

Name: _____

Midterm Exam Math 120, Spring 2023

Part I: Sets

1. Let $X = \{\{a, e, 1, 2\}, 1, 3, 4, \{i\}, o\}$.

a) True or False: $\{1, 3\} \subseteq X$

b) True or False: $\{1, 2\} \subseteq X$

c) True or False: $|X| = 6$

d) True or False: $a \in X$

2. Let $A = \{a, b, c\}$ and $B = \{1, 2\}$.

a) List the elements of $A \times B$.

b) List the subsets of A .

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3. Draw a Venn diagram with three interacting sets A , B , and C and shade the portion of the diagram indicating $A \cap B \cap \overline{C}$.

4. Let

$U = \{\text{grapes, berries, bananas, oranges, apples, avocados, carrots, cherries}\}$

$A = \{X \in U : X \text{ has seven letters}\}$

$B = \{X \in U : X \text{ begins with the letter 'b'}\}$

$C = \{\text{grapes, apples, avocados, berries, cherries}\}$

a) List the elements of $A \cap B$.

b) List the elements of $(A \cup B) \setminus C$.

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Part II: Counting

5. How many binary words of length 10 are there?

6. How many binary words of length 10 have at least two 1's?

7. This question relates to license plates of length 6 where each character is either a letter (A–Z) or a number (0–9).

a) How many different license plates are possible if there are no restrictions on which characters can appear where?

b) Until recently, license plates from the Netherlands had the form $XX-YY-ZZ$, where each of XX , YY , and ZZ is either a pair of numbers OR a pair of letters, like LA-97-BB or 11-92-60, or GO-MA-TH. How many different license plates of this form are possible?

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8. This question concerns an election in which college students are choosing a new President using Approval Voting. In this system, voters decide whether they approve or disapprove of each candidate. The candidate with the widest base of approval (the most yes votes) becomes the president. Suppose there are 15000 students voting for candidates A , B , and C and each student approves of at least one candidate.

Suppose that at the end of the campaign, Candidate A earns 10000 approval votes, Candidate B earns 9000 approval votes, and Candidate C earns 8000 approval votes. (A wins!)

Furthermore, suppose 5000 students approved of both Candidate A and Candidate B (and possibly C), 6000 students approved of both Candidate A and Candidate C (and possibly B), and 4000 students approved of both Candidate B and Candidate C (and possibly A).

a) How many students approved of all three candidates?

b) How many students approved of candidate A only?