1. The multiple choice questions can be found in the attached document. However, I have also inserted them here. I have answered questions 1 & 3 in the longer questions and 1, 2 & 3 in the short question part.

Question	Answer
1	C
2	D
3	A
4	A
5	B
6	B
7	A
8	B
9	C
10	C
11	A
12	D
13	B
14	A
15	D

2. Longer questions

a) *If Laura wants to maximize her utility, the utility function will be the objective function and the budget constraint will be the constraint in the lagrangian. The budget constraint is:*

$$Y = p_T T + p_C C$$

$$160 = 4T + C$$

The utility function is:

$$U(T, C) = TC$$

The Lagrangian will then be:

$$\mathcal{L} = TC - \lambda(4T + c - 160)$$

To find the first order conditions, I differentiate wrt. T C and lambda respectively and set them equal to 0

$$\frac{d\mathcal{L}}{dT} = C - 4\lambda = 0$$

$$\frac{d\mathcal{L}}{dC} = T - \lambda = 0$$

$$\frac{d\mathcal{L}}{d\lambda} = 4T + C - 160 = 0$$

The lagrangian and the first order conditions are seen in the above.

b) What is Laura´s optimal consumption and her utility at that point?

To find this, I divide equation 1 with equation 2 to isolate for C

$$\frac{C - 4\lambda}{T - \lambda} = 0$$

$$\frac{C}{T} = 4$$

$$C = 4T$$

I then insert this value for C in the budget constraint to find the optimal consumption of T

$$160 = 4T + 4T$$

$$160 = 8T$$

$$20 = T$$

To find the value for C, I insert the value for T in the budget constraint

$$160 = 4 * 20 + C$$

$$80 = C$$

Thus, I have found that Laura´s optimal consumption is at 20 train tickets and 80 coffees.

To find her utility I insert the equilibrium values in her utility function

$$U(20{,}80) = 80 * 20 = 1600$$

Thus, her utility is 1600 at the optimal consumption bundle.

That utility is an ordinal measure means that we know the ranking of the bundles, we know that Laura prefer a consumption bundle on a higher indifference curve to that of a lower, but we do not know by how much it is preferred. For example if she gains utility 1000 from another bundle, the equilibrium bundle may not be 1,6 times as good, Laura may just use another scale.

c) Find her demand

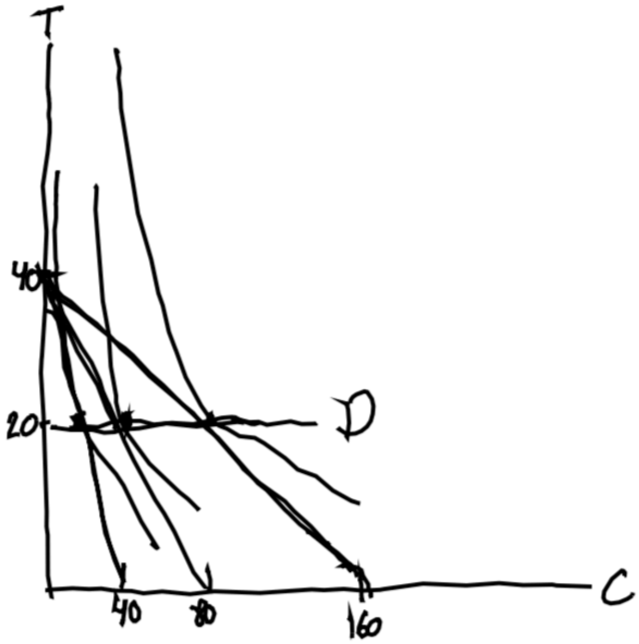
To find her demand for Coffee when the price is 2, I use the general solution for a Cobb-Douglas function. I know, that her utility function is a Cobb-Douglas function with the equation: $AB^{\alpha}Z^{\beta}$
Thus, I know that a general solution to optimizing utility is: $x_1 = \frac{Y}{p_1} * \frac{\alpha}{\alpha+\beta}$. Thus,

$$C = \frac{160}{2} * \frac{1}{1+1} = 80 * 0.5 = 40$$

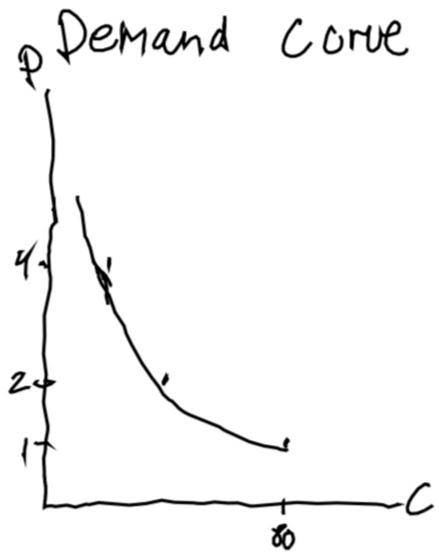
And when the price for coffee increases to 4 USD, her consumption must be:

$$C = \frac{160}{4} * \frac{1}{1+1} = 40 * 0.5 = 20$$

To show how the demand curve can be derived from this, and how it looks see the graph below.



It is seen, that the demand curve can be derived as the intercept between the budget lines and the indifference curves looking at the consumption of coffee. This is possible as the demand curve measures the relationship between price and quantity, and we vary price with different demand curves. Thus, we can make the demand curve seen in the below.



It is seen, that her demand curve is made up of the points where her indifference curves touches her budget constraints, and that the demand curve for coffee is convex.

d) Find her monthly allowance, what is her optimal bundle and why is she overcompensated?

To find the new monthly allowance that would enable her to buy the same optimal bundle as in b) I insert the optimal bundle from that task in the new budget constraint

$$Y = 3T + 2C$$

$$Y = 3 * 20 + 80 * 2 = 60 + 160 = 220$$

Thus, her monthly allowance should be increased to 220 USD to be able to afford the same optimal bundle.

The optimal bundle for her would however be different due to the substitution effect. This is derived via the general formula for a Cobb-Douglas function in the below.

$$T = \frac{Y}{p_t} * \frac{\alpha}{\alpha + \beta}$$

$$T = \frac{220}{3} * \frac{1}{1+1} = 73.33 * 0.5 = 36.67$$

Her consumption of C would then be found by inserting the value for T in the budget constraint

$$220 = 3 * 36.67 + 2C$$

$$110 = 2C$$

$$C = 55$$

Thus, her new optimal consumption bundle will not be that of before, but she will choose to consume 36,67 train tickets and 55 coffees.

Her utility is then: $U(36.67{,}55) = 36.67 * 55 = 2016.85$

Thus it is seen that by increasing Laura´s budget she is overcompensated and moves towards a higher indifference curve. The reason that she is overcompensated is, that her parents does not take the substitution effect (that she due to the changed prices substitute towards the relatively cheaper train tickets) into account, and therefore she is given the opportunity to move towards a higher indifference curve.

3. Monopoly, Duopolies and externalities

a) What is p and Q in the competitive market and in social optimum?

To determine P and Q in the competitive equilibrium we set MC=p, as p=MR in a competitive equilibrium. The reason is that the firms compete on price, and therefore price is set at the price which is equal to marginal cost (the lowest price possible) In the below, the competitive equilibrium is calculated.

$$p = 212 - Q$$

$$MC = 54$$

$$212 - Q = 54$$

$$212 - 54 = Q$$

$$Q = 158$$

To find the price, I insert the value for Q in the price function

$$p = 212 - 158 = 54$$

Thus, in the competitive equilibrium 158 liters would be produced for a price of 54 per liter.

The socially optimal price and quantity would be to set $MC_p + MC_g = MC_s = p$

$$MC_p = 54$$

$$MC_g = 54$$

$$MC_S = 54 + Q$$

$$54 + Q = 212 - Q$$

$$2Q = 158$$

$$Q = 79$$

To find the price, we insert the found Q in the price function

$$p = 212 - 79 = 133$$

Thus, the socially optimal equilibrium is to produce 79 liters at a price of 133 per liter. This is higher and quantity lower than in the competitive equilibrium. The reason is that the negative externalities are accounted for in the social optimum

b) *What is equilibrium if there are only two firms in the market?*

NB! In the following tasks I assume that equilibrium means the equilibrium where $MC_p = MR$ and not the social equilibrium.

As the two firms act simultaneously and choose quantity, I use the Cournot equilibrium to determine the quantity they produce. First I find their best response functions.

$$p = 212 - Q$$

$$p = 212 - q_e - q_d$$

I now determine the marginal revenue (MR) for Elena and set it equal to her MC.

Since the price function is linear, we must have that the MR has double the slope of the price function and the same intercept. Therefore:

$$MR = 212 - 2q_e - q_d$$

This, I equate with MC to find her best response function.

$$212 - 2q_e - q_d = 54$$

$$158 - q_d = 2q_e$$

$$q_e = 79 - 0.5q_d$$

Because of symmetry, q_d must be similar

$$q_d = 79 - 0.5q_e$$

I insert one in the other

$$q_e = 79 - 0.5(79 - 0.5q_e)$$

$$q_e = 79 - 39.5 + 0.25q_e$$

$$0.75q_e = 39.5$$

$$q_e = 52{,}67$$

Because of symmetry, q_d must be the same

$$q_d = 52{,}67$$

I now insert the quantities in the price formula to find the price

$$p = 212 - Q$$

$$p = 212 - 52{,}67 - 52{,}67 = 106{,}67$$

Thus, when the government decides that only two firms are allowed to operate in the market, the quantity supplied will be 105.33 Yoghurts per day and the price per liter will be 106.67.

c) *What will equilibrium be, if the firms compete on price?*

If the two firms choose price simultaneously, they will compete on price rather than quantity. Therefore, they will try to undercut each other on the price until they cannot do so anymore, because they will no longer make a profit. This point is when p=MC. Thus, in a Bertrand equilibrium where both firms choose price simultaneously, the price and quantity will be the same as in the competitive equilibrium. This was found above. However, it is now calculated again

Equilibrium is when $p = MR = MC_p$

$$212 - Q = 54$$

$$Q = 158$$

If we assume that the firms share the market equal, they will each produce

$$q = \frac{Q}{n} = \frac{158}{2} = 79$$

The price is then found by plotting the quantity into the price function

$$p = 212 - 79 - 79 = 54$$

Thus, I have found that if the two firms choose price simultaneously, the price and quantity will be the same as in a competitive market namely a total quantity of 158 and a price of 54.

d) *What is the equilibrium if there is only one seller in the market, and does this improve welfare?*

To determine how much Elena will produce, when she is alone in the market, and what the equilibrium price is in the market, I use the formula for a monopoly to maximize profit namely$MR = MC$. The reason for this is, that there is now only one player in the market Elena, and thus the market has become a monopoly.

$$p = 212 - Q$$

Because the price curve is linear, the marginal revenue for the monopoly must be double the slope of the price curve and have the same intersect.

$$MC_p = 212 - 2Q$$

This, I equate with the marginal cost

$$212 - 2Q = 54$$

$$158 = 2Q$$

$$Q = 79$$

At this quantity the price will be:

$$p = 212 - 79$$

$$p = 133$$

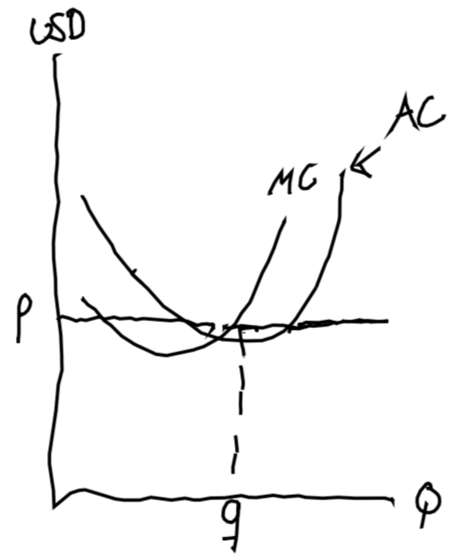
It is, therefore, found that if Elena act as a monopolist in the market, the quantity sold will be 79 and the price in the market will be 133.

With regard to the welfare, the above found equilibrium was also the socially optimal equilibrium. Therefore, allowing Elena to be a monopolist increases welfare in the market. The reason for this is, that when she produces less, less negative externalities are created. However, when she produces less, the PS and CS will also fall. That the welfare increases by her producing less at a higher price, though, shows that the consumers value the decrease of the externalities more than they value an extra good, and therefore allowing only one firm to produce will improve welfare in this economy.

To put it another way, where MR=MC_p is the same point as where $MC_s = p$ and thus the monopoly maximizes welfare

Part III – Short Questions

1. This is false. The MRS (slope of the indifference curve) shows how the consumer is willing to trade one good for another. The slope of the budget line (also called MRT) shows how the consumer *can* exchange the goods in the market. For example, if the prices of cars (measured on the x-axis) is 10000 and the prices of boats is 20000, the MRT (slope of the budget line) will be -2. Thus showing, that in the market the consumer *can* exchange 2 cars for one boat, but that might not be what he is willing to.
2. In a competitive market the firms are price takers. This mean that they cannot set the price, and simply must take the price set in the market. As the firms compete on price, the price will be as low as the firm's long run average costs. Therefore, they will make no profit. It is seen in the graph below.



It is seen that MC=p=MR at the lowest point of the average cost curve. Thus, the firms have no margin between their costs and the price, and their profit will then be (AC-P)*q=0*q=0.

3. To find how the price ceiling effects the market outcome, I first calculate the equilibrium without the restriction by equating the supply and demand curves

$$1500 - 3Q = 100 + Q$$

$$1400 = 4Q$$

$$Q = 350$$

Then, I find the price:

$$P = 1500 - 3 * 350 = 450$$

Now, we assume that the restriction is entered. To see if we are in equilibrium we insert 250 in both curves isolated for Q

$$500 - \frac{p}{3} = p - 100$$

$$500 - \frac{250}{3} = 250 - 100$$

$$416.67 = 150$$

It is thus seen that when the price ceiling is introduced, the consumers want to buy 416,67 kg, but the producers only want to sell 150 kg. Thus, the market is not in equilibrium and an excess demand of 416.67-150=266.67 is produced. The actual amount sold will be 150, because there are not buyers for more goods. See in the graph.