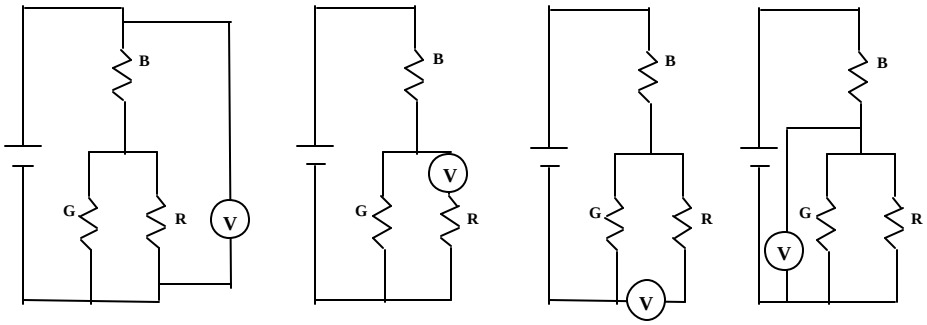
PHYSICS 212 CHECK-OUT QUESTIONS
Laboratory 13: Circuits

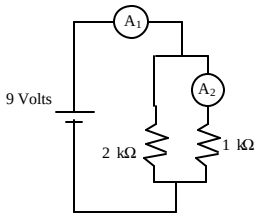
1. Which diagram below shows a correct placement of a voltmeter to measure the voltage across the Red resistor? (R = Red, B = Blue, G = Green) Circle the correct diagram.



Suppose the resistances are such that $R_G = 2R_R = 3R_B$, and the current through the Green resistor is 0.14A. Determine the current through the Red resistor. Show all your work or explain reasoning.

2. The diagram at right shows a circuit composed of a battery and two resistors with values as given in the diagram. Two ammeters A_1 and A_2 are also placed in the circuit to measure currents.

Determine the current measured by ammeter A_1.

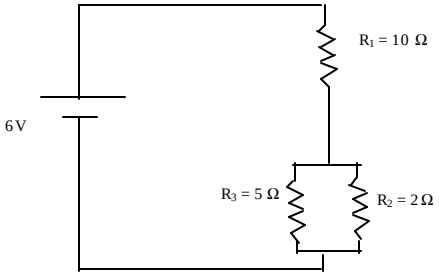


Determine the current measured by ammeter A_2.

PHYSICS 212 CHECK-OUT QUESTIONS
Laboratory 13: Circuits

3. Consider the following circuit:

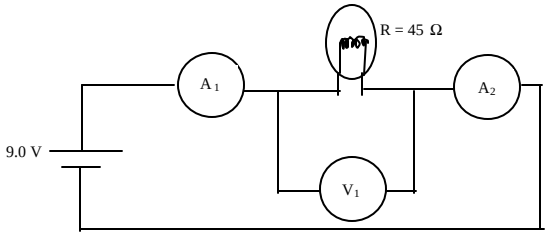
a) Determine the potential difference across R_1 if the current through R_1 is equal to 0.525 A.



b) Determine the current through R_3.

c) How would you place an ammeter in the circuit to measure the current through R_3? Show this by sketching the circuit including the ammeter.

4. Consider the following circuit, which contains a light bulb and a battery that supplies a constant potential difference. Several ammeters and voltmeters are wired into the circuit as shown.



a) Determine the reading on voltmeter V_1.

b) Determine the reading on ammeter A_1.

c) Determine the reading on ammeter A_2.

PHYSICS 212 CHECK-OUT QUESTIONS
Laboratory 14: Charged Particles in Fields

1. In the e/m for electrons lab, you observed a circular path of electrons as they passed through a glass gas-filled tube in a magnetic field. What would happen to the radius of this path if you made the following independent changes?

a) Increasing the accelerating voltage would make the radius

increase decrease stay the same

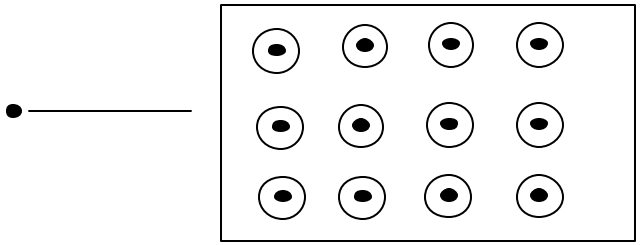
b) Increasing the Helmholtz current (i.e., the current in the large outer coils) would make the radius

increase decrease stay the same

c) Magically doubling the electron mass would make the radius

increase decrease stay the same

2. An electron is shot through a region of magnetic field out of the page, as shown in the picture.



a) On the diagram above, draw the path of the electron as it enters the region of magnetic field.

b) Circle your answer to each of the following statements.

(i) If the magnetic field is doubled the radius of curvature for the electron will increase: True False

(ii) A neutron will curve upward: True False

(iii) An electron and proton have a different radius of curvature: True False

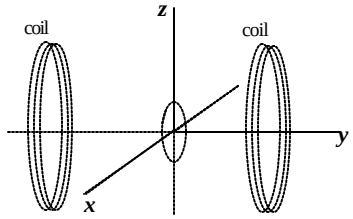
3. In an experiment to measure e/m for an electron, the following five values are obtained:

	e/m (C/kg)
	1.7488×10^{11}
	1.7507×10^{11}
	1.7533×10^{11}
	1.7473×10^{11}
	1.7519×10^{11}
Average =	1.7504×10^{11}
Std dev =	2.1410×10^{8}

a) In your conclusion, how would you write your value of e/m including the uncertainty?

b) Is this data consistent with the actual value of 1.7588×10^{11} C/kg? Explain why or why not.

4. Consider the illustrated path of electrons traveling in the region between two current-carrying coils of wire.



a) Indicate the direction of the magnetic field produced by the current in the coils at the origin of the coordinate system in the above diagram. (Circle one)

$+x$ $-x$ $+y$ $-y$ $+z$ $-z$

b) Starting with Newton's second law, derive an equation for the radius of the electron's path R in terms of the magnetic field strength B, the velocity of the electrons v, the mass of the electrons m, and the charge of the electrons q.

PHYSICS 212 CHECK-OUT QUESTIONS
Laboratory 15: Motors and Generators

1. A wire hooked up to a battery is placed into a magnetic field as shown in the figures below.

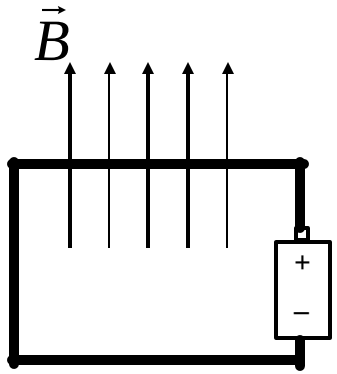


Figure A

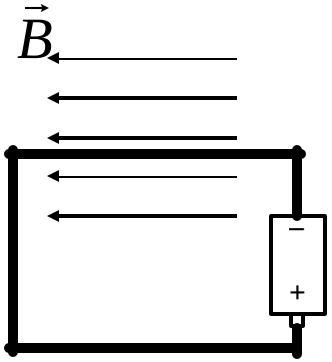


Figure B

a) For Figure A, which of the following is correct for the direction of the magnetic force exerted on the wire in magnetic field? Circle one.

Up	**Left**	**Into Page**	**No Force**
Down	**Right**	**Out of Page**	**Can't be determined**

b) For Figure B, which of the following is correct for the direction of the magnetic force exerted on the wire in magnetic field? Circle one.

Up	**Left**	**Into Page**	**No Force**
Down	**Right**	**Out of Page**	**Can't be determined**

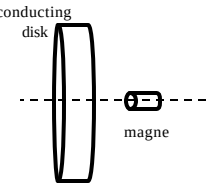
2. In preparing the coil for the simple motor, you were careful to sand only half the axles. Your friend accidentally sanded the axles all the way around and got some different results than you when the circuit was connected. What kinds of motion might you expect to see with your friend's coil?

3. A conducting disk lying flat in the plane of this page can rotate about its axis. A uniform magnetic field points into the plane of the page. A battery connected to the disk by wires allows current to flow either from the center of the disk out to the edge or from the edge of the disk in towards the center. When current flows through the disk, it rotates clockwise.

a) Is the current flowing from the center of the disk to the edge of the disk or from the edge of the disk to the center? Briefly explain.

b) What are two changes you could make that would cause the disk to rotate counter-clockwise?

4. A conducting disk and a cylindrical bar magnet have their axes aligned as shown in the figure. For each of the following cases, what is true about the potential difference generated in the conducting disk?



a) The conducting disk is rotated about its axis while the magnet is held fixed:

Potential difference generated in disk **No potential difference generated in disk**

Not enough information to tell

b) The magnet is rotated about its axis while the conducting disk is held fixed:

Potential difference generated in disk **No potential difference generated in disk**

Not enough information to tell

c) Both the conducting disk and the magnet are rotated about their mutual axis at the same rate:

Potential difference generated in disk **No potential difference generated in disk**

Not enough information to tell

PHYSICS 212 CHECK-OUT QUESTIONS
Laboratory 16: Interference of Light

1. Your lab partner yanks a hair out of your head and shines a laser across it. You notice that it makes a line of bright and dark spots on a distant background screen, and the width of the bright spots is 5 mm. After the bleeding stops, you decide to return the favor, yank a hair out of your partner's head, and repeat the experiment exactly. You notice, however, that the width of the bright spots is only 2.5 mm when using your lab partner's hair.

a) Who has thicker hair, you or your lab partner?

b) How many times thicker is the thicker strand of hair? Circle the best answer:

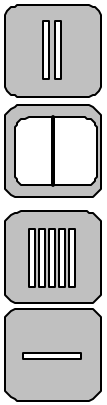
(i) 2.0 (ii) 2.5 (iii) 4.0 (iv) 8.0

2. The figure below shows the pattern on a screen when laser light is illuminates a single slit with width 0.02 mm. In the space below, draw the pattern that you would expect if light illuminates a **double** slit arrangement, where each slit has a width of 0.01 mm and the spacing between the centers of the slits is 0.100 mm.

Pattern with single slit with width 0.02 mm

3. You illuminate several different slides with laser light and noted the resulting intensity patterns produced on a distant screen. For each of the following slides, identify the best corresponding intensity pattern from the list of patterns **A** through **F** given below. Also be sure to circle the appropriate *orientation* of the pattern

	Pattern Choice	Orientation	
a) double slit	A B C D E F	horizontal	vertical
b) a single hair	A B C D E F	horizontal	vertical
c) a 5-slit arrangement	A B C D E F	horizontal	vertical
d) a single slit	A B C D E F	horizontal	vertical



Pattern Choices (Note: grey indicates a bright spot)

A

B

C

D

E

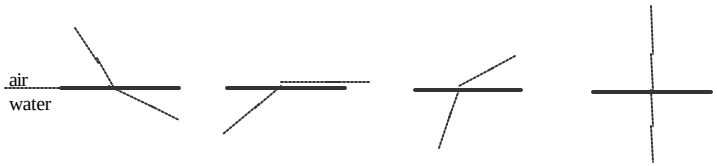
F

PHYSICS 212 CHECK-OUT QUESTIONS
Laboratory 17: Refraction of Light

1. This question involves propagation of light across an interface.

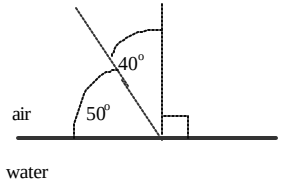
a) Circle all of the following diagrams which correctly illustrate the approximate path light could take in trave ling between two points on the opposite (or same) side of an air-water interface:

A. **B.** **C.** **D.**



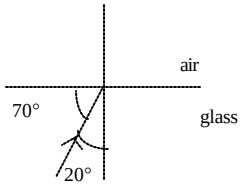
b) Use Snell's Law to calculate the correct angle of the refracted ray for light traveling through air which is incident onto water as shown below. Use these values of the indices of refraction: n_{air} = 1.00; n_{water} = 1.33.

Show your work including a sketch indicating the refracted ray and the angle of refraction.



Angle of refracted ray = ☐

2. Consider a beam of light traveling from glass to air as shown in the figure. The index of refraction of this glass is 1.55. When light strikes the interface, some light is transmitted and some light is reflected.

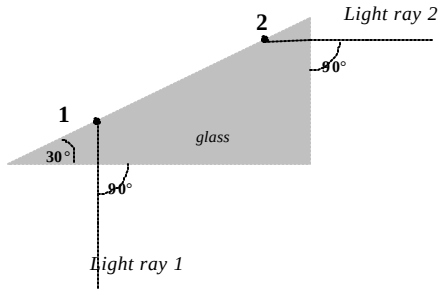


a) Calculate the direction of the transmitted light and the reflected light, and label these carefully on the diagram.

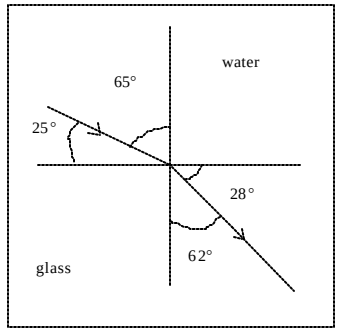
b) Determine the minimum incident angle necessary for the re to be no transmitted light.

3. Consider the glass prism shown in the diagram as viewed from above as it sits on a laboratory table. The refractive index of glass is 1.50 and the refractive index of the surrounding air is 1.00.

Using Snell's Law and your other knowledge of the propagation of light through different materials, sketch all reflected and/or transmitted rays occurring at points 1 and 2. Calculate and label all ray angles with numerical values.



4. Consider light traveling from water into glass, as shown. The refractive index of water is 1.34.



a) Calculate the refractive index of the glass to two decimal places.

b) Under which of the following cases is total internal reflection possible? Circle the appropriate case.

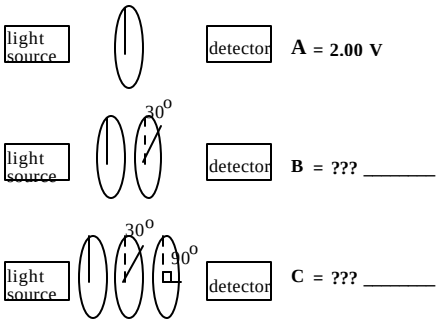
i) Light travelling from water to glass.

ii) Light travelling from glass to water.

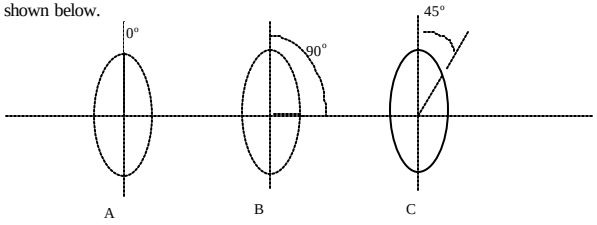
iii) Light travelling from water to glass and from glass to water.

PHYSICS 212 CHECK-OUT QUESTIONS
Laboratory 18: Polarization States of Photons

1. Assume we have ideal polarizers; that is, the polarizers transmit 100% of the incident light that is correctly polarized. Consider the arrangement of polarizers shown below. If the voltage of the photodiode detector in situation A is 2.00V, determine the correct voltage reading for situations B and C below.

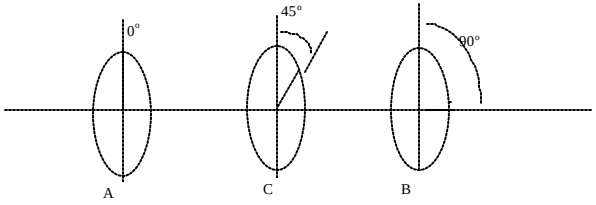


2. Three ideal polarizers are shown in the diagrams below. The transmission axis of polarizer A is at an angle of 0^o with respect to the vertical; polarizer B at an angle of 90^o with respect to the vertical; and polarizer C at an angle of 45^o with respect to the vertical. They are arranged in the order shown below.



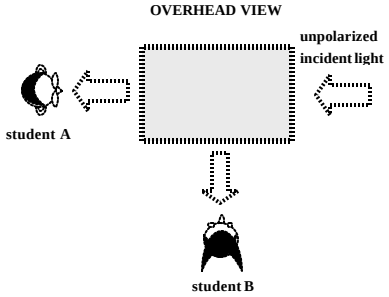
a) The intensity of the light which makes it through polarizer A is I_0. What is the intensity of any light that it makes it through the last polarizer, polarizer C (in terms of I_0)?

Now consider polarizers B and C switched to the different order shown below.

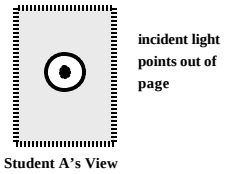


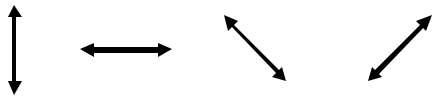
b) The intensity of the light which makes it through polarizer A is I_0. What is the intensity of any light that it makes it through the last polarizer, polarizer B (in terms of I_0)?

3. Unpolarized light passes through a tank filled with a water/creamer mixture, and is observed by two students. Student A, who is looking at the tank along the direction of the incident light, observes light coming directly towards him. Student B, who is looking at the tank from the side (with respect to the incident light,) observes light coming directly towards her.



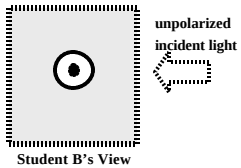
a) Student A looks at the light coming towards him through a polarizing filter. What orientation of the ***transmission axis*** of the polarizer would result in the most noticeable **dimming** of this light? (Circle one.)

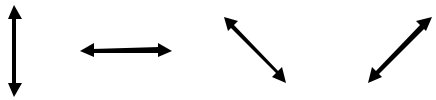




no noticeable dimming

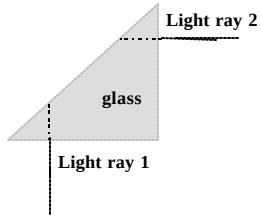
b) Student B looks at the light coming towards her through a polarizing filter. What orientation of the ***transmission axis*** of the polarizer would result in the most noticeable **dimming** of this light? (Circle one.)





no noticeable dimming

4. Consider the glass prism shown in the diagram as viewed from above as it sits on a laboratory table.



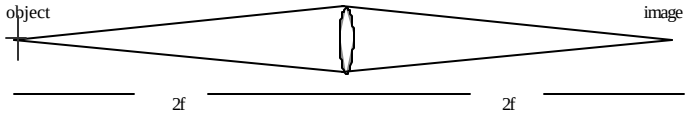
Suppose the electric field vector associated with light ray 1 is polarized in a direction perpendicular to the page (i.e., the electric field vector oscillates in and out of the page) and the electric field vector associated with light ray 2 is polarized in a direction parallel to the page and perpendicular to the direction of light ray 2. Viewing the prism as shown in the figure, which light ray will appear brighter due to the scattering of light from the molecules in the glass? Explain your answer.

Ray 1 **Ray 2** **Both Rays Equally Bright**

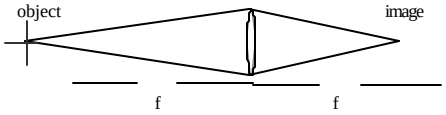
PHYSICS 212 CHECK-OUT QUESTIONS
Laboratory 19: Lenses and Imaging

1. Using the lens equation, determine if the following ray diagrams are possible. Word descriptions are included for clarity. Circle either **TRUE** or **FALSE**.

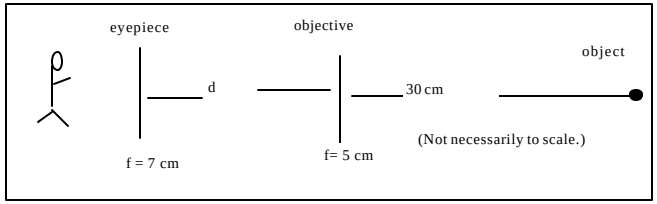
a) An object located at twice the focal length in front of a lens will have a sharply-focused image at the same distance beyond the lens: **TRUE** **FALSE**



b) An object located at a distance greater than the focal length in front of a lens will have a sharply-focused image at a distance less than the focal length beyond the lens:
TRUE **FALSE**



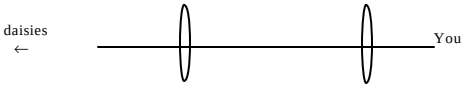
2. The figure below shows a crude telescope similar to the one you made in lab. The focal length of each lens is indicted in the diagram.



a) How many centimeters to the left of the objective is the image formed by the objective?

b) What should be the distance ***d*** for best focussing of the object (i.e., the rays come out of the eyepiece approximately parallel or collimated)?

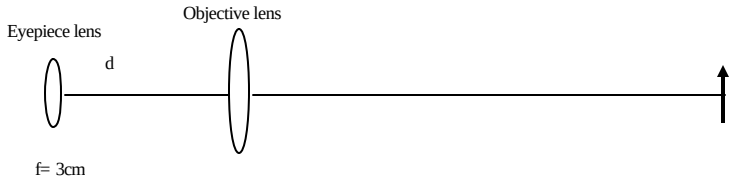
3. You decide to make a telescope to view the daisies in a distant field. You have two converging lenses at your disposal, one of focal length 20 cm, and one of 70 cm. Explain how you should position the lenses so as to optimize the performance of your telescope. Discuss the relative separation of the lenses, and the order in which they are placed.



Your friend is using a small telescope to watch a football practice from his fraternity room. A small bird lands in the apple tree next to his window. He tries to identify the bird, but it appears blurry. How must he adjust his telescope to see the bird clearly?

A. Move entire telescope closer to the bird.
B. Decrease the separation of the eyepiece and objective lenses.
C. Increase the separation of the eyepiece and objective lenses.
D. Clean the eyepiece lens of his telescope.
E. Smear peanut butter on the objective lens.

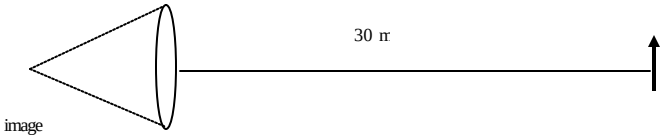
4. Given the telescope configuration given below.



a) Consider the object to be very far away from the objective lens. How far apart should the eyepiece and the objective lens be placed for a clearly focused image?

d= ☐

Consider just the objective lens from above.



b) If the object is now moved from 30 m to 10 m away, the image distance will:

Increase Decrease Stay the same

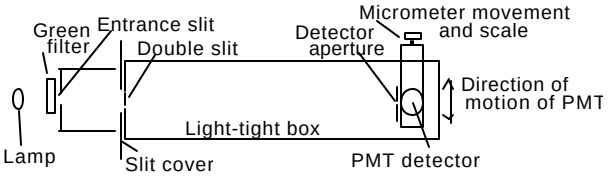
PHYSICS 212 CHECK-OUT QUESTIONS
Laboratory 20: Wave-Particle Duality

1. In the wave-particle duality lab, what was the evidence you found that

a) light can be thought of as a wave?

b) light can be thought of as a bunch of particles?

2. In the wave-particle duality experiment, you investigated the intensity pattern produced by photons passing through two slits and detected by a PMT detector as in the figure below.



For each of the following statements, circle if they are true (T) or false (F).

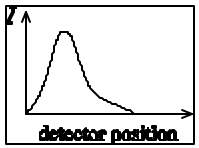
a) An interference type result was obtained with both slits open because a photon going through one slit interferes with a photon going through the other slit. T F

b) At any given detector position, the number of particles detected with both slits open is approximately the sum of the number detected with just slit #1 open and the number detected with just slit #2 open. T F

c) The light seems to behave like particles at the slits and like waves at the detector. T F

d) The observed interference pattern supports the argument that light behaves like a particle. T F

3. To test wave-particle duality of photons, light is first sent through a double-slit apparatus with the **right slit closed.** The following intensity plot results:



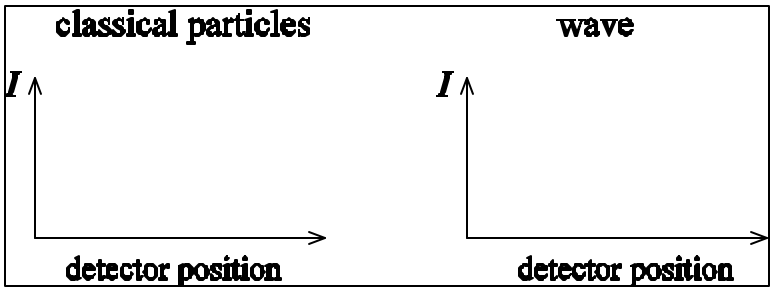
a) On the basis of this data, what can you conclude? (Choose one.)

i) Light behaves like particles, with no interference;

ii) Light behaves like a wave, with interference;

iii) Not enough information to choose between i) and ii).

b) You now send the light through **both** slits. In the space provided below, sketch what the intensity would look like if light were made up of **classical** particles, and then what the intensity would look like if light behaved as a **classical** wave.



c) Indicate the plot that best matches what you observed.

PHYSICS 212 CHECK-OUT QUESTIONS
Laboratory 21: Counting Statistics

1. Chris measured the number of gamma rays emitted in one second from a radioactive cobalt source and found that the average count rate was 1092 counts/sec. Cobalt has a very long half life. Shawn is about to repeat this same experiment. Predict the count rate that Shawn should measure and place your answer in the boxes below.

count rate: [ ] ± [ ] counts/sec

2. A detector measures gamma rays produced each second from a radioactive sample which has a very long half-life, i.e., 30 years. With 100 measurements, the average count rate per second is found to be 243. What is the expected value (with uncertainty) for the 101st measurement?

3. In the geologically active region known as "Shaker Valley," seismologists have been carefully monitoring the frequency of earthquake tremors for the past sixty-two years, and recorded an average of eleven tremors each year. In 1997, the region experienced nine tremors, while in 1998, seismologists a total of eight was recorded. In 1999, fourteen tremors were monitored. It was also the first year in which a multi-national oil company began drilling in the area. Can you legitimately conclude that the increased seismic activity in 1999 was due to the oil drilling? Explain your reasoning.

4. An astronomer is searching for evidence of bright supernova explosions in a distant galaxy. To make the measurement, she connects a photomultiplier tube (PMT) to the focus of a telescope and measures the PMT counts at a sampling frequency of one measurement every second. She observes the galaxy M51 for ten minutes and measures an average count rate of 1012 counts/second and a maximum count rate of 1024 counts/second.

The astronomer would like to know whether the maximum count rate constitutes a significant brightening of the galaxy above its average brightness. Consider the counts collected by the photomultiplier tube to be random events.

a) What is the expected uncertainty in the average count rate?

b) Can she claim a detection of significant brightness increase? Give the reason for your answer in a single sentence.

5. Two different lab groups measure the number of gamma-rays detected from the same long-lived radioactive source as in the "Counting Statistics" lab. Each group measures the total number of counts in a five minute interval using the same equipment. One group measures 4865 counts and the other group measures 4797 counts.

Are the two measurements statistically consistent with one another? Explain.

PHYSICS 212 CHECK-OUT QUESTIONS
Laboratory 22: Radioactivity

1. You are monitoring a radioactive material that has been dumped in the forest behind your house. On May 12, 1990, you detected an average of 2.0×10^7 gamma particles each second when standing a distance 5 m from the material. On May 12, 1998, you measure the radioactivity again and detect an average of 2.5×10^6 gamma particles each second when standing 5 m from the material.

What is the half-life of the radioactive material? Express your answer in years.

2. You are given a radioactive sample which decays to the ground state via the emission of gamma rays. You collect the following data using a scintillation detector and counter-timer. Note that you have already subtracted the background radiation from all of your data.

time (sec)	detection rate (counts/sec)
0	2,392
10	1374
20	789
30	453
40	260
50	150
60	86

The half-life of this substance is _____.

3. The rate of gamma-ray emission from a radioactive source is measured at two different times, as summarized in the table below. From this data, estimate the half-life of the radioactive source. (Show all work for full credit.)

Time(sec)	**Counting Rate**
5	16,000
17	4,000

4. A radioactive sample in the lab was measured to have an initial count rate of 10,000 counts/sec at the beginning of the lab. The sample has a known half-life of 12 minutes.

a) Estimate the count rate of the sample after 24 minutes. Circle the best answer.

1000 counts/sec 1250 counts/sec 2403 counts/sec 2500 counts/sec 2635 counts/sec

b) Estimate the count rate of the sample after 30 minutes. Circle the best answer.

1250 counts/sec 1705 counts/sec 1768 counts/sec 1875 counts/sec 2000 counts/sec

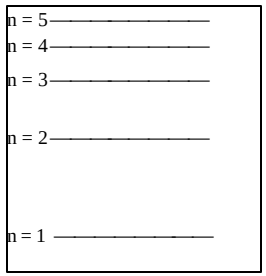
5. The following data was taken from a radioactive sample whose half-life is known to be quite long. The gamma-ray count rate has already had background subtracted.

Date	**Gamma-ray count rate (counts / sec)**
April 15, 1980	*16,000*
April 15, 1992	*4,000*

Based on this sparse data, determine an estimate (in years) for the half-life of this radioactive sample. Clearly explain your method of solution.

PHYSICS 212 CHECK-OUT QUESTIONS
Laboratory 23: Emission Spectra

1. In the emission spectrum lab, you observed a red, green and violet emission line from Hydrogen. Match up the observed line with the appropriate atomic transition. (See figure to the right for the energy levels of Hydrogen.)



a) Red line (circle one)

5 to 2 4 to 2 3 to 2 2 to 5 2 to 4 2 to 3

b) Green line (circle one)

5 to 2 4 to 2 3 to 2 2 to 5 2 to 4 2 to 3

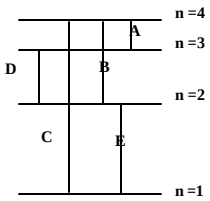
c) Violet line (circle one)

5 to 2 4 to 2 3 to 2 2 to 5 2 to 4 2 to 3

d) Briefly explain why you chose the answers that you did.

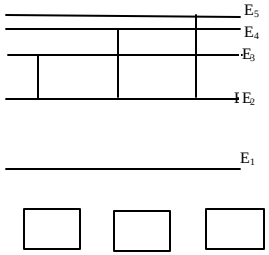
2. The wavelengths of the photons emitted by hydrogen can be determined experimentally using a spectrometer. The energy level diagram at right shows some of the transitions in hydrogen which give rise to photons.

Determine the wavelength of the photon emitted by the hydrogen atom when the transition corresponding to letter *B* occurs.



3. In the emission spectrum lab, we observed a red (656.3 nm), green (486.1 nm), and violet (434.0 nm) line from the spectrum of hydrogen.

On the energy diagram at right, indicate the corresponding transition in the blank boxes provided. Use the notation R,G,V for red, green, and violet respectively.

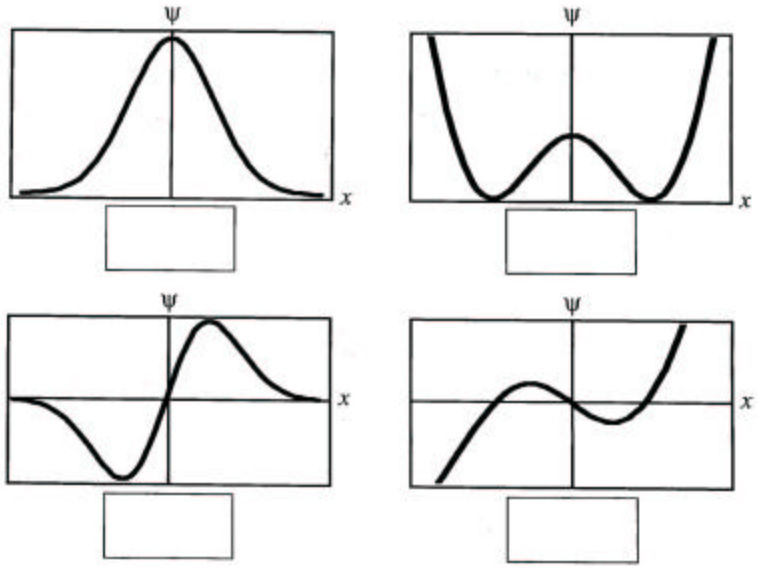


4. In the experiment "**Emission Spectra and Atomic Transitions**" a spectrometer was used to determine the wavelengths for three spectral lines in hydrogen (red, green, and violet). Data for this experiment is provided in the table below. The grating used in the experiment had a spacing d = 1.65 x10^{-6}m. Complete the table below by filling in the missing information. For the uncertainty calculation assume no uncertainty in the grating spacing (i.e. $\Delta d = 0$) and that the uncertainty in the measured angle is $\Delta\theta = \pm 0.05°$.

color	Diffraction angle $\theta_{average}$ (°)	Wavelength λ (nm)	Uncertainty $\Delta\lambda$ (nm)
	15.3		
green	17.2		
	23.4		

PHYSICS 212 CHECK-OUT QUESTIONS
Laboratory 24: Numerical Determination of Energy Levels

1. In the lab "Numerical Determination of Energy Levels," you determined the wavefunction as a function of distance for specific values of energy using the Schrödinger equation and stepping equations. The figures below are examples of the wavefunction as a function of distance generated from these equations.



For each of the figures, write the letter of ***any*** appropriate statement(s) in the box below each figure.

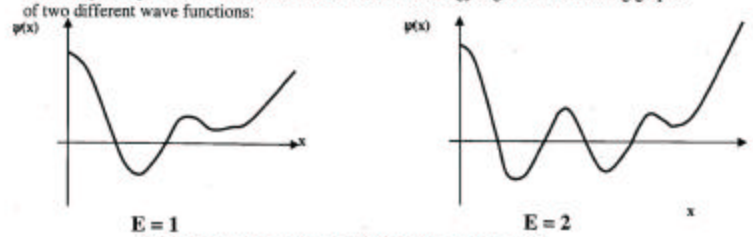
A The energy chosen for this solution of the Schrödinger equation produces a wavefunction which is not acceptable.

B This wavefunction corresponds to the first excited state.

C This wavefunction is not allowed because it cannot satisfy the condition $\int_{-\infty}^{+\infty} |\psi|^2 \, dx = 1$.

D This wavefunction corresponds to the lowest allowed energy.

2. Consider the simple harmonic oscillator potential $U = x^2$. A numerical integration of Schrödinger's equation with two indicated values of the energy E gives the following graphs of two different wave functions:



E = 1 **E = 2**

Of the following statements, circle the one that is TRUE.

There are no allowed energy levels in the range $1 \le E \le 2$.

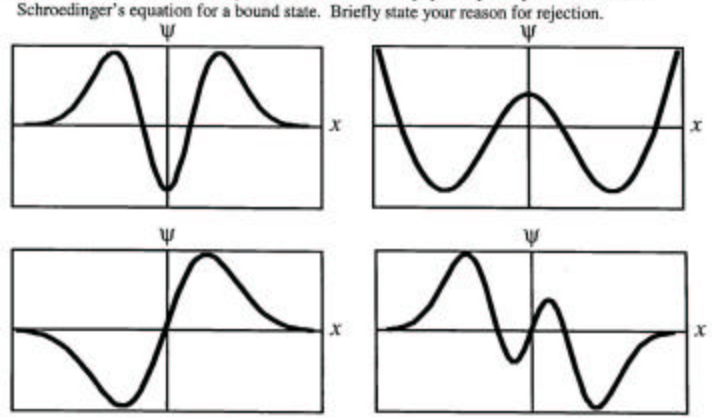
There is exactly 1 allowed energy level in the range $1 \le E \le 2$.

There are exactly 2 allowed energy levels in the range $1 \le E \le 2$.

There are more than 2 allowed energy levels in the range $1 \le E \le 2$.

It is impossible to tell how many allowed energy levels there are in the range $1 \le E \le 2$ from the given information.

3. Identify which of the following wavefunctions is not a physically acceptable solution to Schroedinger's equation for a bound state. Briefly state your reason for rejection.



Of the physically acceptable wavefunctions, identify the one which has the highest energy.