**Advanced Placement Statistics Curriculum**

**Standard: Data**

<table>
<thead>
<tr>
<th>Indicator/Objective</th>
<th>Essential Concepts/Skills</th>
<th>Implementation</th>
<th>Assessment Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Critical Vocabulary</strong></td>
<td>Exploratory analysis of data makes use of graphical and numerical techniques to study patterns and departures from patterns. Emphasis should be placed on interpreting information from graphical and numerical displays and summaries.</td>
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<tr>
<td><strong>What Students Need to Know</strong></td>
<td>1. Construct and interpret graphs.</td>
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<td></td>
<td><strong>What Students Need to Do/Apply</strong></td>
<td>1. Use graphs, tables to organize data, and discover data patterns.</td>
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<td></td>
<td>2. Calculate measures of central tendency, dispersion and position, and determine line of best fit.</td>
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<tr>
<td><strong>Strategies</strong></td>
<td>Frequency distribution; box and whisker plot; stem and leaf; histograms; scatterplots; bar, line, circle graphs; Venn diagrams; pictographs; charts and tables</td>
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<tr>
<td></td>
<td>5 methods of sampling</td>
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<td></td>
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<tr>
<td></td>
<td>Mean, median, mode, range, standard deviation, Z scores, percentiles, quartiles, interquartile range, effect of outliers</td>
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<tr>
<td></td>
<td>USA Today graphs</td>
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<td></td>
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<tr>
<td></td>
<td>Graphing calculators</td>
<td></td>
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<tr>
<td></td>
<td>Student collected data</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>CBL/CBR</td>
<td></td>
<td></td>
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<td></td>
<td>Surveys</td>
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<td>Newspapers</td>
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<td>Magazines</td>
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<td></td>
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<td></td>
<td>Internet examples</td>
<td></td>
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<tr>
<td></td>
<td>Calculator usage</td>
<td></td>
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<tr>
<td></td>
<td>Student data collection</td>
<td></td>
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</tr>
</tbody>
</table>

**What Students Need to Do/Apply**

1. Use graphs, tables to organize data, and discover data patterns.
2. Calculate measures of central tendency, dispersion and position, and determine line of best fit.

**Strategies**

- Frequency distribution; box and whisker plot; stem and leaf; histograms; scatterplots; bar, line, circle graphs; Venn diagrams; pictographs; charts and tables
- 5 methods of sampling
- Mean, median, mode, range, standard deviation, Z scores, percentiles, quartiles, interquartile range, effect of outliers
- USA Today graphs
- Graphing calculators
- Student collected data
- CBL/CBR
- Surveys
- Newspapers
- Magazines
- Internet examples
- Calculator usage
- Student data collection

**Scope and Sequence**

Topics covered through Advanced Algebra II and Trigonometry provide the foundation for this course.

**Sample AP Exam Questions**

1. In the scatter plot of y versus x shown above, the least squares regression line is superimposed on the plot. Which of the following points has the largest residual?

   - (A) A
   - (B) B
   - (C) C
   - (D) D
   - (E) E

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**Indicator/Objective Code:** ▲ - KS Tested Indicator, ■ - KS Constructed Response, N - no calculator

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### MA860X.D.ED.3.
- compares distributions of univariate data (dot plots, back-to-back stem plots, parallel box plots) which include the following:
  - a. comparing center and spread: within group, between group variation
  - b. comparing clusters and gaps
  - c. comparing outliers and other unusual features
  - d. comparing shapes

### MA860X.D.ED.4.
- explores bivariate data which included the following:
  - a. analyzing patterns in scatter plots
  - b. correlation and linearity
  - c. least-squares regression line
  - d. residual plots, outliers, and influential points
  - e. transformations to achieve linearity: logarithmic and power transformations

### MA860X.D.ED.5.
- explores categorical data which include the following:
  - a. frequency tables and bar charts
  - b. marginal and joint frequencies for two-way tables
  - c. dconditional relative frequencies and association
  - d. comparing distributions using bar charts

### Vocabulary Students Should Know and Use:
- univariate data
- dot plot
- stem plot

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2. Some descriptive statistics for a set of test scores are shown above. For this test, a certain student has a standardized score of $z = -1.2$. What score did this student receive on the test?

(A) 266.28  
(B) 779.42  
(C) 1008.02  
(D) 1083.38  
(E) 1311.98

3. Consider a data set of positive values, at least two of which are not equal. Which of the following sample statistics will be changed when each value in this data set is multiplied by a constant whose absolute value is greater than 1?

I. The mean  
II. The median  
III. The standard deviation

(A) I only  
(B) II only  
(C) III only  
(D) I and II only  
(E) I, II, and III
<table>
<thead>
<tr>
<th>histogram</th>
<th>cumulative frequency plot</th>
<th>center and spread</th>
<th>clusters and gaps</th>
<th>outliers</th>
<th>bivariate data</th>
<th>parallel box plots</th>
<th>scatter plots</th>
<th>correlations</th>
<th>linearity</th>
<th>least-squares regression line</th>
<th>residual plots, outliers, and influential points</th>
<th>logarithmic and power transformations</th>
<th>frequency tables</th>
<th>bar charts</th>
<th>marginal and joint frequencies for two-way tables</th>
<th>conditional relative frequencies and association</th>
</tr>
</thead>
</table>

4. The Attila Barbell Company makes bars for weight lifting. The weights of the bars are independent and are normally distributed with a mean of 720 ounces (45 pounds) and a standard deviation of 4 ounces. The bars are shipped 10 in a box to the retailers. The weights of the empty boxes are normally distributed with a mean of 320 ounces and a standard deviation of 8 ounces. The weights of the boxes filled with 10 bars are expected to be normally distributed with a mean of 7,520 ounces and a standard deviation of

(A) 12 ounces
(B) 80 ounces
(C) 224 ounces
(D) 48 ounces
(E) 1,664 ounces
### Standard: Data

<table>
<thead>
<tr>
<th>Indicator/Objective Code</th>
<th>Critical Vocabulary</th>
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</tr>
</thead>
<tbody>
<tr>
<td>MA860X.D.SE.1</td>
<td>looks at an overview of methods of data collection which include the following: a. census b. sample survey c. experiment d. observational study</td>
<td>Data must be collected according to a well-developed plan if valid information on a conjecture is to be obtained. This plan includes clarifying the question and deciding upon a method of data collection and analysis.</td>
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</tr>
<tr>
<td>MA860X.D.SE.2</td>
<td>plans and conducts surveys which include the following: a. characteristics of a well-designed and well-conducted survey b. populations, samples, and random selection c. sources of bias in sampling and surveys d. sampling methods, including simple random sampling, stratified random sampling, and cluster sampling</td>
<td>The student…</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MA860X.D.SE.3</td>
<td>plans and conducts experiments which include: a. characteristics of a well-designed and well-conducted experiment</td>
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</tr>
</tbody>
</table>

**What Students Need to Know**
1. Plan and conduct surveys.

**What Students Need to Do/Apply**
1. Select and use appropriate samples from a population.
2. Design an experiment given a description of data.
3. Distinguish between well and poorly designed experiments.

**Strategies**
- 5 methods of sampling
- Misuses of statistics
- Newspapers
- Magazines
- Internet examples
- Surveys
- Calculator usage
- Student data collection
- USA Today graphs
- Graphing calculators
- Student collected data
- Use of claims from newspapers, advertising news, media

**Scope and Sequence**
Topics covered through Advanced Algebra II and Trigonometry provide the foundation for this course.

**Sample AP Exam Questions**
1. Under which of the following conditions is it preferable to use stratified random sampling rather than simple random sampling?

   (A) The population can be divided into a large number of strata so that each stratum contains only a few individuals.
   (B) The population can be divided into a small number of strata so that each stratum contains a large number of individuals.
   (C) The population can be divided into strata so that the individuals in each stratum are as much alike as possible.
   (D) The population can be divided into strata so that the individuals in each stratum are as different as possible.
   (E) The population can be divided into strata of equal sizes so that each individual in the population still has the same chance of being selected.
<table>
<thead>
<tr>
<th>b. treatments, control groups, experimental units, random assignments, and replication</th>
<th>2. Each person in a simple random sample of 2,000 received a survey, and 317 people returned their survey. How could non-response cause the results of the survey to be biased?</th>
</tr>
</thead>
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<td>c. sources of bias and confounding, including placebo effect and blinding</td>
<td>(A) Those who did not respond reduced the sample size, and small samples have more bias than large samples.</td>
</tr>
<tr>
<td>d. completely randomized design</td>
<td>(B) Those who did not respond caused a violation of the assumption of independence.</td>
</tr>
<tr>
<td>e. randomized block design, including matched pairs design</td>
<td>(C) Those who did not respond were indistinguishable from those who did not receive the survey.</td>
</tr>
</tbody>
</table>

**MA860X.D.SE.5.** generalizes results and types of conclusions that can be drawn from observational studies, experiments, and surveys.

**Vocabulary Students Should Know and Use:**
census
sample survey
experiment
observational study

2. Each person in a simple random sample of 2,000 received a survey, and 317 people returned their survey. How could non-response cause the results of the survey to be biased?

(A) Those who did not respond reduced the sample size, and small samples have more bias than large samples.

(B) Those who did not respond caused a violation of the assumption of independence.

(C) Those who did not respond were indistinguishable from those who did not receive the survey.

(D) Those who did not respond represent a stratum, changing the simple random sample into a stratified random sample.

(E) Those who did respond may differ in some important way from those who did not respond.
**Standard:** Probability  

**Benchmark:** Anticipating Patterns: Exploring random phenomena using probability and simulation

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<th>Essential Concepts/Skills</th>
<th>Implementation</th>
<th>Assessment Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Critical Vocabulary</strong></td>
<td><strong>What Students Need to Know</strong></td>
<td><strong>Scope and Sequence</strong></td>
<td><strong>Sample AP Exam Questions</strong></td>
</tr>
</tbody>
</table>
| Probability is the tool used for anticipating what the distribution of data should look like under a given model. | 1. Determine the probability of an event. | Topics covered through Advanced Algebra II and Trigonometry provide the foundation for this course. | 1. All bags entering a research facility are screened. Ninety-seven percent of the bags that contain forbidden material trigger an alarm. Fifteen percent of the bags that do not contain forbidden material also trigger the alarm. If 1 out of every 1,000 bags entering the building contains forbidden material, what is the probability that a bag that triggers the alarm will actually contain forbidden material? | (A) 0.00097  
(B) 0.00640  
(C) 0.03000  
(D) 0.14550  
(E) 0.97000 |
| The student … | **What Students Need to Do/Apply** | | |
| MA860X.P.AP.1. interprets probability, including long-run relative frequency interpretation and also includes the following: | 1. Calculate the probability of an event. | | |
| a. “Law of Large Numbers” concept | 2. Calculate the number of ways an event can occur. | | |
| b. addition rule, multiplication rule, conditional probability, and independence | 3. Calculate the probability of compound events. | | |
| c. discrete random variables and their probability distributions, including binomial and geometric | 4. Describe and use the differences between discrete and continuous random variables. | | |
| d. simulation of random behavior and probability distributions | 5. Identify different sampling distributions. | | |
| e. mean (expected value) and standard deviation of a random variable, and linear transformation of a random variable | | | |
| MA860X.P.AP.2. combines independent random variables using the following: | | | |
| a. notion of independence versus dependence | | | |
| b. mean and standard deviation for sums and differences of independent random variables | | | |
| Strategies | ➔ Classical probability | | |
| ➔ Relative frequency probability | | | |
| ➔ Counting rules | | | |
| ➔ Combinations | | | |
| ➔ Permutations | | | |
| ➔ Mutually exclusive events | | | |
| ➔ Independent/dependent events | | | |
| ➔ Complementary events | | | |
| ➔ Conditional probability | | | |
| ➔ Conjunctions and disjunctions | | | |
| ➔ Games, dice, cards, calculators | | | |
| ➔ Pascal’s triangle | | | |
| ➔ Simulations, experiments, data from real life events | | | |
| ➔ Venn diagrams | | | |
| ➔ Chart data | | | |

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### MA860X.P.AP.3
studies the normal distribution which include:
- properties of the normal distribution
- using tables of the normal distribution
- the normal distribution as a model for measurements

### MA860X.P.AP.4
studies sampling distributions which include:
- sampling distribution of a sample proportion
- sampling distribution of a sample mean
- Central Limit Theorem
- sampling distribution of a difference between two independent sample proportions
- sampling distribution of a difference between two independent sample means
- simulation of sampling distributions
- t-distribution
- Chi-square distribution

#### Vocabulary Students Should Know and Use:
- “Law of Large Numbers” concept
- conditional probability
- mean and standard deviation
- normal distribution
- sampling distribution
- t-distribution
- Chi-square distribution

<table>
<thead>
<tr>
<th>Formulas</th>
<th>Manipulatives</th>
<th>Cards, marbles, dice</th>
<th>T scores</th>
<th>Z scores</th>
<th>Percentiles</th>
<th>Central limit theorem</th>
<th>Binomial probability formula</th>
<th>Normal distribution</th>
<th>Normal curves</th>
<th>Approximation of binomial distribution</th>
<th>Charts (z and t)</th>
<th>Probability distribution</th>
</tr>
</thead>
</table>

2. A summer resort rents rowboats to customers but does not allow more than four people to a boat. Each boat is designed to hold no more than 800 pounds. Suppose the distribution of adult males who rent boats, including their clothes and gear, is normal with a mean of 190 pounds and standard deviation of 10 pounds. If the weights of individual passengers are independent, what is the probability that a group of four adult male passengers will exceed the acceptable weight limit of 800 pounds?

(A) 0.023  
(B) 0.046  
(C) 0.159  
(D) 0.317  
(E) 0.977

3. In a certain game, a fair die is rolled and a player gains 20 points if the die shows a “6.” If the die does not show a “6,” the player loses 3 points. If the die were to be rolled 100 times, what would be the expected total gain or loss for the player?

(A) a gain of about 1,700 points  
(B) a gain of about 583 points  
(C) a gain of about 83 points  
(D) a loss of about 250 points  
(E) a loss of about 300 points
### Standard: Statistics

#### Benchmark: Statistical Inference: Estimating population parameters and testing hypotheses

<table>
<thead>
<tr>
<th>Indicator/Objective Critical Vocabulary</th>
<th>Essential Concepts/Skills</th>
<th>Implementation</th>
<th>Assessment Examples</th>
</tr>
</thead>
</table>
| Statistical inference guides the selection of appropriate models. | **What Students Need to Do/Apply**  
1. Explain applications of statistics.  
2. Compute, interpret standardized scores.  
3. Recognize and calculate the probability for normal distribution, binomial distributions, and central limit theorem.  
4. Evaluate claims based on confidence intervals and hypothesis testing.  
5. Conduct a statistical study.  
6. Analyze validity of statistical studies. | **Scope and Sequence**  
Topics covered through Advanced Algebra II and Trigonometry provide the foundation for this course. | **Sample AP Exam Questions**  
1. A candy company claims that 10 percent of its candies are blue. A random sample of 200 of these candies is taken, and 16 are found to be blue. Which of the following tests would be most appropriate for establishing whether the candy company needs to change its claim?  
(A) Matched pairs t-test  
(B) One-sample proportion z-test  
(C) Two-sample t-test  
(D) Two-sample proportion z-test  
(E) Chi-square test of association |

**MA860X.S.SI.1** uses estimation (point estimators and confidence intervals) which include:  
a. estimating population parameters and margins of error  
b. properties of point estimators, including unbiasedness and variability  
c. logic of confidence intervals, meaning of confidence level and confidence intervals, and properties of confidence intervals  
d. large sample confidence interval for a proportion  
e. large sample confidence interval for a difference between two proportions  
f. confidence interval for a mean  
g. confidence interval for a difference between two means (unpaired and paired)  
h. confidence interval for the slope of a least-squares regression line

**MA860X.S.SI.2** applies tests of significance which include:  
a. logic of significance testing, null and alternative hypotheses; p-values;  
Strategies  
→ Recognition of the concept of probability and statistics.  
→ Confidence interval for mean  
→ Large samples  
→ Small samples  
→ Proportions  
→ Margin of error  
→ Estimation of sample size  
→ Hypothesis testing for large samples, small samples, proportions  
→ Choose topic  
→ Collect and organize data  
→ Describe data (charts, graphs, central tendency measures of variation)
one- and two-sided tests; concepts of Type I and Type II errors; concept of power
b. large sample test for a proportion
c. large sample test for a difference between two proportions
d. test for a mean
e. test for a difference between two means (unpaired and paired)
f. Chi-square test for goodness of fit, homogeneity of proportions, and independence (one- and two-way tables)
g. test for the slope of a least-squares regression line

Vocabulary Students Should Know and Use:
- point estimators
- confidence intervals
- null and alternative hypotheses
- p-values

2. In a test of $H_0: \mu = 8$ versus $H_a: \mu \neq 8$, a sample of size 220 leads to a $p$-value of 0.034. Which of the following must be true?

(A) A 95% confidence interval for calculated from these data will not include 8.
(B) At the 5% level if $H_0$ is rejected, the probability of a Type II error is 0.034.
(C) The 95% confidence interval for calculated from these data will be centered at 8.
(D) The null hypothesis should not be rejected at the 5% level.
(E) The sample size is insufficient to draw a conclusion with 95% confidence.