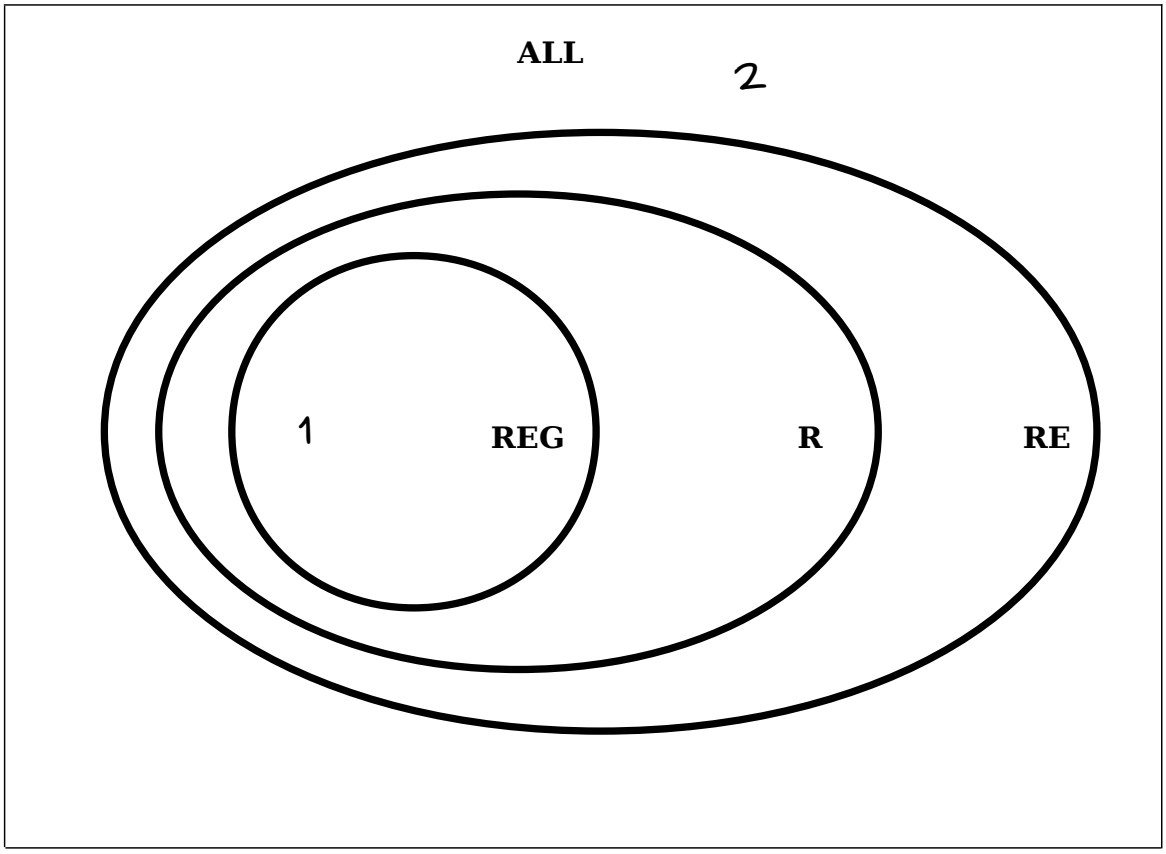
# Extra Practice Problems 3

Here's some more practice problems you can use to review for the final on topics that were specifically requested by students. If there are other topics you'd like to see more of, let us know!

## Problem One: The Lava Diagram

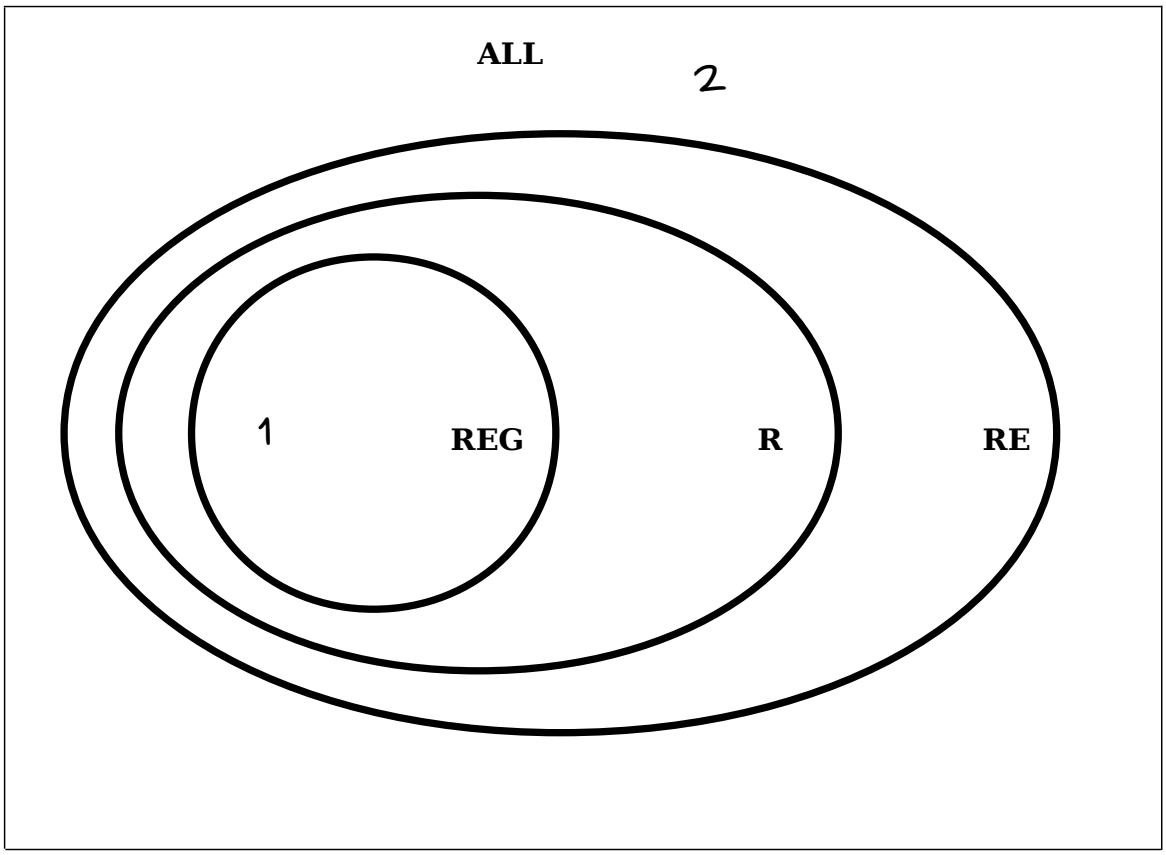
Below is a Venn diagram showing the overlap of different classes of languages we've studied so far. We have also provided you a list of numbered languages. For each of those languages, draw where in the Venn diagram that language belongs. As an example, we've indicated where Language 1 and Language 2 should go. No proofs or justifications are necessary, and there is no penalty for an incorrect guess.




1. $\Sigma^*$
2. $L_D$
3. $\{ \mathtt{1}^m\mathtt{+}\mathtt{1}^n\mathtt{=}\mathtt{1}^{m+n} \mid m, n \in \mathbb{N}$ and $m$ and $n$ are even $\}$
4. $\{ \mathtt{1}^m\mathtt{+}\mathtt{1}^n\mathtt{=}\mathtt{1}^{m+n} \mid m, n \in \mathbb{N}$ and $m \leq 10^{137} \}$
5. $\{ \mathtt{1}^m\mathtt{+}\mathtt{1}^n\mathtt{=}\mathtt{1}^{m+n} \mid m, n \in \mathbb{N}$ and $m + n \leq 10^{137} \}$
6. $\{ \langle M, w \rangle \mid M$ is a TM, $w$ is a string, and $M$ accepts $w$ within $|w|^{137}$ steps $\}$
7. $\{ \langle M \rangle \mid M$ is a TM and $M$ halts on infinitely many inputs $\}$
8. $\{ \langle M, w \rangle \mid M$ is a TM, $w$ is a string, $M$ accepts at least one substring of $w \}$

## Problem Two: Some More Lava Diagram

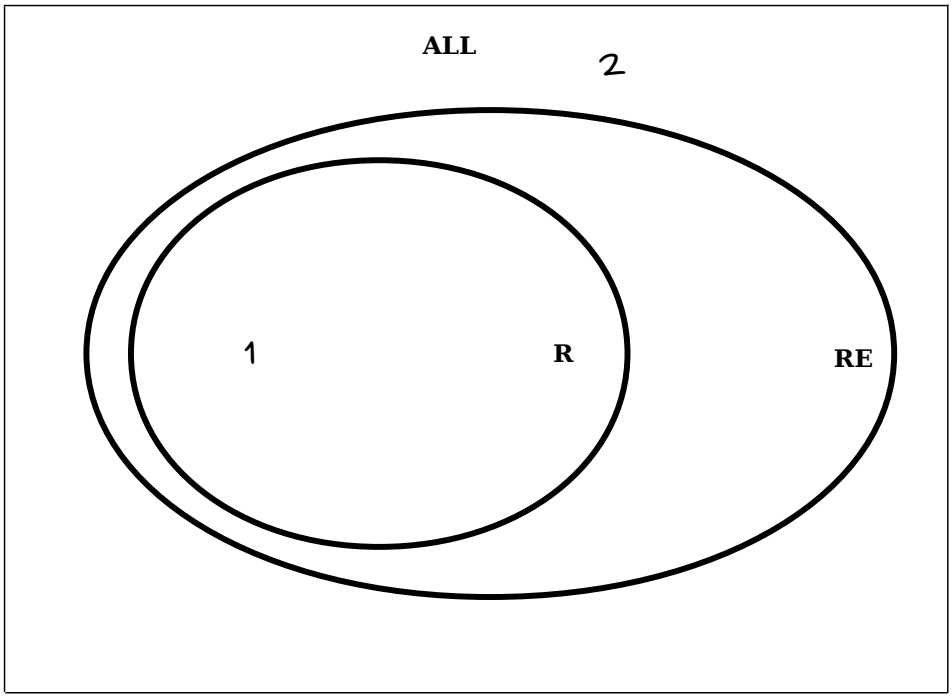
Below is a Venn diagram showing the overlap of different classes of languages we've studied so far. We have also provided you a list of numbered languages. For each of those languages, draw where in the Venn diagram that language belongs. As an example, we've indicated where Language 1 and Language 2 should go. No proofs or justifications are necessary, and there is no penalty for an incorrect guess.




1. $\Sigma^*$
2. $L_D$
3. { $w \in$ {a, b, c, …, z, A, B, C, …, Z, 0, 1, …, 9}* | $w$ contains at least two lower-case letters, at least two upper-case letters, and a digit; $w$ doesn't end with a digit; and $|w| \geq 8$ }
4. { $\langle P \rangle$ | $P$ is a syntactically correct Java program } *(If you don't know Java, don't worry! The answer is the same if you replace Java with any of C, Python, JavaScript, C#, Visual Basic, or Scheme, so feel free to reason about those languages instead.)*
5. {$\langle U_{TM} \rangle$} (As a reminder, $U_{TM}$ is the universal Turing machine.)
6. $\mathcal{L}(U_{TM})$
7. The complement of language (6)
8. { $\langle M, w \rangle$ | $M$ is a TM, $w$ is a string, and $U_{TM}$ rejects $\langle M, w \rangle$ }

## Problem Three: Even More Lava Diagram

Below is a Venn diagram showing the overlap of different classes of languages we've studied so far. We have also provided you a list of numbered languages. For each of those languages, draw where in the Venn diagram that language belongs. As an example, we've indicated where Language 1 and Language 2 should go. No proofs or justifications are necessary, and there is no penalty for an incorrect guess.




1. $\Sigma^*$
2. $L_D$
3. $\{ \langle D, w \rangle \mid D \text{ is a DFA and } D \text{ does not accept } w \}$
4. $\{ \langle R, w \rangle \mid R \text{ is a regular expression and } R \text{ does not match } w \}$
5. $\{ \langle M, w \rangle \mid M \text{ is a TM and } M \text{ does not accept } w \}$
6. $\{ \langle M \rangle \mid M \text{ is a TM and } M \text{ accepts } \langle M \rangle \}$
7. $\{ \langle M \rangle \mid M \text{ is a TM and there is no verifier for } \mathcal{L}(M) \}$