- 2. (9.17) The effect of machine breakdowns on the performance of a manufacturing system was investigated using computer simulation (Industrial Engineering, Aug. 1990). The simulation study focused on a single machine tool system with several characteristics, including a mean interarrival time of 1.25 minutes, a constant processing time of 1 minute, and a machine that breaks down 10% of the time. After n = 5 independent simulation runs of length 160 hours, the mean throughput per 40-hour week was $\overline{y} = 1,908.8$ parts. For a system with no breakdowns, the mean throughput for a 40-hour week will be equal to 1,920 parts. Assuming the standard deviation of the 5 sample runs was s = 18 parts per 40-hour week, test the hypothesis that the true mean throughput per 40-hour week for the system is less than 1,920 parts. Test using $\alpha = .05$.
- 4. (9.20) The EPA sets a limit of 5 parts per million on PCB (a dangerous substance) in water. A major manufacturing firm producing PCB for electrical insulation discharges small amounts from the plant. The company management, attempting to control the amount of PCB in its discharge, has given instructions to halt production if the mean amount of PCB in the effluent exceeds 3 parts per million. A random sampling of 50 water specimens produced the following statistics:

 $\overline{y} = 3.1$ parts per million s = .5 part per million

- (a) Do these statistics provide sufficient evidence to halt the production process? Use $\alpha = .01$.
- (b) If you were the plant manager, would you want to use a large or a small value for ex for the test in part (a)? Explain.
- 6. (9.22) Environmental Science & Technology (Oct. 1993) reported on a study of contaminated soil in The Netherlands. A total of 72.400-gram soil specimens were sampled, dried, and analyzed for the contaminant cyanide. The cyanide concentration (milligrams per kilogram of soil) of each soil specimen was determined using an infrared microscopic method. The sample resulted in a mean cyanide level of y = 84 mg/kg and a standard deviation of s = 80 mg/kg. Use this information to test the hypothesis that the true mean cyanide level in soil in The Netherlands falls below 100 mg/kg. Test at $\alpha = .10$.
- 8. (9.35) Environmental Science & Technology study (Oct. 1993) reported on a study of insecticides used on dormant orcards in the San Joaquin Valley, California. Ambient air samples were collected and analyzed daily at an orchid site during the most intensive period of spraying. The thion and oxon levels (in ng/m^3) in the air samples are recorded in the table, as well as the oxon/thion ratios. Compate the mean oxon/thion ratios of foggy and clear/cloudy conditions at the orchard using hypothesis. Use $\alpha = .05$.

Dat	te	Condition	Thion	Oxon	Oxon/Thion Ratio
Jan.	15	Fog	38.2	10.3	.270
	17	Fog	28.6	6.9	.241
	18	Fog	30.2	6.2	.205
	19	Fog	23.7	12.4	.523
	20	Fog	62.3	(Air sample]	Lost) -
	20	Clear	74.1	45.8	.618
	21	Fog	88.2	9.9	.112

22	год	135.9	44.0	. 330
23	Fog	102.9	27.8	.270
23	Cloudy	28.9	6.5	.225
25	Fog	46.9	11.2	.239
25	Clear	44.3	16.6	.375

10. (9.39) A field experiment was conducted to ascertain the impact of desert granivores (seedeaters) on the density and distribution of seeds in the soil (Ecology, Dec . 1979). Since some desert rodents are known to hoard seeds in surface caches, the study was specifically designed to determine whether these caches eventually produce more seedlings, on the average, than an adjacent control area. Forty small areas excavated by rodents were located and covered with plastic cages to prevent rodents from reusing the caches. A caged control area was set up adjacent to each of the caged caches. The numbers of seedlings germinating from the caches and from the control areas were then observed. A summary of the data is provided in the accompanying table. Is there sufficient evidence (at $\alpha = .05$)to indicate that the average number of seedlings germinating from the seed caches of desert rodents is significantly higher than the corresponding average for the control areas?

Caches Control Areas $n_1 = 40$ $n_2 = 40$ $y_1 = 5.3$ $s_2 = 2.7$ $s_1 = 1.3$ $s_2 = .7$

12. (9.42) Tetrachlorodibenzo-p-dioxin (TCDD) is a highly toxic substance found in industrial wastes. A study was conducted to determine the amount of TCDD present in the tissues of bullfrogs inhabiting the Rocky Branch Creek in central Arkansas, an area known to be contaminated by TCDD (Chemosphere, Feb. 1986). The level of TCDD (in parts per trillion) was measured in several specific tissues of four female bull frogs; the ratio of TCDD in the tissue to TCDD in the leg muscle of the frog was recorded for each. The relative ratios of contaminant for two tissues, the liver and the ovarie s, are given for each of the four frogs in the accompanying table. According to the researchers, the data set suggests that the [mean] relative level of TCDD in the ovaries of female frogs is higher than the [mean] level in the liver of the frogs. Test this claim using $\alpha = .05$.

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14. (9.44) Refer to the Journal of Environmental Engineering (Feb. 1986) study of winter heat loss in wastewater treatment clarifiers, **Exercise 8.40**. The data, reproduced in the table, were used to compare the mean daylong clear-sky solar radiation levels (in BTU/sq. ft.) at two midwest sites. ASAS printout for a test to compare the means follows. Interpret the results of the test.

Date		St. Joseph,	n, Mo. Iowa Great L	akes
December	21	782	593	
January	6	965	672	
January	21	965	672	

rediuary 21	1,414	1,220
March 7	1,633	1,462
March 21	1,852	1,698

- 18. (9.54) Every 10 years the Mechanics Division of ASEE conducts a nationwide survey on undergraduate mechanics education at colleges and universities. In 1985, 66 of the 100 colleges surveyed covered fluid statics in their undergraduate engineering program, compared to 43% in the 1975 survey (Engineering Education, Apr. 1986). Assuming that 100 colleges were also surveyed in 1975, conduct a test to determine whether the percentage of colleges covering fluid statics increased from 1975 to 1985. Use $\alpha = .01$.
- 20. (9.56) Home solar heating systems can be categorized into two groups, passive solar heating systems and active solar heating systems. In a passive solar heating system, the house itself is a solar energy collector, whereas in an active solar heating system, elaborate mechanical equipment is used to convert the sun's rays into heat. Consider the difference between the proportions of passive solar and active solar heating systems that require less than 200 gallons of oil per year in fuel consumption. Independent random samples of 50 passive and 50 active solar-heated homes are selected and the numbers that required less than 200 gallons of oil last year are noted, with the results given in the table. Is there evidence of a difference between the proportions of passive and active solar-heated homes that required less than 200 gallons of oil in fuel consumption last year? Test at a level of signific cance of $\alpha = .02$.

Number of homes	Number that required less	than 200 gallons	of oil last year
Paggive Solar	50	37	
Active Seler	50 E0	16	
ACLIVE SOLAL	50	40	

22. (9.62) Polychlorinated biphenyls (PCBs), used in the manufacture of large electrical transformers and capacitors, are extremely hazardous contaminants when released into the environment. The Environmental Protection Agency (EPA) is experimenting with a new device for measuring PCB concentration in fish. To check the precision of the new instrument, seven PCB readings were taken on the same fish sample. The data are recorded here (in parts per million):

 $6.2 \quad 5.8 \quad 5.7 \quad 6.3 \quad 5.9 \quad 5.8 \quad 6.0.$

Suppose the EPA requires an instrument that yields PCB readings with a variance of less than .1. Does the new instrument meet the EPA's specifications? Test at $\alpha = .05$.

23. (9.63) Refer to Exercise 9.35 (our 8). Recall that an Environmental Science & Technology study was conducted to compare the mean oxon/thion ratios at a California orchard under two weather conditions- foggy and clear/cloudy. Test the assumption of equal variances required for the comparison of means to be valid. Use $\alpha = .05$.

Date		Condition Thion		Oxon	Oxon/Thion Ratio
Jan.	15	Fog	38.2	10.3	.270
	17	Fog	28.6	6.9	.241
	18	Fog	30.2	6.2	.205
	19	Fog	23.7	12.4	.523
	20	Fog	62.3	(Air sample	lost) -
	20	Clear	74.1	45.8	.618
	21	Fog	88.2	9.9	.112

22	год	135.9	44.0	.330
23	Fog	102.9	27.8	.270
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25	Fog	46.9	11.2	.239
25	Clear	44.3	16.6	.375