


② (a)

Stage II

Expression	Var
$((\text{lambden } (x) \ (+ \ x \ 1))) \ 4)$	T_0
$(\text{lambden } (x) \ (+ \ x \ 1))$	T_1
$(+ \ x \ 1)$	T_2
$+$	T_+
x	T_x
1	T_{num1}
4	T_{num4}

Stage III

Expression	Equation
$((\text{lambden } (x) \ (+ \ x \ 1))) \ 4)$	$T_1 = [T_{num4} \rightarrow T_0]$
$(\text{lambden } (x) \ (+ \ x \ 1))$	$T_1 = [T_x \rightarrow T_2]$
$(+ \ x \ 1)$	$T_+ = [T_x * T_{num1} \rightarrow T_2]$
$+$	$T_+ = [N * N \rightarrow N]$
$1, 4$	$T_{num1} = N, \ T_{num4} = N$

Stage IV

Equation

Substitution

$$T_1 = [T_{num1} \rightarrow T_0] \quad (1)$$

~~$$T_1 = [T_x \rightarrow T_2] \quad (2)$$~~

$$T_+ = [T_x * T_{num1} \rightarrow T_2] \quad (3)$$

~~$$T_+ = [N * N \rightarrow N] \quad (4)$$~~

$$T_{num1} = N, \quad T_{num4} = N \quad (5)$$

$$T_x = T_{num4} (N)$$

$$T_2 = T_0 \quad (6)$$

$$T_x = N \quad (7)$$

$$T_2 = N \rightarrow T_0 = N \quad (8)$$

~~$$T_1 = [T_{num1} \rightarrow T_0]$$~~

~~$$T_+ = [T_x * T_{num1} \rightarrow T_2]$$~~

$$T_{num1} = N$$

~~$$T_+ = [T_x * N \rightarrow T_2]$$~~

$$T_{num4} = N$$

~~$$T_1 = [N \rightarrow T_0]$$~~

$$T_x = N$$

~~$$T_+ = [N * N \rightarrow T_2]$$~~

$$T_2 = T_0$$

~~$$T_+ = [N * N \rightarrow T_0]$$~~

$$T_x = N$$

$$T_0 = N$$

$$T_1 = [N \rightarrow N]$$

$$T_+ = [N * N \rightarrow N]$$



(b) Stage II

Expression	Var
$((\text{lambda } (f\ x) (f\ x\ 1))\ 4\ +)$	T_0
$(\text{lambda } (f\ x) (f\ x\ 1))$	T_1
$(f\ x\ 1)$	T_2
f	T_f
x	T_x
1	$T_{\text{num } 1}$
4	$T_{\text{num } 4}$
$+$	T_+

Stage III

Expressions	Equations
$((\text{lambda } (f \ x) (f \ x \ 1)) \ 4 \ +)$	$T_1 = [T_{\text{num}_4} * T_+ \rightarrow T_0]$
$(\text{lambda } (f \ x) (f \ x \ 1))$	$T_1 = [T_f * T_x \rightarrow T_2]$
$(f \ x \ 1)$	$T_f = [T_x * T_{\text{num}_1} \rightarrow T_2]$
$+$	$T_+ = [N * N \rightarrow N]$
$1, 4$	$T_{\text{num}_1} = N, T_{\text{num}_4} = N$

Stage IV

Equations	Substitutions
$T_1 = [T_{\text{num}_4} * T_+ \rightarrow T_0]$ ① $T_1 = [T_f * T_x \rightarrow T_2]$ ② $T_f = [T_x * T_{\text{num}_1} \rightarrow T_2]$ ③ $T_+ = [N * N \rightarrow N]$ ④ $T_{\text{num}_1} = N, T_{\text{num}_4} = N$ ⑤ $T_f = T_{\text{num}_4} (N)$ ⑥ $T_x = T_+$ $T_2 = T_0$	$T_1 = [T_{\text{num}_4} * T_+ \rightarrow T_0]$ $T_f = [T_x * T_{\text{num}_1} \rightarrow T_2]$ $T_+ = [N * N \rightarrow N]$ $T_1 = [T_{\text{num}_4} * [N * N \rightarrow N] \rightarrow T_0]$ $T_{\text{num}_1} = N$ $T_f = [T_x * N \rightarrow T_2]$ $T_{\text{num}_4} = N$ $T_1 = [N * [N * N \rightarrow N] \rightarrow T_0]$

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$$TF = N$$

$$N = [T_x * N \rightarrow T_2] \quad \text{ג'בלו}$$

בטל מ למיני ישנה ללא
ולציה רק קיבלו לשאול