

$$\frac{}{\mathcal{E} \vdash i \Downarrow i} \text{ (E-INT)}$$

$$\frac{}{\mathcal{E} \vdash b \Downarrow b} \text{ (E-BOOL)}$$

$$\frac{(\mathcal{E}(x) = v)}{\mathcal{E} \vdash x \Downarrow v} \text{ (E-VAR)}$$

$$\frac{\mathcal{E} \vdash e_1 \Downarrow i_1 \quad \mathcal{E} \vdash e_2 \Downarrow i_2 \quad i_1 \text{ plus } i_2 \text{ is } i_3}{\mathcal{E} \vdash e_1 + e_2 \Downarrow i_3} \text{ (E-PLUS)}$$

$$\frac{\mathcal{E} \vdash e_1 \Downarrow i_1 \quad \mathcal{E} \vdash e_2 \Downarrow i_2 \quad i_1 \text{ minus } i_2 \text{ is } i_3}{\mathcal{E} \vdash e_1 - e_2 \Downarrow i_3} \text{ (E-MINUS)}$$

$$\frac{\mathcal{E} \vdash e_1 \Downarrow i_1 \quad \mathcal{E} \vdash e_2 \Downarrow i_2 \quad i_1 \text{ times } i_2 \text{ is } i_3}{\mathcal{E} \vdash e_1 * e_2 \Downarrow i_3} \text{ (E-TIMES)}$$

$$\frac{\mathcal{E} \vdash e_1 \Downarrow i_1 \quad \mathcal{E} \vdash e_2 \Downarrow i_2 \quad i_1 \text{ less than } i_2 \text{ is } b_3}{\mathcal{E} \vdash e_1 < e_2 \Downarrow b_3} \text{ (E-LT)}$$

$$\frac{\mathcal{E} \vdash e_1 \Downarrow \text{true} \quad \mathcal{E} \vdash e_2 \Downarrow v}{\mathcal{E} \vdash \text{if } e_1 \text{ then } e_2 \text{ else } e_3 \Downarrow v} \text{ (E-IFT)}$$

$$\frac{\mathcal{E} \vdash e_1 \Downarrow \text{false} \quad \mathcal{E} \vdash e_3 \Downarrow v}{\mathcal{E} \vdash \text{if } e_1 \text{ then } e_2 \text{ else } e_3 \Downarrow v} \text{ (E-IFF)}$$

$$\frac{\mathcal{E} \vdash e_1 \Downarrow v_1 \quad \mathcal{E}, x = v_1 \vdash e_2 \Downarrow v}{\mathcal{E} \vdash \text{let } x = e_1 \text{ in } e_2 \Downarrow v} \text{ (E-LET)}$$

$$\frac{}{\mathcal{E} \vdash \text{fun } x \rightarrow e \Downarrow (\mathcal{E})[\text{fun } x \rightarrow e]} \text{ (E-FUN)}$$

$$\frac{\mathcal{E} \vdash e_1 \Downarrow (\mathcal{E}_2)[\text{fun } x \rightarrow e_0] \quad \mathcal{E} \vdash e_2 \Downarrow v_2 \quad \mathcal{E}_2, x = v_2 \vdash e_0 \Downarrow v}{\mathcal{E} \vdash e_1 e_2 \Downarrow v} \text{ (E-APP)}$$

$$\frac{\mathcal{E}, x = (\mathcal{E})[\text{rec } x = \text{fun } y \rightarrow e_1] \vdash e_2 \Downarrow v}{\mathcal{E} \vdash \text{let rec } x = \text{fun } y \rightarrow e_1 \text{ in } e_2 \Downarrow v} \text{ (E-LETREC)}$$

$$\frac{\mathcal{E} \vdash e_1 \Downarrow (\mathcal{E}_2)[\text{rec } x = \text{fun } y \rightarrow e_0] \quad \mathcal{E} \vdash e_2 \Downarrow v_2 \quad \mathcal{E}_2, x = (\mathcal{E}_2)[\text{rec } x = \text{fun } y \rightarrow e_0], y = v_2 \vdash e_0 \Downarrow v}{\mathcal{E} \vdash e_1 e_2 \Downarrow v} \text{ (E-APPREC)}$$

$$\frac{}{\mathcal{E} \vdash [] \Downarrow []} \text{ (E-NIL)}$$

$$\frac{\mathcal{E} \vdash e_1 \Downarrow v_1 \quad \mathcal{E} \vdash e_2 \Downarrow v_2}{\mathcal{E} \vdash e_1 :: e_2 \Downarrow v_1 :: v_2} \text{ (E-CONS)}$$

$$\frac{\mathcal{E} \vdash e_1 \Downarrow [] \quad \mathcal{E} \vdash e_2 \Downarrow v}{\mathcal{E} \vdash \text{match } e_1 \text{ with } [] \rightarrow e_2 \mid x :: y \rightarrow e_3 \Downarrow v} \text{ (E-MATCHNIL)}$$

$$\frac{\mathcal{E} \vdash e_1 \Downarrow v_1 :: v_2 \quad \mathcal{E}, x = v_1, y = v_2 \vdash e_3 \Downarrow v}{\mathcal{E} \vdash \text{match } e_1 \text{ with } [] \rightarrow e_2 \mid x :: y \rightarrow e_3 \Downarrow v} \text{ (E-MATCHCONS)}$$

$$\frac{(i_3 = i_1 + i_2)}{i_1 \text{ plus } i_2 \text{ is } i_3} \text{ (B-PLUS)}$$

$$\frac{(i_3 = i_1 - i_2)}{i_1 \text{ minus } i_2 \text{ is } i_3} \text{ (B-MINUS)}$$

$$\frac{(i_3 = i_1 * i_2)}{i_1 \text{ times } i_2 \text{ is } i_3} \text{ (B-TIMES)}$$

$$\frac{(b_3 = i_1 < i_2)}{i_1 \text{ less than } i_2 \text{ is } b_3} \text{ (B-LT)}$$