

Part a**SEQ**

$$\frac{\langle e_1, E, S \rangle \Downarrow \langle v_1, S' \rangle, \langle e_2, E, S' \rangle \Downarrow \langle v_2, S'' \rangle}{(\text{seq } e_1 \ e_2) \Downarrow \langle v_2, S'' \rangle}$$

Part b**ALIAS**

$$\frac{l = E(x_2), \langle e, E + \{x_1 \rightarrow l\}, S \rangle \Downarrow \langle v_1, S' \rangle}{(\text{alias } x_1 \ x_2 \ e) \Downarrow \langle v_1, S' \rangle}$$

Part c

$$\frac{\frac{\frac{\frac{\langle 3, \{x \rightarrow l, y \rightarrow l\}, \{l \rightarrow 1\} \rangle \Downarrow \langle 3, \{l \rightarrow 1\} \rangle}{\langle (:= x \ 3), \{x \rightarrow l, y \rightarrow l\}, \{l \rightarrow 1\} \rangle \Downarrow \langle 3, \{l \rightarrow 3\} \rangle} \text{ASSGN}, \frac{\frac{\langle 5, \{x \rightarrow l, y \rightarrow l\}, \{l \rightarrow 3\} \rangle \Downarrow \langle 5, l \rightarrow 3 \rangle}{\langle (:= y \ 5), \{x \rightarrow l, y \rightarrow l\}, \{l \rightarrow 3\} \rangle \Downarrow \langle 5, \{l \rightarrow 5\} \rangle} \text{ASSGN}}{\langle (:= x \ 3), \{x \rightarrow l, y \rightarrow l\}, \{l \rightarrow 1\} \rangle \Downarrow \langle 3, \{l \rightarrow 3\} \rangle} \text{ADD}, \frac{l = E(x), \langle (+ \ (:= x \ 3) \ (:= y \ 5)), \{x \rightarrow l, y \rightarrow l\}, \{l \rightarrow 1\} \rangle \Downarrow \langle 8, \{l \rightarrow 5\} \rangle}{\langle (\text{alias } y \ x \ (+ \ (:= x \ 3) \ (:= y \ 5))), \{x \rightarrow l\}, \{l \rightarrow 1\} \rangle \Downarrow \langle 8, \{l \rightarrow 5\} \rangle} \text{ALIAS}, \frac{l = E(x), v = S(l)}{\langle x, \{x \rightarrow l\}, \{l \rightarrow 5\} \rangle \Downarrow \langle 5, \{l \rightarrow 5\} \rangle} \text{VAR}}{\langle 1, 0, 0 \rangle \Downarrow \langle 1, 0 \rangle} \text{INT} \text{---} \frac{\langle (\text{seq } (\text{alias } y \ x \ (+ \ (:= x \ 3) \ (:= y \ 5))) \ x)), \{x \rightarrow l\}, \{l \rightarrow 1\} \rangle \Downarrow \langle 5, L1 \rightarrow 5 \rangle}{\langle (\text{let } x \ 1 \ (\text{seq } (\text{alias } y \ x \ (+ \ (:= x \ 3) \ (:= y \ 5))) \ x)), 0, 0 \rangle \Downarrow \langle 5, L1 \rightarrow 5 \rangle} \text{LET}$$