1. Read the excerpt below from an article entitled “Railroads Getting in Better Shape for the Long Haul” that appeared in the Wall Street Journal on February 26, 1992.

The chief reason for the industry’s turnaround is big cuts in employment. Santa Fe, for instance, has slashed its work force to 14,000 from 23,000. Overall, rail industry employment has dropped nearly 50% to about 283,000 according to the Association of American Railroads. And railroads expect to save an additional $1 billion a year from new labor pacts that reduce train crews by one or two positions to only an engineer and a conductor. Railroads had been fighting for such contracts for decades.

The reason the railroads were fighting for decades to reduce train crews is because technological innovations that occurred in the early 1970’s allowed railroads to automate which made some jobs done by the train’s crew obsolete. Suppose the graph below depicts the isoquants of a firm in the train industry prior to the early 1970’s and an isocost curve. Assume that the firm produces an output of $Q'$ and minimizes costs prior to the early 1970’s by employing 11 units of capital and 5 units of labor (where the isocost curve is tangent to the isoquant).

![Graph](https://via.placeholder.com/150)

**a)** How has the technological innovations in the early 1970’s in the railroad industry affected the above graph?

The technological innovations resulted in the firm’s isoquants changing. Basically, they resulted in less labor being required to produce a given output. In addition, it likely changed the “trade-off” between capital and labor which is to say it changed the slope of the isoquant curves. More than likely, it made the isoquants flatter because by investing in a little capital (automation), the firm could reduce the amount of labor more (while keeping the output the same) after the technological innovations. Let the dashed line above represent the isoquant curve associated with an output of $Q'$ after the technological innovations.

**b)** Using the graph above, explain how the existing labor contract in the 1970’s affected the firm’s ability to minimize costs. How has this changed with the new labor contract? DEPICT GRAPHICALLY.

Suppose the cost of a unit of labor and a unit of capital did not change in the 1970’s. Therefore, the slope of the isocost curves remained the same. (I have drawn another isocost curve on the graph which is tangent to the new isoquant curve.) In this case, if the firm could select the amount of capital and the amount of labor that would minimize costs of producing an output of $Q'$, they would choose 12 units of capital and 2 units of labor. However, the existing labor contract in the 1970’s required the firm to employ a certain number of labor units. Suppose the contract required the firm to employ 6 units of labor, then the firm would have to employ (approximately) 7 units of capital and 6 units of labor to produce the output of $Q'$. This combination of capital and labor is on a “higher” isocost curve than 12 units of capital and 2 units of labor. (It costs more to produce $Q'$ units of output by employing 10.5 units of capital and 3 units of labor than by
employing 12 units of capital and 2 units of labor.) The new labor contract is less restrictive in terms of how much labor the firm has to employ. This will result in a lower cost to the firm.

c) Suppose the labor contract does not restrict how much labor the firm can employ and it is currently 1969 (so the firm’s isoquants are as depicted above). Assume that the firm has 6 units of capital (K) in the short run. If the cost of capital is $5 per unit and the cost of labor (L) is $20 per unit, what is the firm’s average total cost in the short run (SRATC) at an output of $Q'$? What is the firm’s average total cost at an output of $Q'$ in the long run (LRATC)?

Based on the information above, depict on the graph below possible LRATC and SRATC curves for the firm (indicate the SRATC and LRATC at $Q'$).

If the firm has 6 units of capital, it would have to employ 9 units of labor to produce an output of $Q'$. This would result in a short run total cost of $6(5)+(9)20=210$. In the long run, the firm would employ 11 units of capital and 5 units of labor resulting in a long run total cost of $11(5)+(5)20=155$. Therefore, at an output of $Q'$ the SRATC=$210/Q'$ and the LRATC=$155/Q'$.

2. The graph below depicts the isoquant curves for a particular firm (along with the output, in units, associated with each isoquant) where K denotes units of capital and L denotes units of labor.

Suppose the cost of capital is $10 per unit and the cost of labor is $30 per unit.

a) On the graph above, identify how much capital and labor a profit maximizing firm will employ in the long-run if the firm produces an output of 50 units? EXPLAIN. (I would like you to depict the appropriate isocost curve.)

The amount of capital and labor employed is the amount that minimizes costs subject to producing an output of 50. The depicted isocost curve above is tangent to the isoquant associated with 50 units of output at capital of 6 units and labor of 3 units. [You do not have to be precise in your answer on this one. As long as you draw an appropriate isocost curve and understand how to determine the cost minimizing (which results in profit maximizing) amounts of capital and labor, you will be given full credit].

b) What is the firm’s long-run average total cost associated with producing 50 units of output? SHOW CALCULATIONS.

The long-run average total cost is $6*10+3*30=150$.

c) If the firm has 10 units of capital which it cannot change in the short-run, what is the firm’s short-run average total cost associated with producing 50 units of output? SHOW CALCULATIONS.
To produce 50 units of output with 10 units of capital, the firm would have to employ 2 units of labor. The short-run average total cost would then be $10 \times 10 + 2 \times 30 = 160.$
3. You are the manager at Brueger bagels and must decide whether to open on Sunday. Your lease of the space costs you $6,000 a month. (Assume there are 30 days in the month.) If you open on Sunday, you would sell 1,000 bagels at a price of $.75 per bagel and 500 cups of coffee at a price of $1 per cup. The material (flour, onions, raisins, etc.) for each bagel costs you $.20 and the material for the coffee costs you $.30 per cup. To stay open on Sunday, you require 5 workers. Each worker costs you $100 per day. Assume the utilities used on a Sunday costs you $50. Should you open on Sunday? Show your calculations.

The additional revenue (benefit) obtained from opening on Sunday is 1000(.75)+500(1) = $1250. The additional cost is 1000(.2)+500(.3) +5(100)+50=900. Because the additional revenue is greater than the additional cost, you should open on Sunday.

Note that the cost of the lease does not impact your decision because you have to pay the lease whether or not you open on Sunday.

4. The following table provides information on a firm’s costs.

<table>
<thead>
<tr>
<th>Output</th>
<th>AVERAGE FIXED COSTS (AFC)</th>
<th>AVERAGE VARIABLE COSTS (AVC)</th>
<th>AVERAGE TOTAL COSTS (ATC)</th>
<th>MARGINAL COSTS (MC)</th>
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a) What is the marginal cost (MC) associated with the 1st unit of output? What is the marginal cost (MC) associated with the 4th unit of output?

The total variable cost (TVC) of producing an output of 2 is 2(5.5)=11. The TVC of producing an output of 1 is 11-6=5. The reason for this is because the MC of the second unit is $6 which indicates that total cost increases by $6 when output increases from 1 to 2. Because fixed costs do not vary with output, we know that TVC must have increased by 6. The TVC at an output of 0 is 0. Because the TVC increases by 5 (as well as the total cost) when producing 1 unit versus 0 units of output, the MC associated with the 1st unit of output is 5.

The TVC of producing an output of 5 is 7(5)=35. Because the MC of the 5th unit of output is 9, the TVC of producing an output of 4 is 35-9=26. The TVC of producing an output of 3 is 3(5)=15. Therefore, the MC associated with the 4th unit of output is 26-15=11.

b) Suppose the Total Fixed Costs (TFC) are $21. What is the average total cost (ATC) of producing 2 units of output? If TFC equal 21, AFC at an output of 2 is 21/2=10.5. ATC is just AFC+AVC which is 10.5+5.5=16 at an output of 2.

5. Read the attached article entitled “Big Salt Producer Says Winter Storms Are Mixed Blessing” and briefly discuss (two sentences and a graph will do) what it implies about the shape of Akzo’s short run cost curves. (Again, the idea is to relate it to the material discussed in class.)

The article states that costs have gone up as the Akzo Salt increases its output. (The article appears to be referring to total costs.) This is not very interesting and doesn’t tell us much about Akzo’s short run cost curves. The article also states that “it costs more to transport the salt” and “to offset the problems of moving rock salt de-icers by road and rail, Akzo already has shipped a couple thousand tons of sea salt-based deicers via boat”. This suggests that the marginal cost of transporting salt increases with output; as Akzo has increased output to 3.5 millions tons of rock salt this year.
6. The cost data of the Preservation Embalming Company has been partially entered in the table below. Please fill in the remaining entries in the table.

<table>
<thead>
<tr>
<th>Bodies Embalmed</th>
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<th>TC</th>
<th>MC</th>
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</table>

7. The graph below depicts the cost curves for a particular firm.

Suppose the firm is currently producing an output of 11 units and making total revenue of $200.

a) What are the firm’s total fixed costs? Show calculations.

Select a q, say q = 7. AFC = ATC - AVC = 10 - 6 = 4 at q = 7. So TFC = AFC*q = 4*7 = 28.

b) What are the firm’s profits? Show calculations.

TR - TC = TR - ATC*q = 200 - 11*12 = 68.

c) Suppose the firm is able to sell two additional units of output to a particular consumer for a price of $32 (or $16 for each of the additional units). Assume that the revenue from the first 11 units remains at $200 even if the firm does sell these two additional units of output. How much will the firm’s profits change if they do sell these two additional units? Show calculations.

TR increases by 32. MC of 12th unit is 21 and MC of 13th unit is 23. So TC increases by 44. Therefore, profits decrease by 44 - 32 = 12.
8. The graph below depicts the marginal cost (MC) and average variable cost (AVC) of a firm.

![Graph of MC and AVC](image)

a) Suppose the firm maximizes profits by producing an output of 10. At this output, the firm’s total revenue is $146 and its profits are $20. If this is the case, what is the firm’s total fixed cost (TFC)? Show calculations.

If the firm’s total revenue is $146 and its profits are $20 at an output of 10, then total cost is (because TR-TC=Profits, TC=Profits-TR) 146-20=126. At an output of 10, TVC=AVC*q=11*10=110. Therefore, total fixed cost is 126-110=16 (because TC=TFC+TVC, TFC=TC-TVC).

b) If the firm’s total revenue increases from 100 to 110 by producing an output of 7 compared to an output of 6, how will the firm’s profits change from producing an output of 7 compared to an output of 6? Show calculations.

The easiest and most accurate way to calculate how profits change is to consider the marginal revenue (MR) and marginal cost (MC) associated with the 7th unit of output. The marginal revenue is 110-100=10 and the marginal cost (from the graph) is 12. Therefore, profits decrease 12-10=2 by producing 7 units of output instead of 6.

Another way to estimate how profits change is to calculate profits at an output of 7 and at an output of 6. (Note: You will not be given full credit on the exam if you calculate the change in profits in this manner.) Because the scale of the graph prevents a precise calculation of profits, calculating marginal revenue and marginal cost of the 7th unit provides a more precise answer. Profits at 7 units of output are 110-16-8.5*7=34.5 (TR-TFC-AVC*q) and profits at 6 units of output are 100-16-8*6=36 (TR-TFC-AVC*q). Therefore, the estimated decrease in profits from producing the 7th unit is 36-34.5=1.5.