

You only need to finish the first 10 questions to get the full mark.

1. Assume the wage is \$1000, and the cost of capital is \$2. Fill out the following table. Is the marginal product of labor diminishing?

L	Q	K	VC	TC	AVC	ATC	AFC	$MP_L$	MC
0	0	1000							
2	1800	1000							
4	2800	1000							
5	3000	1000							

2. The firm's short-run cost function  $C(q) = 10 + \frac{1}{2}q^2 + q$ ,  $MC(q) = q + 1$ .
  - a. The price  $p = 6$ . What is the optimal quantity and profit? Should the firm shut down in the short-run? Why?
  - b. If  $p = 2$ , what is the optimal quantity and profit? Should the firm shut down in the short-run? Why?
  - c. At which price does the price just cover the firm's variable cost ( $p = AVC$ )?
  - d. At which price the firm's profit is 0?
  - e. What is the firm's supply curve in the short-run?

Suppose there are 4 identical firms in the market, and the demand function is  $p = 30 - 2Q_d$ .

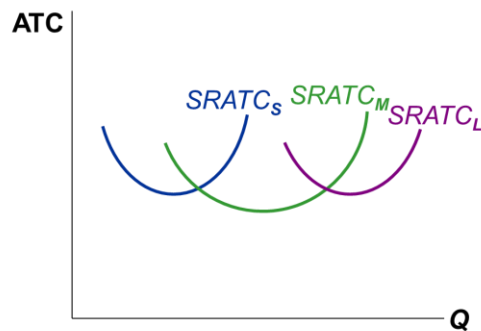
  - f. What is the market supply curve? Compare the slope of the market supply curve with the slope of the supply curve of a single firm. If there are 10 firms in the market, answer these questions again.
  - g. What is the market equilibrium (market price and quantity), profit and output of each firm?

In the long-run suppose the demand function is  $p = 30 - 2Q_d$ .

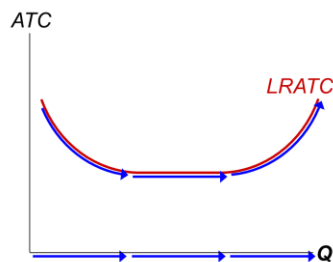
  - h. What is the long-run equilibrium price, market output, output of each firm, and number of firms?
  - i. Suppose the cost function becomes  $C(q) = 10 + \frac{1}{2}q^2 + 2q$ ,  $MC(q) = q + 2$ . What is the long-run equilibrium price, market output, output of each firm, and number of firms?
3. Suppose the production function is  $q = K^{0.6}L^{0.7}$ . Does it have IRS, CRS, or DRS?
4. Suppose the cost function is  $C(q) = 20 + 0.5q^2 + q$ . What are the FC, FC, ATC, AFC, AVC? The  $MC = q + 1$ . Find out the quantity level at which ATC is minimized, the quantity at which AVC is minimized. At which quantity is AFC minimized?

5. Suppose the production function is  $q = \sqrt{KL}$ . In the short-run capital is  $\bar{K}$ , the wage is  $w$ , and the cost of capital is  $r$ . What is the cost function (cost as a function of  $q$ ) in the short-run? What is the MC function? Draw the diagram. (Hint 1: in both of the cost function and MC function we write the costs as a function of output  $q$ ; Hint 2:  $MP_L = \frac{\sqrt{K}}{2\sqrt{L}}$ )
6.  $w = 5, r = 2, q = K^{0.5}L^{0.5}, MP_L = \frac{\sqrt{K}}{2\sqrt{L}}, MP_K = \frac{\sqrt{L}}{2\sqrt{K}}$ . What are the optimal  $K$  and  $L$  that produces an output of 20, 40, and 60? Draw the graph to illustrate your solution, and draw the expansion path in the graph. Draw the total cost function in a new diagram.
7. Suppose  $q = 2K + 3L, w=5, r=1$ . What is the long-run cost function? Now suppose  $w=1$  and  $r=5$ , what is the long-run cost function?
8. Explain why in a perfectly competitive market each firm is a price taker (It wouldn't set the price higher or lower than the market price)?
9. When MC is increasing, and MR is constant or decreasing, explain why at the optimal quantity  $MR=MC$ . (Use a graph if it is helpful.)
10.  $w = 2, r = 3, q = \sqrt{KL}, MP_L = \frac{\sqrt{K}}{2\sqrt{L}}, MP_K = \frac{\sqrt{L}}{2\sqrt{K}}$ . What are the optimal  $K$  and  $L$  that produces an output of 10? Now suppose the wage increases to 4, get the optimal bundle of  $K$  and  $L$ . Draw the graph to illustrate your solution.
11. We usually assume the  $MP_L$  is diminishing. Explain why this assumption makes sense, or does not make sense.
12. Remember Malthus theory? Explain why it worked three hundred years ago but doesn't work today. (If you don't remember it, google it on the internet.)
13. Suppose the production function is  $q = \sqrt{KL}$ . Draw the isoquant at which  $q = 10$ . Find out the slope of the curve at the point of  $(K=10, L=10)$  graphically and mathematically? Is this slope larger or smaller than the slope at the point of  $(K=5, L=20)$ ? (Hint:  $MU_L = \frac{\sqrt{K}}{2\sqrt{L}}, MU_K = \frac{\sqrt{L}}{2\sqrt{K}}$ )
14. Suppose the production function is  $q = 3K + 2L$ . Draw the isoquant at which  $q = 100$ . What is the slope of the line?
15. Suppose the production function is  $q = \min(K, L)$ . Draw the isoquant at which  $q = 100$ .
16. Suppose the production function is  $q = \sqrt{KL}$ . Does it have IRS, CRS, or DRS?
17. Suppose the production function is  $q = K^{0.3}L^{0.7}$ . Does it have IRS, CRS, or DRS?

18. In the long-run all firms in a perfectly competitive market earn a 0 profit. Why are they still in business if their profit is 0?
19. If we assume that  $MP_L$  is increasing. Show that MC is increasing intuitively and mathematically.
20. Suppose we have the following short-run ATC curves. Draw the long-run ATC curve.



21. Explain why when the LRATC is decreasing we have IRS, when the LRATC is stable, we have CRS, and when the LRATC is increasing we have DRS?



22. Can you explain why a firm may have IRS? DRS? What is the optimal number of firms in the market if the firms have IRS, DRS, or CRS?
23. Suppose the wage is 10 and the cost of capital is 5. Draw the isocost line at which the cost is equal to 20. Draw another at which the cost is 60. What are the slopes of these two lines?
24. Suppose the wage is  $w=4$  and the cost of capital is  $r=2$ . It takes 2 unit of labor and 1 unit of capital to produce 1 unit of output. What is the long-run cost function? (If you can't get the general cost function, then calculate the costs at three different quantity levels.). Now suppose  $w=5$  and  $r=1$ . What is the long-run cost function?
25. When there are many firms in the market, explain why the demand curve faced by each firm is horizontal while the market demand curve is still downward sloping.
26. In a same graph draw a typical MC, AVC, and ATC curves. Explain why the MC curve crosses the other two curves at their minimums. Can you prove it mathematically?

27. Explain why a LRATC curve is below all SRATC curves? Draw the graph and show the change in the scale to return.
28. What are conditions a firm uses to decide on the optimal quantity and whether to shutdown in the short run?
29. Suppose  $FC=2000$ ,  $VC=1500$ ,  $q=100$ ,  $p=20$ . What is the short-run profit? Should the firm shutdown? What if the price is 10 now?
30.  $C(q) = 10 + q^2$ ,  $MC = 2q$ , and the price  $p = 6$ . In the same graph, draw the cost curve and the revenue curve. Show the optimal quantity and the profit in the graph.
31. In the same graph, draw the typical MC and ATC curves. Suppose now the price is higher than the minimum of ATC. Show the optimal quantity  $q$  and the profit in the graph. Now suppose MC increases by 1 everywhere. In the same graph draw the new MC, ATC curves. Show the optimal quantity  $q$  and the profit. (You can assume the price is still higher than the minimum of the new ATC curve.) Please label your graph clearly.
32. In the graph, draw the typical MC, AVC, and ATC curves. Do all the following in the same graph:
- Label the price at which the profit of the firm is 0;
  - Show the price range in which the profit is positive.
  - Show the price range in which the profit is negative but the firm should not shut down in the short run.
  - Show the price range in which the firm should shut down in the short run.
  - Show the price range in which the firm should exit in the long run.
33.  $C(q) = 10 + \frac{1}{2}q^2$ ,  $MC = q$ , and the market price  $p = 2$ . What is the firm's supply function in the short run? Suppose there are 3 identical firms in the market, what is the market supply function? Draw the firm's supply curve and the market supply curve in the same graph.
34.  $MC = 3q + 2$ . The demand function is  $Q_D = 20 - p$ . There are 5 identical firms in the market. Characterize the short-run equilibrium. What is the profit of each firm?
35. The long-run cost function is  $C(q) = 4 + q^2$ ,  $MC = 2q$ . The demand function is  $Q_d = 28 - p$ .
- What is the long-run supply function?
  - What is the long-run equilibrium price, quantity, number of firms, output of each firm, and profit of each firm?
  - Suppose the above cost function is also the short-run cost function. There are 12 identical firms in the market. What is the short-run market supply function? If your answer of the number of firms in part b. is also 12, compare the short-run market supply

function with the long-run supply function you get in part a., are they different? If yes, explain why they are different.

36. If the cost function is  $C(q) = 10q - q^2 + \frac{1}{3}q^3$  and  $MC(q) = 10 - 2q + q^2$ .

- a. What is the long-run market supply function?
- b. Do you need the demand function to get the output of each firm in the long-run equilibrium? If no, what is it?
- c. Do you need the demand function to get the profit of each firm in the long-run equilibrium? If no, what is it?

Now suppose the demand function is  $p = 60 - 2Q_d$ .

- d. If a firm needs a license to enter the market, and the government gives out at most 10 licenses. What is the profit of each firm in the long run? What if the government gives out 30 licenses at most?

37. If the cost function is  $C(q) = 9 + 10q + q^2$  and  $MC(q) = 10 + 2q$ . The demand function is  $p = 60 - 2Q_d$ .

- a. What is the number of firms in the long-run equilibrium? (The number of firms does not have to be an integer.)
- e. If the number of firms must be an integer. What is the number of firms in the long run? What is the profit of each firm?