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VCE Mathematical Methods ½
Probability Exam Skills [3.2]
Homework Solutions

Admin Info & Homework Outline:



Student Name	
Questions You Need Help For	
Compulsory Questions	Pg 2 – Pg 15

Section A: Compulsory Questions (51 Marks)

Sub-Section: Exam 1 Questions

Question 1 (6 marks)

Two coins, coin A and coin B are tossed simultaneously. Let A be the event that coin A lands on heads and B be the event that coin B lands on heads.

- a. Explain why A and B are independent events. (1 mark)

The outcome of coin A does not influence the outcome of coin B and vice versa.

- b. Draw a Karnaugh table illustrating the possible outcomes of the toss. (2 marks)

	A	A'	
B	0.25	0.25	0.5
B'	0.25	0.25	0.5
	0.5	0.5	

c. Hence, find the probability that:

i. Coin A returns heads. (1 mark)

$$\Pr(A) = 0.5$$

ii. Exactly one head is obtained. (1 mark)

$$\Pr(\text{one head}) = \Pr(A \cup B) = 0.5$$

iii. No coins return heads. (1 mark)

$$\Pr(\text{no heads}) = \Pr(A' \cup B') = 0.25$$

Question 2 (6 marks)

An aspiring mathematician is studying the properties of a standard deck of 52 cards. He starts by taking one card from the deck, placing it aside, and then taking another card and placing it aside.

Find the probability that:

a. A spade is chosen, followed by a heart. (2 marks)

$$\Pr(\text{spade then heart}) = \frac{1}{4} \times \frac{13}{51} = \frac{13}{204}$$

b. 2 cards from the same suit are chosen. (2 marks)

$$\Pr(\text{same suit}) = 1 \times \frac{12}{51} = \frac{4}{17}$$

- c. The two chosen cards are consecutive (e.g. 6 and 7 or Q and J – this can go both ways e.g. K and A are consecutive, so are A and 2). (2 marks)

$$\Pr(\text{consecutive}) = \Pr(\text{any card}) \times \Pr(1 \text{ of } 2 \text{ consecutive cards from } 4 \text{ suits}) = 1 \times \frac{8}{51} = \frac{8}{51}$$

Question 3 (5 marks)

Given that 2 events A and B are mutually exclusive, and $\Pr(A) = 0.3$ and $\Pr(B') = 0.4$.

Find the probability of:

- a. $\Pr(A \cap B)$. (1 mark)

0

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

$\Pr(A' \cap B) = \Pr(B) = 1 - \Pr(B') = 0.6$

c. $\Pr(A \cup B)$. (2 marks)

	A	A'	
B	0	0.6	0.6
B'	0.3	0.1	0.4
	0.3	0.7	

$\therefore \Pr(A \cup B) = 1 - \Pr(A' \cap B') = 0.9$

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Question 4 (5 marks)

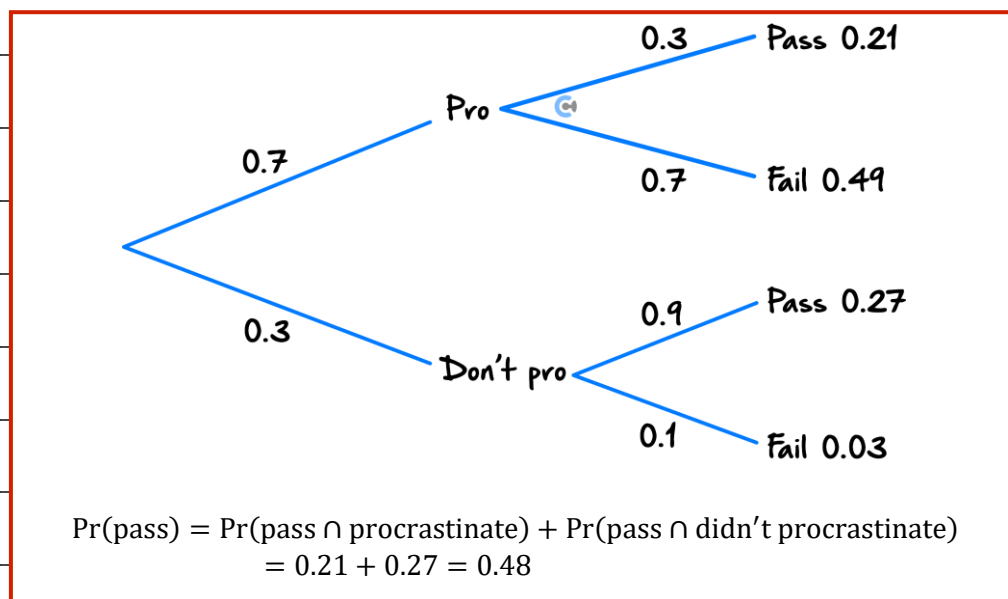
If a particular student does not procrastinate before a test, the probability that they pass the test is 0.9. However, the probability that they do procrastinate, resulting in a 0.3 passing probability, is 0.7.

a. Find the probability that they:

i. Fail the test after procrastinating. (1 mark)

$$\begin{aligned} \text{Rearranging conditional probability formula; } \Pr(A|B) &= \frac{\Pr(A \cap B)}{\Pr(B)} \\ \Pr(\text{fail} \cap \text{procrastinate}) &= \Pr(\text{procrastinate}) \times \Pr(\text{fail}|\text{procrastinate}) \\ &= 0.7 \times 0.7 = 0.49 \end{aligned}$$

ii. Pass the test regardless of whether they procrastinate. (3 marks)



b. Hence, find the probability that the student does not pass the test. (1 mark)

$$\begin{aligned} \Pr(\text{fail}) &= \Pr(\text{fail} \cap \text{procrastinate}) + \Pr(\text{fail} \cap \text{didn't procrastinate}) = 0.49 + 0.03 \\ &= 0.52 \end{aligned}$$

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Question 5 (3 marks)

James is studying independent events. He knows that for 2 events, A and B , that $\Pr(A \cup B) = 0.8$, $\Pr(A' \cup B) = 0.7$ and $\Pr(A) = 0.6$ but does not know how to determine whether or not the events are independent. Help James determine whether the events A and B are independent.

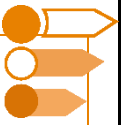
	A	A'	
B	0.3		0.5
B'	0.3	0.2	0.5
	0.6		

From $\Pr(A \cup B) = 0.8$

From $\Pr(A' \cup B) = 0.7$

$\Pr(A) \times \Pr(B) = 0.6 \times 0.5 = 0.3 = \Pr(A \cap B)$
 $\therefore A$ and B are independent.

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Sub-Section: Exam 2 Questions

Question 6

Which of the following Karnaugh tables represents a set of events that are independent?

A.

	A	A'	
B	0.32	0.08	0.4
B'	0.38	0.22	0.6
	0.7	0.3	

B.

	A	A'	
B	0.32	0.08	0.4
B'	0.28	0.32	0.6
	0.6	0.4	

C.

	A	A'	
B	0.3	0.2	0.5
B'	0.2	0.3	0.5
	0.5	0.5	

D.

	A	A'	
B	0.1	0.4	0.5
B'	0.1	0.4	0.5
	0.2	0.8	

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Question 7

The letters from the word ENVIRONMENT are randomised and placed in a row. The probability of the first two letters both being “E” is:

A. $\frac{2}{110}$

B. $\frac{4}{121}$

C. $\frac{2}{121}$

D. $\frac{1}{11}$

Question 8

OpenAI has offered small business owners a taste of their new top-secret business AI model through a lottery. Angad and Amitav are withdrawn from the failure that was AngadGPT and jump on this opportunity. They calculate that their chances of gaining access to juicy business secrets are $\frac{1}{80}$. If 4000 tickets were sold, how many tickets are Angad and Amitav in possession of?

A. 5

B. 10

C. 50

D. 500

Question 9

A coin is thrown 3 times. The total number of outcomes is:

A. 4

B. 3

C. 9

D. 8

Question 10

Two events A and B are independent and mutually exclusive. Which of the following must be true?

- A. $\Pr(A \cup B) = 0$
- B. $\Pr(A) \Pr(B) = 0$
- C. $\Pr(A \cup B) = \Pr(A) \Pr(B)$
- D. None of the above

Question 11 (16 marks)

It is known that a randomly selected summer's day can be rainy or sunny. There is a 0.6 probability that it will be sunny and a 0.2 probability that it will be rainy.

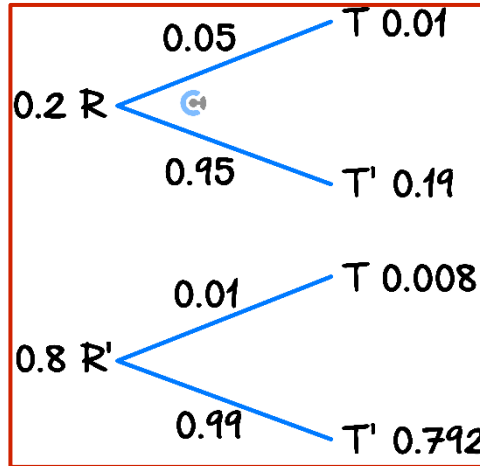
- a. Given that it cannot be rainy and sunny on the same day, use a Karnaugh table to find the probability that it will not be rainy or sunny on a given day (2 marks)

	R	R'	
S	0	0.6	0.6
S'	0.2	0.2	0.4
	0.2	0.8	

$\Pr(R' \cap S') = 0.2$

However, in Melbourne, this is not the case and any combination of weather events can occur on a given day where $\Pr(\text{sunny}) = 0.6$ and $\Pr(\text{rainy}) = 0.2$, with the events “sunny” and “rainy” being independent events.

- b. If it rains, the chance that there is a thunderstorm is 0.05, if it does not rain, the chance that there is a thunderstorm is 0.01. Draw a tree diagram to illustrate these outcomes. (2 marks)



An unsurprising summer day in Melbourne occurs if it is sunny, rainy, and there is a thunderstorm on the same day.

- c. Find the probability that any given summer day is an unsurprising summer day in Melbourne. (2 marks)

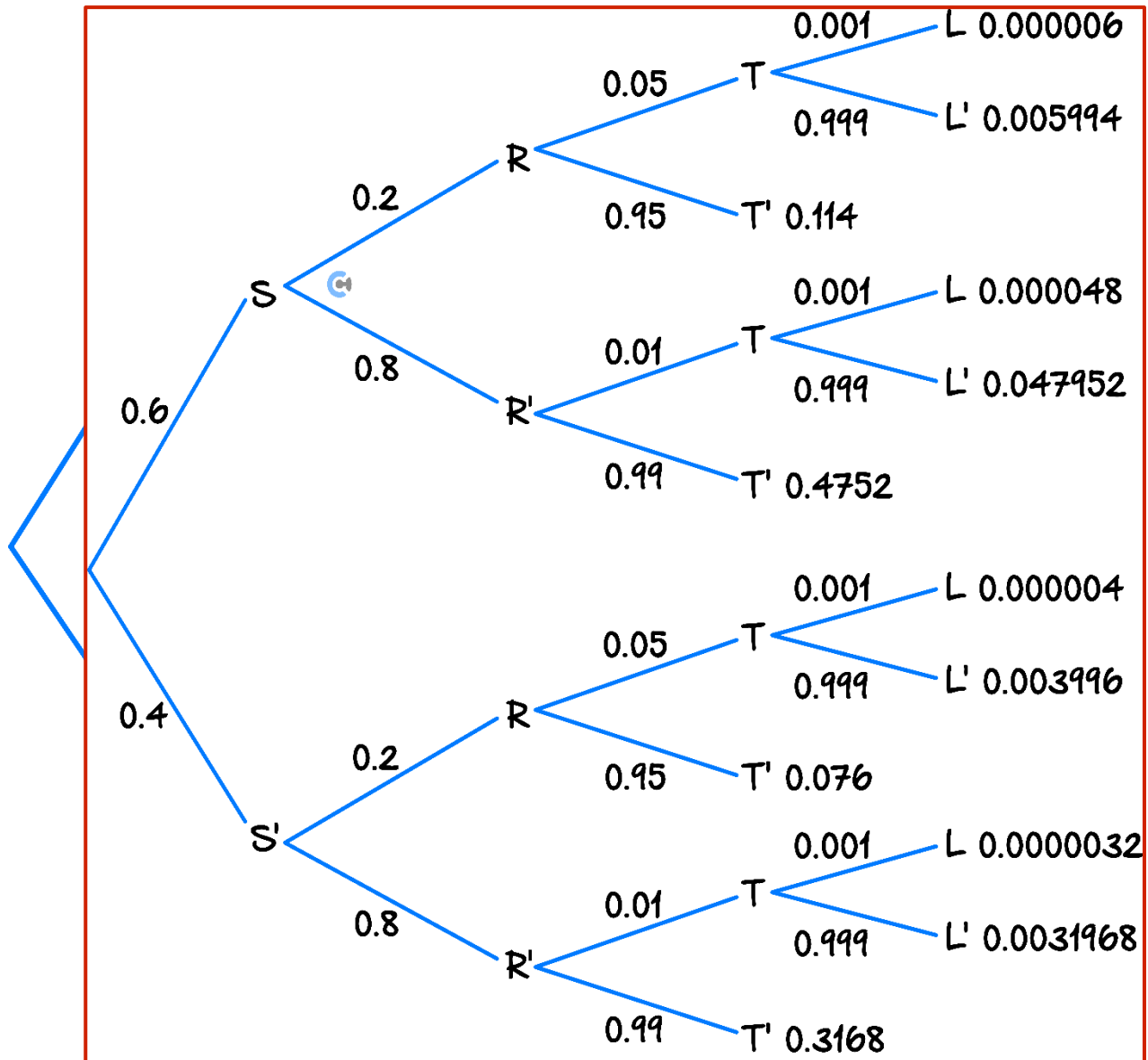
Hint: Stormy weather is not dependent on sunny weather.

$$\Pr(\text{unsurprising}) = \Pr(S \cap R \cap T) = \Pr(S) \times \Pr(R \cap T) = 0.6 \times 0.01 = 0.006$$

During a thunderstorm, the probability of being struck by lightning is 0.001. It is not possible to be struck by lightning when there is not a thunderstorm. It is known that Alex really likes playing in the rain.

- d. Construct a tree diagram of every possible event that can happen on a Melbourne summer day. You do not need to calculate the probabilities of the final outcomes. Calculations of the final probabilities of each outcome are not necessary, but label each branch of the diagram with its corresponding probability. (6 marks)

Hint: Start with sunny or rainy weather.



e. Hence, find the probability that:

- i. Alex is struck by lightning on a rainy day. Give your answer in the form $a \times 10^{-b}$, where $a \in \mathbb{R}^+$ and $b \in \mathbb{Z}^+$. (1 mark)

$$\Pr(R \cap L) = 0.000006 + 0.000004 = 1 \times 10^{-5}$$

- ii. Alex is struck by lightning on an unsurprising summer day. Give your answer in the form $a \times 10^{-b}$, where $a \in \mathbb{Z}^+$ and $b \in \mathbb{Z}^+$. (1 mark)

$$\Pr(\text{unsurprising} \cap L) = \Pr(S \cap R \cap T \cap L) = 0.000006 = 6 \times 10^{-6}$$

- iii. Alex is struck by lightning on any given summer day. Give your answer in the form $a \times 10^{-b}$, where $a \in \mathbb{R}^+$ and $b \in \mathbb{Z}^+$. (2 marks)

$$\Pr(L) = (0.6 + 4.8 + 0.4 + 0.32) \times 10^{-5} = 6.12 \times 10^{-5}$$

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Question 12 (10 marks)

Subu has bought a KFC Chicken Bucket containing 3 original recipes, 2 chicken tenders and 5 nuggets.

- a. Subu is feeling spontaneous today and takes 2 pieces of chicken from the bucket without looking and eats them. Find the probability that Subu does not eat a chicken nugget. (2 marks)

$$\Pr(\text{no nugget}) = \frac{5}{10} \times \frac{4}{9} = \frac{2}{9}$$

Subu is still hungry after he has just eaten 1 chicken nugget and 1 original recipe so he takes another 2 pieces of chicken from the bucket and eats them.

- b. Find the probability that Subu eats a tender and a nugget in any order. (2 marks)

$$\Pr(\text{tender and nugget}) = \Pr(\text{nugget then tender}) + \Pr(\text{tender then nugget}) = \left(\frac{4}{8} \times \frac{2}{7}\right) + \left(\frac{2}{8} \times \frac{4}{7}\right) = \frac{2}{7}$$

Subu is finally satisfied after eating a tender and a nugget on top of what he ate after **part a.** so he gives the rest of the bucket to his friend Sam who has not eaten yet.

- c. Sam eats what's left in the bucket and is too hungry to look at what he is grabbing. Find the probability that he starts with the remaining nuggets before eating anything else. (2 marks)

$$\Pr(3 \text{ nuggets first}) = \frac{3}{6} \times \frac{2}{5} \times \frac{1}{4} = \frac{1}{20}$$

d. After Sam finishes, Subu decides that he is actually still quite hungry and so he and Sam decide to buy another bucket with the same amounts of each chicken item to share. Subu and Sam take turns taking and eating chicken from the bucket without looking at what they are getting.

- i. Explain why the events “Sam eats a chicken nugget” and “Subu eats an original recipe” are not independent events. (1 mark)

If Sam eats a chicken nugget, Subu has a higher chance of eating an original recipe, and vice versa.

- ii. Sam really likes chicken nuggets. Find the probability that it is his lucky day and he manages to grab all of the chicken nuggets in the bucket, taking into account that either Sam or Subu can go first. (3 marks)

Hint: Remember that either Sam or Subu can go first.

For Sam to get all the nuggets, Sam needs to get a nugget every time and Subu needs to get not a nugget every time.

$$\Pr(\text{Sam gets nuggies}) = \Pr(\text{Nuggies} \cap \text{Sam first}) + \Pr(\text{No Nuggies} \cap \text{Subu first})$$

$$= \left(\frac{5}{10} \times \frac{5}{9} \times \frac{4}{8} \times \frac{4}{7} \times \frac{3}{6} \times \frac{3}{5} \times \frac{2}{4} \times \frac{2}{3} \times \frac{1}{2} \right) \times 2 = \frac{1}{126}$$

The chance that Sam gets all the nuggets is the same no matter who goes first so you can just multiply by 2.

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