1. For each of the following descriptions indicate what the response is, what the conditions are and what the experimental material is. Then discuss whether or not the experiment adheres to the three fundamental principles of a designed experiment: control of outside variables, randomization, and replication. If the experiment adheres to a principle describe how. If the experiment does not adhere to a principle indicate how you would change the experiment to make it better. Be specific and be sure to comment on all three principles.

(a) An aluminum smelting operation makes its own carbon anodes for use in their aluminum smelting pots. The density of the anode is an important quality characteristic because it affects the usable life of the anode. An experiment is conducted to see the effect of bake temperature on anode density. Twenty anodes are made using the same raw materials, methods and people. Five anodes are assigned at random to each of four temperatures, 500, 525, 550 and 575 °C. A temperature is picked at random and the five anodes are baked in the oven at that temperature. One of the remaining temperatures is picked at random and the five anodes are baked in the oven at that temperature. This random selection of a temperature and baking 5 anodes continues until all temperatures have been used once. The density of each anode is then measured. The order of measurement is completely random.

(b) A chemist wants to compare a new and simpler assay method with the standard method. She prepares a batch of solution, divides it into 40 specimens, and then selects 20 at random. She asks her technician to analyze these 20 specimens using the new method and the remaining 20 using the standard method. The technician finishes analyzing the 20 specimens using the new method in the morning. He takes a break for lunch and does the remaining 20 specimens using the standard method in the afternoon.

(c) A research psychologist wishes to investigate the difference in maze test times for mice trained using different levels of reinforcement: no reinforcement, positive reinforcement (food given for a correct choice), negative reinforcement (mild electric shock given for an incorrect choice). Thirty mice are available for the experiment. For each mouse a fair 6 sided die is rolled. If the roll is a 1 or 4 the mouse is assigned to group 1 (no reinforcement). If the roll is a 2 or 5 the mouse is assigned to group 2 (positive reinforcement). If the roll is a 3 or 6 the mouse is assigned to group 3 (negative reinforcement). After assignment there are 7 mice in group 1, 12 mice in group 2 and 11 mice in group 3. The mice are all trained using the same maze. After training, each mouse is run in a new maze and the time to complete the new maze is recorded.

2. Below are two scenarios for an experiment involving chocolate chip cookies. Different recipes for the cookies are used. The cookies are evaluated on scores for moistness, texture, flavor, greasiness and appearance. Answer the questions for each scenario.

- **Scenario 1**: One batch of cookie dough is made with vegetable margarine, one batch with lite vegetable margarine, one batch with butter and one batch with vegetable shortening (Crisco). Five cookies are baked from each batch of dough.

- **Scenario 2**: Five batches of cookie dough are made with vegetable margarine, five batches with lite vegetable margarine, five batches with butter and five batches with vegetable shortening (Crisco). One cookie is baked from each batch of dough.

(a) What is the response? What are the conditions? What is the experimental material?

(b) What is the planned systematic variability in the experiment?

(c) What is the chance variability in the experiment?

(d) If cookies made with butter are found to have a significantly higher mean evaluation score than those made with vegetable products, what sort of generalization can be made?