DEPRECIATION CALCULATIONS

An asset, such as a machine, is a unit of capital that loses value over a period of time in which it is used. This decline in the value of an asset is called "**depreciation**". This loss of value of an asset represents actual piece-meal consumption or expenditure of a capital. For example a bulldozer will lose its value as time goes on and will have a very small (when compared to its purchase price) salvage value at the end of its useful life. Therefore, **salvage value** represents the estimated value of an asset at the end of its useful life and hence it is the last book value.

Depreciation calculations are made in order to calculate for the above stated loss of value.

Depreciation calculations are performed for the following purposes:

1. To spread, in a systematic way, the anticipated loss in value over the life of an asset.
2. To continuously have a monetary measure of the value of an enterprise's unexpended physical capital.
3. As machines wear out in productive activities, physical capital is converted to value in the product. This lost capital needs to be accounted for, in order to determine production costs.

In economic analysis, the primary importance of depreciation is its effect on estimated cash flows resulting from the payment of income taxes.

There are four methods for calculating depreciation.

Straight-line Method of Depreciation:

This method assumes that the value of an asset decreases by a uniform amount each year. This can be shown in the following figure.

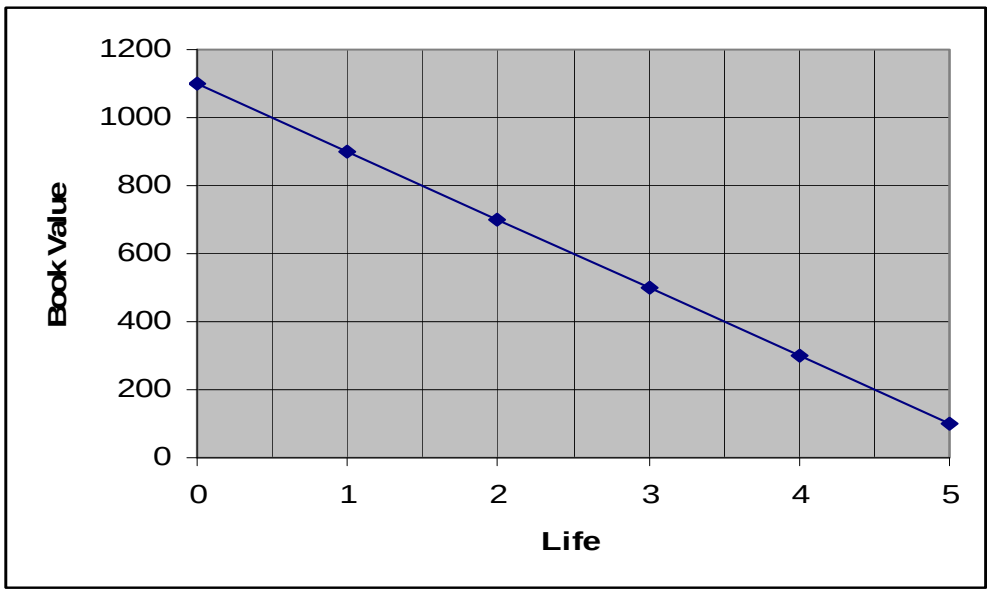


Figure1: Reduction in book value of an asset using straight-line method of depreciation

It can be seen that an asset which has a useful life of 5 years had an initial price of 1.100 TL and a salvage value of 100 TL.

Depreciation per year is calculated as follows:

Yearly depreciation= $\frac{Initial\ \ cost\,(P) - Salvage\ \ value\,(F)}{Useful\ life\,(n)} = \frac{1}{n}(P - F)$

Rate of depreciation= $\frac{1}{n}$

n= Useful Life
P= Initial Cost
F= Salvage Value

The "**Book Value**" is defined as the original value of the equipment minus its accumulated depreciation at any point in time. The following table shows the book values of the previous example.

End of year	Yearly depreciation	Book value (TL)	
0	-	1100	
1	200	900	
2	200	700	
3	200	500	
4	200	300	
5	200	100	⇨ Salvage Value

The salvage value is therefore the last book value.

Dep. at the end of i^{th} year: $\frac{1}{n}(P - F)$

Book value at the end of i^{th} year: $P - (P - F)(\frac{i}{n})$

Double Declining-Balance Method of Depreciation

This method assumes that an asset decreases in value by a greater amount in the earlier portion of its service life than in the latter portion of its life.

In this method, a fixed percentage is multiplied by the book value of the asset at the beginning of each year to determine the depreciation charge for that year.

As the book value of the asset decreases through time, so does the size of the depreciation charge. The maximum rate that can be used is double the amount of straight line rate. Therefore, for an asset with an estimated life of *n* years, the maximum rate that can be used

with this method is $2 \times \frac{1}{n}$. This is also referred to as the **double–declining–balance** method of depreciation.

EXAMPLE:

A small equipment with an initial value of 10 000 TL has been bought. It has a useful life of 5 years, and a salvage value of 1000 TL. Calculate the yearly depreciations and book values by the double-declining-balance method.

Straight line yearly depreciation rate = $\frac{1}{5} = 0.2$

Double-declining-balance rate = $2 \times 0{,}2 = 0.4$

End of year	Yearly depreciation	Book value (TL)
0	0	10.000
1	$10.000 \times 0{,}40 = 4.000$	10.000-4.000 = 6.000
2	$6.000 \times 0{,}40 = 2.400$	6.000-2.400 = 3.600
3	$3.600 \times 0{,}40 = 1.440$	3.600-1.440 = 2.160
4	$2.160 \times 0{,}40 = 864$	2.160-864 = 1.296
5	$1.296 \times 0{,}40 = 518$	1.296-518 = 778
5*	518-(1.000-778) = 296	1.000

It can be seen that the last figure does not match with the pre-set salvage value. In this case, the last line is corrected by bringing the last book value equal to the salvage value and by reducing the depreciation figure accordingly.

Depreciation at the end of i^{th} year = $P(\frac{2}{n})(\frac{n-2}{n})^{(i-1)}$

Book value at the end of i^{th} year = $P(\frac{n-2}{n})^{i}$

Declining-Balance Method of Depreciation

In the declining-balance method, the rate of depreciation may be anything between the straight line rate and the double-declining-balance rate. In order to determine the rate which will give a last book value that is exactly equal to the given salvage value, the following formula is used:

$$R = 1 - \sqrt[n]{\frac{F}{P}}$$

Where: R = Declining-balance rate of depreciation
P = First cost of asset
F = Salvage value
n = Useful life

EXAMPLE:

If P = 10.000 TL and F = 1.000 TL, find the yearly depreciation and the book value for 5 years.

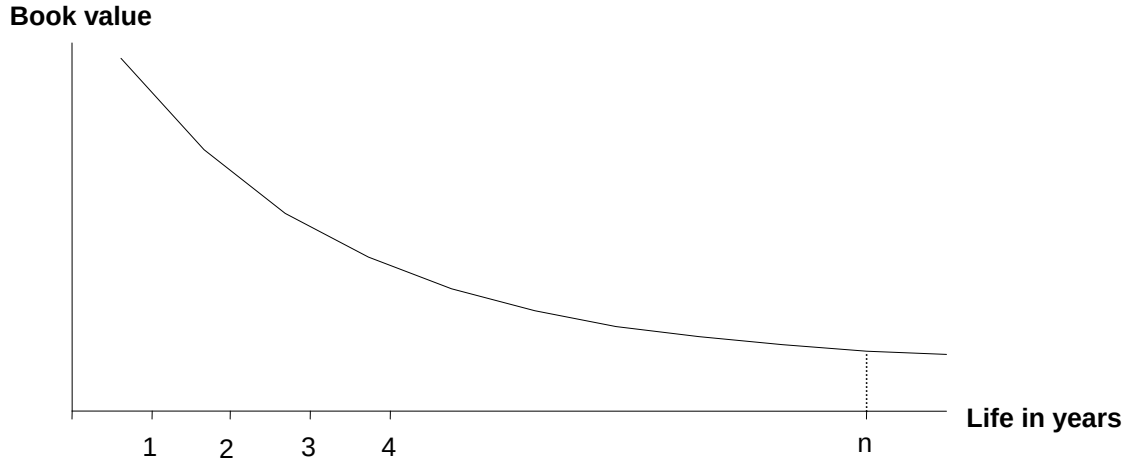
$$R = 1 - \sqrt[n]{\frac{F}{P}}$$

$$R = 1 - \sqrt[5]{\frac{1.000}{10.000}} = 1 - 0{,}631 = 0.369$$

End of year	Yearly depreciation	Book value (TL)
0	0	10.000
1	$10.000 \times 0{,}369 = 3.690$	10.000-3.690 = 6.310
2	$6.310 \times 0{,}369 = 2.328{,}39$	6.310-2.328,39 = 3.981,61
3	$3.981{,}61 \times 0{,}369 = 1.469{,}21$	3.981,61-1.469,21 = 2.512,40
4	$2.512{,}40 \times 0{,}369 = 927{,}07$	2.512,40-927,07 = 1.585,40
5	$1.585{,}40 \times 0{,}369 = 585$	1.585,40-585 = 1.000

It must be stated that if salvage value is zero, then, this formula cannot be used.

Hence; the declining-balance method and the double-declining-balance method always yield a residual value. This is better seen in the following curve.



Book value at the end of ith year = $B.V_i = P(1-R)^i$

Depreciation at the end of ith year = $D_i = PR(1-R)^{(i-1)}$

Sum-of-the-Years-Digit Method of Depreciation

This method assumes that the value of an asset decreases at a decreasing rate.

If an asset has an estimated life of 5 years, the sum-of-the-years-digit will be: 1+2+3+4+5 =15

The sum of the years for any number of years *n* can be computed from the expression:

$$S = \frac{n(n+1)}{2}$$

EXAMPLE:

Life = 5 years

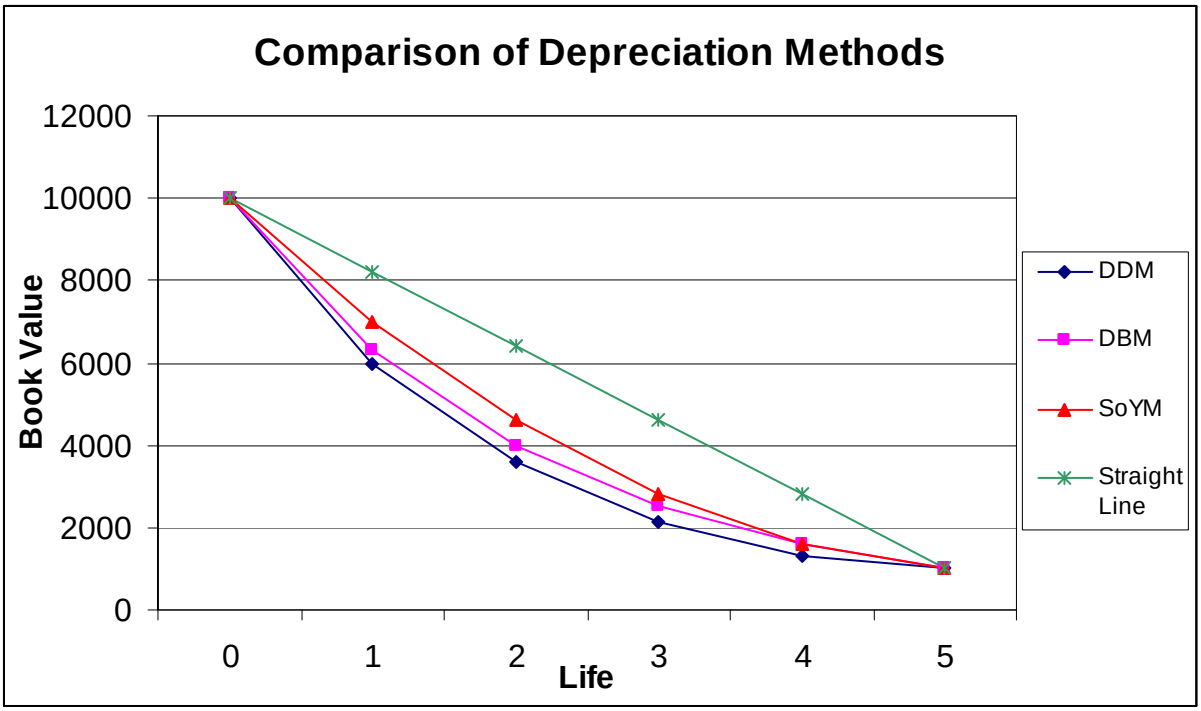
$$S = \frac{5(5+1)}{2} = 15$$

Depreciation at the end of i^{th} year = $D_i = 2(P-F)\left[\frac{n+1-i}{(n^2+n)}\right]$

Book value at the end of i^{th} year = $B.V_i = P(P-F)\left[\frac{2ni-i^2+i}{(n^2+n)}\right]$

The sum-of-the-years-digit method and the declining balance method are similar in that the depreciation charges in the earlier life are larger than the depreciation charges in later life.

The difference is that, the declining balance method produces larger early depreciation charges than the sum-of-the-years digit method. This can better be seen in the following curve where all three methods (including two alternatives for declining balance: double declining and normal declining with formula) are illustrated.



DDB: double-declining-balance method of depreciation
DBM: declining-balance method
SoYM: sum-of-the-years-digit method

From the point of view of the taxpayer, the later s/he pays the tax, the better it is; therefore it is desirable that book values in early life are lower, and higher in later life; i.e., s/he wants high depreciation in early life, and low depreciation in later life. Therefore, it can be seen from the graph that the most advantageous method is the double-declining balance method and the least advantageous is the straight line method of depreciation.

In sum of the years digit method, the yearly depreciation is calculated by multiplying the initial cost minus salvage by a rate of depreciation which is smaller every year.

EXAMPLE: Same as the one in declining balance

End of year	Yearly depreciation (TL)	Book value (TL)
0	0	10.000
1	(10.000 – 1000) x 5/15 = 3000	10.000 – 3000 = 7000
2	9.000 x 4/15 = 2400	7000 – 2400 = 4600
3	9.000 x 3/15 = 1800	4600 – 1800 = 2800
4	9.000 x 2/15 = 1200	2800 – 1200 = 1600
5	9.000 x 1/15 = 600	1600 – 600 = 1000

EXAMPLE 1:

A small concrete mixer has been bought for 20.000 TL. It has a salvage value of 2.000 TL at the end of a useful life of 4 years. Calculate yearly depreciation and book value by using:

a) The straight-line method of depreciation
b) The double-declining-balance method of depreciation
c) The declining-balance method of depreciation
d) The sum-of-the-years-digit method of depreciation

a) Straight-Line Method:

Straight-line rate of depreciation = $\frac{1}{n} = \frac{1}{4} = 0.25$

Yearly depreciations = $\frac{1}{n}(P - F) = 0.25(20.000 - 2.000) = 4.500$ TL/year

End of year	Yearly depreciation	Book value (TL)
0	0	20.000
1	4500	15.500
2	4500	11.000
3	4500	6.500
4	4500	2.000 salvage value

b) Double-Declining-Balance Method:

Straight-line depreciation rate = $\frac{1}{n} = \frac{1}{4} = 0.25$

Double-declining-balance rate of depreciation = 2 x 0.25 = 0.50

End of year	Yearly depreciation	Book value (TL)
0	0	20.000
1	20.000 x 0.50 = 10.000	20.000 – 10.000 = 10.000
2	10.000 x 0.50 = 5.000	10.000 – 5.000 = 5.000
3	5.000 x 0.50 = 2.500	5.000 – 2.500 = 2.500
4	2.500 x 0.50 = 1.250	2.500 – 1.250 = 1.250
4*	**1.250 – (2.000 – 1.250) = 500**	**2000 salvage value**

c) Declining-balance method:

Declining balance rate of depreciation = $R = 1 - \sqrt[n]{\frac{F}{P}}$

$$R = 1 - \sqrt[4]{\frac{2.000}{20.000}} = 1 - 0.562 = 0.438$$

End of year	Yearly depreciation	Book value (TL)
0	0	20.000
1	20.000 x 0.438 = 8.760	20.000 – 8.760 = 11.240
2	11.240 x 0.438 = 4.923	11.240 – 4.923 = 6.317
3	6.317 x 0.438 = 2.767	6.317 – 2.767 = 3.550
4	3.550 x 0.438 = 1.555	3.550 – 1.555 = 2.000 salvage value

d) <u>Sum-of-the-years-digit method</u>

Sum-of-the-years: $S = \frac{n(n+1)}{2} = \frac{4(4+1)}{2} = 10$

End of year	Yearly depreciation	Book value (TL)
0	0	20.000
1	(20.000 – 2.000) x 4/10 = 7.200	20.000 – 7.200 = 12.800
2	18.000 x 3/10 = 5.400	12.800 – 5.400 = 7.400
3	18.000 x 2/10 = 3.600	7.400 – 3.600 = 3.800
4	18.000 x 1/10 = 1.800	3.800 – 1.800 = 2.000 salvage value

<u>EXAMPLE 2</u>:

A construction company purchases an excavation equipment for 150.000 TL. The equipment has 4 years of useful life and a salvage value of 12.500 TL. If the company earns 100.000 TL net profit (income – cost) and if the tax to be charged from taxable profit is 40 %:

a) Calculate the taxes to be paid by the company at the end of each year, using all methods of depreciation.
b) Using 15% interest rate, show the present worth amounts of the company's taxes for each method. Which method should be selected for the company?

Solution:

Let us find the yearly depreciations using each method first:

1- Straight line method:

$$\text{Yearly depreciation} = \frac{1}{n}(P - F) = \frac{1}{4}(150.000 - 12.500) = 34.375\ \text{TL}$$

End of year	Yearly depreciation	Book value (TL)
0	0	150.000
1	34.375	150.000 – 34.375= 115.625
2	34.375	115.625 – 34.375= 81.250
3	34.375	81.250 –34.375 = 46.875
4	34.375	46.875 – 34.375 = 12.500

2- Declining –balance method:

$$R = 1 - \sqrt[n]{\frac{F}{P}} = 1 - \sqrt[4]{\frac{12.500}{150.000}} = 1 - 0.5373 = 0.4627$$

End of year	Yearly depreciation	Book value (TL)
0	0	150.000
1	150.000 x 0.4627 = 69.405	150.000 – 69.405 = 80.595
2	80.595 x 0.4627 = 37.291	80.595 – 37.291 = 43.304
3	43.304 x 0.4627 = 20.037	43.304 – 20.037 = 23.267
4	23.267 x 0.4627 = 10.767	23.267 – 10.767 = 12.500

3- <u>Double-declining-balance method:</u>

Rate of depreciation = $2x\frac{1}{4} = 0.5$

End of year	Yearly depreciation	Book value (TL)
0	0	150.000
1	150.000 x 0.5 = 75.000	150.000 – 75.000 = 75.000
2	75.000 x 0.5 = 37.500	75.000 – 37.500 = 37.500
3	37.500 x 0.5 = 18.750	37.500 – 18.750 = 18.750
4	18.750 x 0.5 = 9.375	18.750 – 9.375 = 9.375
4*	(18.750-12.500) = 6.250	18.750 – 6.250 = 12.500

4- <u>Sum-of-the-years-digits method:</u>

Sum-of-the-years: $S = \frac{n(n+1)}{2} = \frac{4(4+1)}{2} = 10$

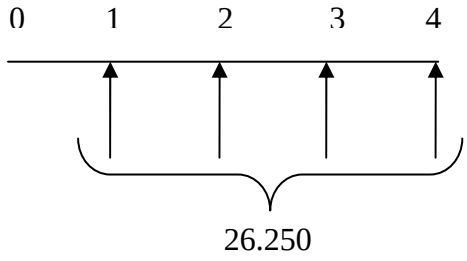
End of year	Yearly depreciation	Book value (TL)
0	0	150.000
1	(150.000 – 12.500) x 4/10 = 55.000	150.000 – 55.000 = 95.000
2	137.500 x 3/10 = 41.250	95.000 – 41.250 = 53.750
3	137.500 x 2/10 = 27.500	53.750 – 27.500 = 26.250
4	137.500 x 1/10 = 13.750	26.250 – 13.750 = 12.500

a) The taxes to be paid by the company:

	(1)	(2)				(3) = (1) – (2)				(4) = (3) x (40%)			
		Depreciation				Taxable profit				Tax (40%)			
End of Year	Income	St. Line	Dec. Balance	D. Dec. Balance	Sum of Years	St. Line	Dec. Balance	D. Dec. Balance	Sum of Years	St. Line	Dec. Balance	D. Dec. Balance	Sum of Years
1	100.000	34.375	69.405	75.000	55.000	65.625	30.595	25.000	45.000	26.250	12.238	10.000	18.000
2	100.000	34.375	37.291	37.500	41.250	65.625	62.709	62.500	58.750	26.250	25.084	25.000	23.500
3	100.000	34.375	20.037	18.750	27.500	65.625	79.963	81.250	72.500	26.250	31.985	32.500	29.000
4	100.000	34.375	10.767	6.250	13.750	65.625	89.233	93.750	86.250	26.250	35.693	37.500	34.500
		137.500								105.000			

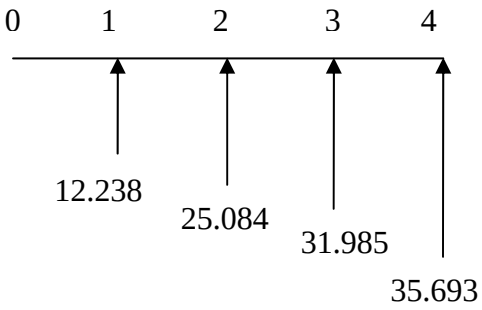
b) Present worth amounts of the taxes

1- <u>Straight line method:</u>



$$PW(15) = 26.250\overbrace{(P/A, 15\%, 4)}^{2,8550} = 75.658 \text{ TL}$$

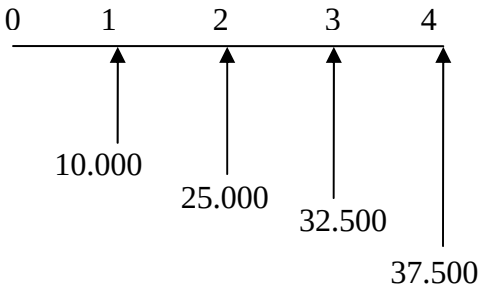
2- <u>Declining-balance method:</u>



$$PW(15) = 12.238\overbrace{(P/F,15,1)}^{0,8696} + 25.084\overbrace{(P/F,15,2)}^{0,7561} + 31.985\overbrace{(P/F,15,3)}^{0,6575} + 35.693\overbrace{(P/F,15,4)}^{0,5718}$$

$$= 71.048 \text{ TL}$$

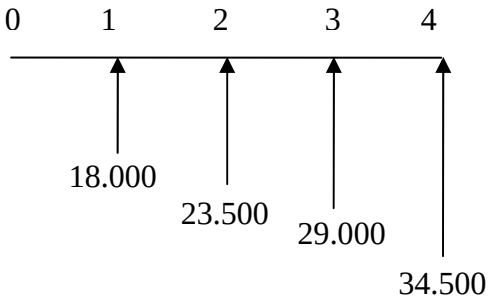
3- <u>Double declining-balance method:</u>



$$PW(15) = 10.000\overbrace{(P/F,15,1)}^{0,8696} + 25.000\overbrace{(P/F,15,2)}^{0,7561} + 32.500\overbrace{(P/F,15,3)}^{0,6575} + 37.500\overbrace{(P/F,15,4)}^{0,5718}$$

$$= 70.410 \text{ TL}$$

4- <u>Sum-of-the-years-digit method:</u>



$$PW(15) = 18.000\overbrace{(P/F,15,1)}^{0,8696} + 23.500\overbrace{(P/F,15,2)}^{0,7561} + 29.000\overbrace{(P/F,15,3)}^{0,6575} + 34.500\overbrace{(P/F,15,4)}^{0,5718}$$

$$= 72.216 \text{ TL}$$

In the Turkish Practice, only straight line method of depreciation could be used until 2006.

Since 2006, companies are free to select either the straight line or the double declining balance method of depreciation (*azalan bakiyeler usulü ile amortisman veya hızlandırılmış amortisman yöntemi*) up to a rate of 0.40.

One should keep in mind that, even though when we compare the methods using the graph above, we said that the double-declining balance method is the most advantageous from the tax payer point of view, it may not be valid all the time.

Depending on the yearly incomes (or losses), sometimes the straight line method of depreciation may be more advantageous. This can be shown by an example.

EXAMPLE 3:

Same example as Example 2, but yearly net income is 40.000 TL in this case.

The taxes to be paid by the company:

		Depreciation		Taxable profit		Tax (40%)	
End of Year	Income	St. Line	D. Dec. Balance	St. Line	D. Dec. Balance	St. Line	D. Dec. Balance
1	40.000	34.375	75.000	5.625	-	2.250	-
2	40.000	34.375	37.500	5.625	2.500	2.250	1.000
3	40.000	34.375	18.750	5.625	21.250	2.250	8.500
4	40.000	34.375	6.250	5.625	33.750	2.250	13.500
		137.500				9.000	23.000