Linear Programming Problems **Total: 30 marks**

1. A company produces two types of party bag, Infant and Junior. Both types of bag contain a balloon, a toy and a whistle. In addition the Infant bag contains 3 sweets and 3 stickers and the Junior bag contains 10 sweets and 2 stickers.

The sweets and stickers are produced in the company's factory. The factory can produce up to 3000 sweets per hour and 1200 stickers per hour. The company buys a large supply of balloons, toys and whistles.

Market research indicates that at least twice as many Infant bags as Junior bags should be produced.

Both types of party bag are sold at a profit of 15p per bag. All the bags are sold. The company wishes to maximise its profit.

Let x be the number of Infant bags produced and y be the number of Junior bags produced per hour.

(*a*) Formulate the above situation as a linear programming problem. **(5)**

(*b*) Represent your inequalities graphically, indicating clearly the feasible region. **(5)**

(*c*) Find the number of Infant bags and Junior bags that should be produced each hour and the maximum hourly profit. Make your method clear. **(3)**

In order to increase the profit further, the company decides to buy additional equipment. It can buy equipment to increase the production of **either** sweets **or** stickers, but **not both**.

(*d*) Using your graph, explain which equipment should be bought, giving your reasoning. **(3)**

The manager of the company does not understand why the balloons, toys and whistles have not been considered in the above calculations

(*e*) Explain briefly why they do not need to be considered. **(1)**

2. A company produces two types of self-assembly wooden bedroom suites, the 'Oxford' and the 'York'. After the pieces of wood have been cut and finished, all the materials have to be packaged. The table below shows the time, in hours, needed to complete each stage of the process and the profit made, in pounds, on each type of suite.

	Oxford	York
Cutting	4	6
Finishing	3.5	4
Packaging	2	4
Profit (£)	300	500

The times available each week for cutting, finishing and packaging are 66, 56 and 40 hours respectively.
The company wishes to maximise its profit.
Let x be the number of Oxford, and y be the number of York suites made each week.

(*a*) Write down the objective function. **(1)**
(*b*) In addition to $2x + 3y \leq 33$, $x \geq 0$, $y \geq 0$,
find two further inequalities to model the company's situation. **(2)**
(*c*) Illustrate all the inequalities, indicating clearly the feasible region. **(5)**
(*d*) Explain how you would locate the optimal point. **(2)**
(*e*) Determine the number of Oxford and York suites that should be made each week and the maximum profit gained. **(3)**

It is noticed that when the optimal solution is adopted, the time needed for one of the three stages of the process is less than that available.

(*f*) Identify this stage and state by how many hours the time may be reduced. **(2)**