Activity 2: Arithmetic

Now that you've written a few programs, let's take a step back and discuss how to do basic arithmetic. The behavior of Java operators (+, -, *, /, %) depends on the type of data you have.

Content Learning Objectives

After completing this activity, students should be able to:

- Summarize the benefits of working as a team.
- Evaluate Java expressions that use the % operator with integers.
- Explain the difference between integer and floating-point division.
- Identify operator precedence for addition, division, and assignment.

Process Skill Goals

During the activity, students should make progress toward:

- Recognizing mathematical operations based on tables. (Information Processing)

Model 1   Group vs Team

Throughout the course, you will need to examine and process information, ask and answer questions, construct your own understanding, and develop new problem-solving skills.

Questions (8 min)   **Start time:** _____

1. What are some advantages to working in groups/teams?

2. What are some disadvantages to working in groups/teams?

3. What is the difference between a group and a team? Come up with a precise answer.

4. How can working as a team help you accomplish the tasks described in Model 1? Give at least two specific examples.

Model 2   The % Operator

9 / 4	evaluates to	2
10 / 4	evaluates to	2
11 / 4	evaluates to	2
12 / 4	evaluates to	3
13 / 4	evaluates to	3
14 / 4	evaluates to	3
15 / 4	evaluates to	3
16 / 4	evaluates to	4

9 % 4	evaluates to	1
10 % 4	evaluates to	2
11 % 4	evaluates to	3
12 % 4	evaluates to	0
13 % 4	evaluates to	1
14 % 4	evaluates to	2
15 % 4	evaluates to	3
16 % 4	evaluates to	0

Questions (12 min)   Start time: _____

5. Which numbers % 4 evaluate to 0 in the table above? If the table were extended to include more rows, which other numbers % 4 would evaluate to 0?

6. Look at the expressions in the second table that evaluate to 1. How do the left operands in these expressions (9, 13, 17) differ from those that evaluate to 0?

7. List three numbers % 5 that will evaluate to 0 and three numbers % 5 that will evaluate to 2.

8. Evaluate the following Java expressions:
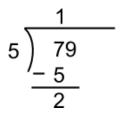
        18 % 4   19 % 4   19 % 5   19 % 6

9. Consider how you were taught to do long division in elementary school. Finish solving for $79 \div 5$. What is the answer?

$$
\begin{array}{r}
1 \\
5 \overline{)\ 79} \\
-5 \\
\hline
2
\end{array}
$$

10. Imagine that you are given candy mints to divide evenly among your team members.

   a) If your team receives 11 mints, how many mints are left over?

   b) If your team receives 2 mints, how many mints are left over?

11. Describe what the % operator does. How are the / and % operators related?

12. Would it make sense to apply the % operator to real numbers? Why or why not?

Model 3   Dividing Numbers

9 / 4	evaluates to	2
10 / 4	evaluates to	2
11 / 4	evaluates to	2
12 / 4	evaluates to	3
13 / 4	evaluates to	3
14 / 4	evaluates to	3
15 / 4	evaluates to	3
16 / 4	evaluates to	4

9 / 4.0	evaluates to	2.25
10 / 4.	evaluates to	2.5
11. / 4	evaluates to	2.75
12 / 4.0	evaluates to	3.0
13 / 4.	evaluates to	3.25
14.0 / 4	evaluates to	3.5
15 / 4.0	evaluates to	3.75
16 / 4.	evaluates to	4.0

Questions (15 min)   Start time: _____

13. In the first table, which number(s) divided by 4 evaluate to 3? What is significant about the number of answers you have written down?

14. How do the answers in the first table differ from the second table?

15.   To the right of the second table, round each answer to the closest integer. How do those values compare to what you see in the first table?

16. Carefully explain the difference between the number formats in the first and second tables.

17. Complete the table:

14. / 4.	*evaluates to*	
14. / 4	*evaluates to*	
14 / 4.	*evaluates to*	
14 / 4	*evaluates to*	

18. Dividing real numbers (also known as *floating-point* numbers) gives you different results from dividing integers. In the previous question:

  a) Which rows evaluate to an integer?

  b) Which rows evaluate to a real number?

  c) When will Java perform *integer division*?

19. Imagine you are writing a Java program that requires division.

  a) What must be true about the *operands* (the numbers before and after the operator) for you to get the mathematically correct answer?

  b) Does it need to be true for both operands?

20. Consider what you know about addition (+). If you add two integers in Java, will the result always be mathematically correct? Justify your answer.

21. What about subtraction (-) and multiplication (*)? If you subtract or multiply two integers in Java, will the answer always be mathematically correct? Justify your answer.

22. Summarize what you have learned about the difference between integer division and floating-point division.

Model 4   Order of Operations

Java follows a specific order for math and other operations. For example, multiplication and division take *precedence* over addition and subtraction. The following table lists several Java operators from highest precedence to lowest precedence.

Parenthesis	( )
Unary (positive or negative signs)	+ -
Multiplicative	* / %
Additive	+ -
Assignment	=

For the following questions, assume you have these two variables:

```java
int x;
double y;
```

Questions (10 min)   **Start time:** _____

23. What operator has the lowest precedence? Why do you think Java is designed that way?

24. What operator has the highest precedence? Why do you think Java is designed that way?

25. The + and - operators show up twice in the table of operator precedence. For the Java statement `x = 5 * -3;` explain how you know whether the - operator is being used as an unary or binary operator.

26. Give the order of operations in the Java expression: `x = 5 * -3;`

   a) First operator to be evaluated:

   b) Second operator:

   c) Third operator:

27. Give the order of operations in the Java expression: `y = 9 / 2;`

   a) First operator to be evaluated:

   b) Second operator:

28. Based on your answer to the previous question, explain why the variable `y` would be assigned 4.0 (as opposed to 4 or 4.5).

29. Rewrite the assignment for `y` so that it would be set correctly to 4.5. (Hint: you'll need to recall what you learned about division in Model 3.)