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Ling 185A
Assignment 1: typed answers

1.

a. let x = 4 + 5 in (3 * x)

⇒ let x = 9 in (3 * x)	arithmetic
⇒ (3 * 9)	let reduction
⇒ 27	arithmetic

b. (\x -> 3 * x) (4 + 5)

⇒ (\x -> 3 * x) 9	arithmetic
⇒ 3 * 9	lambda reduction
⇒ 27	arithmetic

c. ((\x -> (\y -> x + (3 * y))) 4) 1

⇒ (\y -> 4 + (3 * y)) 1	lambda reduction
⇒ 4 + (3 * 1)	lambda reduction
⇒ 4 + 3	arithmetic
⇒ 7	arithmetic

d. let x = 4 in (let y = 1 + x in (x + (3 * y)))

⇒ let x = 4 in (x + (3 * (1 + x)))	let reduction
⇒ 4 + (3 * (1 + 4))	let reduction
⇒ 4 + (3 * 5)	arithmetic
⇒ 4 + 15	arithmetic
⇒ 19	arithmetic

e. ((\x -> (\y -> y + (3 * y))) 4) 1

⇒ (\y -> y + (3 * y)) 1	lambda reduction
⇒ 1 + (3 * 1)	lambda reduction
⇒ 1 + 3	arithmetic
⇒ 4	arithmetic

f. (\y -> y + ((\y -> 3 * y) 4)) 5

⇒ (\y -> y + (3 * 4)) 5	lambda reduction
⇒ 5 + (3 * 4)	lambda reduction
⇒ 5 + 12	arithmetic
⇒ 17	arithmetic

g. (\y -> ((\y -> 3 * y) 4) + y) 5

⇒ (\y -> (3 * 4) + y) 5	lambda reduction
⇒ (\y -> 12 + y) 5	arithmetic
⇒ 12 + 5	lambda reduction
⇒ 17	arithmetic

h. (\x -> x * (let x = 3 * 2 in (x + 7)) + x) 4

⇒ (\x -> x * (let x = 6 in (x + 7)) + x) 4	arithmetic
⇒ (\x -> x * (6 + 7) + x) 4	let reduction
⇒ (\x -> x * 13 + x) 4	arithmetic
⇒ 4 * 13 + 4	lambda reduction

⇒ 52 + 4 arithmetic
⇒ 56 arithmetic

i. g ((let x = 4 in (\y -> x + y)) 2)
⇒ g ((\y -> 4 + y) 2) let reduction
⇒ g (4 + 2) lambda reduction
⇒ g 6 arithmetic
⇒ (\z -> z + 4) 6 substitution
⇒ 6 + 4 lambda reduction
⇒ 10 arithmetic

j. let x = 5 in (\z -> x * z)
⇒ (\z -> 5 * z) let reduction, partial application

k. (\x -> (\z -> x * z)) 5
⇒ (\z -> 5 * z) lambda reduction, partial application

l. f ((\fn -> fn Rock) (\x -> whatItBeats x))
⇒ f ((\x -> whatItBeats x) Rock) lambda reduction
⇒ f (whatItBeats Rock) lambda reduction
⇒ f (Scissors) case reduction
⇒ (\s -> case s of {Rock -> 334; Paper -> 138; Scissors -> 99}) Scissors
substitution
⇒ 99 case reduction

m. ((\f -> (\x -> f (f x))) whatItBeats) Paper
⇒ (\x -> whatItBeats (whatItBeats x)) Paper lambda reduction
⇒ whatItBeats (whatItBeats Paper) lambda reduction
⇒ whatItBeats (Rock) case reduction
⇒ Scissors case reduction