

Get book open to page 128

\$17 - (pre tax) price      final cost = ?  
 5% - Sales tax      <sup>Salestax</sup>  
 $\uparrow$  .05 ~~17~~ (.05) = .85  
~~17~~ + .85 = 17.85

Page 1

\$19.26 - total w/taxes      pre-tax price = ?  
 7% - Sales tax      (original) X  
 $\uparrow$  .07  
 $1X + .07(X) = 19.26$   
 $1.07X = \frac{19.26}{1.07}$        $X = \$18$   
 75.8 17.76  
 76. 101.40

Page 2

\$107.69 total w/tax      original price = ?  
 6.2% - Salestax      X  
 $\uparrow$  .062  
 $1X + .062X = 107.69$   
 $1.062X = \frac{107.69}{1.062}$   
 $X = \$101.40$

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44% <sup>(.44)</sup>  $\uparrow$       How many previously  
 10.4% - 8th Now      smoked = ?  
 $\uparrow$  .104      X  
 $1X + .44X = .104$   
 $1.44X = .104$   
 $X = .072$       7.2%

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77. 80.04 %  
78. 24.24 %

### Scientific Notation

Scientific notation is a format in which a number is expressed as a number between 1 and 10 multiplied by a power of 10

Rewrite each of the following statements using scientific notation

A. total spending in the federal budget is \$3,900,000,000.

$$3.9 \times 10^9$$

B. The diameter of a hydrogen nucleus is about 0.000000000000001 meter.

$$1.0 \times 10^{-15}$$

### Approximation with Scientific Notation

We can quickly approximate the answer to  $5795 \times 326$  by rounding.

$$1,800,000 \quad (6 \times 10^3) \times 10^{3+2-5} \quad 1,889,170$$

EX 2: Checking answers with approximations

You and a friend are doing a rough calculation of how much garbage New City residents produce every day. You estimate that, on average, each of the 8.3 million residents produce 1.8 pounds or 0.0009 ton, of garbage each day. The total amount of garbage is?

$$8.3 \text{ million} \quad 8,300,000 \times 1.8 \quad 17.94 \times 10^6$$

$$8.3 \times 10^6 \times 1.8 \quad 18 \times 10^6$$

$$1.8 \times 10^7$$

### Giving meaning to Numbers

Perspective through estimation

How high is 1000 feet?

With your group, come up with a way to explain to someone what 1000 feet looks like

5 minutes to brain storm \*

2 minutes to present

1 minute to decide who had the best description

3 fthl fields  
10 stories  
Tower of Americas  
5 min Run  
1,000 Rulers  
1.3 of track lap  
2 tracks  
1/5 mile  
Empire st building

### EX 3: Order of Magnitude of Ice Cream Spending

An order of magnitude estimate specifies only a broad range of values, usually within one or two powers of ten, such as "in the ten thousands" or "in the Millions".

Make an order of magnitude estimate of total annual spending on ice cream in the US

Before we see the books answer, lets try to make an estimation of our own.

Total annual spending = serving per person x price per serving x population

$$\begin{aligned} & \$150,000,000 \quad \text{person} \quad \$2.8 \text{ billion} \quad \text{serving} \quad 1.5 \times 10^8 \text{ person} \\ & \$546,000,000 \quad \$9.6 \text{ billion} \\ & \$760,000,000 \\ & \$1095,000,000 \\ & \$1.21 \text{ billion} \\ & \$1.8 \text{ billion} \end{aligned}$$

### Perspective through comparison

How big is \$100 billion?

Suppose you were asked to count \$100 billion. How long would it take you?

$$\begin{aligned} \$20 - 100y & \quad \$100 - 13d \\ \$100 - 4d & \quad \$100 - 2yrs \\ \$100 - 2wk & \quad \$1 - 1mil yr \\ \$100 - 1M & \\ & 1m - 2m \checkmark \end{aligned}$$

### Ex 4: US vs. World Energy Consumption

Compare the US population to the world population and US energy consumption to world energy consumption. What does this tell you about energy usage by Americans?

The world population is of order 7 billion and the US population is of order 300 million

$$\begin{aligned} \frac{US}{World} &= \frac{3 \times 10^8}{7 \times 10^9} = .42 \times 10^{-1} = .042 \approx 4\% \\ \frac{US \text{ cons}}{World} &= \frac{1.0 \times 10^{29}}{5.3 \times 10^{20}} = .188 \approx 19\% \end{aligned}$$

### Now try this one

How many average candy bars would you have to eat to supply the energy needed for 6 hours of running?

$$\begin{aligned} \text{Candy} &= 1 \times 10^6 \\ \text{Running} &= \frac{4 \times 10^6}{1 \text{ hr}} (6) = 24 \times 10^6 = 2.4 \times 10^7 \\ & \quad \text{Run Candy } \frac{2.4 \times 10^7}{1 \times 10^6} = 24 \times 10^1 = 240 \end{aligned}$$

### Ex 5: Fusion Power

If you had a portable fusion power plant and hooked it up to the faucet of your kitchen sink, how much power could you generate from the hydrogen in the water flowing through it?

A typical faucet pours out about 3 liters of water per minute.

Energy released by fusion of hydrogen in 1 liter of water =  $6.9 \times 10^{13}$  Joules per Liter

$$\begin{aligned} & \frac{6.9 \times 10^{13} \text{ J}}{\text{Liter}} \cdot \frac{3 \text{ L}}{\text{min}} = 2.1 \times 10^{14} \text{ J/min} \\ & \frac{2.1 \times 10^{14} \text{ J}}{\text{min}} \cdot \frac{60 \text{ min}}{1 \text{ hr}} \cdot \frac{24 \text{ hr}}{1 \text{ d}} \cdot \frac{365 \text{ d}}{1 \text{ yr}} = 1.1 \times 10^{20} \text{ J} \end{aligned}$$

### EX 6: Scale Ratio

A city map states, "One inch represents one mile." What is the scale ratio for this map?

$$\begin{aligned} 1 \text{ inch} &= 1 \text{ mile} \\ 1 \text{ inch} &= 1 \text{ inch} \\ 1 \text{ mile} &= 5280 \text{ ft} (12) = \end{aligned}$$

63,360 in  
63,000 in

78,915,601  
79,000,000  
1 mile

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### Try these

Convert to Meters

2cm on the map represents 100KM

$$1 \text{ cm} = 50 \text{ KM}$$

$$1 \text{ cm} = 500 \text{ KM}$$

$$50 \text{ KM} = \frac{50(1000)}{50,000} \text{ m} = \frac{(50,000)(100)}{50,000} \text{ cm} = 1 \text{ cm}$$

1 to 5,000,000 cm  
1 cm to 50,000,000 cm

$$1 \text{ KM} = 1000 \text{ m}$$

$$1 \text{ m} = 100 \text{ cm}$$

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### Ex 7: Earth and Sun

The distance from the Earth to the Sun is about 150 million KM. The diameter of the Sun is about 1.4 million KM, and the equatorial diameter of the Earth is about 12,760 KM.

Put these number ins perspective by using a scale model of the solar system with a 1 to 10 billion Scale.

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### EX 8: Distances to the stars

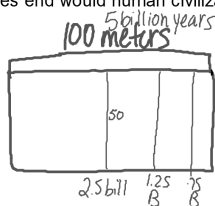
The distance from Earth to the nearest star besides the sun (the three stars of the Alpha centauri system) is about 4.3 light years. On the 1 to 10 billion scale, how far are these stars from the Earth? A light-year is the distance that light can travel in one year; 1 light-year =  $9.5 \times 10^{12}$

$$\begin{aligned} (9.5 \times 10^{12})(4.3) &= 40.85 \times 10^{12} \\ &= \frac{4.1 \times 10^{13}}{10^{10}} \\ &= 4.1 \times 10^3 \\ &= 4100 \text{ km} \end{aligned}$$

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### Ex 9: Timeline

Human civilization, at least since the time of ancient Egypt, is on the order of 5000 years old. The age of the Earth is on the order of 5 billion years. Suppose we use the length of a football field, or about 100 meters, as a timeline to represent the age of the Earth. If we put the birth of the Earth at the start of the timeline, how far from the lines end would human civilization begin?



$$1 \text{ E-}6 = \frac{\$0.0001 \text{ m}}{\$1,000,000,000}$$

### Pg 148:

12, 16, 18, 20, 28, 38, 42, 46, 54, 58, 60

Work must be shown for credit

### Significant Digits

The digits in a number that represent actual measurements are called significant digits. The larger the # of significant digits, the finer the precision.

Rules for Zeroes	
Rule	Examples
Zeros appearing between nonzero digits are significant	<ul style="list-style-type: none"><li>• 40.7 L has three sig figs</li><li>• 07.009 km has five sig figs</li></ul>
Zeros appearing in front of nonzero digits are not significant	<ul style="list-style-type: none"><li>• 0.095 987 m has five sig figs</li><li>• 0.0009 kg has one sig fig</li></ul> <p>95 9x</p>
Zeros at the end of a number and to the right of a decimal are significant	<ul style="list-style-type: none"><li>• 65.00 g has four sig figs</li><li>• 9 000 000 000 mm has 10 sig figs</li></ul> <p>2.000</p>
Zeros at the end of a number but to the left of a decimal may or may not be significant. If such a zero has been measured, or is the first estimated digit, it is significant. On the other hand, if the zero has not been measured or estimated but is just a placeholder, it is not significant. A decimal placed after the zeros indicates that they are significant.	<ul style="list-style-type: none"><li>• 2000 m may contain from one to four sig figs, depending on how many zeros are placeholders. For measurements given in this text, assume that 2000 has one sig fig.</li><li>• 2000. m contains four sig figs, indicated by the presence of the decimal point.</li></ul>
Scientific notation - All digits expressed before the exponential term are significant.	<ul style="list-style-type: none"><li>• <math>5.060 \times 10^{-2}</math> m has four sig figs.</li><li>• <math>5.00 \times 10^2</math> g has three sig figs.</li></ul>

### Exercise 1: How many significant figures does each quantity have?

- |                  |         |
|------------------|---------|
| 1) 107cm         | Ans.: 3 |
| 2) 10,700cm      | Ans.: 3 |
| 3) 1,270cm       | Ans.: 3 |
| 4) 12,703cm      | Ans.: 5 |
| 5) 1,060,809cm   | Ans.: 7 |
| 6) 1,040,700cm   | Ans.: 5 |
| 7) 10,407,005cm  | Ans.: 8 |
| 8) 100,000,002cm | Ans.: 9 |
| 9) 100,000,000cm | Ans.: 1 |

## Exercise 2: How many significant figures does each quantity have?

- 1)  $0.12070\text{kg}$  Ans. 5
- 2)  $1.07000\text{cm}$  Ans.: 6
- 3)  $0.0007\text{cm}$  Ans.: 1
- 4)  $22.0000\text{cm}$  Ans.: 6
- 5)  $0.000009\text{cm}$  Ans.: 1
- 6)  $1.0400700\text{cm}$  Ans.: 8
- 7)  $10.407005\text{cm}$  Ans.: 8
- 8)  $100.000,0020\text{cm}$  Ans.: 10
- 9)  $100,000,000.0\text{cm}$  Ans.: 10
- 10)  $100,000,000,000\text{cm}$  Ans.: 1

## Some Rounding Rules

1. When adding or subtracting numbers, find the number which is known to the fewest decimal places, then round the result to that decimal place.

Example:  $21.398 + 405 - 2.9 = 423$

2a. When multiplying or dividing numbers, find the number with the fewest significant figures, then round the result to that many significant figures.

Example:  $0.049623 \times 32.0 / 478.8 = 0.00332$

raising a number to some power which isn't very large or very small -- say, squaring it (power = 2) or taking its square root (power = 1/2) -- count the number's significant figures, then round the result to that many significant figures.

Example:  $(5.8)^2 = 34$

Since 5.8 is known to two significant figures, so the result must be rounded to two significant figures.)

## EX 2: Rounding with significant digits

Do the following operations and write the results with the correct number of significant figures

- 1)  $75\text{m} \times 4\text{m} = 300$   $3 \times 10^2$
- 2)  $75\text{cm} \times 4.0\text{cm} = 300$   $30$   $3.0 \times 10^2$
- 3)  $0.750\text{ft} \times 4.000\text{ft} = 3$   $.003 \times 10^{-3}$   $3.00$
- 4)  $7500\text{in.} \times 0.004\text{in.} = 30$   $3 \times 10^1$
- 5)  $125\text{m} / 25\text{s} = 5$   $\Rightarrow 5.0$
- 6)  $80\text{ft} / 16\text{s} = 5$   $5.0$
- 7)  $33,333\text{mi} / 3\text{h} = 11,111$   $1 \times 10^4$   $10,000$
- 8)  $3750\text{km} / 2.50\text{s} = 1500$   $1.50 \times 10^3$
- 9)  $(25\text{m} - 16\text{m}) / 0.0003\text{s} = 30,000$   $3 \times 10^4$

Answers:

## pg 160

Work through these problems. 15 - 34  
15 - 16 answer only  
17 - 28 has 2 answers numerical answer and the value it is "rounded" to.

29 - 34 do the operation given and round according to the rules

Skip 30 & 32

18.9001  $5$  thousandths  
22.450,000  $2$  ten-thousandths

1	3	2	7	8	6	9	4
tens	ones	tenths	hundredths	thousandths	ten thousandths	hundred thousandths	millionths
whole numbers		worth less than 1, getting smaller and smaller					

## 2 types of Measurement Error

Random and systematic

Each person come up with an example of each  
Then share with your group and the group decides on one example of each to present to the class  
As a class we will decide which one to use as our class example.

Systematic error - you can go back and adjust

Random error - making many measurements and averaging them

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## Ex 3:

(1) temperatures were measured with simple thermometers and the data was recorded by hand <sup>systematic</sup> Random: recording wrong <sup>sensor broken</sup>

(2) most temperature measurements were recorded in or near urban areas <sup>climate change</sup> <sup>black box</sup> <sup>rain drop it</sup> <sup>car heat</sup>

Identify whether each of these 2 difficulties produce random or systematic errors

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## EX 4: Census

What are some random and systematic errors in the US census

Random  
They mixup #'s  
babies born  
death  
Systematic  
No mail  
Computer glitch  
← Homeless →

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## Absolute and Relative Error

Absolute error - describes how far a measured value lies from the true value

Relative error - compares the size of the absolute error to the value and it often expressed as a percentage

$$\text{Ab error} = \text{measured} - \text{true}$$

$$\text{Rel error} = \frac{\text{measured} - \text{true}}{\text{true}} \times 100$$

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### EX 5: Absolute and Relative Error

Your true weight is 125 lbs, but a scale says you weigh 130 lbs

$$AE: 130 - 125 = \boxed{5 \text{ lbs}} \quad RE: \frac{5}{125} \times 100 = \boxed{4\%} \quad \text{measure}$$

The government claims that a program costs \$49.0 billion, but an audit shows that the true cost is \$50.0 billion.

### Accuracy and Precision

Accuracy describes how close the measured value lies to the true value. (usually defined by the relative error) An accurate rate measurement has a small relative error.

Precision describes the amount of detail in the measurement.

#### How to Remember?

- aCcurate is Correct
- pReCise is Repeating

All of the height measurements you found ranged between 5' 7.5" and 5' 8.5", which is a range of only an inch. If all of your measurements ranged between 5' 7.95" and 5' 8.05", your measurements would have been super precise! And if they had ranged from 5' 1" to 6' 3", they clearly would have been much less precise.

$$\begin{aligned} 8/4 \\ 7.8 / 4.2 &= \underline{2} \quad (\text{solve using rounding}) \\ 7.8 / 4.2 &= \underline{1.857143} \quad (\text{solve without rounding}) \\ &\quad \text{Precise} \quad \text{Accurate} \end{aligned}$$

Which is precise and which is accurate?

### EVEN PROBLEMS ONLY!

PG 160: 38 - 42 Random & Systematic errors  
48 - <sup>58</sup>62 <sup>9</sup>(11 problems)

48-54 Absolute error  
Relative error > Show work!

56-58 Accuracy & Precision

### Quiz 2 tomorrow

Finish work from yesterday and make corrections to page 160

**November 30, 2012**

### 3D Index numbers: The CPI and Beyond

**MEDINA-OLIVO, VICTORIA**

Overview

Mrs. Medina

Tutoring Times

AQR

AQR Syllabus

1st 9 weeks material

2nd 9 weeks material

CLASS NOTES

1st period

2nd period

3rd period

AQR Journal - 2

Page 1

Page 2

TABLE 3.2

YEAR	PRICE	WORK	PRICE AS A % OF 1980 PRICE	PRICE INDEX (1980 = 100)	PRICE INDEX (2000 = 100)
1960	\$0.31	$\frac{0.31}{1.22} \times 100$	25.4%	25.4	
1970	\$0.36	$\frac{0.36}{1.22} \times 100 = 29.501$	29.5%	29.5	
1980	\$1.22	$\frac{1.22}{1.22} \times 100$	100.0%	100.0	
1990	\$1.23	$\frac{1.23}{1.22} \times 100$	100.8%	100.8	
2000	\$1.56	$\frac{1.56}{1.22} \times 100$	127.9%	127.9	
2010	\$2.84	$\frac{2.84}{1.22} \times 100$	232.8%	232.8	

**Index Number** - provides a simple way to compare measurements made at different times/places.

$$\text{index number} = \frac{\text{value}}{\text{reference value}} \times 100$$

### EX 1: Finding an Index Number

\$3.77 gas today, using 1980 price to find price index

$$\frac{\$3.77 \text{ (Price now)}}{\$1.22 \text{ (Price in 1980)}} \times 100 = 309.016$$

\$1.78 gas today, use 2000 price to find price index

$$\frac{1.78}{1.56} \times 100 = 114.1$$

### Making Comparisons with Index Numbers

We can also do comparisons when neither value is a reference value

$$\frac{\text{index\# for 1990}}{\text{index\# for 1960}} = \frac{100.8}{25.4} = 3.97$$

Gas price of today to 1990

\$10 in 1960  
\$39.70 in 1990  
In 1990 gas ~~was~~ is 3.97 times more than the price of 1960

### EX 2: Using the Gas Price Index

**DEC 1st**

Cost \$15.00 to gas up in 1980, how much should it cost in 2010?

$$\frac{2010}{1980} = \frac{232.8}{100.0} = 2.328 (\$15) = \$34.92$$

Cost \$21.00 in 2000, how much should it have cost in 1960

$$\frac{1960}{2000} = \frac{25.4}{127.9} = .198 (21.00) = \$4.17$$

### Changing the reference value

TABLE 3.2

YEAR	PRICE	WORK	PRICE AS A % OF 1980 PRICE	PRICE INDEX (1980 = 100)	PRICE INDEX (2000 = 100)
1960	\$0.31	$\frac{0.31}{1.22}$	25.4%	25.4	19.9
1970	\$0.36	$\frac{0.36}{1.22} = .295$	29.5%	29.5	23.1
1980	\$1.22	$\frac{1.22}{1.22}$	100.0%	100.0	78.2
1990	\$1.23	$\frac{1.23}{1.22}$	100.8%	100.8	78.8
2000	\$1.56	$\frac{1.56}{1.22}$	127.9%	127.9	100.0
2010	\$2.84	$\frac{2.84}{1.22}$	232.8%	232.8	182.1

2015 3.50

?

### EX 3: 2000 index

Using 2000 price as the reference value, find the price index if today's gasoline price is \$3.77 per gallon. How does it compare to our answer in Example 1?

$$\frac{3.77}{1.56} \times 100 = 241.7$$

Today's price is 241.7% more than 2000

How do they compare?

### EX 1: Finding an Index Number

\$3.77 gas today, using 1980 price to find price index

$$\frac{3.77}{1.22} \times 100 = 309.016$$

\$1.78 gas today, use 2000 price to find price index

$$\frac{1.78}{1.56} \times 100 = 114.1$$

gas today is 114.1% more than gas in 2000

### CPI

Find out how much higher typical prices were in 2010 than in 1995, we compute the ratio of their CPI's

$$\frac{CPI_{2010}}{CPI_{1995}} = \frac{218.1}{152.4} = 1.4311$$

Compare 1990 to 2010. How many times more is the price currently to then?

↑ increase of 1995 to 2010

$$\begin{array}{r} .599 \\ .60 \end{array}$$

### EX 4: Cost of living

$$\frac{2015}{1982} = \frac{237.0}{96.5} = 2.456$$

need \$30,000 to maintain a standard of living in 2000. How much would you have needed in 2012 to maintain the same living standard?

Want  
Ref

$$\frac{CPI_{2012}}{CPI_{2000}} = \frac{229.6}{172.2} = 1.33(30,000) = \$40,000$$

Find the average CPI for this year. Then using your birth year, how much would you need in order to maintain the same lifestyle?

$$\frac{2015}{BY} = \frac{237.0}{\quad} = \quad$$

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT
2015	233.707	234.722	236.119	236.599	237.605	238.638	238.654	238.316	237.645	237.838

Pg 170: 11 - 18 All  
Show your work

Answers in back

11 & 12	EX 1
13 & 14	EX 2
15 & 16	EX 3
17 & 18	EX 4

### DEC 31st 7th

RATE OF INFLATION - refers to the relative change in the CPI from one year to the next.

From 1978 to 1979

$$\text{inflation rate 1978 to 1979} = \frac{CPI_{1979} - CPI_{1978}}{CPI_{1978}}$$
$$\frac{72.6 - 65.2}{65.2} = 0.113 = 11.3\%$$

$$\frac{CPI_{NEW} - CPI_{OLD}}{CPI_{OLD}}$$

### EX 5: INFLATION COMPARISON

Find the inflation rate from 2011 to 2012.

$$\text{inflation rate 2011 to 2012} = \frac{\text{CPI}_{2012} - \text{CPI}_{2011}}{\text{CPI}_{2011}}$$
$$\frac{229.6 - 224.9}{224.9} = 0.021 = 2.1\%$$

\$10

How does the inflation rate from 1997 compare to the inflation rate of 2015 (237.0)? What does that number mean?

\$15 47.7%

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### EX 6: Baseball Salaries

In 1987, the mean salary for major league baseball players was \$412,000. In 2012, it was \$3,440,000. Compare the two salaries in "2012 dollars". How does the rise in baseball salaries compare to the overall rise in price with inflation?

$$\text{salary in } \$_{2012} = \left( \text{salary in } \$_{1987} \right) \times \frac{\text{CPI}_{2012}}{\text{CPI}_{1987}}$$

$$= \$412,000 \times \frac{229.6}{113.6} \quad \text{---} \quad 2.02$$

$$\approx \$833,000 \quad \text{---} \quad \text{What does this number mean?}$$

Salaries actually quadrupled in "real terms".  $\$3,440,000 / \$833,000 = 4.1296, \dots$

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A box of macaroni and cheese cost \$0.25 in 1976. What was its price in 2005 dollars?

\$0.86



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### EX 7: Computer prices

1985 - \$30 Mill  
2012 - \$1000

$$\text{salary in } \$_{2012} = \left( \text{salary in } \$_{1985} \right) \times \frac{\text{CPI}_{2012}}{\text{CPI}_{1985}}$$

$$= \$1,000 \times \frac{229.6}{107.6}$$

$$\approx \$64,000,000$$



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If a movie ticket cost \$9.00 in 2008, what was its price in 1980 dollars?

\_\_\_\_\_

What was the purchasing power of \$1 in 1976 in terms of 2006 dollars?

\_\_\_\_\_

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**HOMEWORK DUE TOMORROW!!**

1. What was the overall inflation as a percentage from 2000 to 2010?
2. A car cost \$1500 in 1980. What was its price in 2006 dollars?
3. If a ski lift cost \$85 in 2008, what was its price in 1980?
4. What was the purchasing power of \$1 in 1979 in terms of 2008 dollars?

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**Class work due today**

pg 170: 27 - 31, 33, 43

Work must be shown for credit.

Miami: \$\$\$

Chugene: \$\$\$

$$RC: \frac{\text{New-old}}{\text{old}} \times 100 = \underline{\hspace{2cm}}$$

$$\frac{CPI_{\text{new}} - CPI_{\text{old}}}{CPI_{\text{old}}} \times 100 = \underline{\hspace{2cm}}$$

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