

Problem 1: Questionnaire Design (33.3%)

A company has come up with a new idea for a mixed-fruit popsicle, and wants to determine how it should be made and marketed. By happenstance, the production process is extremely environmentally-friendly. The popsicles are all-natural to begin with, and they can also add a vitamin supplement to make them very nutritious. The inclusion of the vitamin supplement will increase the manufacturing cost by 25 cents per popsicle. A box typically contains 12-15 popsicles.

- a) Define a set of appropriate survey objectives. *Hint: consider the tradeoffs you might need to make*
- b) What attitude(s) or intent(s) should you aim to measure? *Hint: Be very specific*
- c) Design a short survey to meet your stated objectives and clearly specify your scale(s). You may have multiple sections and scales, but limit your survey to **no more** than 10 questions/statements total. **DO NOT** use filter or pivot questions in this survey.

Problem 2: Factorial Experiment Design (33.3%)

Applebirds is a new restaurant in its second year. They have an already good apple pie that they would like to spice up. Their chefs have developed two new ideas to help them make their apple pie zestier: a new spice mix and a new cherry tart sauce to mix in. They have 900 people volunteering for taste testing.

- a) What is the research goal, and what is an appropriate research hypothesis?
- b) Identify the dependent and independent variables needed to test your hypothesis.
- c) Describe in 1 sentence or less how you would measure the dependent variable
- d) Design a factorial experiment to test the hypothesis. Identify reasonable treatment levels and list the resulting treatment combinations (cells). Please limit the treatment levels to **no more than 3 (including control) per independent variable**. Ensure that you specify which cell is the control cell.
- e) How many people should be put in each cell?

Problem 3: Constrained Experiment with Confounding – Randomized Block Design (33.3%)

You have developed three new supplements (A, B, and C) that you think can enable people to run a faster mile. These have been proven safe when used independently, but no testing has been conducted on mixing them – so you do not want to mix them. Each of the supplements are cleared from the body completely in 15 hours or less. You have 27 volunteers to experiment with: volunteers 1-15 are soccer players, and volunteers 16-27 are non-athletes. You have an experiment budget of \$5000, and each time you make a subject run a mile your company policy is to pay \$100 to that person.

- a) Identify the dependent variable, treatments (including control) and confounding factor(s).
- b) Design a set of treatment sequence blocks to enable a balanced design that maximizes the number of observations per treatment, subject to the specified budget and number of total volunteers available. Do not consider differences between soccer players vs. non-athletes in this part. *Hint: You will need two treatments per block.*
- c) In your design above, assign subjects to blocks to control for confounding. You **must** consider differences between soccer players vs. non-athletes in this part. How many volunteers are not used?
- d) How many observations per treatment are achieved in your design? How much does the experiment end up costing?