PS3-5 Using Number Lines

Goals
Students will use number lines to solve problems.

PRIOR KNOWLEDGE REQUIRED
Can tell and write time to the nearest minute
Can measure time intervals in minutes
Can draw a number line with increasing numbers from left to right for horizontal number lines
Can use a number line to solve word problems involving addition and subtraction of time intervals
Can skip count forward
Can add several two-digit numbers
Can use organized search (for Problem Bank 7)
Can use number lines that skip count (for Problem Banks 3, 4)

MATERIALS
BLM Number Line Word Problems (p. P-70)
BLM Phone Rings (p. P-72, see Extended Problem)
BLM Clock Word Problems (pp. P-73–74, see Extended Problem)

Using number lines is easier than counting backwards. Write on the board:

36, 31, 26, 21

ASK: Is this pattern increasing or decreasing? (decreasing) PROMPT: Do the numbers get bigger or smaller? (smaller) SAY: The numbers get smaller, so this is a decreasing pattern. ASK: How much do the numbers get smaller by each time? (5) Ask a volunteer to write the next term in the pattern on the board. (16) ASK: How did you get that? (I counted backwards; I subtracted 21 – 5)

Write on the board:

Karen decides to hike from her home to Tea Lake.
On Monday morning, she is 20 km away from the lake.
She hikes 6 km each day.
How far from the lake will she be by Wednesday evening?

ASK: What is the farthest she is from the lake? (20 km) SAY: She started 20 kilometres away and she is getting closer each day, so 20 kilometres is the farthest. So, let’s make a number line up to 20. Number lines are easier to use than counting backwards because you can write the numbers going up in order. Draw on the board:

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How far from the lake will she be by Wednesday evening?

ASK: What is the farthest she is from the lake? (20 km) SAY: She started 20 kilometres away and she is getting closer each day, so 20 kilometres is the farthest. So, let’s make a number line up to 20. Number lines are easier to use than counting backwards because you can write the numbers going up in order. Draw on the board:
Point to the dot at 20 and SAY: On Monday, she starts 20 kilometres away from the lake. Ask different volunteers to show her progress each day, as shown below:

![Number line showing progress](image)

SAY: Because Karen is getting closer to the lake each day, you just have to show moving back 6 spaces at a time. You could count back 6 to find out how far she is after each day, but you don’t have to. The number line does the counting back for you, because you’ve already written the numbers in order. ASK: How far will Karen be from the lake by the end of the day Wednesday? (2 km) If students say just “2,” ASK: Two what? (kilometres) Point out that in order to answer how far, you have to say whether Karen is 2 centimetres, 2 metres, or 2 kilometres from where she wants to be—otherwise, you really don’t know how far she is.

In the exercises below, students will solve real-life word problems by counting backwards on a number line.

**Exercise:** Complete BLM Number Line Word Problems.

**Selected solution**

3. c)

![Number line solution](image)

**Answers:** 1. 5 km; 2. 1 km; 3. a) 2 km, b) 6 minutes, c) 5 km

**Bonus**

1. A snail crawls 3 cm in one hour. It starts 20 cm away from the end of the branch and crawls towards the end of the branch.
   a) How far from the end of the branch will it be after 4 hours of crawling?
   b) A cherry hangs 5 cm before the end of the branch. How long after the snail starts crawling will it reach the cherry?

2. A messenger pigeon flies 1 km every 3 minutes.
   a) How long will it take the pigeon to carry a letter to a person who lives 6 km away?
   b) The message needs to arrive by 9:00 a.m. What time should the pigeon leave?

**Answers:** 1. a) 8 cm, b) after 5 hours; 2. a) 18 minutes, b) 18 minutes to 9 or 8:42
Jumps in two directions on a number line. Tell students that Amy is riding an elevator in her apartment building. Draw a vertical number line on the board, as shown below:

```
10 9 8 7 6 5 4 3 2
Ground level = G = 1
Basement = B = 0
```

Tell students that number lines can be vertical too, and this vertical number line shows the floor numbers in the building. SAY: Amy starts at the second floor. Have a volunteer show where she starts by drawing a dot on the number line. SAY: Amy goes up five floors. Have a volunteer draw an arrow to show where Amy travels to. (to the 7th floor) SAY: Amy now goes down two floors. Have a volunteer draw an arrow to show Amy’s movement. (to the 5th floor) The completed number line is shown below:

```
10 9 8 7 6 5 4 3 2
Ground level = G = 1
Basement = B = 0
```

SAY: So, Amy ends on the fifth floor.

**Exercises:** Draw a vertical number line in your notebook to answer the question.

a) Amy starts at the 5th floor. She goes up 4 floors, then down 7 floors. What floor does she end on?

b) Amy starts at the 10th floor. She goes down 6 floors, then up 4 floors. What floor does she end on?

c) Amy starts at the 8th floor. She goes up 2 floors, then down 5 floors. What floor does she end on?

d) Amy is on the 3rd floor. She goes up to the 9th floor. How many floors did she go up?

e) Amy pushes the button to go to the 10th floor. She travels up four floors before getting off. What floor did she start on?

**Bonus:** Amy starts at the 7th floor. She goes down 5 floors, up 6 floors, and then down 3 floors. What floor does she end on?

**Answers:** a) 2nd, b) 8th, c) 5th, d) 6, e) 6th, Bonus: 5th
Using number lines with unknown numbers. Write on the board:

Anton is 2 years older than Megan.
Kathy is 7 years older than Megan.
Evan is 3 years younger than Kathy.
Who is older, Anton or Evan? How much older?

Read the problem aloud. SAY: A good way to start a problem like this is to draw a number line so that you can see how far apart everyone’s ages are on the line. Draw on the board:

SAY: On the number line, we’ll use one place to the right to mean one year older. Look at the first sentence. ASK: Who is older, Anton or Megan? (Anton) Underline “Anton is” and “older than Megan,” as shown below:

Anton is 2 years older than Megan.

ASK: How much older? (2 years) SAY: That means we should place Anton two places to the right of Megan. Add “Megan” and “Anton” to the number line on the board, as shown below:

SAY: We can’t put numbers on the number line, because we don’t know anyone’s actual age. We just know how they compare to each other—that Anton is two years older than Megan. We don’t know yet if we need more places on the left or the right, so I’ve written their names in the middle of the number line. If there is not enough room, I might have to add to the line. Read the second sentence of the problem aloud, and then have a volunteer extend the number line to show Kathy’s age, as shown below:

Show the two comparisons done so far, using arrows, as shown below:

Read the third sentence of the problem aloud, and have a volunteer show Evan’s age. Show this comparison with an arrow, as shown below:
SAY: Now we can answer the problem. ASK: Who is older, Anton or Evan? (Evan) How do you know Evan is older? (his age is to the right of Anton’s) How much older? (2 years) Show how you can get from Anton's age to Evan's age with a jump forward of size 2 by tracing the jump with your finger. ASK: Do you know from this picture how old anyone is? (no, we just know how the ages compare)

NOTE: For the exercises below, tell students to make sure to leave lots of room on each side of the number line they draw, in case they have to add to it.

Exercises: Draw a number line to answer the questions.

a) Jake is 3 years older than Sandy. Rick is 5 years older than Sandy. Lily is 4 years younger than Rick. Who is older, Jake or Lily? How much older?

b) Rick, Marko, Sam, and Glen are identical quadruplets. Glen is 19 minutes older than Rick. Glen is 6 minutes older than Sam. Marko is 9 minutes younger than Sam. Who is older, Rick or Marko? How much older?

Bonus: Josh’s birthday is 3 weeks before Kyle’s. Sara’s birthday is 4 days after Kyle’s. Nina is 2 weeks younger than Sara. Whose birthday is first, Josh’s or Nina’s? By how many days? Hint: A week has 7 days.

Answers: a) Jake is 2 years older than Lily, b) Marko is 4 minutes older than Rick, Bonus: Josh’s birthday is 11 days before Nina’s

For extra practice, students can complete the following exercises.

Exercises

1. David plants four apple trees in a row. The nearest tree is 5 m from his house. The trees are 2 m apart. How far away from David’s house is the last tree? Hint: Put David’s house at zero on the number line.

   Answer: 11 m

2. A snail is at the bottom of a well on Monday morning. Every day, the snail climbs 3 m, and every night it slides back 1 m. The well is 7 m deep. On what day does the snail reach the top of the well?

   Solution
Problem Bank

1. When Ansel wakes up, he takes 4 minutes to get dressed, 3 minutes to brush his teeth, 8 minutes to have breakfast, 2 minutes to gather his books, 2 minutes to put on his shoes, and 4 minutes to bike to school. If Ansel needs to be at school by 8:30 a.m., what time should he set his alarm for?

Answer: 8:07 a.m.

2. Marko gets up at 8:10 a.m. It takes him 8 minutes to shower and get dressed, 4 minutes to eat breakfast, 2 minutes to gather his books, and 1 minute to walk to the bus stop. If the bus leaves at 8:32 a.m., for how long can Marko play with his sister before he leaves?

Answer: 7 minutes

3. Ella takes 10 minutes to have breakfast, and 10 minutes to get ready for school. It takes her 5 minutes to walk to school. If she has to be at school by 8:30 a.m., what time does Ella have to wake up?

   a) Draw a number line from 0 to 30. Use it to solve the problem.
   b) Solve the problem again using a number line that counts by 5.
   c) Did you get the same answer in parts a) and b)?
   d) Which way was faster?
   e) Glen tries to use a number line that counts by 10 to solve the same problem. What difficulty will he have?

   Answers: a) 8:05 a.m., b) 8:05 a.m., c) yes, d) part b), e) there won’t be a marking for when Ella gets to school—it will be halfway between two markings

4. Draw a number line that skip counts to solve the problem. Use as few markings as you can.

   a) Tina takes 6 minutes to have breakfast and 8 minutes to get ready for school. It takes her 12 minutes to bike to school. If Tina has to be at school by 8:45 a.m., what time does she have to wake up?

      Answers: a) skip count by 2s, she has to wake up by 8:19 a.m.;
      b) skip count by 3s, she can wake up as late as 8:12 a.m.

   b) Tina takes 6 minutes to get ready for school, 9 minutes to eat breakfast, and 3 minutes to walk to the bus stop. If the bus leaves at 8:30 a.m., what is the latest time Tina can wake up?

      Answers: a) skip count by 2s, she has to wake up by 8:19 a.m.;
      b) skip count by 3s, she can wake up as late as 8:12 a.m.

5. Zara is at soccer practice. She does dribbling exercises for 10 seconds, then rests for 5 seconds. Zara dribbles four times and rests three times. Does the drill take more or less than 1 minute (60 seconds)?

   Answer: less, it takes 55 seconds
6. For a school fundraiser, Marcel sold 5 more muffins than Eddy. Liz sold 3 fewer muffins than Eddy. Shelly sold 4 more muffins than Liz. Marcel sold 43 muffins. How many did the four students sell altogether?

**Solution:** Liz sold 35, Eddy sold 38, Shelly sold 39, and Marcel sold 43, so altogether they sold $35 + 38 + 39 + 43 = 155$ muffins

**NOTE:** Problem 7 combines number lines with strategic searching from earlier problem-solving lessons. If students struggle, suggest that they decide who has the fewest marbles (Grace), and ask how many marbles the children have altogether if Grace has 1 marble, then 2 marbles, and so on.

7. Ethan has 8 more marbles than Grace. Grace has 5 fewer marbles than Cody. Jennifer has 7 more marbles than Cody. Altogether they have 41 marbles.

   a) How many marbles does each friend have?
   b) Check your answer to part a) by adding your answers together. Do you get 41? If not, find your mistake.

**Answers:** a) Grace has 4 marbles, Cody has 9 marbles, Ethan has 12 marbles, and Jennifer has 16 marbles; b) $4 + 9 + 12 + 16 = 41$

8. A painter’s ladder has 12 steps. The painter spills red paint on the ground, and on every second step. He spills blue paint on the ground and on every third step.

   a) Which steps have red and blue paint on them?
   b) Which steps will have no paint on them?

**Answers:** a) 6th and 12th; b) 1st, 5th, 7th, and 11th
Number Line Word Problems

1. On Tuesday morning, Jin is camping 20 km away from the next town. He plans to walk 5 km each day towards the town. How far from the town will he be on Thursday evening? _________

2. Clara is playing baseball in a park 16 km from her home. She decides to jog home. She can jog 5 km every hour. How far from home will she be after 3 hours? _________

3. Draw a number line on the grid for the problem, then solve the problem. The first number line is started for you.
   a) Ren is 11 km from home. He is walking home. He can walk 3 km every hour. How far from home will he be after 3 hours? _________

   b) Mary is 12 blocks from home. She can walk 2 blocks in a minute. How long will it take her to walk home? ________________

   c) Ray walks 4 km in the first hour and 3 km each hour after that. When he starts walking home, he is 15 km from home. How far from home is he after 3 hours? ________________
Extended Problem: Clock Problems

MATERIALS
BLM Phone Rings (p. P-72)
BLM Clock Word Problems (pp. P-73–74)

Preparation for the extended problem. Have students complete BLM Phone Rings, in which they solve a multi-part problem in a contextual setting. This will prepare students for the extended problem and allow you to gauge students’ ability to do independent work in a multi-part contextual problem. If students are not ready to do such work, wait until later in the year when they have had a chance to build confidence. (a) 19, 16, 17; b) Tom’s; c) Matt’s; d) yes)

When students are ready to do the extended problem, tell students to look at the clock in the classroom, and ASK: What time does it say? Then ask if anyone has a watch that shows a different time. How much are they off by? Draw three clocks on the board, showing 3:21, 3:24, and 3:29. SAY: The correct time is 3:24. Have students point to the correct clock. Then point to the other two, and ASK: Is this clock ahead or behind? By how much? (the clock showing 3:21 is behind by 3 minutes and the clock showing 3:29 is ahead by 5 minutes)

Extended Problem: Clock Word Problems. Provide students with BLM Clock Word Problems. Question 6 provides an opportunity to apply the problem-solving strategy of using a number line. All students might find an answer to Question 6, but students who notice that the strategy can be used will find the problem easier.

Answers: 1. a) circle clock B, b) I circled clock B because it shows 2:19, which is 4 minutes ahead of the other clock; 2. a) 2:04, b) 1:09, c) 12:16; 3. a) 3:04, b) 1:11, c) 10:26; 4. 5:25; 5. a) 6, b) 9, c) after 20 years, d) $6 \times 7 = 42$; 6. 9:27
Phone Rings

I. Tom, Matt, and Kate each have a phone. Each phone has a different ring.
   - On Tom’s phone, rings last for 3 seconds each with a 1-second pause between rings. His phone takes a message after 5 rings.
   - On Matt’s phone, rings last for 4 seconds each with a 2-second pause between rings. His phone takes a message after 3 rings.
   - On Kate’s phone, rings last for 2 seconds each with a 1-second pause between rings. Her phone takes a message after 6 rings.

a) Use a number line to show how long each person’s phone rings for from the beginning of the first ring to the end of the last ring.

   Tom:
   [Number line from 0 to 20]
   Tom’s phone takes a message after _______ seconds.

   Matt:
   [Number line from 0 to 20]
   Matt’s phone takes a message after _______ seconds.

   Kate:
   [Number line from 0 to 20]
   Kate’s phone takes a message after _______ seconds.

b) From the beginning of the first ring to the end of the last ring, whose phone ring lasts the longest? __________________________

c) From the beginning of the first ring to the end of the last ring, whose phone ring lasts the shortest? __________________________

d) When Kate is playing outside, it takes her 15 seconds from the time the first ring starts to get to her phone. Will she answer before the phone takes a message?
Clock Word Problems (I)

The clock in Mr. C’s classroom is always 4 minutes ahead.

1. One clock below is correct and the other one is the clock in Mr. C’s classroom.
   a) Circle the clock that is in Mr. C’s classroom.

   A.  
   B.  

   b) Explain your choice.

2. The correct time is given. What time does Mr. C’s classroom clock show?
   a) 2:00 ______  b) 1:05 ______  c) 12:12 ______

3. Mr. C’s classroom clock shows the time given. What is the correct time?
   a) 3:08 ______  b) 1:15 ______  c) 10:30 ______

4. Mr. C’s classroom clock is shown below.

   What is the correct time? ______
Clock Word Problems (2)

5. Ms. K buys a clock for her classroom. She sets it to the correct time. After 1 year, it is 3 minutes ahead.
   a) How many minutes ahead will the clock be after 2 years? ______
   b) How many minutes ahead will the clock be after 3 years? ______
   c) When will the clock be 60 minutes ahead? _________________
   d) After two years, the principal says she will bring the class 7 balloons for every minute the clock is ahead. How many balloons will the principal bring?

6. Ray’s clock is 5 minutes ahead of Sally’s clock.
   Bill’s clock is 2 minutes behind Sally’s clock.
   Jun’s clock is 4 minutes ahead of Bill’s clock.
   What time does Jun’s clock say when Ray’s clock says 9:30?