Problem 1:
A student makes 10 one-second measurements of the disintegration of a sample of a long-lived radioactive isotope and obtains the following values.
3, 0, 2, 1, 2, 4, 0, 1, 2, 5
How long should the student count to establish the rate to an uncertainty of 1 percent?
(A) 80 s
(B) 160 s
(C) 2,000 s
(D) 5,000 s
(E) 6,400 s

Problem 2:
Use the table below to answer the question that follows.

	Gun A	Gun B
Mean Distance	141.3 cm	138.5 cm
Standard Deviation	2.4 cm	3.1 cm

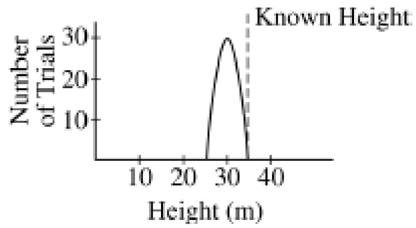
The table gives data on the horizontal distance traveled by a ball fired from two different spring guns under identical conditions. Which of the following statements best describes the data?
A. The data collected for gun A are more precise than the data collected for gun B.
B. The data collected for gun A are more accurate than the data collected for gun B.
C. The data collected for gun A show a greater random error than the data collected for gun B.
D. The data collected for gun A show a greater amount of experimental design error than the data collected for gun B.
E. None of the above.

Problem 3:
Consider a single-slit diffraction pattern for a slit of width d. It is observed that for light of wavelength 400 nanometers, the angle between the first minimum and the central maximum is 4×10^{-3} radians. The value of d is
(A) 1×10^{-5} m
(B) 5×10^{-5} m
(C) 1×10^{-4} m
(D) 2×10^{-4} m
(E) 1×10^{-3} m

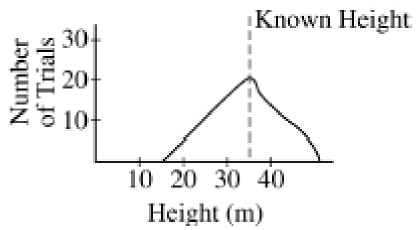
Problem 4:

Five classes of students measure the height of a building. Each class uses a different method and each measures the height many different times. The data for each class are plotted below. Which class made the most precise measurement?

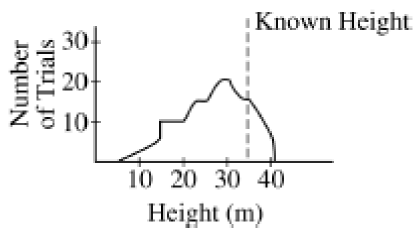
(A)



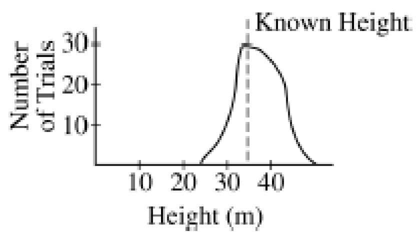
(B)



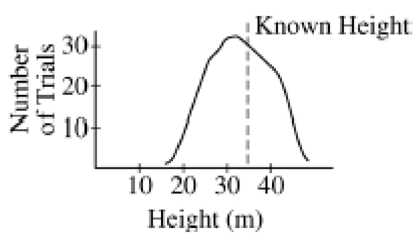
(C)



(D)



(E)

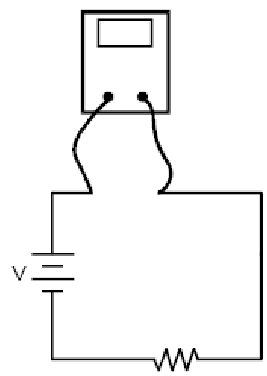


Problem 5:

A collimated laser beam emerging from a commercial HeNe laser has a diameter of about 1 millimeter. In order to convert this beam into a well-collimated beam of diameter 10 millimeters, two convex lenses are to be used. The first lens is of focal length 1.5 centimeters and is to be mounted at the output of the laser. What is the focal length, f, of the second lens and how far from the first lens should it be placed?

	f	Distance
(A)	4.5 cm	6.0 cm
(B)	10 cm	10 cm
(C)	10 cm	11.5 cm
(D)	15 cm	15 cm
(E)	15 cm	16.5 cm

Problem 6:



The meter in the circuit above is positioned to measure:

(A) charge stored in the resistor.
(B) current through the resistor.
(C) impedance of the resistor.
(D) potential difference across the resistor.
(E) inductance of the resistor

Problem 7:

Consider a single-slit diffraction pattern for a slit of width d. It is observed that for light of wavelength 400 nanometers, the angle between the first minimum and the central maximum is 4×10^{-3} radians. The value of d is

(A) 1×10^{-5} m

(B) 5×10^{-5} m

(C) 1×10^{-4} m

(D) 2×10^{-4} m

(E) 1×10^{-3} m

Problem 8:

A beam of 10^{12} protons per second is incident on a target containing 10^{20} nuclei per square centimeter. At an angle of 10 degrees, there are 10^2 protons per second elastically scattered into a detector that subtends a solid angle of 10^{-4} steradians. What is the differential elastic scattering cross section, in units of square centimeters per steradian?

(A) 10^{-24}
(B) 10^{-25}
(C) 10^{-26}
(D) 10^{-27}
(E) 10^{-28}

Problem 9:

The magnitude of the force F on an object can be determined by measuring both the mass m of an object and the magnitude of its acceleration a, where $F = ma$. Assume that these measurements are uncorrelated and normally distributed. If the standard deviations of the measurements of the mass and the acceleration are σ_m and σ_a, respectively, then σ_F/F is

(A) $\left(\frac{\sigma_m}{m}\right)^2 + \left(\frac{\sigma_a}{a}\right)^2$

(B) $\left(\frac{\sigma_m}{m} + \frac{\sigma_a}{a}\right)^{\frac{1}{2}}$

(C) $\left[\left(\frac{\sigma_m}{m}\right)^2 + \left(\frac{\sigma_a}{a}\right)^2\right]^{\frac{1}{2}}$

(D) $\frac{\sigma_m \sigma_a}{ma}$

(E) $\frac{\sigma_m}{m} + \frac{\sigma_a}{a}$