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VCE Mathematical Methods ½
Combinations & Permutations [3.3]
Test Solutions

32.5 Marks. 1 Minute Reading. 26 Minutes Writing.

Results:

Test Questions	_____ / 32.5

Section A: Test Questions (32.5 Marks)

Question 1 (3.5 marks)

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

Statement	True	False
a. The multiplication principle states that if there are n ways to perform the first task and m ways to perform the second task, then there are $n \times m$ ways to perform both tasks.	✓	
b. In a permutation, order matters.	✓	
c. In a permutation formula, $(n-r)!$ represents the number of missing arrangements due to missing spots.	✓	
d. Combinations are used when order doesn't matter.	✓	
e. The formula for combinations is $\frac{n!}{r!(n-r)!}$.	✓	
f. Combination is $\frac{{}^{n}P_{r}}{r!}$ where $r!$ represents the number of different arrangements for the same selection.	✓	
g. The number of ways to choose k objects from a set of n identical objects is ${}^{n}C_{k}$.		✓

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Question 2 (8 marks)

Decide whether or not the order of selection is important, and then write the formula to work out the following:

a. How many different sets of three colours can be selected from the colours red, orange, yellow, green, blue, and violet? (2 marks)

Not important, ${}^{6}C_{3}$.

b. In how many ways can a team of female basketball players be selected from eight girls? (2 marks)

Not important, ${}^{8}C_{5}$.

c. A race has 8 runners. In how many ways can the first three places be decided? (2 marks)

Important, ${}^{8}P_{3}$.

d. A secretary has nine letters and only five stamps. How many ways can he select the letters for posting? (2 marks)

Important (if stamps are distinct), ${}^{9}P_{5}$.

Question 3 (1 mark)

An ice cream shop offers 3 types of cones and 5 different flavours of ice cream. How many possible ice cream cone combinations are there?

For each of the 3 cones there are 5 possible toppings so altogether there are $3 \times 5 = 15$ possible ice-cream cone combinations.

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Question 4 (4 marks)

a. A teacher wants to randomly choose five people from the class of 30 to help out at the open-day BBQ. In how many ways can this be done? (2 marks)

In the first case, the 5 people are chosen, and it doesn't matter whether a person is chosen first, second or fifth, they all receive the same extra work, and so there are

$$^{30}\mathrm{C}_5 = \frac{30 \times 29 \times 28 \times 27 \times 26}{5 \times 4 \times 3 \times 2 \times 1} = 142,506$$

ways to choose the students with those conditions.

b. A teacher wants to award prizes for $1^{\text{st}}, 2^{\text{nd}}, 3^{\text{rd}}, 4^{\text{th}}$, and 5^{th} in the class of 30. In how many ways can the prizes be awarded (assuming no two students tie)? (2 marks)

Here the order that the student are chosen does matter, and so there are

$$^{30}\mathrm{P}_5 = 30 \times 29 \times 28 \times 27 \times 26 = 17,100,720$$

ways to choose the students with those conditions. This is a significantly more as expected.

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Question 5 (4 marks)

For each of the following, write the answer in factorial notation:

a. In a lottery, you select 6 numbers out of 40. How many ways are there to do this? (2 marks)

$$\frac{40!}{6!\,34!}$$

b. A student must select 6 subjects. In how many ways can they do that if there are 13 subjects and 1 is compulsory? (2 marks)

$$\frac{12!}{7!\,5!}$$

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Question 6 (2 marks)

In how many ways can you choose 2 chocolates from a bag containing 6 different chocolates?

$^6C_2 = 15$

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Question 7 (4 marks)

A bag contains 8 distinct tiles, each labelled with a different letter. The bag contains 3 vowels (A, E, I) and 5 consonants (B, C, D, F, G).

a. How many ways can three tiles be randomly drawn and arranged in a row to form a 3-letter code? (2 marks)

$8 \times 7 \times 6 = 336$

b. If the first letter chosen is a vowel (A, E, I, O, U), what is the probability that the resulting 3-letter code contains at least one consonant? (2 marks)

There are $7 \times 6 = 42$ ways to pick the next two tiles.

Another vowel is picked in $2 \times 1 = 2$ ways. Therefore,

$$\Pr(\textit{at least one consonant}) = 1 - \Pr(\textit{all vowels})$$
$$= 1 - \frac{2}{42}$$
$$= \frac{20}{21}$$

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Question 8 (3 marks) **Extension.**

How many arrangements of the letters of the word "irrigation" are there?

There are 10 letters. If the letters were all different, there would be 10! arrangements. However, there are three I's and two R's, and so we need to divide by $3! \times 2!$. Therefore, the answer is $\frac{10!}{3!2!}$.

TUTORS: "The changing of orders of same letters are not relevant. Hence, we divide them."

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Question 9 (3 marks) **Extension.**

A committee of 8 members is seated in a row. Two particular members, Alex and Bella, refuse to sit next to each other, while another two members, Chris and Dana, insist on sitting together. Considering these restrictions, in how many ways can the 8 members be seated in a row.

Without considering Alex and Bella restriction there are $7! \times 2! = 10{,}080$ arrangements.

Now treat Alex and Bella as their own block.
There are $6! \times 2! \times 2! = 2880$ arrangements where Alex and Bella sit together and Chris and Dana sit together.

Therefore, our answer is $10080 - 2880 = 7200$.

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