

# Time Value of Money

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2020-07-26

## Time Value of Money

Understanding the time value of money is essential to finance. The value of something is not a static but dynamic thing. Dating back as far as 5000 BC, this concept is the foundation of modern day finance (<https://www.encyclopedia.com/finance/encyclopedias-almanacs-transcripts-and-maps/time-value-money>). Thankfully R makes calculations for TVM easy and efficient. TVM calculations are broken down into 4 topics: Future Value, Present Value, Rates of Return and Amortization.

```
#install.packages("modelr")
#install.packages("FinCal")
#install.packages("dplyr")
#install.packages("FinancialMath")
```

```
library("modelr")
library("FinCal")
library("dplyr")
```

```
##
## Attaching package: 'dplyr'

## The following objects are masked from 'package:stats':
##
##   filter, lag

## The following objects are masked from 'package:base':
##
##   intersect, setdiff, setequal, union
```

```
library("FinancialMath")
library("ggplot2")
```

## Future Value and Present Value

```
#Below is random cash flow data I have added for these exercises. We are going to assume our investment
cash_flow <- c(-10023,-84949,-84940,-83838,-93838,-73839,-83383,-102939)
```

```
i = 1.10
```

```
#Manual calculation of FV
```

```
(cash_flow[1] * i ^ 7) + (cash_flow[2] * i ^ 6) + (cash_flow[3] * i ^ 5) + (cash_flow[4] * i ^ 4) + (
```

```
## [1] -838472.1
```

```
#R makes this calculation much easier
```

```
fv.uneven(.1,cash_flow)
```

```
## [1] 838472.1
```

```
#FV of Annuity Due. Int = 10%, T = 8, type = 1 which means payment at the beginning of each period  
fv(.10,8,pv = 0, pmt = 1000, 1)
```

```
## [1] -12579.48
```

```
#Manual Calculation of PV  
(cash_flow[1]/(i) ^ 1) + (cash_flow[2] / i ^ 2) + (cash_flow[3] / i ^ 3) + (cash_flow[4] / i ^ 4) +  
/ i ^ 8)
```

```
## [1] -391153.4
```

```
#Again R makes PV calculation easier  
pv.uneven(.1, cash_flow)
```

```
## [1] 391153.4
```

```
#PV of Annuity Due. Int = 10%, T = 8, type = 1 which means payment at the beginning of each period  
pv(.1,8, fv = 0, pmt = 1000, type = 1)
```

```
## [1] -5868.419
```

## Rates of Return

```
#Calculating Rates of Return in R  
FV = 149374838  
PV = 84933  
N = 89  
M = 4 # number of compounding periods  
Iper = .1
```

```
#Calculating annualized returns manually. Couldnt find a function for this in R  
return = (FV/PV) ^ 1/N - 1
```

```
return
```

```
## [1] 18.76109
```

```
#Finding the EAR.  
EAR = (1 + Iper/M)^M - 1
```

```
EAR
```

```
## [1] 0.1038129
```

```
#Amortization Tablesin R
```

```
#Add Numbers to Values to Quick Calculations  
FV = 0  
PV = 300000  
N = 30  
M = 12 # frequency of payments per year  
Iper = .023
```

```
#Step 1 find the PMT  
PMT = -pmt(Iper/M,N*M,PV,FV,type = 0)
```

PMT

```
## [1] 1154.404
```

```
#Step 2 create the data frame
```

```
Amort <- data.frame(payment = 1:360)
```

```
#Step 3 assign beginning value to start loop
```

```
Amort[1,2] <- PV
```

```
#Step 4 Create for loop to fill in amortization table
```

```
for(i in 1:360){ #number of periods is 360
```

```
Amort[i,3] <- Amort[i,2] * Iper/12 #Interest Paid is Beginning Balance x Interest Rate
```

```
Amort[i,4] <- PMT - Amort[i,3] #Principle Paid is equal to the Payment minus Interest Paid
```

```
Amort[i,5] <- Amort[i,2] - Amort[i,4] #Ending Balance is equal to the Beginning Balance minus the Princ
```

```
Amort[i + 1,2] <- Amort[i,5] #Assign Beginning Balance as last payments Ending Balance
```

```
}
```

```
#Add column names
```

```
names(Amort)[2] <- 'Beginning Balance'
```

```
names(Amort)[3] <- 'Interest Paid'
```

```
names(Amort)[4] <- 'Principle Paid'
```

```
names(Amort)[5] <- 'Ending Balance'
```

```
#View the finished table
```

```
head(Amort)
```

```
##    payment Beginning Balance Interest Paid Principle Paid Ending Balance
## 1      1      300000.0      575.0000      579.4039      299420.6
## 2      2      299420.6      573.8895      580.5144      298840.1
## 3      3      298840.1      572.7768      581.6270      298258.5
## 4      4      298258.5      571.6620      582.7418      297675.7
## 5      5      297675.7      570.5451      583.8588      297091.9
## 6      6      297091.9      569.4261      584.9778      296506.9
```

```
#I created this amortization using a for loop, but fortunately R has a package for this
```

```
#Amort.table function in R
```

```
amort_table <- amort.table(Loan=PV,n=360,i=Iper,ic=12,pf=12)
```

```
head(amort_table["Schedule"], n = 10L)
```

```
## $Schedule
```

```
##      Year Payment Interest Paid Principal Paid Balance
## 1    0.08  1154.4      575.00      579.40 299420.60
## 2    0.17  1154.4      573.89      580.51 298840.08
## 3    0.25  1154.4      572.78      581.63 298258.45
## 4    0.33  1154.4      571.66      582.74 297675.71
## 5    0.42  1154.4      570.55      583.86 297091.85
## 6    0.50  1154.4      569.43      584.98 296506.88
```

|       |      |        |        |        |           |
|-------|------|--------|--------|--------|-----------|
| ## 7  | 0.58 | 1154.4 | 568.30 | 586.10 | 295920.78 |
| ## 8  | 0.67 | 1154.4 | 567.18 | 587.22 | 295333.55 |
| ## 9  | 0.75 | 1154.4 | 566.06 | 588.35 | 294745.21 |
| ## 10 | 0.83 | 1154.4 | 564.93 | 589.48 | 294155.73 |
| ## 11 | 0.92 | 1154.4 | 563.80 | 590.61 | 293565.13 |
| ## 12 | 1.00 | 1154.4 | 562.67 | 591.74 | 292973.39 |
| ## 13 | 1.08 | 1154.4 | 561.53 | 592.87 | 292380.52 |
| ## 14 | 1.17 | 1154.4 | 560.40 | 594.01 | 291786.51 |
| ## 15 | 1.25 | 1154.4 | 559.26 | 595.15 | 291191.36 |
| ## 16 | 1.33 | 1154.4 | 558.12 | 596.29 | 290595.08 |
| ## 17 | 1.42 | 1154.4 | 556.97 | 597.43 | 289997.65 |
| ## 18 | 1.50 | 1154.4 | 555.83 | 598.58 | 289399.07 |
| ## 19 | 1.58 | 1154.4 | 554.68 | 599.72 | 288799.35 |
| ## 20 | 1.67 | 1154.4 | 553.53 | 600.87 | 288198.48 |
| ## 21 | 1.75 | 1154.4 | 552.38 | 602.02 | 287596.45 |
| ## 22 | 1.83 | 1154.4 | 551.23 | 603.18 | 286993.28 |
| ## 23 | 1.92 | 1154.4 | 550.07 | 604.33 | 286388.94 |
| ## 24 | 2.00 | 1154.4 | 548.91 | 605.49 | 285783.45 |
| ## 25 | 2.08 | 1154.4 | 547.75 | 606.65 | 285176.80 |
| ## 26 | 2.17 | 1154.4 | 546.59 | 607.82 | 284568.98 |
| ## 27 | 2.25 | 1154.4 | 545.42 | 608.98 | 283960.00 |
| ## 28 | 2.33 | 1154.4 | 544.26 | 610.15 | 283349.86 |
| ## 29 | 2.42 | 1154.4 | 543.09 | 611.32 | 282738.54 |
| ## 30 | 2.50 | 1154.4 | 541.92 | 612.49 | 282126.05 |
| ## 31 | 2.58 | 1154.4 | 540.74 | 613.66 | 281512.39 |
| ## 32 | 2.67 | 1154.4 | 539.57 | 614.84 | 280897.55 |
| ## 33 | 2.75 | 1154.4 | 538.39 | 616.02 | 280281.53 |
| ## 34 | 2.83 | 1154.4 | 537.21 | 617.20 | 279664.34 |
| ## 35 | 2.92 | 1154.4 | 536.02 | 618.38 | 279045.96 |
| ## 36 | 3.00 | 1154.4 | 534.84 | 619.57 | 278426.39 |
| ## 37 | 3.08 | 1154.4 | 533.65 | 620.75 | 277805.64 |
| ## 38 | 3.17 | 1154.4 | 532.46 | 621.94 | 277183.69 |
| ## 39 | 3.25 | 1154.4 | 531.27 | 623.14 | 276560.56 |
| ## 40 | 3.33 | 1154.4 | 530.07 | 624.33 | 275936.23 |
| ## 41 | 3.42 | 1154.4 | 528.88 | 625.53 | 275310.70 |
| ## 42 | 3.50 | 1154.4 | 527.68 | 626.73 | 274683.98 |
| ## 43 | 3.58 | 1154.4 | 526.48 | 627.93 | 274056.05 |
| ## 44 | 3.67 | 1154.4 | 525.27 | 629.13 | 273426.92 |
| ## 45 | 3.75 | 1154.4 | 524.07 | 630.34 | 272796.59 |
| ## 46 | 3.83 | 1154.4 | 522.86 | 631.54 | 272165.04 |
| ## 47 | 3.92 | 1154.4 | 521.65 | 632.75 | 271532.29 |
| ## 48 | 4.00 | 1154.4 | 520.44 | 633.97 | 270898.32 |
| ## 49 | 4.08 | 1154.4 | 519.22 | 635.18 | 270263.14 |
| ## 50 | 4.17 | 1154.4 | 518.00 | 636.40 | 269626.74 |
| ## 51 | 4.25 | 1154.4 | 516.78 | 637.62 | 268989.12 |
| ## 52 | 4.33 | 1154.4 | 515.56 | 638.84 | 268350.28 |
| ## 53 | 4.42 | 1154.4 | 514.34 | 640.07 | 267710.21 |
| ## 54 | 4.50 | 1154.4 | 513.11 | 641.29 | 267068.92 |
| ## 55 | 4.58 | 1154.4 | 511.88 | 642.52 | 266426.40 |
| ## 56 | 4.67 | 1154.4 | 510.65 | 643.75 | 265782.65 |
| ## 57 | 4.75 | 1154.4 | 509.42 | 644.99 | 265137.66 |
| ## 58 | 4.83 | 1154.4 | 508.18 | 646.22 | 264491.43 |
| ## 59 | 4.92 | 1154.4 | 506.94 | 647.46 | 263843.97 |
| ## 60 | 5.00 | 1154.4 | 505.70 | 648.70 | 263195.27 |

|        |      |        |        |        |           |
|--------|------|--------|--------|--------|-----------|
| ## 61  | 5.08 | 1154.4 | 504.46 | 649.95 | 262545.32 |
| ## 62  | 5.17 | 1154.4 | 503.21 | 651.19 | 261894.13 |
| ## 63  | 5.25 | 1154.4 | 501.96 | 652.44 | 261241.69 |
| ## 64  | 5.33 | 1154.4 | 500.71 | 653.69 | 260588.00 |
| ## 65  | 5.42 | 1154.4 | 499.46 | 654.94 | 259933.06 |
| ## 66  | 5.50 | 1154.4 | 498.21 | 656.20 | 259276.86 |
| ## 67  | 5.58 | 1154.4 | 496.95 | 657.46 | 258619.40 |
| ## 68  | 5.67 | 1154.4 | 495.69 | 658.72 | 257960.69 |
| ## 69  | 5.75 | 1154.4 | 494.42 | 659.98 | 257300.71 |
| ## 70  | 5.83 | 1154.4 | 493.16 | 661.24 | 256639.46 |
| ## 71  | 5.92 | 1154.4 | 491.89 | 662.51 | 255976.95 |
| ## 72  | 6.00 | 1154.4 | 490.62 | 663.78 | 255313.17 |
| ## 73  | 6.08 | 1154.4 | 489.35 | 665.05 | 254648.12 |
| ## 74  | 6.17 | 1154.4 | 488.08 | 666.33 | 253981.79 |
| ## 75  | 6.25 | 1154.4 | 486.80 | 667.61 | 253314.18 |
| ## 76  | 6.33 | 1154.4 | 485.52 | 668.89 | 252645.30 |
| ## 77  | 6.42 | 1154.4 | 484.24 | 670.17 | 251975.13 |
| ## 78  | 6.50 | 1154.4 | 482.95 | 671.45 | 251303.68 |
| ## 79  | 6.58 | 1154.4 | 481.67 | 672.74 | 250630.94 |
| ## 80  | 6.67 | 1154.4 | 480.38 | 674.03 | 249956.91 |
| ## 81  | 6.75 | 1154.4 | 479.08 | 675.32 | 249281.59 |
| ## 82  | 6.83 | 1154.4 | 477.79 | 676.61 | 248604.98 |
| ## 83  | 6.92 | 1154.4 | 476.49 | 677.91 | 247927.07 |
| ## 84  | 7.00 | 1154.4 | 475.19 | 679.21 | 247247.86 |
| ## 85  | 7.08 | 1154.4 | 473.89 | 680.51 | 246567.34 |
| ## 86  | 7.17 | 1154.4 | 472.59 | 681.82 | 245885.53 |
| ## 87  | 7.25 | 1154.4 | 471.28 | 683.12 | 245202.40 |
| ## 88  | 7.33 | 1154.4 | 469.97 | 684.43 | 244517.97 |
| ## 89  | 7.42 | 1154.4 | 468.66 | 685.74 | 243832.23 |
| ## 90  | 7.50 | 1154.4 | 467.35 | 687.06 | 243145.17 |
| ## 91  | 7.58 | 1154.4 | 466.03 | 688.38 | 242456.79 |
| ## 92  | 7.67 | 1154.4 | 464.71 | 689.70 | 241767.10 |
| ## 93  | 7.75 | 1154.4 | 463.39 | 691.02 | 241076.08 |
| ## 94  | 7.83 | 1154.4 | 462.06 | 692.34 | 240383.74 |
| ## 95  | 7.92 | 1154.4 | 460.74 | 693.67 | 239690.07 |
| ## 96  | 8.00 | 1154.4 | 459.41 | 695.00 | 238995.07 |
| ## 97  | 8.08 | 1154.4 | 458.07 | 696.33 | 238298.74 |
| ## 98  | 8.17 | 1154.4 | 456.74 | 697.66 | 237601.08 |
| ## 99  | 8.25 | 1154.4 | 455.40 | 699.00 | 236902.08 |
| ## 100 | 8.33 | 1154.4 | 454.06 | 700.34 | 236201.74 |
| ## 101 | 8.42 | 1154.4 | 452.72 | 701.68 | 235500.05 |
| ## 102 | 8.50 | 1154.4 | 451.38 | 703.03 | 234797.02 |
| ## 103 | 8.58 | 1154.4 | 450.03 | 704.38 | 234092.65 |
| ## 104 | 8.67 | 1154.4 | 448.68 | 705.73 | 233386.92 |
| ## 105 | 8.75 | 1154.4 | 447.32 | 707.08 | 232679.84 |
| ## 106 | 8.83 | 1154.4 | 445.97 | 708.43 | 231971.41 |
| ## 107 | 8.92 | 1154.4 | 444.61 | 709.79 | 231261.61 |
| ## 108 | 9.00 | 1154.4 | 443.25 | 711.15 | 230550.46 |
| ## 109 | 9.08 | 1154.4 | 441.89 | 712.52 | 229837.95 |
| ## 110 | 9.17 | 1154.4 | 440.52 | 713.88 | 229124.07 |
| ## 111 | 9.25 | 1154.4 | 439.15 | 715.25 | 228408.82 |
| ## 112 | 9.33 | 1154.4 | 437.78 | 716.62 | 227692.20 |
| ## 113 | 9.42 | 1154.4 | 436.41 | 717.99 | 226974.20 |
| ## 114 | 9.50 | 1154.4 | 435.03 | 719.37 | 226254.83 |

|        |       |        |        |        |           |
|--------|-------|--------|--------|--------|-----------|
| ## 115 | 9.58  | 1154.4 | 433.66 | 720.75 | 225534.08 |
| ## 116 | 9.67  | 1154.4 | 432.27 | 722.13 | 224811.95 |
| ## 117 | 9.75  | 1154.4 | 430.89 | 723.51 | 224088.44 |
| ## 118 | 9.83  | 1154.4 | 429.50 | 724.90 | 223363.54 |
| ## 119 | 9.92  | 1154.4 | 428.11 | 726.29 | 222637.25 |
| ## 120 | 10.00 | 1154.4 | 426.72 | 727.68 | 221909.57 |
| ## 121 | 10.08 | 1154.4 | 425.33 | 729.08 | 221180.49 |
| ## 122 | 10.17 | 1154.4 | 423.93 | 730.47 | 220450.01 |
| ## 123 | 10.25 | 1154.4 | 422.53 | 731.87 | 219718.14 |
| ## 124 | 10.33 | 1154.4 | 421.13 | 733.28 | 218984.86 |
| ## 125 | 10.42 | 1154.4 | 419.72 | 734.68 | 218250.18 |
| ## 126 | 10.50 | 1154.4 | 418.31 | 736.09 | 217514.09 |
| ## 127 | 10.58 | 1154.4 | 416.90 | 737.50 | 216776.59 |
| ## 128 | 10.67 | 1154.4 | 415.49 | 738.92 | 216037.67 |
| ## 129 | 10.75 | 1154.4 | 414.07 | 740.33 | 215297.34 |
| ## 130 | 10.83 | 1154.4 | 412.65 | 741.75 | 214555.59 |
| ## 131 | 10.92 | 1154.4 | 411.23 | 743.17 | 213812.42 |
| ## 132 | 11.00 | 1154.4 | 409.81 | 744.60 | 213067.82 |
| ## 133 | 11.08 | 1154.4 | 408.38 | 746.02 | 212321.79 |
| ## 134 | 11.17 | 1154.4 | 406.95 | 747.45 | 211574.34 |
| ## 135 | 11.25 | 1154.4 | 405.52 | 748.89 | 210825.45 |
| ## 136 | 11.33 | 1154.4 | 404.08 | 750.32 | 210075.13 |
| ## 137 | 11.42 | 1154.4 | 402.64 | 751.76 | 209323.37 |
| ## 138 | 11.50 | 1154.4 | 401.20 | 753.20 | 208570.17 |
| ## 139 | 11.58 | 1154.4 | 399.76 | 754.64 | 207815.53 |
| ## 140 | 11.67 | 1154.4 | 398.31 | 756.09 | 207059.44 |
| ## 141 | 11.75 | 1154.4 | 396.86 | 757.54 | 206301.90 |
| ## 142 | 11.83 | 1154.4 | 395.41 | 758.99 | 205542.91 |
| ## 143 | 11.92 | 1154.4 | 393.96 | 760.45 | 204782.46 |
| ## 144 | 12.00 | 1154.4 | 392.50 | 761.90 | 204020.55 |
| ## 145 | 12.08 | 1154.4 | 391.04 | 763.36 | 203257.19 |
| ## 146 | 12.17 | 1154.4 | 389.58 | 764.83 | 202492.36 |
| ## 147 | 12.25 | 1154.4 | 388.11 | 766.29 | 201726.07 |
| ## 148 | 12.33 | 1154.4 | 386.64 | 767.76 | 200958.31 |
| ## 149 | 12.42 | 1154.4 | 385.17 | 769.23 | 200189.07 |
| ## 150 | 12.50 | 1154.4 | 383.70 | 770.71 | 199418.36 |
| ## 151 | 12.58 | 1154.4 | 382.22 | 772.19 | 198646.18 |
| ## 152 | 12.67 | 1154.4 | 380.74 | 773.67 | 197872.51 |
| ## 153 | 12.75 | 1154.4 | 379.26 | 775.15 | 197097.37 |
| ## 154 | 12.83 | 1154.4 | 377.77 | 776.63 | 196320.73 |
| ## 155 | 12.92 | 1154.4 | 376.28 | 778.12 | 195542.61 |
| ## 156 | 13.00 | 1154.4 | 374.79 | 779.61 | 194763.00 |
| ## 157 | 13.08 | 1154.4 | 373.30 | 781.11 | 193981.89 |
| ## 158 | 13.17 | 1154.4 | 371.80 | 782.61 | 193199.28 |
| ## 159 | 13.25 | 1154.4 | 370.30 | 784.11 | 192415.18 |
| ## 160 | 13.33 | 1154.4 | 368.80 | 785.61 | 191629.57 |
| ## 161 | 13.42 | 1154.4 | 367.29 | 787.11 | 190842.45 |
| ## 162 | 13.50 | 1154.4 | 365.78 | 788.62 | 190053.83 |
| ## 163 | 13.58 | 1154.4 | 364.27 | 790.13 | 189263.70 |
| ## 164 | 13.67 | 1154.4 | 362.76 | 791.65 | 188472.05 |
| ## 165 | 13.75 | 1154.4 | 361.24 | 793.17 | 187678.88 |
| ## 166 | 13.83 | 1154.4 | 359.72 | 794.69 | 186884.20 |
| ## 167 | 13.92 | 1154.4 | 358.19 | 796.21 | 186087.99 |
| ## 168 | 14.00 | 1154.4 | 356.67 | 797.74 | 185290.25 |

|        |       |        |        |        |           |
|--------|-------|--------|--------|--------|-----------|
| ## 169 | 14.08 | 1154.4 | 355.14 | 799.26 | 184490.99 |
| ## 170 | 14.17 | 1154.4 | 353.61 | 800.80 | 183690.19 |
| ## 171 | 14.25 | 1154.4 | 352.07 | 802.33 | 182887.86 |
| ## 172 | 14.33 | 1154.4 | 350.54 | 803.87 | 182083.99 |
| ## 173 | 14.42 | 1154.4 | 348.99 | 805.41 | 181278.58 |
| ## 174 | 14.50 | 1154.4 | 347.45 | 806.95 | 180471.63 |
| ## 175 | 14.58 | 1154.4 | 345.90 | 808.50 | 179663.13 |
| ## 176 | 14.67 | 1154.4 | 344.35 | 810.05 | 178853.08 |
| ## 177 | 14.75 | 1154.4 | 342.80 | 811.60 | 178041.48 |
| ## 178 | 14.83 | 1154.4 | 341.25 | 813.16 | 177228.32 |
| ## 179 | 14.92 | 1154.4 | 339.69 | 814.72 | 176413.61 |
| ## 180 | 15.00 | 1154.4 | 338.13 | 816.28 | 175597.33 |
| ## 181 | 15.08 | 1154.4 | 336.56 | 817.84 | 174779.49 |
| ## 182 | 15.17 | 1154.4 | 334.99 | 819.41 | 173960.08 |
| ## 183 | 15.25 | 1154.4 | 333.42 | 820.98 | 173139.09 |
| ## 184 | 15.33 | 1154.4 | 331.85 | 822.55 | 172316.54 |
| ## 185 | 15.42 | 1154.4 | 330.27 | 824.13 | 171492.41 |
| ## 186 | 15.50 | 1154.4 | 328.69 | 825.71 | 170666.70 |
| ## 187 | 15.58 | 1154.4 | 327.11 | 827.29 | 169839.41 |
| ## 188 | 15.67 | 1154.4 | 325.53 | 828.88 | 169010.53 |
| ## 189 | 15.75 | 1154.4 | 323.94 | 830.47 | 168180.06 |
| ## 190 | 15.83 | 1154.4 | 322.35 | 832.06 | 167348.00 |
| ## 191 | 15.92 | 1154.4 | 320.75 | 833.65 | 166514.35 |
| ## 192 | 16.00 | 1154.4 | 319.15 | 835.25 | 165679.10 |
| ## 193 | 16.08 | 1154.4 | 317.55 | 836.85 | 164842.25 |
| ## 194 | 16.17 | 1154.4 | 315.95 | 838.46 | 164003.79 |
| ## 195 | 16.25 | 1154.4 | 314.34 | 840.06 | 163163.73 |
| ## 196 | 16.33 | 1154.4 | 312.73 | 841.67 | 162322.05 |
| ## 197 | 16.42 | 1154.4 | 311.12 | 843.29 | 161478.77 |
| ## 198 | 16.50 | 1154.4 | 309.50 | 844.90 | 160633.86 |
| ## 199 | 16.58 | 1154.4 | 307.88 | 846.52 | 159787.34 |
| ## 200 | 16.67 | 1154.4 | 306.26 | 848.14 | 158939.20 |
| ## 201 | 16.75 | 1154.4 | 304.63 | 849.77 | 158089.43 |
| ## 202 | 16.83 | 1154.4 | 303.00 | 851.40 | 157238.03 |
| ## 203 | 16.92 | 1154.4 | 301.37 | 853.03 | 156385.00 |
| ## 204 | 17.00 | 1154.4 | 299.74 | 854.67 | 155530.33 |
| ## 205 | 17.08 | 1154.4 | 298.10 | 856.30 | 154674.03 |
| ## 206 | 17.17 | 1154.4 | 296.46 | 857.95 | 153816.08 |
| ## 207 | 17.25 | 1154.4 | 294.81 | 859.59 | 152956.49 |
| ## 208 | 17.33 | 1154.4 | 293.17 | 861.24 | 152095.25 |
| ## 209 | 17.42 | 1154.4 | 291.52 | 862.89 | 151232.37 |
| ## 210 | 17.50 | 1154.4 | 289.86 | 864.54 | 150367.82 |
| ## 211 | 17.58 | 1154.4 | 288.20 | 866.20 | 149501.63 |
| ## 212 | 17.67 | 1154.4 | 286.54 | 867.86 | 148633.77 |
| ## 213 | 17.75 | 1154.4 | 284.88 | 869.52 | 147764.24 |
| ## 214 | 17.83 | 1154.4 | 283.21 | 871.19 | 146893.05 |
| ## 215 | 17.92 | 1154.4 | 281.55 | 872.86 | 146020.20 |
| ## 216 | 18.00 | 1154.4 | 279.87 | 874.53 | 145145.66 |
| ## 217 | 18.08 | 1154.4 | 278.20 | 876.21 | 144269.46 |
| ## 218 | 18.17 | 1154.4 | 276.52 | 877.89 | 143391.57 |
| ## 219 | 18.25 | 1154.4 | 274.83 | 879.57 | 142512.00 |
| ## 220 | 18.33 | 1154.4 | 273.15 | 881.26 | 141630.74 |
| ## 221 | 18.42 | 1154.4 | 271.46 | 882.94 | 140747.80 |
| ## 222 | 18.50 | 1154.4 | 269.77 | 884.64 | 139863.16 |

|        |       |        |        |        |           |
|--------|-------|--------|--------|--------|-----------|
| ## 223 | 18.58 | 1154.4 | 268.07 | 886.33 | 138976.83 |
| ## 224 | 18.67 | 1154.4 | 266.37 | 888.03 | 138088.80 |
| ## 225 | 18.75 | 1154.4 | 264.67 | 889.73 | 137199.06 |
| ## 226 | 18.83 | 1154.4 | 262.96 | 891.44 | 136307.62 |
| ## 227 | 18.92 | 1154.4 | 261.26 | 893.15 | 135414.48 |
| ## 228 | 19.00 | 1154.4 | 259.54 | 894.86 | 134519.62 |
| ## 229 | 19.08 | 1154.4 | 257.83 | 896.57 | 133623.04 |
| ## 230 | 19.17 | 1154.4 | 256.11 | 898.29 | 132724.75 |
| ## 231 | 19.25 | 1154.4 | 254.39 | 900.01 | 131824.73 |
| ## 232 | 19.33 | 1154.4 | 252.66 | 901.74 | 130922.99 |
| ## 233 | 19.42 | 1154.4 | 250.94 | 903.47 | 130019.53 |
| ## 234 | 19.50 | 1154.4 | 249.20 | 905.20 | 129114.33 |
| ## 235 | 19.58 | 1154.4 | 247.47 | 906.93 | 128207.39 |
| ## 236 | 19.67 | 1154.4 | 245.73 | 908.67 | 127298.72 |
| ## 237 | 19.75 | 1154.4 | 243.99 | 910.41 | 126388.30 |
| ## 238 | 19.83 | 1154.4 | 242.24 | 912.16 | 125476.14 |
| ## 239 | 19.92 | 1154.4 | 240.50 | 913.91 | 124562.24 |
| ## 240 | 20.00 | 1154.4 | 238.74 | 915.66 | 123646.58 |
| ## 241 | 20.08 | 1154.4 | 236.99 | 917.41 | 122729.16 |
| ## 242 | 20.17 | 1154.4 | 235.23 | 919.17 | 121809.99 |
| ## 243 | 20.25 | 1154.4 | 233.47 | 920.93 | 120889.05 |
| ## 244 | 20.33 | 1154.4 | 231.70 | 922.70 | 119966.35 |
| ## 245 | 20.42 | 1154.4 | 229.94 | 924.47 | 119041.89 |
| ## 246 | 20.50 | 1154.4 | 228.16 | 926.24 | 118115.65 |
| ## 247 | 20.58 | 1154.4 | 226.39 | 928.02 | 117187.63 |
| ## 248 | 20.67 | 1154.4 | 224.61 | 929.79 | 116257.84 |
| ## 249 | 20.75 | 1154.4 | 222.83 | 931.58 | 115326.26 |
| ## 250 | 20.83 | 1154.4 | 221.04 | 933.36 | 114392.90 |
| ## 251 | 20.92 | 1154.4 | 219.25 | 935.15 | 113457.75 |
| ## 252 | 21.00 | 1154.4 | 217.46 | 936.94 | 112520.80 |
| ## 253 | 21.08 | 1154.4 | 215.66 | 938.74 | 111582.06 |
| ## 254 | 21.17 | 1154.4 | 213.87 | 940.54 | 110641.53 |
| ## 255 | 21.25 | 1154.4 | 212.06 | 942.34 | 109699.19 |
| ## 256 | 21.33 | 1154.4 | 210.26 | 944.15 | 108755.04 |
| ## 257 | 21.42 | 1154.4 | 208.45 | 945.96 | 107809.08 |
| ## 258 | 21.50 | 1154.4 | 206.63 | 947.77 | 106861.31 |
| ## 259 | 21.58 | 1154.4 | 204.82 | 949.59 | 105911.73 |
| ## 260 | 21.67 | 1154.4 | 203.00 | 951.41 | 104960.32 |
| ## 261 | 21.75 | 1154.4 | 201.17 | 953.23 | 104007.09 |
| ## 262 | 21.83 | 1154.4 | 199.35 | 955.06 | 103052.03 |
| ## 263 | 21.92 | 1154.4 | 197.52 | 956.89 | 102095.14 |
| ## 264 | 22.00 | 1154.4 | 195.68 | 958.72 | 101136.42 |
| ## 265 | 22.08 | 1154.4 | 193.84 | 960.56 | 100175.86 |
| ## 266 | 22.17 | 1154.4 | 192.00 | 962.40 | 99213.46  |
| ## 267 | 22.25 | 1154.4 | 190.16 | 964.24 | 98249.22  |
| ## 268 | 22.33 | 1154.4 | 188.31 | 966.09 | 97283.13  |
| ## 269 | 22.42 | 1154.4 | 186.46 | 967.94 | 96315.18  |
| ## 270 | 22.50 | 1154.4 | 184.60 | 969.80 | 95345.38  |
| ## 271 | 22.58 | 1154.4 | 182.75 | 971.66 | 94373.72  |
| ## 272 | 22.67 | 1154.4 | 180.88 | 973.52 | 93400.20  |
| ## 273 | 22.75 | 1154.4 | 179.02 | 975.39 | 92424.82  |
| ## 274 | 22.83 | 1154.4 | 177.15 | 977.26 | 91447.56  |
| ## 275 | 22.92 | 1154.4 | 175.27 | 979.13 | 90468.43  |
| ## 276 | 23.00 | 1154.4 | 173.40 | 981.01 | 89487.42  |



|    |     |       |        |        |         |          |
|----|-----|-------|--------|--------|---------|----------|
| ## | 277 | 23.08 | 1154.4 | 171.52 | 982.89  | 88504.54 |
| ## | 278 | 23.17 | 1154.4 | 169.63 | 984.77  | 87519.77 |
| ## | 279 | 23.25 | 1154.4 | 167.75 | 986.66  | 86533.11 |
| ## | 280 | 23.33 | 1154.4 | 165.86 | 988.55  | 85544.56 |
| ## | 281 | 23.42 | 1154.4 | 163.96 | 990.44  | 84554.12 |
| ## | 282 | 23.50 | 1154.4 | 162.06 | 992.34  | 83561.78 |
| ## | 283 | 23.58 | 1154.4 | 160.16 | 994.24  | 82567.53 |
| ## | 284 | 23.67 | 1154.4 | 158.25 | 996.15  | 81571.38 |
| ## | 285 | 23.75 | 1154.4 | 156.35 | 998.06  | 80573.32 |
| ## | 286 | 23.83 | 1154.4 | 154.43 | 999.97  | 79573.35 |
| ## | 287 | 23.92 | 1154.4 | 152.52 | 1001.89 | 78571.46 |
| ## | 288 | 24.00 | 1154.4 | 150.60 | 1003.81 | 77567.66 |
| ## | 289 | 24.08 | 1154.4 | 148.67 | 1005.73 | 76561.92 |
| ## | 290 | 24.17 | 1154.4 | 146.74 | 1007.66 | 75554.26 |
| ## | 291 | 24.25 | 1154.4 | 144.81 | 1009.59 | 74544.67 |
| ## | 292 | 24.33 | 1154.4 | 142.88 | 1011.53 | 73533.14 |
| ## | 293 | 24.42 | 1154.4 | 140.94 | 1013.47 | 72519.68 |
| ## | 294 | 24.50 | 1154.4 | 139.00 | 1015.41 | 71504.27 |
| ## | 295 | 24.58 | 1154.4 | 137.05 | 1017.35 | 70486.92 |
| ## | 296 | 24.67 | 1154.4 | 135.10 | 1019.30 | 69467.61 |
| ## | 297 | 24.75 | 1154.4 | 133.15 | 1021.26 | 68446.36 |
| ## | 298 | 24.83 | 1154.4 | 131.19 | 1023.22 | 67423.14 |
| ## | 299 | 24.92 | 1154.4 | 129.23 | 1025.18 | 66397.96 |
| ## | 300 | 25.00 | 1154.4 | 127.26 | 1027.14 | 65370.82 |
| ## | 301 | 25.08 | 1154.4 | 125.29 | 1029.11 | 64341.71 |
| ## | 302 | 25.17 | 1154.4 | 123.32 | 1031.08 | 63310.63 |
| ## | 303 | 25.25 | 1154.4 | 121.35 | 1033.06 | 62277.57 |
| ## | 304 | 25.33 | 1154.4 | 119.37 | 1035.04 | 61242.53 |
| ## | 305 | 25.42 | 1154.4 | 117.38 | 1037.02 | 60205.51 |
| ## | 306 | 25.50 | 1154.4 | 115.39 | 1039.01 | 59166.50 |
| ## | 307 | 25.58 | 1154.4 | 113.40 | 1041.00 | 58125.50 |
| ## | 308 | 25.67 | 1154.4 | 111.41 | 1043.00 | 57082.50 |
| ## | 309 | 25.75 | 1154.4 | 109.41 | 1045.00 | 56037.51 |
| ## | 310 | 25.83 | 1154.4 | 107.41 | 1047.00 | 54990.51 |
| ## | 311 | 25.92 | 1154.4 | 105.40 | 1049.01 | 53941.50 |
| ## | 312 | 26.00 | 1154.4 | 103.39 | 1051.02 | 52890.49 |
| ## | 313 | 26.08 | 1154.4 | 101.37 | 1053.03 | 51837.46 |
| ## | 314 | 26.17 | 1154.4 | 99.36  | 1055.05 | 50782.41 |
| ## | 315 | 26.25 | 1154.4 | 97.33  | 1057.07 | 49725.34 |
| ## | 316 | 26.33 | 1154.4 | 95.31  | 1059.10 | 48666.24 |
| ## | 317 | 26.42 | 1154.4 | 93.28  | 1061.13 | 47605.11 |
| ## | 318 | 26.50 | 1154.4 | 91.24  | 1063.16 | 46541.95 |
| ## | 319 | 26.58 | 1154.4 | 89.21  | 1065.20 | 45476.76 |
| ## | 320 | 26.67 | 1154.4 | 87.16  | 1067.24 | 44409.52 |
| ## | 321 | 26.75 | 1154.4 | 85.12  | 1069.29 | 43340.23 |
| ## | 322 | 26.83 | 1154.4 | 83.07  | 1071.34 | 42268.89 |
| ## | 323 | 26.92 | 1154.4 | 81.02  | 1073.39 | 41195.51 |
| ## | 324 | 27.00 | 1154.4 | 78.96  | 1075.45 | 40120.06 |
| ## | 325 | 27.08 | 1154.4 | 76.90  | 1077.51 | 39042.55 |
| ## | 326 | 27.17 | 1154.4 | 74.83  | 1079.57 | 37962.98 |
| ## | 327 | 27.25 | 1154.4 | 72.76  | 1081.64 | 36881.34 |
| ## | 328 | 27.33 | 1154.4 | 70.69  | 1083.71 | 35797.62 |
| ## | 329 | 27.42 | 1154.4 | 68.61  | 1085.79 | 34711.83 |
| ## | 330 | 27.50 | 1154.4 | 66.53  | 1087.87 | 33623.96 |

|    |     |       |        |       |         |          |
|----|-----|-------|--------|-------|---------|----------|
| ## | 331 | 27.58 | 1154.4 | 64.45 | 1089.96 | 32534.00 |
| ## | 332 | 27.67 | 1154.4 | 62.36 | 1092.05 | 31441.95 |
| ## | 333 | 27.75 | 1154.4 | 60.26 | 1094.14 | 30347.81 |
| ## | 334 | 27.83 | 1154.4 | 58.17 | 1096.24 | 29251.58 |
| ## | 335 | 27.92 | 1154.4 | 56.07 | 1098.34 | 28153.24 |
| ## | 336 | 28.00 | 1154.4 | 53.96 | 1100.44 | 27052.80 |
| ## | 337 | 28.08 | 1154.4 | 51.85 | 1102.55 | 25950.24 |
| ## | 338 | 28.17 | 1154.4 | 49.74 | 1104.67 | 24845.58 |
| ## | 339 | 28.25 | 1154.4 | 47.62 | 1106.78 | 23738.79 |
| ## | 340 | 28.33 | 1154.4 | 45.50 | 1108.90 | 22629.89 |
| ## | 341 | 28.42 | 1154.4 | 43.37 | 1111.03 | 21518.86 |
| ## | 342 | 28.50 | 1154.4 | 41.24 | 1113.16 | 20405.70 |
| ## | 343 | 28.58 | 1154.4 | 39.11 | 1115.29 | 19290.41 |
| ## | 344 | 28.67 | 1154.4 | 36.97 | 1117.43 | 18172.98 |
| ## | 345 | 28.75 | 1154.4 | 34.83 | 1119.57 | 17053.40 |
| ## | 346 | 28.83 | 1154.4 | 32.69 | 1121.72 | 15931.69 |
| ## | 347 | 28.92 | 1154.4 | 30.54 | 1123.87 | 14807.82 |
| ## | 348 | 29.00 | 1154.4 | 28.38 | 1126.02 | 13681.80 |
| ## | 349 | 29.08 | 1154.4 | 26.22 | 1128.18 | 12553.62 |
| ## | 350 | 29.17 | 1154.4 | 24.06 | 1130.34 | 11423.27 |
| ## | 351 | 29.25 | 1154.4 | 21.89 | 1132.51 | 10290.76 |
| ## | 352 | 29.33 | 1154.4 | 19.72 | 1134.68 | 9156.08  |
| ## | 353 | 29.42 | 1154.4 | 17.55 | 1136.85 | 8019.23  |
| ## | 354 | 29.50 | 1154.4 | 15.37 | 1139.03 | 6880.19  |
| ## | 355 | 29.58 | 1154.4 | 13.19 | 1141.22 | 5738.98  |
| ## | 356 | 29.67 | 1154.4 | 11.00 | 1143.40 | 4595.57  |
| ## | 357 | 29.75 | 1154.4 | 8.81  | 1145.60 | 3449.98  |
| ## | 358 | 29.83 | 1154.4 | 6.61  | 1147.79 | 2302.19  |
| ## | 359 | 29.92 | 1154.4 | 4.41  | 1149.99 | 1152.20  |
| ## | 360 | 30.00 | 1154.4 | 2.21  | 1152.20 | 0.00     |

```

amort_schedule <- as.data.frame(amort_table["Schedule"])
amort_schedule$period <- c(1:360)

#From graph,
ggplot(data = amort_schedule, aes(x = period, y = Schedule.Principal.Paid)) +
  geom_bar(stat = "identity", color="blue") +
  labs (title = "Amount of Principle Paid Over Life of Loan", x = "Payment Period", y = "Dollars")

```

