1. a. You can only say that you will not hire the 6th and 7th workers. The 7th causes total output to go down, hence decreasing revenue (price x quantity), and also must be paid a wage, which causes costs to increase. The 7th unit of labor therefore decreases profits. Similarly, the 6th unit of labor causes profits to fall. This unit of labor adds to costs, but since they have zero marginal product, they do not add anything to revenues.

For workers 1-5, you need more information to know if you will hire them. Specifically, you need to know the price of the output that you sell (so that you know the workers contribution to revenue) and you need to know the wage (so that you know the workers contribution to costs). If they add more to revenue than they do to costs, they cause profits to increase and hence should be hired.

b. The point of diminishing marginal returns is after the 3rd worker.

c. As we added units of a variable input (labor) to a certain amount of fixed inputs, eventually we reach a point where the extra production obtained from the variable input will decrease.

We reach a point of diminishing marginal returns - where adding more units of the variable input will no longer increase output. This is the Law of diminishing marginal returns → the extra production obtained from increases in a variable input will eventually diminish as more of the variable input is used with fixed inputs.

⇒ there is a limit to the extra production we can get by adding workers to fixed capital.
⇒ for a given amount of capital, there is some optimal quantity of labor.

2. No. the law of diminishing marginal returns does not hold in the “long run” because, by definition, there are no fixed inputs in the long-run, and diminishing returns is a direct result of using variable inputs in combination with fixed inputs.

3. **Economic Profit** = total revenue - economic costs where Economic cost = explicit + implicit costs.

**Accounting Profit** = total revenue - accounting costs where Accounting Costs = explicit costs only

**Normal profit** is earned when accounting profits are large enough to cover implicit costs. In other words a normal profit is when economic profit = 0.

Since economic costs are always greater than or equal to accounting costs, accounting profit will always be greater than or equal to economic profit.
4. Both short-run and long-run cost curves are u-shaped because of the inverse relationship between productivity and unit costs. However, the reason for the changes in productivity, and hence the resulting changes in unit costs, is different in the short-run than in the long-run. In the short-run, the principle of diminishing marginal returns (DMR) holds. That is, when adding units of a variable input to fixed amounts of other inputs, the marginal returns may increase at first, but eventually will decrease (the fixed inputs serve as a limit to the additional gains from the variable input ~ remember the in-class production example). Hence, as short-run productivity rises initially (prior to reaching the point of DMR), the firm is getting more output from each additional unit of inputs, so we should expect unit costs to fall. Beyond the point of DMR however, the firm is getting fewer units of output from each input, so unit costs should rise.

In the Long-run, there are no fixed inputs by definition, so we must explore changes in productivity that come about as a result of changes in the use of all inputs. This idea is known as "returns to scale", where scale is simply the size of the firm. We learned that as firms expand the scale of operations initially (increasing the use of all inputs) they might first experience increasing returns to scale (IRTS): as a firm gets bigger (larger scale of operations) it gets more efficient, and therefore unit costs of production decrease.

✪ IRTS ⇒ A given percentage increase in all inputs ⇒ a larger percent change in output ⇒ unit costs decrease. (3 reasons for this --- you should know them)

However, a firm may get too big, such that further increases in size serve to decrease productivity. This is known as decreasing returns to scale (DRTS): An increase in the size or scale of the firm may result in a decrease in efficiency and therefore an increase in unit costs.

✪ DRTS ⇒ A given percent change in the use of all inputs results in a smaller percent change in output ⇒ unit costs increase. (2 reasons for this --- you should know them)

Somewhere in the middle the firm might experience a range of constant returns to scale:
✪ CRTS ⇒ A given percentage increase in all inputs ⇒ the same percent change in output ⇒ no change in unit costs. (replication of a production process).

Hence we can illustrate the changes in returns to scale and the resulting changes in unit costs as follows:

---

Costs ($)  

<table>
<thead>
<tr>
<th>IRTS</th>
<th>CRTS</th>
<th>DRTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>↑ scale ⇒ no Δ in efficiency ⇒ no Δ in unit costs</td>
<td>↑ scale ⇒ no Δ in efficiency ⇒ no Δ in unit costs</td>
<td>↑ scale ⇒ no Δ in efficiency ⇒ no Δ in unit costs</td>
</tr>
<tr>
<td>↑ efficiency ⇒</td>
<td></td>
<td></td>
</tr>
<tr>
<td>↓ unit costs</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Q (output = size of firm)
5. F
6. C
7.   a. $53,000 (labor, rent, other)
     b. $99,600 (explicit + opportunity costs of time and funds)
     c. $117,000
     d. $70,400
     e. $46,600

8. D
9. B
10. A
11. True
12. False
13. True – the marginal product per dollar spent is higher for capital than for labor
14. D – technology D has the lowest cost

15. B
16. C
17. D
18. A
19. C
20. C
21. C

22.

<table>
<thead>
<tr>
<th>Labor (L)</th>
<th>Output (Q)</th>
<th>Total Fixed Costs</th>
<th>Total Variable Costs</th>
<th>Total Costs</th>
<th>Average Fixed Costs</th>
<th>Average Variable Costs</th>
<th>Average Total Costs</th>
<th>Marginal Costs</th>
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<td>0</td>
<td>500</td>
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<td>2.73</td>
<td>5.00</td>
<td>3.75</td>
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</tbody>
</table>

22. False
23. False