Name: ____________________
PID: ______________________
Date: ________ Time: _______
Instructor: _________________

Physics 117 Lab Practicum – SAMPLE (with answers)

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. 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 answers 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 other resources such as your lab manual, graded lab reports, sample lab exam, notes, and textbook. The questions may be answered in any order, so adjust your work according to the availability of the lab equipment, and* ***do not spend more than 15 minutes at any lab exam station*** *so that every student has an equal opportunity to complete the exercises. Record your start and stop times as indicated. When you are finished using any equipment,* ***disassemble all circuits*** *and move to an empty seat to allow other students access to the 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?

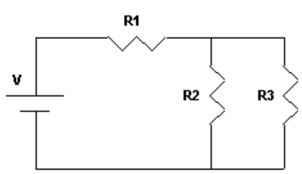
I = *(1.87 ± 0.04) mA* *(note that the current value is rounded to agree with the uncertainty)*

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

$\sin\theta$ = *0.996 ± 0.002* *(can use either propagation of uncertainty or upper-lower bound method)*

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:
$I_1 = (18.8 \pm 0.4)$ *mA*
$I_2 = (6.9 \pm 0.1)$ *mA*
$I_3 = (12.3 \pm 0.3)$ *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) Ω* *(measured with ohmmeter, 1% accuracy)*
R_{hot} = *(49 ± 1) Ω* *(from simultaneous measurements of V and I at 0.1 A using multimeters with 1% accuracy)*

5. (5 pts.) Describe how you could estimate the time constant for a laptop power supply with an LED that fades in brightness after it is unplugged.

The time constant for an RC circuit is the time it takes the voltage to drop exponentially to 37% of its original value. Assuming that the brightness of the LED is proportional to the voltage across the equivalent RC circuit within the power supply, the time constant could be estimated to be the time it takes the light to reach approximately 1/3 of its original brightness.

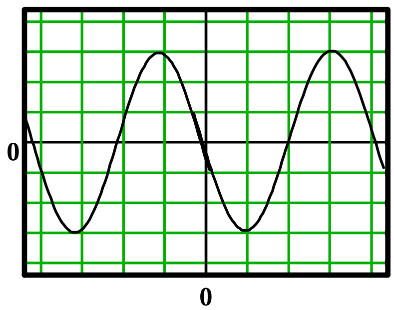
6. (15 pts.) Identify two resistors and connect them so that they provide the maximum and minimum possible resistance. Calculate the expected value of the total resistance and its uncertainty for each case based on the 5% tolerance rating of each resistor. Use an ohmmeter to measure and report the resistance in each case and compare with the expected values.

$R_1 = (470 \pm 24)\ \Omega$, $R_2 = (510 \pm 26)\ \Omega$ (nominal resistance identified from color code chart)

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

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 = (90 ± 3) V

f = 1/T = (49 ± 2) Hz

A voltmeter would read the rms voltage:
*Vrms = Vpp/[2*sqrt(2)] = (32 ± 1) V*

8. (10 pts.) Use a function generator and oscilloscope to find the resonance frequency of an LCR circuit using the unmarked inductor and capacitor provided. Explain the procedure you used.

fo = (3.64 ± 0.02) kHz This result was found by observing the voltage across the resistor displayed on the oscilloscope while varying the frequency from the function generator and identifying the frequency that produced the maximum voltage. The uncertainty was estimated by approaching this resonance peak from above and below to find the approximate upper and lower limits.

9. (10 pts.) Describe how to use a Hall probe to measure the magnetic field inside and outside of a solenoid.

First, check to make sure the Hall probe is working properly (zeroed and calibrated) by rotating the probe in the Earth's magnetic field and verifying that the measurements vary from about +0.5 G to -0.5 G as expected. Then position the probe near the middle of the solenoid so that the flat paddle is perpendicular to the axis of the solenoid. This should give the maximum reading of the magnetic field, which should be relatively uniform within the coil. Holding the probe in a similar position outside of the solenoid should give a much smaller reading (especially farther away) with opposite sign to indicate that the magnetic field points in the opposite direction.

10. (10 pts.) Use a HeNe laser and a ruler to find the spacing between adjacent tracks on a CD (compact disc), and describe the procedure you used.

d = *$(1.51 \pm 0.07)\ \mu m$, which agrees with the industry standard of 1.6 microns for the pitch of a CD*

The CD was used as a reflection grating by pointing a laser normal to its surface and measuring the angles to the first order maxima. These angles and the known wavelength of the laser (632.8 nm) were used to compute the track spacing, d, from the diffraction grating equation: $d\sin(\theta) = \lambda$.

Note: This measurement could be made with a laser pointer, but there would be slightly more uncertainty in the result because the wavelength of a diode laser is not known as precisely as for a gas laser.