Linear Equations

- Algebra, Lesson 2.1 -
Loans

They lend you money
Loans

Return money + **extra (interest)**
Advertised Interest Rates

• Credit Card:
• Payday Loan:
Advertised Interest Rates

• Credit Card: 12% - 30%
• Payday Loan:
Advertised Interest Rates

- Credit Card: 12% - 30%
- Payday Loan: 15% - 30%
“Actual” Interest Rates

- Credit Card: 12% - 30%
- Payday Loan: 390% - 780%

Source: Consumer Financial Protection Bureau
“Actual” Interest Rates

- Credit Card: 12% - 30%
- Payday Loan: 390% - 780%

Source: Consumer Financial Protection Bureau
Today’s Key Analysis

Helpful or Predatory?
Algebra, Lesson 2.1
Guided Notes

Handout: skewthescript.org/algebra/2-1
Topics

1. Linear Patterns
2. Constructing a Linear Model
3. Making Predictions
Topics

1. Linear Patterns
2. Constructing a Linear Model
3. Making Predictions
Payday Loans

• Fast, cash loans that people take out to make ends meet until their next payday

• Pay off loan at your next payday (with interest)

Source: Consumer Financial Protection Bureau
Payday Loans

• **Good:** Helps people survive after job layoff, emergency, etc.

• **Bad:** Notoriously high interest rates

*Source: Consumer Financial Protection Bureau*
How They Work

Imagine you take out a payday loan for $500. The lender advertises a 15% interest rate, to be paid in two weeks (your next payday).

These are fairly typical payday loan parameters, according to the Consumer Financial Protection Bureau

How They Work

Imagine you take out a payday loan for $500. The lender advertises a 15% interest rate, to be paid in two weeks (your next payday).

You pay the lender back plus some amount in interest. Interest is how lenders make profit.

These are fairly typical payday loan parameters, according to the Consumer Financial Protection Bureau

How They Work

Imagine you take out a payday loan for $500. The lender advertises a 15% interest rate, to be paid in two weeks (your next payday).

a) Calculate the interest (dollar amount) charged for the first two weeks.

These are fairly typical payday loan parameters, according to the Consumer Financial Protection Bureau

How They Work

Imagine you take out a payday loan for $500. The lender advertises a 15% interest rate, to be paid in two weeks (your next payday).

15% of $500

These are fairly typical payday loan parameters, according to the Consumer Financial Protection Bureau

How They Work

*Imagine you take out a payday loan for $500. The lender advertises a 15% interest rate, to be paid in two weeks (your next payday).*

15% of $500

multiply

These are fairly typical payday loan parameters, according to the Consumer Financial Protection Bureau

How They Work

Imagine you take out a payday loan for $500. The lender advertises a 15% interest rate, to be paid in two weeks (your next payday).

\[0.15 \times 500\]
How They Work

Imagine you take out a payday loan for $500. The lender advertises a 15% interest rate, to be paid in two weeks (your next payday).

\[
0.15 \times $500 = $75
\]

These are fairly typical payday loan parameters, according to the Consumer Financial Protection Bureau
How They Work

Imagine you take out a payday loan for $500. The lender advertises a 15% interest rate, to be paid in two weeks (your next payday).

You owe $500 + $75 in two weeks!

These are fairly typical payday loan parameters, according to the Consumer Financial Protection Bureau

How They Work

Imagine you take out a payday loan for $500. The lender advertises a 15% interest rate, to be paid in two weeks (your next payday).

You owe $575 in two weeks!
• You give them a check for **full amount**
• **Lender will cash it** in 2 weeks, after you get paid (so your bank account is full)
Two weeks pass ...
Then something interesting happens...
Lender says:

“To be nice, we’ll let you roll over your loan. Just pay the $75, and we’ll keep your check for another two weeks.”
Lender says:

“To be nice, we’ll let you roll over your loan. Just pay the $75, and we’ll keep your check for another two weeks.”

Called a roll over
Lender says:

“To be nice, we’ll let you **roll over** your loan. Just pay the $75, and we’ll **keep your check** for another two weeks.”

**Can keep rolling over** until can pay full check
Roll overs are common

According to the Consumer Financial Protection Bureau:

Roll overs are common

According to the Consumer Financial Protection Bureau:

- > 80% of payday loans are rolled over
- > 60% of loans go through 7 or more cycles (6 or more roll overs)

b) Why are roll overs common?

b) Why are roll overs common?

• People get payday loans during hard times (lose job, financial emergency, etc.).

• Starts a cycle of debt (roll overs) that is hard to overcome. Even if get paid, may not have enough left over for bills, so you keep rolling over your loan.

$500 loan, 15% interest (two-week cycle)

c) Complete the table, assuming roll overs

<table>
<thead>
<tr>
<th>Weeks After Loan</th>
<th>Amount Owed/Paid</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
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<tr>
<td>4</td>
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<tr>
<td>6</td>
<td></td>
</tr>
</tbody>
</table>
### $500 loan, 15% interest (two-week cycle)

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**Loan Amount (Start)**
## $500 loan, 15% interest (two-week cycle)

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### Interest

+ $75
### $500 loan, 15% interest (two-week cycle)

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$500 loan, 15% interest (two-week cycle)

Full amount on check
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<td></td>
</tr>
</tbody>
</table>

$500 loan, 15% interest (two-week cycle)

Roll Over

You pay $75 to roll over the loan. The lender **still has your $575 check**.
$500 loan, 15% interest (two-week cycle)

You pay $75 to roll over the loan. The lender still has your $575 check.

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$500 loan, 15% interest
(two-week cycle)

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$500 loan, 15% interest (two-week cycle)

Roll Over Again

+$75
### $500 loan, 15% interest (two-week cycle)

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</table>

**Roll Over Again**
### $500 loan, 15% interest (two-week cycle)

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<td><strong>$725</strong></td>
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</table>

Amount owed/paid is already **$725**!
<table>
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</table>

Linear Pattern: increases by *same amount* over time.
Graphing linear patterns

\[ x = \text{weeks since loan} \]
\[ y = \text{amount owed/paid} \]

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Graphing linear patterns

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Amount owed/paid ($) vs. Weeks since loan
Graphing linear patterns

What about the people taking 7 cycles (14 weeks) to pay off loans?

Can we make a model that shows us what they pay, without having to add $75 a bunch of times?
Topics

1. Linear Patterns
2. Constructing a Linear Model
3. Making Predictions
Linear Model

\[
\text{Amount Paid/Owed} = \text{Start Amount} + \text{Interest}
\]
Linear Model

Amount Paid/Owed = Start Amount + Interest

Let’s fill in the pieces!
<table>
<thead>
<tr>
<th>Weeks</th>
<th>Amount</th>
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<tbody>
<tr>
<td>0</td>
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<tr>
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<td>$725</td>
</tr>
</tbody>
</table>

**Graph:**

- **Y-axis:** Amount owed/paid ($)
- **X-axis:** Weeks since loan

The graph shows a linear relationship between weeks since the loan and the amount owed or paid. The increase in the amount is consistent over time.
Start Amount (y-int) = $500

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>0</td>
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</tr>
</tbody>
</table>
Linear Model

\[
\text{Amount Paid/Owed} = \text{Start Amount} + \text{Interest}
\]
Linear Model

Amount Paid/Owed = Start Amount + Interest

$y - \text{int} = 500$
Linear Model

\[ y = \$500 + \text{Interest} \]
Linear Model

\[ y = \$500 + \text{Interest} \]

Total interest depends on number of weeks (x)
How much does interest climb per week?

<table>
<thead>
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</thead>
<tbody>
<tr>
<td>0</td>
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</table>
Climbed by $75

<table>
<thead>
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</tr>
</tbody>
</table>
Over 2 weeks

<table>
<thead>
<tr>
<th>Weeks</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
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</table>

Weeks since loan

$75

Skew The Script
skewthescript.org
We want $ per week

<table>
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<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
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</tbody>
</table>
A graph showing the rise in amount over weeks since loan. The table below the graph provides the following data:

<table>
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The graph indicates a linear increase with each week, starting from $500 at week 0 and increasing by $75 each week.
Weeks since loan

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Weeks since loan

Week 2 wk = $37.50 per week

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Linear Model

\[ y = 500 + \text{Interest} \]
Linear Model

\[ y = 500 + \text{Interest} \]

$37.50$ per week, for \( x \) weeks
Linear Model

\[ y = 500 + 37.5x \]
Linear Model

\[ y = 500 + 37.5x \]

*Rearrange*
Linear Model

\[ y = 37.5x + 500 \]
Linear Model

\[ y = 37.5x + 500 \]

\[ y = mx + b \]

Every mathematician’s favorite one-liner!
Linear Model

\[ y = 37.5x + 500 \]

Every mathematician’s favorite one-liner!
Check the model

\[ y = 37.5x + 500 \]
Check the model

Amount owed/paid ($)

Weeks since loan

\[ y = 37.5x + 500 \]

Amount if pay off the loan in 8 weeks?
Check the model

Amount owed/paid ($) vs. Weeks since loan

\[ y = 37.5x + 500 \]

\[ y = 37.5(8) + 500 \]
Check the model

Amount owed/paid ($) vs. Weeks since loan

- $300
- $200
- $100
- $400
- $600
- $700
- $800

\[ y = 37.5x + 500 \]

At week 8:

\[ y = 37.5(8) + 500 \]
Check the model

\[ y = 37.5x + 500 \]

\[ y = 37.5(8) + 500 \]

\[ y = 800 \]
Consistent with the graph!

$y = 37.5x + 500$

$y = 37.5(8) + 500$

$y = 800$
Topics

1. Linear Patterns
2. Constructing a Linear Model
3. Making Predictions
Recall

According to the Consumer Financial Protection Bureau:

- > 60% of loans go through 7 or more cycles (6 or more roll overs)

Recall

According to the Consumer Financial Protection Bureau:

- > 60% of loans go through **7 or more cycles** (6 or more roll overs)

**How much would we owe after 7 loan cycles?**
7 cycles = 14 weeks
7 cycles = 14 weeks

Amount owed/paid ($) vs. Weeks since loan

Off The Graph
7 cycles = 14 weeks

\[ y = 37.5x + 500 \]
Payday Loans

3. a) For your $500 & 15% interest payday loan, what is the amount paid/owed after 7 loan cycles? (loan cycle = 2 weeks)
Payday Loans

3. a) For your $500 & 15% interest payday loan, what is the amount paid/owed after 7 loan cycles? (loan cycle = 2 weeks)

\[ y = 37.5x + 500 \]

Where: \( y \): Amount Paid/Owed
\( x \): Weeks of Loan
Payday Loans

3. a) For your $500 & 15% interest payday loan, what is the amount paid/owed after 7 loan cycles? (loan cycle = 2 weeks)

\[ y = 37.5x + 500 \]

\[ y = 37.5(14) + 500 \]

Where:  
\( y \): Amount Paid/Owed  
\( x \): Weeks of Loan
Payday Loans

3. a) For your $500 & 15% interest payday loan, what is the amount paid/owed after 7 loan cycles? (loan cycle = 2 weeks)

\[ y = 37.5x + 500 \]

Where: \( y \): Amount Paid/Owed

\[ y = 37.5(14) + 500 \]

\[ y = 525 + 500 \]
3. a) For your $500 & 15% interest payday loan, what is the amount paid/owed after 7 loan cycles? (loan cycle = 2 weeks)

\[ y = 37.5x + 500 \]

Where: \( y: \text{Amount Paid/Owed} \)

\( x: \text{Weeks of Loan} \)

\[ y = 37.5(14) + 500 \]

\[ y = 525 + 500 \]

Paying more than $500 in interest
3. a) For your $500 & 15% interest payday loan, what is the amount paid/owed after 7 loan cycles? (loan cycle = 2 weeks)

\[ y = 37.5x + 500 \]

Where: \( y \): Amount Paid/Owed  
\( x \): Weeks of Loan

\[ y = 37.5(14) + 500 \]

\[ y = 525 + 500 \]

That’s >100% interest!
Payday Loans

3. a) For your $500 & 15% interest payday loan, what is the amount paid/owed after 7 loan cycles? (loan cycle = 2 weeks)

\[ y = 37.5x + 500 \]

Where: \( y \): Amount Paid/Owed

\[ y = 37.5(14) + 500 \]

\[ y = $1,025 \]

Wow
Payday Loans

b) How many weeks before the amount paid/owed climbs to $2,450?

\[ y = 37.5x + 500 \]

Where: 
\[ y: \text{Amount Paid/Owed} \]
\[ x: \text{Weeks of Loan} \]
Payday Loans

b) How many weeks before the amount paid/owed climbs to $2,450?

\[ y = 37.5x + 500 \]

Where:  
\[ y: \text{Amount Paid/Owed} \]
\[ x: \text{Weeks of Loan} \]
Payday Loans

b) How **many weeks** before the amount paid/owed climbs to $2,450?

\[ y = 37.5x + 500 \]

Where: \( y \): Amount Paid/Owed

\[ 2,450 = 37.5x + 500 \]
Payday Loans

b) How many weeks before the amount paid/owed climbs to $2,450?

\[ y = 37.5x + 500 \]

Where:  
- \( y \): Amount Paid/Owed
- \( x \): Weeks of Loan

\[ 2,450 = 37.5x + 500 \]

\[ 2,450 - 500 = 37.5x + 500 - 500 \]

\[ 1,950 = 37.5x \]

\[ \frac{1,950}{37.5} = x \]

\[ x = 52 \]

Therefore, it takes 52 weeks for the amount paid/owed to climb to $2,450.
Payday Loans

b) How many weeks before the amount paid/owed climbs to $2,450?

$$\begin{align*}
y &= 37.5x + 500 \\
2,450 &= 37.5x + 500 \\
-500 &= 37.5x \\
1,950 &= 37.5x
\end{align*}$$

Where:
- \( y \): Amount Paid/Owed
- \( x \): Weeks of Loan
Payday Loans

b) How many weeks before the amount paid/owed climbs to $2,450?

1,950 = 37.5x
Payday Loans

b) How many weeks before the amount paid/owed climbs to $2,450?

\[
1,950 = 37.5x
\]

\[
\frac{1,950}{37.5} = \frac{37.5x}{37.5}
\]

\[
x = 52
\]
Payday Loans

b) How many weeks before the amount paid/owed climbs to $2,450?

\[
\frac{1,950}{37.5} = \frac{37.5x}{37.5}
\]

\[
52 = x
\]
Payday Loans

b) How many weeks before the amount paid/owed climbs to $2,450?

\[ x = 52 \]

52 weeks or 1 year
APR

Credit cards report their interests rates as Annual Percent Rates (APR). This shows you the interest over a full year. Credit card APR’s usually range from 12-30%.
Payday Loans

c) Using your previous answer, calculate the **APR** for the payday loan (as a percent).
Payday Loans

c) Using your previous answer, calculate the **APR** for the payday loan (as a percent).

In **one year** (52 weeks), amount increased from **$500** to **$2,450**.
Payday Loans

c) Using your previous answer, calculate the **APR** for the payday loan (as a percent).

\[ \text{Interest paid} = 2,450 - 500 = 1,950 \]
Payday Loans

c) Using your previous answer, calculate the **APR** for the payday loan (as a percent).

As a percent:

$1,950 / $500 = $
c) Using your previous answer, calculate the **APR** for the payday loan (as a percent).

As a percent:

\[
\frac{\$1,950}{\$500} = 3.9
\]
Payday Loans

c) Using your previous answer, calculate the APR for the payday loan (as a percent).

As a percent:

\[
\frac{1,950}{500} = 390\% \text{ APR}
\]
Payday Loans

d) The payday loan agreement said you had a **15% interest rate**. Is this misleading?
Payday Loans

d) The payday loan agreement said you had a **15% interest rate**. Is this misleading?

15% ($75) per two-week cycle
Payday Loans

d) The payday loan agreement said you had a 15% interest rate. Is this misleading?

15% ($75) per two-week cycle

Due to roll overs, most people end up paying more than 15%
d) The payday loan agreement said you had a 15% interest rate. Is this misleading?

15% ($75) per two-week cycle

Also...
Payday Loans

d) The payday loan agreement said you had a **15% interest rate**. Is this misleading?

15% ($75) **per two-week cycle**

**APR = 390%**
Payday Loans

d) The payday loan agreement said you had a 15% interest rate. Is this misleading?

Most credit and loans are reported in APR

**APR = 390%**
Payday Loans

d) The payday loan agreement said you had a **15% interest rate**. Is this misleading?

Credit Card APR: 12% - 30%

**APR = 390%**
Payday Loans

d) The payday loan agreement said you had a **15% interest rate**. Is this misleading?

So yes, 15% **may be misleading**
As a result: Many state governments require payday lenders to list interest in APR.
Lesson 2.1
Discussion
Payday loan store locations in Travis County (Austin, TX).

Jacob Villanueva, Texas Tribune
texastribune.org/2009/12/02/payday-lenders-cluster-in-low-income-areas
Discussion

a) What trend do you see? Why do you believe this trend exists?
Discussion

a) What trend do you see? Why do you believe this trend exists?

**Hint:** Think about what makes payday loans **profitable**.
b) Should the government limit interest rates? Why or why not?
Lesson 2.1 Practice
Choosing a loan plan

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The extra cost for the longer plans is called **interest**.
## Choosing a loan plan

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2) Build a model for the total cost, based on the number of loan months.
Choosing a loan plan

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2) Build a model for the total cost, based on the number of loan months.

Total cost increases by $600 every 12 months
Choosing a loan plan

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2) Build a model for the total cost, based on the number of loan months.

+$600 every 12 months ➔

$600/12 = $50 per month
Choosing a loan plan

Total Cost = $50(months) + $20,000

\[ y = mx + b \]

Every mathematician’s favorite one-liner!
Choosing a loan plan

Total Cost = $50(months) + $20,000

\[ y = mx + b \]

*Every mathematician’s favorite one-liner!*
Choosing a loan plan

Where:  \( y: \) Total Cost (\$)  
       \( x: \) Months of Loan

\[ y = 50x + 20,000 \]

Every mathematician’s favorite one-liner!
Choosing a loan plan

3) Graph your model.

Where:
- \( y \): Total Cost ($)
- \( x \): Months of Loan

\[ y = 50x + 20,000 \]

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Choosing a loan plan

3) Graph your model.

Where:

\[ y: \text{Total Cost (\$)} \]
\[ x: \text{Months of Loan} \]

\[ y = 50x + 20,000 \]

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Longer Loan

4) After spending on necessities (food, housing, etc.), you only have about **$400 left over** at the end of each month. So, none of these main plans work for you. However, you know you’ll own the car for 5 years, and you’d like to have it paid off before selling it. Would you be able to afford the car **on a 5 year plan**?

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Longer Loan

a) Use the model to get the total cost on a 5 year plan.
Longer Loan

a) Use the model to get the total cost on a 5 year plan.

Algebraically:

Where:  
- $y$: Total Cost ($)
- $x$: Months of Loan

$$y = 50x + 20,000$$

5 years $= 5 \times 12 = 60$ months
Longer Loan

a) Use the model to get the total cost on a 5 year plan.

*Algebraically:* 

Where:  
- **y**: Total Cost ($)
- **x**: Months of Loan

\[ y = 50x + 20,000 \]

\[ y = 50(60) + 20,000 \]
Longer Loan

a) Use the model to get the total cost on a 5 year plan.

Algebraically: Where:  
- **y**: Total Cost ($)
- **x**: Months of Loan

\[ y = 50x + 20,000 \]
\[ y = 3,000 + 20,000 \]
\[ y = $23,000 \]
Longer Loan

b) Will you be able to afford the monthly car payments under this 5 year plan? Calculate the monthly payments to find out.

Total Cost: $23,000  
5 years = 60 months  

Budget: $400 /month
Longer Loan

b) Will you be able to afford the monthly car payments under this 5 year plan? Calculate the monthly payments to find out.

Total Cost: $23,000
5 years = 60 months

$23,000 / 60 = $383.33 per month

Budget: $400 /month
b) Will you be able to afford the monthly car payments under this 5 year plan? Calculate the monthly payments to find out.

Total Cost: $23,000
5 years = 60 months
$23,000 / 60 = $383.33 per month

Budget: $400 / month

Affordable!
Longer Loan

c) The dealership describes the 5-year plan to you as the more “affordable” option. Is this true or misleading? Explain.
Longer Loan

c) The dealership describes the 5-year plan to you as the more “affordable” option. Is this true or misleading? Explain.

Misleading: Even though lower monthly payments, you end up paying $3,000 more!
Longer Loan

d) Calculate how long it would take for the total cost of the car to double.

Total Cost = $40,000

\[ y = 50x + 20,000 \]
d) Calculate how long it would take for the total cost of the car to double.

Total Cost = $40,000

40,000 = 50x + 20,000
Longer Loan

d) Calculate how long it would take for the total cost of the car to *double*.

\[
\text{Total Cost} = \$40,000
\]

\[
40,000 = 50x + 20,000
\]

\[
-20,000 \quad -20,000
\]
Longer Loan

d) Calculate how long it would take for the total cost of the car to double.

Total Cost = $40,000

\[ 40,000 = 50x + 20,000 \]

\[ 20,000 = 50x \]
Longer Loan

d) Calculate how long it would take for the total cost of the car to double.

Total Cost = $40,000

\[
40,000 = 50x + 20,000
\]

\[
\frac{20,000}{50} = \frac{50x}{50}
\]
Longer Loan

d) Calculate how long it would take for the total cost of the car to *double*.

Total Cost = $40,000

\[ 40,000 = 50x + 20,000 \]

\[ 400 = x \]

400 months / 12 ≈ 33 years
Discussion

Some used car dealers charge high interest on car loans. These dealers often prefer low-income customers. Why?