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VCE Mathematical Methods ½
Combinations & Permutations Exam Skills [3.4]
Homework

Admin Info & Homework Outline:

Student Name	
Questions You Need Help For	
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Section A: Compulsory Questions

Sub-Section[3.4.1]: Applying Pascal's Triangle and Symmetrical Properties of Combinations

Pascals Triangle and ${}^{n}C_{r}$

- You may find this useful for the following questions.

Question 1

a. Find ${}^{5}C_{2}$ using Pascal's Triangle. An illustration of Pascal's Triangle may be useful but not necessary.

b. Express ${}^{5}C_{2}$ as a sum of 2 combinations using Pascal's Triangle.

c. Hence, express ${}^nC_r$ as a sum of 2 combinations, where $n > 1$ and $r \in [1, n)$.

Question 2

a. Find a combination equivalent to ${}^nC_r$ using Pascal's triangle, where $n > 1$ and $r \in [1, n)$.

b. Given that ${}^{14}C_5 = 2002, {}^{13}C_7 = 1716$, and ${}^{13}C_9 = 715$, by using Pascal's Triangle, find:

i. ${}^{14}C_9$

ii. ${}^{14}C_8$

Question 3

Room 6 at Contour Glen Waverley has been downsized due to budget constraints. There are now only 6 seats on the outer U and the rest of the seats are in the middle. Thankfully, the maths meeting today only has 10 tutors attending, so everyone still gets a seat. James has to decide who gets to sit on the outside and who has to sit in the middle.

a. James has to pick 4 tutors to sit in the middle. How many ways can he do this?

b. Hence, state the number of ways James can pick the 6 tutors who don't have to sit in the middle.

c. Sam shows up to the meeting late after his date with Emily while James is allocating seats. Now 5 people must sit in the middle.

i. Without doing numerical calculations, how many ways can James allocate the middle seats if Sam has to sit in the middle as a punishment for ruining James' plans?

ii. How many ways can James allocate the middle seats if Sam doesn't have to sit in the middle and gets away with his shenanigans, given that there would have been 252 ways to seat 5 people in the middle before Sam showed up?

d. For the next meeting in a larger room, James forgets the number of tutors that will be attending, but he remembers that there were the same number of ways to choose the 10 people who didn't have to sit in the middle and the 4 people who did have to sit in the middle. How many tutors are attending the next meeting?

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Sub-Section [3.4.2]: Finding Selections of Any Size

Question 4

Subu would like some KFC, but now that bulking season is over, he wants to eat responsibly. He has 5 menu items to choose from, and he can eat any number of them, including none. How many different meal combinations can Subu eat?

Hint: You may refer to Pascal's Triangle at the start of the booklet.

Question 5

Contour students receive homework each week. This week, the question booklet has n questions on it. The students can choose to do any number of questions in the booklet, including none.

a. How many different ways can the homework booklet be attempted? Express your answer in terms of n.

b. If there are 512 ways that the homework booklet can be attempted, find the number of questions on the booklet this week.

c. The student's parents will be notified if they have not completed at least half of the questions in the booklet. How many outcomes will lead to a student's parents being notified?

Question 6

Liz has a sticker pad with n stickers on it. When she is marking a student's homework, she can put any amount of stickers on it, including none if the student has not gotten anything right (or if they have copied from the answers – which is very easy to spot).

a. One week, Liz realises that her pad is running out of stickers and that there are only 1024 different ways that she can apply her remaining stickers to a homework booklet. How many stickers does Liz have left?

b. However, Liz is in a good mood today so she definitely wants to give away at least one sticker. How many different sticker distribution selections are now possible?

c. Liz discovers that her sticker pad actually has one more sticker on the last page. She is in an even better mood after discovering this and wants to give away at least 2 stickers now. How many different sticker distributions are now possible?

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Sub-Section: Exam 1 Questions

Question 7 (3 marks)

This week your class has 8 students. Every week, your tutor selects 3 students to answer questions.

a. How many ways can your tutor select 3 students to answer questions this week? (1 mark)

b. If the students are randomly selected, what is the probability that you get selected to answer a question this week? (2 marks)

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Question 8 (4 marks)

A student ID consists of 4 digits chosen from the numbers 0-9.

a. How many different student ID codes can be created if the digits can be repeated? (1 mark)

b. If each digit in the ID must be unique, how many different IDs can be created? (1 mark)

c. If the ID cannot start with 0, and each digit must be unique, how many different IDs can be created? (2 marks)

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Question 9 (3 marks)

James is arranging the 5 senior members of the VCE Maths team at Contour for a photo. However, James must be at one of the two ends because he is the head of maths. How many different ways can the tutors be arranged?

Question 10 (3 marks)

A 4 character pin on a strange website is made in a way in which:

- The first 2 characters are letters chosen from A, B, C, D, E and F.
- The last 2 characters are numbers chosen from $1, 2, 3$ and 4.

a. How many different pins can be created? (1 mark)

b. If a pin is chosen at random, what is the probability that both letters are vowels? (2 marks)

Question 11 (3 marks)

Joseph is writing a practice exam. He has 6 different questions from last year's exam that he can yoink, and he can yoink any number of them.

a. How many different ways can Joseph write the exam using last year's questions? (1 mark)

_____

_____

b. Joseph is on a time crunch and has to use at least 2 of the questions from last year. How many ways can he write the exam now? (2 marks)

_____

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Question 12 (6 marks)

Contour is forming a 4-person team of students to compete in a competition between tutoring companies. 10 students volunteer to be part of this team.

a. How many different ways can Contour select the team? (1 mark)

b. Show that selecting 4 students to be on the team is the same as selecting 6 students not to be on the team. (2 marks)

c. Another student volunteers late, increasing the group to 11 students. Show that the new number of ways to select 4 students can be found using Pascal's identity (${}^{n}C_{r} = {}^{n-1}C_{r-1} + {}^{n-1}C_{r}$). (3 marks)

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Sub-Section: Exam 2 Questions

Question 13 (1 mark)

A debating team needs to select 3 speakers from a group of 9 students. How many different ways can they be chosen?

A. 56

B. 84

C. 126

D. 168

Question 14 (1 mark)

Some of the Contour team are lining up for a photo at the AGM. There are 6 team members, but Sam and Emily must stand together. How many different ways can they be arranged?

A. 240

B. 480

C. 720

D. 1440

Question 15 (1 mark)

A school library has 15 different books on a shelf. A student randomly selects 4 books to borrow. What is the probability that a specific book, *Calculus for Fun*, is chosen?

A. $\frac{1}{3}$

B. $\frac{1}{5}$

C. $\frac{2}{5}$

D. $\frac{4}{15}$

Question 16 (1 mark)

In the upcoming Contour Maths meeting, there are 7 potential topics to be discussed. When making the agenda, James cannot decide what topics need to be discussed. Suppose that any amount of subjects can be discussed, but at least one has to be discussed. How many different agendas can James create?

A. 128

B. 63

C. 255

D. 127

Question 17 (1 mark)

A school principal team has to decide on 4 school captains from a pool of 10 candidates. Which of the following expressions is equivalent to the number of ways to form the school captains?

A. ${}^{10}C_3$

B. ${}^{9}C_4 + {}^{9}C_3$

C. ${}^{10}C_7$

D. ${}^{11}C_5 - {}^{10}C_4$

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Question 18 (11 marks)

Contour is hosting an exam revision session, where tutors will go through students' questions. There are 15 tutors available for the session, but Contour doesn't have the budget to pay all of them for it.

a. How many ways can Contour select 3 tutors? (1 mark)

b. Once chosen, the tutors must be assigned a speaking order. How many ways can this be done? (1 mark)

c. What is the probability that Sam will be selected to present? (2 marks)

d. If Sam is selected, what is the probability that he will go first? (2 marks)

e. If at least one of the two most popular tutors (Sam and Subu) must be included, how many selections are possible? (2 marks)

f. Contour realises that Sam and Subu had an argument over their KFC so they cannot work together on the session. What is the probability that a selected group will have to be redone because of this restriction? (3 marks)

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Question 19 (9 marks)

The maths team at Contour have decided to have a maths competition on their upcoming road trip. 11 tutors are going on the trip, and teams of 4 must be formed.

a. How many ways are there to form the first team of 4 from the 11 tutors? (1 mark)

_____

_____

b. Alex insists that he has to be on the first team that is formed. How many ways can the first team be formed now? (1 mark)

_____

_____

c. Despite the fact that the maths team are all demons at maths, no one realised that 11 isn't divisible by 4, so they have to settle on 2 teams of 4 and 1 team of 3. How many ways can the 3 teams be formed? (3 marks)

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_____

_____

_____

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_____

Sam decides that team bonding is more important than his date with Emily, so he cancels their date to go on the road trip, meaning 12 tutors are going on the trip now.

d. Show that the number of ways to select the first team of 4 now is equal to the sum of the number of ways to select the team of 3 first before Sam came, and the number of ways to select a team of 4 first before Sam came. (2 marks)

e. There are currently 2 senior tutors going on the trip. What is the probability that a randomly chosen team of 4 tutors from the pool of 12 has a senior tutor in it? (2 marks)

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Section B: Supplementary Questions

Sub-Section[3.4.1]: Applying Pascal's Triangle and Symmetrical Properties of Combinations

Question 20

a. Using Pascal's Triangle, determine the value of ${}^{n}C_{n}$ for $n \in \mathbb{Z}^{+}$.

b. Find ${}^{6}C_{3} + {}^{6}C_{4}$ using Pascal's Triangle. Express your answer in the form ${}^{n}C_{r}$, where $n, r \in \mathbb{Z}^{+}$.

c. Find ${}^{6}C_{2}$ without directly calculating using the symmetrical property of combinations. You may leave your answer in the form ${}^{n}C_{r}$, where $n, r \in \mathbb{Z}^{+}$.

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Question 21

Consider the expression ${}^{n}C_{2} = 28$ where $n \in \mathbb{Z}^{+}\backslash\{1\}$.

a. Using the symmetrical property of combinations, state the value of ${}^{n}C_{n-2}$.

b. Find n.

c. Hence, find the value of ${}^{n+1}C_{2}$.

Question 22

Contour is trying to find 2 Maths tutors to be assistant heads of maths because James has finally reached his limit. There are n sign-ups, where n is an integer larger than 2.

a. Find the smallest value of n for which ${}^{n}C_{2} = {}^{n}C_{n-2}$.

b. Given that Subu is guaranteed the role because of his crazy teaching hours, how many possible ways can the 2 assistant heads be selected? Give your answer in terms of n.

c. Let $n = 10$. It is known that ${}^{10}C_{r} = {}^{10}C_{r^2-7r+18}$. Find all possible values of r, given that $r \in \mathbb{Z}^{+} \cup \{0\}$.

Sub-Section [3.4.2]: Finding Selections of Any Size

Question 23

James is organising another maths meeting. There are 6 possible attendees. Given that any number of attendees can attend or skip the meeting, how many possible attendee lists are possible?

Question 24

Your group of friends is planning your VCE results day hangout so everyone has something to look forward to. Everyone is discussing what movies to watch from a list of n movies. Any number of movies can be watched, including none if no one is feeling it.

a. Express the number of movie combinations in terms of n.

b. How many movies are there to choose from if there are 128 possible movie combinations?

c. In the event that at least one movie must be watched, how many possible selections are there now?

Question 25

Sam is choosing snacks to bring to his secret snack stash at Contour. He has n different snacks to choose from, and he can pick any number of snacks, including none if he is feeling less cheeky that day.

a. One morning, Sam wakes up a little too smart and realises he has 2048 different snack combinations, but can't count how many snacks he has to choose from. How many different snacks does Sam have to choose from?

b. Wanting to make sure he brings at least one snack to Contour, how many different snack combinations does Sam have now?

c. Sam goes shopping before he goes to Contour and buys 2 more snacks, which makes him more likely to have something that Emily enjoys. He also wants to bring at least 3 snacks so that he definitely has something to give to Emily and something to eat for himself. How many different snack combinations are possible now?

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Sub-Section: Exam 1 Questions

Question 26 (2 marks)

Sam no longer wants KFC after having a falling out with Subu because Sam ate all of the chicken nuggets. Now he goes to McDonald's but doesn't feel like any of the menu items so he decides to build his own burger. On top of the patty, the burger contains:

- 3 ingredients were chosen from lettuce, tomato, onion, pickles and cheese.
- 2 sauces chosen from ketchup, mustard, aioli, and BBQ sauce.

a. How many different burgers can Sam build if he can have multiple of the same ingredient or sauce if the order of the ingredients in the burger does matter (e.g. lettuce on top of cheese and cheese on top of lettuce are as different burgers)? (1 mark)

_____

_____

_____

b. How many different burgers can Sam build if all the ingredients and sauces must be different? (1 mark)

_____

_____

_____

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Question 27 (3 marks)

A student randomly selects 2 books from a shelf of 8 books in a library.

a. How many ways can the student select the 2 books? (1 mark)

b. If 3 of the books on the shelf are textbooks, what is the probability that both selected books are textbooks? (2 marks)

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Question 28 (4 marks)

James wants to take a photo with the top 5 most senior members of the maths team. Everybody will stand in a line, but Sam and Subu still have beef after their falling out over KFC so they refuse to stand next to each other. How many different possible lines exist?

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Question 29 (5 marks)

A lucky draw consists of 6 different prizes and a contestant randomly selects 2 prizes. 2 of the prizes are identical gift cards.

a. How many ways can the contestant select 2 prizes? (1 mark)

b. What is the probability that the contestant wins both gift cards? (2 marks)

c. If the contestant wins at least one gift card, how many prize selections are possible? (2 marks)

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Question 30 (4 marks)

Khushi is choosing paint colours for a palette for a painting project. She has n different colours and can choose any number of them, including none.

a. If there are 64 possible palettes, find n. (1 mark)

b. Khushi realises that at least one colour of paint is needed to be able to paint. How many possible palettes can Khushi make now? (1 mark)

c. Khushi is gifted 2 new colours of paint by her friend, and so Khushi decides that she will use at least 3 colours on her palette. How many palettes can Khushi make now? (2 marks)

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Question 31 (3 marks)

A row of chairs contains 6 chairs. 3 students must be seated in this row. However:

- The students must all sit together in a single cluster.
- The other 3 chairs must stay empty.

Find the number of different ways the students can be seated in a row.

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Sub-Section: Exam 2 Questions

Question 32 (1 mark)

A 14-person club needs to form a 5-person leadership team out of the 14 members. Which of the following expressions is equivalent to the number of ways that this can happen?

A. ${}^{14}C_4 + {}^{14}C_5$

B. ${}^{14}C_5$

C. ${}^{14}C_9$

D. Both B and C.

Question 33 (1 mark)

A student is packing their bag after school and their locker has 8 things in it. The student can bring any number of these things home, including none. How many different packed bags are possible?

A. 64

B. 128

C. 256

D. 512

Question 34 (1 mark)

A group of 6 friends is deciding how they will sit on a theme park ride. Within the group, there is a couple who insist on sitting together. How many seating arrangements are possible?

A. 120

B. 240

C. 480

D. 720

Question 35 (1 mark)

A school randomly selects 3 parents from a committee of 10 to help organise an event.

What is the probability that a specific parent, Jennifer, is chosen?

A. $\frac{3}{10}$

B. $\frac{1}{3}$

C. $\frac{1}{4}$

D. $\frac{1}{10}$

Question 36 (1 mark)

A lock screen pin consists of 4 digits chosen from 0-9, where the first digit must be even and not 0, and digits cannot repeat. How many different pins are possible?

A. 10000

B. 5040

C. 2520

D. 2016

Question 37 (9 marks)

Joseph is preparing a set of practice SAC questions for Methods from a set of pre-existing questions. There are 12 pre-existing questions, and Joseph has to choose 4 of them.

a. How many ways can these 4 questions be selected? (1 mark)

_____

_____

b. Once selected, the 4 questions must be ordered. How many ways can this be done? (1 mark)

c. What is the probability of a specific question, Question 7, being included in the final selection? (2 marks)

d. If Question 7 is selected, what is the probability that it is chosen to go first in the final order? (2 marks)

e. Of the 12 questions, 3 of them are on probability. Joseph wants at least one probability question to be on the final question set. How many selections are now possible? (3 marks)

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Question 38 (11 marks)

A school is forming a relay team.

a. There are 10 candidates available. How many ways can a 4-person team be formed? (1 mark)

b. Once the team is selected, a running order must be decided. How many running orders are possible? (1 mark)

c. Instead of choosing 4 candidates, the school chooses to eliminate 6 candidates. Show that the number of ways to do this is equal to your answer from **part a.** (2 marks)

d. The school decides that a reserve should be picked for the team, bringing the total number of team members up to 5. How many possible relay teams can be formed now? (1 mark)

A last-minute candidate joins, increasing the total number of candidates to 11.

e. Show that the new amount of possible teams with a reserve is equal to the sum of your answer from **part a.** and **part c.**, and state the principle that this property is derived from. (3 marks)

f. At least one of the candidates chosen for the team must be an experienced runner. If 4 of the candidates are experienced runners, what is the probability that a randomly chosen team meets the requirements? (3 marks)

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