

Practice Quiz 7: Mortgage Borrowing (Solutions)

1. Jack and Jill are looking for a new home and find a \$400,000 house that they like. Their bank offers them a 30-year mortgage at a 7% APR with a 15% down payment and no points. Calculate the monthly payment for this mortgage.

Ans. With a down payment of 15%, Jack and Jill will need to finance $0.85 \times \$400,000 = \$340,000$ of the house price. The monthly payment can be found using a financial calculator (the monthly interest rate is $7\%/12 = 0.583\%$):

<u>Time Value of Money</u>	
PV	\$340,000
FV	\$0
i	0.583%
n	360
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PMT=	-\$2,262.03

Thus, the monthly payment will be \$2,262.03.

2. Their bank also offers Jack and Jill a 15-year mortgage at a 6.25% APR for the \$400,000 house, also with a 15% down payment and no points. Calculate the payment on this mortgage and compare the total interest cost of this mortgage to the total interest cost of the 30-year mortgage in problem 1.

Ans. Using a financial calculator (with a monthly interest rate of $6.25\%/12 = 0.521\%$):

<u>Time Value of Money</u>	
PV	\$340,000
FV	\$0
i	0.521%
n	180
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PMT=	-\$2,915.24

The monthly payment on the 15-year mortgage will be \$2,915.24.

For the 30 year mortgage, the interest expense over the life of the loan will cost them \$474,330.80 additional dollars (the difference between the monthly payment multiplied by 360 and the principal amount of the loan). For the 15 year mortgage, the interest expense over the life of the loan will cost them \$184,743.20 (the difference between the monthly payment multiplied by 180 and the principal amount of the loan).

3. If Jack and Jill are willing to pay two points, their bank will drop the APR on the 30-year mortgage in problem 1 to 6.5%. Calculate the implicit APR on this mortgage assuming Jack and Jill stay in the home for (a) 30 years, (b) 10 years, and (c) 4 years.

Ans. With points, the APR on the 30-year mortgage will drop to 6.5% and the monthly payment will be (the monthly interest rate is $6.5\%/12 = 0.542\%$):

<u>Time Value of Money</u>	
PV	\$340,000
FV	\$0
i	0.542%
n	360
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PMT=	-\$2,149.03

Two points will cost $0.02 * \$340,000 = \$6,800$ up front.

(a) If Jack and Jill remain in the home for 30 years, the cash flows associated with their mortgage will be: A \$340,000 receipt from their loan and a \$6,800 payment for the points, for a net cash flow of \$333,200 today. 360 monthly payments of \$2,149.03. The implicit monthly interest rate on such a series of payments is:

<u>Time Value of Money</u>	
PV	\$333,200
FV	\$0
PMT	-\$2,149.03
n	360
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i=	0.558%

This corresponds to an APR of $12 * 0.558\% = 6.7\%$. Because this is less than the 7.0% APR with no points, it will be financially cheaper to pay points if Jack and Jill plan to stay in the home for 30 years.

(b) If Jack and Jill remain in the home for 10 years, they will have the following mortgage balance to repay after selling the home:

<u>Time Value of Money</u>	
PV	\$340,000
PMT	-\$2,149.03
i	0.542%
n	120
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FV=	-\$288,239.05

In this case, the cash flows for the loan will be: \$333,200 in net proceeds today, 120 monthly payments of \$2,149.03, and a final payment of \$288,239.05 to close out their debt after 10 years. The implicit monthly interest rate on such a debt is:

<u>Time Value of Money</u>	
PV	\$333,200
FV	-\$288,239.05
PMT	-\$2,149.03
n	120
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i=	0.566%

This corresponds to an APR of $12 \times 0.566\% = 6.79\%$. Because this is less than the 7% APR without points, paying the points will be cheaper for Jack and Jill if they stay in the home for 10 years.

(c) If Jack and Jill remain in the home for 4 years, they will have the following mortgage balance to repay after selling the home:

<u>Time Value of Money</u>	
PV	\$340,000
PMT	-\$2,149.03
i	0.542%
n	48
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FV=	-\$323,202.62

In this case, the cash flows for the loan will be: \$333,200 in net proceeds today, 48 monthly payments of \$2,149.03, and a final payment of \$323,202.62 to close out their debt after 4 years. The implicit monthly interest rate on such a debt is:

<u>Time Value of Money</u>	
PV	\$333,200
FV	-\$323,202.62
PMT	-\$2,149.03
n	48
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i=	0.591%

This corresponds to an APR of $12 \times 0.591\% = 7.1\%$. Because this is greater than the 7% APR without points, paying points will be more expensive for Jack and Jill if they only stay in the home for 4 years.

4. If a student graduates with a \$12,000 in student debt at a 5% APR to be repaid over 10 years, what will her monthly payment be?

Ans. The monthly payment can be found using a financial calculator ($\text{APR}/12 = 5\%/12 = 0.417\%$):

<u>Time Value of Money</u>	
PV	\$12,000
FV	\$0
i	0.417%
n	120
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PMT=	-\$127.28

The monthly payments will then be \$127.28.

5. Fifteen years ago, the O'Connell family took out a \$400,000 30-year mortgage at a 5.4% APR. They are now considering refinancing with a new 15-year mortgage at a 4.9% APR. They plan to sell the house and move into a new one in 8 years after putting their daughter through school. Assuming \$8,000 in closing costs, What is the implicit APR for refinancing? Should the O'Connell family refinance?

Implicit APR = 5.45%

Should the O'Connell family refinance? Yes / No

Answer: The original payment and the current outstanding balance can be found to be:

<u>Time Value of Money</u>	
P/Y	12
PV	\$400,000
FV	\$0
N	360
I/Y	5.4%
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PMT=	-\$2,246.12
N	180
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FV=	-\$276,688.87

The refinanced payment will be:

<u>Time Value of Money</u>	
P/Y	12
PV	\$276,688.87
FV	\$0
N	180
I/Y	4.9%
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PMT=	-\$2,173.65

And the outstanding balance 8 years from today, under refinancing, will be:

<u>Time Value of Money</u>	
P/Y	12
PV	\$276,688.87
PMT	-\$2,173.65
N	96
I/Y	4.9%
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FV =	-\$154,302.52

Our cashflows are:

1. Closing cost subtracted from balance today = $\$276,688.87 - \$8,000 = \$268,688.87$
2. Monthly mortgage payments under refinancing = $-\$2,173.65$
3. Balance in 8 years when house is sold = $-\$154,302.52$

<u>Time Value of Money</u>	
P/Y	12
PV	\$268,688.87
PMT	-\$2,173.65
N	96
FV	-\$154,302.52
I/Y =	5.45%

The implicit APR is 5.45%. Since the implicit APR is higher than APR without refinancing, 5.4%, the O'Connell family should not refinance.

6. Albert just graduated from a top law school and was hired by a successful practice in his home city with a starting annual salary of \$120,000, but carries \$30,000 in student debt at a 6% APR to be repaid over 10 years. Albert has no other debt. Albert wants to buy a house worth \$420,000. Property tax in his city is 2% and homeowner's insurance is 0.5% of a home's value. With a down payment of 20%, his bank will provide him a 30-year mortgage at a 4.5% APR. If his bank requires a housing expense ratio of 28% and a maximum total expense ratio of 35%, will Albert be approved for this loan?

Ans. The housing expense ratio of 28% requires that:

$$\text{Payment} + \text{Taxes} + \text{Insurance} \leq 0.28 * \text{Monthly Income}$$

Albert's monthly mortgage payment will be:

<u>Time Value of Money</u>	
P/Y	12
PV	\$336,000
N	360
I/Y	4.5%
FV	\$0
PMT =	-\$1,702.46

Note \$336,000 is the loan amount (\$420,000 * .8).

The monthly tax and insurance payments, in terms of the house price, can be found to be:

$$\begin{aligned} \text{Taxes} &= \frac{0.02}{12} * \text{House Price} = .00167 * 420,000 = \$700 \\ \text{Insurance} &= \frac{0.005}{12} * \text{House Price} = .00042 * 420,000 = \$175 \end{aligned}$$

Albert has a monthly income of $\$120,000/12 = \$10,000$ per month.

Left side of the equation:

$$\$1,702.46 + \$700 + \$175 = \$2,577.46$$

Right side of the equation:

$$0.28 * \text{monthly income} = 0.28 * 10,000 = 2,800$$

Since $\$2,577.46 < \$2,800$, Albert's loan application is approved so far.

Next, we consider if Albert meets the total expense ratio requirement of 35%:

$$\text{Payment} + \text{Taxes} + \text{Insurance} + \text{Debt Payments} \leq 0.35 * \text{Monthly Income}$$

Albert's monthly student debt payment can be found using a financial calculator:

<u>Time Value of Money</u>	
PV	\$30,000
FV	\$0
i	0.5%
n	120
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PMT=	-\$333.06

Left side of the equation:

$$\$1,702.46 + \$700 + \$175 + \$333.06 = \$2,910.52$$

Right side of the equation:

$$0.35 * \$120,000/12 = \$3,500$$

Since $\$2,910.52 < \$3,500$, Albert will be approved for this loan.