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VCE Mathematical Methods ¾

Discrete Random Variables I [5.1]

Test

31.5 Marks. 1 Minute Reading. 23 Minutes Writing.

Results:

Test Questions	_____ / 14.5
Extension Test Questions	_____ / 17

Section A: Test Questions (14.5 Marks)

Question 1 (3.5 marks)

Tick whether the following statements are **true** or **false**.

Statement	True	False
a. The sample space represents the set of all possible outcomes.		
b. Mutually exclusive events can occur simultaneously.		
c. Independent events can occur simultaneously.		
d. Independent events do not affect each other's probability and are given by $\Pr(A) \times \Pr(B) = \Pr(A \cup B)$.		
e. Conditional probability occurs when the sample space is restricted due to the given condition.		
f. For conditional probability, a Venn diagram is best to use for complicated questions.		
g. The conditional probability for independent events is the same as the conditional probability for dependent events.		

Space for Personal Notes

Question 2 (2 marks)

Two events A and B from a given event space are such that $\Pr(A) = \frac{1}{5}$ and $\Pr(B) = \frac{1}{3}$.

a. Calculate $\Pr(A' \cap B)$ when $\Pr(A \cap B) = \frac{1}{8}$. (1 mark)

b. Calculate $\Pr(A' \cap B)$ when A and B are mutually exclusive events. (1 mark)

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Question 3 (5 marks)

For events A and B from a sample space, $\Pr(A \mid B) = \frac{1}{5}$ and $\Pr(B \mid A) = \frac{1}{4}$. Let $\Pr(A \cap B) = p$.

a. Find $\Pr(A)$ in terms of p. (1 mark)

b. Find $\Pr(A' \cap B')$ in terms of p. (2 marks)

c. Given that $\Pr(A \cup B) \leq \frac{1}{5}$, state the largest possible interval for p. (2 marks)

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Question 4 (4 marks)

Two boxes each contain four stones that differ only in colour.
Box 1 contains four black stones.
Box 2 contains two black stones and two white stones.
A box is chosen randomly, and one stone is drawn randomly from it.
Each box is equally likely to be chosen, as is each stone.

a. What is the probability that the randomly drawn stone is black? (2 marks)

b. It is known from which box the stone has been drawn.

Given that the stone that is drawn is black, what is the probability that it was drawn from Box 1? (2 marks)

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Section B: Extension Test Questions (17 Marks)

Question 5 (11 marks) **Tech-Active.**

A mobile phone technician is studying the performance of two brands of phones, Brand A and Brand B.

When a phone is sent in for repair, the technician classifies the phone as either" easily repairable" or "difficult to repair". Based on the past records, 60% of all phones are Brand A, and the remaining 40% are Brand B.

The technician believes:

- 90% of Brand A phones are easily repairable.
- 50% of Brand B phones are easily repairable.

Let R represent the event that a phone is easily repairable, A represent the event that the phone is Brand A, and B represent the event that the phone is Brand B.

a.

i. Find the probability that a phone is easily repairable. (2 marks)

_____

_____

_____

_____

ii. Given that a randomly chosen phone is easily repairable, find the probability that it is a Brand A phone. (1 mark)

_____

_____

_____

iii. Given that a randomly chosen phone is not easily repairable, find the probability that it is a Brand B phone. (2 marks)

A third phone brand, Brand C, is introduced. The technician now records 67% of all phones sent in as easily repairable. Brand C makes up 20% of all phones sent in for repair.

Brand A and B keep the same statistics as above, and the ratio of Brand A phones to Brand B phones that are sent in for repair is $3:2$. Let c be the probability that a randomly chosen Brand C phone is easily repairable.

b.

i. Find the fraction of phones that are Brand A and the fraction of phones that are Brand B. (2 marks)

ii. Hence, find the value of c. (2 marks)

An external agency believes that the technician's assumption about repairability (that 67% of phones are easily repairable) is only valid for phones sent in during the morning. They believe that for phones sent in during the afternoon, the probability that a phone is easily repairable is x, where $0.8 \leq x \leq 0.95$.

c. Let the probability that a phone is sent in the afternoon be y. If the overall proportion of easily repairable phones observed is 0.78, find the minimum and maximum values of y, assuming the external agency's beliefs are correct. (2 marks)

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Question 6 (3 marks)

There are 100 people in line to board a plane with 100 seats. The first person has lost his boarding pass, so he takes a random seat. Everyone that follows takes their assigned seat if it's available, but otherwise takes a random unoccupied seat. What is the probability that the last passenger ends up in his or her assigned seat?

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Question 7 (3 marks)

A man is stranded on an island. A benevolent genie presents three boxes, 23 white marbles and 7 black marbles and instructs the man, "You may distribute the marbles into the boxes any way you see fit, but you must use all of the marbles. Once you finish, you will choose a box at random and then choose a marble from that box at random. If the marble is white, then I will help you escape from this place."

Assuming the man distributes the marbles in his best interest, what is the probability that he escapes the island? And what is the best way to distribute the marbles?

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