Name: _____

1. (1 pt.)

   ○ **Read all material carefully.**
   ○ *If in doubt whether something is allowed, ask, don't assume.*
   ○ You may refer to your books, papers, and notes during this test.
   ○ E-books may be used *subject to the restrictions* noted in class.
   ○ Computers are not permitted, except when used strictly as e-books.
   ○ Network access of any kind (cell, voice, text, data, ...) is not permitted.
   ○ Write, and draw, carefully. Ambiguous or cryptic answers receive zero credit.
   ○ Use class and textbook conventions for notation, algorithmic options, etc.

   Write your name in the space provided above.

WAIT UNTIL INSTRUCTED TO CONTINUE TO REMAINING QUESTIONS.

Do not write on this page below this point.

Q	Full	Score
1	1	
2	9	
3	10	
4	15	
5	10	
total	45	

1

2. (9 pts.) Consider the language consisting of strings over the alphabet $\{\texttt{a}, \texttt{b.c}\}$ in which the number of $\texttt{a}$s equals the number of $\texttt{b}$s.

   (a) Provide three strings that belong to this language, with brief explanations.

   (b) Provide three strings that do not belong to this language, with brief explanations.

   (c) Provide a formal definition of the language.

3. (10 pts.) Provide a *high-level description* (interpreted as explained in class, using the textbook's conventions) of a Turing machine that *decides* language of Question 2 (that is, a TM that always halts and accepts exactly the string of that language).

Explain briefly why your answer is correct.

4. (15 pts.) Provide an *informal description* (interpreted as explained in class, that is, a properly annotated state-transition diagram using the textbook's conventions) of the Turing machine of Question 3.

   Explain briefly why your answer is correct.

5. (10 pts.) Is the language of Question 2 *context-free*? If so, then provide either a context-free grammar or a pushdown automaton (your choice) for that language. If not, then use the appropriate pumping lemma to prove that the langage is not context-free.

   Explain briefly why your answer is correct.

[additional space for answering the earlier question]