AP Stats: Lunchtime Review #5 and #6
Probability

Simulations

Sample Space

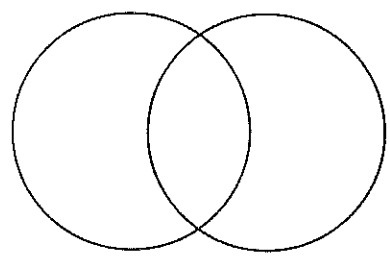
Law of Large Numbers

Some basic rules:

Probability

Mutually Exclusive Events

Independent Events



General Addition Rule

Conditional Probability

$A \cup B$

$A \cap B$

Chapter 5 Multiple Choice Practice

Directions. *Identify the choice that best completes the statement or answers the question. Check your answers and note your performance when you are finished.*

1. The probability that you will win a prize in a carnival game is about 1/7. During the last nine attempts, you have failed to win. You decide to give it one last shot. Assuming the outcomes are independent from game to game, the probability that you will win is:

A. 1/7
B. (1/7) - (1/7)^9
C. (1/7) + (1/7)^9
D. 1/10
E. 7/10

2. A friend has placed a large number of plastic disks in a hat and invited you to select one at random. He informs you that half are red and half are blue. If you draw a disk, record the color, replace it, and repeat 100 times, which of the following is true?

A. It is unlikely you will choose red more than 50 times.
B. If you draw 10 blue disks in a row, it is more likely you will draw a red on the next try.
C. The overall proportion of red disks drawn should be close to 0.50.
D. The chance that the 100^{th} draw will be red depends on the results of the first 99 draws.
E. All of the above are true.

3. The two-way table below gives information on males and females at a high school and their preferred music format.

	CD	mp3	Vinyl	Totals
Males	146	106	48	300
Females	146	64	40	250
Totals	292	170	88	550

You select one student from this group at random. Which of the following statement is true about the events "prefers vinyl" and "Male"?

A. The events are mutually exclusive and independent.
B. The events are not mutually exclusive but they are independent.
C. The events are mutually exclusive, but they are not independent.
D. The events are not mutually exclusive, nor are they independent.
E. The events are independent, but we do not have enough information to determine if they are mutually exclusive.

4. People with type O-negative blood are universal donors. That is, any patient can receive a transfusion of O-negative blood. Only 7.2% of the American population has O-negative blood. If 10 people appear at random to give blood, what is the probability that at least 1 of them is a universal donor?

A. 0
B. 0.280
C. 0.526
D. 0.720
E. 1

5. A die is loaded so that the number 6 comes up three times as often as any other number. What is the probability of rolling a 4, 5, or 6?

A. 2/3
B. 1/2
C. 5/8
D. 1/3
E. 1/4

6. You draw two candies at random from a bag that has 20 red, 10 green, 15 orange, and 5 blue candies without replacement. What is the probability that both candies are red?

A. 0.1551
B. 0.1600
C. 0.2222
D. 0.4444
E. 0.8000

7. An event A will occur with probability 0.5. An event B will occur with probability 0.6. The probability that both A and B will occur is 0.1.

A. Events A and B are independent.
B. Events A and B are mutually exclusive.
C. Either A or B always occurs.
D. Events A and B are complementary.
E. None of the above is correct.

8. Event A occurs with probability 0.8. The conditional probability that event B occurs, given that A occurs, is 0.5. The probability that both A and B occur is:

A. 0.3
B. 0.4
C. 0.625
D. 0.8
E. 1.0

9. At Lakeville South High School, 60% of students have high-speed internet access, 30% have a mobile computing device, and 20% have both. The proportion of students that have neither high-speed internet access nor a mobile computing device is:

A. 0%
B. 10%
C. 30%
D. 80%
E. 90%

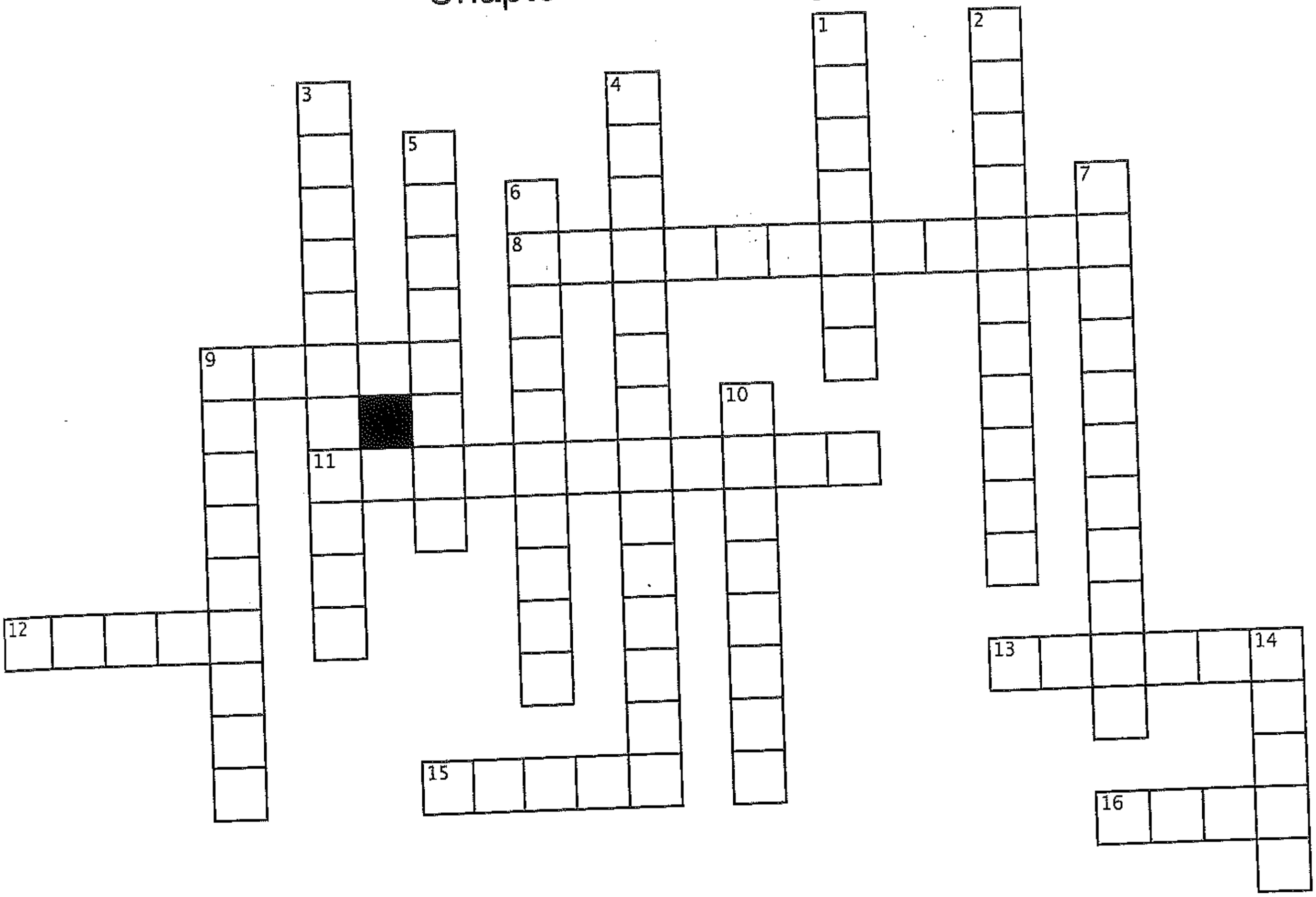
10. Experience has shown that a certain lie detector will show a positive reading (indicates a lie) 10% of the time when a person is telling the truth and 95% of the time when a person is lying. Suppose that a random sample of 5 suspects is subjected to a lie detector test regarding a recent one-person crime. The probability of observing no positive readings if all suspects plead innocent and are telling the truth is:

A. 0.409
B. 0.735
C. 0.00001
D. 0.591
E. 0.99999

Multiple Choice Answers

Problem	Answer	Concept	Right	Wrong	Simple Mistake?	Need to Study More
1	A	Probability Basics				
2	C	Definition of Probability				
3	B	Mutually Exclusive/Independent				
4	C	Probability Calculations				
5	C	Probability Calculations				
6	A	Probability Calculations				
7	C	Probability Basics				
8	B	Conditional Probabilities				
9	C	General Addition Rule				
10	D	Conditional Probabilities				

Chapter 5: Probability



Across

8. The collection of outcomes that occur in both of two events.
9. A collection of outcomes from a chance process.
11. The proportion of times an outcome would occur in a very long series of repetitions.
12. ______ Theorem can be used to find probabilities that require going "backward" in a tree diagram.
13. In statistics, this doesn't mean "haphazard." It means "by chance."
15. The collection of outcomes that occur in either of two events.
16. A _____ diagram can help model chance behavior that involves a sequence of outcomes.

Down

1. The law of large _____ states that the proportion of times an outcome occurs in many repetitions will approach a single value.
2. The probability that one event happens given another event is known to have happened.
3. The set of all possible outcomes for a chance process (two words).
4. The probability that two events both occur can be found using the general ______ rule.
5. P(A or B) can be found using the general ______ rule.
6. The imitation of chance behavior, based on a model that reflects the situation.
7. The occurrence of one event has no effect on the chance that another event will happen.
9. Another term for disjoint: Mutually ______.
10. Two events that have no outcomes in common and can never occur together.
14. A probability _____ describes a chance process and consists of two parts.

2. The ELISA tests whether a patient has contracted HIV. The ELISA is said to be positive if it indicates that HIV is present in a blood sample, and the ELISA is said to be negative if it does not indicate that HIV is present in a blood sample. Instead of directly measuring the presence of HIV, the ELISA measures levels of antibodies in the blood that should be elevated if HIV is present. Because of variability in antibody levels among human patients, the ELISA does not always indicate the correct result.

   As part of a training program, staff at a testing lab applied the ELISA to 500 blood samples known to contain HIV. The ELISA was positive for 489 of those blood samples and negative for the other 11 samples. As part of the same training program, the staff also applied the ELISA to 500 other blood samples known to not contain HIV. The ELISA was positive for 37 of those blood samples and negative for the other 463 samples.

   (a) When a new blood sample arrives at the lab, it will be tested to determine whether HIV is present. Using the data from the training program, estimate the probability that the ELISA would be positive when it is applied to a blood sample that does not contain HIV.

   (b) Among the blood samples examined in the training program that provided positive ELISA results for HIV, what proportion actually contained HIV?

   (c) When a blood sample yields a positive ELISA result, two more ELISAs are performed on the same blood sample. If at least one of the two additional ELISAs is positive, the blood sample is subjected to a more expensive and more accurate test to make a definitive determination of whether HIV is present in the sample. Repeated ELISAs on the same sample are generally assumed to be independent. Under the assumption of independence, what is the probability that a new blood sample that comes into the lab will be subjected to the more expensive test if that sample does not contain HIV?

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Question 2

Intent of Question

The primary goal of this question was to assess students' ability to evaluate conditional probabilities as they relate to diagnostic testing.

Solution

Part (a):

The estimated probability of a positive ELISA if the blood sample does not have HIV present is

$\frac{37}{500}$ *OR* $\frac{37}{500} = 0.074$

Part (b):

A total of 489 + 37 = 526 blood samples resulted in a positive ELISA. Of these, 489 samples actually contained HIV. Therefore the proportion of samples that resulted in a positive ELISA that actually contained HIV is

$\frac{489}{526}$ *OR* $\frac{489}{526} \approx 0.9297$

Part (c):

From part (a), the probability that the ELISA will be positive, given that the blood sample does not actually have HIV present, is 0.074. Thus, the probability of a negative ELISA, given that the blood sample does not actually have HIV present, is $1 - 0.074 = 0.926$.

P(new blood sample that does not contain HIV will be subjected to the more expensive test)

= *P*(*1st ELISA positive* and *2nd ELISA positive* OR *1st ELISA positive* and *2nd ELISA negative* and *3rd ELISA positive* | *HIV not present in blood*)
= *P*(*1st ELISA positive* and *2nd ELISA positive* | *HIV not present in blood*)
+ *P*(*1st ELISA positive* and *2nd ELISA negative* and *3rd ELISA positive* | *HIV not present in blood*)
= (0.074)(0.074) + (0.074)(0.926)(0.074)
= 0.005476 + 0.005070776
= 0.010546776
≈ 0.0105

OR

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Question 2 (continued)

P(new blood sample that does not contain HIV will be subjected to the more expensive test)

$= P(\textit{1st ELISA positive and not both the 2nd and 3rd are negative})$
$= (0.074)(1 - 0.926^2)$
$= (0.074)(0.142524)$
$= 0.010546776$
≈ 0.0105

Scoring

Parts (a), (b), and (c) are each scored as essentially correct (E), partially correct (P), or incorrect (I).

Part (a) is scored as follows:

Essentially correct (E) if the student writes the correct fraction for the estimated probability.

Partially correct (P) if the decimal answer of 0.074 is given with no justification.

Incorrect (I) otherwise.

Part (b) is scored as follows:

Essentially correct (E) if the student writes the correct fraction for the proportion or gives a decimal approximation with justification.

Partially correct (P) if the student writes the wrong fraction but either correctly selects 489 as the numerator or correctly computes $489 + 37 = 526$ as the denominator.

Incorrect (I) otherwise.

Part (c) is scored as follows:

Essentially correct (E) if the student computes the correct probability, showing work.

Partially correct (P) if method is equivalent to *P*(*1st ELISA is positive*) · *P*(*at least one of two subsequent ELISAs is positive*) $= (0.074)(0.1425)$, except that one of the factors is incorrect.

OR

The student correctly computes *P*(*at least one of two subsequent ELISAs is positive*) = 0.1425, failing to include the first factor (0.074).

OR

The student correctly computes the probability of getting at least two positive ELISAs by testing negative blood three times:

$$\binom{3}{2}(0.074)^2(0.926) + \binom{3}{3}(0.074)^3 = 3(0.074)^2(0.926) + (0.074)^3 \approx 0.015617552$$

Incorrect (I) otherwise.

2004 AP® STATISTICS FREE-RESPONSE QUESTIONS

3. At an archaeological site that was an ancient swamp, the bones from 20 brontosaur skeletons have been unearthed. The bones do not show any sign of disease or malformation. It is thought that these animals wandered into a deep area of the swamp and became trapped in the swamp bottom. The 20 left femur bones (thigh bones) were located and 4 of these left femurs are to be randomly selected without replacement for DNA testing to determine gender.

   (a) Let X be the number out of the 4 selected left femurs that are from males. Based on how these bones were sampled, explain why the probability distribution of X is not binomial.

   (b) Suppose that the group of 20 brontosaurs whose remains were found in the swamp had been made up of 10 males and 10 females. What is the probability that all 4 in the sample to be tested are male?

   (c) The DNA testing revealed that all 4 femurs tested were from males. Based on this result and your answer from part (b), do you think that males and females were equally represented in the group of 20 brontosaurs stuck in the swamp? Explain.

   (d) Is it reasonable to generalize your conclusion in part (c) pertaining to the group of 20 brontosaurs to the population of all brontosaurs? Explain why or why not.

4. Two antibiotics are available as treatment for a common ear infection in children.

   - Antibiotic A is known to effectively cure the infection 60 percent of the time. Treatment with antibiotic A costs $50.
   - Antibiotic B is known to effectively cure the infection 90 percent of the time. Treatment with antibiotic B costs $80.

   The antibiotics work independently of one another. Both antibiotics can be safely administered to children. A health insurance company intends to recommend one of the following two plans of treatment for children with this ear infection.

   - Plan I: Treat with antibiotic A first. If it is not effective, then treat with antibiotic B.
   - Plan II: Treat with antibiotic B first. If it is not effective, then treat with antibiotic A.

   (a) If a doctor treats a child with an ear infection using plan I, what is the probability that the child will be cured?

   If a doctor treats a child with an ear infection using plan II, what is the probability that the child will be cured?

   (b) Compute the expected cost per child when plan I is used for treatment.

   Compute the expected cost per child when plan II is used for treatment.

   (c) Based on the results in parts (a) and (b), which plan would you recommend?

   Explain your recommendation.

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(2)

AP® STATISTICS
2004 SCORING GUIDELINES

Question 3

Solution

Part (a):

X is not binomial since the trials are not independent and the conditional probabilities of selecting a male change at each trial depending on the previous outcome(s), due to the sampling without replacement.

Part (b):

$$P(X=4)=\left(\frac{10}{20}\right)\left(\frac{9}{19}\right)\left(\frac{8}{18}\right)\left(\frac{7}{17}\right)=\frac{5040}{116280}=0.043$$

Part (c):

No. If males and females were equally represented, the probability of observing four males is small (0.043).

Part (d):

No, we can't generalize to the population of all brontosaurs because it is not reasonable to regard this sample as a random sample from the population of all brontosaurs; there is reason to suspect that this sampling method might cause bias.

Scoring

Parts (a), (b), and (c) are scored as essentially correct, partially correct, or incorrect. Part (d) is scored as essentially correct or incorrect.

Part (a): Score as:

Essentially correct if the response indicates that

(i) trials are not independent, with an explanation that independence means the outcome on any trial will not impact the probability of success on future trials OR

(ii) the probability of selecting a male on any given trial depends on the results of previous trials.

Partially correct if the response indicates that

(i) the student is focusing on one of the concepts above, but discussion is weak OR

(ii) there is sampling without replacement without connection to one of the concepts under Essentially Correct above.

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Question 3 (cont'd.)

Part (b): Score as:

Essentially correct if the probability is correctly computed (with minor arithmetic errors being overlooked), with supporting work or rationale. A statement that this is a hypergeometric distribution (either in Part(a) or Part(b)) will suffice. It is OK if the student leaves the answer as the product of fractions. The probability that all four femurs belong to males can also be computed by using the formula $P(X=4)=\dfrac{\binom{10}{4}\binom{10}{0}}{\binom{20}{4}}=.043$.

Partially correct if there is a correct answer (to 3 decimal places) with incomplete justification.

Incorrect if arithmetic errors result in a probability that is negative or greater than one.

Part (c): Score as:

Essentially correct if the probability provided in Part (b) is interpreted correctly.

Partially correct if it is not clear that the student used the probability from Part (b).

Incorrect if just a "Yes" or "No" is given without an explanation.

Part (d): Score as:

Essentially correct if the response indicates that generalization is not possible because this sample

(i) cannot be viewed as a random sample of all brontosaurs OR
(ii) there is reason to suspect that this sample might not be representative of the population at large.

Incorrect if "No" is given without an explanation.

Note: Discussions about conditions for inference are irrelevant.

Each essentially correct response is worth 1 point; each partially correct answer is worth ½ point.

(2)

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Question 4

Solution

Part (a):

Let A be the event "antibiotic A works."
Let B be the event "antibiotic B works."

The probability that a child will be cured with Plan I is:

$$\begin{aligned} P(\text{Cure}_{\text{I}}) &= P(\text{A}) + P(\text{not A})P(\text{B}) \\ &= 0.6 + (0.4 \times 0.9) \\ &= 0.96 \end{aligned}$$

The probability that a child will be cured with Plan II is:

$$\begin{aligned} P(\text{Cure}_{\text{II}}) &= P(\text{B}) + P(\text{not B})P(\text{A}) \\ &= 0.9 + (0.1 \times 0.6) \\ &= 0.96 \end{aligned}$$

Part (b):

Treatment with antibiotic A costs \$50, and treatment with antibiotic B costs \$80.

The expected cost per child when Plan I is used for treatment is:

$$\begin{aligned} E(\text{Cost}_{\text{I}}) &= \$50 \times 0.6 + \$130 \times 0.4 \\ &= \$30 + \$52 \\ &= \$82 \end{aligned}$$

The expected cost per child when Plan II is used for treatment is:

$$\begin{aligned} E(\text{Cost}_{\text{II}}) &= \$80 \times 0.9 + \$130 \times 0.1 \\ &= \$72 + \$13 \\ &= \$85 \end{aligned}$$

Part (c):

Since the probability that a child will be cured is the same under either plan, some other criterion must be used to make a recommendation. From a financial point of view, Plan I should be recommended because the expected cost per child is less than Plan II.

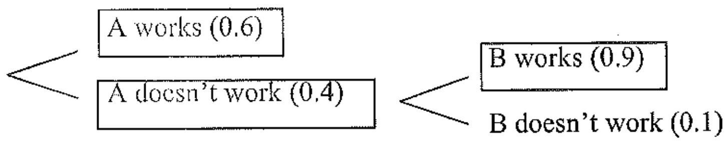
Question 4 (cont'd.)

Scoring

Each part is scored as essentially correct, partially correct, or incorrect.

Part (a) is essentially correct if the probabilities of cure are calculated correctly with justification for both plans.

Plan I:



$$P(\text{Cure}_{\text{I}}) = 0.6 + (0.4 \times 0.9) = 0.96$$

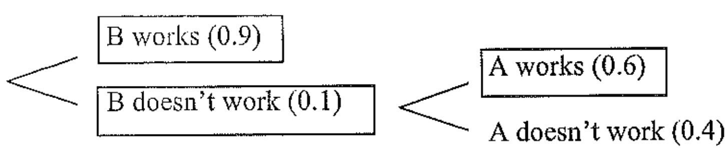
OR

$$P(\text{Cure}_{\text{I}}) = P(\text{A} \cup \text{B}) = 0.6 + 0.9 - (0.6 \times 0.9) = 0.96$$

OR

$$P(\text{Cure}_{\text{I}}) = 1 - P(\text{not A})P(\text{not B}) = 1 - (0.4) \times (0.1) = 0.96$$

Plan II:



$$P(\text{Cure}_{\text{II}}) = 0.9 + (0.1 \times 0.6) = 0.96$$

OR

$$P(\text{Cure}_{\text{II}}) = P(\text{B} \cup \text{A}) = 0.9 + 0.6 - (0.9 \times 0.6) = 0.96$$

OR

$$P(\text{Cure}_{\text{II}}) = 1 - P(\text{not B})P(\text{not A}) = 1 - (0.1) \times (0.4) = 0.96$$

Question 4 (cont'd.)

Part (a) is partially correct if

one of the two probabilities is calculated correctly with justification,

OR

both probabilities are correct with incomplete justifications.

Part (b) is essentially correct if the expected costs per child are calculated correctly with justification for both plans.

The expected cost per child when Plan I is used for treatment is:

$$E(\text{Cost}_{\text{I}}) = \$50\times0.6+\$130\times0.4 = \$30+\$52 = \$82$$

OR

$$E(\text{Cost}_{\text{I}}) = \$50+0.4\times\$80 = \$50+\$32 = \$82$$

The expected cost per child when Plan II is used for treatment is:

$$E(\text{Cost}_{\text{II}}) = \$80\times0.9+\$130\times0.1 = \$72+\$13 = \$85$$

OR

$$E(\text{Cost}_{\text{II}}) = \$80+0.1\times\$50 = \$80+\$5 = \$85$$

Part (b) is partially correct if
the expected cost per child is calculated correctly with justification for one of the two plans,

OR

both expected costs are correct with incomplete justifications,

OR

the expected costs are incorrectly calculated but the probabilities involved add up to 1. For example the following computations would receive a partial.

The expected cost per child when Plan I is used for treatment is:

$$= \$50\times0.6+\$80\times0.4 = \$30+\$32 = \$62$$

The expected cost per child when Plan II is used for treatment is:

$$= \$80\times0.9+\$50\times0.1 = \$72+\$5 = \$77$$

(2)

Question 4 (cont'd.)

In contrast, the following computations would receive an incorrect because the probabilities involved do not add up to 1.

The expected cost per child when Plan I is used for treatment is:

$$= \$50 \times 0.6 + \$130 \times 0.36 = \$30 + \$46.80 = \$76.80$$

The expected cost per child when Plan II is used for treatment is:

$$= \$80 \times 0.9 + \$130 \times 0.06 = \$72 + \$7.80 = \$79.80$$

Part (c) is essentially correct if the recommendation contains a statistical argument based on parts (a) and (b). That is, the student must base the recommendation on probabilities from part (a) and expected values from part (b). The following two examples are essentially correct:

Since the probability that a child will be cured is the same under either plan, some other criterion must be used to make a recommendation. From a financial point of view, Plan I should be recommended because the expected cost per child is less than Plan II.

Since the probability that a child will be cured is the same under either plan, some other criterion must be used to make a recommendation. Parents might prefer Plan II, regardless of its higher cost, because their child is more likely to need only the first drug.

Part (c) is partially correct if the recommendation contains a statistical argument based only on part (a) or (b) but not both.

Part (c) is incorrect if no recommendation is made.

2008 AP® STATISTICS FREE-RESPONSE QUESTIONS

3. A local arcade is hosting a tournament in which contestants play an arcade game with possible scores ranging from 0 to 20. The arcade has set up multiple game tables so that all contestants can play the game at the same time; thus contestant scores are independent. Each contestant's score will be recorded as he or she finishes, and the contestant with the highest score is the winner.

After practicing the game many times, Josephine, one of the contestants, has established the probability distribution of her scores, shown in the table below.

Josephine's Distribution				
Score	16	17	18	19
Probability	0.10	0.30	0.40	0.20

Crystal, another contestant, has also practiced many times. The probability distribution for her scores is shown in the table below.

Crystal's Distribution			
Score	17	18	19
Probability	0.45	0.40	0.15

(a) Calculate the expected score for each player.

(b) Suppose that Josephine scores 16 and Crystal scores 17. The difference (Josephine minus Crystal) of their scores is -1. List all combinations of possible scores for Josephine and Crystal that will produce a difference (Josephine minus Crystal) of -1, and calculate the probability for each combination.

(c) Find the probability that the difference (Josephine minus Crystal) in their scores is -1.

(d) The table below lists all the possible differences in the scores between Josephine and Crystal and some associated probabilities.

Distribution (Josephine minus Crystal)						
Difference	−3	−2	−1	0	1	2
Probability	0.015			0.325	0.260	0.090

Complete the table and calculate the probability that Crystal's score will be higher than Josephine's score.

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AP® STATISTICS
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Question 3

Intent of Question

The primary goals for this question were to assess a student's ability to (1) recognize and calculate the mean as the expected value of a probability distribution; (2) demonstrate how to use two distributions to form all possible ways a specific difference may occur; (3) calculate a probability for this specific difference occurring; and (4) calculate a probability from the probability distribution of all possible differences.

Solution

Part (a):

The expected scores are as follows:

Josephine

$\mu_J = 16(0.1) + 17(0.3) + 18(0.4) + 19(0.2) = 17.7$

Crystal

$\mu_C = 17(0.45) + 18(0.4) + 19(0.15) = 17.7$

Part (b):

J	C	Probability
16	17	(0.1)(0.45) = 0.045
17	18	(0.3)(0.40) = 0.12
18	19	(0.4)(0.15) = 0.06

Part (c):

The probability is

$0.045 + 0.12 + 0.06 = 0.225$

Part (d):

P(difference = –1) = 0.225 (from part c)

P(difference = –2) = 1 – 0.015 – 0.225 – 0.325 – 0.260 – 0.90 = 0.085

Distribution of Josephine – Crystal

Differences	–3	–2	–1	0	1	2
Probability	0.015	**0.085**	**0.225**	0.325	0.260	0.090

The probability that Crystal's score is higher than Josephine's score is

$P(\text{difference} < 0) = 0.015 + 0.085 + 0.225 = 0.325$

Scoring

This problem is scored in three sections. Section 1 consists of part (a). Section 2 consists of parts (b) and (c). Section 3 consists of part (d). Each section is scored as essentially correct (E), partially correct (P), or incorrect (I).

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Question 3 (continued)

Section 1 [part (a)] is scored as follows:

Essentially correct (E) if correct expected scores (means) are calculated for both Josephine and Crystal with appropriate calculations or formulas shown for at least one of the players.

Partially correct (P) if the student makes one of the following errors:

- Rounds both expected values to integers (e.g., approximately 18 or 17–18)
- Calculates only one player's score correctly with appropriate calculations or formula
- Uses nonuniversal calculator syntax with linkage to the values in the table to describe how the correct expected values for both players are calculated
- Shows correct work for the expected values but gives answers of 17.5 and 18 (the unweighted averages)
- Gives correct expected values but does not show the multiplications or does not show the additions

Incorrect (I) if two or more of the errors above are made *OR* if no justification is given for correct answers *OR* if both expected scores are calculated using an incorrect method *OR* if the expected values are not calculated.

Note: If the student shows correct work but has at most one minor arithmetic error and/or copies at most one probability incorrectly from the table, the student should not be penalized for these types of errors.

Section 2 [parts (b) and (c)] is scored as follows:

Essentially correct (E) if all five of the components below are correctly completed by the student:

- Lists all the score combinations that result in a difference of −1 in part (b)
- Calculates the probabilities correctly in part (b)
- Shows appropriate work or formula in part (b)
- Calculates the correct probability for the difference of −1 in part (c)
- Shows appropriate work or formula in part (c)

Partially correct (P) if three or four of the previous components are correct.

Incorrect (I) if at most two of the previous components are correct.

Notes:

- If a student gets incorrect answers for the three combinations that result in a difference of −1 but uses them correctly in part (c), the student can still get credit for the last two components if the resulting probability is between 0 and 1.
- If the student shows correct work but has at most one minor arithmetic error and/or copies at most one probability incorrectly from the table, the student should not be penalized for these types of errors.

Section 3 [part (d)] is scored as follows:

Essentially correct (E) if both of the components below are successfully done by the student:

- Completes the table correctly
- Calculates the correct probability that Crystal's score is higher than Josephine's score *AND* shows appropriate work or formula

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Question 3 (continued)

Partially correct (P) if only one of the components is correct.

Incorrect (I) if both components are incorrect.

Notes:

- It is possible to calculate P(difference = –2) = 0.085 by listing the two combinations that result in a difference of –2.

J	C	Probability
16	18	(0.1)(0.4) = 0.04
17	19	(0.3)(0.15) = 0.045

- If a student has an incorrect answer in part (c) but uses it correctly in part (d), then the P(difference = –2) must be 0.085 *OR* the probabilities in the table must add up to 1 to get credit for the first component.
- If any of the values in the table are less than 0 or greater than 1, then no credit will be given for the first component.
- If the student shows correct work but has at most one minor arithmetic error and/or copies at most one probability incorrectly from the table, the student should not be penalized for these types of errors.

4 **Complete Response**

All three sections essentially correct

3 **Substantial Response**

Two sections essentially correct and one section partially correct

2 **Developing Response**

Two sections essentially correct and no sections partially correct

OR

One section essentially correct and one or two sections partially correct

OR

Three sections partially correct

1 **Minimal Response**

One section essentially correct and no parts partially correct

OR

No sections essentially correct and two sections partially correct