Name: _____
Student ID# _____

Physics 25 Lab Exam – SAMPLE (with answers)

Date: _____ Time: _____
Lab Instructor: _____

Instructions: *Work individually to complete each exercise to the best of your ability, show all your work, and clearly explain your answers in the spaces provided or on the back of these papers.*

Be sure to record all measurements (in SI units) and show all calculations. For items that require a numerical result, write your answer as you would for a formal lab report, including a meaningful ***label*** *to identify a value. Your answer will be graded based on the* ***accuracy*** *of your result and proper reporting of* ***uncertainty***, ***significant figures***, *and* ***units***.

Once the lab exam begins, you are not permitted to receive any assistance from your TA or other students. However, you may use your lab manual, graded lab reports, notes, and textbook as resources for this exam. The questions may be answered in any order, so adjust your work according to the availability of the lab equipment.

Honor Pledge: *All work presented here is my own.* _____

1. (5 pts.) An ammeter gives a reading of 1.867 mA. How should this current measurement be reported if the user's manual for the meter specifies an accuracy rating of ± 2% for DC currents in the range of 1 mA to 2 A?

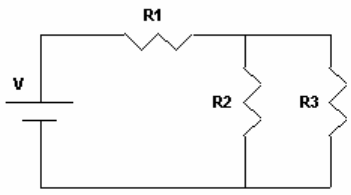
I = *1.87 ± 0.04 mA*

2. (5 pts.) A student uses a protractor to measure an angle to be $q = 85° \pm 1°$. What should she report for $\sin q$?

$\sin q$ = *0.996 ± 0.002*

3. (15 pts.) Connect the following circuit and measure the current through each resistor. Verify that $I_1 = I_2 + I_3$.

V = 12.0 V
R_1 = 300 Ω
R_2 = 1000 Ω
R_3 = 500 Ω



Using an ammeter with 2% accuracy rating:
I_1 = *18.8 ± 0.4 mA*
I_2 = *6.9 ± 0.1 mA*
I_3 = *12.3 ± 0.3 mA*
$I_1 = I_2 + I_3 = 6.9 + 12.3 = 19.2 \pm 0.4$ *mA*
Yes, they agree within uncertainty.

4. (15 pts.) Determine the cold and hot resistance of a light bulb when the current is near 0 and 0.1 A, respectively. Describe the procedure you used and show your calculations.

R_{cold} = *3.2 ± 0.5 W* *(measured with ohmmeter, 1% accuracy)*

R_{hot} = *49 ± 1 W* *(from simultaneous measurements of V and I at 0.1 A using multimeters with 1% accuracy)*

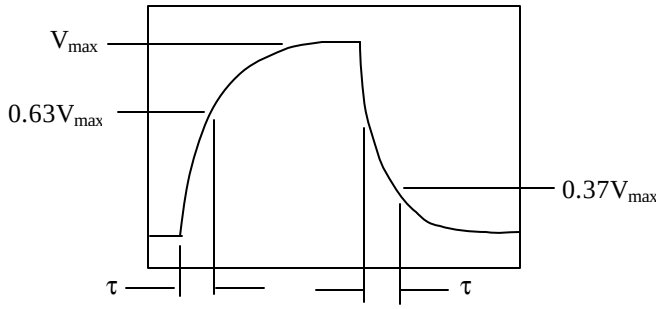
5. (15 pts.) Identify two resistors and connect them so that they provide the maximum and minimum possible resistance. Calculate the expected value of the total resistance and its uncertainty for each case based on the 5% tolerance rating of each resistor. Use an ohmmeter to measure and report the resistance in each case and compare with the expected values.

$R_1 = 470 \pm 24\ \Omega$, $R_2 = 510 \pm 26\ \Omega$

Expected from calculation:
R_{max} *(in series)* $= 980 \pm 35\ \Omega$
R_{min} *(in parallel)* $= 245 \pm 9\ \Omega$

Measured with ohmmeter, 1% accuracy:
$R_{max} = 995 \pm 10\ \Omega$ - *Agrees with expected*
$R_{min} = 252 \pm 3\ \Omega$ - *Agrees with expected*

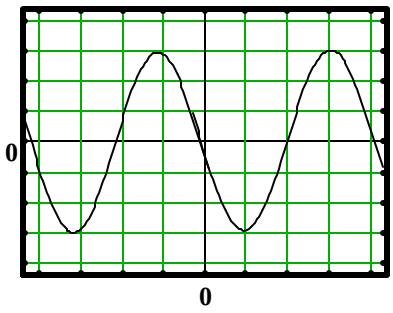
6. (15 pts.) Use an oscilloscope to measure the time constant for an RC circuit consisting of a 5600 Ω resistor and an unknown capacitor. Your measurement should be as accurate as possible with the available equipment. Sketch the oscilloscope screen and the trace displayed, and show how you found the time constant from this graph. From the time constant, calculate and report your estimate of the value for C.



$t = \underline{1.27 \pm 0.06\ ms}$

$C = t/R = \underline{0.23 \pm 0.01\ nF}$

7. (10 pts.) An oscilloscope displays the trace below when the gain is set at 15 V/div and the sweep is set at 5 ms/div. Find the peak-to-peak voltage and frequency of the input signal. What value would be read by an AC voltmeter measuring this same signal?



Vpp $= \underline{90 \pm 3\ V}$
$f = 1/T = \underline{49 \pm 2\ Hz}$

A voltmeter would read the rms voltage:
*Vrms = Vpp/[2*sqrt(2)]* $= \underline{32 \pm 1\ V}$

8. (10 pts.) Use a light ray box to measure the focal length of a converging lens as accurately as possible. (Use the back of this page to trace the rays and make measurements.)

$f = \underline{10.4 \pm 0.3\ cm}$

9. (10 pts.) Determine the radioactive half-life from the following set of radioactive decay data taken at 30-second intervals: 221, 161, 137, 135, 127, 128, 102, 96, 81, 76, 82, 71, 68, 62, 58, 47, 55, 60, 49, 52, 48

Graph ln(counts-background) vs time, where background ~ 40. Half-life is then ln2/slope.

half-life $= \underline{1.8 \pm 0.1\ min}$