**Profit Maximization**

1. The graph below depicts the monthly demand (D) and monthly cost curves for Folgers coffee if they do not purchase a new piece of equipment for their factory that roasts their coffee beans. Assume all of Folgers’ fixed costs are sunk. If they do invest in the new piece of equipment, the taste of Folgers coffee would improve resulting in an increase in demand. If they do invest in this new piece of equipment, the monthly demand for Folgers coffee increases from D to D’. However, to install this new piece of equipment, Folgers must shut down the factory for 2 months during which time they will be unable to produce or sell any coffee.

![Graph depicting demand and cost curves](image_url)

For simplicity, assume Folgers plans to sell the coffee factory in 4 months irrespective of whether they purchase the new piece of equipment and that the monthly profits are incurred at the start of each month. Folgers believes the price they can obtain from selling the factory will be $20 more if the factory contains the new piece of equipment.

a) If Folgers cannot price discriminate and the monthly interest rate is 2% (i=0.02), what is the maximum amount Folgers is willing to pay for this new piece of equipment if Folgers pays for the equipment in its entirety at the time the piece of equipment starts to produce the improved coffee (i.e., becomes “on-line”)? SHOW CALCULATIONS.

**ONE WAY TO DO THE PROBLEM.**
First note that the monthly total fixed costs are \((9-2) \times 4 = 28\) (calculate TFC by selecting any quantity and multiplying that quantity by \(AFC=ATC-AVC\) at the quantity). The problem states that these fixed costs are sunk so they must be paid whether or not the factory is producing output.
Monthly Profits if Folgers does not buy new equipment are 6*4-9*4=-12 (quantity is 4, price is 6 and ATC at an output of 4 is 9).

Monthly Profits (excluding cost of new equipment) if Folgers buys new equipment are 10*6-7*6=+18 (quantity is 6, price is 10 and ATC at an output of 4 is 7).

**Present Value of Payoff if Folgers does not buy new equipment where X is the amount Folgers can sell the factory for in 4 months.**

\[-12-12/1.02-12/1.02^2-12/1.02^3 +X/1.02^4 = -46.61+X/1.02^4\]

**Present Value of Payoff if Folgers does buy new equipment for a price P.**

\[-28-28/1.02-P/1.02^2+18/1.02^3+18/1.02^4 +(X+20)/1.02^4 = -2.71- P/1.02^2+X/1.02^4\]

Folgers will buy the piece of equipment if \(-2.71- P/1.02^2+X/1.02^4\geq-46.61+X/1.02^4\) which is the case if \(P\leq45.67\).

**ANOTHER WAY TO DO THE PROBLEM.**

Define “monthly returns” as the difference between monthly revenue and monthly variable costs.  
Monthly Returns if Folgers does not buy new equipment are 6*4-2*4=+16 (quantity is 4, price is 6 and AVC at an output of 4 is 2).

Monthly Returns (excluding cost of new equipment) if Folgers buys new equipment are 10*6-2.33*6=+46 (quantity is 6, price is 10 and AVC at an output of 4 is 2.33).

**Present Value of Payoff (excluding sunk costs) if Folgers does not buy new equipment where X is the amount Folgers can sell the factory for in 4 months.**

\[16+16/1.02+16/1.02^2+16/1.02^3 +X/1.02^4 =62.14+X/1.02^4\]

**Present Value of Payoff (excluding sunk costs) if Folgers does buy new equipment for a price P.**

\[-P/1.02^2+46/1.02^3+46/1.02^4 +(X+20)/1.02^4 =106.04- P/1.02^2+X/1.02^4\]

Folgers will buy the piece of equipment if \(106.04- P/1.02^2+X/1.02^4\geq62.14+X/1.02^4\) which is the case if \(P\leq45.67\).

**THERE ARE OTHER WAYS TO DO THE PROBLEM AS WELL SUCH AS COMPARING THE MARGINAL BENEFIT AND MARGINAL COST OF BUYING THE EQUIPMENT.**

b) Yes. The reason is that if the fixed costs were not sunk then Folgers would not have to pay them if they closed the plant for two months while installing the equipment. For example, suppose Folgers could lay off the plants’ manager when the factory was shut down and that the manager’s salary is fixed costs. In this case, the costs are not sunk – however if Folgers could not layoff the manager when the plant was shut down, then his/her salary costs would be sunk.

You can see that in the above calculations because the payoff in the first two months would not be -28 if the fixed costs were not sunk. In addition, if less than $12 of the fixed costs were not sunk, then the firm would not produce if they did not buy the equipment. You can also receive partial credit if you discussed whether the cost of the new equipment was sunk.
2. Read the article below entitled “The Tricky Business of Rolling Out New Toilet Paper”. Suppose the graph below depicts the yearly demand (D) and cost curves for Kleenex Cottenelle’s new toilet paper if they do not spend anything in promoting the brand. If they do promote the brand, the demand for the new toilet paper increases demand from D to D’.

If promoting costs Kleenex Cottenelle $50,000, should they pay the $50,000 for promotion? Show calculations.

If don’t promote, Kleenex should sell 500 units at a price of 200. Profits if don’t promote are \( P \times Q - ATC \times Q = 200 \times 500 - 140 \times 500 = 30,000 \).

If promote, Kleenex should sell 700 units at a price of 260. Profits if promote are \( 260 \times 700 - 130 \times 700 - 50000 = 41000 \).

Promote because profits are greater.

Ares-Serono SA of Switzerland has conceived a fertility drug that is easier to make, more convenient for women to inject and higher in purity and consistency. Similar drugs have been derived from the urine of postmenopausal women, involving complex collection procedures and purification: when orders surged, companies couldn’t always produce enough.

Serono’s new bioengineered drug, Gonal-F, eliminates the use of human urine and ensures an adequate supply. But the price is high … and a woman may use two dozen or more per (month). Serono attributes the price to the need to recoup the costs of research and new production facilities. Nonetheless, “People will pay whatever it takes to have a baby. It’s an emotional issue.” says drug-industry analyst Hemant Shah.

The graph below depicts the daily demand for Gonal-F. Suppose Serono’s total fixed cost is $10,000 and their marginal cost of producing an ampule of Gonal-F is constant at $80. (Based on the article, an ampule is the unit of quantity.)

![Graph showing demand and marginal cost]

a) If Serono is profit maximizing, does their statement attributing the high price for Gonal-F to their need to recoup the costs of research make sense? EXPLAIN.

Research costs are a fixed cost so they should not influence the price that maximizes profits.

b) If Serono cannot price discriminate, what are Serono’s daily profits from Gonal-F? SHOW CALCULATIONS.

To maximize profits, Serono sets a price equal to $140 and sells 600 units. Profits are $(140-80)600-10000=26,000.$
4. The graph below depicts the demand curve faced by a firm and the firm’s cost curves.

a) If the firm is unable to price discriminate, how much will the firm’s profits change if the firm increases its output from 6 units to 7 units? Show calculations. Be precise in your answer by making use of the MC curve.

Total revenue at a quantity of 6 is $6 \times 4 = 24$ and total revenue at a quantity of 7 is $7 \times 2 = 14$. Therefore, the marginal revenue associated with the 7th unit is $-10$. The marginal cost of the 7th unit is 11 (go to 6.5 and use the MC curve) so the firm’s profits would decrease 21 if the firm increases output from 6 to 7.

b) If the firm is unable to price discriminate, what are the maximum profits for the firm? Show calculations.

Profits are maximized at an output of 3. The profits would be $10 \times 3 - 5.6 \times 3 = 13.20$. 