

Average Rate of Change

Name _____

A third way to measure and quantify change is average rate of change. To find the average rate of change, first find the absolute change, then divide that number by the period of time over which the change occurred. (It may help to think of the data as ordered pairs: (year a, quantity a) and (year b, quantity b)).

$$\text{Average rate of change} = \frac{\text{absolute change}}{\text{Period of time}} = \frac{\text{quantity b} - \text{quantity a}}{\text{year b} - \text{year a}}$$

Example : On September 20, a gallon of gas at my usual gas station cost \$1.83. On September 30, I noticed that the price had gone down to \$1.65 per gallon. The **average rate of change** in the price of gas between September 20 and September 30 is

$$\frac{(1.65 - 1.83)}{\text{Sept. 30} - \text{Sept. 20}} = \frac{-0.18}{10 \text{ days}} = \$-0.18 \text{ per gallon} \text{ or } \$-0.018 \text{ per gallon/day}$$

We say that the price of gas *decreased* on average by 1.8 cents per gallon each day.

Summary-- The Measures of Change: Let a be the original quantity and b be the new quantity.

- The **absolute change** between the quantities is $b - a$.
- The **percentage change** between the quantities is $\left(\frac{b - a}{a} \right) 100$.
- The **average rate of change** between (year a, quantity a) and (year b, quantity b) is $\frac{\text{quantity b} - \text{quantity a}}{\text{year b} - \text{year a}}$

Practice problems:

Now go back to problems 1 – 6 and calculate the average rate of change for each one.

Practice problems

1. In 1950, the world population was estimated to be 2,520,000,000. By 1980, the population had increased to 4,440,000,000.
2. During the past two years, median household income for families living in the Midwest went from \$44,531 to 43,622.
3. The census Bureau reported that the number of Americans without health insurance grew from 41.4 million in 2002 to 43.6 million in 2003.
4. UMass Boston tuition cost per credit (not counting fees) was 79.50 in 1988. In 2004 the per credit tuition is \$71.50.



5. Undergraduate enrollment at UMass Boston was 10,071 in 2002, down from 10,656 in 2001.

6. In fiscal year 2001 UMass Boston received \$85.6 million from the State, compared to \$60.7 million this year (fiscal year 2004).

7. The chart below shows sales of used books nationally between 2003 and 2004.

Used Books Sales Revenue (in millions)

Year	Online sales	Book store sales	Other locations	Total
2003	\$457	\$1498	\$45	\$2001
2004	\$609	\$1567	\$48	\$2223

a. Find the average rate of change of **Online sales** of used books i from 2003 to 2004?

b. Find the average rate of change of **all sales** of used books increase from 2003 to 2004?

Use the chart below to gather your answers for **absolute change**, **percentage change** and **average rate of change** for each of the six problems. Be sure to include units where appropriate.

Problem	absolute change	percentage change	average rate of change
1.			
2.			
3.			
4.			
5.			
6.			

