

Section 15-1: Empirical Probability

1. 069901a, P.I. A.S.20

A fair coin is thrown in the air four times. If the coin lands with the head up on the first three tosses, what is the probability that the coin will land with the head up on the fourth toss?

[A] $\frac{1}{16}$ [B] $\frac{1}{8}$ [C] $\frac{1}{2}$ [D] 0

2. 010209a, P.I. A.S.20

A fair coin is tossed three times. What is the probability that the coin will land tails up on the second toss?

[A] $\frac{3}{4}$ [B] $\frac{1}{3}$ [C] $\frac{1}{2}$ [D] $\frac{2}{3}$

3. 060712a, P.I. A.S.20

When a fair coin was tossed ten times, it landed heads up the first seven times. What is the probability that on the eighth toss the coin will land with tails up?

[A] $\frac{3}{10}$ [B] $\frac{1}{2}$ [C] $\frac{3}{7}$ [D] $\frac{7}{10}$

4. 010709a, P.I. A.S.20

Seth tossed a fair coin five times and got five heads. The probability that the next toss will be a tail is

[A] $\frac{1}{2}$ [B] $\frac{1}{6}$ [C] $\frac{5}{6}$ [D] 0

5. 010832a, P.I. A.S.20

As captain of his football team, Jamal gets to call heads or tails for the toss of a fair coin at the beginning of each game. At the last three games, the coin has landed with heads up. What is the probability that the coin will land with heads up at the next game? Explain your answer.

Section 15-3: Evaluating Simple Probabilities

6. 060415a, P.I. A.S.20

Mary chooses an integer at random from 1 to 6. What is the probability that the integer she chooses is a prime number?

[A] $\frac{3}{6}$ [B] $\frac{5}{6}$ [C] $\frac{2}{6}$ [D] $\frac{4}{6}$

7. 080011a, P.I. A.S.20

A box contains six black balls and four white balls. What is the probability of selecting a black ball at random from the box?

[A] $\frac{4}{6}$ [B] $\frac{1}{10}$ [C] $\frac{6}{10}$ [D] $\frac{6}{4}$

8. 060705a, P.I. A.S.20

A six-sided number cube has faces with the numbers 1 through 6 marked on it. What is the probability that a number less than 3 will occur on one toss of the number cube?

[A] $\frac{2}{6}$ [B] $\frac{1}{6}$ [C] $\frac{4}{6}$ [D] $\frac{3}{6}$

The Impossible Case

9. 010811a, P.I. A.S.20

Which event has a probability of zero?

[A] choosing a triangle that is both isosceles and right

[B] choosing a number that is greater than 6 and is even

[C] choosing a letter from the alphabet that has line symmetry

[D] choosing a pair of parallel lines that have unequal slopes

The Probability of Any Event

10. 060630a, P.I. A.S.20
Which inequality represents the probability, x , of any event happening?
- [A] $0 \leq x \leq 1$ [B] $x \geq 0$
[C] $0 < x < 1$ [D] $x < 1$

Section 15-5: The Probability of (A or B)

11. fall0702ia, P.I. A.S.20
Throughout history, many people have contributed to the development of mathematics. These mathematicians include Pythagoras, Euclid, Hypatia, Euler, Einstein, Agnesi, Fibonacci, and Pascal. What is the probability that a mathematician's name selected at random from those listed will start with either the letter E or the letter A ?
- [A] $\frac{6}{8}$ [B] $\frac{3}{8}$ [C] $\frac{2}{8}$ [D] $\frac{4}{8}$

Section 15-6: The Probability of (Not A)

12. 080604a, P.I. A.S.20
The faces of a cube are numbered from 1 to 6. What is the probability of *not* rolling a 5 on a single toss of this cube?
- [A] $\frac{1}{5}$ [B] $\frac{1}{6}$ [C] $\frac{5}{6}$ [D] $\frac{4}{5}$
13. 060202a, P.I. A.S.20
If the probability that it will rain on Thursday is $\frac{5}{6}$, what is the probability that it will *not* rain on Thursday?
- [A] 1 [B] $\frac{5}{6}$ [C] 0 [D] $\frac{1}{6}$

14. 010805a, P.I. A.S.20
A box contains 6 dimes, 8 nickels, 12 pennies, and 3 quarters. What is the probability that a coin drawn at random is *not* a dime?
- [A] $\frac{8}{29}$ [B] $\frac{6}{29}$ [C] $\frac{23}{29}$ [D] $\frac{12}{29}$
15. 010017a, P.I. A.S.20
The party registration of the voters in Jonesville is shown in the table below.

Registered Voters in Jonesville	
Party Registration	Number of Voters Registered
Democrat	6,000
Republican	5,300
Independent	3,700

- If one of the registered Jonesville voters is selected at random, what is the probability that the person selected is *not* a Democrat?
- [A] 0.600 [B] 0.667
[C] 0.333 [D] 0.400

Section 15-7: The Counting Principle, Sample Spaces, and Probability

16. 010321a, P.I. A.S.19
If Laquisha can enter school by any one of three doors and the school has two staircases to the second floor, in how many different ways can Laquisha reach a room on the second floor? Justify your answer by drawing a tree diagram or listing a sample space.

17. 010731a, P.I. A.S.19
Kimberly has three pair of pants: one black, one red, and one tan. She also has four shirts: one pink, one white, one yellow, and one green. Draw a tree diagram or list the sample space showing all possible outfits that she could wear, if an outfit consists of one pair of pants and one shirt. How many different outfits can Kimberly wear?
18. 089922a, P.I. A.S.19
The Grimaldis have three children born in different years.
a Draw a tree diagram or list a sample space to show all the possible arrangements of boy and girl children in the Grimaldi family.
b Using your information from part *a*, what is the probability that the Grimaldis have three boys?
19. fall0736ia, P.I. A.S.19
Mr. Laub has three children: two girls (Sue and Karen) and one boy (David). After each meal, one child is chosen at random to wash dishes. If the same child can be chosen for both lunch and dinner, construct a tree diagram or list a sample space of all the possible outcomes of who will wash dishes after lunch and dinner on Saturday. Determine the probability that one boy and one girl will wash dishes after lunch and dinner on Saturday.
20. 080111a, P.I. A.N.7
A certain car comes in three body styles with a choice of two engines, a choice of two transmissions, and a choice of six colors. What is the minimum number of cars a dealer must stock to have one car of every possible combination?
[A] 36 [B] 42 [C] 13 [D] 72
21. 060403a, P.I. A.N.7
How many different outfits consisting of a hat, a pair of slacks, and a sweater can be made from two hats, three pairs of slacks, and four sweaters?
[A] 9 [B] 24 [C] 12 [D] 29
22. 080204a, P.I. A.N.7
Juan has three blue shirts, two green shirts, seven red shirts, five pairs of denim pants, and two pairs of khaki pants. How many different outfits consisting of one shirt and one pair of pants are possible?
[A] 130 [B] 420 [C] 84 [D] 19
23. 010405a, P.I. A.N.7
In a school building, there are 10 doors that can be used to enter the building and 8 stairways to the second floor. How many different routes are there from outside the building to a class on the second floor?
[A] 10 [B] 18 [C] 1 [D] 80
24. 080404a, P.I. A.N.7
The school cafeteria offers five sandwich choices, four desserts, and three beverages. How many different meals consisting of one sandwich, one dessert, and one beverage can be ordered?
[A] 12 [B] 3 [C] 1 [D] 60
25. 010503a, P.I. A.N.7
A deli has five types of meat, two types of cheese, and three types of bread. How many different sandwiches, consisting of one type of meat, one type of cheese, and one type of bread, does the deli serve?
[A] 25 [B] 10 [C] 75 [D] 30

Independent Events

26. 089923a, P.I. A.N.7
Paloma has 3 jackets, 6 scarves, and 4 hats. Determine the number of different outfits consisting of a jacket, a scarf, and a hat that Paloma can wear.
27. 060501a, P.I. A.N.7
Jeremy's bedroom has two doors leading into the hallway. His house has four doors leading to the outside. Using the doorways, in how many different ways can Jeremy leave his room and go outside?
[A] 8 [B] 6 [C] 4 [D] 5
28. 080502a, P.I. A.N.7
Cole's Ice Cream Stand serves sixteen different flavors of ice cream, three types of syrup, and seven types of sprinkles. If an ice cream sundae consists of one flavor of ice cream, one type of syrup, and one type of sprinkles, how many different ice cream sundaes can Cole serve?
[A] 3 [B] 10,836 [C] 336 [D] 26
29. 060728a, P.I. A.N.7
Max goes through the cafeteria line and counts seven different meals and three different desserts that he can choose. Which expression can be used to determine how many different ways Max can choose a meal and a dessert?
[A] $7! \cdot 3!$ [B] ${}_7P_3$
[C] $7 \cdot 3$ [D] ${}_7C_3$
30. 010612a, P.I. A.N.7
Robin has 8 blouses, 6 skirts, and 5 scarves. Which expression can be used to calculate the number of different outfits she can choose, if an outfit consists of a blouse, a skirt, and a scarf?
[A] $8 + 6 + 5$ [B] ${}_{19}C_3$
[C] $8 \cdot 6 \cdot 5$ [D] $8!6!5!$
31. 060607a, P.I. A.N.7
Leo purchased five shirts, three pairs of pants, and four pairs of shoes. Which expression represents how many different outfits consisting of one shirt, one pair of pants, and one pair of shoes Leo can make?
[A] $5 + 3 + 4$ [B] $5 \cdot 3 \cdot 4$
[C] ${}_{12}C_3$ [D] ${}_{12}P_3$
32. 080704a, P.I. A.N.7
Jen and Barry's ice cream stand has three types of cones, six flavors of ice cream, and four kinds of sprinkles. If a serving consists of a cone, one flavor of ice cream, and one kind of sprinkles, how many different servings are possible?
[A] ${}_{13}P_3$ [B] 72 [C] ${}_{13}C_3$ [D] 90
33. 080636a, P.I. A.N.7
Debbie goes to a diner famous for its express lunch menu. The menu has five appetizers, three soups, seven entrees, six vegetables, and four desserts. How many different meals consisting of either an appetizer *or* a soup, one entree, one vegetable, and one dessert can Debbie order?
34. 010218a
When Kimberly bought her new car, she found that there were 72 different ways her car could be equipped. Her choices included four choices of engine and three choices of transmission. If her only other choice was color, how many choices of color did she have?
[A] 6 [B] 12 [C] 65 [D] 60

Section 15-8: Probabilities with Two or More Activities

Without Replacement

35. 080430a, P.I. A.S.23
Selena and Tracey play on a softball team. Selena has 8 hits out of 20 times at bat, and Tracey has 6 hits out of 16 times at bat. Based on their past performance, what is the probability that both girls will get a hit next time at bat?
- [A] $\frac{31}{40}$ [B] $\frac{14}{36}$ [C] 1 [D] $\frac{48}{320}$
36. 060305a, P.I. A.S.23
Bob and Laquisha have volunteered to serve on the Junior Prom Committee. The names of twenty volunteers, including Bob and Laquisha, are put into a bowl. If two names are randomly drawn from the bowl without replacement, what is the probability that Bob's name will be drawn first and Laquisha's name will be drawn second?
- [A] $\frac{1}{20} \cdot \frac{1}{20}$ [B] $\frac{2}{20}$
[C] $\frac{1}{20} \cdot \frac{1}{19}$ [D] $\frac{2}{20!}$
37. 010525a, P.I. A.S.23
A student council has seven officers, of which five are girls and two are boys. If two officers are chosen at random to attend a meeting with the principal, what is the probability that the first officer chosen is a girl and the second is a boy?
- [A] $\frac{10}{42}$ [B] $\frac{7}{13}$ [C] $\frac{7}{14}$ [D] $\frac{2}{7}$
38. 060529a, P.I. A.S.23
The probability that the Cubs win their first game is $\frac{1}{3}$. The probability that the Cubs win their second game is $\frac{3}{7}$. What is the probability that the Cubs win both games?
- [A] $\frac{16}{21}$ [B] $\frac{6}{7}$ [C] $\frac{2}{5}$ [D] $\frac{1}{7}$
39. 080127a, P.I. A.S.23
There are four students, all of different heights, who are to be randomly arranged in a line. What is the probability that the tallest student will be first in line and the shortest student will be last in line?
40. 060130a, P.I. A.S.23
Mr. Yee has 10 boys and 15 girls in his mathematics class. If he chooses two students at random to work on the blackboard, what is the probability that both students chosen are girls?

Section 15-9: Permutations

Factorials

41. 080107a, P.I. A.N.6
The value of $5!$ is
- [A] 120 [B] $\frac{1}{5}$ [C] 20 [D] 5
42. 080503a, P.I. A.N.6
The value of $\frac{7!}{3!}$ is
- [A] 4 [B] 840 [C] 7 [D] 24
43. 060605a, P.I. A.N.6
What is the value of $\frac{8!}{4!}$?
- [A] $4!$ [B] 2 [C] $2!$ [D] 1,680

Representing Permutations

44. 010713a, A2.S.10
Which value is equivalent to ${}_3P_3$?
[A] 3! [B] 9 [C] 27 [D] 1
45. 089917a, P.I. A.N.8
How many different 6-letter arrangements can be formed using the letters in the word "ABSENT," if each letter is used only once?
[A] 720 [B] 36 [C] 6 [D] 46,656
46. 010013a, P.I. A.N.8
How many different 4-letter arrangements can be formed using the letters of the word "JUMP," if each letter is used only once?
[A] 4 [B] 12 [C] 24 [D] 16
47. 080616a, P.I. A.N.8
Julia has four different flags that she wants to hang on the wall of her room. How many different ways can the flags be arranged in a row?
[A] 10 [B] 1 [C] 16 [D] 24
48. 010323a, P.I. A.N.8
Six members of a school's varsity tennis team will march in a parade. How many different ways can the players be lined up if Angela, the team captain, is always at the front of the line?

Permutations That Use Some of the Elements

49. 060723a, P.I. A.N.8
What is the total number of different four-letter arrangements that can be formed from the letters in the word "VERTICAL," if each letter is used only once in an arrangement?
[A] 6,720 [B] 1,680
[C] 8 [D] 40,320

50. 060125a, P.I. A.N.8
There were seven students running in a race. How many different arrangements of first, second, and third place are possible?
51. 060016a, P.I. A.N.8
How many different five-digit numbers can be formed from the digits 1, 2, 3, 4, and 5 if each digit is used only once?
[A] 24 [B] 20 [C] 60 [D] 120
52. 010114a, P.I. A.N.8
A locker combination system uses three digits from 0 to 9. How many different three-digit combinations with no digit repeated are possible?
[A] 720 [B] 504 [C] 1,000 [D] 30
53. 060023a, P.I. A.N.8
All seven-digit telephone numbers in a town begin with 245. How many telephone numbers may be assigned in the town if the last four digits do *not* begin or end in a zero?
54. 080034a, P.I. A.N.8
The telephone company has run out of seven-digit telephone numbers for an area code. To fix this problem, the telephone company will introduce a new area code. Find the number of new seven-digit telephone numbers that will be generated for the new area code if both of the following conditions must be met:
o The first digit cannot be a zero or a one.
o The first three digits cannot be the emergency number (911) or the number used for information (411).

55. 010435a, P.I. A.N.8
In Jackson County, Wyoming, license plates are made with two letters (A through Z) followed by three digits (0 through 9). The plates are made according to the following restrictions:
o the first letter must be J or W, and the second letter can be any of the 26 letters in the alphabet
o no digit can be repeated
How many different license plates can be made with these restrictions?
56. 060329a, P.I. A.N.8
A certain state is considering changing the arrangement of letters and numbers on its license plates. The two options the state is considering are:
Option 1: three letters followed by a four-digit number with repetition of both letters and digits allowed
Option 2: four letters followed by a three-digit number without repetition of either letters or digits
[Zero may be chosen as the first digit of the number in either option.]
Which option will enable the state to issue more license plates? How many *more* different license plates will that option yield?

Section 15-10: Permutations with Repetition

57. 080727a, P.I. A.N.8
Which expression represents the number of different 8-letter arrangements that can be made from the letters of the word "SAVANNAH" if each letter is used only once?
- [A] $8!$ [B] $\frac{8!}{3!2!}$ [C] ${}_8P_5$ [D] $\frac{8!}{5!}$

58. 010829a, P.I. A.N.8
What is the total number of different seven-letter arrangements that can be formed using the letters in the word "MILLION"?
[A] 2,520 [B] 1,260 [C] 210 [D] 30

Section 15-11: Combinations

Comparing Permutations and Combinations

59. 060426a, P.I. A2.S.11
In a game, each player receives 5 cards from a deck of 52 different cards. How many different groupings of cards are possible in this game?
[A] ${}_{52}P_5$ [B] $5!$ [C] $\frac{52!}{5!}$ [D] ${}_{52}C_5$
60. 010307a, P.I. A2.S.9
There are 12 people on a basketball team, and the coach needs to choose 5 to put into a game. How many different possible ways can the coach choose a team of 5 if each person has an equal chance of being selected?
[A] ${}_{12}C_5$ [B] ${}_5P_{12}$ [C] ${}_5C_{12}$ [D] ${}_{12}P_5$
61. 010628a, P.I. A2.S.9
A committee of five members is to be randomly selected from a group of nine freshmen and seven sophomores. Which expression represents the number of different committees of three freshmen and two sophomores that can be chosen?
[A] ${}_9C_3 \cdot {}_7C_2$ [B] ${}_9C_3 + {}_7C_2$
[C] ${}_9P_3 \cdot {}_7P_2$ [D] ${}_{16}C_3 \cdot {}_{16}C_2$
62. 010515a, P.I. A2.S.11
How many different three-member teams can be selected from a group of seven students?
[A] 35 [B] 1 [C] 5,040 [D] 210

63. 010729a, P.I. A2.S.11
If the Math Olympiad Club consists of eighteen students, how many different teams of four students can be formed for competitions?
[A] 73,440 [B] 66 [C] 3,060 [D] 72
64. 069907a, P.I. A2.S.11
How many different three-member teams can be formed from six students?
[A] 120 [B] 216 [C] 20 [D] 720
65. 060320a, P.I. A2.S.11
How many different five-member teams can be made from a group of eight students, if each student has an equal chance of being chosen?
[A] 40 [B] 56 [C] 6,720 [D] 336
66. 080626a, P.I. A2.S.11
In the next Olympics, the United States can enter four athletes in the diving competition. How many different teams of four divers can be selected from a group of nine divers?
[A] 3,024 [B] 126 [C] 6,561 [D] 36
67. 010424a, P.I. A2.S.11
Five people have volunteered to work on an awards dinner at Madison High School. How many different committees of four can be formed from the five people?
[A] 20 [B] 5 [C] 10 [D] 1
68. 080025a, P.I. A2.S.11
Alan, Becky, Jesus, and Mariah are four students in the chess club. If two of these students will be selected to represent the school at a national convention, how many combinations of two students are possible?
69. 060534a, P.I. A2.S.11
An algebra class of 21 students must send 5 students to meet with the principal. How many different groups of 5 students could be formed from this class?
70. 080126a, P.I. A2.S.11
Megan decides to go out to eat. The menu at the restaurant has four appetizers, three soups, seven entrees, and five desserts. If Megan decides to order an appetizer or a soup, and one entree, and two different desserts, how many different choices can she make?
71. 080229a, P.I. A2.S.11
On a bookshelf, there are five different mystery books and six different biographies. How many different sets of four books can Emilio choose if two of the books must be mystery books and two of the books must be biographies?
72. 060114a, P.I. A2.S.11
If there are four teams in a league, how many games will have to be played so that each team plays every other team once?
[A] 16 [B] 8 [C] 6 [D] 3
73. 060632a, P.I. A2.S.11
Five friends met for lunch, and they all shook hands. Each person shook the other person's right hand only once. What was the total number of handshakes?
- Some Relationships Involving Combinations
74. 080527a, P.I. A2.S.11
The expression ${}_9C_2$ is equivalent to
[A] ${}_9P_7$ [B] ${}_9C_7$ [C] ${}_9P_2$ [D] $\frac{9!}{2!}$

75. 080720a, P.I. A2.S.11

The expression ${}_8C_3$ is equivalent to

- [A] ${}_8P_5$ [B] $\frac{8!}{3!}$ [C] ${}_8P_3$ [D] ${}_8C_5$

Section 15-12: Permutations, Combinations, and Probability

76. 010034a, P.I. A2.S.12

Three roses will be selected for a flower vase. The florist has 1 red rose, 1 white rose, 1 yellow rose, 1 orange rose and 1 pink rose from which to choose.

- a* How many different three rose selections can be formed from the 5 roses?
b What is the probability that 3 roses selected at random will contain 1 red rose, 1 white rose, and 1 pink rose?
c What is the probability that 3 roses selected at random will *not* contain an orange rose?

77. 060034a, P.I. A2.S.12

Paul orders a pizza. Chef Carl randomly chooses two different toppings to put on the pizza from the following: pepperoni, onion, sausage, mushrooms, and anchovies. If Paul will not eat pizza with mushrooms, determine the probability that Paul will *not* eat the pizza Chef Carl has made.

78. 010126a, P.I. A2.S.12

Sal has a small bag of candy containing three green candies and two red candies. While waiting for the bus, he ate two candies out of the bag, one after another, without looking. What is the probability that both candies were the same color?

79. 060234a, P.I. A2.S.12

Alexi's wallet contains four \$1 bills, three \$5 bills, and one \$10 bill. If Alexi randomly removes two bills without replacement, determine whether the probability that the bills will total \$15 is greater than the probability that the bills will total \$2.

80. 069932a, P.I. A2.S.12

A bookshelf contains six mysteries and three biographies. Two books are selected at random without replacement.

- a* What is the probability that both books are mysteries?
b What is the probability that one book is a mystery and the other is a biography?

[1] C

[2] C

[3] B

[4] A

[2] $\frac{1}{2}$ or an equivalent answer, and an

appropriate explanation is written.

[1] A correct explanation is written, but the probability is not stated.

or [1] $\frac{1}{2}$ or an equivalent answer, but no

explanation is written.

[0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously

[5] incorrect procedure.

[6] A

[7] C

[8] A

[9] D

[10] A

[11] D

[12] C

[13] D

[14] C

[15] A

[2] 6, and a correct tree diagram is drawn or sample space is listed.

[1] A correct tree diagram is drawn or sample space is listed, but no answer or an incorrect answer is found.

or [1] An appropriate answer is found, based on an incorrect tree diagram or sample space.

or [1] 6, but no tree diagram is drawn or sample space is listed.

[0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously

[16] incorrect procedure.

[2] 12, and a correct tree diagram or a correct sample space is shown.

[1] An incomplete tree diagram or sample space is shown with at least 8 possible combinations shown, and an appropriate number of outfits is found.

or [1] A correct tree diagram or sample space is shown, but the number of possible outfits is missing or is incorrect.

or [1] 12, but 3×4 is used to find the number of outfits.

[0] 12, but no work is shown.

or [0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an

[17] obviously incorrect procedure.

a [1] A correct tree diagram or listing of all 8 possibilities is shown.

b [1] $\frac{1}{8}$

or [1] An appropriate answer is given for an incorrect part a tree diagram or listing.

a and b

[0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously

[18] incorrect procedure.

[3] $\frac{4}{9}$, and a correct tree diagram or sample

space is shown.

[2] A correct tree diagram or sample space is shown, but no probability or an incorrect probability is given.

or [2] An incorrect tree diagram or sample space is shown, but an appropriate probability is found.

[1] Appropriate work is shown, but one conceptual error is made.

or [1] $\frac{4}{9}$, but no work is shown.

[0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously

[19] incorrect procedure.

[20] D

[21] B

[22] C

[23] D

[24] D

[25] D

[2] 72 and an appropriate method, such as $3 \times 6 \times 4$, is shown.

[1] 72 and no explanation is given.

or [1] An appropriate method is shown, but the student has one computational mistake or an incomplete listing, such as 2 of the 3 clothing categories.

[0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously

[26] incorrect procedure.

[27] A

[28] C

[29] C

[30] C

[31] B

[32] B

[3] 1,344, and appropriate work is shown, such as $8 \cdot 7 \cdot 6 \cdot 4$.

[2] Appropriate work is shown, but one computational error is made.

[1] Appropriate work is shown, but two or more computational errors are made.

or [1] Appropriate work is shown, but one conceptual error is made, such as basing the answer on ordering an appetizer and a soup, using $5 \cdot 3 \cdot 7 \cdot 6 \cdot 4$.

or [1] 1,344, but no work is shown.

[0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously

[33] incorrect procedure.

[34] A

[35] D

[36] C

[37] A

[38] D

[3] $\frac{2}{24}$ or an equivalent answer, and an

appropriate explanation is given or appropriate work is shown, such as a tree diagram, sample space, or permutations.

[2] Appropriate work is shown, but one computational error is made.

or [2] Appropriate work is shown, but only a numerator or a denominator is determined correctly.

or [2] $\frac{2}{24}$ or an equivalent answer, but only

work for either the numerator or the denominator is shown.

[1] The probability of the tallest or the probability of the shortest student being in the proper position is correct, such as .

or [1] Only a tree diagram, sample space, or permutations are shown.

or [1] $\frac{2}{24}$ or an equivalent answer, but no work is shown.

[0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously

[39] incorrect procedure.

[3] $\frac{7}{20}$ or an equivalent answer, and

appropriate work is shown, such as $\frac{15}{25} \cdot \frac{14}{24}$

or $\frac{{}_{15}C_2}{{}_{25}C_2}$.

[2] $\frac{15}{25} \cdot \frac{14}{24}$ or $\frac{{}_{15}C_2}{{}_{25}C_2}$ is shown, but one

computational error is made or no further work is shown.

or [2] ${}_{15}C_2$ and ${}_{25}C_2$ are computed correctly, but no further work is shown.

or [2] Appropriate work is shown, but one computational error is made.

[1] The correct probabilities are found, but they are added instead of multiplied.

or [1] Only one of the two parts of the probability is correct.

or [1] Appropriate work is shown, but more than one error is made.

or [1] $\frac{7}{20}$ or an equivalent answer, but no

work is shown.

[0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously

[40] incorrect procedure.

[41] A

[42] B

[43] D

[44] A

[45] A

[46] C

[47] D

- [2] 120, and appropriate work is shown, such as $1 \cdot 5 \cdot 4 \cdot 3 \cdot 2 \cdot 1$.
 [1] Appropriate work is shown, but one computational error is made.
 or [1] 720 and ${}_6P_6$ or $6!$ is shown.
 or [1] 120, but no work is shown.
 [0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously incorrect procedure.
- [48] _____
- [49] B _____
- [2] 210, and appropriate work is shown, such as $7 \cdot 6 \cdot 5$ or ${}_7P_3$.
 [1] Appropriate work is shown, but no answer or an incorrect answer is found.
 or [1] 210, but no work is shown.
 [0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously incorrect procedure.
- [50] _____
- [51] D _____
- [52] A _____
- [2] 8,100 and appropriate work is shown, such as $9 \times 10 \times 10 \times 9$.
 [1] 10,000 but appropriate work is shown.
 or [1] Appropriate work is shown, but the student multiplies incorrectly.
 or [1] An appropriate pattern is shown, such as $9 \times 10 \times 10 \times 9$.
 or [1] 8,100 but no work is shown.
 [0] 38 is shown.
 or [0] The student attempts to use the counting principle, but adds.
 or [0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously incorrect procedure.
- [53] _____

- [4] 7.98×10^6 or 7,980,000 and appropriate work is shown, such as $8 \times 10^6 - 2 \times 10^4$.
 [3] Appropriate work is shown, but one computational error is made.
 or [3] The student uses 1–9 instead of 0–9 as the number of digits in $8 \times 9^6 - 2 \times 9^4$.
 [2] The student correctly produces only one part, 8×10^6 or 2×10^4 , but carries the process to an appropriate result.
 or [2] Appropriate work is shown, but more than one error is made.
 [1] The student produces only one part, 8×9^6 or 2×9^4 .
 or [1] 7,980,000 but no work is shown.
 [0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously incorrect procedure.
- [54] _____
- [2] 37,440 and appropriate work is shown, such as $2 \times 26 \times 10 \times 9 \times 8$ or ${}_2P_1 \times {}_{26}P_1 \times {}_{10}P_3$.
 [1] Appropriate work is shown, but one computational or conceptual error is made.
 or [1] Appropriate work is shown for at least one restriction, such as 2×26 or $10 \times 9 \times 8$.
 or [1] 37,440 but no work is shown.
 [0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously incorrect procedure.
- [55] _____

[3] Option 2 will yield 82,576,000 more possibilities, and appropriate work is shown, such as $26^3 \bullet 10^4$ and ${}_{26}P_4 \bullet {}_{10}P_3$.

[2] Appropriate work is shown, but one computational error is made, but the appropriate option is identified.

or [2] The correct numbers of arrangements are found for both Option 1 and Option 2, but the question of which option will yield more arrangements is not answered or is answered incorrectly.

[1] Appropriate work is shown, but more than one computational error is made, but the appropriate option is identified.

or [1] Appropriate work is shown, but one conceptual error is made, but the appropriate option is identified.

or [1] Either Option 1 or Option 2 is found correctly, but no further correct work is shown.

or [1] Option 2 will yield 82,576,000 more possibilities, but no work is shown.

[0] Option 2, but no work or inappropriate work is shown.

or [0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an

[56] obviously incorrect procedure.

[57] B

[58] B

[59] D

[60] A

[61] A

[62] A

[63] C

[64] C

[65] B

[66] B

[67] B

[2] 6 and appropriate work is shown, such as using the combination ${}_4C_2$, listing all six possible outcomes, or drawing a correct tree diagram.

[1] A correct setup of combinations is shown, but an incorrect solution, such as leaving ${}_4C_2$, or no integral solution is found.

or [1] An appropriate list or tree diagram is shown, but an incorrect solution is found, such as 5, by omitting one of the possible combinations.

or [1] 12 but a complete list or tree diagram is shown.

or [1] 6 but no work is shown.

[0] The answer is completely incorrect, such as ${}_4P_2$ or 4×3 .

or [0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously incorrect procedure.

[68]

[2] 20,349, and appropriate work is shown, such as ${}_{21}C_5 = 20,349$.

[1] Appropriate work is shown, but one computational error is made.

or [1] Appropriate work is shown, but one conceptual error is made, such as determining the value of ${}_{21}P_5$.

or [1] 20,349, but no work is shown.

[0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously

[69] incorrect procedure.

[3] 490, and appropriate work is shown, such as $7 \cdot 7 \cdot 10$.

[2] Appropriate work is shown, but one computational error is made.

or [2] Appropriate work is shown, but an incorrect answer is found, based on an incorrect

number of possible dessert combinations or an incorrect number of soup or appetizer choices.

or [2] Appropriate work is shown, but an incorrect answer is found, based on one error in

the tree diagram.

or [2] $\frac{1}{490}$, but appropriate work is shown.

[1] 7, 7, and 10 are added instead of multiplied.

or [1] The counting principle is used correctly, but incorrect substitutions are made, but

an appropriate answer is shown.

or [1] 490, but no work is shown.

[0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously

[70] incorrect procedure.

[3] 150, and appropriate work is shown, such as ${}_5C_2 \cdot {}_6C_2$.

[2] Appropriate work is shown, but one computational error is made.

or [2] All the possible combinations of two mystery books and all the possible combinations of two biographies are calculated, but the answers are not multiplied.

[1] Appropriate work is shown, but more than one computational error is made.

or [1] Appropriate work is shown, but one conceptual error is made, such as the computation ${}_{11}C_4 = 330$.

or [1] 150, but no work is shown.

[0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously

[71] incorrect procedure.

[72] C

[2] 10, and appropriate work is shown, such as ${}_5C_2$ or a diagram or a list.

[1] Appropriate work is shown, but one computational error is made.

or [1] Appropriate work is shown, but one conceptual error is made.

or [1] 10, but no work is shown.

[0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously

[73] incorrect procedure.

[74] B

[75] D

a [2] 10 and an appropriate tree diagram, list, sample space, or ${}_5C_3 = 10$ is shown.

[1] 10 and no work is shown.

or [1] An appropriate method is shown, but not all 10 possible combinations are listed

b [1] $\frac{1}{10}$

or [1] An appropriate answer is found for an incorrect response in part a.

c [1] $\frac{4}{10}$ or $\frac{2}{5}$ or 0.4

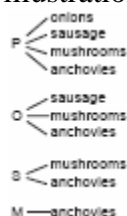
or [1] An appropriate answer is found for an incorrect response in part a.

a and b and c [0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by

[76] an obviously incorrect procedure.

[4] $\frac{4}{10}$ and appropriate work is shown, such

as the following illustration or any other correct method:



[3] Appropriate work is shown, but one computational error is made.

or [3] Appropriate work and complement $\frac{6}{10}$

are shown.

or [3] Appropriate work is shown, but the answer is incomplete.

[2] ${}_5C_2$ and the work is appropriate but incomplete.

or [2] 10 but appropriate work is shown.

or [2] A correct sample space or tree diagram is shown.

[1] Incorrect work leading to $0 \leq \text{fraction} \leq 1$ or $0 \leq \text{percent} \leq 100$ is shown.

or [1] $\frac{4}{10}$ but no work is shown.

[0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously

[77] incorrect procedure.

[3] $\frac{8}{20}$ or an equivalent answer, and

appropriate work is shown, such as using a tree diagram or writing the equation

$$\frac{6}{20} + \frac{2}{20} = \frac{8}{20}.$$

[2] One computational error is made in

finding $\frac{6}{20}$ or $\frac{2}{20}$, but an appropriate sum is found.

or [2] $\frac{2}{20}$ and $\frac{6}{20}$ are found, but no sum is shown.

[1] $\frac{6}{20}$ or $\frac{2}{20}$, and appropriate work is shown.

or [1] An appropriate answer is found, using replacement with a tree diagram or an

equation such as $\frac{3}{5} \cdot \frac{3}{5} + \frac{2}{5} \cdot \frac{2}{5} = \frac{13}{25}.$

or [1] $\frac{8}{20}$, but no work is shown.

[0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously

[78] incorrect procedure.

[4] No, and an appropriate explanation is given, such as $P(15) = \frac{6}{56} < P(2) = \frac{12}{56}$.

[3] One of the two probabilities is found correctly, but one computational error is made in finding the other, but an appropriate conclusion is drawn, based on the values found.

or [3] Replacement is used to conclude

$$P(15) = \frac{6}{64} < P(2) = \frac{12}{64}.$$

or [3] The two probabilities are found correctly, but no conclusion or the incorrect conclusion is drawn.

[2] One of the probabilities is found correctly, but one computational error is made in finding the other, and no conclusion or the incorrect conclusion is drawn.

[1] An appropriate method is used, such as a tree diagram or sample space, but the probabilities are not determined or are determined incorrectly.

or [1] $P(15) = \frac{6}{56} < P(2) = \frac{12}{56}$, but no work is shown.

[0] No, but no work is shown.

or [0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct

response that was obtained by an obviously

[79] incorrect procedure.

a [2] $\frac{30}{72}$ or an equivalent value is found and an appropriate explanation is given.

[1] An acceptable method is used correctly, such as a tree diagram, sample space, or combinations, but the correct answer is not given.

or [1] Replacement is used, and an answer of $\frac{36}{81}$ or an equivalent is found.

or [1] $\frac{30}{72}$ and no work is shown.

b [2] $\frac{36}{72}$ or an equivalent value is found and an appropriate explanation is given.

or [2] An appropriate probability for an incorrect denominator for part a is found.

[1] An appropriate method is shown, but one computational mistake is made.

or [1] Replacement is shown, and the answer $\frac{36}{81}$ or an equivalent is found.

or [1] The student does not take into account both orders and answers $\frac{18}{72}$ or an equivalent.

or [1] $\frac{36}{72}$ and no work is shown.

or a and b

[1] An error in method is made but the erroneous answer is interpreted correctly in either part a or b or both.

[0] A zero response is completely incorrect, irrelevant, or incoherent or is a correct response that was obtained by an obviously

[80] incorrect procedure.