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

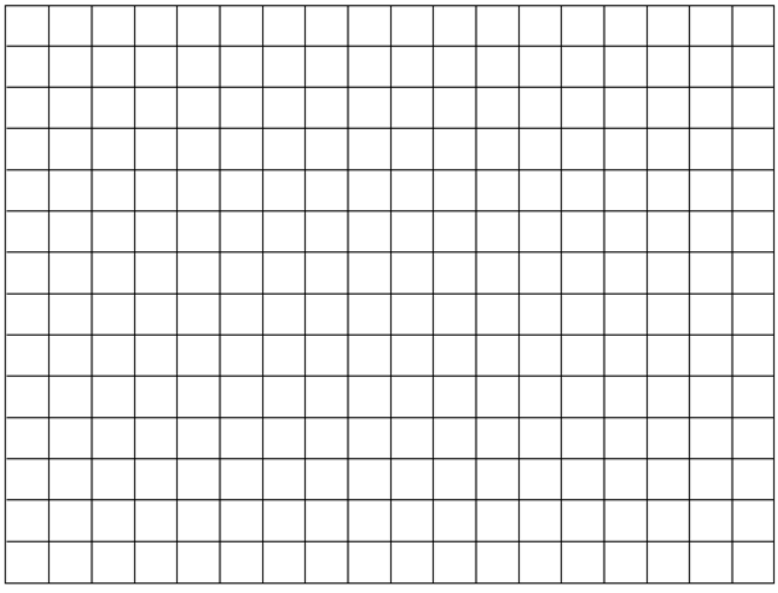
   Complete the table and calculate the probability that Crystal's score will be higher than Josephine's score.

4. An experiment was conducted to study the effect of temperature on the reliability of an electronic device used in an undersea communications system. The experiment was done in a laboratory where tanks of seawater were maintained at either 10°C, 30°C, 50°C, or 70°C. After the electronic devices were submerged in the tanks for 5,000 hours, each device was inspected to determine if it was still working. The following table provides information on the number of devices tested at each temperature and the number of working devices at the end of the 5,000-hour test.

Seawater temperature	10°C	30°C	50°C	70°C
Number of working devices	29	42	21	12
Number of devices tested	30	50	30	20

You may assume that the result for any single device is not influenced by the result for any other device.

(a) Using the information in the table, construct a scatterplot that would be useful for showing the effect of water temperature on the ability of the devices to work for at least 5,000 hours.



(b) Comment on any trend or pattern that is revealed by the scatterplot you constructed.

(c) An estimate of the proportion of devices that would work after 5,000 hours of submersion in 40°C seawater can be obtained by averaging the estimates at 30°C and 50°C. Compute this estimate and the associated standard error.

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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(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