

Written Homework for 14.1-14.3

1. Find  $F_\mu$ ,  $F_r$ , and  $F_y$  for  $F = \frac{G\mu y}{(r^2 + y^2)^{3/2}}$ . Show all work and simplify your answers.

2. The Wilson lot size formula in economics says that the most economical quantity  $Q$  of goods for a store to order is given by the formula  $Q(K, M, H) = \sqrt{\frac{KM}{H}}$  where  $K$  is the cost of placing the order,  $M$  is the number of items sold per week, and  $H$  is the weekly storage cost for each item.

A. Find the differential of  $Q$ .

B. Use differentials to determine which of the variables is most sensitive near the point  $(2, 10, 0.5)$ .

3. The cardiac output, represented by  $c$ , is the volume of blood flowing through a person's heart, per unit time. The systemic vascular resistance (SVR), represented by  $s$ , is the resistance to blood flowing through veins and arteries. A person's blood pressure,  $p$ , is a function of  $c$  and  $s$ .

A. Give a practical interpretation of  $\frac{\partial p}{\partial c}$ .

B. If blood pressure is directly proportional to  $c$  and  $s$ , write a formula for  $p = f(c, s)$ . Include the sign of your proportionality constant.

C. Sketch three level curves of  $p$  in quadrant I. Explain the shape of the curves in terms of cardiac output and systemic vascular resistance. Note: Your sketch should be large enough and clearly drawn because you will be labeling points on your sketch for parts D and E.

D. For a person with a weak heart, it is desirable to have the heart pumping against less resistance, while maintaining the same blood pressure. Such a person may be given the drug nitroglycerine to decrease the SVR and the drug Dopamine to increase the cardiac output. Illustrate this on your graph from part C by labeling a point  $A$  representing the person's state before drugs are given and a point  $B$  for after. What is the connection between your illustration and partial derivatives?

E. Right after a heart attack, a patient's cardiac output drops, thereby causing the blood pressure to drop. A common mistake made by medical residents is to get the patient's blood pressure back to normal by using drugs to increase the SVR, rather than by increasing the cardiac output. Illustrate this on your graph from part C by labeling a point  $D$  representing the patient's state before the heart attack, a point  $E$  for right after the heart attack, and a third point  $F$  for right after the resident has given the drugs to increase the SVR. How does your illustration show that the medical resident is making a mistake?