

## Examples from old Exams (modified) - **Answers**

Gasoline stations are to be compared for total gasoline sales (in gallons). The sales are to be analyzed for the effectiveness of certain types of sales promotions. The sales promotion types are (1) gasoline reduced by 2 cents per gallon, (2) gasoline price not reduced but Coca cola is on sale, and (3) gasoline price not reduced but a free carwash with fill-up. Seven different stations (of 21 stations total) are allocated at random to each treatment and the variable of interest is total sales (gallons) in a 2-week period.

- What is the treatment arrangement for this experiment? (a) single factor
- What is the experimental design for this experiment? (a) CRD
- Does it seem to you that the treatments are fixed or random? (a) fixed
- What is the experimental unit for this experiment? Station
- What is the sampling unit for this experiment? Station
- If the design is RBD, what are the blocks? NA
- What are the degrees of freedom for the lowest level error?  $t-1=2$ ,  **$t(n-1)=18$**

As a Science Fair project, students sampled drinking fountains for bacterial growth. Forty fountains were chosen for sampling, where 20 of the fountains are simple fountains and the other 20 have water tanks with cooling devices. Half of each type of fountain (10 simple and 10 cooled) was washed a week before sampling to simulate regular cleaning while the other half of each fountain type were not cleaned. Each fountain was sampled and the sample incubated in a culture plate. The dependent variable was the number of bacterial colonies on each culture plate. The students would like to know if there are differences between the cooled and uncooled fountains and if cleaning helps reduce the bacterial levels.

- What is the treatment arrangement for this experiment? (b) factorial (2x2)
- What is the experimental design for this experiment? (a) CRD
- Does it seem to you that the treatments are fixed or random? (a) fixed
- What is the experimental unit for this experiment? Fountain = plate
- What is the sampling unit for this experiment? Fountain = plate
- If the design is RBD, what are the blocks? NA
- What are the degrees of freedom for the lowest level error?  $t-1=3$ ,  **$t(n-1)=36$**

A new standardized statistical test is being used to see if there are significant differences between individual classes and between universities in terms of the statistical abilities of graduate students. Four graduate level classes are chosen at random at each of 3 universities (12 classes in all). The classes are all life science "ecology" related classes. All classes discuss some statistics, but the course coverage and class content does not match at each university. Students in each class are given the test, and their scores are used as the variable of interest.

- What is the treatment arrangement for this experiment? (c) nested 3(4)
- What is the experimental design for this experiment? (a) CRD
- Does it seem to you that the treatments are fixed or random? Hard to tell for U
- What is the experimental unit for this experiment? Student
- What is the sampling unit for this experiment? Student
- If the design is RBD, what are the blocks? NA
- What are the degrees of freedom for the lowest level error?  $t-1=11$ ,  $t(n_i-1)=?$

A distributor of snacks and candies wants to compare Halloween sales of candy by small grocery stores in (1) urban, (2) suburban and (3) rural areas. He randomly chooses 15 stores in each area type, and asks them to report their mean daily sales for the week (7 days) preceding Halloween (one value per store). The stores are then asked to record the mean daily sales of candies during a week (7 days) for a period after Halloween for comparison. The variable of interest is the mean daily sales (for 7 days) of candies for each store.

- What is the treatment arrangement for this experiment? (a) single factor
- What is the experimental design for this experiment? (d) Repeated Meas
- Does it seem to you that the treatments are fixed or random? (a) fixed
- What is the experimental unit for this experiment? Store
- What is the sampling unit for this experiment? Store/Week
- If the design is RBD, what are the blocks? NA
- What are the degrees of freedom for the lowest level error? Not for split plot
- $t_1-1=2$ ,  $t_1(s-1)=42$ ,  $t_2-1=1$ ,  $t_1*t_2=2$ , residual (several pooled sources) = 42

Computer disks are to be tested for temperature tolerance. Twenty disks from each of 3 different Brands (60 disks total) are each loaded with a large file and then subjected to high temperatures for 12 hours. The temperatures are 220°F, 240°F, 260°F and 280°F, and five disks from each manufacturer are allocated at random to each temperature. The variable of interest is the number of errors in the large file after exposure to temperature. The researchers are interested in differences between the Brands of disks and differences between temperatures. They would also like to know if the Brands respond similarly to the various temperatures.

- What is the treatment arrangement for this experiment? (b) factorial (3x4)
- What is the experimental design for this experiment? (a) CRD
- Does it seem to you that the treatments are fixed or random? (a) fixed
- What is the experimental unit for this experiment? Disk
- What is the sampling unit for this experiment? Disk = file
- If the design is RBD, what are the blocks? NA
- What are the degrees of freedom for the lowest level error?  $t-1=11$ ,  $t(n-1)=48$

For the design described above, give the Sources of Variation and the degrees of freedom for each source (you may not need to write in all of the lines provided to include all sources).

Source	d.f.
Brand	2
Temp	3
Brand x Temp	2
Disk (Brand x Temp)	48

Pumpkins are notorious for spoilage in transport. Research sponsored by the Great Pumpkin Society is intended to identify modes of transport that will reduce spoilage. The research planned at present will examine three packing strategies and two temperature regimes. The three packing strategies are (1) cardboard boxes, (2) wooden boxes and (3) pumpkins just piled up in the truck. The two temperature regimes are 15C and 20C. Every combination of temperature with packing strategy will occur in the study, and there will be 5 replicate shipments for each combination (30 shipments in all). Each shipment is of the same size and the variable used to measure pumpkin damage is the “putrid pumpkin poundage” at the end of the trip.

- What is the treatment arrangement for this experiment? (b) factorial
- What is the experimental design for this experiment? (a) CRD
- Does it seem to you that the treatments are fixed or random? (a) fixed
- What is the experimental unit for this experiment? Truck
- What is the sampling unit for this experiment? Truck
- If the design is RBD, what are the blocks? NA
- What are the degrees of freedom for the lowest level error?  $t-1=5, t(n-1) = 24$

As a Science Fair project, students sampled pumpkins for bacteria counts. The students are interested in comparing three types of shipping vehicles for potential pumpkin contamination. The three transport types are (1) refrigerated trucks, (2) closed, but unrefrigerated trucks and (3) open trucks. Ten shipments from each vehicle type is examined. Five pumpkins from each shipment were sampled for external bacterial counts and one culture with its bacterial count was made per pumpkin.

- What is the treatment arrangement for this experiment? (a) single factor
- What is the experimental design for this experiment? (a) CRD
- Does it seem to you that the treatments are fixed or random? (a) fixed
- What is the experimental unit for this experiment? vehicle = truck
- What is the sampling unit for this experiment? pumpkin
- If the design is RBD, what are the blocks? NA
- What are the degrees of freedom for the lowest level error?  
 $t-1=2, t(s-1)=27, ts(n-1)=120$