

The population of the United States changes continuously, with people being born, immigrating, emigrating, and dying every second. The chart above shows not the size of the population over time, but the rates at which the population was changing. Determine if the following statements are true or false. Explain.

- The US population had an annual increase of approximately 0.8% in 2010.
- The population of the US in 1970 was a little more than 120 million.
- The rate of change in the population of the US between 1990 and 1992 was $\frac{1.39 - 1.13}{2}$.
- The US population has been declining since the 1990s.

Solution

- True. The chart gives the percentage increase for the US population for each year over the previous year. In 2010, the population grew by about 0.8% over 2009.
- False. The chart does not provide any information about the actual size of the US population at any point in history. However, the population growth was about 1.2% in 1970.
- False. The calculation shows the rate of change in the US population growth rate percentage, not the rate of change of the actual population.
- False. The US population increased in every year on the chart. It has just been increasing at a slower rate since 1990. For the population to be decreasing, the growth rate would need to drop below 0%.

Rate of change is a cornerstone of the branch of mathematics called differential calculus. It is the study of how quantities change from moment to moment and is used in disciplines such as physics, engineering, kinesiology, and economics, among many others.

Skill Check Answers

1. \$1.60 per pound 2. $\frac{1.5 \text{ L} \div 24}{24 \text{ hr} \div 24} = \frac{0.0625 \text{ L}}{1 \text{ hr}}$

4.3 Exercises

✓ CONCEPT CHECK

- A _____ is a fraction used to compare two quantities that are not necessarily in the same unit.
- When we compare things to a single unit, such as miles per gallon or cost per pound, it is referred to as a _____.
- The _____ of one quantity with respect to another is how much the first quantity changes for each unit change of the second quantity.

4. True or False: The ratios $\frac{5 \text{ tacos}}{\$7}$ and $\frac{\$7}{5 \text{ tacos}}$ both represent a local restaurant's advertisement of 5 tacos for \$7.
5. True or False: If a car has an advertised mileage rate of 20 mpg, that means it uses 20 gallons for every mile driven.

**PRACTICE**

Write each rate described.

6. An ad for a local vitamin and nutrition shop advertises that a certain brand of protein bar is on sale for \$38 per box of 18.
7. The price of tuition for a semester at an in-state university is \$4800 for 15 credit hours.
8. The cost of tuition at a local daycare center is \$1150 for 20 days of care per month.
9. Google Voice advertises its competitive price for international calling on mobile phones as 15 cents per minute from Mexico.
10. A freelance online editorial company offers document indexing for \$3.50 for 12 indexable printed pages.
11. The Department of Veterans Affairs offers tuition assistance for active military personnel under a new GI Bill that pays up to \$1473.00 per month for full-time status at a higher education institution.
12. The local grocery store offers 10 cans of tomato sauce for \$10 in the weekly sales ad.
13. Grayson needs to work 65 hours every three weeks to meet the quota for his school internship.

Write each rate described and then convert to a percentage. Round to the nearest tenth, if necessary.

14. In Parma, Ohio, for the May 4, 2021, primary elections, a total of 10,420 people voted out of 51,697 eligible voters in the city.
15. During the 2020 tax year, a tax return form indicates that a filer who earned \$32,750 paid \$3732 in federal taxes.
16. During the 2020 tax year, a tax return form indicates that the filer paid \$23,960 in federal taxes and earned a total of \$124,500.
17. For the 2019 enrollment period at Clemson University, a total of 3932 new freshman enrolled out of the 29,070 people who applied to the school.

Choose the correct from of the rate given.

18. Packs of noodle side dishes are on sale for \$5 when you purchase 4 packs.

a. $\frac{\$4}{5 \text{ packs}}$

b. $\frac{4 \text{ packs}}{\$5}$

c. $\frac{\$5}{4 \text{ packs}}$

d. $\frac{5 \text{ packs}}{\$4}$

19. Cooking instructions recommend roasting a 14-pound turkey for approximately 3 hours.

a. $\frac{3 \text{ hours}}{14 \text{ pounds}}$

b. $\frac{14 \text{ pounds}}{3 \text{ hours}}$

c. $\frac{1 \text{ hour}}{14 \text{ pounds}}$

d. $\frac{3 \text{ hours}}{1 \text{ pound}}$

20. To advertise their weekly special, Carol needs a sign made. One pen costs \$3.18, but she is going to offer 3 pens for the price of one. Which is the correct sign?

a. \$3.18/pen

b. 3 pens/\$3.18

c. \$9.54/3 pens

21. Tyson can run 4 km in 30 minutes.

a. 4 km/30 min

b. 7.5 km/min

c. 2 km/hour

d. 1 hour/2 km

APPLICATIONS

Solve. Round your answer to the nearest hundredth, if necessary.

22. A patient in a hospital is prescribed IV fluids with a rate of 5 grams of sugar per 100 milliliters of water. If a patient is prescribed 1000 milliliters of fluids, how many grams of sugar will be delivered?

23. A patient in a hospital is prescribed IV fluids with a rate of 9 grams of sodium chloride per 1000 milliliters of water. If a patient is prescribed 1500 milliliters of fluids, how many grams of sodium chloride will be delivered?

24. A patient in a hospital is prescribed IV fluids with a rate of 4.5 grams of sodium chloride per 1000 milliliters of water. If a patient is prescribed 500 milliliters of fluids, how many grams of sodium chloride will be delivered?

25. To treat the water in a swimming pool, it is recommended to add 10 milliliters of chlorine per 1000 liters of water. How much chlorine is needed to treat the water in a pool that holds 34,000 liters?

26. Lucinda earns \$16.32 per hour working as a pharmacy technician. If Lucinda worked 171.5 hours last month, what was her gross pay for the month?
27. The average rainfall in Phoenix is 8.04 inches per year. If this average is maintained, how many inches of rain would Phoenix receive over 7 years?
28. The density of a cooking oil is 0.93 g/mL. By comparison, the density of water is approximately 1 g/mL. What is the mass of 1 cup of the oil? (Note that 1 cup is approximately 236.59 mL.)
29. The fastest speed recorded for English language typing is 216 words per minute. If the record holder maintains that rate for 11.5 minutes, how many words would be typed?
30. An SUV is advertised to have fuel tank capacity of 23 gallons and can travel 330 miles on a full tank of gas. Find the miles per gallon the SUV gets.
31. If your car can go 433 miles on a full tank of gas, find the miles per gallon your car gets if the tank holds 17.2 gallons.
32. You are planning to buy a mid-sized car and plan to factor fuel efficiency into your decision. Using the given information, decide which mid-sized car gets the best gas mileage.
- 2021 Honda Civic: 397 miles on 12.4 gallons
 - 2021 Mazda Mazda6: 476 miles on 16.4 gallons
 - 2021 Toyota Camry: 459 miles on 14.4 gallons
33. You want to buy a used truck and are interested in the fuel consumption rate for each of the three trucks you are considering. Using the information given, decide which of the used trucks gets the best gas mileage.
- 2008 Chevy Silverado: 500 miles on 29.4 gallons
 - 2006 Toyota Tundra: 428 miles on 26.4 gallons
 - 2007 Ford F-150: 250 miles on 15.6 gallons
34. Two competing stores sent out fliers for back-to-school sales and listed similar items for sale. Use unit prices to decide which store to buy each item from if you need to purchase all of the items listed.

Price Comparison		
Item	Closeout Closet	Discount Dollar
Mechanical Pencils	8 for \$2.39	10 for \$2.64
Pens	10 for \$1.49	10 for \$1.57
Notebooks	3 for \$4.99	5 for \$9.99
Wide-Ruled Paper	3 for \$2.50	4 for \$3.00

35. It costs \$130.11 per week to rent a standard-size car in Nashville, TN. Find the price per day it costs to rent this car.

36. It costs \$2.01 to drive 25 miles in a new 2012 Hybrid car. How much does it cost per mile to drive 25 miles?
37. It costs \$4.78 to drive 25 miles in a 2012 sedan. How much does it cost per mile to drive 25 miles?
38. Ron gets paid \$51,630 per year. If he works 2087 hours in a year, find his hourly rate of pay.
39. If a 4-pound bag of sugar costs \$2.99, what is the unit cost for a pound of sugar?
40. The advertised special is \$9.99 for 16 ounces of frozen shrimp. Find the unit cost of the shrimp.
41. Eggplants are 4 for \$5.00. What is the cost per eggplant? How much eggplant do you get per dollar?

Use the following table of exchange rates for Exercises 42–43.

US Dollar Exchange Rates		
US Dollar (USD)	Units per USD	USD per Unit
British Pound (GBP)	0.711576	1.405332
Indian Rupee (INR)	73.669595	0.013574
Australian Dollar (AUD)	1.294470	0.772517
Canadian Dollar (CAD)	1.212872	0.824489
Japanese Yen (JPY)	109.642453	0.009121

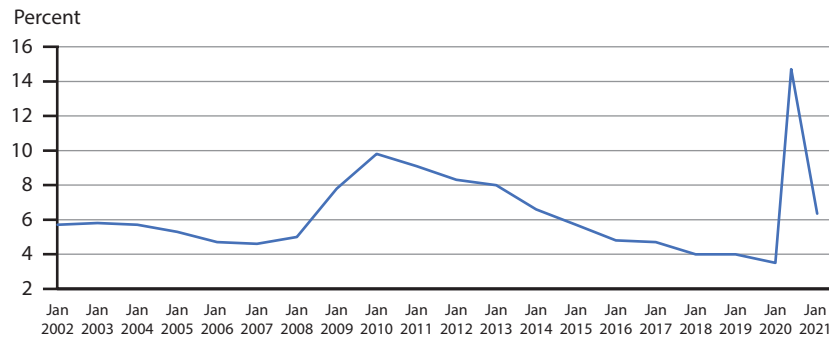
42. Use the table to answer the following questions.
- What is the unit exchange rate of US dollars to British Pounds?
 - What is the unit exchange rate of British Pounds to US dollars?
 - If a pair of shoes costs 75 US dollars, approximately how many British Pounds do the shoes cost?
43. Use the table to answer the following questions.
- What is the unit exchange rate of US dollars to Japanese Yen?
 - What is the unit exchange rate of Japanese Yen to US dollars?
 - If a comic books costs 500 Japanese Yen, approximately how many US Dollars does the comic book cost?

44. The projected velocity of a space shuttle during its first three minutes in the air is given below.

Time (s)	Altitude (m)	Velocity (m/s)
0	-8	0
20	1244	139
40	5377	298
60	11,617	433
80	19,872	685
100	31,412	1026
120	44,726	1279
140	57,396	1373
160	67,893	1490
180	77,485	1634

- What is the space shuttle's acceleration during the first 20 seconds?
 - Does the space shuttle accelerate more between 20–40 seconds or between 120–140 seconds?
45. The civilian unemployment rate as determined by the US Bureau of Labor Statistics⁴ is shown for 2002–2021.

Civilian unemployment rate, seasonally adjusted



- When was the unemployment rate the highest?
- What is the average rate of change from January 2012 to January 2016?
- Are there any intervals where the unemployment rate is not changing?
- What interval has the steepest decline?

⁴ Source: "Civilian unemployment rate," Bureau of Labor Statistics, accessed December 8, 2021, <https://www.bls.gov/charts/employment-situation/civilian-unemployment-rate.htm>.

46. The Consumer Price Index,⁵ which is “a measure of the average change over time in the prices paid by urban consumers for a market basket of consumer goods and services,” is shown for May 2007 to May 2021.

Consumer Price Index, May 2007-May 2021



- a. When was the Consumer Price Index the lowest?
- b. What is the average rate of change from May 2015 to May 2020?
- c. Are there any intervals where the Consumer Price Index appears to have no change over time?
- d. What interval has the steepest decline?

⁵ Source: “Consumer prices increase 5.0 percent for the year ended May 2021,” Bureau of Labor Statistics, accessed December 8, 2021, <https://www.bls.gov/opub/ted/2021/consumer-prices-increase-5-0-percent-for-the-year-ended-may-2021.htm>.