var, x	term variable
loc, l	location
tvar, X	type variable

term, t	::=			term
	|	x		variable
	|	$\lambda\, x\, .\, t$	bind x in t	abstraction
	|	$t_1\ t_2$		application
	|	$()$		unit
	|	l		location
	|	**ref** t		reference
	|	$!\, t$		get
	|	$t_1 := t_2$		set
	|	$(\, t\,)$	S	
	|	$\{\, t_1 \,/\, x\, \}\, t_2$	M	
value, v	::=			value
	|	$\lambda\, x\, .\, t$	bind x in t	abstraction
	|	$()$		unit
	|	l		location
type, S, T	::=			type
	|	X		variable
	|	$T\ \rightarrow\ T'$		function
	|	**unit**		unit
	|	T **ref**		ref
	|	$(\, T\,)$	S	
env, Γ	::=			type environment
	|	**empty**		
	|	*env* , x : T		
phi, Φ	::=			type location environment
	|	**empty**		
	|	*phi* , l : T		
sto, μ	::=			store
	|	**empty**		
	|	*sto* , l : t		
formula	::=			
	|	*judgement*		
	|	x : T **in** *env*		
	|	l : T **in** *phi*		
	|	l : t **in** *sto*		
	|	**ok** *env*		
	|	l # μ		
terminals	::=			
	|	λ		
	|	$\rightarrow$		

	$\mid$	$\vdash$
	$\mid$	$\longrightarrow$
Stook	::=	
	$\mid$	$\mathbf{ok}\, sto$
Jtype	::=	
	$\mid$	$\Gamma\,!\,\Phi \vdash t : T$
Jop	::=	
	$\mid$	$t_1 \mid \mu_1 \longrightarrow t_2 \mid \mu_2$ $\quad$ t_1 μ_1 reduces to t_2 μ_2
judgement	::=	
	$\mid$	*Stook*
	$\mid$	*Jtype*
	$\mid$	*Jop*
user_syntax	::=	
	$\mid$	*var*
	$\mid$	loc
	$\mid$	*tvar*
	$\mid$	*term*
	$\mid$	*value*
	$\mid$	*type*
	$\mid$	*env*
	$\mid$	*phi*
	$\mid$	*sto*
	$\mid$	*formula*
	$\mid$	*terminals*

$\boxed{\mathbf{ok}\, sto}$

$$\frac{}{\mathbf{ok}\,\mathbf{empty}} \quad \text{STO\_OK\_EMPTY}$$

$$\frac{\mathbf{ok}\,\mu}{\mathbf{ok}\,\mu\,,\,\mathsf{l} : t} \quad \text{STO\_OK\_PUSH}$$

$\boxed{\Gamma\,!\,\Phi \vdash t : T}$

$$\frac{\begin{array}{l}\mathbf{ok}\,\Gamma\\ x : T\,\mathbf{in}\,\Gamma\end{array}}{\Gamma\,!\,\Phi \vdash x : T} \quad \text{TYPING\_VAR}$$

$$\frac{\Gamma\,,\,x : S\,!\,\Phi \vdash t : T}{\Gamma\,!\,\Phi \vdash \lambda\,x\,.\,t : S \to T} \quad \text{TYPING\_ABS}$$

$$\frac{\begin{array}{l}\Gamma\,!\,\Phi \vdash t_1 : S \to T\\ \Gamma\,!\,\Phi \vdash t_2 : S\end{array}}{\Gamma\,!\,\Phi \vdash t_1\, t_2 : T} \quad \text{TYPING\_APP}$$

$$\frac{\mathbf{ok}\,\Gamma}{\Gamma\,!\,\Phi \vdash () : \mathbf{unit}} \quad \text{TYPING\_UNIT}$$

$$\frac{\begin{array}{c}\mathbf{ok}\,\Gamma\\ \mathsf{l}\ :\ T\,\mathbf{in}\,\Phi\end{array}}{\Gamma\,!\,\Phi\ \vdash\ \mathsf{l}\ :\ T\,\mathbf{ref}}\quad\textsc{typing\_loc}$$

$$\frac{\Gamma\,!\,\Phi\ \vdash\ t_1\ :\ T}{\Gamma\,!\,\Phi\ \vdash\ \mathbf{ref}\,t_1\ :\ T\,\mathbf{ref}}\quad\textsc{typing\_new}$$

$$\frac{\Gamma\,!\,\Phi\ \vdash\ t_1\ :\ T\,\mathbf{ref}}{\Gamma\,!\,\Phi\ \vdash\,!\,t_1\ :\ T}\quad\textsc{typing\_get}$$

$$\frac{\begin{array}{c}\Gamma\,!\,\Phi\ \vdash\ t_1\ :\ T\,\mathbf{ref}\\ \Gamma\,!\,\Phi\ \vdash\ t_2\ :\ T\end{array}}{\Gamma\,!\,\Phi\ \vdash\ t_1 := t_2\ :\ \mathbf{unit}}\quad\textsc{typing\_set}$$

$\boxed{t_1\,|\,\mu_1\ \longrightarrow\ t_2\,|\,\mu_2}$ t_1 μ_1 reduces to t_2 μ_2

$$\frac{\mathbf{ok}\,\mu}{(\,\lambda\,x\,.\,t_1\,)\,v_2\,|\,\mu\ \longrightarrow\ \{\,v_2\,/\,x\,\}\,t_1\,|\,\mu}\quad\textsc{red\_beta}$$

$$\frac{\begin{array}{c}\mathbf{ok}\,\mu\\ \mathsf{l}\,\#\,\mu\end{array}}{\mathbf{ref}\,v\,|\,\mu\ \longrightarrow\ \mathsf{l}\,|\,\mu\,,\,\mathsf{l}\ :\ v}\quad\textsc{red\_new}$$

$$\frac{\begin{array}{c}\mathbf{ok}\,\mu\\ \mathsf{l}\ :\ t\,\mathbf{in}\,\mu\end{array}}{!\,\mathsf{l}\,|\,\mu\ \longrightarrow\ t\,|\,\mu}\quad\textsc{red\_get}$$

$$\frac{\mathbf{ok}\,\mu}{\mathsf{l} := v\,|\,\mu\ \longrightarrow\ (\,)\,|\,\mu\,,\,\mathsf{l}\ :\ v}\quad\textsc{red\_set}$$

$$\frac{t_1\,|\,\mu\ \longrightarrow\ t_1'\,|\,\mu'}{t_1\ t_2\,|\,\mu\ \longrightarrow\ t_1'\ t_2\,|\,\mu'}\quad\textsc{red\_app\_1}$$

$$\frac{t_2\,|\,\mu\ \longrightarrow\ t_2'\,|\,\mu'}{v_1\ t_2\,|\,\mu\ \longrightarrow\ v_1\ t_2'\,|\,\mu'}\quad\textsc{red\_app\_2}$$

$$\frac{t_1\,|\,\mu\ \longrightarrow\ t_1'\,|\,\mu'}{\mathbf{ref}\,t_1\,|\,\mu\ \longrightarrow\ \mathbf{ref}\,t_1'\,|\,\mu'}\quad\textsc{red\_new\_1}$$

$$\frac{t_1\,|\,\mu\ \longrightarrow\ t_1'\,|\,\mu'}{!\,t_1\,|\,\mu\ \longrightarrow\,!\,t_1'\,|\,\mu'}\quad\textsc{red\_get\_1}$$

$$\frac{t_1\,|\,\mu\ \longrightarrow\ t_1'\,|\,\mu'}{t_1 := t_2\,|\,\mu\ \longrightarrow\ t_1' := t_2\,|\,\mu'}\quad\textsc{red\_set\_1}$$

$$\frac{t_2\,|\,\mu\ \longrightarrow\ t_2'\,|\,\mu'}{v_1 := t_2\,|\,\mu\ \longrightarrow\ v_1 := t_2'\,|\,\mu'}\quad\textsc{red\_set\_2}$$

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Definition rules:         20 good    0 bad
Definition rule clauses: 45 good    0 bad
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