1. (50 points total – 5 points for each of 8 parts plus 10 for diagram) The production technology of a firm is given in the table below.

<table>
<thead>
<tr>
<th>Number of workers</th>
<th>Units of output</th>
<th>MPN</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>—</td>
</tr>
<tr>
<td>1</td>
<td>48</td>
<td>48</td>
</tr>
<tr>
<td>2</td>
<td>84</td>
<td>36</td>
</tr>
<tr>
<td>3</td>
<td>108</td>
<td>24</td>
</tr>
<tr>
<td>4</td>
<td>128</td>
<td>20</td>
</tr>
<tr>
<td>5</td>
<td>143</td>
<td>15</td>
</tr>
<tr>
<td>6</td>
<td>155</td>
<td>12</td>
</tr>
<tr>
<td>7</td>
<td>165</td>
<td>10</td>
</tr>
</tbody>
</table>

a. Define the marginal product of labor, explain how it relates to the production function (with N on horizontal axis and Y on vertical axis) and find the marginal product of labor (MPN) for each level of employment (fill in the third column of table).

\[
\text{Marginal Product of Labor} = \frac{\Delta Y}{\Delta N}
\]

\[
\text{Marginal Product of Labor is the slope of the Production Function.}
\]
b. Assume that the price of a unit of output is $8. Calculate the number of workers that will be hired if the nominal wage rate is $168. Calculate the number of workers the firm will hire if the nominal wage is $128. Calculate the number of workers that the firm will hire if the nominal wage is $88.

Draw a production function and real labor demand curve vertically with the PF on top (like we do in class), labeling point A as the wage / price combo of $168 / $8, point B as the $128 / $8 combo, and point C as the $88 / $8 wage / price combo.

A correct and completely labeled diagram is worth 10 points.

A correct and completely labeled diagram is worth 10 points.

c. What could cause wages to fall like this (name and support 2 reasons)?

1. **Expected Income (y_e)**
   - When the expected income decreases, people will work more than they are now so the labor supply will decrease, thus the wage will fall.

2. **Wealth**
   - When the wealth goes down, people will also work more to remain at the same level of living standards. The labor supply shifts to the right, which will decrease the wage as well.
d. Why exactly does the firm's behavior change when the nominal wage changes, all else constant? Make sure you refer to the **profit maximizing condition** when answering this question.

Since when Nominal wage changes, the MPN changes corresponding, as calculated above. According to \( W = MPN \), which is the profit-maximizing condition, \( W \) should change as MPN changes. If only MPN changes, but \( W \) does NOT change. Then it violates the profit-maximizing condition. Therefore, the company should either increase their wages or increase the labor hired.

Therefore, the firm will change its behavior when the nominal wage change.

e. Let's return back to the initial conditions in the beginning of part b, with prices at $8, and nominal wages at $168 (point A). Now we let prices change and fall from $8 to $6, holding nominal wages constant at $168. What could cause such a price change (name at least 2 reasons)?

1. Deflation is a factor that could cause the decrease in price.

2. Recession is another factor that could cause the decrease in price as well, because people don't have the extra money to buy as much goods as the recovery period.

f. Locate this 'new' point as point D on your two diagrams. Similar to part d), why exactly does the firm's behavior change when price fall from $8 to $6, all else constant? Again, make sure you refer to the **profit maximizing condition** when answering this question.

**Point D:** MPN = \$168/\$1 = 8 \rightarrow 2 workers, \( y = 84 \)

When the price falls from $8 to $6 while keep others constant, firms will fire workers.

If the firm still keeps the same level of labor, the extra workers' MPN will be smaller than their real wage.

However, the profit maximizing condition states in order to maximize profit, \( W = MPN \). Therefore, it violates the profit-maximizing condition. So as real wages decrease, firm will change their behavior by hiring less workers.
g. Let's return to point A, the initial conditions where the nominal wage rate is $168 and the price of a unit of output = $8. Assume that a new technology increases the number of units of output that each worker can produce by 25%. Calculate the number of workers that the firm will hire and the number of units of output that will be produced (fill in the table below).

<table>
<thead>
<tr>
<th>Number of workers</th>
<th>Units of output</th>
<th>MPN</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>2</td>
<td>105</td>
<td>45</td>
</tr>
<tr>
<td>3</td>
<td>135</td>
<td>20</td>
</tr>
<tr>
<td>4</td>
<td>160</td>
<td>15</td>
</tr>
<tr>
<td>5</td>
<td>178.75</td>
<td>18.75</td>
</tr>
<tr>
<td>6</td>
<td>193.75</td>
<td>15</td>
</tr>
<tr>
<td>7</td>
<td>206.25</td>
<td>12.5</td>
</tr>
</tbody>
</table>

Now locate this point as point E on both diagrams.

\[ \text{Number of workers: } N = 4 \]

h. Comment on the macroeconomic implications of this technology shock (as in assume many firms in the economy experience similar technology shocks) on prices (inflation), employment, economic growth, real wages, the stock market via the profit implications, and the budgetary implications for the Government (make sure you refer to each economic variable).

As the market goes through the technology shock, the price stays the same; the employment of workers increases; the economic growth increases due to the outward shift in production function; the real wages do NOT change; the stock market increases its profitability; and the Government budget increases.
2. (50 points total – 5 for each of 8 parts and 10 for diagram) This is an old exam question and is in your packet… I tweaked it a little.

For the new Real World State College season MTV is looking for Penn State students. Students are asked to produce “drama” as a part of their contract. The marginal productivity of labor curve is given by $MPN = 230 - 3N$. The marginal productivity of labor curve is given by $MPN = 230 - 3N$.

The supply of Penn State students is given by $N_s = 30 + 3w$; where $w$ is the real wage per hour.

2a) Compute equilibrium values for the real wage and employment.

Illustrate this equilibrium on a labor market diagram in real wage space. Please be sure you label the diagram completely and label this initial equilibrium point as $point A$.

A correct and completely labeled diagram is worth 10 points.
2b) Now the Penn State student union successfully forces MTV to pay each student a minimum “happy valley living real wage” equal to 20.00 per hour. That is, 20.00 per hour is the effective real minimum wage. What is the level of employment now?

\[ W = MPN = 20.00 \]
\[ 20 = 230 - 3N \]
\[ 3N = 230 - 20 \]
\[ N = (230 - 20) / 3 \]
\[ N = 70 \]

\[ \text{Point } B \quad W = 20. \]

\[ \text{willing to hire} \]

2c) Compare the number of people willing to work vs. the number of people MTV is willing to hire under this living wage program. What do we call the difference in these values when the quantity of labor supplied exceeds the quantity of labor demanded? Add these two points to your diagram and label these points as point(s) B. Make sure you identify the unemployed in your diagram.

\[ N_s = 30 + 3W = 30 + 3 \times 20 = 90 \quad \text{Point } B \quad W = 20. \]

As the labor supply exceeds the labor demand, there is a difference when \( N_s > N_d \). The difference is called extra labor supply / the unemployment.

And the difference is \( 90 - 70 = 20 \)

2d) The intuition part 1: Why exactly did we move along the labor demand curve? In particular, why does the profit maximizing level of labor input change with the living wage program (make sure you write out the profit maximizing condition and explain why it has changed i.e., why does MTV rationally change their quantity demanded of labor the way they did)?

According to the profit - maximizing condition:

\[ W = MPN \]

When real wage increases, if the firm still keeps the same amount of labor, the extra workers exceed the demand will have \( MPN > W \), which violates the profit maximizing condition mentioned above. Therefore, the firm will lay off workers to achieve the profit - maximizing condition. Since they fire workers, there is a movement along the Nd curve.
2e) The intuition part 2. We also experience a movement along the labor supply curve. Explain the intuition here as to why are more people willing to work using and explaining the substitution and income effects associated with labor supply. Which effect dominates and what has happened to the price of leisure for those that are still working, given the living wage program?

There is also a movement along the labor supply curve because as the real wage goes up, the opportunity cost for leisure will increase, so workers will work more. Substitution effect is when the wages increase, workers will substitute leisure for working. Income Effect is when the labor wages increase, workers will work less, and enjoy more leisure because they can have the same level of living standard by working less than they used to be. According to the graph, as wage increases, the Ns increases. Therefore, the substitution effect dominates, so the price increases.

2f) Suppose now that a new course offered by the Drama Department increases the productivity of each student (via an increase in human capital) so that the new marginal product of labor equals MPN = 290 - 3N. Find the equilibrium market clearing wage and level of employment. Please show all work below.

Please depict this new development on your original diagram labeling this new equilibrium point as point C. Be sure to label diagram completely.

\[ W = MPN = 290 - 3(30 + 3W) \]
\[ 10W = 200 \]
\[ W = 20 \]

\[ Ns = 30 + 3W \]
\[ = 30 + 3 \times 20 \]
\[ = 90 \]
2g) Compare the welfare of the workers under the two scenarios: 1) the living wage program vs. 2) no living wage program but the productivity shock as in part f. In other words, are workers better off in part b) or are they better off in part f)? Be sure to explain.

Workers are better off under productivity shock (part f).

In living wage program (part b), firms are forced to pay higher wages to workers, and based on profit-maximizing condition, firms need to lay off workers. Therefore an increase in unemployment occurs. In comparing, during a productivity shock, even though working workers end up with the same amount of real wages, the number of workers employed increases. The overall and total labor is benefited if the economy experiences the productivity shock (part f).

Therefore, the productivity shock (part f) will allow all workers in the labor market better off.

2h) Compare the welfare of the firm, the producer. Is the firm better off in terms of profits in part b) or in part f)? Be sure to explain (feel free to refer to the plastering example and/or the new economy).

From the firm's perspective, part f will make the firm better off.

Even though part (b) and part (f) have the same labor wages, and part (b) hires less workers part (f) still has the productivity shock which increases the MPN greatly, thus increasing the profit of the firm.

Also, from profit-maximizing point of view, part (b), the firm does NOT meet its profit-maximizing wages & labor. However, for part (f), the $20 wage and 90 employment labor is the profit-maximizing point for the firm. Therefore, part (f) allows the firm better off.
An economy's aggregate production function is given by $Y = A \cdot K \cdot N - N^2$. The marginal product of labor for this production function is $MPN = A \cdot K - 2N$.

(a) Assume that $A = 2$ and $K = 16$. Suppose that the labor supply function for this economy is given by $N_s = 4 + w$. Find the equilibrium real wage rate, the full employment level of employment, and the full-employment level of output for this economy.

Draw a production function and labor demand curve vertically as we did in class (many times) and label this initial equilibrium point as point A.

A correct and completely labeled diagram is worth 15 points

(b) Suppose that a new innovation leads to an increase in total factor productivity so that $A$ increases to 2.75. Everything else remains as in part (a). Find the equilibrium real wage rate, the full employment level of employment, and the full-employment level of output for this economy and label on your diagrams as point B.
(c) Let's go back to our initial conditions (point A). Instead of a new innovation impacting the economy, assume that severe weather destroys a portion of the capital stock, so that \( K = 13 \). Everything else is as it was in part (a). (In particular, \( A = 2 \).) Find the new levels of the equilibrium real wage rate, the full employment level of employment, and the full-employment level of output for this economy and label (on both diagrams) as point C.

\[ \text{Point } C \]

\[ M^P_N = A^e + 2N = 2 \times 13 - 2N = 26 - 2N \]

\[ N^* = M^P_N = 26 - 2(4 + W) \]

\[ 2w = 26 - 8 \]

\[ w = \frac{18}{3} \]

\[ W^* = 6 \]

(d) Instead of a new innovation or bad weather impacting the economy (we are back to point A), suppose that there is a change in the supply of labor so that \( N^s = 7 + w \) (All else remains as in part (a)). (In particular, \( A = 2 \) and \( K = 16 \).) Find the new levels of the equilibrium real wage rate, the full employment level of employment, and the full-employment level of output for this economy and label on your diagrams as point D.

\[ \text{Point } D \]

\[ M^P_N = 2 \times 16 - 2N \]

\[ N^* = M^P_N = 4 + w = 16 - \frac{18}{3} \]

\[ W^* = 6 \]

\[ y^* = 2 \times 16 \times \frac{12}{3} \]

\[ = 247 \]

(e) Give two well supported answers as to why \( N^s \) might have changed as it did in part (d) above.

\[ 1 \text{ Demograph.} \]

As workers in a more competitive working location, the labor market increases, therefore, \( N^s \) increases.

\[ 2 \text{ Participation} \]

With greater level of labor participation, the workers want to work more and more involvements. So \( N^s \) increases.

\[ 3 \text{ Expected income (} y^e \text{)} \]

If workers' expected future income decreases, they will want to work more today. And \( N^s \) increases.

\[ 4 \text{ Immigration (} J_{NM} \text{)} \]

As more immigrants move in, the labor force increases and