II.2 Example 2. Comparison of two sales commission plans

Through this example we discuss the design of formulae in spread sheets, copying of formulae from one range to another and simple what if analysis.

A company wants to compare two proposed plans for sales commission. In Plan-A, when the number of units sold is less than or equal to 20,000 (call it Volume-1) no sales commission is to be paid; otherwise, sales commission is to be paid at the rate of Re. 1 for each unit sold beyond 20,000. In Plan-B also, for sales upto 20,000 units there is no commission. For sales between 20,000 and 60,000 (call it Volume-2) the commission is at the rate of Rs. 0.6 for each unit above 20,000; for sales beyond 60,000, the commission is at the rate of Rs. 1.5 for each unit in excess of Rs. 60,000.

The variable costs are estimated as follows:
Raw material cost per unit of final product = Rs. 15
Utilities cost per unit of final product = Rs. 5
The fixed costs per year are given as:
Rent = Rs. 60,000; Salaries = Rs. 2,00,000; Advertising Expenditure = Rs. 80,000
Other Miscellaneous fixed costs = Rs. 20,000.

The sales price per unit is Rs. 25.

In comparing the two policies, we are required to find the break even sales volume for each of the two plans. We are also required to find the sales volume, if any, at which both the policies yield the same profit; below this sales volume, one of the policies is the more profitable, and above it, the other policy is the better.

1. A spread sheet design for this problem is presented below: (see Figure 2a).Parameters: As some data is common for both policies, this data is entered in the range A3:C14. In this range, Column A is reserved for the titles of the parameters, and C for their values. Column B is left blank for the sake of legibility.
2. The data on sales commission, which is different for the two policies, is given in the range E3:G7. Column E consists of the titles, F the data for Plan-A, and G the data for Plan-B.

Output

The output can be split into two parts: in one we show the total costs and total revenues for each of the plans for a certain sales volume. In another, we show the sensitivity analysis: how the net income varies with sales volume for each plan. The first part is shown in the range E9:G15, the second in I5:K16.
Cell Widths. To choose the widths of columns D and H as 1, click the mouse on the desired column, and use the menu options Format -- Column Width. In the dialogue box that appears enter the desired width in the Column Width field. The other columns will remain at the default column width.

Cell Formulae . The cell formulae in the range E9:G15 are shown in Figure 2b. Most of the formulae are self explanatory, and can be easily derived by the reader; for example, total raw material cost = raw material cost per unit of product (cell C5) * number of units sold (cell C14). Hence the formula to be entered into F10 is either C5*C14 or $C$5*$C$14. Of these two, we choose the latter, because while copying this formula to the corresponding cell in Plan-B we do not want the cell addresses to change.

The formulae for total sales commission are more complex than the others. These can be derived as below:

Total sales commission in A = 0 if sales (cell C14)<=20000 (cell F4)
= (sales volume-20000)*1 otherwise.

The format of IF function is IF (Condition, expression-1, expression-2); this means that the contents of the current cell should be obtained by evaluating expression1 if condition is true, and by expression2 otherwise. The condition to be verified here is $C$14<=F4. If the condition is satisfied, then the commission is 0; otherwise it should be equal to ($C$14-F4)*F5. Accordingly the formula in cell F12 is

= IF($C$14 <= F4, 0, ($C$14-F4)*F5)

As the formulae in Plan-A and Plan-B are similar, enter the formulae only for Plan-A, that is in column F, range F9:F15, and then copy these into column G, range G9:G15. The formula for sales commission in cell G12 needs to be changed through editing, because sales commission is computed differently in the two policies.

Figure-2a: Comparison of two sales commission plans

	A	B	C	D	E	F	G	H	I	J	K
1											
2						Plan-A	Plan-B		Data Table-1		
3	Common Data				Sales comm				Sales Volume vs Net income		
4					Volume-1	20000	20000		c14	f15	g15
5	Unit r.m. cost		15		Comm-1/unit	1	0.6			20000	21000
6	Unit util cost		5		Volume-2		60000		83000	-8000	-3500
7	Unit price		25		Comm-2/unit		1.5		84000	-4000	0
8									85000	0	3500
9	Rent		60000		Tot fix cost	360000	360000		86000	4000	7000
10	Salaries		200000		Tot rm cost	1350000	1350000		87000	8000	10500
11	Advertising		80000		Tot util cost	450000	450000		88000	12000	14000
12	Other fixed csts		20000		Tot sales comm	70000	69000		89000	16000	17500
13					Tot cost	2230000	2229000		90000	20000	21000
14	No.of units sold		90000		Tot sales tev	2250000	2250000		91000	24000	24500
15					Net income	20000	21000		92000	28000	28000
16									93000	32000	31500

Figure-2b: Formulae and other entries in range E9:G15

	E	F	G
9	Tot fix cost	= SUM($C$9:$C$12)	= SUM($C$9:$C$12)
10	Tot rm cost	= $C$14*$C$5	= $C$14*$C$5
11	Tot util cost	= $C$14*$C$6	= $C$14*$C$6
12	Tot sales comm	= IF($C$14<=F4,0, ($C$14-F4)*F5)	= IF(c14<=G4,0, (IF($C$14<=G6, ($C$14-G4)*G5, ($C$14-G6)*G7+(G6-G4)*G5))
13	Tot cost	= SUM(F9:F12)	= SUM(G9:G12)
14	Tot sales rev	= $C$14*$C$7	= $C$14*$C$7
15	Net income	= F14-F13	= G14-G13

Sensitivity Analysis

The break-even volumes can be found by changing the entry in cell C14 till the net income reaches a value zero in cell F15 or G15. However, this process involves considerable amount of search and hence is tedious. This process can be simplified considerably by building a table with a range of sales volumes in one column, and the corresponding net income figures in the other columns. This is achieved by letting the spreadsheet fill what is known as a data table. First, choose the range of the data table as I5:K16. Fill the first column of this range, starting from cell I6, with the range of the sales volumes that we are interested in testing. In J5, the first cell of the second column, enter the cell address of the first dependent variable, that is, =F15; and in K5, the first cell of the third column, enter the address of the second dependent variable, that is, =G15. Highlight the table region, that is, I5:K16 by positioning the mouse pointer on I5 and dragging it to K16 with the left button pressed. Next choose the menu options Data -- Table. A dialogue box with two fields, row input cell and column input cell appears. Keep the row input cell field blank, and fill the column input cell field with the address C14. Then press the OK button. The software fills the second and third columns of the table automatically.

Figure-2 shows the results of sensitivity analysis for sales volume varying from 83,000 to 93,000. From this we get the answers for all the given questions:

1. The break-even sales volumes for Plan-A and Plan-B are 85,000 and 84,000respectively.

2. For the sales volume 92,000 both the policies give the same net income. For sales volumes less than 92,000 policy B is better than A; and for those above 92,000, A is better than B.

II.3 Example 3. Extension to Example 2

Through this example we discuss the use of functions, particularly IF and VLOOKUP in Excel.
In the above example we have assumed that the advertising expenditure is fixed and is independent of the sales volume. Suppose this assumption is to be relaxed. Let the relation between the sales volume and advertising expenditure be specified as below:

Sales volume	Advertising Expenditure
0 - 29,999	5,000
30,000 - 59,999	10,000
60,000 - 79,999	30,000
80,000 - 89,999	60,000
>= 90,000	90,000

The spread sheet for this is shown in Figure-3. Note that this spread sheet has a new partition, the range A16:B22, to accommodate the data given above. The following changes are made to the spread sheet in Figure-2 to incorporate the new feature:

The advertising expenditure is no more a fixed cost, but it is to be computed for any given sales quantity. Hence it is removed from the parameters set, and is included as a separate item in the range F8:G8. The values in these cells are to be obtained by matching the sales volume with the values in the range A18:A22, and taking the corresponding value of advertising expenditure from the next column, column B. Therefore the formula for cell F8 and G8 is VLOOKUP($C$14,A18:B22,2). The results of the sensitivity analysis for this modification show that, unlike in the previous case, the net income does not exhibit a monatomic behaviour; it fluctuates, with increase in sales.

51. Conference Budget.

Mr. Eradico, a manager of an NGO, proposes to conduct a two-day workshop on eradication of illiteracy. He has negotiated with a local educational institution for a conference hall in which the sessions of the conference could be held, and for hostel rooms in which the delegates could be accommodated. The educational institute agreed to provide a conference hall for two days, and accommodation for one night for a maximum of fifty people. A caterer was to to supply breakfast, lunch, on both days, conference dinner in the evening on the first day, special tea following the inaugural function, normal tea once in the afternoon on both days, and normal tea once in the morning on the second day. The information relevant for working out the conference budget is given below:

1. The number of delegates will be between twenty and forty. Delegates are required to register in advance, along with submission of registration fee.

2. The number of people in the organizing team will be ten, including all volunteers.

3. There will be four invited speakers from different parts of the country.

4. The costs of different items are:

Inaugural tea and snacks: Rs 100 per person. The inauguration is expected to be attended by the delegates, the organizing team, invited speakers, and about twenty other invitees.

Lunch: Rs 200 per plate. Lunch is given to all delegates, speakers, and organizers, on both the days.

Normal tea: Rs 50 per person. This is given in the afternoon on the first day, and in the morning and afternoon on the second day. For this item, speakers, delegates, and organizers are included.

Breakfast: Rs 100 per person. Breakfast is given to delegates, speakers, and organizers on both the days.

Conference dinner: Rs 250 per person. This happens in the evening on the first day. In addition to the delegates, speakers, organizers, fifteen guests would attend the conference dinner. Dinner is not needed on the second day.

Rental charge for the conference hall along with audio visual equipment: Rs 10,000 per day.

Accommodation charges are Rs 1500 per person per night; it is estimated that all delegates and speakers will arrive in the morning on the inaugural day, and leave by 7.00 PM on the second day. Hence the delegates and speakers need to be provided accommodation for only one night.

Conference kit: Rs 500 per kit. The kit includes a bag, conference material, and some stationery. The kit is to be provided to the delegates, speakers, and organizers.

Pickup and drop. Airport/railway station pickup and drop are to be provided to each delegate and speaker. The estimated charge for pickup is Rs 200 per person, and for drop also Rs 200 per person.

Return airfare: Each speaker is to be reimbursed return airfare, which is estimated to be Rs 10,000 per each speaker.

Honorarium: Each speaker is to be given an honorarium of Rs 4,000.

For administrative expenses like telephone, courier and clerical work, a sum of Rs 40,000 is to be set apart.

Questions:

- If the entire expenditure of the conference is to be met by the registration fee alone, then what should be the registration fee per participant?
- If a maximum amount of Rs two lakh could be raised through sponsorships, what should be the registration fee per participant?

To answer the above questions, experiment with various possible values of parameters like number of delegates and sponsorship amount.

- Can you conclude from your experiments that, in general, the more the participants, the less the registration fee per participant, for break-even?

52. Top 100 of Forbes 2000.

Given below is the list of top 100 companies of the Forbes 2000 list, March 2004 (Source for the data is the website: http://www.forbes.com/2004/03/24/04f2000land.html), arranged in ascending order of rank. The ranks are obtained by developing a composite index using the following attributes of each company: 1. sales, 2. profits, 3. assets, and 4. market value.

A. Enter the list into a spreadsheet. Reorganize the list by sorting it on each of the dimensions mentioned above; additionally, sort it by country and category.

B. Develop a table showing for each country and category combination, the number of companies in the list that come under the combination.

C. Using a suitable set of features to list all companies whose sales were more than $80 billion and market value greater than or equal to $200 billion.

D. How many companies in the list are close to the maximum value in each attribute; that is, find the number of companies whose sales is close to the highest sales in the list; find the number of companies whose profit is close to the highest profit in the list, and so on. A company is considered close to another company on a given dimension, if its value in that dimension is greater than a certain given percentage (for example 95%) of the highest value in that dimension. Provide the percentage for defining the closeness as a parameter.

E. Consider the idea of closeness to the top company as discussed in D above. Some companies are close to the topmost company on one dimension, some on two dimensions, some on three, and some on all four. Thus, depending on how many dimensions a company is close to the corresponding top most company, you can classify companies into four classes. Count and display the companies belonging to each class.

F. Prepare a table of total sales category-wise, and find the category with maximum sales.

G. Show all companies with profits greater than or equal to 20% of sales, or profits greater than or equal to 10% of assets.

II. EXAMPLES

II.1 Example 1. Weekly wage computation

Suppose you are given the following data related to a week on each employee of a company:

i. Employee code
ii. Hours worked during the week
iii. Basic wage in Rupees per hour
iv. Number of pieces produced

Further, the following data that applies to all employees is also given:

i. Standard rate of production in number of pieces per hour
ii. Extra pay (or, incentive pay) for each piece produced over and above the standard production, in Rupees per piece

Design a spreadsheet to contain the above data, and to compute using this data the following:

i. For each employee, the regular pay for the week
ii. For each employee, the incentive wage, if any, for the week
iii. For each employee, the total pay for the week
iv. For all the employees put together, the sum of regular, incentive, and total pay
v. The sum of incentive pay as a percentage of the sum of total pay.

Figure-1a shows an Excel spread sheet for a sample of five employees. This sheet consists of four areas:

i. Title of the sheet in rows 1 and 2
ii. The parameters section in the range A3:D5; this consists of the values of the two parameters, standard rate of production, and incentive wage per extra piece produced.
iii. The employee data in the range A11:H15; the range A6:H 10, and the range A16:H16 are used for column headings and dividing lines.
iv. Overall statistics on pay roll data in the range F17:H18.

Note that the data in columns titled EmpCode, Basic Wage, Hrs worked, and Pcs produced is to be input by you. Similarly, the values of standard rate of production is to be input in cell D4, and that of incentive wage rate in Rs per piece is to be input in cell D5. The other values are computed by the software, through the formulae, shown in Figure-1b.

These formulae are devised based on the following rules:

i. Extra production = Maximum of {(actual production- standard production),0}
= Maximum of {actual number of pieces produced-hours worked*standard rate of production),0}

ii.Regular pay = Basic wage in Rs per hour * hours worked

iii.Incentive pay = Extra production * incentive rate in Rs per piece

iv.Total pay = Regular pay + incentive pay.

The formulae shown in Figure-1b are self- explanatory. Consider the formula in cell E11, for example. This formula is devised to compute the extra number of pieces produced by employee E1.

From formula i shown above, we need to compute the maximum of two quantities; this is done by the MAX function. Of the two quantities involved, the first one is the difference between actual production, given in cell D11, and the standard production; the standard production in turn is obtained by multiplying the standard rate of production, given in cell D4 with the number of hours worked, given in cell c11. The formula for the first quantity is D11 - D4 * C11; however, note that D4 is written in Figure-1b as $D$4, which is nothing but absolute referencing of that cell. The absolute referencing is used so that when this formula is copied to corresponding cells of other employees, the address of the parameter does not change. The second quantity inside MAX is the constant 0. Thus, the entire formula in E11 is MAX((D11-$D$4*C11),0). This formula is copied to cells in the range E12:E15 to obtain formulae for extra production for each of the other employees.

Figure-1a. A spread sheet for wage computation

	A	B	C	D	E	F	G	H
1			**Wage Computation Example**					
2								
3	Paramtrs:							
4	1. Std Rt (Pcs/hr)			10				
5	2. Incnt Rt (Rs/piece)			5				
6								
7	Emp	Basic	Hrs	Pcs	Extra	Pay	Pay	Pay
8	Code	wage	worked	produced	productn	regular	incntv	totl
9		(Rs/hr)				(Rs)	(Rs)	(Rs)
10								
11		20	40	440	40	800	200	1000
12		25	48	530	50	1200	250	1450
13		25	56	490	0	1400	0	1400
14		20	32	350	30	640	150	790
15		30	40	350	0	1200	0	1200
16								
17					Totals:	5240	600	5840
18					**Incntv/totl as %:**			**10.27**

Figure-1b. Formulae in the spread sheet of Figure-1a

Cell	Formula	Comments
E11	=MAX(D11-$D$4*C11,0)	Copied to E12:E15
F11	=B11*C11	Copied to F12:F15
G11	=e11*$D$5	Copied to G12:G15
H11	=F11+G11	Copied to H12:H15
F17	=SUM(F11:F15)	
G17	=SUM(G11:G15)	
H17	=SUM(H11:H15)	
H18	=100*G17/H17	

Example 1.1 Weekly Wage Computation: Extension-1.

Suppose, the problem remains the same as in the previous case, with the following difference: the basic wage in Rs/hour for a worker is not directly known. All employees are divided into five types, A,B,C,D, and E. The basic wage varies from one type to another as shown in the following table:

Employee Type	Basic Wage in Rs/hour
A	20
B	25
C	30
D	40
E	45

For each employee in question, her or his type is given as input. With other rules remaining the same before, compute the regular, incentive, and total wage for each employee and the grand total incentive wage as percentage of the grand total of total wage.

The spreadsheet for this extension is shown in figures 1.1a and 1.1b.

This solution consists of one new step, namely to get the basic wage in Rs/hr by using the type, given as input in column B. The basic wage is obtained in column C. To facilitate this step, the table for Basic wage corresponding to each type is given in the range **K7:L11**. The basic wage for a specific employee is obtained by looking up the this table, using the value in the type field as the lookup value. The table lookup is accomplished through a formula. The formula for the first employee is entered in cell C11; then it is copied to cells C12:C15 to get the formulae for the remaining employees. This formula is:

=VLOOKUP(B11, $K$7:$L$11,2,FALSE)

The V in the VLOOKUP in the above formula denotes that the lookup table is vertical: the keys, A,B,C,D, and E are in a column and so are the corresponding values for Basic Wage. The range K7:L11 is called the lookup table, and its first column, the range K7:K11, is called the lookup vector.

The first argument in the above formula denotes the lookup value: the lookup value, the type of employee E11 is in cell B11, and hence the first argument of the above VLOOKUP function is B11.

The second argument indicates the range of the lookup table, which is K7:L11. This address is surrounded in $ symbols, because the range remains the same, even for other employees. Lookup involves going down the first column of keys in the lookup table to find which of them is matching with the given lookup-value. In this case, the lookup-value is E, and this is found to match with the key of the fifth row of the lookup-table.

The idea of lookup is to take as result a value from the matching row; which column of the matching row has the result is specified as the third argument. The third argument in this case is 2, implying that the result of the lookup is contained in the second column of the matching row, that is the second column of the fifth row. So, the result of the vlookup is 45, which is the value of the second column of the matching row of the lookup table.

Range lookup in VLOOKUP. What happens if the lookup value does not match with any of the keys in the lookup table? In this case, lack of a match implies an error in the lookup value, and hence an error needs to be indicated. However, in some other contexts, if no exact match is obtained, one of the closest keys is taken as the matching value, and such a lookup is called

range-lookup. Whether or not we need range-lookup is indicated as the fourth argument of the VLOOKUP function: FALSE implying that range-lookup is not to be used (which means only exact match is needed, and otherwise an error is to be reported), and TRUE implying that range-lookup is to be used (which means that if exact match is not found an approximate match, as per a rule, is to be found). In the present context, an exact match is needed and hence FALSE is given as the fourth argument.

Range look up is also needed when the range of lookup keys is very large, and divided into intervals. Each key given in the first column of the vlookup table corresponds to an interval, and as a part of the search, first the interval into which the lookup value falls is determined, and then from the corresponding row, the result is taken.

As the VLOOKUP formula is copied vertically downwards in the range C11:C15, it is enough if $ symbols are put only in front of the row numbers, that is, even the following specification would work correctly:

=VLOOKUP(B11, K$7:L$11,2,FALSE)

The logic for the formulae in other columns is the same as before and hence we do not explain them here.

HLOOKUP function. The lookup vector can also be horizontal, instead of being vertical. In that case, you need to use the function HLOOKUP. The keys in a HLOOKUP table are in the first row, the search first determines the matching column of the HLOOKUP table, and the result is in a row of the matching column(specified as the third argument). The match can be exact (that is the fourth argument of HLOOKUP is FALSE), or it can be interval-based (that is the fourth argument is TRUE). In the case of range lookup, the key values in the first row are to be in the ascending order, and the search takes place from left to right.

Figure-1.1 a Main Spreadsheet for example 1.1

	A	B	C	D	E	F	G	H	I
1									
2									
3	Parameters:								
4	1. Std. Rt	(Pcs/hr)			10				
5	2.Incntv. Rt	(Rs/piece)			5				
6									
7	**Emp**	**Emp**	**Basic**	**Hrs**	**Pieces**	**Extra**	**Pay**	**Pay**	**Pay**
8	**Code**	**Type**	**Wage**	**Worked**	**Produced**	**Prodn**	**Regular**	**Incntv**	**Total**
9			**(Rs/Hr)**				**(Pcs)**	**(Rs)**	**(Rs)**
10									
11	E1	E	45	40	440	40	1800	200	2000
12	E2	D	40	48	530	50	1920	250	2170
13	E3	C	30	56	490	0	1680	0	1680
14	E4	B	25	32	350	30	800	150	950
15	E5	A	20	40	350	0	800	0	800

Figure 1.1 b. Lookup Table in the Spreadsheet of Example 1.1

	K	**L**
6	Emp Type	BasicWage
7	A	20
8	B	25
9	C	30
10	D	40
11	E	45

Figure 1.1c. Important formulae in the spreadsheet of example 1.1

Cell	**Formula**	**The range to which the cells formula is copied**
C11	=VLOOKUP(B11,$K$7:$L$11,2,FALSE)	C12:C15
F11	=IF(E11>$E$4*D11,E11-$E$4*D11,0)	F12:F15
G11	=D11*C11	G12:G15
H11	=F11*$E$5	H12:H15
I11	=G11+H11	I12:I15
G17	=SUM(G11:G15)	H17:I17
I18	=100*H17/I17	

Example 1.2 Weekly Wage Computation: Extension-2.

Consider another extension, independent of the previous extension, to example 1. Suppose that the basic wage (rupees per hour) depends on a performance index (PScore) which is computed and updated periodically for each worker. PScore forms one of the inputs to the problem. The PScore is divided into several intervals and the basic wage of a worker depends on the interval to which his/her PScore belongs. This relationship is defined by the following table:

Range of PScore	Basic (Rs/hr)
PScore ≤ 10	20
10 < PScore ≤ 20	25
20 < PScore ≤30	30
30 < PScore ≤40	40
PScore > 40	60

You can assume that PScore is computed to two decimal places; it is never negative, and rarely exceeds 40. Other inputs and outputs required remain the same as in the original version of the problem (Example 1).

A solution to the above problem is given in the spreadsheet shown in Figures 1.2a and 1.2b. A new feature in this spreadsheets is the conversion of PScore to basic wage. This is done through the formulae in range C11:C15.

As can be guessed, these formulae used VLOOKUP. The lookup table is given in range K7 : L11. Let us analyze the following formula in cell C11:

= VLOOKUP (B11, K$7 : L$11, 2, TRUE)

The arguments in the above formula have the meanings already explained in the previous example. The only difference here is that the fourth argument is TRUE, which means that during the lookup, range lookup procedure needs to be followed. Let us explain this using the data for worker E1 whose PScore is given as 10.5 in cell B11. Therefore, the lookup value in VLOOKUP is 10.5. This is compared with the keys in the first column of the lookup table from top-down till a matching value is found, or till a key that exceeds the lookup value is encountered for the first time. If an exact match is found, then the result is the value in the column number (of the matching row) given by the third argument of the VLOOKUP. Else, the row previous to the key that first exceeds the lookup value is taken as the matching row, and the result as before is taken from the column specified by the third argument of the VLOOKUP. In the present case, as 10.5 is compared with the keys in the first column of table K7 : L11, the first key that exceeds 10.5 happens to be 20.01, which is in the third row of the lookup table. Therefore, the matching row is taken to be row 2, one row prior to the row in which 20.01 occurs. In row 2, the result is in the second column, which is 25. The basic of Rs 25/ hr is of course correct according to the problem definition.

In a similar way, for the second worker, the matching row is the third row, and hence the result is 30. In general, the rule for finding matching row is as follows:

The matching row is that row whose key is the greatest key less than or equal to the lookup value. The lookup table has to be formulated such that keys of successive rows are in ascending order, and no key is duplicated. If the lookup value is greater than all the key values in the lookup table, the last key is taken to be the greatest key less than or equal to the lookup value and accordingly the last row becomes the matching row. On the other hand, if the lookup value is smaller than even the first key, then the VLOOKUP fails to yield a result, and prints an error message.

The formulae in other columns (see Figure 1.2 c) are similar to those in the other two versions of the problem and hence are not explained further.

Figure 1.2a Spreadsheet of Example 1.2: Main area

	A	B	C	D	E	F	G	H	I
1									
2									
3	Parameters:								
4	1. Std. Rt	(Pcs/hr)			10				
5	2.Incntv. Rt	(Rs/piece)			5				
6									
7	**Emp**	**PScore**	**Basic**	**Hrs**	**Pieces**	**Extra**	**Pay**	**Pay**	**Pay**
8	**Code**		**Wage**	**Worked**	**Produced**	**Prodn**	**Regular**	**Incntv**	**Total**
9			**(Rs/Hr)**				**(Pcs)**	**(Rs)**	**(Rs)**
10									
11	E1	10.5	25	40	440	40	1000	200	1200
12	E2	20.5	30	48	530	50	1440	250	1690
13	E3	42	60	56	490	0	3360	0	3360
14	E4	35	40	32	350	30	1280	150	1430
15	E5	6	20	40	350	0	800	0	800

Figure-1.2b Spreadsheet of Example 1.2: Lookup Table

	K	L
7	0	20
8	10.01	25
9	20.01	30
10	30.01	40
11	40.01	60

Figure-1.2c Important formulae in the spreadsheet of example 1.2.

Cell	**Formula**	**The range to which the cells formula is copied**
C11	=VLOOKUP(B11,$K$7:$L$11,2,TRUE)	C12:C15
F11	=IF(E11>$E$4*D11,E11-$E$4*D11,0)	F12:F15
G11	=D11*C11	G12:G15
H11	=F11*$E$5	H12:H15
I11	=G11+H11	I12:I15
G17	=SUM(G11:G15)	H17:I17
I18	=100*H17/I17	

3. FREQUENT FLYER SCHEME OF IA

The frequent flyer scheme of Indian Airlines (IA) offers free travel to IA customers for mileage points earned by them through earlier travels. The cities and mileage points required to avail a free ticket to those cities are given in the IAFF Mileage Points Table on the IA website. A segment of the table is rearranged (in the ascending order of points required) and reproduced in columns **A to C** (rows 1-14) of the spreadsheet below.

	A	B	C	D	E	F	G	H
1	**IA Frequent Flyer Mileage Points Table (Ahmedabad Segment)**							
2		Points required for						
3	To City	Executive	Economy	z	Flying Points Accrued:		**12000**	
4	Vadodara	2880	1920		Class of Interest:		**Economy**	----------
5	Mumbai	8280	5520		Free travel to city:		**Delhi**	----------
6	Jaipur	9840	6560					
7	Delhi	14160	9540		Farthest Possible City		----------	
8	Hyderabad	16290	10860		Balance Pts:		----------	
9	Muscat	17600	13000					
10	Sharjah	17660	13040					
11	Kuwait	20100	14900					
12	Bangalore	23220	15480					
13	Bhubaneswar	26220	17480					
14	Kolkata	35160	23440					

The flying points earned by a customer are given in cell **G3**. Also the class and city to which the customer is interested to travel using free entitlement is given in cells **G4** and **G5** respectively. *The formulae you develop for the questions below should work with any valid data entered in these cells.*

Questions

1. Enter a formula in cell **H4** to obtain the column number in the table **A3:C14** of the class in cell **G4**. For example, if the class given in **G4** is *Economy*, the value in **H4** should be *3*. ***Use this result in subsequent questions, to simplify the formulae where ever possible.***

Formula: _____

2. Enter a formula in cell **H5** to obtain one of the text strings "*Yes*" or "*No*" depending on whether the points given in **G3** are adequate (*Yes*) or not adequate (*No*) to travel by the class in **G4** to the city in **G5**. For example, with *12000* points, the customer can travel free by *Economy* class to the desired city *Delhi* (required points *9540*) and therefore the output should be *Yes* for this data.
   Formula: _____

3. Enter a formula in cell **G7** to obtain the farthest possible city the customer can travel free with the points accrued (given in **G3**), by the class given in **G4**. For example with *12000* points, the farthest city the customer can travel free by *Economy* class is *Hyderabad*.

Formula: _____

4. Enter a formula in cell **G8** to obtain the balance mileage points; i.e. the difference of points accrued and points required to travel by the class in **G4** to the farthest city obtained in **G7**. For example, with *12000* points, after traveling to the farthest city (*Hyderabad*) in *Economy* class, the balance is *1140 (12000-10860)*.

Formula: _____

Extension: Re-develop solutions to the above, if ***more than two*** classes are to be considered.

6. ANALYSIS OF TRANSPORTATION COSTS

The distributor of bulk items needs a tool to compute the transportation costs from the goods movement data and distance matrix.. It is also required to study the impact of changes in freight tariff on transportation costs. A sample of distance matrix for five major cities is given below as a lower diagonal matrix:

Distance Matrix (in km)

City	Chennai	Delhi	Hyderabad	Kolkata	Mumbai
Chennai	0				
Delhi	2160	0			
Hyderabad	700	1450	0		
Kolkata	1680	1440	1520	0	
Mumbai	1370	1410	740	2080	0

The typical goods movement data are given in the table below:

Consignment #	From City	To City	Tonnage
1	Mumbai	Kolkata	500
2	Mumbai	Hyderabad	200
3	Hyderabad	Chennai	800
4	Hyderabad	Kolkata	200
5	Kolkata	Delhi	100
6	Kolkata	Chennai	100
7	Delhi	Chennai	600
8	Delhi	Hyderabad	900
9	Chennai	Mumbai	70

Questions

1. Assuming a basic freight rate of Rs.1.3 per tonne-km, develop a spreadsheet based solution to interactively workout the following:

    a. Freight charges for each transaction and total charges.
    b. Revised total freight charges, in the form of a table, with increase in the freight rate say by 5, 7, 10, 12, 15 and 20 per cent.

2. Re-compute the freight charges with slab based tariff: Rs.2 up to 100,000 tonne-km, Rs.1.8 for 100,001 -150,000 tonne-km, Rs.1.5 for 150,001 to 250,000 tonne-km, Rs.1.25 for 250,001 to 500,000 tonne-km, and Rs.1.1 per tonne-km for amount above 500,000 tonne-km.

Note that the last two parameters in the above syntax are boolean that is you can give TRUE or ALSE in the corresponding position. If you say 'FALSE' for 'want to estimate constant', then the constant in the regression is assumed to be zero; otherwise, it is estimated. If you say 'FALSE' for 'want to get regression statistics', then the system outputs only the regression coefficients and constant; otherwise, several other statistics associated with the regression line are output.

II.9 Example-9. Queries on a Personnel Data Base

This example deals with the facilities of Excel for selectively retrieving a part of the information from a specified range and processing it further in various different ways.

Figure-8a contains, in the range A1:F11, data on the staff of a company. The first row of this range, that is row 1, contains the labels of the data items, and the other ten rows contain the data values, one row for each employee. For the sake of convenience, let us refer to the rows as records, and columns as fields. Call the above range (including the labels row) as input range or data base or list range.

Question: Extract from the above data base the details of all the female employees with experience of 8 years.

Through a simple visual inspection, you can easily answer the above question. The employee with S.No. 4 is the only one who is female and has eight years of experience. Hence the corresponding record (that is row 5) is the record to be extracted. But visual inspection becomes difficult when the input range is large and the queries are complex. For such cases, Excel provides some useful menu options under the group Data and functions called data base statistical functions.

For answering the above question, choose the menu options Data → Sort & Filter → Filter. As a result of this, each of the field titles in row 1 will have a button similar to the drop down box button appears at its right edge. Since we are interested in filtering the records based on values in the fields Sex and Exp, first press the button on the Sex field title. A box showing the different values available in this field appears. Click on the value F, indicating that you would like to see those records with value F in Sex field. Immediately, all records of the data range, except the three corresponding to the female employees, will disappear. Next, click on the button in the Exp field. Again from the box that appears click on the value 8 indicating that from among the records that are currently being shown, you would like to see only those with 8 in the Exp field. Now only one record, that corresponding to serial number 4, remains in view. If you want to get back on display all the records simply choose the menu options Data → Sort & Filter → Filter. Note that filter option is like a toggle switch. In the earlier versions of excel, this option was called auto-filter.

The filter option works only when the criteria for choice are simple ones, and the filtering is to be done based on only one field at a time. How to deal with questions such as the following: Give the details of the female employees whose experience is more than five years. Here, the criterion involves an inequality, namely, Exp >5.

For this we need to use the feature called advanced filtering. Advanced filtering requires you to prepare a range called a criterion range. The criterion range specifies for each field the kind of values that are to be possessed by a record for it to be selected. The first row of the criterion range should contain the names of the fields, with the same spellings as in the original data range, which are to be used in the selection process. They need not however be in the same order as in the original data range (also called list range). In the second row specify underneath each field heading the corresponding selection criterion.

Figure-8a : A Personnel Data Base

	A	B	C	D	E	F	G
1	S.No.	Name	Age	Exp	Sex	Salary	Cadre
2	1	Agarwal B	28	3	F	1500	A
3	2	Jain A	30	4	M	1600	A
4	3	Rao D	26	2	M	1400	B
5	4	Sharma V	32	8	F	2000	B
6	5	Desai N	29	4	M	1400	A
7	6	Patel M	33	9	M	2200	C
8	7	Narayan V	44	20	F	1000	C
9	8	Rao K	34	8	M	2000	C
10	9	Srinivas J	44	21	M	6000	A
11	10	Nayar Y	27	2	M	1100	D

Figure-8b. Criterion range

	A	B	C	D	E	F
14	S.No.	Name	Age	Exp	Sex	Salary
15				>5	F	

For answering the present question, select the range A14:F15 as the criterion range (Figure-8b). Fill in A14:F14 with the field headings. In D15 type >5 and in E15 type F. This means we are interested in selecting records with the following feature: The value in the Exp field should be greater than 5, and the value in Sex field F. Because the other fields are left blank, those fields do not play any role in the selection process; in fact, a blank value is supposed to match with every value. Suppose our intention is to copy the selected records into a certain range, say from row 27 onwards. Fill A27:F27 with field headings so that the output can appear as per these headings. Now select the menu options Data → Sort & Filter → Filter→Advanced.

In the dialogue box that appears, fill the required addresses as follows, after choosing the option copy to another location:

List range	A1:F11
Criteria range	A14:F15
Copy to	A27:F27

When you press the OK button of this box, two records will be chosen and will be written in rows 28 and 29.

If you want to filter records with a specified name, you should be a little cautious in making entries in your criterion range. Note first of all that while comparing names, small letters and capitals are not distinguished. Secondly, if you give the desired name directly in the corresponding cell of the criteria range, you will be surprised to find that all the records with names whose first few letters are the given name, no matter what the other part consists of, will be filtered. For example if you give Ram in the criterion range, even records with Rama, Ramraju, Ramanna etc will be selected, because all the above names begin with Ram. To obtain an exact match, specify the entry in the criteria range as =”=text”, where text is the desired string; for example, in the case of Ram the entry in the criterion range would be =”=Ram”; in this case only records with Ram in their name field will be selected. An alternative way of accomplishing exact string match during filtering would be to specify EXACT function in the criteria range. The EXACT function would be explained later in the example on text processing.

It is possible to handle still more complex queries, queries having several AND's and OR's (ex: Exp <10 yrs AND Exp >5 years); the rules for specifying the corresponding criteria will be discussed later.

Question: Find from the above data base the average salary of all female employees.

There are two ways of answering this question. The first is to extract the records of all female employees using the advanced filter option mentioned above and then to find the average value of the entries in the Salary field of the output range. This, however, involves the use of an output range; then in `what if' analysis, the advanced filter option has to be repeated every time an input value is changed. Furthermore, the size of the output range itself keeps changing, with changes in input values. These problems can be avoided by using an alternative approach.

In the alternative approach, we achieve the desired result without explicitly writing the selected records in an output range, (in fact we do not need an output range) but by directly doing the required computation through a function, which uses the input range, criterion range, and the desired field position as its arguments. The function to be used in this example is DAVERAGE(A1:F11,6,A14:F15). Enter this function in an empty cell, and as soon as it is calculated you will see the result 1500, which is the average salary of the three female employees in the data base. As this entry is a function, it will be recomputed whenever any change is made in the input (unless the automatic recalc facility is switched off). The DAVERAGE function belongs to a family of functions known as data base statistical functions, each of which computes a certain statistic of a specified field in the records selected when a criterion is applied to an input range. The different statistics that can be computed are: maximum value, minimum value, sum, standard deviation, average, variance, and number of values. All these functions have the same format: the function name begins with D, and each function has three arguments. The first argument is the address or name of the input range; the second is the position of the field to be used in the computation, the offset of the left most field being counted as one; the third argument is the address or name of the criterion range.

Use of data base statistical functions requires good insight, but a mastery of these enables the user to perform many tricky, intricate and complex tasks in spread sheets.

Question: In Figure-8a, how do we re-arrange the given data in ascending order of salary? For this we have to use the Data Sort option. First highlight the list range along with the field titles, like in the data filter operation. Choose the menu options ***Data → Sort & Filter → Sort***. A table appears with three columns with the respective titles Column, Sort on, and Order. Each of the above titles has below it a drop down box. In the column titled as Column, choose the field on which the sorting needs to be done, which in your case is Salary. In the Sort on column, specify whether the sorting needs to be based on values or colour of the cell, background or fore goround colour; choose the option values. In the last column, specify the order of sorting, ascending or descending; in your case, the order is ascending, ie A to Z. Then press the OK button, to see the records rearranged in the desired order (Figure-8C). In case the sorting has more than one level, that is if you want to use a secondary sort key in case there is a tie in the first, you need to give the corresponding information by adding to the above table as many levels as you need.

It is not necessary that the key field is numeric; it can also have alphabetic values. In the case of alphabets the order A-Z is considered ascending, and Z-A as descending (strictly speaking, the order is decided by the ANSI codes of the different characters). In the coding system used by the EXCEL system (Appendix-V) the order of occurrence of the different characters is the digits (0-9), then the capital letters (A-Z), and then the small letters (a-z).

Figure -8c. Personnel data base: Sorted in ascending order of Salary

	A	B	C	D	E	F	G
1	S.No.	Name	Age	Exp	Sex	Salary	Cadre
2	7	Narayan V	44	20	F	1000	C
3	10	Nayar Y	27	2	M	1100	D
4	3	Rao D	26	2	M	1400	B
5	5	Desai N	29	4	M	1400	A
6	1	Agarwal B	28	3	F	1500	A
7	2	Jain A	30	4	M	1600	A
8	4	Sharma V	32	8	F	2000	B
9	8	Rao K	34	8	M	2000	C
10	6	Patel M	33	9	M	2200	C
11	9	Srinivas J	44	21	M	6000	A

Question. In Figure-8a you are also given information on the cadre to which an employee belongs. Find for each cadre the minimum salary in each sex, and represent the information in the form of a table, called pivot table, showing the cadres on rows and sexes on columns.

Steps to be followed:

Select the data table

Select the menu options: Insert→Tables → Pivot Table

Pivot Table Wizard with 4 steps appears.

In step1, it wants to know where is the data you want to analyze; select the answer option: Microsoft Excel List or Database

In step2, give the range of the database

In step 3, the pivot table template appears, with blank rows and columns. Into the column, drag and drop the field, sex; into the row, drag and drop the field cadre; and into data area, drag and drop the field salary. The data will be summarized by sum of salary by default. The summary statistic will appear as a button. Click on it and you will see a list of possible statistics, from which choose min.

Then say finish. It wants to know the location of the pivot table; you can say existing worksheet. The pivot table that is obtained as a result of executing the above steps is shown in Figure-8d.

When you change the source data, the result may not be automatically reflected in Pivot table. In that case choose the menu options: Data→Refresh All →Refresh

Even after generating a pivot table, it is possible to modify it; for example, you can change the field being exhibited in the columns, rows or the field being summarized in the data area. For this purpose, you need to first highlight the pivot table that needs to be modified and then choose the menu options Insert→Tables → Pivot Table; then a dialog box containing a picture of the pivot table along with one button for each field appears. By dragging and dropping the field buttons or by double clicking on the data area the desired modifications can be brought about.

Figure-8d. A Pivot Table

Min of Salary	Sex		
Cadre	F	M	Grand Total
A	1000	1100	1000
B	1500	1600	1500
C	2000	2000	2000
D		6000	6000
Grand Total	1000	1100	1000

A pivot table is an interesting and useful feature for two-way summarization of data. The default summary statistic for summarizing the data is sum. The other options are: count (how many data items are there?), average of the data items, maximum value, minimum value, product of the data items, standard deviation and variance of the items.

Calculated fields in a pivot table: In the pivot table, we can also use, in addition to the fields in the data list, fields generated by computaions on the fly. In the above example, we could have used a computational field called SalaryinThousands, which is computed by dividing each of the salary values by 1000. The SalaryinThousands can be defined as a calculated field, which appears in the list of fields in the dialog box, and hence can be used for row or column labels, or as a value field.

For defining a computed field, the menu items and the items in dialog boxes to be chosen are:

Pivot table tools → Options → Calculations → Fields,Items & Sets → Calculated field

In the corresponding dialog box, fill in the name, and formula boxes and click on the OK button.

Sorting a pivot table: A pivot table can be sorted based on any of its columns. For this task, you need to place the cell pointer on any of the values in the column based on which to sort the table, and choose Pivot table tools → Options → Sort

It is not good to base the formulae of cells in the other part of the spreadsheet to refer to values in a pivot table, especially if the size of the pivot table is liable to change.

Changing Row, column or value fields or changing the summary statistic: The easiest way of accomplishing this is to get the panel associated with field list and dragging the fields in to appropriate boxes. The corresponding menu options are:

Pivot Table Tools → Options → Show/hide → Field list

II.10 Example -10. Sales Revenue Analysis: Handling Complex Queries.

The following table (Figure-9) shows the maximum and minimum daily sales revenue earned by a company in 10 cities, considering the sales in the month of June.

1. How many cities are there whose maximum sales revenue was greater than Rs 50000 OR the average sales revenue (take the average as equal to half of the sum of maximum and minimum revenues) was greater than Rs 35000?

2. How many cities are there whose maximum sales revenue was greater than Rs 80000 AND minimum was less than Rs10000 ?

Problem: Board Exam Results

The spreadsheet below contains exam results (A2:J89) for students of a school for the last three years. Note that some rows are hidden to save space. Answer the questions below regarding this data:

Question 1: The Exam Id for a student consists of the following format: four characters for year followed by one/two characters for stream-code, followed by five characters for the Std Id.

Example: 2012SP20297 translates to year as 2012, stream as SP (Sc-Pure) and Std Id 20297.

The stream-code is given in a table in range G91:H94.

a) Write a formula for cell B3 (to be copied down for all students) to extract the Std ID.

_____

b) Formula for C3 (again to be copied downwards) for year.

_____

c) Formula for D3 for the Stream (which will be copied down to all rows).

_____

Question 2: If a student gets >=40% in Subject1 and any other 3 subjects, he/she passes overall. Column J is the Pass/Fail result for each student. What is the formula for J3 (to be copied for all students) ?

_____

Question 3: The table in range A91:D95 contains the number of students who Passed have, for the different years and streams. Write a formula for cell B92, to be copied both vertically and horizontally, to fill the table.
(Hint: Use **COUNTIFS** function that applies criteria to cells across multiple ranges and counts the number of times all criteria are met.)

```
COUNTIFS (criteria_range1, criteria1, [criteria_range2, criteria2]...)
```

_____

	A	B	C	D	E	F	G	H	I	J
1	**Board Exam Results 2010, 2011, 2012**				**% marks**					
2	**Exam Id**	**Std Id**	**Year**	**Stream**	**Subject1**	**Subject2**	**Subject3**	**Subject4**	**Subject5**	**Result**
3	2012SP20297	20297	2012	Sc-Pure	63	73	98	73	82	Pass
4	2011A21840	21840	2011	Arts	37	87	97	84	82	Fail
5	2012SP21843	21843	2012	Sc-Pure	41	98	84	56	95	Pass
6	2010SB21846	21846	2010	Sc-Bio	98	89	85	94	87	Pass
7	2012SB22860	22860	2012	Sc-Bio	50	73	72	85	91	Pass
8	2011C40738	40738	2011	Com	47	91	90	79	98	Pass
9	2011SB40744	40744	2011	Sc-Bio	62	70	99	71	95	Pass
10	2010SP40750	40750	2010	Sc-Pure	65	66	96	94	79	Pass
11	2010A40835	40835	2010	Arts	78	75	75	85	71	Pass
12	2011A45515	45515	2011	Arts	72	95	58	46	99	Pass
13	2010SB54572	54572	2010	Sc-Bio	62	64	87	79	80	Pass
14	2012SP63812	63812	2012	Sc-Pure	89	82	47	86	72	Pass
15	2011SB68016	68016	2011	Sc-Bio	77	81	89	77	58	Pass
16	2012SP68059	68059	2012	Sc-Pure	76	58	63	98	86	Pass
17	2010SB68068	68068	2010	Sc-Bio	30	90	53	87	70	Fail
18	2011A68071	68071	2011	Arts	98	82	98	65	67	Pass
19	2012C72694	72694	2012	Com	85	98	62	81	79	Pass
89	2010SP96236	96236	2010	Sc-Pure	68	93	69	64	92	Pass
90										
91	**Table:Passed**	2010	2011	2012			A	Arts		
92	Arts	2	13	4			C	Com		
93	Com	7	5	4			SP	Sc-Pure		
94	Sc-Bio	6	5	8			SB	Sc-Bio		
95	Sc-Pure	5	6	9						
96										
97	**Table: Average of Passed Candidates**									
98	74.95	**Arts**	**Com**	**Sc-Pure**	**Sc-Bio**					
99	Subject1	74.95	65.11	64.65	68.37					
100	Subject2	66.10	70.81	71.25	65.40					
101	Subject3	70.32	69.11	69.19	75.52					
102	Subject4	69.74	73.72	69.23	70.58					
103	Subject5	76.15	63.07	78.47	68.24					
104										
105	Q5	68041								
106								71		
107										

Question 4: Range A98:E103 contains a table of the average score of candidates who secured >= 40% , for the different streams and subject combinations. This is built as a 2-way data table. You can use the range G98:H99 for intermediary work.

G98: _____ H98: _____

G99: _____ H99: _____

Answer the following questions for the Data-table operation:

What is the formula in cell A98: _____

What is the range to be selected? _____

Row Input cell : _____ Column Input Cell: _____

Question 5: B105 contains the Std Id of the topper (assume unique) in Subject 1 in Arts in 2010.

You can use the range D105:E106 for intermediary work.

D105: _____ E105: _____

D106: _____ E106: _____

Formula in B105: _____

Question 6: Cell H106 contains the number of students whose highest marks and lowest marks differ by more than 30. You can use the range G105:G106 for intermediary work.

G105: _____ G106: _____

Formula for H106: _____

Question 7: Conditional formatting is used to highlight those Exam Ids where the average of all five subjects is greater than or equal to 80%. For cell A3, what is the formula to be entered in the conditional formatting window?

_____

Honorarium: Each speaker is to be given an honorarium of Rs 4,000.

For administrative expenses like telephone, courier and clerical work, a sum of Rs 40,000 is to be set apart.

Questions:

- If the entire expenditure of the conference is to be met by the registration fee alone, then what should be the registration fee per participant?

- If a maximum amount of Rs two lakh could be raised through sponsorships, what should be the registration fee per participant?

To answer the above questions, experiment with various possible values of parameters like number of delegates and sponsorship amount.

- Can you conclude from your experiments that, in general, the more the participants, the less the registration fee per participant, for break-even?

52. Top 100 of Forbes 2000.

Given below is the list of top 100 companies of the Forbes 2000 list, March 2004 (Source for the data is the website: http://www.forbes.com/2004/03/24/04f2000land.html), arranged in ascending order of rank. The ranks are obtained by developing a composite index using the following attributes of each company: 1. sales, 2. profits, 3. assets, and 4. market value.

A. Enter the list into a spreadsheet. Reorganize the list by sorting it on each of the dimensions mentioned above; additionally, sort it by country and category.

B. Develop a table showing for each country and category combination, the number of companies in the list that come under the combination.

C. Using a suitable set of features to list all companies whose sales were more than $80 billion and market value greater than or equal to $200 billion.

D. How many companies in the list are close to the maximum value in each attribute; that is, find the number of companies whose sales is close to the highest sales in the list; find the number of companies whose profit is close to the highest profit in the list, and so on. A company is considered close to another company on a given dimension, if its value in that dimension is greater than a certain given percentage (for example 95%) of the highest value in that dimension. Provide the percentage for defining the closeness as a parameter.

E. Consider the idea of closeness to the top company as discussed in D above. Some companies are close to the topmost company on one dimension, some on two dimensions, some on three, and some on all four. Thus, depending on how many dimensions a company is close to the corresponding top most company, you can classify companies into four classes. Count and display the companies belonging to each class.

F. Prepare a table of total sales category-wise, and find the category with maximum sales.

G. Show all companies with profits greater than or equal to 20% of sales, or profits greater than or equal to 10% of assets.

Forbes 2000 Rank	Name	Country	Category	Sales ($bil)	Profits ($bil)	Assets ($bil)	Market Value ($bil)
1	Citigroup	United States	Banking	94.71	17.85	1,264.03	255.30
2	General Electric	United States	Conglomerates	134.19	15.59	626.93	328.54
3	American Intl Group	United States	Insurance	76.66	6.46	647.66	194.87
4	ExxonMobil	United States	Oil & gas operations	222.88	20.96	166.99	277.02
5	BP	United Kingdom	Oil & gas operations	232.57	10.27	177.57	173.54
6	Bank of America	United States	Banking	49.01	10.81	736.45	117.55
7	HSBC Group	United Kingdom	Banking	44.33	6.66	757.60	177.96
8	Toyota Motor	Japan	Consumer durables	135.82	7.99	171.71	115.40
9	Fannie Mae	United States	Diversified financials	53.13	6.48	1,019.17	76.84
10	Wal-Mart Stores	United States	Retailing	256.33	9.05	104.91	243.74
11	UBS	Switzerland	Diversified financials	48.95	5.15	853.23	85.07
12	ING Group	Netherlands	Diversified financials	94.72	4.73	752.49	54.59
13	Royal Dutch/Shell Group	Netherlands/ United Kingdom	Oil & gas operations	133.50	8.40	100.72	163.45
14	Berkshire Hathaway	United States	Insurance	56.22	6.95	172.24	141.14
15	JP Morgan Chase	United States	Banking	44.39	4.47	792.70	81.94
16	IBM	United States	Technology hardware & equipment	89.13	7.58	104.46	171.54
17	Total	France	Oil & gas operations	131.64	8.84	87.84	116.64
18	BNP Paribas	France	Banking	47.74	4.73	745.09	59.29
19	Royal Bank of Scotland	United Kingdom	Banking	35.65	4.95	663.45	90.21
20	Freddie Mac	United States	Diversified financials	46.26	10.09	752.25	44.25
21	DaimlerChrysler	Germany	Consumer durables	157.13	5.12	195.58	47.43
22	Altria Group	United States	Food, drink & tobacco	60.70	9.20	96.18	111.02
23	ChevronTexaco	United States	Oil & gas operations	112.94	7.43	82.36	92.49
24	Pfizer	United States	Drugs & biotechnology	40.36	6.20	120.06	285.27
25	Wells Fargo	United States	Banking	31.80	6.20	387.80	97.53
26	Verizon Commun	United States	Telecommunications services	67.75	2.57	165.97	103.97
27	Barclays	United Kingdom	Banking	33.69	4.90	791.54	61.33
28	Morgan Stanley	United States	Diversified financials	33.00	3.64	580.63	64.81
29	General Motors	United States	Consumer durables	185.52	3.82	450.00	27.47
30	Nippon Tel & Tel	Japan	Telecommunications services	92.41	2.17	150.87	73.00
31	Microsoft	United States	Software & services	34.27	8.88	85.94	287.02
32	Nestlé	Switzerland	Food, drink & tobacco	64.56	5.48	62.15	106.55

Forbes 2000 Rank	Name	Country	Category	Sales ($bil)	Profits ($bil)	Assets ($bil)	Market Value ($bil)
33	SBC Communications	United States	Telecommunications services	39.16	5.97	100.17	82.93
34	Deutsche Bank Group	Germany	Diversified financials	58.85	1.53	792.49	50.23
35	Siemens Group	Germany	Conglomerates	86.62	2.81	85.47	75.77
36	HBOS	United Kingdom	Banking	32.68	3.09	571.76	52.87
37	ENI	Italy	Oil & gas operations	53.29	4.82	67.91	76.13
38	ConocoPhillips	United States	Oil & gas operations	90.49	4.83	81.95	46.72
39	Banco Santander Central	Spain	Banking	28.70	3.28	442.24	56.78
40	Merrill Lynch	United States	Diversified financials	26.64	3.47	485.77	57.52
41	Wachovia	United States	Banking	24.47	4.25	400.87	62.35
42	Time Warner	United States	Media	38.08	2.65	121.78	77.95
43	Hewlett-Packard	United States	Technology hardware & equipment	73.06	2.54	74.71	70.20
44	Procter & Gamble	United States	Household & personal products	46.99	5.81	53.86	131.89
45	Samsung Electronics	South Korea	Semiconductors	50.22	5.95	54.58	72.72
46	Johnson & Johnson	United States	Drugs & biotechnology	40.01	6.74	46.66	160.96
47	Lloyds TSB Group	United Kingdom	Banking	24.48	2.87	406.99	48.11
48	ABN-Amro Holding	Netherlands	Banking	23.64	3.98	704.95	39.29
49	Honda Motor	Japan	Consumer durables	67.44	3.61	63.09	40.61
50	American Express	United States	Diversified financials	24.17	3.00	175.00	68.89
51	Nissan Motor	Japan	Consumer durables	57.77	4.19	60.56	41.71
52	Bank One	United States	Banking	21.04	3.40	290.01	58.38
53	AXA Group	France	Insurance	90.10	1.00	456.13	41.39
54	Société Générale Group	France	Banking	35.52	1.61	526.54	40.61
55	PetroChina	China	Oil & gas operations	29.53	5.67	58.36	90.49
56	Goldman Sachs Group	United States	Diversified financials	22.84	2.54	394.14	50.12
57	BBVA-Banco Bilbao Vizcaya	Spain	Banking	24.10	2.81	288.80	44.67
58	Intel	United States	Semiconductors	30.14	5.64	47.14	196.87
59	MetLife	United States	Insurance	35.79	2.24	326.84	26.34
60	Home Depot	United States	Retailing	62.90	4.04	35.37	82.29
61	Viacom	United States	Media	25.85	2.47	90.94	68.66
62	Allstate	United States	Insurance	32.15	2.73	134.14	32.90
63	Merck & Co	United States	Drugs & biotechnology	30.78	7.33	42.59	108.76
64	Novartis Group	Switzerland	Drugs & biotechnology	26.77	5.40	46.92	116.43
65	ENEL	Italy	Utilities	38.99	2.11	71.36	46.84

Forbes 2000 Rank	Name	Country	Category	Sales ($bil)	Profits ($bil)	Assets ($bil)	Market Value ($bil)
66	Unilever	Netherlands/ United Kingdom	Food, drink & tobacco	50.70	2.24	45.49	72.19
67	Washington Mutual	United States	Banking	18.01	3.88	275.18	39.69
68	Crédit Agricole	France	Banking	31.77	1.12	531.01	38.80
69	Deutsche Post	Germany	Transportation	41.23	1.64	169.33	26.83
70	Comcast	United States	Media	18.35	3.24	109.16	67.30
71	Volkswagen Group	Germany	Consumer durables	91.33	2.71	112.87	17.42
72	Tokyo Electric Power	Japan	Utilities	41.62	1.40	116.68	30.63
73	Munich Re	Germany	Insurance	45.85	1.14	191.33	26.63
74	BMW-Bayerische Motor	Germany	Consumer durables	52.23	2.12	58.11	29.03
75	Ford Motor	United States	Consumer durables	164.20	0.76	312.56	26.29
76	Tyco International	Bermuda	Conglomerates	37.57	1.19	62.80	58.41
77	US Bancorp	United States	Banking	14.57	3.73	189.29	52.88
78	Roche Group	Switzerland	Drugs & biotechnology	25.18	2.48	45.77	95.38
79	Royal Bank of Canada	Canada	Banking	18.82	2.28	305.01	31.82
80	GlaxoSmithKline	United Kingdom	Drugs & biotechnology	34.16	6.34	29.19	124.79
81	China Petroleum & Chemical	China	Oil & gas operations	39.16	1.94	45.32	50.09
82	Sony	Japan	Consumer durables	63.23	0.98	68.04	38.00
83	Nokia	Finland	Technology hardware & equipment	37.05	4.52	29.15	104.30
84	BellSouth	United States	Telecommunications services	22.58	3.59	49.62	54.08
85	Walt Disney	United States	Media	28.44	1.92	51.52	55.06
86	Natl Australia Bank	Australia	Banking	15.34	2.69	269.94	36.51
87	Gazprom	Russia	Oil & gas operations	19.21	3.81	77.15	36.28
88	Carrefour Group	France	Food markets	96.94	1.45	40.11	37.19
89	Cisco Systems	United States	Technology hardware & equipment	19.82	4.35	36.59	166.09
90	FleetBoston Finl	United States	Banking	14.22	2.13	196.40	47.19
91	RWE Group	Germany	Utilities	45.68	1.10	97.35	23.76
92	UniCredito Italiano	Italy	Banking	16.53	1.89	223.60	33.53
93	BT Group	United Kingdom	Telecommunications services	29.58	4.24	44.42	28.73
94	United Parcel Service	United States	Transportation	32.81	3.54	28.37	79.62
95	United Technologies	United States	Conglomerates	31.03	2.36	34.65	48.77
96	Fortis	Netherlands	Diversified financials	52.51	0.56	507.98	30.19
97	Dow Chemical	United States	Chemicals	32.63	1.74	41.89	39.85
98	Aegon Insurance Group	Netherlands	Insurance	17.75	1.63	266.59	23.49
99	Dexia	Belgium	Banking	19.62	1.36	368.37	21.64

Forbes 2000 Rank	Name	Country	Category	Sales ($bil)	Profits ($bil)	Assets ($bil)	Market Value ($bil)
100	Renault Group	France	Consumer durables	38.17	2.05	54.04	19.64

53. Optimal Machine Operation. (Based on problem-8, Chapter 18, page 498, in Thuesen, H.G.,Fabrycky, W.J., Thuesen G.J., **Engineering Economy**, Fifth Edition, Prentice Hall, 1977)

ABC Machine shop has just purchased eighteen identical automatic machines, each at a cost of 10,000 monetary units(MUs) . It employs six operators, one per three machines. Each operator is paid wages at the rate of 5 monetary units (MUs) per hour and the shop operates 2000 hours per year. According to some of the neighboring machine shops, each of the machines should be operated at 360 revolutions per minute (rpm). At this speed, the expected life of a machine would be 5 years, and its annual maintenance cost 1500 MUs. The rate of production of a machine would be 180 units of the product per year. The annual power cost would be 360 MUs. Assuming that the above are the only major costs, the proprietor wanted to know the break-even price that he should charge per unit of the product at the above speed of operation.

On further inquiry, the proprietor came to know that the speed at which a machine is operated determines its cost of operation; both the power consumption and maintenance charges increase with the speed of operation, while the life of the machine remains more or less the same. The cost of power can be assumed to be proportional to the speed of operation, while the maintenance cost changes non-linearly with increase in speed. However, low speeds are not desirable, because the quantity of production increases with speed, the quantity being directly proportional to the speed in rpm of the machine. To decide the speed at which the machines have to be operated, the proprietor had the following data collected on the maintenance costs likely to be incurred at different possible speeds:

Speed (rpm)	Maintenance cost (MUs per year per machine)
225	600
250	700
300	800
330	950
360	1500
380	2200
400	3200

Using the above data, find the most desirable speed of operation of the machines from the financial view point, assuming that the quantity of production is directly proportional to the speed of operation of a machine, and that the quality of the product and the per-unit price that could be charged are independent of the speed. Use the discount rate of 12% per year in your analysis. Furthermore, the salvage value at the end of the life of a machine can be taken to be zero.

54. Distances between villages.

Consider a set of 10 villages, each of whose X and Y coordinates are given in columns B and C of range A20:C29 respectively, while column A of the range consists of their serial numbers, 1,2,…, 10. In range B31:K40 the types of distance, S or R, between each pair of villages are to be obtained; row 31 consisting of types of distance from village 1 to each of the other villages, and row 32 from village 2, and so on. Cells A31:K31 consist of the serial numbers of the villages and so do the cells B30:K30.

The type of distance between a pair of villages is defined as follows:

56. Fruit Prices

A certain type of fruit is available in different colors and weight. The fruit coming into a market for sale are sorted based on their color and each carton is filled with 100 units of the same color. Then each box is weighed and both the color of the fruit contained by it and the total weight are written on the top of the box. The weight is written as an integer between 15 and 25 corresponding to the weight in kgs, whereas the color is written as per the following code:

Color	Color code
Red	R
Orange	O
Yellow	Y
Greenish Yellow	GY

In writing the weight and color code no fixed sequence is followed. For example, a 25 kg box with greenish yellow fruit is sometimes coded as GY25, and sometimes as 25GY. Call the combination of weight and color code written on a box as its box code. The price (in Rs.) of each box depends on both the color of the fruit contained by it and its total weight as given in the following table, each row of which corresponds to a color and each column to a weight range as indicated.

	15 kg-18kg	19 kg - 21 kg	22 kg - 23 kg	24 kg - 25 kg
R	200	210	225	250
O	210	225	260	280
Y	220	240	290	320
GY	230	260	320	350

The next figure shows a spread sheet designed to compute and analyze the prices related to a set of the above boxes. Data related to a sample of 10 boxes is provided in the figure. The column headings are self-explanatory. The basic input consists of the serial number of each box **(A6:A15)** and the code indicating the color and the weight as mentioned above **(B6:B15)**. The price matrix is given in the range **J6:M9**.

Question 1.

In the range **C6:C15**, the weight of the box is extracted from the box code contained in the corresponding cells of the range **B6:B15**. What is the formula in cell **C6** (this formula is copied to **C7:C15**), considering that your formula can be confined only to the four color codes given above and need not be very general.

Answer:_____

_____

Question 2.

In the range **D6:D15**, the color code is extracted from the box code contained in the corresponding cells of **B6:B15**. What is the formula in cell D6 (this formula is copied to **D7:D15**).

Answer:_____

_____

	A	B	C	D	E	F	G	H	I	J	K	L	M
1					**FRUIT PRICES**								
2													
3													
4										15	19	22	24
5	**Sl.No**	**BoxCode**	**Kg**	**Color**	**WtType**	**Price**				1	2	3	4
6	1	25R	25	R	4	250			R	200	210	225	250
7	2	O20	20	O	2	225			O	210	225	260	280
8	3	22Y	22	Y	3	290			Y	220	240	290	320
9	4	GY21	21	GY	2	260			GY	230	260	320	350
10	5	Y18	18	Y	1	220							
11	6	19GY	19	GY	2	260							
12	7	24O	24	O	4	280							
13	8	19Y	19	Y	2	240							
14	9	GY16	16	GY	1	230							
15	10	15R	15	R	1	200							
16													
17	**Sl.No**	**BoxCode**	**Kg**	**Color**	**WtType**	**Price**							
18				GY									
19													
20				**Avg Price**	**NoofBoxes**								
21				250	3								
22			R	225	2								
23			O	252.5	2								
24			Y	250	3								
25			GY	250	3								
26													
27				252.5	3								
28				O	Y								

Question 3.

The weight ranges are divided into four types, type 1 corresponding to the range 15 kgs to 18 kgs, type 2 to 19 kgs to 21 kgs, type 3 to 22 kgs to 23 kgs, and type 4 to 24 kgs to 25 kgs. Assume that weight is expressed as integral number of kgs and it is never less than 15 nor greater than 25. In range **E6:E15**, the weight types are obtained, using the information in **C6:C15** and the categorization given in **J4:M5**. What is the formula in **E6** (this formula is copied from **E7:E15**).

Answer:_____

Question 4.

The price of each box is obtained in the range **F6:F15** from the information contained in the ranges and cells mentioned above. What is the formula in **F6** (this formula is copied to **F7:F15**).

Answer:_____

Question 5.

In the sample data mentioned above, the average price of boxes corresponding to each color, and the number of boxes corresponding to each color are to be tabulated respectively in the range **D22:E25** as shown in the

figure. The codes of the colors of each of the rows in the above table are given in **C22:C25**. Data table option is chosen from the Excel menu system by highlighting the table range **C21:E25** for the above purpose (you can use **A17:F18** as criteria range if you wish in answering the following questions).

5A What is the formula in cell **D21**? _____

5B What is the formula in cell **E21**? _____

5C What is the column input cell given as a part of the above data table operation?

Answer_____

Question 6 From the data table obtained above, the maximum average price and the maximum number of boxes by comparing the different color categories are obtained in cells **D27** and **E27** respectively. The corresponding color codes (in case of a tie, the first one eligible in the corresponding column is taken) are obtained in cells **D28** and **E28** respectively.

6A What is the formula in cell **D28**?_____

6B What is the formula in cell **E28**?_____

57. Cheapest Neighbor Heuristic for TSP.

Suppose there are n cities, 1,2,3,…,n, and the cost of travel from each city to each other city is given. Starting with city-1, a salesperson is required to visit each of the above cities once and only once, and finally return to city-1, such that the total cost of travel is a minimum. Specifically, the sequence of the cities in the tour should be of the form 1, J_2,J_3,…,J_k,…J_n,1, such that :

$$J_k \# 1, \text{ for } 2 \le k \le n$$
$$J_r \# J_s \text{ if } r \# s, \; 2 \le r,s \le n$$

The above problem, popularly known as the *travelling salsperson problem (TSP)* is very difficult to solve optimally, especially when the number of cities n is large. Therefore a number of different techniques called *heuristics* are used to obtain a feasible and hopefully a low cost solution. One such heuristic is the *cheapest neighbor heuristic*. The steps of this heuristic are:

1. **Current city** is 1. Goto next step.

2. Consider the cities other than 1, which are not yet visited. From among them choose the **next city** to be visited as that which has the minimum cost of travel from current city. Goto next step

3. Make the next city as the current city. Goto next step.

4. If all cities are not visited, go to step 2; Otherwise goto next step.

5. Return to city 1 from the n^{th} city chosen above and stop.

For example, for the six city problem shown in the range B5:G10 in the spreadsheet below, the above heuristic yields the sequence 1,6,5,2,3,4,1 with a total cost of travel equal to 128 monetary units. Note that

Figure-13a. To set cell format for display of date data

Step-1. Highlight the cells (or range) whose format you want to set.
Step-2. Choose the menu commands Cells→Format → Format Cells..
Step-3. In the resulting dialog box click on the tab titled *Number.*
Step-4. Click on the item *Date* in the list titled *Category*.
Step-5. In the list titled *Format codes* a number of date formats are displayed. If the format you want is available there click on it. Otherwise, enter the desirable format, mm/dd/yy, in the input box titled *Code*.
Then click on the OK button to quit the dialog box.

Figure-13b. To record a macro

Step-1. Choose the menu commands: View → Macros→Macros→Macro → Record Macro

Step-2: The dialog Box titled Record New Macro appears.

2a.In the input box for macro name, type in the name of your macro, which is to be specified when you want to run, edit or delete the macro later. Fill in the input box for description with details like author, date, and what the macro does

2b. In the input box for *short cut key* enter a single letter, or Ctrl+single letter, which should be pressed along with the control key to invoke the macro.

2c. The box titled *store in:* presents three options, one of which is to be chosen by pressing the radio button against it. You can store the code of the macro in a separate workbook, in a personal macro workbook, or in the current workbook itself as a separate module.

2d. Click the OK button to finish with the dialog box.

Step-3. Perform manually the task to be automated. Note that only your key strokes and menu-choices while you are operating within the spread sheet system can be recorded. While you perform the task, the macro code gets generated.

Step-4. Once you are through with your recording, stop the recording, by choosing the menu options View→Macros→Macros→Stop Recording.

II.15 Example-15. Modification of Part Codes

Through this example, we learn how to manipulate strings in a spread sheet. Excel provides several powerful functions for string manipulation. Some of these will be used in this example, while, for the use of the others, the reader is referred to Appendix.

Currently ABC company uses the following coding method for its pipes. A pipe code consists of a minimum of 3 fields; additionally, an imported product consists of one more field, thus making the maximum number of fields in a pipe code 4. A field is separated from its next field by a dash (-). The three necessary fields are: 1. the pipe length in (integral) metres. The width of this field varies from 1 to 2 characters. 2. the diameter of the pipe in (integral) centimeters. The width of this field also varies from one to two characters. 3. The material of the pipe. There are four categories of material possible: steel, aluminium, plastic, and brass. These are to be denoted by the codes A, B, C, and D respectively in the part code. In addition, if the pipe is imported its first field consists of the character F. Thus the code F-5-8-B indicates that the pipe under question is an imported one, with length 5 metres and diameter 8 centimeters, and that it is made of aluminium. Similarly, the code 8-15-D refers to the non imported brass pipe with length 8 metres and diameter 15 centimeters.

The above method has been designed several years back. The systems department, during a recent study, suggested the following modifications to this coding system.

1. The first character of a pipe code should explicitly indicate whether the pipe is imported or indigenous. The existing practice of using F as the first character for the imported ones should be continued, whereas for the indigenous ones the character I should form the first field. This makes the number of fields in each part code uniformly equal to four.

2. The material code which forms the last field of a part code should be more self explanatory: it should be the first character of the spelling for the concerned material. Accordingly, in the last (or fourth) field of their part codes, steel pipes are denoted by S, aluminium pipes by A, plastic pipes by P, and finally the brass ones by B.

3. To be consistent with some engineering specifications, the diameter of a pipe is to be denoted in millimeters instead of in centimeters.

Consider for example the existing code 8-5-B. This indicates an indigenous pipe. Hence its first field in the modified code should be I. The diameter of this pipe is 5 centimeters, which when expressed in millimeters becomes 50. Hence the third field in the modified code should be 50. The material is aluminium. Hence the fourth field of the modified code should consist of the character A. Thus the modified code for the above pipe is I-8-50-A.

All the existing part codes are available in a spread sheet. We are required to produce the modified code for each of the existing codes using the spread sheet facilities.

Figure-13a shows a spread sheet with a sample of 7 codes in column A, in the range A3:A9. The other columns consist of various formulae to solve our problem. The new codes obtained by these formulae are shown in column E. Columns B, C and D show the results of the intermediate steps in converting the old codes to the new codes. The range G3:H6 consists of the table that shows the old material codes and their corresponding new ones. Let us now explain in detail how the conversion of the part codes is achieved. The formulae in the cells of each column are such that it is enough for us to explicitly enter the formulae in row 3; others are obtained by copying these formulae to the cells in the remaining rows. Hence, in the following discussion we focus on only the formulae in row 3 of each column.

Let us first introduce some preliminary notions about strings in Excel. These are the notion of a sub string, the length of a string, the position of a character within a string, and the concatenation of two or more strings. A part of a given string is called a sub string of the given string. For example, consider the string INSTITUTE. The strings INS, TI, STIT are some of the sub strings within the above string. The length of the above string is nine, which means that the string is made of nine characters. The character S occurs in the third position of the above string. By concatenating one string to another we get a larger string, with the second string at the tail end of the first string. For example, if we concatenate the string ABC with the string DEF we get the string ABCDEF. The ampersand character,&, is used in Excel as the concatenation operator. In the following discussion we use string functions that can do the following tasks: 1. To extract the sub string of a given length from the left end of a given string, 2. To extract the sub string of a given length from the right end of a given string, 3. In a given string, to replace a specified sub string with another string.

The spread sheet of Figure-13a uses the following steps in converting a given part code to its corresponding new one:

- For each part code under consideration, find the new material code to be used, and write it in column B

- In each part code, replace the old material code with the new code found in the above step. Write the resulting intermediate code in column C
- If a code obtained in column C does not start with F, then put I as the first field of the corresponding code. Write the resulting codes in column D.
- For the diameter value which ends at the last but second position, append the character zero, to convert the diameter value from centi meters to millimeters, and write the resulting code in column E. This completes the conversion process.

Let us now examine the formulae in columns B,C,D, and E.

1. Column B shows the new material code to be used in the last field of each of the given part. These values are easily obtained by using VLOOKUP function, with the old material code as the value for the table look up, the range $G$3..$H$6 as the table range, and the column position for the result as 2. However, in order to use this VLOOKUP function, we must be able to first extract the old material code from the given part code. For this we use the string functions RIGHT, which can produce as its result the sub string of a specified length, occurring at the right end of another specified string. Thus the arguments of this function are two in number; the first one indicates the original string given as a literal (i.e. the string itself enclosed in double quotation marks), or by the address of the cell which contains the string; the second one indicates the length in number of characters of the sub string to be extracted as output. In each of the old part codes the material code consists of only one character, and it occurs at the extreme right of the part code. Hence, taking the specific case of the code given in cell A3, the function that can produce the material codes from this part code is RIGHT(A3,1). Therefore, the VLOOKUP function entered in cell B3 is VLOOKUP(RIGHT(A3,1),$G$3..$H$6,2). This function is copied from B3 to B4..B9, to obtain the new material codes for the rest of the part codes.

2. Column C shows the partially modified part codes, after the old material code is replaced by the new material code of column B. This replacement is achieved by using the string function REPLACE. Among the arguments of this function are an original string, a sub string within the original string, and a replacement string. The function replaces the given sub string of the original string with the replacement string; the resulting string is produced as the output in the cell in which the REPLACE function is contained. The sub string to be replaced is specified not directly but by means of two arguments: the starting position of the sub string within the original string, and the length of the sub string in number of characters. Both the original string and the replacement string can be given within the function as literals or by references to the cells which contain them. Specifically, the function used in cell C3 is REPLACE(A3, LEN(A3),1,B3). Note that the first argument is A3 because the original string which needs to undergo modifications is in cell A3. The second argument should denote the position from where the sub string to be replaced begins. Here, the sub string to be replaced is the last character of the original string. Accordingly, the starting position of this sub string is equal to the length of the original string. The length of a string, in turn is given by the string function LEN. Thus the second argument above is LEN(A3). The third argument specifies the length of the sub string to be replaced, which in this case is only one character. Accordingly, the third argument is given as 1. The fourth and the last argument is the replacement string. This string is contained in cell B3. Hence the fourth argument is given as B3.

3. The partially modified codes of column C are further modified by incorporating the sub string "I-"wherever needed, to get the codes in column D. The above modification, that is appending (or concatenating) the string contained in column C to the string "I-" is needed only when the code being dealt with does not belong to an imported item, that is when the first character (or the left most character) of the code in column C is not the character F. Taking cell D3 as an example, the formula there should be an IF function. The condition of the IF should be whether the left most character of the string in C3 is F. If the condition is true, then the output of the IF should be the

string in C3 itself without any modification; else, the output should be the string obtained by the concatenation of the strings "I-" and the string of C3. Thus the IF can be stated informally as IF (the given condition, C3, "I-" & A3). Note that in the third argument we specify two strings, the literal "I-" and the string in A3 with the ampersand character in between. The ampersand character is the concatenation operator, the result of which is to produce the string obtained by joining the given strings in the given order, (i.e. the second string is attached at the right end of the first). The IF function is complete except for the first argument. This condition is to be given as left most character of C3="F". How do we get the left most character of C3? by the string function LEFT(C3,1). Just as the RIGHT function is used to extract any sub string of given length from the right end of a string, LEFT is used to extract a sub string of a given length from its left end. Now, the full IF function in D3 is
IF(LEFT(C3,1)="F",C3,"I-"&C3).

4. We are now left with only one more modification, that is converting the diameter expressed in centimeters to millimeters. All we have to do for this is append the character zero to what is already there in the third field of each code in column D. Let us concentrate as before on the first code of the sample, the one in cell D3. The character in the third field of this string is 5; therefore after the appending of the zero character, it becomes 50, thus making the complete new code F-10-50-A. One way of accomplishing the above task would be to consider the old code as consisting of the two components, “F-10-5”,”-A”. To obtain the new code, we must simply replace the second component with “0-A”, i.e. with “0” appended to the front of the already existing second component. This is accomplished by the formula given in cell E3.

Figure-14a: Spreadsheet for part code change

	A	B	C	D	E	F	G	H
1	OLDCODE				NEWCODE			
3	F-10-5-A	S	F-10-5-S	F-10-5-S	F-10-50-S		A	S
4	10-10-B	A	10-10-A	I-10-10-A	I-10-100-A		B	A
5	8-15-C	P	8-15-P	I-8-15-P	I-8-150-P		C	P
6	F-10-5-B	A	F-10-5-A	F-10-5-A	F-10-50-A		D	B
7	F-8-5-C	P	F-8-5-P	F-8-5-P	F-8-50-P			
8	5-5-D	B	5-5-B	I-5-5-B	I-5-50-B			
9	F-4-4-A	S	F-4-4-S	F-4-4-S	F-4-40-S			

Figure-14b : Important Formulae in the Spreadsheet of Figure-12.

Cell Address	Formula
B3	=VLOOKUP(RIGHT(A3,1),$G$3:$H6,2)
C3	=REPLACE(A3,LEN(A3),1,B3)
D3	=IF(LEFT(C3)="F",C3,"I-"&C3
E3	=REPLACE(D3,LEN(D3)-1,2,"0"&RIGHT(D3,2))