* Describe what happens with the following instruction executes:
* J Loop

jumps to the top of the loop

* LUI $t0, 0xffff
* Show the execution steps of the following instructions:
* Without forwarding

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| addi $s1 $s0 1 | If | id | ex | mem | wb |  |  |  |  |  |  |  |  |  |
| add $s2 $s2 $s2 |  | if | id | ex | mem | wb |  |  |  |  |  |  |  |  |
| add $s3 $s2 $s3 |  |  |  | if | id | ex | mem | wb |  |  |  |  |  |  |
| add $s4 $s1 $s2 |  |  |  |  | if | id | ex | mem | wb |  |  |  |  |  |
| sw $s2 0($s3) |  |  |  |  |  | if | id | ex | mem | wb |  |  |  |  |

* With forwarding

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| addi $s1 $s0 1 | If | id | ex | mem | wb |  |  |  |  |  |  |  |  |  |
| add $s2 $s2 $s2 |  | if | id | ex | mem | wb |  |  |  |  |  |  |  |  |
| add $s3 $s2 $s3 |  |  | if | id | ex | mem | wb |  |  |  |  |  |  |  |
| add $s4 $s1 $s2 |  |  |  | if | id | ex | mem | wb |  |  |  |  |  |  |
| sw $s2 0($s3) |  |  |  |  | if | id | ex | mem | wb |  |  |  |  |  |

* What is the percent speedup of the execution in problem 3 compared with problem 2?

10 vs 9 \* 1m

10,000,000 vs 9