1. A company manufactures two pump models (low-cost and high-end) and produces two components.

* Department A: impellers (max 120 h per day)
  + 1 h work for low-cost impeller
  + 2 h work for high-end impeller
* Department B: case (max 90 h per day)
  + 1 h work for low-cost case
  + 1 h work for high-end case
* Production line 1: Produces low-cost model (max 70 units per day)
* Production line 2: Produces high-end model (max 50 units per day)
* Profit: £20 per unit for low-cost, £30 per unit for high-end

If all pumps are sold (a very big if!) how is profit maximised given constraints?

1. A different blending problem: A company producing chicken feed supplement uses two types of additives with different vitamin contents. The feed supplement product is obtained by mixing the additives in suitable quantities.

* Additive 1 costs £20 per box and contains Vit A (1 gr/box), Vit B (2 gr/box), Vit C (2 gr/box), Vit D (0 gr/box)
* Additive 2 costs £30 per box and contains Vit A (0 gr/box), Vit B (1 gr/box), Vit C (5 gr/box), Vit D (1 gr/box)
* The supplement must contain at least Vit A (2 gr), Vit B (12 gr), Vit C (36 gr), Vit D (4 gr)

How many boxes and of which additives should be purchased to blend for the supplement that minimises the costs?

1. A planning problem, production schedule over a 5 month period: A company supplies heat exchangers, it can manufacture internally or subcontract for external manufacture.

* Internal production costs £10k per unit and can produce 2000 units
* External production costs £15k per unit and can produce 600 units
* It cost the company to hold inventory at £2k per unit per month.
* At the start the company holds an inventory of 300 units and after the 5 months wants to still have an inventory of 300 units.
* The order book demands for the next 5 months are as follows: M1 1200 units, M2 2100 units, M3 2400 units, M4 3000 units, M5 4000 units.

How many heat exchangers should be produced (and where), each month, in order to meet demands on time and minimize the costs?

1. Extension to exercise 3, you can only hold a maximum inventory of 2000 units, is it possible to still meet the demands, and if so how?

For question 3: *(Hint, getting close to the solution to this is actually straight forward, but programming it is tricky, so let’s work out a good guess first, and then see if you can get a programme to get the full solution:*

*In total we need to produce 1200+2100+2400+3000+4000 = 12700, the most we can produce is 5 x (2000 + 600) = 13000, so we can see that we are going to be maxed out on production most of the time to meet the demands. It is cheapest to produce internally, so would expect to make my full 2000 of these each week. As it costs money to store units, I would like to keep my inventory as low as possible, so it would suggest that 300 in the first month from external and then 600 thereafter would be the cheapest way to go, but tricky to check that this doesn’t contravene a constraint. So would expect the solution to look like*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| ***Month*** | ***Internal*** | ***External*** | ***Inventory*** | ***Demand*** |
| *0* | *0* | *0* | *300* | *0* |
| *1* | *2000* | *300* | *1400* | *1200* |
| *2* | *2000* | *600* | *1900* | *2100* |
| *3* | *2000* | *600* | *2100* | *2400* |
| *4* | *2000* | *600* | *1700* | *3000* |
| *5* | *2000* | *600* | *300* | *4000* |
| *Total* | *10000* | *2700* |  | *12700* |

*Actually this does meet all the constraints, and is the optimal solution)*