1. For each of following utility functions graph the indifference curves through the bundles (2,3) and (2,4). Find one other bundle on each indifference curve. For each of them find the formula for the marginal rate of substitution (if possible) and find the value of the MRS at (2,3) and at (2,4). Which ones have strictly decreasing marginal rates of substitution?

   a) $U(x,y) = xy$
   b) $U(x,y) = x + 4y$
   c) $U(x,y) = min[2x,4y]$
   d) $U(x,y) = ln\ x + ln\ y + 12$
   e) $U(x,y) = 5xy + 7$
   f) $U(x,y) = 2x + ln\ y$

2. The following questions refer to the utility functions and their indifference curves in question 1.

   a) Do you notice anything similar about the indifference curves in (a), (d) and (e)?
   b) Looking only at the indifference curves for (b) describe the relationship between all of the indifference curves?
   c) Looking only at the MRS for (f) what is the effect of changes in the amount of x on the MRS? What does this imply about the relationship between all of the indifference curves as you vary x but keep y constant?
   d) Every straight line through the origin can be represented as $y = ax$ where a is a real number. Looking only at the MRS for (a) how does the MRS change as you move along a line through the origin? What does this imply about the relationship between all of the indifference curves as you move along a line through the origin? What does this imply about the indifference curves for (d) and (e)?

3. Martin is shopping for school supplies. He needs to purchase pens which cost $1 per package and notebooks which cost $1.5 each. He has $9 to spend on school supplies.

   a) Putting pens on the x-axis and notebooks on the y-axis illustrate Martin's budget set. What is Martin's budget line? What is the opportunity cost of purchasing an additional package of pens in notebooks?
   b) If Martin has one coupon for $.25 off a package of pens then illustrate below his new budget set. Include the budget line from (a) in your diagram.
   c) If the store is offering a free package of pens with every notebook purchased then illustrate his new budget set. Include the budget line from (a) in your diagram. What is the opportunity cost of pens in notebooks?

4. Draw the indifference curve relationship implied by the following statements:
   a) Put butter on the x axis and Mazola margarine on the y axis. Mazola is just as good as butter.
   b) Put Grey Poupon on the x-axis and other mustard on the y-axis. Grey Poupon mustard – but of course, I will have no other.
   c) Put Ranch Style Doritos on the x-axis and other food on the y-axis. Ranch Style Doritos are addictive – if you eat one, you must eat another, and another, and another.