

$$\begin{aligned} & \langle 1, \emptyset \rangle \\ \xRightarrow{[ASS]} & \{i \mapsto 42\} \end{aligned} \quad (1)$$

$$\begin{aligned} & \langle \text{for 2 test 3 update 4 do 5}, \{i \mapsto 42\} \rangle \\ \xRightarrow{[FOR]} & \langle 2; \text{while 3 do 5}; 4, \{i \mapsto 42\} \rangle \end{aligned} \quad (2)$$

$$\begin{aligned} & \langle 2, \{i \mapsto 42\} \rangle \\ \xRightarrow{[ASS]} & \{i \mapsto 42, j \mapsto 23\} \end{aligned} \quad (3)$$

$$\begin{aligned} & \langle \text{while 3 do 5}; 4, \{i \mapsto 42, j \mapsto 23\} \rangle \\ \xRightarrow{[WH_T]} & \langle 5; 4; \text{while 3 do 5}; 4, \{i \mapsto 42, j \mapsto 23\} \rangle \end{aligned} \quad (4)$$

$$\begin{aligned} & \langle 5, \{i \mapsto 42, j \mapsto 23\} \rangle \\ \xRightarrow{[ASS]} & \{i \mapsto 65, j \mapsto 23\} \end{aligned} \quad (5)$$

$$\begin{aligned} & \langle 4, \{i \mapsto 65, j \mapsto 23\} \rangle \\ \xRightarrow{[ASS]} & \{i \mapsto 65, j \mapsto 3\} \end{aligned} \quad (6)$$

$$\begin{aligned} & \langle \text{while 3 do 5}; 4, \{i \mapsto 65, j \mapsto 3\} \rangle \\ \xRightarrow{[WH_T]} & \langle 5; 4; \text{while 3 do 5}; 4, \{i \mapsto 65, j \mapsto 3\} \rangle \end{aligned} \quad (7)$$

$$\begin{aligned} & \langle 5, \{i \mapsto 65, j \mapsto 3\} \rangle \\ \xRightarrow{[ASS]} & \{i \mapsto 68, j \mapsto 3\} \end{aligned} \quad (8)$$

$$\begin{aligned} & \langle 4, \{i \mapsto 68, j \mapsto 3\} \rangle \\ \xRightarrow{[ASS]} & \{i \mapsto 68, j \mapsto -17\} \end{aligned} \quad (9)$$

$$\begin{aligned} & \langle \text{while 3 do 5}; 4, \{i \mapsto 68, j \mapsto -17\} \rangle \\ \xRightarrow{[WH_F]} & \{i \mapsto 68, j \mapsto -17\} \end{aligned} \quad (10)$$

$$\begin{aligned} & \langle 1; \text{do for 2 test 3 update 4 do 5 while 6}, \emptyset \rangle \\ \xRightarrow{[COMP_2],(1)} & \langle \text{do for 2 test 3 update 4 do 5 while 6}, \{i \mapsto 42\} \rangle \end{aligned}$$

$$\begin{aligned} & \xRightarrow{[DO]} \langle \text{for 2 test 3 update 4 do 5}; \\ & \quad \text{while 6 do for 2 test 3 update 4 do 5}, \{i \mapsto 42\} \rangle \end{aligned}$$

$$\begin{aligned} & \xRightarrow{[COMP_1],(2)} \langle 2; \text{while 3 do 5}; 4 \\ & \quad \text{while 6 do for 2 test 3 update 4 do 5}, \{i \mapsto 42\} \rangle \end{aligned} \quad (3)$$

$$\begin{aligned} & \xRightarrow{[COMP_2],(3)} \langle \text{while 3 do 5}; 4 \\ & \quad \text{while 6 do for 2 test 3 update 4 do 5}, \{i \mapsto 42, j \mapsto 23\} \rangle \end{aligned}$$

$$\begin{aligned} & \xRightarrow{[COMP_1],(4)} \langle 5; 4; \text{while 3 do 5}; 4 \\ & \quad \text{while 6 do for 2 test 3 update 4 do 5}, \{i \mapsto 42, j \mapsto 23\} \rangle \end{aligned} \quad (4)$$

$$\begin{aligned} & \xRightarrow{[COMP_2],(5)} \langle 4; \text{while 3 do 5}; 4 \\ & \quad \text{while 6 do for 2 test 3 update 4 do 5}, \{i \mapsto 65, j \mapsto 23\} \rangle \end{aligned} \quad (5)$$

$$\begin{aligned} & \xRightarrow{[COMP_2],(6)} \langle \text{while 3 do 5}; 4 \\ & \quad \text{while 6 do for 2 test 3 update 4 do 5}, \{i \mapsto 65, j \mapsto 3\} \rangle \end{aligned}$$

$$\begin{aligned} & \xRightarrow{[COMP_1],(7)} \langle 5; 4; \text{while 3 do 5}; 4 \\ & \quad \text{while 6 do for 2 test 3 update 4 do 5}, \{i \mapsto 65, j \mapsto 3\} \rangle \end{aligned} \quad (6)$$

$$\begin{aligned} & \xRightarrow{[COMP_2],(8)} \langle 4; \text{while 3 do 5}; 4 \\ & \quad \text{while 6 do for 2 test 3 update 4 do 5}, \{i \mapsto 68, j \mapsto 3\} \rangle \end{aligned}$$

$$\begin{aligned} & \xRightarrow{[COMP_2],(9)} \langle \text{while 3 do 5}; 4 \\ & \quad \text{while 6 do for 2 test 3 update 4 do 5}, \{i \mapsto 68, j \mapsto -17\} \rangle \end{aligned} \quad (8)$$

$$\begin{aligned} & \xRightarrow{[COMP_2],(10)} \langle \text{while 6 do for 2 test 3 update 4 do 5}, \{i \mapsto 68, j \mapsto -17\} \rangle \\ & \xRightarrow{[WH_F]} \{i \mapsto 68, j \mapsto -17\} \end{aligned} \quad (9)$$