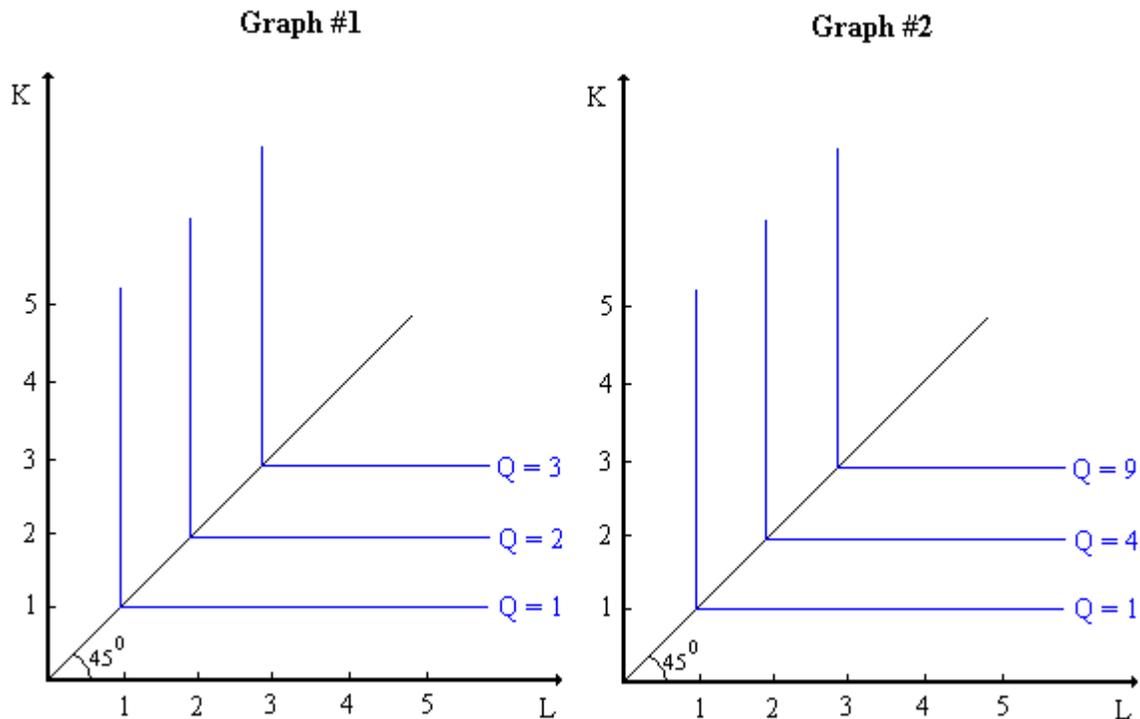


Problem Set #3

1. A firm uses two variable inputs, labor (L) and capital (K), to produce a single output, Q. The firm's technology is represented by the isoquant map in graph #1:



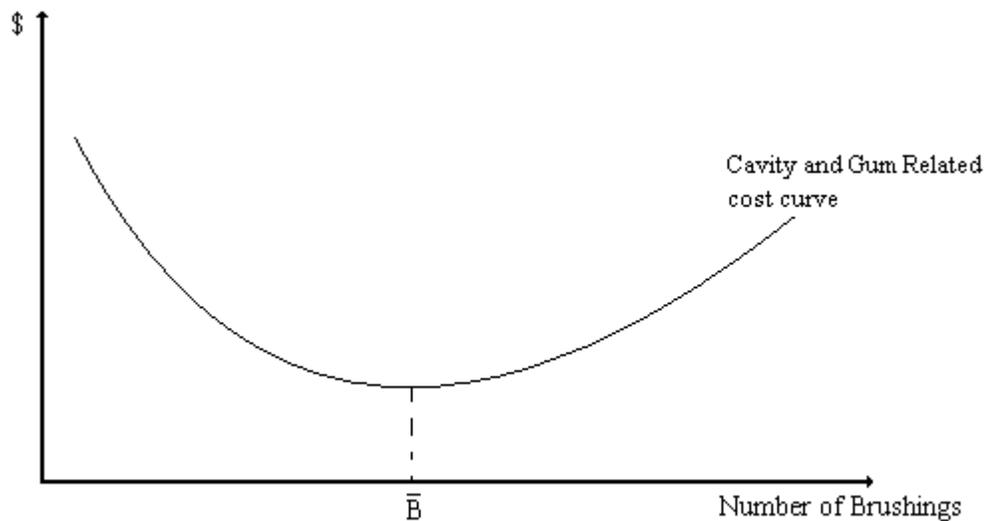
- Over the range of output depicted ($Q \leq 3$), does the firm's technology exhibit increasing, decreasing, or constant returns to scale?
- If the fixed prices of the two inputs are $P_K = 2$ and $P_L = 2$, what will be the firm's expansion path? Express algebraically or graphically the firm's total cost function.
- What is the marginal cost function? Is it increasing, decreasing or constant with output?
- Answer parts (a) and (b) for the isoquant map in graph #2.

2. Brushing one's teeth is a very important economic activity. The more an individual brushes his teeth, the less cavities he gets and the lower his annual expenses for dental services will be. However, if he brushes his teeth too often he hurts his gums, so that beyond a certain number of brushings, \bar{B} , his dental expenses start rising.

Moreover, the expenditure on toothpaste rises the more an individual brushes his teeth. Suppose consumption of toothpaste is proportional to the number of brushings and that the price of toothpaste is given.

Finally, regardless of the number of brushings per year, this individual visits his dentist twice a year for a routine check-up at a cost of \$25 per visit.

- a) Given the cavity and gum-related cost curve below for an individual's annual number of brushing, fill in the cost curve representing expenditures on toothpaste and the curve for routine check-ups.
- b) If the individual wants to minimize the total costs associated with brushing his teeth, graphically indicate the desired number of brushings per year.



- c) What happens to the optimal choice of brushing if:
- the government pays for his two routine visits?
 - the government partially subsidizes the cost of toothpaste (i.e. reduces the unit price of toothpaste)?

3. A producer of light bulbs claims to have the following production function:

$$Q = 10L * G \quad \text{where, } Q \text{ is the number of light bulbs produced per year}$$

$$L \text{ is the number of work-hours per year}$$

$$G \text{ is the number of pounds of glass per year}$$

- a) What is the marginal product of labor? of glass?
- b) Draw the relevant isoquant map and isocost line if the cost of labor is \$4 per work-hour and the cost of glass is \$4 per pound and 90 light bulbs are to be produced.

What is the cost minimizing combination of glass and labor?

- c) If Q were to increase to 160 light bulbs, would this firm exhibit constant, increasing, or decreasing returns to scale? Explain.

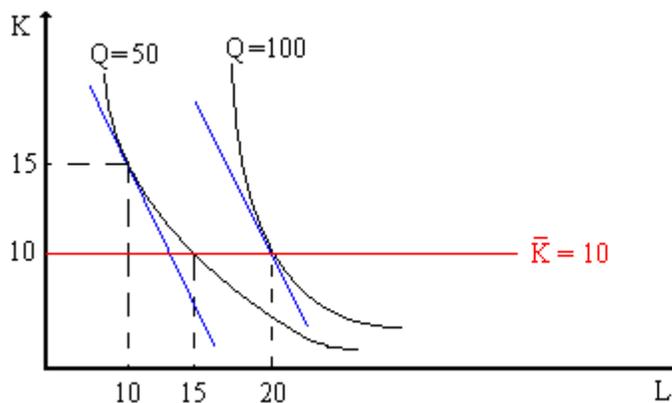
4. Suppose a firm's short run cost curves were found to be:

$$\begin{aligned} \text{Total Cost} &= \text{SRTC} = 1 + 2Q + Q^2 \\ \text{Marginal Cost} &= \text{SRMC} = 2 + 2Q \end{aligned} \quad , \text{where } Q \text{ is output.}$$

Assume the firm behaves as a price-taker and sells its output at $P = \$8$ per unit (that is, its demand curve is flat at $P = \$8$).

- a) If the firm maximizes profits, how much will it produce?
- b) What are the marginal, average, and total cost at that point?
- c) What is the firm's profit?

5. Consider the following isocost and isoquant graph:



The price of labor is \$2 unit. The price of capital is \$1 per unit.

In the short-run, there is a fixed quantity of capital: only $\bar{K} = 10$ units are available for production.

- a) Find the total and variable costs of producing 100 units of output.
- b) What is the difference between the short-run and long-run total costs of producing 50 units of output?

6. Assume downward sloping or flat demand and a U-shaped LRAC curve.

In each of the following situations, determine graphically and/or verbally:

- a) Does the firm have the cost-minimizing amount of capital given its output level? If not, should the firm increase or decrease its amount of capital given its output?
- b) Does the firm have the profit maximizing level of output given its amount of capital? If not, should the firm increase or decrease its level or output, given its capital?

If the situation is impossible, state why.

i) $SRAC > LRAC$
 $SRMC > LRMC$
 $MR = SRMC$

ii) $SRAC > LRAC$
 $SRMC < LRMC$
 $MR = SRMC$

iii) $SRAC < LRAC$
 $SRMC > LRMC$
 $MR = SRMC$

iv) $SRAC > LRAC$
 $SRMC > LRMC$
 $MR > SRMC$

v) $SRAC > LRAC$
 $SRMC < LRMC$
 $MR > SRMC$

vi) $SRAC = LRAC$
 $SRMC = LRMC$
 $MR > SRMC$

vii) $SRAC = LRAC$
 $SRMC > LRMC$
 $MR = SRMC$

viii) $SRAC = LRAC$
 $SRMC = LRMC$
 $MR = SRMC$