GROUND RULES:

- **Print** your full name clearly at the top of this page. Use the name that appears on university records.

- This is a closed-book and closed-notes exam. You can not use external notes of any kind.

- You may use a calculator. You may not use your phone as a calculator.

- Moore and Notz's Table B is provided on the last page of this exam.

- This exam contains two parts

  - Part 1. Multiple Choice. 54 questions, 2 points each (**108 points** total)
  - Part 2. Extra Credit. 1 question (**8 points** total).

  This exam is worth **108 points** (but it is possible to get up to 116 points).

- Any discussion or inappropriate communication between you and another examinee, as well as the appearance of any unnecessary material, is not allowed. All violations will be reported to the Student Conduct and Academic Integrity Office immediately.

- You have **2.5 hours** to complete this exam.

HONOR PLEDGE FOR THIS EXAM:

After you have finished the exam, please read the following statement and sign your name below it.

I promise that I did not discuss any aspect of this exam with anyone other than the instructor, that I neither gave nor received any unauthorized assistance on this exam, and that the work presented herein is entirely my own.

HELPFUL FORMULAS

$$\textbf{margin of error} = \frac{1}{\sqrt{n}}$$

Measured value = True value + Bias + Random error.

$$\text{percentage change} = \frac{\text{amount of the change}}{\text{starting value}} \times 100\%.$$

$$\bar{x} = \frac{1}{n} \sum x \qquad s = \sqrt{\frac{1}{n-1} \sum (x - \bar{x})^2}$$

$$z = \frac{\text{observation} - \text{mean}}{\text{standard deviation}}$$

$$r = \frac{1}{n-1} \sum \left(\frac{x - \bar{x}}{s_x} \right) \left(\frac{y - \bar{y}}{s_y} \right) \qquad y = a + bx$$

$\hat{p}$ is (approximately) normal with mean p and standard deviation $\sqrt{\dfrac{p(1-p)}{n}}$

$$\hat{p} \pm z^* \sqrt{\frac{\hat{p}(1 - \hat{p})}{n}}$$

C	80%	90%	95%	99%
z^*	1.28	1.64	1.96	2.58

$\bar{x}$ is (approximately) normal with mean μ and standard deviation $\dfrac{\sigma}{\sqrt{n}}$

$$\bar{x} \pm z^* \left(\frac{s}{\sqrt{n}} \right)$$

MULTIPLE CHOICE. Circle the best answer. Make sure your answer is clearly marked. Ambiguous responses will be marked wrong.

1. One of the challenges with Alzheimer's disease is that it is difficult to diagnose in advance. By the time a diagnosis is made, usually the patient has had the disease for a long time. This prevents early treatment options.

In a recent study, researchers from Lund University collected blood samples from people who were being evaluated because of their cognitive symptoms. The researchers used a new blood test called PrecivityAD2, which correctly predicted a diagnosis of Alzheimer's disease 90% of the time.

With respect to predicting a future diagnosis of Alzheimer's disease, we would say the PrecivityAD2 test outcome has predictive

(a) validity
(b) variability
(c) causality
(d) reliability

2. A researcher in the Department of Psychology wants to learn about sleep patterns in high school students in South Carolina. There are 249 high schools in South Carolina. Here is how she will obtain her sample of students:

- She will take a simple random sample of 10 schools from the 249.

- At each of the 10 schools, she will select two simple random samples: one from all underclassmen (9th, 10th grade) and one from all upperclassmen (11th, 12th grade).

Which type of **sampling design** is this?

(a) simple random sample
(b) convenience sample
(c) systematic random sample
(d) none of the above

3. English test scores on a statewide exam for 10th grade students in Indiana follow a normal distribution with mean $\mu = 550$ and standard deviation $\sigma = 50$. This distribution is shown below:


Test score
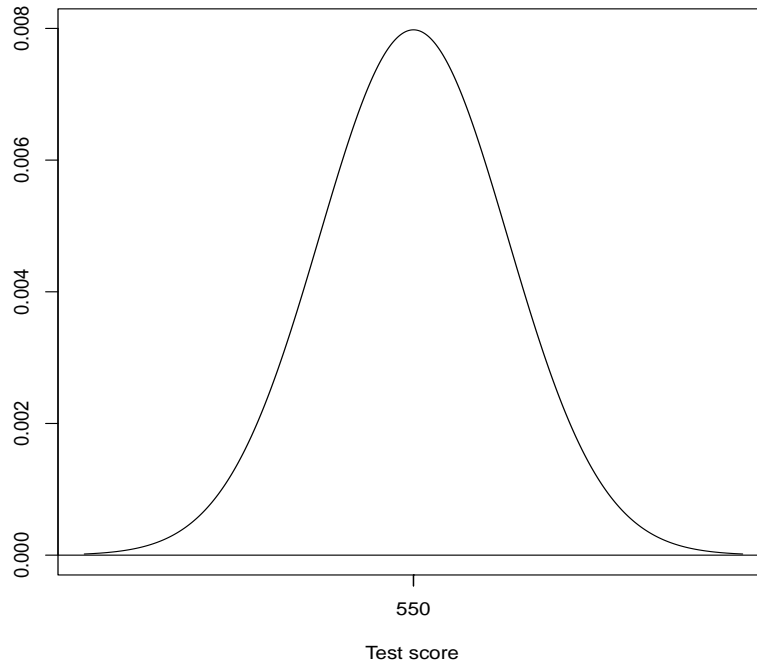
What is the probability a randomly selected 10th grade student from this population will score above 600? Round your answer to two decimal places.

(a) 0.03
(b) 0.84
(c) 0.32
(d) 0.16

4. We talked about an instance of academic and research fraud involving Dr. Anil Potti and Duke University. We watched a 60 Minutes story in class which described the fraud. What did Dr. Potti do that was unethical?

(a) He released the names of the sharecroppers involved in the Tuskegee syphilis experiment.
(b) He used blood samples taken from impoverished women in Africa without their informed consent.
(c) He published confidential data on patients who were HIV positive.
(d) He took data and manipulated them to support his new theory about how to treat cancer.

5. The histogram below shows the number of active medical doctors (per 100,000 residents) for each of the 50 states in the United States. For example, South Carolina has 219 active medical doctors for every 100,000 residents in our state.
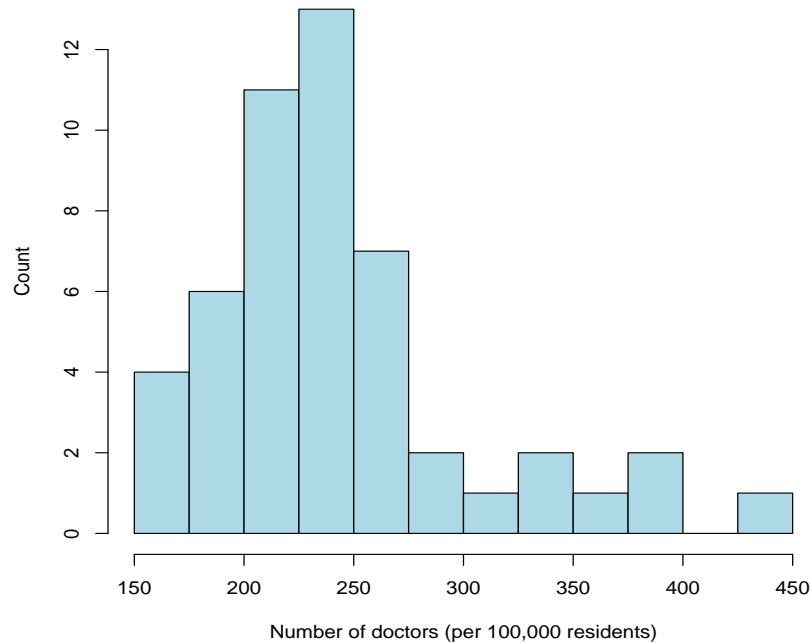
Which term best describes the **shape** of this distribution?

(a) symmetric
(b) biomodal
(c) skewed left
(d) skewed right

6. Refer to Question 5. Would it make sense to think about a **population density curve** in this example?

(a) Yes, it makes sense to think about the number of active medical doctors practicing in the United States.
(b) No, it does not make sense to think of the 50 observations in the histogram as a sample from a larger population.

7. An intern at the Student Success Center contacts 60 undergraduate students at USC (25 males and 35 females). Students are asked how many hours they study each week. The two variables in this example are **sex** and the **number of hours** spent studying each week. Which types of variables are these?

(a) Both variables are categorical.
(b) Sex is categorical and the number of hours is quantitative.
(c) Both variables are quantitative.
(d) Sex is quantitative and the number of hours is categorical.

8. In class, we examined the line graph (below) of the number of air miles (in 1000s) traveled by passengers in the United States each month from January 1996 to May 2005.
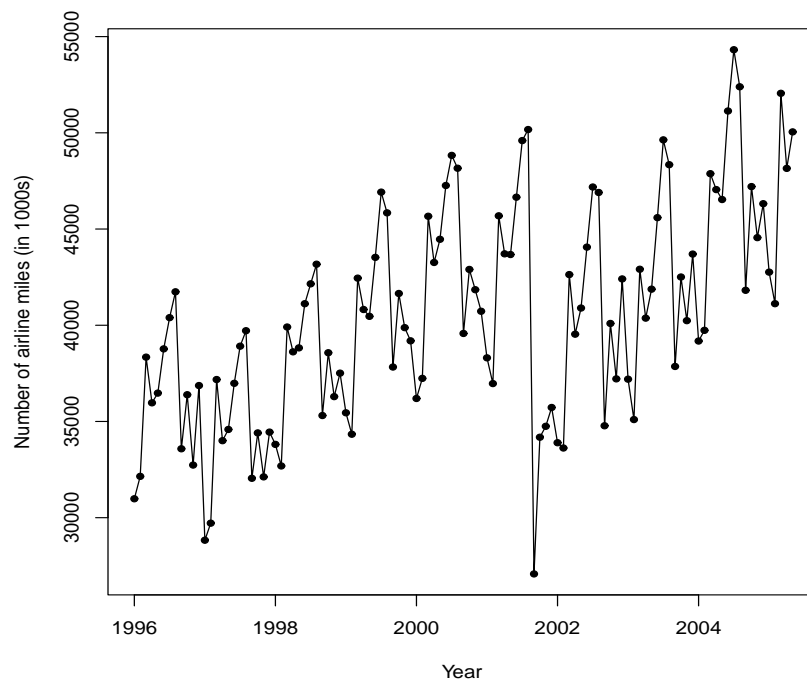
Why did we use a line graph to display these data and not another display like a histogram or a stemplot?

(a) The number of air miles traveled by passengers is not a quantitative variable.
(b) The goal here is to show how the number of air miles traveled by passengers changes over time.
(c) There would be too many intervals for a histogram to adequately show the distribution, and there is no obvious choice of "stem" and "leaf" for the stemplot.
(d) We only use histograms and stemplots with data from randomized comparative experiments.

9. Researchers at the University of Memphis were interested in studying the relationship between insomnia and education status in adult males in Tennessee. They used random-digit dialing to contact 575 adult male Tennessee residents and recorded the education status of each male and the number of insomnia episodes over the last six months.

In this example, what is the **population**?

(a) the adult males who had insomnia episodes among those who were contacted
(b) the 575 adult males contacted
(c) all adult males who have insomnia
(d) all adult males in Tennessee

10. Members of an advocacy group in Washington DC state "the world's rainforests are being decimated at a 10% increase each year." This figure is soon after reported in a *New York Times* editorial and then later on a nightly news program on CNN. Policy makers in Washington DC soon cite this statistic when lobbying Congress for more EPA funding, and the UN's environmental group presents this statistic to world leaders throughout Asia and South America.

When the advocacy group members were later pressed to explain how the "10% increase" statistic was calculated, they could not explain themselves.

Dr. Joel Best, author of *Damned Lies and Statistics*, has a name for a statistic like the "10% increase" figure, in particular, one that comes from a potentially unreliable source and then spreads aggressively to others who also do not check its accuracy. What did he call this?

(a) a misclassified statistic
(b) a variable statistic
(c) a mutant statistic
(d) an unbiased statistic

11. What is the defining characteristic of a **simple random sample** (**SRS**)?

(a) Every sample of the same size has the same probability of being selected.
(b) Every SRS is guaranteed to be representative of the population.
(c) Every SRS will produce statistically significant results.
(d) It is the only sampling design that produces no non-sampling error.

12. A probability model for first digits of numerical entries in legitimate tax returns is known as Benford's model, shown below:

First digit	1	2	3	4	5	6	7	8	9
Probability	0.301	0.176	0.125	0.097	0.079	0.067	0.058	0.051	0.046

Under this model, what is the probability the first digit of an entry is 1, 2, or 3?

(a) 0.699
(b) 0.301
(c) 0.006
(d) 0.602

13. Gallup recently observed a sample of $n = 1015$ American adults. Each adult was asked,

"Do you feel childhood vaccinations are extremely important?"

Five hundred and forty-eight (548) of those adults sampled felt childhood vaccinations are extremely important. Is the proportion

$$\hat{p} = \frac{548}{1015} \approx 0.54$$

a parameter or a statistic?

(a) parameter
(b) statistic

14. An optometrist prescribes a medicine for an eye infection that her patients may have. The probability of a specific side effect from taking the medicine is 0.001 (which is 0.1% or 1 out of 1000). Which interpretation below is correct?

(a) If we were to observe many patients over the long term, approximately 1 out of 1000 would experience the side effect.
(b) If we observed a simple random sample of 1000 patients, then exactly one would experience the side effect.
(c) Many more patients will experience the side effect than patients who do not.
(d) If one patient experiences the side effect, then the next 999 patients will not experience it.

15. We learned this semester that convenience samples and voluntary response samples are **biased** sampling designs. What does this mean?

(a) Neither design will provide sufficiently large samples because the sampling frame is unreliable.
(b) Both designs will produce large non-sampling errors.
(c) Neither design will produce statistically significant results due to a large margin of error.
(d) Both designs systematically favor the selection of certain individuals over others.

16. I track the number of unique hits (# hits) to my professional web site each week. Below are the last 20 weeks of data. These observations are for weeks 30-49 of the 2024 calendar year.

Week	# hits	Week	# hits	Week	# hits	Week	# hits
30	41	35	123	40	103	45	107
31	52	36	134	41	113	46	193
32	42	37	182	42	194	47	169
33	127	38	357	43	197	48	59
34	290	39	120	44	106	49	89

I used R to calculate the mean and standard deviation of these 20 observations:

```
> mean(hits) # mean
[1] 139.9
> sd(hits) # standard deviation
[1] 80.4
```

How do we interpret the standard deviation $s = 80.4$?

(a) This value describes the range of the middle 50 percent of the data.
(b) Observations falling below 80.4 would be classified as outliers on the low side.
(c) Each observation is a certain distance from the mean 139.9. The standard deviation is the mean distance for the 20 observations.
(d) It is the percentage of observations that have positive standard scores.

17. In a regression analysis, what is meant by the term **extrapolation**?

(a) It refers to the process by which we estimate the margin of error.
(b) It refers to predicting the value of the response variable outside of the range of the data.
(c) It refers to using the correlation to assess causal effects from the regression.
(d) It refers to the algorithm R uses to calculate the least-squares regression line.

18. In class, we watched a short video featuring **Hans Rosling**, who was an internationally known expert in health and medical statistics. The highlight of the video was his use of visual displays to show data in multiple dimensions. What was he was talking about?

(a) measurements from experiments offering new treatments for breast cancer
(b) life expectancy and wealth over time for every country in the world
(c) increased radon and arsenic levels in manufacturing settings
(d) artificial intelligence models for pandemic prediction

19. Final exam scores from STAT 110 (Spring 2024) are shown below. The total number of points possible, including extra credit, was 108.

```
> stem(final)

    2 | 1
    2 |
    3 |
    3 | 779
    4 |
    4 |
    5 | 0
    5 | 7778
    6 | 333444
    6 | 55777789
    7 | 02333444
    7 | 55556666777778999999
    8 | 0111122233333344444
    8 | 555556677888999999
    9 | 011111122333333344
    9 | 5556667777788899
   10 | 133
   10 | 55
```

There were 127 students who took the final exam. What percentage of students got 100 points or more? Round your answer to the nearest percent.
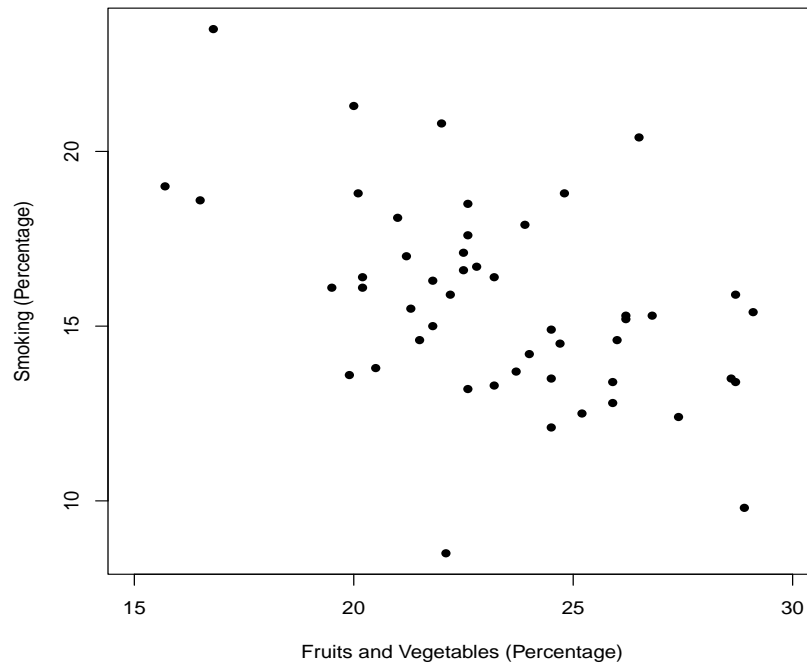
(a) 10%
(b) 4%
(c) 5%
(d) 2%

20. The Centers for Disease Control collects data related to health conditions and risk behaviors. The scatterplot below shows values of

x = the percentage of residents who eat fruits and vegetables regularly
y = the percentage of residents who smoke

for each of the 50 states (that is, each observation corresponds to one state).

The correlation r is closest to which value?

(a) -0.99
(b) 0.73
(c) -0.48
(d) 0.01

21. Refer to Question 20. All of the following statements, except one, contain an error. Which statement is correct?

(a) There is a causal relationship between the percentage of residents who smoke and the percentage of residents who eat fruits and vegetables regularly.
(b) The correlation r would not change if you switched the variables, plotting smoking percentage on the horizontal axis and plotting fruits and vegetables percentage on the vertical axis.
(c) The correlation r is not useful in this example because there is a curved relationship between the variables.
(d) The correlation r is the percentage of variability of the smoking percentages explained by the straight-line relationship with the fruits and vegetables percentages.

22. **Bias** and **variability** are two terms commonly used to describe how a statistic will behave when sampling from a population over and over again. What do these terms mean?

(a) Bias refers to how large the margin of error is for a given sample. Variability describes the amount of undercoverage in the sampling design.
(b) Bias describes the amount of reliability in the statistic. Variability also examines reliability but on the squared scale of measurement.
(c) Bias describes how far statistics are from parameters. Variability describes how far parameters are from other parameters.
(d) Bias refers to what happens to the statistic on average. Variability refers to how spread out the values of the statistic will be.

23. Excessive exposure to ovarian hormones over time was believed to be associated with breast cancer. One investigation used past information from 1811 pairs of female twins, one or both of whom had breast cancer. Hormone levels were measured in each twin pair at the age of puberty and then again when breast cancer first occurred. The analysis did not show an association between breast cancer occurrence and hormone exposure.

Is this an observational study or an experiment?

(a) experiment
(b) observational study

24. Right before Thanksgiving break, we discussed the **birthday problem** in class. What important lesson did we learn?

(a) There is a spurious correlation between the month that people are born and the day that people are born.
(b) Probabilities can be 0 or 1 but only in very extreme situations.
(c) Probabilities of certain outcomes may disagree with what our intuition says they should be.
(d) Probabilities follow the law of averages when the sample size is large.

25. Biologists assume the time to death (in days) for rats treated with a toxic substance is described by the population density curve below:
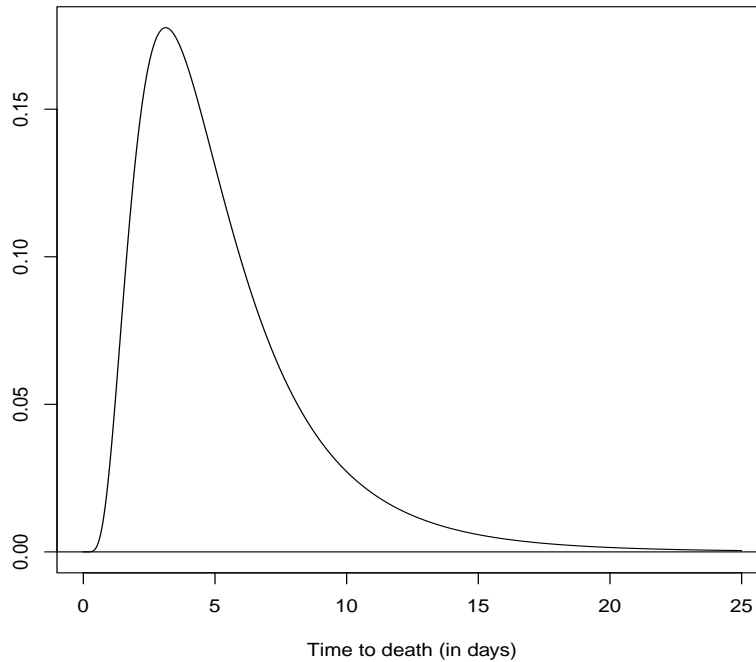
How does the mean time to death compare to the median time to death for rats in this population?

(a) The mean is less than the median.
(b) The mean is greater than the median.
(c) The mean and the median are equal.

26. President Trump won the 2024 presidential election with 50% of the popular vote among all votes cast in the United States. As a population proportion, this is $p = 0.50$.

Suppose Rasmussen repeatedly takes simple random samples from the population of all 2024 presidential election voters in the United States and calculates the sample proportion $\hat{p}$ of voters for President Trump. Each sample is of size $n = 2500$.

We would expect 95% of all sample proportions $\hat{p}$ to fall in which interval?

(a) $(0.48, 0.52)$
(b) $(0.40, 0.60)$
(c) $(0.49, 0.51)$
(d) $(0.45, 0.55)$

27. On a Fox News broadcast in September 2021, the anchor used a chart showing the percentage of Americans who claimed to be Christians. The chart sugested the percentage of Americans who identified as Christian had dropped drastically between 2009 and 2019.

Why is this graph misleading?

(a) Bar graphs should not be used with quantitative variables like percentages. A histogram or box plot would be better for a visual display.
(b) The percentage change in the percentage of Americans identifying as Christian between 2009 and 2019 is about -16%. However, the bar heights suggest this percentage decrease is much greater.
(c) Reporting percentages for the two groups misleads the viewer because percentages are not valid measurements of a property like religious affiliation. It would be better to report counts for the two years instead.
(d) The graph does not describe if there is a correlation between the two years. This can be accomplished by adding the correlation r in a legend or inset in the graph.

28. My colleague and his wife have 4 children and they are all boys. If they become pregnant again (and have a single birth), the probability they have another boy is closest to which value?

(a) 0.03
(b) 0.8
(c) 0.5
(d) 0.2

29. Nursing students at Tampa Medical College examined 50 patients recently admitted to the coronary care unit at Bayonet Point Hospital in St. Petersburg, Florida. For each patient, the students recorded two variables:

$$x \; = \; \text{number of factors administered}$$
$$y \; = \; \text{length of stay (in days).}$$

In medical or nursing speak, "factors" are things like intravenous tubing, IV fluid, needles, shave kits, bed pans, diapers, dressings, medications, code charts, and anything else administered to the patient.

Below is a scatterplot of the observations for the 50 patients. The least-squares regression line is superimposed.
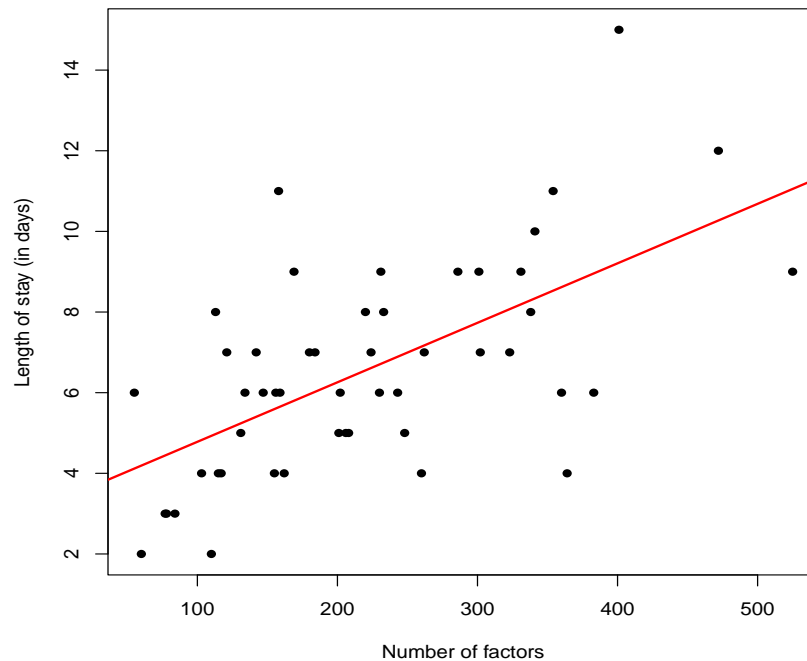
The equation of the least-squares regression line is

$$y = 3.3 + 0.015x.$$

What length of stay would you predict from a newly admitted patient that requires a total of 300 factors during their stay in the unit?

(a) 6.1 days
(b) 9.3 days
(c) 4.5 days
(d) 7.8 days

30. Refer to Question 29 (previous page). I used R to calculate the correlation for the coronary care unit data:

```
cor(no.factors,length.of.stay) # correlation
[1] 0.60
```

What percentage of the variability in the length of stay data is explained by the straight-line relationship with the number of factors?

(a) 1.5%
(b) 120%
(c) 36%
(d) 60%

31. According to the 2023-2024 National Survey on Drug Use and Health, among young adults aged 18-25, approximately

- 342,000 residents of Michigan used marijuana within the last year

- 147,900 residents of Arizona used marijuana within the last year

- 262,080 residents of Colorado used marijuana within the last year.

A politician running for state representative in Michigan says,

> *"Among these three states, Michigan has the highest rate of its young people using marijuana. I plan to lobby the federal government for funds to combat this public health crisis."*

Which statement below is true?

(a) The number of residents using marijuana is not a valid measurement when comparing the three states.
(b) The politician is demonstrating an example of innumeracy.
(c) The numbers stated above are not rates.
(d) All of the above.

32. The University of South Carolina had 38,300 students enrolled on the Columbia campus in Fall 2024, which is a record high. This is an increase from the 36,538 students enrolled in Fall 2023.

Calculate the **percentage increase** in enrollment between Fall 2023 and Fall 2024.

(a) 4.8%
(b) 5.2%
(c) 6.1%
(d) 4.5%

33. Geologists at the EPA collected 105 rain water samples in Moraine State Park (just north of Pittsburgh) and measured the acidity level of each sample (measured by pH). Here is a box plot of the 105 pH measurements:
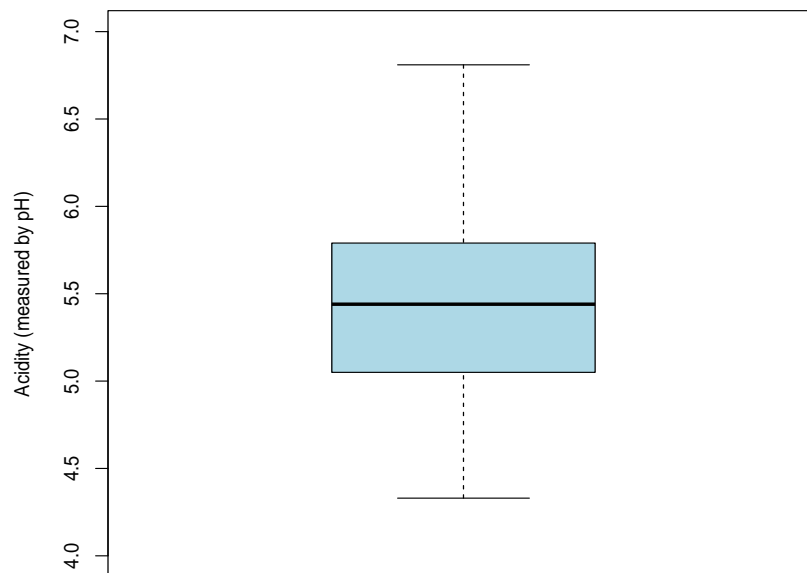
The **75th percentile** of the pH measurements is closest to

(a) 0.75
(b) 5.80
(c) 5.05
(d) 5.45

34. An orthopedic health researcher wants to compare the following medical interventions for individuals with severe knee pain due to inflammation:

- Group 1: Aggressive (epidural steroid injection into the knee)

- Group 2: Conservative (physical therapy on the knee)

- Group 3: Control (ibuprofin only).

Ninety (90) subjects were recruited and randomized to one of the three treatment groups. Each subject provided a before and after rating of pain. The difference in these two ratings was used as a response variable.

After the results were analyzed, the orthopedist concluded the average differences among the groups were **not** statistically significant. What does this mean?

(a) The average difference was the same for all three groups.
(b) The average difference may have been different for the three groups, but the variability among the average differences could be explained by random chance.
(c) The variability among the average differences was larger than the margin of error.
(d) The standard deviation among the three average differences is 0.

35. True or False. If an unbiased sampling design is used in a sample survey, then random sampling error cannot occur.

(a) True
(b) False

36. A sample survey examined the relationship between pet ownership and physical activity in older American adults (aged 65 and over). Among the 2,533 survey participants, 594 reported they owned a pet currently. The proportion of pet owners in the sample is

$$\widehat{p} = \frac{594}{2533} \approx 0.235.$$

I calculated a 95% confidence interval to be $(0.218, 0.251)$.

If I had calculated a **99% confidence interval** instead, which statement below would be true?

(a) The 99% confidence interval would be longer because the confidence level is larger.
(b) The 99% confidence interval would be longer because the margin of error is smaller.
(c) The 99% confidence interval would be shorter because the confidence level is larger.
(d) The 99% confidence interval would be shorter because the margin of error is smaller.

37. In class last week, we talked about **sampling distributions**. What does a sampling distribution describe?

(a) how a parameter's value will vary from sample to sample
(b) how a statistic's value will vary from sample to sample
(c) the values of all individuals in a population
(d) the values of all individuals in a sample

38. The author of an article I read online recently made the observation,

> *"A sample survey in the United States revealed that 50% of obese people earn less than the national median income."*

What can we infer from this statement?

(a) Obese people may have a harder time finding jobs, so the jobs they do get pay less.
(b) Our state and federal governments can do more to end employment discrimination on the basis of obesity status.
(c) This sample results suggest that obese Americans are underpaid when compared to the rest of the population.
(d) None of the above.

39. *Does smiling make you happier?* In 1988, researchers reported participants found cartoons funnier when they held a pen between their teeth, forcing them to smile, when compared to if they held a pen between their lips, forcing them to pout. An article summarizing the results of this study has been cited more than 1500 times.

A later article published in 2016 described how 17 different psychology labs (involving nearly 2000 participants) each found no effect of mouth position on people's rating of the funniness of cartoons.

We would say the initial 1988 study results could not be

(a) controlled
(b) randomized
(c) replicated
(d) correlated

40. An accepted premise in the medical research community is that clinical trials are ethical under the **equipoise** requirement. What does equipoise mean?

(a) Variables measured in the trial have sufficiently high predictive validity for the condition or disease under investigation.
(b) Lurking variables are removed so that treatment groups can be compared more precisely.
(c) Clinical trial subjects are assigned to different treatment groups with equal probabilities.
(d) There is genuine uncertainty about which treatment would be superior for patients.

41. A November 2024 Gallup poll asked a random sample of $n = 1037$ American adults,

"Roughly how much will you spend on purchasing Christmas gifts this year?"

The sample results were

$$\overline{x} = \$894 \ \ (\text{mean})$$
$$s = \$150 \ \ (\text{standard deviation}).$$

I used the formula

$$\overline{x} \pm z^* \left(\frac{s}{\sqrt{n}} \right)$$

to calculate the 90% confidence interval (\$886, \$902). Which interpretation below is correct?

(a) Ninety percent (90%) of the Americans sampled plan to spend between \$886 and \$902 when purchasing Christmas gifts this year.
(b) Approximately 90% of all Americans will spend between \$886 and \$902 when purchasing Christmas gifts this year.
(c) We are 90% confident the population mean is between \$886 and \$902.
(d) We are 90% confident the sample mean is between \$886 and \$902.

42. The length of human pregnancies follows a normal distribution with mean $\mu = 266$ days and standard deviation $\sigma = 16$ days. If the length of pregnancy for the next birth at Richland Hospital has a standard score of -2.5, what does this mean?

(a) The length of this pregnancy is 2.5 standard deviations below the mean.
(b) The length of this pregnancy is less than 2.5% of the human pregnancies in the population.
(c) The length of this pregnancy is greater than 2.5% of the human pregnancies in the population.
(d) The length of this pregnancy is 2.5 standard deviations above the mean.

43. *Does eating chocolate help trigger headaches?* An experiment recruited 128 women suffering from chronic migraine headache and randomly assigned them to one of two groups:

- Group 1: eat a chocolate preparation

- Group 2: eat the same preparation made with carob.

Carob is a natural extract that tastes like chocolate, but it doesn't have the caffeine and other psychoactive substances that chocolate has. Researchers recorded the number of headaches each subject experienced over a 30-day period.

Why is it important to use **randomization** when assigning subjects to groups?

(a) It removes all lurking variables from the experiment.
(b) It guarantees that all subjects will be evaluated in the same way as the experiment proceeds.
(c) It ensures the results will be statistically significant.
(d) It creates two groups of subjects that are similar on average before the experiment begins.

44. Refer to Question 43. Some researchers believe headache frequency in response to the chocolate/carob preparations may depend on whether the subjects are underweight, of healthy weight, overweight, or obese.

If this is true, which experimental design should be used?

(a) a randomized block design with weight groups as blocks and chocolate/carob preparations as treatments
(b) a completely randomized design with weight groups as treatments
(c) a completely randomized design with chocolate/carob preparations as treatments
(d) a randomized block design with weight groups as treatments and chocolate/carob preparations as blocks

45. Moore and Notz (2020) describe a study (from the early 1970s) that took place in a men's public restroom. Investigators installed cameras and placed observers at inconspicuous locations in the restroom so they could observe the behavior of men and their bathroom-use practices. For example, they noted which urinal each man picked and how long it took for men to start and finish urinating. Men using the restroom were never aware the study was taking place.

This study would never be approved by any institutional review board today. Why not?

(a) There is no control group, so investigators have no basis for a statistical comparison.
(b) Men using the restroom did not agree beforehand to participate in the study.
(c) Stall choice and urination times do not have predictive validity when assessing behavior.
(d) This study would not give a sufficient amount of information on behavior and bathroom-use practices for a larger population.

46. Members of a police force are comparing the effectiveness of two types of breathalyzer devices. These are devices which measure the amount of alcohol in one's blood.

An inebriated subject volunteers for the study. Below are the blood alcohol content measurements (in g/100 mL) provided by the breathalyzers. Four measurements for each breathalyzer were obtained on the subject. Means and variances are shown.

- Breathalyzer A: 0.111, 0.112, 0.111, 0.110 (mean = 0.111, variance = 0.00000067)

- Breathalyzer B: 0.105, 0.093, 0.127, 0.107 (mean = 0.108, variance = 0.00019867)

Which breathalyzer is more reliable?

(a) Breathalyzer B, because its variance is larger.
(b) Breathalyzer B, because its mean is smaller.
(c) Breathalyzer A, because its mean is larger.
(d) Breathalyzer A, because its variance is smaller.

47. Bupropion is a drug used to treat depression. One group of researchers wanted to know if bupropion could also be used to help people quit smoking. An experiment used 429 men and women who were 18 years or older and had smoked 15 cigarettes or more per day for the previous year. All subjects were highly motivated to quit.

The 429 subjects were randomized to one of two groups:

- Group 1: Bupropion (300 mg per day)

- Group 2: Placebo.

At the end of one year, researchers observed whether each subject had successfully abstained from smoking or had relapsed.

In this experiment, what is the **response variable**?

(a) whether a subject had abstained or relapsed from smoking after one year
(b) the drug assigned (bupropion/placebo)
(c) the sex of the subjects
(d) the number of cigarettes smoked per day

48. Refer to Question 47. We have learned that in some experiments, subjects may respond positively regardless of which group they are assigned to. What is this called?

(a) the placebo effect
(b) causation
(c) blocking
(d) non-adherence

49. Which of the following statements is true?

(a) The conclusion of a confidence statement always applies to the sample, not the population.
(b) The conclusion of a confidence statement always applies to the population, not the sample.

50. The International Rhino Foundation estimates there are 17,800 rhinoceroses living in the wild in Africa and Asia. A breakdown of the number of rhinos of each species is reported in the table below:

Species	African Black	African White	Sumatran	Javan	Indian
Number	3,610	11,330	300	60	2,500

Which graph would we use to display the distribution of the rhino species type?

(a) bar chart
(b) boxplot
(c) population density curve
(d) stemplot

51. A recent Rasmussen simple random sample (SRS) of $n = 1012$ American adults found that 627 are satisfied with the total cost they pay for their health care. The announced margin of error is ± 3 percentage points. The announced confidence level is 95%. These results were announced to a health subcommittee in Congress.

A member of Congress is satisfied with a 95% confidence level, but she inquires how a poll result could produce a **smaller** margin of error. If Rasmussen used the same SRS design at the 95% confidence level, which sample size below would accomplish this?

(a) $n = 2500$
(b) $n = 400$
(c) $n = 625$
(d) $n = 100$

52. This Saturday, the American Powerlifting Organization will host a powerlifting meet in Columbia, SC. Twenty-five lifters (including me) will participate. These lifters are listed below in alphabetical order; each lifter has been assigned a two-digit code.

Lifter	Code	Lifter	Code	Lifter	Code
Abbey	01	Keener	09	Register	17
Avellaneda	02	Lackley	10	Richards	18
Beaulieu	03	Lee	11	Sheffield	19
Belk	04	Lucas	12	Solorzano	20
Brazell	05	Marston	13	Tebbs	21
Carter	06	Neely	14	Ware	22
Chamber	07	Overhultz	15	Warr	23
Dickson	08	Potter	16	Wilburn	24
				Zevchik	25

Meet officials will take a simple random sample of $n = 3$ lifters and test them for banned substances. Line 140 from the Table of Random Digits gives the following digits:

12975 23258 13048 45144 72321 81940 00360 02428

Reading the digits in this line from <u>left to right</u>, who are the three lifters chosen?

(a) Abbey, Avellaneda, Keener
(b) Abbey, Neely, Tebbs
(c) Lucas, Marston, Belk
(d) Lucas, Warr, Sheffield

53. Here are IQ test scores of 10 randomly selected fifth-grade students:

145 139 126 122 125 130 96 110 118 118

What is the **median** test score?

(a) 122.9
(b) 123.5
(c) 127.5
(d) 118

54. A physical fitness association is including the mile run in its secondary school fitness test for students. The time it takes to run one mile (in seconds) for students in this population has a normal distribution with mean $\mu = 450$ and standard deviation $\sigma = 40$. This distribution is shown below:

Time to run one mile (in seconds)
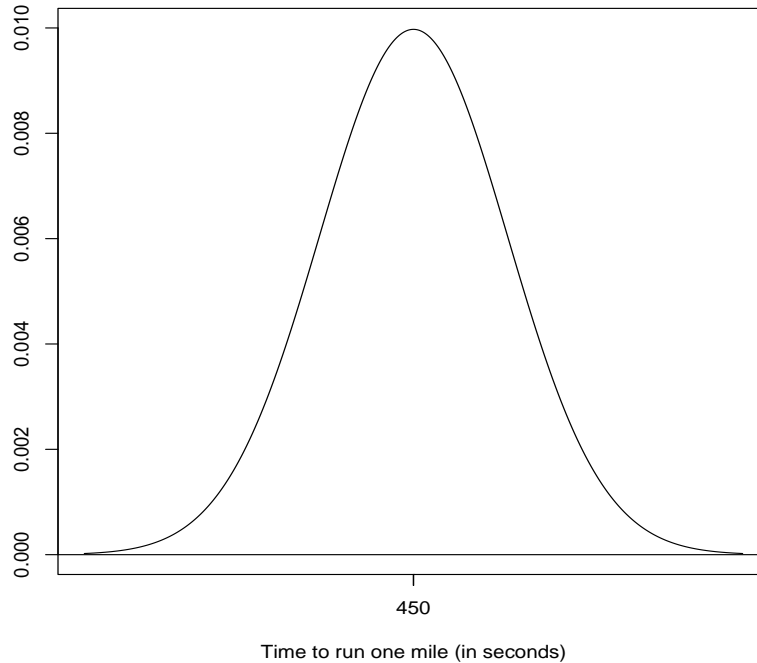
What percentage of students in this population will run one mile in 390 seconds or less?

(a) 11.51%
(b) 1.5%
(c) 15.87%
(d) 6.68%

PART 2: EXTRA CREDIT. Give a detailed response. Please write clearly.

On November 2, 2024, just 3 days before the 2024 Presidential Election, a Des Moines Register Iowa poll showed Vice President Harris beating President Trump 47% to 44% among likely voters in Iowa. The margin of error associated with the poll was 3%. The reported confidence level was 95%.

When this poll result was published, it generated a lot of attention because Iowa had voted for President Trump in the 2016 and 2020 elections by wide margins. Media "experts" and others in the political universe inferred that this result would foretell good things for Vice President Harris on Election Day−not only in Iowa but in other critical battleground states in the Midwest, like Michigan and Wisconsin.

When all the votes had been counted, President Trump actually won Iowa by 13 percentage points, 56%-43%. This is a 16 percentage point swing from the Des Moines Register Iowa poll result. *How could the Iowa poll result been so wrong?*

Question 1: We know the margin of error associated with sample surveys, like the Des Moines Register Iowa poll, only quantifies random sampling error. It does not include non-sampling errors.

(a) Describe what random sampling error is.
(b) Give two examples of non-sampling errors that may have biased the Iowa poll result.

Question 2 is on the next page.

The normal distribution below describes the sampling distribution associated with the Iowa poll result. By specifying the mean of this distribution to be "Harris (+3)," this distribution assumes the Iowa poll is making the "correct" inference for the population on average. In other words, the picture below assumes the population of all Iowa voters vote for Vice President Harris by a +3 point margin. The variability in the distribution below is determined from the poll's reported margin of error.

Trump (+13)

Harris (+3)
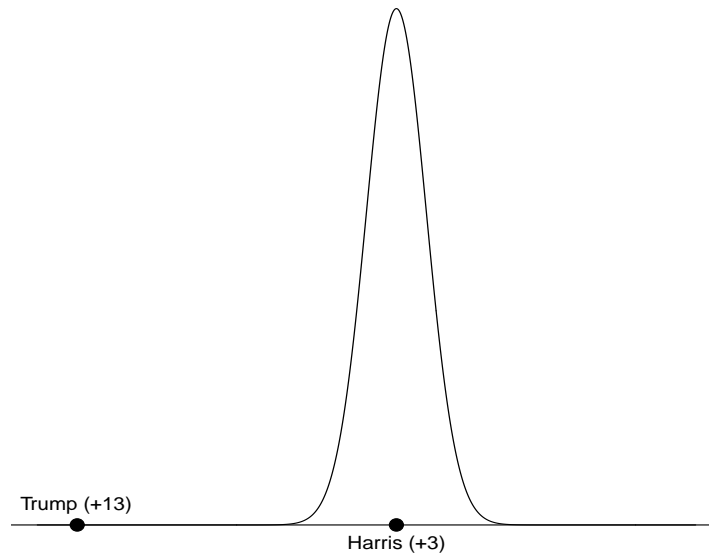
Question 2: The actual Election Day result "Trump (+13)" is also shown above. This result is a staggering 10.7 standard deviations below what the poll said would happen. (Read the last sentence again).

(a) Explain how unlikely the "Trump (+13)" result would be under the assumption that "Harris (+3)" is correct for the population. *Hint:* To get an idea of how unusual this is, you could think of the 68-95-99.7% Rule first and then go from there.
(b) The author of the Iowa poll, Ann Seltzer, announced her "retirement" from the polling industry after the 2024 Presidential Election. This is probably a good idea because no one will trust her polling methods again. What other famous polling debacle did we discuss this semester? It also dealt with a presidential election.

642   **Table B**

Area represents percentile
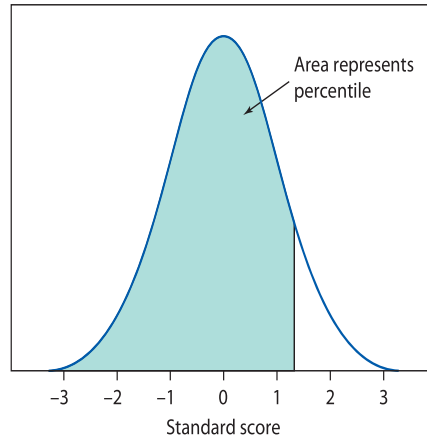
Table B Percentiles of the Normal distributions

Standard score →	Percentile	Standard score →	Percentile	Standard score →	Percentile
−3.4	0.03	−1.1	13.57	1.2	88.49
−3.3	0.05	−1.0	15.87	1.3	90.32
−3.2	0.07	−0.9	18.41	1.4	91.92
−3.1	0.10	−0.8	21.19	1.5	93.32
−3.0	0.13	−0.7	24.20	1.6	94.52
−2.9	0.19	−0.6	27.42	1.7	95.54
−2.8	0.26	−0.5	30.85	1.8	96.41
−2.7	0.35	−0.4	34.46	1.9	97.13
−2.6	0.47	−0.3	38.21	2.0	97.73
−2.5	0.62	−0.2	42.07	2.1	98.21
−2.4	0.82	−0.1	46.02	2.2	98.61
−2.3	1.07	0.0	50.00	2.3	98.93
−2.2	1.39	0.1	53.98	2.4	99.18
−2.1	1.79	0.2	57.93	2.5	99.38
−2.0	2.27	0.3	61.79	2.6	99.53
−1.9	2.87	0.4	65.54	2.7	99.65
−1.8	3.59	0.5	69.15	2.8	99.74
−1.7	4.46	0.6	72.58	2.9	99.81
−1.6	5.48	0.7	75.80	3.0	99.87
−1.5	6.68	0.8	78.81	3.1	99.90
−1.4	8.08	0.9	81.59	3.2	99.93
−1.3	9.68	1.0	84.13	3.3	99.95
−1.2	11.51	1.1	86.43	3.4	99.97