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VCE Mathematical Methods ½
Probability [3.1]
Test Solutions

30 Marks. 1 Minute Reading. 24 Minutes Writing.

<u>Results</u>:

Test Questions	_____ / 30

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Section A: Test Questions (30 Marks)

Question 1 (5 marks)

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

Statement	True	False
a. For a sample space of two events, if $P(\emptyset) = 0$, then $P(\xi) = 1$.	✓	
b. If two events are mutually exclusive/disjoint, then $\Pr(A \cap B) = \Pr(A) + \Pr(B)$.		✓
c. When two events are mutually exclusive, their complements are also mutually exclusive.		✓
d. All complement events are mutually exclusive. However, not all mutually exclusive events are complements.	✓	
e. If two events A and B are independent, then $\Pr(A \cap B) = \Pr(A) \times \Pr(B)$.	✓	
f. When two events are independent, their complements are also independent.	✓	
g. If $P(A) = 0.5$ and $P(B) = 0.7$ and $P(A \cup B) = 0.3$ then $P(A \cap B) = 0.9$.	✓	
h. The probability of A given B is always equal to the probability of B given A.		✓
False. The probability of A given B is not necessarily equal to the probability of B given A, unless A and B are independent events.		
i. If A and B are independent events, then the probability of A given B is equal to the probability of A.	✓	
j. If $P(A) = 0.5$ and $P(B) = 0.8$, then $P(A \cap B)$ must be greater than or equal to 0.5.		✓
False. $P(A$ and $B)$ can be at most 0.5 (the smaller of $P(A)$ and $P(B)$).		

Space for Personal Notes

Question 2 (6 marks)

Suppose that for events A and $B,$ we know the following probabilities:

$$P(A) = 0.3, P(B) = 0.3 \text{ and } P(A \cup B) = 0.5.$$

Compute:

a. $P(A')$. (2 marks)

_____

_____

$$\boxed{P(A') = 0.7}$$

_____

_____

b. $P(A' \cap B')$. (2 marks)

_____

_____

$$\boxed{P(A' \cap B') = 0.5}$$

_____

c. $P(A \cap B)$. (2 marks)

_____

_____

$$\boxed{(c) \ P(A \cap B) = 0.1,}$$

_____

_____

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Question 3 (6 marks)

Suppose that A and B mutually exclusive events for which $P(A) = 0.3$ and $P(B) = 0.5$. What is the probability that:

a. Either A or B occurs? (2 marks)

Since A and B are mutually exclusive then $P(A \cup B) = P(A) + P(B)$.

Part (a): To calculate the probability that either A or B occurs we evaluate $P(A \cup B) = P(A) + P(B) = 0.3 + 0.5 = 0.8$

b. A occurs but B does not? (2 marks)

Part (b): To calculate the probability that A occurs but B does not we want to evaluate $P(A \backslash B)$. This can be done by considering

$$P(A \cup B) = P(B \cup (A \backslash B)) = P(B) + P(A \backslash B),$$

where the last equality is due to the fact that B and $A \backslash B$ are mutually independent. Using what we found from part (a) $P(A \cup B) = P(A) + P(B)$, the above gives

$$P(A \backslash B) = P(A) + P(B) - P(B) = P(A) = 0.3.$$

c. Both A and B occur? (2 marks)

Part (c): To calculate the probability that both A and B occurs we want to evaluate $P(A \cap B)$, which can be found by using

$$P(A \cup B) = P(A) + P(B) - P(A \cap B).$$

Using what we know in the above we have that

$$P(A \cap B) = P(A) + P(B) - P(A \cup B) = \boxed{0.3 + 0.5 - 0.8 = 0}$$

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Question 4 (2 marks)

A survey of all year 11 Contour students found that 70% of the students study Maths Methods and 60% of the students study Chemistry and 40% study both subjects.

A random Contour student is selected, find the probability that they study either Maths Methods or Chemistry.

$$\Pr(M \cup C) = \Pr(M) + \Pr(C) - \Pr(M \cap C)$$
$$= 0.7 + 0.6 - 0.4$$
$$= 0.9$$

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Question 5 (6 marks)

Two hundred patients who had either hip surgery or knee surgery were asked whether they were satisfied or dissatisfied regarding the result of their surgery. The following table summarises their response.

Surgery	Satisfied (S)	Dissatisfied (D)	Total
Knee (K)	70	25	95
Hip (H)	90	15	105
Total	160	40	200

a. If one person from the 200 patients are selected at random, determine the probability that the person was satisfied *GIVEN* that the person had knee surgery. (2 marks)

$$P(satisfied\ given\ person\ had\ knee\ surgery) = P(S|K) = \frac{n(S \cap K)}{n(K)} = \frac{70}{95} = \frac{14}{19}$$

b. Was dissatisfied given that they had hip surgery. (2 marks)

$$P(satisfied\ given\ person\ had\ hip\ surgery) = P(D|H) = \frac{n(D \cap H)}{n(H)} = \frac{15}{105} = \frac{1}{7}$$

c. Had knee surgery given that they were dissatisfied. (2 marks)

$$P(had\ knee\ surgery\ given\ they\ were\ dissatisfied) = P(K|D) = \frac{n(K \cap D)}{n(D)} = \frac{25}{40} = \frac{5}{8}$$

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Question 6 (5 marks)

A school cafeteria offers two meal options: Vegetarian (V) and Non-Vegetarian (N). A survey found that:

➤ 40% of students choose the Vegetarian meal.

➤ 60% of students choose the Non-Vegetarian meal.

Additionally, students can either like (L) or dislike (D) their chosen meal. The probabilities of students liking their chosen meal are:

➤ 70% of Vegetarian meal eaters like their meal.

➤ 50% of Non-Vegetarian meal eaters like their meal.

a. Draw a tree diagram for this scenario. (2 marks)
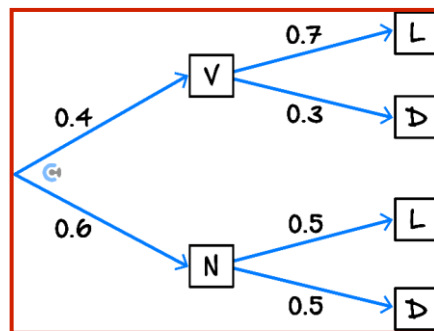
b. What is the probability that a random student likes their meal? (1 mark)

$$\Pr(L) = 0.28 + 0.3 = 0.58$$

c. Given that the student likes the meal, what is the probability that they chose the vegetarian option? (2 marks)

$$\Pr(V|L) = \frac{0.28}{0.58} = \frac{14}{29}$$

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