Name: ______________________ Date: __________________

Partners: _____________________

"Front Bench" Capacitor Labs

Exercise 1: "Look before you Leap"

You'll be working with a variable air capacitor, of the sort shown in Fig. P26.6 on page 746 of your text. Therefore:

a) …some members of your group should work problem # 26.6,

b) …while other members try to obtain approximate values for the plate radius, *R*, and plate spacing, *d*, for the particular type of variable air capacitor sitting at your lab table. [Note: whenever you remove screws from *anything*, you should have a place to keep them, such as a jar or a lid. Whenever possible, put the screws back where they belong *immediately*, so that you don't lose track of them! Also, there is no need to tighten these screws very much: *over*-tightening does damage!]
Take great care to ensure that your actions to not result in *bending* the "plates" of the capacitor. [Don't set the capacitor down on its plates! Don't contaminate plates!]

c) Using the results above, you should be able to **record** an estimate of the numerical value for the maximum capacitance *before* taking any electrical measurements:

Lab 1: Capacitance vs. Effective Plate Area

In the first part of this lab, you will measure the capacitance how capacitance scales with plate area (*i.e.*, you will really measure C as a function of the angle of rotation, θ).

It is *essential* that you

ALWAYS discharge any capacitor *before* connecting it to a capacitance meter

(Failure to do so will destroy the meter.)

a) Adjust the angle of rotation, θ, while the capacitor is connected to the meter. – On one meter there is a tenuous contact: you may have to gently "fiddle" with it if you to not find a C_{max} of roughly the value you expect.

b) Tabulate your measurements of C as a function of the angle of rotation, θ, and plot (and fit) your results.

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Lab 2: Parallel, Series, and "Neither" Combinations

1) Measure the individual capacitance of each of the three capacitors on your breadboard:

#	Nominal *C* (see package)	Measured *C*
1		
2		
3		

2) We say that two capacitors are connected in "series" when the same magnitude of charge will accumulate on each of their plates. Measure the total capacitance across any two of these hooked in series. Repeat with all three in series

Combination	Series *C* calculated from measured individual values	Measured Series *C*	% Error
$C_1 + C_2$			
$C_1 + C_3$			
$C_2 + C_3$			
$C_1 + C_2 + C_3$		-----------	

3) We say that two capacitors are connected in "parallel" when they have the same voltage difference across their plates. Measure the total capacitance across any two of these hooked in parallel. Repeat with all three in parallel.

Combination	Parallel *C* calculated from measured individual values	Measured C_{eff}	% Error
$C_1 + C_2$			
$C_1 + C_3$			
$C_2 + C_3$			
$C_1 + C_2 + C_3$		-----------	

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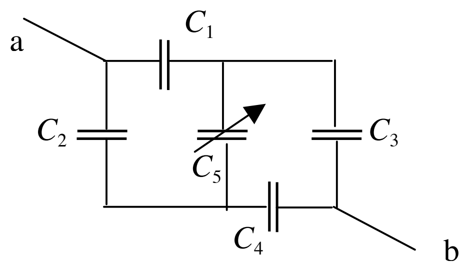
4) It is also possible that a collection of capacitors is *neither* connected in parallel or in series. Find two single capacitors, C_1 and C_2, in the 5 – 50 nF range. Try to construct an IDENTICAL MATCH for each of these by using the variable "Capacitor Decade Boxes" (or anything else!) to yield two effective capacitors, C_3 and C_4, with values that you make as close as humanly possible to those of the two single capacitors, C_1 and C_2.

Next, hook up the following circuit, where C_5 is another variable capacitor, with a median value on the same order of magnitude as the others:



Note that the circuit shown above is not, *in general*, a simple series or parallel combination. However, in the special case that I have very kindly led you to, where $C_1 = C_3$ and $C_2 = C_4$, then it *is* possible to think about some of the capacitors as being either in parallel or in series.

a) *Calculate* the effective capacitance between points *a* and *b* for several different values of C_5.

b) Now *measure* the effective capacitance between points *a* and *b* for several different values of C_5. Does your result depend upon the value of C_5 in the manner you predicted?

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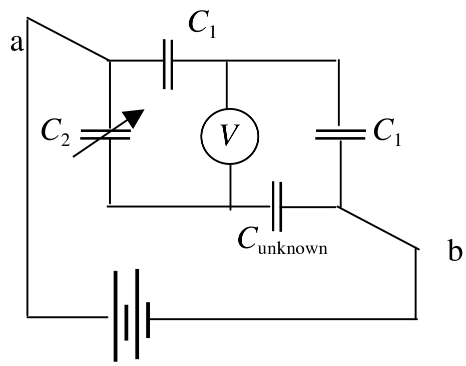
The rest is just wishful thinking: there isn't enough time to try it:

If you disconnect the capacitance meter and replace C_5 with a voltmeter, and apply a voltage difference across points *a* and *b*, then you can replace the discrete C_2 capacitor with an unknown capacitor. By adjusting the remaining C_2 decade box you can "find" the value of the unknown. Explain.



Try it! And compare your results to what you obtain via other methods:

This final circuit is called a "bridge circuit" and it plays an important role in the field of precision or low-level measurement (see Handout).

As time allows, you may:

5) Switch places with the "back benchers" and do the last part of their lab

6) Explore the temperature dependence of capacitance (ask Dr. Spalding for help).

6) Examine the capacitance per unit length of coaxial cable.