

TEACHER AND STUDENT RESOURCE

Sets and Venn Diagrams



DCS.N.3

Number and Quantity

Seven instructional sections. Thirty multiple-choice and thirty open or performance tasks, original mathematical visuals, generous workspaces, teaching scripts, and worked keys.

Free sample | Contents

DCS.N.3 | NC Discrete Mathematics for Computer Science mathematics

This sample contains 19 complete selected pages from the 98-page resource, plus this sample contents page. Original printed page numbers are retained. Gaps are intentional.

Included original pages: 1-15, 31-32, 61, 76

Representative activities

M01: sample PDF page(s) 16; original page(s) 15

M02: sample PDF page(s) 16; original page(s) 15

O01: sample PDF page(s) 17; original page(s) 31

O02: sample PDF page(s) 18; original page(s) 32

Selected teacher prompts and keys: original page(s) 61, 76

Using this sample

Read the preparation and access guidance before using a selected activity.
Keep teacher keys and private preparation pages separate from student copies.
Use the original resource contents to see the scope of the complete packet.

Complete paid download

The complete resource includes the full PDF task bank and teaching materials.

ALIGNMENT

Standard and learning targets

Understand set theory to solve problems.

DCS.N.3.1 Recognize sets, subsets, and proper subsets.

DCS.N.3.2 Implement set operations to find unions, intersections, complements and set differences with multiple sets.

DCS.N.3.3 Represent properties and relationships among sets using Venn diagrams.

DCS.N.3.4 Interpret Venn diagrams to solve problems.

The decimal codes are the official objectives. All are represented in the item bank. These materials support several sessions, not one 60-task lesson.

NAVIGATION

Choose evidence deliberately

Warm-up: M01-M04 and O01-O04

I Do: M05-M08 and O05-O08

We Do: M09-M13 and O09-O13

Collaborative practice: M14-M18 and O14-O18

Independent practice: M19-M23 and O19-O23

Small-group reteach: M24-M27 and O24-O27

Exit ticket: M28-M30 and O28-O30

DCS.N.3.1: M01, M02, M03, M04, M16, M17, M29, O01, O02, O03, O04, O05

DCS.N.3.2: M05, M06, M07, M08, M13, M14, M18, M19, M23, M24, M27, M30, O06, O07, O08, O09, O10, O11, O12, O13, O27, O29

DCS.N.3.3: M09, M15, M22, M26, O14, O15, O16, O17, O18, O19, O28

DCS.N.3.4: M10, M11, M12, M20, M21, M25, M28, O20, O21, O22, O23, O24, O25, O26, O30

DAILY LEARNING TARGETS

A multi-session teaching path

Session 1 Build and interpret representations

Learning target: Recognize sets, subsets, and proper subsets. Implement set operations to find unions, intersections, complements and set differences with multiple sets.

Use selected Warm-up and I Do tasks; compare an initial prediction with the worked model.

Session 2 Apply and explain methods

Learning target: Represent properties and relationships among sets using Venn diagrams. Interpret Venn diagrams to solve problems.

Use We Do and collaborative tasks across the objectives. Require each learner to explain one mathematical choice.

Session 3 Transfer and collect independent evidence

Learning target: Apply the listed objectives with accurate representations, justified methods, and contextual checks.

Choose independent tasks covering each objective. Reteach an evidenced gap, then use a fresh exit task without answer-supplying cues.

PLANNING

Materials, access and pacing

Materials

Pencils, erasers, straightedge, printed tasks, and optional scratch paper. A calculator may support arithmetic after the method is stated. Use graph paper or movable labels when useful without supplying the requested construction.

Prerequisites

Membership, whole-number counting, and reading disjoint regions.

Pacing

Select two to four tasks for a session. Preserve first independent evidence, discuss a model, and revisit with a fresh task. The full banks are reusable choices, not a timed requirement.

Neutral access

Read directions aloud without identifying a method or answer. Enlarge diagrams, allow dictated or typed reasoning, and provide accessible tables. Preserve all mathematical conditions.

Keep evidence interpretable

Record neutral supports separately from answer-supplying cues. Retain first responses. A selected distractor is not by itself a diagnosis.

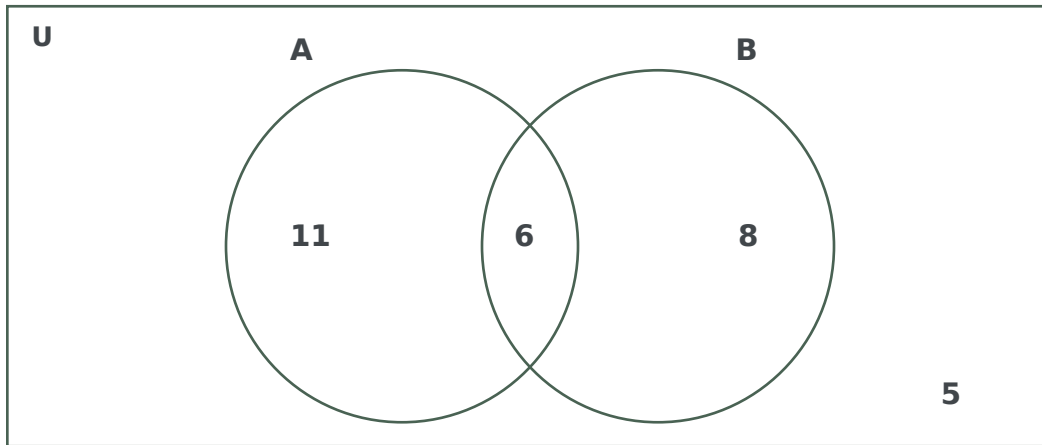
Conventions

$\cup$ means union, $\cap$ intersection, $\setminus$ set difference, and superscript c complement relative to the stated universe U . A proper subset is a subset not equal to the whole set. $\emptyset$ is the empty set.

TEACHER MODEL

Partition before counting

A class has 30 students; 17 join A, 14 join B, and 6 join both. Build the four disjoint count regions.



Start with overlap 6. A-only = $17 - 6 = 11$; B-only = $14 - 6 = 8$. Union = $11 + 6 + 8 = 25$; outside = $30 - 25 = 5$. The four regions sum to 30.

Think aloud: Each student belongs in one disjoint region, even if that region lies inside two sets. I check the whole-universe total after filling the overlap first.

REUSABLE REASONING GUIDE

Represent justify interpret

Givens and conditions

Model and calculation

Justification and independent check

Conclusion in context

WARM-UP

Teaching script

Core 001 | DCS.N.3.1

Collect a short first response before discussion. Ask learners what is given and which condition controls the method.

Display and ask

Let $A = \{2, 4, 6\}$. List all subsets and mark which are proper. Explain why A itself is not proper but $\emptyset$ is.

Work and discuss

Subsets: $\emptyset, \{2\}, \{4\}, \{6\}, \{2, 4\}, \{2, 6\}, \{4, 6\}, \{2, 4, 6\}$. The first seven are proper because they omit at least one A element. A itself is equal to A , so it is not proper. $\emptyset$ is proper because A is nonempty.

Listen for evidence

Complete enumeration and correct boundary classifications.

Probe and respond

Ask whether a region includes or excludes an overlap. If a learner double counts, partition the diagram into disjoint regions, then use a fresh item without supplying its region values.

Next: use M01 for contrast after discussion. Select another task from M01-M04 or O01-O04 to check transfer. Record support and the new evidence separately.

I DO

Teaching script

Core 005 | DCS.N.3.1

Make a prediction before modeling. Think aloud through the core task, making each calculation and check visible.

Display and ask

A finite set has exactly 15 proper subsets. Determine how many elements it has, justify the equation, and explain whether the empty set is included among the 15.

Work and discuss

For n elements there are 2^n subsets and $2^n - 1$ proper subsets. Solve $2^n - 1 = 15$, giving $2^n = 16$ and $n = 4$. Since the set is nonempty, its empty subset is one of the 15 proper subsets.

Listen for evidence

Reverse the subset-count relationship and address the empty-set case.

Probe and respond

Ask whether a region includes or excludes an overlap. If a learner double counts, partition the diagram into disjoint regions, then use a fresh item without supplying its region values.

Next: use M05 for contrast after discussion. Select another task from M05-M08 or O05-O08 to check transfer. Record support and the new evidence separately.

WE DO

Teaching script

Core 009 | DCS.N.3.2

Ask learners to propose the next step and have a partner verify it against the original conditions.

Display and ask

Find a counterexample to the claim $A \setminus (B \cup C) = (A \setminus B) \cup (A \setminus C)$. Calculate both sides, then repair the right-side operation to make a valid identity.

Work and discuss

Take $A = \{1, 2\}$, $B = \{1\}$, $C = \{2\}$. Left side is $\emptyset$; right side is $\{2\} \cup \{1\} = \{1, 2\}$. The valid identity uses intersection: $A \setminus (B \cup C) = (A \setminus B) \cap (A \setminus C)$, because an A member must avoid both B and C .

Listen for evidence

A valid counterexample and an explained repair from union to intersection.

Probe and respond

Ask whether a region includes or excludes an overlap. If a learner double counts, partition the diagram into disjoint regions, then use a fresh item without supplying its region values.

Next: use M09 for contrast after discussion. Select another task from M09-M13 or O09-O13 to check transfer. Record support and the new evidence separately.

COLLABORATIVE PRACTICE

Teaching script

Core O14 | DCS.N.3.3

Assign reader, modeler, checker, and explainer roles. Require a private first attempt before comparing approaches.

Display and ask

Draw a two-set Venn diagram for $U=\{1,2,3,4,5,6,7\}$, $A=\{1,2,4\}$, $B=\{2,3,4,6\}$. Place every universe element exactly once and reconstruct both rosters from the completed diagram.

Work and discuss

$A\text{-only}=\{1\}$; $\text{overlap}=\{2,4\}$; $B\text{-only}=\{3,6\}$; $\text{outside}=\{5,7\}$. Reading $A\text{-only}$ plus overlap recovers $\{1,2,4\}$; overlap plus $B\text{-only}$ recovers $\{2,3,4,6\}$. All seven U elements appear in exactly one disjoint region.

Listen for evidence

A correctly labeled diagram, exhaustive placement, and two roster checks.

Probe and respond

Ask whether a region includes or excludes an overlap. If a learner double counts, partition the diagram into disjoint regions, then use a fresh item without supplying its region values.

Next: use M14 for contrast after discussion. Select another task from M14-M18 or O14-O18 to check transfer. Record support and the new evidence separately.

INDEPENDENT PRACTICE

Teaching script

Core O19 | DCS.N.3.3

Provide only neutral access supports. Keep the first response and ask for justification without selecting a method.

Display and ask

A learner places element 4 twice in a Venn diagram because 4 belongs to both A and B. Explain the error and repair the placement. Use $A=\{1,4\}$, $B=\{2,4\}$, $U=\{1,2,3,4\}$.

Work and discuss

Each universe element belongs to exactly one disjoint region. Put 4 once in the overlap, 1 in A-only, 2 in B-only, and 3 outside. Listing 4 twice would double-count one object, not represent its shared membership correctly.

Listen for evidence

Diagnose duplicate placement and supply a complete corrected partition.

Probe and respond

Ask whether a region includes or excludes an overlap. If a learner double counts, partition the diagram into disjoint regions, then use a fresh item without supplying its region values.

Next: use M19 for contrast after discussion. Select another task from M19-M23 or O19-O23 to check transfer. Record support and the new evidence separately.

SMALL-GROUP RETEACH

Teaching script

Core O24 | DCS.N.3.4

Use the earlier work to identify a specific gap. Model that connection, then remove the cue on a fresh item.

Display and ask

Three clubs have counts $A=25, B=22, C=20$; $AB=10, AC=8, BC=7, ABC=4$. Pairwise counts include the triple. Find all seven inside regions and the union.

Work and discuss

Triple=4. AB-only=6, AC-only=4, BC-only=3. A-only= $25-6-4-4=11$; B-only= $22-6-3-4=9$; C-only= $20-4-3-4=9$. Union= $11+9+9+6+4+3+4=46$. Check $25+22+20-10-8-7+4=46$.

Listen for evidence

Convert inclusive overlaps to disjoint regions and verify by inclusion-exclusion.

Probe and respond

Ask whether a region includes or excludes an overlap. If a learner double counts, partition the diagram into disjoint regions, then use a fresh item without supplying its region values.

Next: use M24 for contrast after discussion. Select another task from M24-M27 or O24-O27 to check transfer. Record support and the new evidence separately.

EXIT TICKET

Teaching script

Core O28 | DCS.N.3.3

Collect a concise claim and supporting computation before showing the key. Use the evidence to select a next task.

Display and ask

Create a two-set count diagram with $|U|=24$, $|A|=14$, $|B|=11$, and exactly 9 members in one set but not both. Find the overlap and all regions, or show inconsistency.

Work and discuss

Let $\text{overlap}=x$. Exactly one $= (14-x) + (11-x) = 25-2x=9$, giving $x=8$. A-only 6, B-only 3, union 17, neither 7. All counts are nonnegative and total 24, so the diagram is feasible.

Listen for evidence

Derive the overlap from exclusive counts and construct all disjoint regions.

Probe and respond

Ask whether a region includes or excludes an overlap. If a learner double counts, partition the diagram into disjoint regions, then use a fresh item without supplying its region values.

Next: use M28 for contrast after discussion. Select another task from M28-M30 or O28-O30 to check transfer. Record support and the new evidence separately.

MULTIPLE-CHOICE BANK

M01 / M02 Select and justify**M01 | Warm-up | DCS.N.3.1** **$A = \{2, 4, 6\}$. Which statement is true?**

- A. $4 \in A$
- B. $5 \in A$
- C. $A \in 4$
- D. $\{4\} \in A$

Reasoning: _____

M02 | Warm-up | DCS.N.3.1 **$A = \{a, b, c\}$ and $B = \{a, c\}$. Which relationship is correct?**

- A. A and B are disjoint.
- B. $B = A$.
- C. A is a subset of B.
- D. B is a proper subset of A.

Reasoning: _____

WARM-UP

001 Show your reasoning

DCS.N.3.1 | Recognize sets, subsets, and proper subsets.

Let $A = \{2, 4, 6\}$. List all subsets and mark which are proper. Explain why A itself is not proper but $\emptyset$ is.

Representation and calculation

Explanation and check

WARM-UP

002 Show your reasoning

DCS.N.3.1 | Recognize sets, subsets, and proper subsets.

Construct sets A and B with A a proper subset of B and $|B|=4$. Then construct C that is not a subset of B but shares at least one element with B. Verify both claims with witnesses.

Representation and calculation

Explanation and check

WORKED TEACHER KEYS

M01 / M02**M01 | DCS.N.3.1****Answer A: $4 \in A$**

Membership refers to one object belonging to a set. Since 4 is listed, $4 \in A$.

- A. Correct. The number 4 is an element of A.
- B. The number 5 is not listed.
- C. The number 4 is not a set containing A.
- D. The listed elements are numbers, not the singleton set $\{4\}$.

Evidence: Distinguish an element from a set containing that element.

M02 | DCS.N.3.1**Answer D: B is a proper subset of A.**

$B \subset A$ because $B \subseteq A$ and $B \neq A$; b witnesses strict inclusion.

- A. They share a and c.
- B. A contains b but B does not.
- C. Element b of A is not in B.
- D. Correct. Every B element is in A, and b is missing from B.

Evidence: Both inclusion and inequality are needed for a proper subset.

WORKED TEACHER KEYS

001 / 002**001 | DCS.N.3.1**

Subsets: $\emptyset, \{2\}, \{4\}, \{6\}, \{2,4\}, \{2,6\}, \{4,6\}, \{2,4,6\}$. The first seven are proper because they omit at least one A element. A itself is equal to A , so it is not proper. $\emptyset$ is proper because A is nonempty.

Evidence: Complete enumeration and correct boundary classifications.

002 | DCS.N.3.1

For example $B = \{1,2,3,4\}$, $A = \{1,3\}$, $C = \{2,5\}$. Every A member is in B and $2 \in B \setminus A$, so $A \subset B$. C is not a subset because $5 \notin B$, while $2 \in C \cap B$. Other constructions satisfying all conditions are valid.

Evidence: Construct all three sets and identify witnesses for strict inclusion, failed inclusion, and overlap.