

You have the full ninety minutes to complete this exam. Recall that partial credit will be given to partial work. Write neatly, and good luck.

### 1. Poppin' Fresh and Vertical Integration (40 points)

Pillsbury is a monopoly supplier of cookie dough to two firms who are in turn monopolists in their respective markets. The first firm is One's Enuff, a producer of chocolate-chip-cookie-dough ice cream that faces a demand function of  $q_1 = 6400 - 80p_1$ . The second firm is the Mallinckrodt student food court, which faces a demand curve of  $q_2 = 3200 - 80p_2$  for its chocolate chip cookies. (Both prices are in dollars.) Assume that Pillsbury's marginal cost of producing a unit of cookie dough is constant and equal to \$8 and that one unit of dough is required to produce one unit of ice cream or one unit of cookies. (These are big boxes of dough and units of ice cream/cookies.) Beyond the cost required to purchase the cookie dough from Pillsbury (denoted by  $w$ ), the two downstream firms face zero marginal costs. You may assume throughout that fixed costs are zero.

A. Assume that third degree price discrimination by Pillsbury is not possible. In words (no numbers), what are all the reasons that Pillsbury can improve its profits by vertically integrating with a dough-using firm? Does intuition suggest which vertical merger Pillsbury should pursue?

B. The Department of Justice generally looks favorably upon vertical mergers. Again in words (no numbers), would the above merger(s) be exceptional in this regard? (Assume that the DOJ is interested only in consumer surplus when making its decision.)

C. (Numbers here) Now assume that Pillsbury must pay legal fees in order to vertically integrate. What is the lowest value of these fees that would make Pillsbury prefer *not* to integrate with its preferred downstream firm?

### 2. Going up (30 points)

One of my favorite far-out ideas is the space elevator: Get a Pacific island, put a satellite in geosynchronous orbit above it, and connect the two with a cable. The problem is finding a material strong and light enough to serve as the cable. Consider the following model of innovation for carbon nanotubes, the leading contender for such a cable. If such nanotubes are invented, they will have inverse demand  $P = 10 - Q$ . (Don't worry about the scales of prices and quantities.) The total variable cost structure will be  $C(q) = 2q$ . To have a chance of inventing the nanotubes, each of the  $N$  participating firms must invest  $C_{R\&D} = 25.6$  on R&D. Suppose the probability that at least one firm is successful is  $\rho(N) = (1/5)N - (1/100)N^2$  (the number of firms is never greater than ten, so this expression is always increasing). You may assume that ties in this innovation race never occur. If such nanotubes are invented, they are invented in  $t=0$  and will be used an infinite number of periods. Assume the discount factor is  $\beta = 0.9$ . (Recall that

$\sum_{t=0}^{\infty} \beta^t = \frac{\beta^0}{1-\beta}$ .) R&D costs are incurred immediately, and the first payoffs (if such nanotubes are discovered) are also received immediately (in  $t=0$ ).

A. Find the optimal number of firms competing for the nanotube discovery, assuming marginal-cost pricing after discovery.

B. Assume a patent lasts 20 periods, after which marginal-cost pricing occurs. How many firms will enter into the patent race? How much (expected present discounted value) welfare is lost by using the patent as opposed to the ideal?

C. Find the range of (immediately granted) prize amounts that will achieve the optimal level of innovating entrants.

## 3. Bill (Gates, that is) has been to the mountaintop (15 points)

Explain the features of both operating systems and software applications that will tend to push such markets toward near-monopoly. What policy steps might be taken to ensure robust competition *for* the market?

## 4. Happy Jack and Milk Cartons (15 points)

My wife and I took our kids to Thurtene two weekends ago. Jack (almost three years old) is permitted to walk around in non-crowded places without holding either parent's hand. Our one-year old daughter Catherine, on the other hand, requires constant supervision from my wife, and thus Jack is entirely my responsibility in these environments. Recalling that I sometimes have difficulty concentrating on watching our son, I suggested writing Jack's name and my wife's cell phone number on his hand in case he wandered away. My wife was appalled at the notion.

Interpret this anecdote within the strategic context of commitment. You should distinguish between the two related possibilities of Jack wandering away, namely, being quickly returned with minimal psychic damage and being returned an emotional wreck after a sizable length of time (we won't discuss him not returning at all). You may assume that my wife and I have the same (negative) payoffs, that my attention-costs do not factor into her decision-making, and that the traumatic outcome is at least as bad (from our perspective) as the easy outcome. From my wife's reaction, what can you infer about her expectations of my parenting? What else can you infer from the incident? (Hint: quite a bit, and all without making unnecessary derogatory comments at my expense.) If you'd like to additionally sharpen the question, you can make additional assumptions that do not run contrary to the above assumptions.