1) Consumer Choice. Use data in the following table:

<table>
<thead>
<tr>
<th>Month</th>
<th>Income</th>
<th>P_Coke</th>
<th>P_Pepsi</th>
<th>Q_Coke</th>
<th>Q_Pepsi</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>$200</td>
<td>$1.25</td>
<td>$1.00</td>
<td>60</td>
<td>125</td>
</tr>
<tr>
<td>February</td>
<td>$240</td>
<td>$1.00</td>
<td>$1.00</td>
<td>90</td>
<td>150</td>
</tr>
<tr>
<td>March</td>
<td>$200</td>
<td>$1.00</td>
<td>$1.00</td>
<td>80</td>
<td>120</td>
</tr>
</tbody>
</table>

a) Compute Coke’s income elasticity (you do not need to use the “arc” formula for these calculations).
b) Compute Coke’s price elasticity.
c) Compute Pepsi’s cross-price elasticity of demand. What kind of goods are these?
d) Derive an equation for the consumer’s budget constraint in January. Graph this equation and show the consumer’s optimal choice.
e) Add the consumer’s March budget constraint to your graph. What happened to the consumer’s Marginal Rate of Substitution of Pepsi for Coke between January and March? Explain.
f) Explain the income and substitution effects that occur between January and March. Which effect dominates?
g) Explain why all consumers will have the same MRS after the price changes. Why does this result imply that competitive markets with no externalities yield Pareto efficiency?

2) Supply, Demand, and Elasticities

In the market for milk, initially 100 million gallons are purchased at a price of $2 per gallon. At this price and quantity the price-elasticity of demand for milk is -2, while the price-elasticity of supply of milk is 0.5.

a) If the government imposed a price floor of $2.20, estimate the change in the quantity demanded and supplied.
b) Would there be a shortage or surplus of milk on the market?

3) Intertemporal Consumption Choice

Bill lives for two periods. Bill can borrow and lend at the same interest rate, which is currently 10%. Bill currently lends money out in the first period (i.e., he consumes less than his first period income). If the interest rate increased to 15%, how would Bill change his first period consumption? (Note: assume consumption in both periods are normal goods).

4) Government Intervention in Labor Markets

Explain why you would want to know the “elasticity of labor demand” if you were trying to estimate the effect of an increase in the minimum wage.
5) **Tax Burdens**

Social Security taxes are paid equally by employers and employees. Employers pay the government 6.25% of their employees wages, and employees pay 6.25% of their wages. Explain how this split of the taxes accurately or does not accurately reflect the burdens of the tax.

6) **Pareto Efficiency**

Define Pareto Efficiency. Do you think this is an appropriate criterion for judging an allocation of resources? List at least one way in which it is inappropriate. Under what circumstances will a competitive equilibrium be Pareto efficient?

7) **Endowment Economy**

In a simple endowment economy, Jack and Jill are the only two consumers. Suppose that only two goods are consumed in this economy: apples and pails of water. Initially, Jack has an endowment of 5 apples and 10 pails of water. At this endowment, his marginal rate of substitution of water for apples is -1. Jill’s endowment consists of 15 apples and 20 pails of water, and her marginal rate of substitution of water for apples is -3. Is the endowment Pareto efficient? If so, explain why. If not, describe a way to reallocate resources in order to make both agents better off. Draw an Edgeworth box diagram to illustrate your answer.

8) **Efficiency of Markets**

List and explain three conditions under which the market would NOT produce an efficient amount and allocation of goods.

9) **Monopolies**

A monopolist faces the following demand curve: \( Q_d = 50 - P/4 \). The monopolist's marginal cost is the following: \( MC = 10 + Q_s \).

a) Compute the number of units sold by the monopolist and the price charged.
b) If regulators wanted to maximize social surplus by setting a price ceiling, what price would they choose? Explain your answer.

10) **Social Surplus, Taxes, Externalities**

Suppose that demand and supply for SUVs is given by the following equations:

\[
\begin{align*}
Q_d &= 100 - 4P \\
Q_s &= -20 + 2P
\end{align*}
\]

a) Compute the equilibrium price and quantity. Compute the equilibrium consumer surplus, producer surplus, and social surplus.
b) If there were no externalities present, explain why the unregulated market would maximize social surplus.
c) Now, suppose that each SUV caused a $10 negative externality. Compute the external costs that SUV use imposes on others in the unregulated market.
d) Show graphically the deadweight loss caused in the unregulated SUV market. Compute this deadweight loss.
e) How would a tax on SUVs eliminate this deadweight loss?
11) **Taxes and Externalities**

Suppose supply and demand for a good are given by the following equations:

Supply: \( P = 3 + 2Q_s \)
Demand: \( P = 80 - 5Q_d \)

a) Compute the equilibrium price and quantity for this good.

b) If a seven-dollar tax is placed on this good, calculate deadweight loss, assuming there are no externalities.

c) Now, suppose that each good produced causes a $10 negative externality. Explain the concept of a negative externality. After the tax was imposed, would the deadweight loss be larger or smaller? Explain your answer graphically.

12) **Public Goods**

a) Explain why a public good is likely to be underprovided (\( Q < Q^* \)) by the private market.

b) Suppose that the government wants to provide the public good. They want to produce the Pareto efficient quantity (\( Q^* \)). What information would they need and how would they use that information.
Answers

1) Consumer Choice. Use data in the following table:

<table>
<thead>
<tr>
<th>Month</th>
<th>Income</th>
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<td>$1.00</td>
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<td>120</td>
</tr>
</tbody>
</table>

a) Compute Coke’s income elasticity (you do not need to use the “arc” formula for these calculations).

Using February and March:

\[
\%\Delta \text{Income} = \frac{(200 - 240)}{240} = -16.7%
\]

\[
\%\Delta \text{Coke} = \frac{(80 - 90)}{90} = -11.1%
\]

Income elasticity = \(\frac{\%\Delta \text{Coke}}{\%\Delta \text{Income}}\) = -11.1% / -16.7% = 0.667

b) Compute Coke’s price elasticity.

Using January and March:

\[
\%\Delta \text{Price} = \frac{(1 - 1.25)}{1.25} = -20%
\]

\[
\%\Delta \text{Coke} = \frac{(80 - 60)}{60} = 33.33%
\]

Price elasticity = \(\frac{\%\Delta \text{Coke}}{\%\Delta \text{Price}}\) = 33.3% / -20% = -1.67

c) Compute Pepsi’s cross-price elasticity of demand. What kind of goods are these?

Using January and March:

\[
\%\Delta \text{Price of Coke} = \frac{(1 - 1.25)}{1.25} = -20%
\]

\[
\%\Delta \text{Pepsi} = \frac{(120 - 125)}{125} = -4%
\]

Cross Price elasticity = \(\frac{\%\Delta \text{Pepsi}}{\%\Delta \text{Price of Coke}}\) = -4% / -20% = 0.2

Since the cross price elasticity is positive, these two goods are substitutes.

d) Derive an equation for the consumer’s budget constraint in January. Graph this equation and show the consumer’s optimal choice.

Budget Constraint: \(P_x X + P_y Y = \text{Income}\)

\(1.25 * \text{Coke} + 1* \text{Pepsi} = 200\)

Given the data in the table above, the optimal choice is at Coke = 60 and Pepsi = 125

e) Add the consumer’s March budget constraint to your graph. What happened to the consumer’s Marginal Rate of Substitution of Pepsi for Coke between January and March? Explain.

Budget Constraint: \(P_x X + P_y Y = \text{Income}\)

\(1 * \text{Coke} + 1* \text{Pepsi} = 200\)
With Coke on the x-axis, the MRS of Pepsi for Coke would fall from 1.25 to 1.00 since \( MRS = \frac{P_{coke}}{P_{pepsi}} \).

f) Explain the income and substitution effects that occur between January and March. Which effect dominates?

With a lower price of Coke, the consumer should substitute from Pepsi to Coke. With a lower price of Coke, the consumer has more income (in effect) and will spend more on all normal goods. By looking at the change in behavior between February and March (when income falls), we can see that both goods are normal. Thus:

<table>
<thead>
<tr>
<th></th>
<th>Coke</th>
<th>Pepsi</th>
</tr>
</thead>
<tbody>
<tr>
<td>Substitution Effect</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Income Effect</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Total Effect</td>
<td>+</td>
<td>?</td>
</tr>
</tbody>
</table>

Since Pepsi falls between January and March, we can conclude that the substitution effect dominates the income effect.

g) Explain why all consumers will have the same MRS after the price changes. Why does this result imply that competitive markets with no externalities yield Pareto efficiency?

All consumers will face the same price ratio, which falls from 1.25 to 1.00. Since all utility maximizing consumers set \( MRS = \frac{P_{coke}}{P_{pepsi}} \), the MRS for all consumers will fall to 1.00. Since all consumers have the same MRS, there is no way to transfer Coke and Pepsi between them in such a way that no consumers are worse off – thus, the market equilibrium is Pareto efficient.

2) Supply, Demand, and Elasticities

In the market for milk, initially 100 million gallons are purchased at a price of $2 per gallon. At this price and quantity the price-elasticity of demand for milk is -2, while the price-elasticity of supply of milk is 0.5.

a) If the government imposed a price floor of $2.20, estimate the change in the quantity demanded and supplied.

\[
\%\Delta P = \frac{(2.2-2)}{2} = 10\%
\]
\[
\%\Delta Qd/10\% = -2
\]
\[
\%\Delta Qd = -20\%
\]
\[
\%\Delta Qs/10\% = +0.5
\]
\[
\%\Delta Qs = +5\%
\]

\( Qd \) would fall to 80 million gallons and \( Qs \) would rise to 105 million gallons.

b) Would there be a shortage or surplus of milk on the market?

There would be a surplus of 25 million gallons.
3) **Intertemporal Consumption Choice**

Bill lives for two periods. Bill can borrow and lend at the same interest rate, which is currently 10%. Bill currently lends money out in the first period (i.e., he consumes less than his first period income). If the interest rate increased to 15%, how would Bill change his first period consumption? (Note: assume consumption in both periods are normal goods).

*The increase in the interest rate would raise the present value of his lifetime income (as his savings now grow at a faster rate). Thus, Bill is richer. He will spread this new income to consumption in both periods (positive income effect on C1). However, the change in the interest rate makes second period consumption relatively cheaper (negative substitution effect on C1). Thus, overall it is unclear whether Bill will increase or decrease first period consumption.*

4) **Government Intervention in Labor Markets**

Explain why you would want to know the “elasticity of labor demand” if you were trying to estimate the effect of an increase in the minimum wage.

*The elasticity of labor demand tells you how many fewer workers the firms will hire once the wage is increased. If this elasticity is high, then policy makers should be concerned about the disemployment effect of the minimum wage.*

5) **Tax Burdens**

Social Security taxes are paid equally by employers and employees. Employers pay the government 6.25% * their employees wages, and employees paychecks have 6.25% of their wages taxed. Explain how this split of the taxes accurately or does not accurately reflect the burdens of the tax.

*If labor supply by employees is more inelastic than labor demand by employers, then employees will bear a high burden of the tax. Conversely, if labor supply by employees is more elastic than labor demand by employers, then employers will bear a high burden of the tax. The only way the tax burden will be equally shared is if labor demand elasticity = labor supply elasticity. It does not matter who actually pays the tax in computing these burdens.*

6) **Pareto Efficiency**

Define Pareto Efficiency. Do you think this is an appropriate criterion for judging an allocation of resources? List at least one way in which it is inappropriate. Under what circumstances will a competitive equilibrium be Pareto efficient?

*A Pareto Efficient allocation of goods exists when there is no way to increase one person’s utility without lowering the other’s utility. A Pareto efficient allocation is a minimal criterion for a “good” outcome – it ignores equity considerations. A competitive equilibrium will be Pareto efficient under the following circumstance:*

a) The market is competitive – i.e., all market participants take the prices as given by the market and no one participant can affect or set the price. Furthermore all consumers pay only one price. Lastly, consumers can buy all that they want at the given price (there are no large consumers).

b) There are no “externalities” to the consumption decision. An externality occurs when the welfare of one person is affected by the consumption decision of another person (e.g., driving and smog).
7) Endowment Economy

In a simple endowment economy, Jack and Jill are the only two consumers. Suppose that only two goods are consumed in this economy: apples and pails of water. Initially, Jack has an endowment of 5 apples and 10 pails of water. At this endowment, his marginal rate of substitution of water for apples is -1. Jill’s endowment consists of 15 apples and 20 pails of water, and her marginal rate of substitution of water for apples is -3. Is the endowment Pareto efficient? If so, explain why. If not, describe a way to reallocate resources in order to make both agents better off. Draw an Edgeworth box diagram to illustrate your answer.

The endowment is not Pareto efficient as the consumer’s marginal rates of substitution are not equal. Both would be better off if Jack traded some of his apples for some of Jill’s water. Jack is willing to give up one apple for one pair of water and Jill is willing to give up three pails of water for one apple. The final “price” for one apple will be between 1 and 3 pails of water.

8) Efficiency of Markets

List and explain three conditions under which the market would NOT produce an efficient amount and allocation of goods.

1. Large buyer or seller who can set the price (e.g., monopolist, oligopolist, etc.)—possibly caused by barriers to entry or lack of a homogenous good.
2. Information asymmetry between the buyer and seller.
3. Lack of information on the prices of goods in the market.
4. Goods with externalities or goods that are public goods.

9) Monopolies

A monopolist faces the following demand curve: Qd = 50 – P/4. The monopolist's marginal cost is the following: MC=10+Qs.

a) Compute the number of units sold by the monopolist and the price charged.

\[ Qd = 50 - \frac{P}{4} \]
\[ 4 * Qd = 200 - P \]
\[ P = 200 - 4 * Qd \]
\[ MR = 200 - 8 * Q \]

Set \( MR = MC \)

\[ 200 - 8 * Q = 10 + Q \]
\[ 190 = 9 * Q \]
\[ Qm = 190 / 9 = 21.11 \]

Plug into the demand curve:

\[ P = 200 - 4 * (21.11) \]
\[ P = 115.6 \]
b) If regulators wanted to maximize social surplus by setting a price ceiling, what price would they choose? Explain your answer.

\[ Q^* \text{ is where } SMB = SMC. \]

Assuming no externalities, \( SMB = 200 - 4Q \), and \( SMC = 10 + Q \)

\[
200 - 4Q = 10 + Q \\
190 = 5Q \\
Q^* = 190/5 = 38
\]

Plug into the demand curve:

\[
P = 200 - 4(38) \\
P = 48
\]

NOTE: the regulator would want to make sure that profit > $0 at that price. If not, the regulator may need to subsidize the monopolist, or let them charge a higher price.

10) Social Surplus, Taxes, Externalities

Suppose that demand and supply for SUVs is given by the following equations:

\[ Q_d = 100 - 4P \]
\[ Q_s = -20 + 2P \]

a) Compute the equilibrium price and quantity. Compute the equilibrium consumer surplus, producer surplus, and social surplus.

\[
100 - 4P = -20 + 2P \\
120 = 6P \\
P = 20 \\
Q = 100 - 4*20 = 20
\]

\[
CS = \frac{1}{2} * \text{Base} * \text{Height} = \frac{1}{2} * Qe * (P-intercept - Pe) = \frac{1}{2} * 20 * (25 - 20) = $50 \\
PS = \frac{1}{2} * \text{Base} * \text{Height} = \frac{1}{2} * Qe * (Pe - P-intercept) = \frac{1}{2} * 20 * (20 - 10) = $100 \\
SS = CS + PS + \text{Positive Externalities} - \text{Negative Externalities} + \text{Govt Revenue} - \text{Govt Expenditure} \\
SS = $50 + $100 = $150.
\]

b) If there were no externalities present, explain why the unregulated market would maximize social surplus.

Since the supply curve is constructed from firm’s MC curves, the supply curve gives the SMC of production. The demand curve is the SMB of production. At market equilibrium, Demand = Supply – thus, SMB = SMC.

c) Now, suppose that each SUV caused a $10 negative externality. Compute the external costs that SUV use imposes on others in the unregulated market.

External costs are $10 * 20 units = $200.
d) Show graphically the deadweight loss caused in the unregulated SUV market. Compute this deadweight loss.

Find \( Q^* \):

\[
SMC = PMC + \text{Externality}
\]

Rearrange the supply curve to find \( PMC \):

\[
Qs + 20 = 2P
P = Q/2 + 10 = PMC
SMC = Q/2 + 20
\]

Rearrange the demand curve to find \( PMB \):

\[
Qd = 100 - 4P
Qd - 100 = -4P
P = -Q/4 + 25 = PMB = SMB
\]

Set \( SMB = SMC \):

\[
-Q/4 + 25 = Q/2 + 20
5 = \frac{3}{4}Q
Q^* = \frac{20}{3} = 6.67
\]

\[
DWL = \frac{1}{2} \times \text{Base} \times \text{Height}
DWL = \frac{1}{2} \times (Qe - Q^*) \times (\text{SMC at } Qe - \text{SMB at } Qe)
DWL = \frac{1}{2} \times (20 - 6.67) \times ((20/2 + 20) - (-20/4 + 25))
DWL = \frac{1}{2} \times (13.33) \times ((30) - (20))
DWL = $66.7
\]

e) How would a tax on SUVs eliminate this deadweight loss?

A $10 tax placed on buyers or suppliers would cause the externality cost to be internalized. Thus, \( Qe = Q^* \).

11) Taxes and Externalities

Suppose supply and demand for a good are given by the following equations:

Supply: \( P = 3 + 2Qs \)
Demand: \( P = 80 - 5Qd \)

a) Compute the equilibrium price and quantity for this good.

\[
3 + 2Q = 80 - 5Q
7Q = 77
Q = 11
P = 3 + 2*11 = 25
\]

b) If a seven-dollar tax is placed on this good, calculate deadweight loss, assuming there are no externalities.

If we assume this tax is placed on the buyers, the new demand curve will be \( P = 73 - 5Qd \):
\[ 3 + 2Q = 73 - 5Q \]
\[ 7Q = 70 \]
\[ Q = 10 \]
\[ P = 3 + 2*10 = 23 \text{ – this is the price to suppliers. The price to buyers} = 30. \]

\[ DWL = \frac{1}{2} \times \text{Base} \times \text{Height} \]
\[ DWL = \frac{1}{2} \times (Q* - Qe) \times (\text{Buyer’s price at Qe} - \text{Supplier’s price at Qe}) \]
\[ DWL = \frac{1}{2} \times (11 - 10) \times (30 - 23) \]
\[ DWL = 3.50 \]

c) Now, suppose that each good produced causes a $10 negative externality. Explain the concept of a negative externality. After the tax was imposed, would the deadweight loss be larger or smaller? Explain your answer graphically.

*In this case, the tax would help consumers internalize some of the negative externality. The market equilibrium would be closer to Q* and deadweight loss would be reduced.*

12) **Public Goods**

a) Explain why a public good is likely to be underprovided (Q<Q*) by the private market.

*Free riders prevent private markets from providing the socially efficient quantity (Q*). Since free riders get to enjoy the product without paying for the product, and since everyone has an incentive to free ride, public goods are unlikely to be produced.*

b) Suppose that the government wants to provide the public good. They want to produce the Pareto efficient quantity (Q*). What information would they need and how would they use that information.

*First, they would want to know each citizen’s marginal benefit (demand) curve for the good. Second, they would vertically sum these marginal benefit curves to find the good’s social marginal benefit curve. Third, they would want to know the marginal cost of production of the good. The government would set the social marginal benefit equal to the social marginal cost to find Q*.***