P505, Autumn 2016, IMP Formal Large-Step Semantics

$$
\begin{array}{rcl}
s & ::= & \mathsf{skip} \mid x := e \mid s; s \mid \mathsf{if}\ e\ s\ s \mid \mathsf{while}\ e\ s \\
e & ::= & c \mid x \mid e + e \mid e * e \\
(c & \in & \{\ldots, -2, -1, 0, 1, 2, \ldots\}) \\
(x & \in & \{\mathtt{x}_1, \mathtt{x}_2, \ldots, \mathtt{y}_1, \mathtt{y}_2, \ldots, \mathtt{z}_1, \mathtt{z}_2, \ldots, \ldots\})
\end{array}
$$

Not shown: Definition for "getting" and "setting" a variable in the heap. Informally:

- get(H,x,c) means looking up x in H produces c.
- set(H_1,x,c,H_2) means H_2 is like H_1 except in H_2 looking up x produces c (which might or might not be what you get when looking up x in H_1).

$\boxed{H\ ;\ e \Downarrow c}$

$$\frac{}{H\ ;\ c \Downarrow c}\ \textsc{const} \qquad \frac{\mathrm{get}(H, x, c)}{H\ ;\ x \Downarrow c}\ \textsc{var} \qquad \frac{H\ ;\ e_1 \Downarrow c_1 \qquad H\ ;\ e_2 \Downarrow c_2}{H\ ;\ e_1 + e_2 \Downarrow c_1{+}c_2}\ \textsc{add} \qquad \frac{H\ ;\ e_1 \Downarrow c_1 \qquad H\ ;\ e_2 \Downarrow c_2}{H\ ;\ e_1 * e_2 \Downarrow c_1{*}c_2}\ \textsc{mult}$$

$\boxed{H_1\ ;\ s_1 \Downarrow H_2}$

$$\frac{}{H\ ;\ \mathsf{skip} \Downarrow H}\ \textsc{skip} \qquad \frac{H\ ;\ e \Downarrow c \qquad \mathrm{set}(H, x, c, H')}{H\ ;\ x := e \Downarrow H'}\ \textsc{assign} \qquad \frac{H\ ;\ s_1 \Downarrow H_1 \qquad H_1\ ;\ s_2 \Downarrow H_2}{H\ ;\ (s_1; s_2) \Downarrow H_2}\ \textsc{seq}$$

$$\frac{H\ ;\ e \Downarrow c \qquad H\ ;\ s_1 \Downarrow H' \qquad c{\neq}0}{H\ ;\ \mathsf{if}\ e\ s_1\ s_2 \Downarrow H'}\ \textsc{if1} \qquad \frac{H\ ;\ e \Downarrow c \qquad H\ ;\ s_2 \Downarrow H' \qquad c{=}0}{H\ ;\ \mathsf{if}\ e\ s_1\ s_2 \Downarrow H'}\ \textsc{if1}$$

$$\frac{H\ ;\ \mathsf{if}\ e\ (s; \mathsf{while}\ e\ s)\ \mathsf{skip} \Downarrow H'}{H\ ;\ \mathsf{while}\ e\ s \Downarrow H'}\ \textsc{while}$$