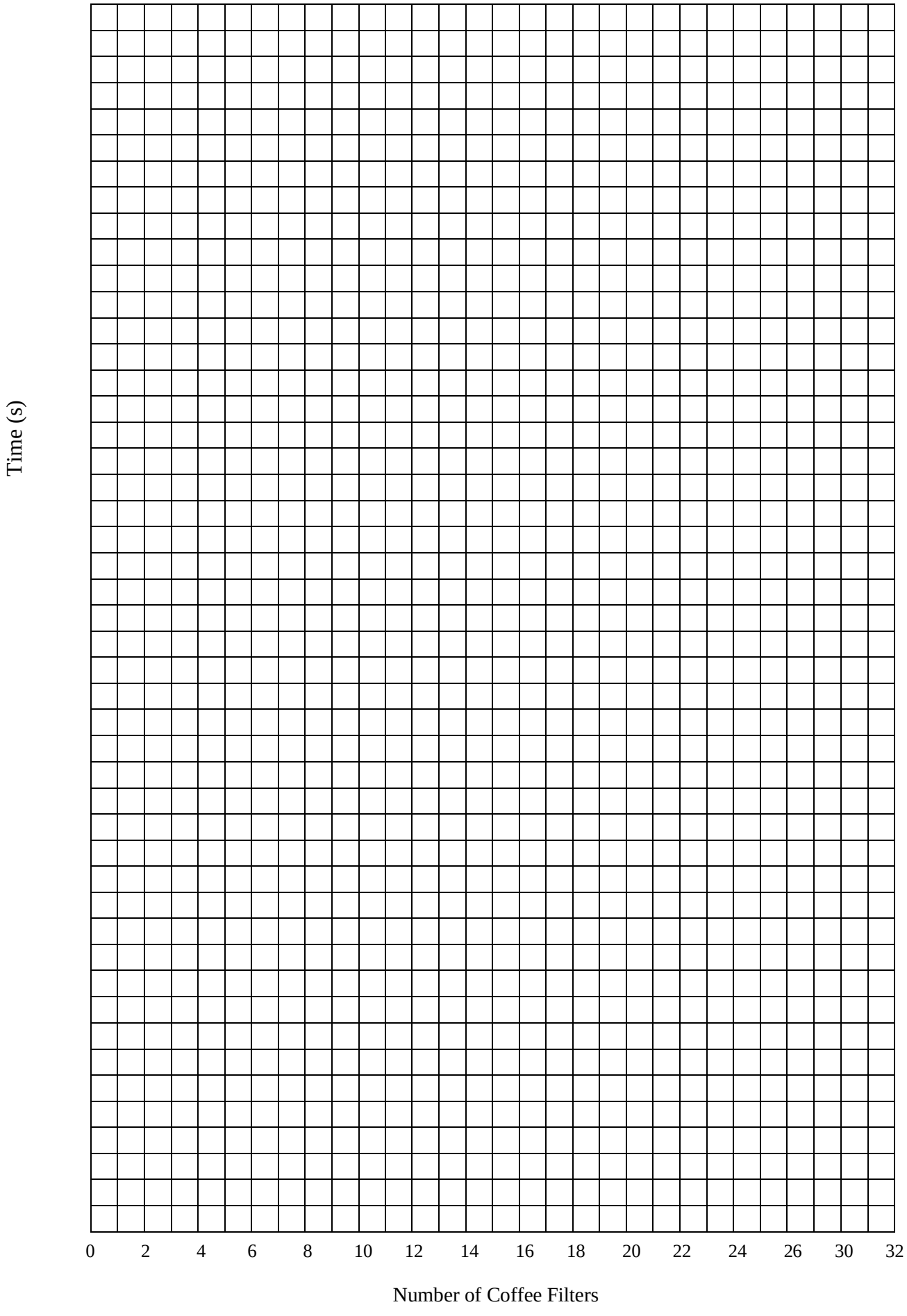
6. According to the measured data, about how many nested falling coffee filters are needed to achieve free fall? How do you know?

7. What time is expected (extrapolate from your graph) for 32 nested coffee filters to fall the drop distance? Explain why 32 nested filters are not slowed by air resistance.

8. What acts to slow 1 falling coffee filter so it does **NOT** free fall in gravity? Explain how air acts when it slows the fall of a coffee filter. Draw vectors to describe

9. Why was it important to keep the coffee filters "nested" together when you began increasing number of filters?

10. How can this activity be improved (what are possible sources of error)?


Time (s)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
30
32
Number of Coffee Filters