All cell phones must be turned off. Show work to receive full credit.

1. [12 pts - 3 each] For each word problem below, write the number sentence it requires and give the name of the model it illustrates for that operation.
   (a) Dana had $20 before she went to the fair; now she has only $8. How much did she spend?

   (b) Eldon made party snacks out of 4 different types of cheese on 5 types of crackers. How many different combinations could he make?

   (c) Louisa’s mom made 12 cupcakes for her and her 3 friends to munch during a slumber party. How many cupcakes did each girl get?

   (d) Tom’s read 12 pages of his history assignment, but it’s 19 pages long altogether. How many does he have to go?

2. [9 pts - 3 each] Make up a word problem requiring each number sentence, model, and choice of objects or measurements specified below.
   (a) 6 − 4 = 2, missing addend, measurements

   (b) 15 ÷ 3 = 5, repeated subtraction, objects

   (c) 3 × 6 = 18, area/array, objects

3. [5 pts - 1 each] Fill in each blank with the correct term. Spelling counts.
   (a) In the number sentence 2+3 = 5, the numbers 2 and 3 are called the ________________ while the answer, 5, is called the ________________.

   (b) In the number sentence 4×7 = 28, the numbers 4 and 7 are called the ________________.

   (c) In the number sentence 60÷6 = 10, the number 60 is called the ________________ while the answer, 10, is called the ________________.

4. [4 pts] Precisely state the set-based definition of the operation $c − d$. 
5. [4 pts - 2 each] Demonstrate the constructivist definitions for each of the following:
   (a) 5 × 3
   (b) 5 − 3

6. (a) [5 pts] Is the set \{1, 3, 5, 7, \ldots\} closed under addition? Explain your response, referring to the meaning of this term.
   (b) [5 pts] What does it mean to say that an operation is associative? Give a supporting computational example.
   (c) [5 pts] Name an operation that is not commutative, giving a counterexample to support your claim.
   (d) [5 pts] What does it mean to say that a number is an identity for an operation? Give a supporting example.

7. [4 pts - 2 each] Name the property being demonstrated in each number sentence below:
   (a) \((2 \cdot 3) \cdot 4 = 4 \cdot (2 \cdot 3)\)
   (b) \((1 + 2) \cdot 3 = 1 \cdot 3 + 2 \cdot 3\)

8. [6 pts - 3 each] Write the three numbers that immediately precede each one below, in the given base.
   (a) 201_{\text{four}}
   (b) T12_{\text{twelve}}
9. \[4 \text{ pts}\] Convert \(A21_{sixteen}\) into base ten, showing work.

10. \[4 \text{ pts}\] Clearly draw and verbally explain how to use your choice of manipulatives to add \(233_{five} + 401_{five}\) entirely in base five.

11. Perform the following computations entirely in the given base. Choose a different algorithm for each problem.
   (a) \[5 \text{ pts}\] \(5002 - T26\) in base twelve
   
   (b) \[5 \text{ pts}\] \(426 \times 35\) in base seven
(c) 5 pts 84 × 35 in base nine

(d) 8 pts 11530 ÷ 35 in base six (Turn page sideways if needed.)

(e) 5 pts Add in base five:

\[
\begin{array}{c}
424 \\
123 \\
23 \\
400 \\
114 \\
232 \\
+ 102 \\
\end{array}
\]