Lab Methods

Problem 1:

The Hall effect is used in solid-state physics to measure

(A) ratio of charge to mass
(B) magnetic susceptibility
(C) the sign of the charge carriers
(D) the width of the gap between the conduction and valence bands
(E) Fermi energy

Problem 2:

In experiments located deep underground, the two types of cosmic rays that most commonly reach the experimental apparatus are

(A) alpha particles and neutrons
(B) protons and electrons
(C) iron nuclei and carbon nuclei
(D) muons and neutrinos
(E) positrons and electrons

Problem 3:

A counter near a long-lived radioactive source measures an average of 100 counts per minute. The probability that more than 110 counts will be recorded in a given one-minute interval is most nearly

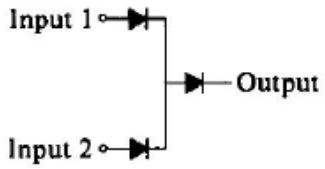
(A) zero.
(B) 0.001.
(C) 0.025.
(D) 0.15.
(E) 0.5.

Problem 4:

A beam of neutral hydrogen atoms in their ground state is moving into the plane of this page and passes through a region of a strong inhomogeneous magnetic field that is directed upward in the plane of the page. After the beam passes through this field, a detector would find that it has been

(A) deflected upward
(B) deflected to the right
(C) undeviated
(D) split vertically into two beams
(E) split horizontally into three beams

Problem 5:



If logical 0 is 0 volts and logical 1 is +1 volt, the circuit shown above is a logic circuit commonly known as

(A) an OR gate
(B) an AND gate
(C) a 2-bit adder
(D) a flip-flop
(E) a fanout

Problem 6:

An 8-centimeter-diameter by 8-centimeter-long NaI(Tl) detector detects gamma rays of a specific energy from a point source of radioactivity. When the source is placed just next to the detector at the center of the circular face, 50 percent of all emitted gamma rays at that energy are detected. If the detector is moved to 1 meter away, the fraction of detected gamma rays drops to

(A) 10^{-4}
(B) 2×10^{-4}
(C) 4×10^{-4}
(D) $8\pi \times 10^{-4}$
(E) $16\pi \times 10^{-4}$

Problem 7:

A sample of radioactive nuclei of a certain element can decay only by γ -emission and β -emission. If the half-life for γ -emission is 24 minutes and that for β -emission is 36 minutes, the half-life for the sample is

(A) 30 minutes
(B) 24 minutes
(C) 20.8 minutes
(D) 14.4 minutes
(E) 6 minutes

Problem 8:

An experimenter measures 9934 counts during one hour from a radioactive sample. From this number the counting rate of the sample can be estimated with a standard deviation of most nearly

(A) 100 (B) 200 (C) 300
(D) 400 (E) 500

Problem 9:

A proton beam is incident on a scatterer 0.1 centimeter thick. The scatterer contains 10^{20} target nuclei per cubic centimeter. In passing through the scatterer, one proton per incident million is scattered. The scattering cross section is

(A) 10^{-29} cm^2
(B) 10^{-27} cm^2
(C) 10^{-25} cm^2
(D) 10^{-23} cm^2
(E) 10^{-21} cm^2

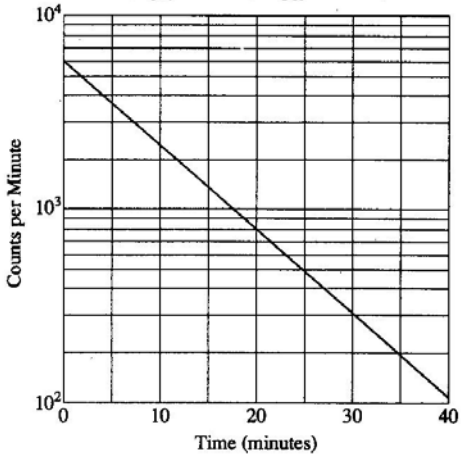
Problem 10:

In transmitting high frequency signals on a coaxial cable, it is important that the cable be terminated at an end with its characteristic impedance in order to avoid

(A) leakage of the signal out of the cable
(B) overheating of the cable
(C) reflection of signals from the terminated end of the cable
(D) attenuation of the signal propagating in the cable
(E) production of image currents in the outer conductor

Problem 11:

($\log_{10} 2 = 0.30$; $\log_{10} e = 0.43$)

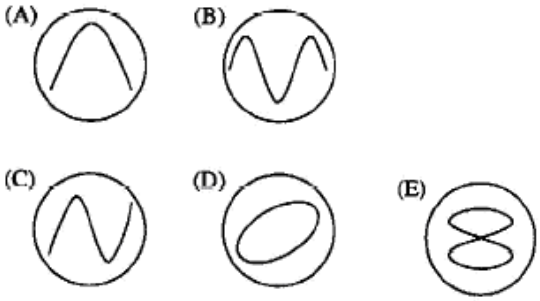


A radioactive nucleus decays, with the activity shown in the graph above. The half-life of the nucleus is

(A) 2 min
(B) 7 min
(C) 11 min
(D) 18 min
(E) 23 min

Problem 12:

The outputs of two electrical oscillators are compared on an oscilloscope screen. The oscilloscope spot is initially at the center of the screen. Oscillator Y is connected to the vertical terminals of the oscilloscope and oscillator X to the horizontal terminals. Which of the following patterns could appear on the oscilloscope screen, if the frequency of oscillator Y is twice that of oscillator X?



Problem 13:

Two horizontal scintillation counters are located near the Earth's surface. One is 3.0 meters directly above the other. Of the following, which is the largest scintillator resolving time that can be used to distinguish downward-going relativistic muons from upward-going relativistic muons using the relative time of the scintillator signals?

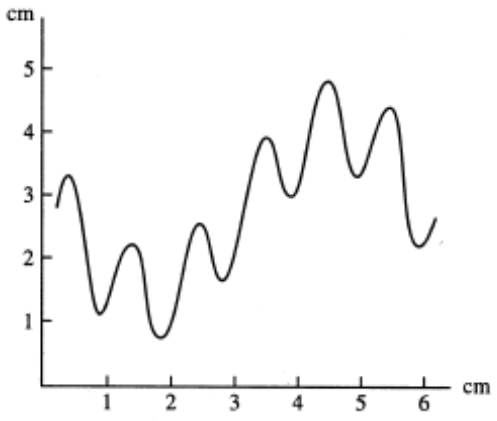
(A) 1 picosecond
(B) 1 nanosecond
(C) 1 microsecond
(D) 1 millisecond
(E) 1 second

Problem 14:

In laboratory experiments, graphs are employed to determine how one measured variable depends on another. These graphs generally fall into three categories: linear, semilog (logarithmic *versus* linear), and log-log. Which type of graph listed in the third column below would NOT be the best for plotting data to test the relationship given in the first and second columns?

Relation	Variables Plotted	Type of Graph
(A) $dN/dt \propto e^{-2t}$	Activity *vs.* time for a radioactive isotope	Semilog
(B) $eV_s = hf - W$	Stopping potential *vs.* frequency for the photoelectric effect	Linear
(C) $s \propto t^2$	Distance *vs.* time for an object undergoing constant acceleration	Log-log
(D) $V_{out}/V_{in} \propto 1/\omega$	Gain *vs.* frequency for a low-pass filter	Linear
(E) $P \propto T^4$	Power radiated *vs.* temperature for blackbody radiation	Log-log

Problem 15:



The figure above represents the trace on the screen of a cathode ray oscilloscope. The screen is graduated in centimeters. The spot on the screen moves horizontally with a constant speed of 0.5 centimeter/millisecond, and the vertical scale is 2 volts/centimeter. The signal is a superposition of two oscillations. Which of the following are most nearly the observed amplitude and frequency of these two oscillations?

	Oscillation 1	Oscillation 2
(A)	5V, 250Hz	2.5V, 1000Hz
(B)	1.5V, 250Hz	3V, 1500Hz
(C)	5V, 6Hz	2V, 2Hz
(D)	2.5V, 83Hz	1.25V, 500Hz
(E)	6.14V, 98Hz	1.35V, 257Hz