Microeconomics

Remember that you are allowed to use a graphic display calculator (GDC) and this can prove very useful.

1.1 Competitive markets: demand and supply

Linear demand functions
A linear demand curve has the form: \( Q_d = a - bP \)
This simply states that quantity demanded per period is inversely related to price reflecting the law of demand and that the demand curve is a straight line from the northwest to the southeast on your paper.
The term \( a \) is a constant while the term \( -b \) is the slope of the function.
If the term \( a \) increases, the demand curve shifts to the right, indicating that demand has increased. If the term \( a \) decreases, the demand curve shifts to the left, indicating that demand has decreased.
If the absolute value of the coefficient of price increases then the demand curve you will have plotted on the graph paper becomes flatter, whereas if the absolute value of the coefficient of price decreases the demand curve becomes steeper. If this seems surprising remember that the convention we have, since the work of Alfred Marshall, is for the independent variable (price) to be on the vertical axis.
If you are asked to plot a demand function, first find the \( P \) intercept by putting in zero for quantity demanded in your function and then find the \( Q \) intercept by putting in zero for price. Connect the points. Initially, use a soft pencil and once you are sure you have done it right, go over the line with a black pen. The question paper will provide you the two axes for the demand curve is a straight line from the northwest to the southeast on your paper.

Linear supply functions
A linear supply curve has the form: \( Q_s = c + dP \)
This simply states that quantity supplied per period is directly related to price reflecting the law of supply and that the supply curve is a straight line from the southwest to the northeast on your paper.
The term \( c \) is a constant while \(+d\) is the slope of the function.
If \( c \) increases, the supply curve shifts to the right, indicating that supply has increased. If \( c \) decreases, the supply curve shifts to the left, indicating that supply has decreased.
If the coefficient of price increases, the supply curve plotted on the graph paper becomes flatter whereas if the coefficient of price decreases, the supply curve becomes steeper. Remember the convention to place the independent variable (price) on the vertical axis.
The question paper will provide the two axes with numbers on them. Choose any two convenient prices within the range given on the vertical axis and find the quantity supplied for each. Just substitute the values for \( P \) in the supply function. You will have determined two points on your paper which you simply connect. Use a soft pencil and then go over the line with a black ink pen. Remember that you are allowed to use a GDC calculator but ask to plot the inverse of the linear supply function you are given. Only positive numbers for price and quantities make sense.

Equilibrium price and quantity
The equilibrium condition requires that quantity demanded per period is equal to quantity supplied per period. You will have three equations: the demand equation, the supply equation and the equilibrium condition (given below as (1), (2) and (3) respectively) and you will have three unknowns (the price, the quantity demanded and the quantity supplied):

\[
(1) \ Q_d = a - bp \\
(2) \ Q_s = c + dp \\
(3) \ Q_d = Q_s 
\]

Put (1) and (2) into the equilibrium condition (3) and solve for \( P \). Put the equilibrium price you find into either the demand or the supply equation to find equilibrium quantity. For example:

\[
Q_d = 60 - 2P \\
Q_s = 4P \\
Q_d = Q_s
\]

Substituting the demand and the supply equations in the equilibrium condition:

\[
60 - 2P = 4P \\
60 = 6P \\
P = 10
\]

By putting the equilibrium price 10 into the supply equation we find that the equilibrium quantity is 40. Double check your answer by also substituting the value 10 for \( P \) into the demand equation. If you put into the demand and supply functions any price greater than 10 (the equilibrium price), quantity supplied will be greater than quantity demanded and their difference will be the excess supply resulting at that price. For example, if you put the price 20 into the demand function, quantity demanded will equal 20 units, whereas if you put 20 into the supply function, quantity supplied will be 80 units. Quantity supplied exceeds quantity demanded by 60 units, which is the excess supply resulting at a price of 20.
Indirect taxes
An indirect tax is a tax on goods or services. For the quantitative part of the exam you need to focus only on specific taxes (that is, a specific ‘dollar’ amount per unit of the good). If you do not care about the logic of the problem, the easiest way to deal with such a tax is to rewrite your supply equation substituting the term P with (P – tax). So, if the supply equation is:

$$Q_s = 4P$$

and a $3.00 tax per unit is imposed, rewrite it as:

$$Q_s = 4(P - 3)$$

The next step is to equate the demand with the new supply curve to find the new market price. Subtracting the tax from the new market price you just calculated will give you the new, net of tax, price that producers earn. Note that before the tax was imposed, the market price was also the average revenue earned by firms whereas after the tax is imposed, the average revenue earned is the net of tax market price found by subtracting the tax from the new market price.

If you have already plotted the original demand and supply curves on graph paper, you can just shift the supply curve vertically upwards by the amount of the tax to find the new market quantity and to answer a lot of other related questions.

Remember that an ad valorem tax (say a 15% VAT or sales tax) will not lead to a parallel shift of the supply curve but the new supply curve will create a ‘wedge’ with the original one (their vertical distance will be increasing).

Here is some advice on solving indirect tax problems.
- Solve algebraically before plotting on the graph paper to ensure that your calculations are precise.
- Avoiding using P1 and P2 and instead adopt more meaningful symbols like Pm or Pc for the new higher market price and the new market quantity and to answer a lot of other related questions.
- Be very systematic and neat. Write down all the relevant information in a table as this will facilitate any additional calculations you are asked to make.

For example, assume that demand and supply are given by:

$$Q_d = 60 - 2P$$

Denoting the original equilibrium price by $P_0$ and the original equilibrium quantity by $Q_0$ we have already found that:

$$P_0 = 10$$

$$Q_0 = 40$$

Remembering that in the posttax supply function we substitute (P – t) for the term P we must solve now the equations:

$$Q_s = 60 - 2P$$

$$Q_s = 4(P - 3)$$

Solving the system will yield the new market price that consumers will pay $P_t = 12$ and the new equilibrium quantity $Q' = 36$.

This is how the table might look:

<table>
<thead>
<tr>
<th>$P_t$</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>$Q_s$</td>
<td>40</td>
</tr>
<tr>
<td>$P_s$</td>
<td>12</td>
</tr>
<tr>
<td>$Q'$</td>
<td>36</td>
</tr>
<tr>
<td>$P_t = (P_t - \text{tax})$</td>
<td>9</td>
</tr>
<tr>
<td>Incidence on consumers</td>
<td>$12 - 10 = 2$ (consumers pay $\frac{2}{3}$ of the tax)</td>
</tr>
<tr>
<td>Incidence on consumers</td>
<td>$10 - 9 = 1$ (producers pay $\frac{1}{3}$ of the tax)</td>
</tr>
<tr>
<td>Initial revenues and expenditures $TR_0$</td>
<td>$P_s \times Q_s = 10 \times 40 = 400$</td>
</tr>
<tr>
<td>Post-tax producer revenues</td>
<td>$P_s \times Q' = 9 \times 36 = 324$</td>
</tr>
<tr>
<td>Post-tax consumer expenditures</td>
<td>$P_t \times Q' = 12 \times 36 = 432$</td>
</tr>
<tr>
<td>Tax revenues collected by government</td>
<td>$t \times Q' = 3 \times 36 = 108$</td>
</tr>
<tr>
<td>Initial consumer surplus</td>
<td>Area of a triangle is $\frac{1}{2} \times$ (base $\times$ height). Since the vertical intercept of the demand curve is 30, the height of the consumer surplus triangle is $30 - 10 = 20$. The base is the quantity 40 so $CS = \frac{1}{2} \times 40 \times 20 = 400$</td>
</tr>
<tr>
<td>Initial producer surplus</td>
<td>Similarly, $\frac{10 \times 40}{2} = 200$</td>
</tr>
<tr>
<td>New consumer surplus</td>
<td>$30 - 12 = 18$ is the new height and 36 is the base so consumer surplus is $\frac{(18 \times 36)}{2} = 324$</td>
</tr>
<tr>
<td>New producer surplus</td>
<td>$\frac{(9 \times 36)}{2} = 162$</td>
</tr>
<tr>
<td>Initial social welfare</td>
<td>$400 + 200 = 600$</td>
</tr>
<tr>
<td>New social welfare</td>
<td>$324 + 162 + 108 = 594$</td>
</tr>
<tr>
<td>Welfare loss</td>
<td>$600 - 594 = 6$ or $(12 - 9) \times \frac{(40 - 36)}{2} = 3 \times \frac{4}{2}$ $= 6$ (the area of the triangle)</td>
</tr>
</tbody>
</table>

Subsidies
A subsidy is a payment to producers aimed at lowering production costs and so market price and increasing production and consumption of the good. Again, if you do not care about the logic of the problem, the easiest way to deal with such a subsidy is to rewrite your supply equation.
substituting the term $P$ with $(P + \text{subsidy})$. So, if the supply equation is:

$$Q_s = 4P$$

and a $3.00 subsidy per unit is granted, rewrite it as:

$$Q_s = 4(P + 3)$$

The next step is to equate the demand with the new supply curve to find the new market price. Adding the subsidy to the new market price will give you the new, inclusive of the subsidy, price that producers earn. Note that before the subsidy was granted, the market price was also the average revenue earned by firms, whereas after the subsidy is granted, the average revenue earned is inclusive of the subsidy market price found by adding the subsidy to the new market price consumers pay.

If you have already plotted the original demand and supply curves on graph paper, you can just shift the supply curve vertically downwards by the amount of the subsidy to find the new market price and the new market quantity and to answer a lot of other related questions.

The same advice given for indirect tax problems holds for subsidy problems, as follows.

- Solve algebraically before plotting on the graph paper to ensure that your calculations are precise.
- Avoiding using $P_1$ and $P_2$ and instead adopt more meaningful symbols like $P_m$ or $P_c$ for the new lower market price consumers pay after the subsidy and $P_p$ for the inclusive of subsidy price producers earn (their new average revenue).
- Be very systematic and neat. Write down all the relevant information in a table as this will facilitate any additional calculations you are asked to make.

For example, assume that demand and supply are again given by:

$$Q_d = 60 - 2P$$
$$Q_s = 4P$$

Denoting the original equilibrium price by $P_o$ and the original equilibrium quantity by $Q_o$, we have already found that:

$$P_o = 10$$
$$Q_o = 40$$

Remembering that in the post-subsidy supply function we substitute $(P + s)$ for the term $P$ we must solve now the equations:

$$Q_s = 60 - 2P$$
$$Q_s = 4(P + 3)$$

Solving the system will yield the new market price that consumers will pay $P = 8$ and the new equilibrium quantity $Q' = 44$.

This is how the table might look:

<table>
<thead>
<tr>
<th>$P_s$</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>$Q_s$</td>
<td>40</td>
</tr>
<tr>
<td>$P_c$</td>
<td>8</td>
</tr>
<tr>
<td>$Q'  $</td>
<td>44</td>
</tr>
<tr>
<td>$P_c$</td>
<td>$(P_c + \text{subsidy}) = 11$</td>
</tr>
</tbody>
</table>

### Benefit to consumers

| Benefit to consumers | $10 - 8 = 2$ (consumers enjoy $\frac{2}{3}$ of the subsidy) |

### Benefit to producers

| Benefit to producers | $11 - 10 = 1$ (producers enjoy $\frac{1}{3}$ of the tax) |

### Initial revenues and expenditures $\mathcal{TR}$

| Initial revenues and expenditures $\mathcal{TR}$ | $P_s \times Q_s = 10 \times 40 = 400$ |

### Post-subsidy producer revenues

| Post-subsidy producer revenues | $P_c \times Q' = 11 \times 44 = 484$ |

### Post-subsidy consumer expenditures

| Post-subsidy consumer expenditures | $P \times Q' = 8 \times 44 = 352$ |

### Total cost of subsidy to the government

| Total cost of subsidy to the government | $s \times Q' = 3 \times 44 = 132$ |

### Initial consumer surplus

| Initial consumer surplus | Area of a triangle is $\frac{1}{2}$ (base $\times$ height). Since the vertical intercept of the demand curve is 30, the height of the consumer surplus triangle is $(30 - 10) = 20$. The base is the quantity 40 so consumer surplus $= 400$ |

### Initial producer surplus

| Initial producer surplus | Similarly: $(10 \times 40) = 200$ |

### New consumer surplus

| New consumer surplus | $(30 - 8) = 22$ is the new height and 44 is the base, so consumer surplus is $\frac{(22 \times 44)}{2} = 484$ |

### New producer surplus

| New producer surplus | $(11 \times 44) \div 2 = 242$ |

### Initial social welfare

| Initial social welfare | $400 + 200 = 600$ |

### New social welfare

| New social welfare | $484 + 242 = 726$ minus the cost of the subsidy $132 = 594$ |

### Welfare loss

| Welfare loss | $600 - 594 = 6$ or $\frac{(12 - 9) \times (40 - 36)}{2} = 3 \times \frac{4}{2} = 6$ (the area of the triangle) |

#### Price ceilings

A price ceiling or maximum price (or rent control in the case of housing) is a price set by the government below the equilibrium price. This implies that quantity demanded is greater than quantity supplied so that excess demand, referred to in this case as a shortage, results.

You may be asked to calculate the resulting shortage. You would just have to subtract the quantity supplied from the quantity demanded at the maximum price by putting it into both the supply and then the demand equations.

Using the same demand and supply conditions:

$$Q_d = 60 - 2P$$
$$Q_s = 4P$$

with

$$P_o = 10$$
$$Q_o = 40$$

defining the original market equilibrium price and quantity, assume that a maximum price $P = 7$ is imposed. Substituting
this price into the demand and then into the supply functions
helps us determine the quantity demanded $Q_d$ and the quantity
supplied $Q_s$:

\[ Q_d = 46 \]
\[ Q_s = 28 \]

so that a shortage equal to $Q_d - Q_s = 18$ units results.
You may be asked to calculate the change in consumer
expenditures. Consumer expenditures are found by multiplying
the price paid times the actual number of units bought. Keep
in mind that the short end of the market always prevails, so
that if only 28 units were made available by firms at the
maximum price set it is immaterial that consumers were
demanding 46 units.
Initially consumer expenditures were $10 \times 40 = 400$ whereas
after the maximum price is set they will be $7 \times 28 = 196$.
The change is therefore $196 - 400 = -204$. This means that
consumer expenditures decreased by 204 (for example dollars
or euros) which makes sense as both the price is lower and the
quantity consumed is less. Consumer expenditures in this case
are equal to total revenues producers collect.

Price floors
A price floor or minimum price (or price support) is a price
set by the government above the equilibrium price. This
implies that quantity demanded is less than the quantity
supplied so that excess supply, referred to in this case as a
surplus, results.
You may be asked to calculate the resulting surplus. You would
just have to subtract the quantity demanded from the quantity
supplied at the minimum price by substituting it into both the
supply and the demand equations.
Using the same demand and supply conditions:

\[ Q_d = 60 - 2P \]
\[ Q_s = 4P \]

with

\[ P_0 = 10 \]
\[ Q_0 = 40 \]

the original market equilibrium price and quantity, assume
that a minimum price $P = 14$ is imposed. Substituting this
price into the demand and then into the supply functions
helps us determine the quantity demanded $Q_d$ and the quantity
supplied $Q_s$:

\[ Q_d = 32 \]
\[ Q_s = 56 \]

so that a surplus equal to $Q_s - Q_d = 24$ units results.
You may be asked to calculate the change in consumer
expenditures. Consumer expenditures are found by multiplying
the price paid times the actual number of units bought. Keep
in mind that the short end of the market always prevails, so that if
only 32 units were demanded by consumers at the minimum
price set it is immaterial that firms were offering in the market
56 units.
Initially, consumer expenditures were $10 \times 40 = 400$ while
after the minimum price they were equal to $14 \times 32 = 448$
(for example dollars or euros). Note that these expenditures are
greater than the expenditures made at the lower price. Since
the price paid increased, the quantity purchased will have
decreased (law of demand) so that consumer expenditures may
have increased, decreased or remained the same depending on
the price elasticity of demand (PED) for the good. What we
have here is a movement along a demand curve. Since in this
example the higher price paid resulted in higher expenditures
by consumers, it implies that PED is less than one (demand is
price inelastic).
In the case of a minimum price, the government must intervene
and buy from producers at the promised minimum price the
surplus created. It follows that producers earn not only what
consumers spend on the good but also what the government
spends to buy the surplus. Remember producers sell all of what
they have produced: some to consumers and the rest to the
government. So producers earn the product of the price set
($14$ or whatever) times the total amount supplied (56 units),
that is, $14 \times 56 = 784$. The government expenditures in
the case of a minimum price are the product of the surplus
(24 units) purchased times the minimum price promised ($14$),
or $14 \times 24 = 336$.

To double check remember that the revenues collected
must equal the sum of the expenditures consumers made
plus the amount of money the government spent to buy
the surplus from producers or, in this example, $448 + $336 = 784$.

1.5 Theory of the firm and market structures

Total, marginal and average product
You may be asked to calculate from a table (with empty cells)
or from a graph, total, marginal and average products. This is
an easy task if you remember exactly what each concept means
and the formula one can use.
To calculate average product (of, say, labour) you need to divide
the total product (TP) by the number of
workers used (L) or:

\[ AP = \frac{TP}{L} \]

Notice that equation (1) has three terms so if you know any
two you can solve for the third. For example, if five workers can
produce an average of 120 shirts per day then each worker can
produce on average 24 shirts per day. Average product
is $120 \div 5 = 24$ shirts per worker per day. Or, if you know that the
average product per worker per day is 24 shirts and that the
firm employs five workers you can find the total average
product which is $5 \times 24 = 120$ shirts per day.
To calculate marginal product (of, say, labour) you need to remember that marginal means extra (additional) so that
marginal product (MP) is the change in output induced by a change in the number of workers employed. It is equal to the ratio of the change in output produced over the change in labour employed. If the change in the number of workers is 1 (that is, you have data on the output of 0, 1, 2, 3, 4, etc. workers) then marginal product is just the change in output in:  

$$\text{MP}_i = \frac{\Delta TP}{\Delta L} = \frac{\Delta Q}{\Delta L}.$$  

and, if $\Delta L$ is always 1, then $\text{MP} = \Delta Q = Q_j - Q_i$ (2).

Note from equation (2) that it follows that $\text{MP} + Q = Q_j$, so if we know that the marginal product of, say, the fifth worker is 25 apples (per period) and that with four workers total product is 100 apples, then total product with five workers will be $25 + 100 = 125$ apples. This is very useful to remember when completing such tables.

For example, consider the table below.

<table>
<thead>
<tr>
<th>Labour or number of workers (L)</th>
<th>Output (Q) or total product (TP)</th>
<th>Average product (AP)</th>
<th>Marginal product (MP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>$(0 + 120) = 120$</td>
<td>$(\frac{120}{1}) = 120$</td>
<td>120</td>
</tr>
<tr>
<td>2</td>
<td>$(2 \times 150) = 300$</td>
<td>150</td>
<td>$(300 - 120) = 180$</td>
</tr>
<tr>
<td>3</td>
<td>$(300 + 200) = 500$</td>
<td>$166.67$</td>
<td>$200$</td>
</tr>
<tr>
<td>4</td>
<td>640</td>
<td>$(\frac{640}{4}) = 160$</td>
<td>$(640 - 500) = 140$</td>
</tr>
<tr>
<td>5</td>
<td>$(5 \times 135) = 675$</td>
<td>135</td>
<td>$(675 - 640) = 35$</td>
</tr>
<tr>
<td>6</td>
<td>$(675 + 0) = 675$</td>
<td>$(\frac{675}{6}) = 112.5$</td>
<td>0</td>
</tr>
</tbody>
</table>

Assume that the table originally contains only the cells given in black on white above and that you are asked to calculate the remaining (shaded) cells. The calculation required and the result for each cell is given in shaded cells. Note two things: if no (zero) workers are employed neither the marginal nor the average can be calculated as they are meaningless concepts; also, in each row, only one number is needed to calculate the other two. For example, for three workers you are only given that the marginal product of the third worker is 200 units of output. But since you have calculated that the total product of two workers is 300 units, you just need to add the extra output from the third worker to the total product of two workers to calculate the total product of three workers (which is equal to $300 + 200 = 500$ units).

Now that you have the total product for three workers it is easy to calculate the average product when three workers are employed by dividing total product by the number of workers, or $\frac{500}{3} = 166.67$ units per worker per period.

**Total, marginal and average cost**

The same logic explained above for the calculation of total product, marginal product and average product holds for calculating total, marginal and average costs (TC, MC and AC).

The definitions (formulas) to remember include:

- $\text{TC} = \text{FC} + \text{VC}$
- $\text{ATC} = \frac{\text{FC}}{Q} + \frac{\text{VC}}{Q}$
- $\text{MPL}$
- $\text{MP}$
- $\text{MPC}$
- $\text{AVC}$
- $\text{ATC}$
- $\text{AVC}$
- $\text{ATC}$

These may look difficult but they are extremely easy. Equation (1) states that total costs (TC) are the sum of fixed and variable costs (FC and VC). In the long run, since there are no fixed costs costs are variable costs. You derive equation (2) by dividing all terms of equation (1) by $Q$ (the level of output) to arrive at per unit of output (that is, average) costs. It states that average total cost (ATC) is the sum of average fixed costs (AFC) plus average variable costs (AVC). The equations labelled (4) are useful as each has three terms so, if two of them are known you can solve for the third term. Remember that fixed costs are fixed as the level of output increases but average fixed costs continuously decrease as the level of output increases. The equations labelled (4) state that marginal cost (MC) is the change in either total or variable costs divided by the change in output. Equations (5) and (6) are most useful as they state that if we know that the total costs (or variable costs) of producing, say, eight units is $200.00 and that the marginal cost of the ninth unit is $22.00 then the total costs (or variable costs) of producing nine units is $200.00 + $22.00 = $222.00. This is most useful when asked to complete cost tables.

In the table below you are given only the total cost of production (in black on white) and you may be asked to fill in the rest of the table. The answers are in the shaded areas.

<table>
<thead>
<tr>
<th>Q</th>
<th>TC</th>
<th>FC</th>
<th>VC</th>
<th>AVC</th>
<th>ATC</th>
<th>AFC</th>
<th>MC</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>100</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>100</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>150</td>
<td>100</td>
<td>50</td>
<td>$(\frac{50}{1}) = 50$</td>
<td>$(\frac{150}{1}) = 150$</td>
<td>$(\frac{100}{1}) = 100$</td>
<td>$(150 - 100)$ or $(50 - 0) = 50$</td>
</tr>
<tr>
<td>2</td>
<td>180</td>
<td>100</td>
<td>80</td>
<td>$(\frac{80}{2}) = 40$</td>
<td>$(\frac{180}{2}) = 90$</td>
<td>$(\frac{100}{2}) = 50$</td>
<td>$(180 - 150)$ or $(80 - 50) = 30$</td>
</tr>
</tbody>
</table>

continued...
behind product and cost functions. The formulas are:

\[ MR = \frac{\Delta TR}{\Delta Q} \]  

And, if \( \Delta Q = 1 \), then:

\[ MR = \frac{\Delta TR}{\Delta Q} = TR_2 - TR_1, \text{ so } TR_1 + MR = TR_2 \]

Equation (1) states that AR is the ratio of total revenue over output. Since TR is the product of price times output it follows that AR is always equal to price for any level of output Q independent of market structure. This is labelled on the demand curve as ‘D, AR’.

For example, consider the table below where the demand schedule for a product is given (that is, the quantity demanded for each price). The average revenue (AR) column as a result of equation (1) above is identical to the price column (P). The total revenue (TR) column is the product of each price times the quantity demanded. The marginal revenue (MR) is the extra revenue collected from each extra unit sold so it is the difference between successive total revenue figures (since the difference in Qs is always equal to 1).

Note that since TR collected from selling zero units are zero (dollars) whereas when 1 unit is sold TR collected are 80 (dollars), it follows that MR collected from selling the first unit is 80 (dollars).

<table>
<thead>
<tr>
<th>Q</th>
<th>FC</th>
<th>VC</th>
<th>AVC</th>
<th>ATC</th>
<th>AFC</th>
<th>MC</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>190</td>
<td>100</td>
<td>90</td>
<td>63.33</td>
<td>33.33</td>
<td>(190 – 180) or (90 – 80) = 10</td>
</tr>
<tr>
<td>4</td>
<td>200</td>
<td>100</td>
<td>100</td>
<td>50</td>
<td>25</td>
<td>(200 – 190) or (100 – 90) = 10</td>
</tr>
<tr>
<td>5</td>
<td>220</td>
<td>120</td>
<td>120</td>
<td>44</td>
<td>20</td>
<td>(220 – 200) or (120 – 100) = 20</td>
</tr>
<tr>
<td>6</td>
<td>260</td>
<td>160</td>
<td>160</td>
<td>43.33</td>
<td>16.67</td>
<td>(260 – 220) or (160 – 120) = 40</td>
</tr>
<tr>
<td>7</td>
<td>320</td>
<td>220</td>
<td>220</td>
<td>45.71</td>
<td>14.29</td>
<td>(320 – 260) or (220 – 160) = 60</td>
</tr>
<tr>
<td>8</td>
<td>420</td>
<td>320</td>
<td>320</td>
<td>52.5</td>
<td>12.5</td>
<td>(420 – 320) or (320 – 220) = 100</td>
</tr>
<tr>
<td>9</td>
<td>570</td>
<td>470</td>
<td>470</td>
<td>63.33</td>
<td>11.11</td>
<td>(570 – 420) or (470 – 320) = 150</td>
</tr>
<tr>
<td>10</td>
<td>770</td>
<td>670</td>
<td>670</td>
<td>77</td>
<td>10</td>
<td>(770 – 570) or (670 – 470) = 200</td>
</tr>
</tbody>
</table>

Total, marginal and average revenue

The logic behind the calculations of total, average and marginal revenues is once again exactly the same as the logic behind product and cost functions. The formulas are:

\[ AR = \frac{TR}{Q} = \frac{P \times Q}{Q} = P \]  

\[ MR = \frac{\Delta TR}{\Delta Q} \]  

Bear in mind that the revenue-maximizing level of output is that at which MR is zero. In the above case you should choose five units as for the fifth unit MR = 0. As a result of the fact that the table above does not correspond to a continuous function but is just a collection of discrete data, maximum revenues of 200 (dollars) are also collected when four units are sold. In an exercise when this happens, choose that level for which MR = 0.
Economic profits
Economic profits $\pi$ for each level of output $Q$ is given by the equation:

$$\pi(Q) = TR(Q) - TC(Q)$$

To maximize profits choose that level of output for which:

$$MR = MC$$

You may be given a table with cost and revenue data to complete and determine the level of output at which maximum profits are achieved. Remember that as long as $MR$ exceeds $MC$, profits are rising so choose that level of output $Q$ for which $MR = MC$ or the largest level output $Q$ for which $MR$ is still greater than $MC$.

In a diagram, determine the level of output for which $MR$ and $MC$ intersect and then find $TR$ by multiplying that output with price. Find $TC$ by determining for the chosen level of output the corresponding $ATC$ and multiplying the two figures.

Issues in market structures
You may be asked to calculate the short-run shutdown price and the break-even price from a set of data or a graph.

The break-even price is that price for which total revenues are equal to total costs and thus economic profits are zero (that is, normal; the minimum required for the firm to remain in business). For a perfectly competitive firm the break-even price can be found on a diagram at the minimum of the $U$-shaped $ATC$ curve it faces. Remember that a perfectly competitive firm faces a horizontal demand (and so $AR$) curve. For all other types of firms facing a negatively sloped demand curve the break-even price is found where the negatively sloped demand (and $AR$ curve) is tangent to the $U$-shaped $ATC$ curve. If given a table with $TR$ and $TC$ figures (or $AR$ and $ATC$ figures) it is that level of output for which the two are equal.

The shutdown price and the break-even price are identical in the long run.

In the short run, when fixed costs exist and on a diagram both $ATC$ and $AVC$ cost curves are depicted, the shutdown price for a perfectly competitive firm is at the minimum of the $AVC$ curve. If provided with a table with data to determine the shutdown price you just have to determine the lowest $AVC$ figure. At any price below that price the firm will immediately shut down.
2.1 The level of overall economic activity

Measures of economic activity
You may be asked to calculate nominal GDP from sets of national income data, using the expenditure approach. In this case you just add (C + I + G + X) and then subtract imports (M). Often in such exercises students are given additional data as ‘smoke’ to confuse them. Ignore the additional data. If asked to find the per capita GDP (or GNI) just divide GDP (or GNI) by population.

You may be asked to calculate GNP or GNI from data. GNP is GDP plus income from abroad minus factor (or property) income from abroad or plus net factor (or property) income from abroad.

Lastly, you may be asked to calculate real GDP or GNI using a price deflator. A price deflator is a price index. Divide GDP (or GNI) by the GDP deflator and multiply the result by 100. Once again, the relationship has three terms so if any two are provided you can solve for the third one.

The Keynesian multiplier
The Keynesian multiplier states that the change in income is a multiple of the change in any injection:

\[ \Delta Y = k \Delta J, \text{ where } J = (C, I, X) \]

It follows that if any two terms are given you can solve for the third one.

In addition, \( k = \frac{1}{1 - \text{MPC}_d} \), where \( \text{MPC}_d = \frac{\Delta C_d}{\Delta Y} \)

\( \text{MPC}_d \) is the additional spending on domestic goods from additional income. So, if you are told that from an extra dollar (which has 100 cents) people spend 80 cents it follows that

\[ \text{MPC}_d = \frac{80}{100} = 0.8. \]

It also follows that the remaining 20 cents were paid in tax, saved and/or spent but on imports. The multiplier may therefore be written as:

\[ k = \frac{1}{\text{MRT} + \text{MPS} + \text{MPM}} = \frac{1}{\text{MPW}}, \]

where MRT is the marginal tax rate (the extra tax paid out of an extra dollar earned), MPS is the additional savings out of an additional dollar earned and MPM is the additional spending on imports out of an additional dollar earned:

\[ \text{MRT} = \frac{\Delta T}{\Delta Y}, \text{ MPS} = \frac{\Delta S}{\Delta Y} \text{ and } \text{MPM} = \frac{\Delta M}{\Delta Y} \]

and MPW is the marginal propensity to withdraw, or \( \frac{\Delta W}{\Delta Y} \).

Continuing the previous example, if people are taxed 12 cents, save 3 cents and spend on imports 5 cents out of each additional dollar earned then:

\[ \text{MRT} = 0.12, \text{ MPS} = 0.03 \text{ and } \text{MPM} = 0.05 \]

so that MPW = 0.20 (their sum).

The multiplier \( k \) is thus equal to:

\[ \frac{1}{(1 - \text{MPC}_d)} = \frac{1}{(1 - 0.8)} = \frac{1}{0.2} = 5 \]

or using the MPW figure directly:

\[ \frac{1}{\text{MPW}} = \frac{1}{0.2} = 5 \]

If the government increases spending by 150 billion, then national income will increase by \( 5 \times 150 = 750 \) billion.

Or if, for example, the government wants national income to increase by 1.2 trillion then government expenditures should rise by \( \frac{1.2}{5} = 240 \) billion.

2.3 Macroeconomic objectives

The unemployment rate
You may be asked to calculate the unemployment rate from a set of data. The unemployment rate is a percentage. It is the number of unemployed expressed as a proportion of the labour force:

\[ \text{unemployment rate} = \frac{\text{number of unemployed}}{\text{labour force}} \times 100 \]

Again, you have a relationship with three terms so if any two are given you can solve for the third one. The labour force is not the same thing as the population of a country. It includes the employed and the unemployed individuals, so given a total population figure, the number of those unwilling and/or unable to work are excluded. Babies, older people as well as people within the working age population who are neither working nor actively searching for a job are not part of the denominator in the calculation of the unemployment rate as they are not included in the labour force.

The inflation rate
You may be asked to calculate the inflation rate from a set of data. The inflation rate is also a percentage. It is the percentage change in the average price level between two periods of time, usually between two years. The average price level is given by a price index.

Typical price indices include the consumer price index (CPI or retail price index) and the producer price index (PPI). If we denote by \( P_t \) the CPI at period \( t \) and by \( P_{t-1} \) the CPI the previous period (so that if \( t \) is 2009 then \( t - 1 \) is 2008) then:

\[ \text{inflation rate in } t = \% \Delta P = \frac{P_t - P_{t-1}}{P_{t-1}} \times 100 \]
So if the CPI for 2008 was calculated at 158.2 and the CPI for 2009 was at 165.6 then inflation in year-on-year inflation in 2009 was:

\[
\frac{165.6 - 158.2}{158.2} \times 100 = \frac{7.4}{158.2} \times 100 = 0.0467 \times 100 = 4.68% 
\]

Note that if this percentage was negative then there was deflation. Remember that if you were to calculate inflation for, say, two consecutive years and the results were positive but the rate was smaller in the second year then there was disinflation (that is, prices continued to increase but at a decreasing rate).

You may be asked to construct a weighted price index using a set of data provided. This is very easy. You will be given a limited number of goods (say, three to five), their prices in two or more periods (typically months or years) and, in addition, the number of units of each good that the typical household (consumer) purchased in the base period or reference period (month or year). These are the weights of each good. Remember that goods do not carry the same weight in the calculation of the average price level or of the calculation of the cost of the ‘basket’ of goods purchased. The weight of each good in your simple calculation of the weighted average is the number of units of each good purchased.

So, to calculate the cost of each basket of goods in each period you just multiply the price of each good during the period times the number of units consumed by the typical consumer and add the expenditures across goods. To convert the cost (say, dollars) arrived at to a price index divide the cost of the basket in each year by its cost in the base year chosen and multiply by 100. To calculate the inflation rate of a year find the percentage between the two price indices computed. Remember it is the percentage change of the price index of one period with respect to its value in the previous period. The next example will help you understand.

The following table has the prices of three goods in some period with respect to its value in the previous period. The next example will help you understand.

<table>
<thead>
<tr>
<th>Year</th>
<th>Price of X</th>
<th>Price of Y</th>
<th>Price of Z</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>€6.00</td>
<td>€0.50</td>
<td>€3.00</td>
</tr>
<tr>
<td>2013</td>
<td>€6.60</td>
<td>€0.60</td>
<td>€3.10</td>
</tr>
<tr>
<td>2014</td>
<td>€6.80</td>
<td>€0.75</td>
<td>€3.40</td>
</tr>
</tbody>
</table>

We assume that the basket of the typical consumer contains 10 units of good X, 30 units of good Y and 20 units of good Z. Construct a weighted price index for all three years assuming that 2010 is the base year and calculate the inflation rate for 2013 and 2014.

First calculate the cost of the basket in each year. The cost for 2012 will be:

\[
(6.00 \times 10) + (0.50 \times 30) + (3.00 \times 20) = 60.00 + 15.00 + 60.00 = €135.00 
\]

The cost for 2013 will be:

\[
(6.60 \times 10) + (0.60 \times 30) + (3.10 \times 20) = 66.00 + 18.00 + 62.00 = €146.00 
\]

So if the CPI for 2008 was calculated at 158.2 and the CPI for 2009 was at 165.6 then inflation in year-on-year inflation in 2009 was:

\[
\frac{165.6 - 158.2}{158.2} \times 100 = \frac{7.4}{158.2} \times 100 = 0.0467 \times 100 = 4.68% 
\]

You could calculate the inflation rate in 2013 as the percentage change in the cost of living between 2012 and 2013:

\[
\frac{(146 - 135)}{135} \times 100 = 8.15% \quad \text{and, similarly, the inflation rate in 2014:} \quad \frac{(146 - 146)}{146} \times 100 = 0% 
\]

Or you could construct the consumer price index using 2012 as the base year:

price index for 2012 (base year) = \(\frac{135}{135} \times 100 = 100\)

price index for 2013 = \(\frac{146}{135} \times 100 = 108.15\)

price index for 2014 = \(\frac{146}{135} \times 100 = 117.41\)

and then calculate the inflation rate for 2012 as the percentage change in the price indices between 2013 and 2012:

\[
\frac{108.15 - 100}{100} \times 100 = 8.15% 
\]

and then the inflation rate for 2014 as the percentage change in the price indices between 2014 and 2013:

\[
\frac{117.41 - 108.15}{108.15} \times 100 = 8.56% 
\]

**Growth**

You may be asked to calculate the rate of economic growth between two years from a set of data. This is nothing more than a straightforward percentage change calculation assuming proportional growth in discrete time. Denoting the growth rate in year t as \(g_t\) and real GDP of year t as \(Y_t\), we arrive at:

\[
g_t = \frac{(Y_t - Y_{t-1})}{Y_t} 
\]

Remember that to calculate real GDP from nominal (or money) GDP or CNI data you just divide nominal GDP by the GDP deflator and multiply by 100.

**Equity**

**The role of taxation in promoting equity**

You may be asked to calculate the marginal tax rate (MRT) and the average tax rate (ATR) from a set of data. Remember that the ATR is the ratio of the tax paid over whatever is taxed, for example expenditure, wealth and business profits) The ATR is the ratio of the tax paid over income (or, more generally, the tax base). Assuming the typical case of an income tax:

\[
\text{MRT} = \frac{\Delta T}{\Delta Y} \quad \text{and,} \quad \text{ATR} = \frac{T}{Y} 
\]

If the ATR is increasing as income (or, more generally, the tax base) is increasing then the tax is progressive. It follows that MRT > ATR.

If the ATR is constant as income (or, more generally, the tax base) is increasing then the tax is proportional. It follows that MRT = ATR.

If the ATR is decreasing as income (or, more generally, the tax base) is increasing then the tax is regressive. It follows that MRT < ATR.
5.3 International economics

3.1 International trade

Comparative advantage and opportunity costs
You may be asked to calculate opportunity costs from a set of data in order to identify comparative advantage. In an example featuring two goods, the opportunity cost of producing more of one good is the amount of the other good that needs to be sacrificed. The production possibilities curve (PPC) that you will be presented with will be linear. Assuming that good $X$ is measured on the horizontal axis and good $Y$ on the vertical then the opportunity cost of producing an extra unit of good $X$ is given by $\frac{\Delta Y}{\Delta X}$, which of course is the slope of the PPC.

Remember that $Y = Y_2 - Y_1$.

Restrictions on trade: tariffs, quotas and subsidies
You may be asked to calculate from diagrams the effects of imposing a tariff on imported goods on different stakeholders, including domestic producers, foreign producers, consumers and the government. These can all easily be calculated from linear functions but the syllabus specifies that you will be asked to make calculations from diagrams. Beyond being able to read a diagram properly you will need to remember that the area of a triangle is given by $\frac{\text{base} \times \text{height}}{2}$, the area of a rectangle is $a \times b$ and that the area of a trapezoid is $\frac{(B + b)}{2} \times h$.

3.2 Exchange rates

Floating exchange rates
Here you may be asked to calculate the value of one currency in terms of another currency.

Keep in mind that if the exchange rate of currency $\alpha$ in terms of currency $\beta$ is $e$, then the exchange rate of currency $\beta$ in terms of $\alpha$ will be $\frac{1}{e}$. For example if $\text{€1.00} = \$1.44$ then $\text{€1.00} = \text{\$0.69}$.

You may be asked to calculate the exchange rate for linear demand and supply functions and to plot the curves. The process is identical to the determination of the equilibrium price and output for a good and the plotting of the linear demand and supply functions.

Or, you may be asked to calculate the price of a good in different currencies using exchange rates. For example, if you are given the price of an item in, say, US dollars and you want to calculate it in Indian rupees (INR) you multiply the price of the item in dollars times the $\frac{\text{INR}}{\text{\$}}$ exchange rate.

Assume that US$1.00 = \text{INR44.69}$ and the item is an Abercrombie and Fitch shirt that sells for US$70.00. Its price in INR is its price in US dollars times $\frac{\text{INR}}{\text{\$}}$ or, $\text{\$70.00} \times \text{INR} = \text{INR}3,128.3$

Lastly, you may be asked to calculate the change in the value of a currency from a set of data. Here keep in mind that if currency $\alpha$ depreciates by $x\%$ compared with currency $\beta$ then currency $\beta$ has not appreciated by $x\%$ compared with currency $\alpha$. If the dollar depreciates against the euro by 10% then the euro has not appreciated against the dollar by 10%. You will need to calculate the inverse of the exchange rates given and then find the percentage change. If the euro was $\text{€1.00}$ and appreciated to $\text{€2.00}$ it appreciated by 100%. The dollar depreciated by 50% as it was $\text{\$1.00}$ and it went down to $\text{\$0.50}$.

3.3 The balance of payments

The structure of the balance of payments
Here you may be asked to calculate elements of the balance of payments from a set of data. You just need to remember a few things.

To find the balance on any item you must subtract payments (debits) from receipts (credits). If the result is a positive number you have a surplus in that item, while if it is negative you have a deficit.

To find the current account from its components you add net exports of goods, net exports of services, net income and net current transfers together.

To find the financial account balance from its components you add net direct investment abroad, net portfolio investment and net other investments and reserve assets together.

The sum of the capital and financial accounts must equal the current account balance.

Therefore, the sum of the capital, financial and current accounts must equal zero by construction. If the sum is not zero it is because of errors and omissions the size of the non-zero figure found with the opposite sign.
3.5 Terms of trade

The meaning of terms of trade
You may be asked to calculate the terms of trade of a country. The terms of trade (TOT in the equation below) are the ratio of the average price of exports over the average price of imports of a country expressed as index numbers times 100.

\[
\text{TOT} = \frac{\text{average price of exports}}{\text{average price of imports}} \times 100
\]

An index number is a number that has no units of measurement and because of this it facilitates comparisons. You may be given the average price of exports and of imports of a country for a number of years or you may be told that a country exports only one product, say oil or coffee, and imports only one good, say tractors or computers, to make things simpler.

To convert each average exports price into an index number you will need to divide it by the average export price for the what is chosen as the base year (or reference year) and multiply the result by 100. You will do the same to convert each average imports price into an index number. Through this you are expressing the average price of exports (or of imports) for each year as a percentage of its average price in the chosen base year. It follows that the index number value for any variable in the base year is equal to 100.

For example, assume a country that exports only coffee and imports only laptops. You are given the price of coffee and the price of laptops between 2010 and 2014 as well as the revenues in millions of US dollars from its coffee exports. You are also told that 2011 is the base year. You may be asked to calculate the terms of trade and to express export revenues as an index number (to fill in the columns in grey in the table).

First you calculate export prices as an index number by dividing the export price in each year by the export price of the base year (2011) and then multiplying by 100. Do exactly the same calculation to determine import prices as an index number. Remember that in the base year the value of an index number is 100. To find the terms of trade in each year divide the index of export prices by the index of import prices and multiply by 100. Remember that the terms of trade in the base year are equal to 100.

To express export revenues as an index number divide export revenues in each year by export revenues in the base year and multiply the result by 100.

<table>
<thead>
<tr>
<th>Year</th>
<th>Price of coffee per ton (USD)</th>
<th>Average exports price as an index number</th>
<th>Price of a laptop (USD)</th>
<th>Average imports price as an index number</th>
<th>Terms of trade (TOT) ( p_x / p_m \times 100 )</th>
<th>Export revenues (USD millions)</th>
<th>Export revenues as an index number</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>1500</td>
<td>1500 \times 100 = 90.91</td>
<td>450</td>
<td>450 \times 100 = 90</td>
<td>90.91 \times 100 = 101</td>
<td>36.5</td>
<td>36.5 \times 100 = 102.24</td>
</tr>
<tr>
<td>2011</td>
<td>1650</td>
<td>1650 \times 100 = 100</td>
<td>500</td>
<td>500 \times 100 = 100</td>
<td>100 \times 100 = 100</td>
<td>35.7</td>
<td>35.7 \times 100 = 100</td>
</tr>
<tr>
<td>2012</td>
<td>1770</td>
<td>1770 \times 100 = 107.27</td>
<td>540</td>
<td>540 \times 100 = 108</td>
<td>107.27 \times 100 = 99.32</td>
<td>34.8</td>
<td>34.8 \times 100 = 97.48</td>
</tr>
<tr>
<td>2013</td>
<td>1850</td>
<td>1850 \times 100 = 112.12</td>
<td>575</td>
<td>575 \times 100 = 115</td>
<td>112.12 \times 100 = 97.5</td>
<td>34.3</td>
<td>34.3 \times 100 = 96.08</td>
</tr>
<tr>
<td>2014</td>
<td>1920</td>
<td>1920 \times 100 = 116.36</td>
<td>610</td>
<td>610 \times 100 = 122</td>
<td>116.36 \times 100 = 95.38</td>
<td>33.2</td>
<td>33.2 \times 100 = 92</td>
</tr>
</tbody>
</table>

Summary
If you know:

(1) that the percentage change in \( X \) is \( \frac{X_2 - X_1}{X_1} \times 100 \)

(2) that if Total \( X \) is \( TX \) and Marginal \( X \) is \( MX \) (so that \( MX = X_2 - X_1 \) then \( X_2 = X_1 + MX \)

(3) that the area of a triangle is given by \( \text{base} \times \text{height} / 2 \)
the area of a rectangle is \( a \times b \) and
the area of a trapezoid is \( (B + b) / 2 \times h \)

(4) and how to solve a system of two linear equations
you should be fully prepared for the calculations part of HL Paper 3.