| `bar` core expressions

|_ `spec alas (map term tome)`
produce a door (a core with sample)

|% `(unit term) (map term tome)`
produce a core (battery and payload)

|@ `(unit term) (map term tome)`
produce a wet core (battery and payload)

|: `[hoon hoon]`
produce a gate with a custom sample

|. hoon
produce a trap (a core with one arm)

|- `hoon`
produce a trap (a core with one arm) and evaluates it

|^ `hoon (map term tome)`
produce a core whose battery includes a `$` arm and computes the latter

|~ `[spec value]`
produce an iron gate

|* `[spec value]`
produce a wet gate (a one-armed core with sample)

|= `[spec value]`
produce a dry gate (a one-armed core with sample)

|? `hoon`
produce a lead trap

|$ `(lest term) spec`
produce a mold

$ `buc` structures

$@ `[spec spec]`
structure that normalizes a union tagged by head atom

$_ `hoon`
structure that normalizes to an example `_foo`

$: `(list spec)`
form a cell type (tuple) `[a=foo b=bar c=baz]`

$% `(list spec)`
structure that recognizes a union tagged by head atom (*e.g.*, a list of named parameters)

$< `[spec spec]`
structure from filter (excluding)

$> `[spec spec]`
structure from filter (requiring)

$| `[spec hoon]`
structure with verification

$& `[spec hoon]`
repaired structure

$^ `hoon`
structure that normalizes a union tagged by head depth (cell)

$~ `[hoon spec]`
define a custom type default value

$- `[spec spec]`
structure that normalizes to an example gate

$= `[skin spec]`
structure that wraps a face around another structure `foo=bar`

$? `(list spec)`
form a type from a union of other types `?($foo $bar $baz)`

$. `[spec (map term spec)]`
structure as read–write core

$* `hoon` `*foo`
bunt a value (provide default “empty” value)

$; `hoon`
manual structure

% `cen` calls & samples

%_ `[wing (list (pair wing hoon))]`
resolve a wing with changes, preserving type

%. `[hoon hoon]`
call a gate, inverted

%^ `[hoon hoon hoon hoon]`
call a gate with triple sample

%+ `[hoon hoon hoon]`
call a gate with a cell sample

%- `[hoon hoon]`
call a gate `(fun arg)`

%: `[hoon (list hoon)]`
call a gate with many arguments

%~ `[wing hoon hoon]`
evaluate an arm in a door `~(arm core arg)`

%* `[wing hoon (list (pair winghoon))]`
evaluate an expression, then resolves a wing with changes

%= `[wing (list (pair wing hoon))]`
resolve a wing with changes `foo(x 1, y 2, z 3)`

: `col` cells

:_ `[hoon hoon]`
construct a cell, inverted

:^ `[hoon hoon hoon hoon]`
construct a cell, 4-tuple `[a b c d]`

:+ `[hoon hoon hoon]`
construct a cell, 3-tuple `[a b c]`

:- `[hoon hoon]`
construct a cell, 2-tuple `[a b]`, `a^b` `(a^b^c)`

:~ `(list hoon)`
constructs a null-terminated list `~[a b c]`

:* `(list hoon)`
construct an n-tuple `[a b c d e …]`

::
mark a comment (digraph, not rune)

. `dot` nock evaluations

.+ `atom`
increment an atom using Nock 4 `+(42)`

.* `[hoon hoon]`
evaluate using Nock 2

.= `[hoon hoon]`
test for equality using Nock 5 `=(a b)`

.? `hoon`
test for cell or atom using Nock 3

.^ `[spec hoon]`
load from namespace using Nock 12 (scry)

-/= terminators

-- terminate core expression (digraph, not rune)

== terminate running series of Hoon expressions (digraph, not rune)

^ ket typecasting

^| hoon
convert a gold core to an iron core (invariant)

^. [hoon hoon]
typecast on value

^- [spec hoon]
typecast by explicit type label `` `foo`bar ``

^+ [hoon hoon]
typecast by inferred type (a fence)

^& hoon
convert a core to a zinc core (covariant)

^~ hoon
fold constant at compile time

^= [skin hoon]
bind name to a value `foo=bar`

^? hoon
convert a core to a lead core (bivariant)

^* spec
bunt, produces default mold value `*foo`

^: spec `,foo`
produce a ‘factory’ gate for a type (switch from regular parsing to spec/type parsing)

~ sig interpreter hints

~| [hoon hoon]
print in stack trace if failure

~$ [term hoon]
profiler hit counter

~_ [hoon hoon]
print in stack trace, user-formatted

~% [chum hoon tyre hoon]
register jet

~/ [chum hoon]
register jet with registered context

~< [$@(term [term hoon]) hoon]
raw hint, applied to product (“backward”)

~> [$@(term [term hoon]) hoon]
raw hint, applied to computation (“forward”)

~+ [@ hoon]
cache computation

~& [@ud hoon hoon]
print (used for debugging)

~? [@ud hoon hoon hoon]
print conditionally (used for debugging)

~= [hoon hoon]
detect duplicate

~! [hoon hoon]
print type if compilation failure

; `mic` macros

;: `[hoon (list hoon)]`
call a binary function as an n-ary function — `:(fun a b c d)`

;/ `hoon`
(Sail) yield tape as XML element

;< `[spec hoon hoon hoon]`
glue a pipeline together (monadic bind)

;~ `[hoon (list hoon)]`
glue a pipeline together with a product-sample adapter (monadic bind)

;; `[spec hoon]`
normalize with a mold, asserting fixpoint

;+
(Sail) make a single XML node

;*
(Sail) make a list of XML nodes from Hoon expression

;= `marl:hoot`
(Sail) make a list of XML nodes

= `tis` subject modifications

=| `[spec hoon]`
combine default type value with the subject

=. `[wing hoon hoon]`
change one leg in the subject

=? `[wing hoon hoon hoon]`
change one leg in the subject conditionally

=^ `[skin wing hoon hoon]`
pin the head of a pair; changes a leg with the tail

=: `[(list (pair wing hoon)) hoon]`
change multiple legs in the subject

=/ `[skin hoon hoon]`
combine a named noun with the subject

=; `[skin hoon hoon]`
combine a named noun with the subject, inverted

=< `[hoon hoon]`
compose two expressions, inverted — `foo:bar`

=> `[hoon hoon]`
compose two expressions

=- `[hoon hoon]`
combine a new noun with the subject

=* `[(pair term (unit spec)) hoon hoon]`
define an alias

=, `[hoon hoon]`
expose namespace (defines a bridge)

=+ `[hoon hoon]`
combine a new noun with the subject

=~ `(list hoon)`
compose many expressions

? `wut` conditionals

?| `(list hoon)`
logical OR (loobean) — `|(foo bar baz)`

?: `[hoon hoon hoon]`
branch on a boolean test

?. `[hoon hoon hoon]`

branch on a boolean test, inverted

?< `[hoon hoon]`
negative assertion

?> `[hoon hoon]`
positive assertion

?- `[wing (list (pair spec hoon))]`
switch against a union, no default

?^ `[wing hoon hoon]`
branch on whether a wing of the subject is a cell

?= `[spec wing]`
test pattern match

?# `[skin wing]`
test pattern match

?+ `[wing hoon (list (pair spec hoon))]`
switch against a union, with default

?& `(list hoon)`
logical AND (loobean) `&(foo bar baz)`

?@ `[wing hoon hoon]`
branch on whether a wing of the subject is an atom

?~ `[wing hoon hoon]`
branch on whether a wing of the subject is null

?! `hoon`
logical NOT (loobean) `!foo`

! `zap` wildcards

!: `hoon`
turn on stack trace

!. `hoon`
turn off stack trace

!, `[*hoon hoon]`
emit AST of expression (use as `!, *hoon expression`)

!; `[hoon hoon]`
emit the type for an expression using the type of type

!> `hoon`
wrap a noun in its type

!< `hoon`
lift dynamic value into static context

!@ `[(list wing) hoon hoon]`
evaluate conditionally

!= `hoon`
make the Nock formula for a Hoon expression

!? `[$@(@ {@ @}) hoon]`
restrict Hoon Kelvin version

!! `~`
crash

/ `fas` build operations (`++ford` arm of `%clay`)

/? `foo`
pin a version number

/- `foo, *bar, baz=qux`
import a file from the `sur` directory (* pinned with no face, = with specified face)

/+ `foo, *bar, baz=qux`
import a file from the `lib` directory (* pinned with no face, = with specified face)

/= `clay-raw /sys/vane/clay`

import results of user-specified path wrapped in face

/% `%mark`

import mark definition from `mar/`

/$ `%from %to`

import mark conversion gate from `mar/`

/* `myfile %hoon /gen/myfile/hoon`

import the contents of a file in the desk converted to a mark (build-time static data)

/~ `face type /path`

import contents of a directory under `face=(map @ta type)`

+ **`lus` arm definitions**

+|

label a chapter (produces no arm)

+$ `[term spec]`

produce a structure arm (type definition)

++ `[term hoon]`

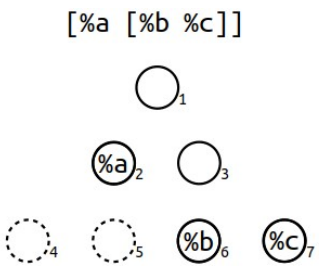
produce a (normal) arm

+* `[term term spec]`

produce a type constructor arm

syntax

```
+1:[%a [%b %c]] [%a [%b %c]]
+2:[%a [%b %c]] %a
+3:[%a [%b %c]] [%b %c]
+4:[%a [%b %c]] %ride failed
+6:[%a [%b %c]] %b
+7:[%a [%b %c]] %c
```




```
.:[%a [%b %c]] [%a [%b %c]]
-:[%a [%b %c]] %a
+:[%a [%b %c]] [%b %c]
-<:[%a [%b %c]] %ride failed
+<:[%a [%b %c]] %b
+>:[%a [%b %c]] %c
```

`&n`	*n*th element
`|n`	tail after *n*th element
`<[1 2 3]>`	renders list as a tape
`>[1 2 3]<`	renders list as a tank
`.`	current subject
`+`	`+:.`
`-`	`-:.`
`+>`	`+>:.`
`a.b.c`	limb search path
`~`	0 (nil)
`%.y` `&`	yes/true/`0`
`%.n` `|`	no/false/`1`
`%a`	constant
`$`	empty `term` (`@tas`)
`'urbit'`	`cord`, atom `@t`
`"urbit"`	`tape` or list of characters
`=wire`	shadow type name (in defn)
`/path`	path name
`%`	current path

lark syntax equivalents

`+1`	`+5 ->`
`+2 -`	`+6 +<`
`+3 +`	`+7 +>`
`+4 -<`	`+8 -<-`

`^face`	face in outer core (`^^face`)
`..arm`	core in which `++arm` is defined
`, ,.`	strip the face
`-:!>`	type spear, use as `-:!>(.3.14)`

`eny`	entropy
`now`	current time
`our`	ship

```
`a [~ a]
~[a b c] [a b c ~]
[a b c]~ [[a b c] ~]
a/b [%a b]
```

elementary molds

`*`	noun
`@`	atom (`atom`)
`^`	cell
`?`	loobean
`~`	null

aura notation

Each aura has a characteristic pattern allowing unique identification in its representation. Typically this is indicated by a combination of ~, ., and -.

@	*Empty aura*	
@c	*Unicode codepoint*	`~-~45fed.`
@d	*Date*	
@da	*Date, absolute*	`~2020.12.25..7.15.0..1ef5`
@dr	*Date, relative*	`~d71.h19.m26.s24..9d55`
@f	*Loobean (for compiler, not castable)*	`&`
@i	*Internet address*	
@if	*IPv4 address*	`.195.198.143.90`
@is	*IPv6 address*	`.0.0.0.0.0.1c.c3c6.8f5a`
@n	*Nil (for compiler, not castable)*	`~`
@p	*Phonemic base*	`~laszod-dozser-fosrum-fanbyr`
@q	*Phonemic base, unscrambled (used with Urbit HD wallet)*	`.~laszod-dozser-dalteb-hilsyn`
@r	*IEEE-754 floating-point number*	
@rh	*Floating-point number, half-precision, 16-bit*	`.~~3.14`
@rs	*Floating-point number, single-precision, 32-bit*	`.3.141592653589793`
@rd	*Floating-point number, double-precision, 64-bit*	`.~3.141592653589793`
@rq	*Floating-point number, quadruple-precision, 128-bit*	`.~~~3.141592653589793`
@s	*Integer, signed (sign bit low)*	
@sb	*Signed binary*	`--0b10.0000`
@sd	*Signed decimal*	`--1.000`
@sv	*Signed base-32* `0123456789abcdefghijklmnopqrstuv`	`--0v201.4gvml.245kc`
@sw	*Signed base-64* `0123456789abcdefghijklmnopqrstuvwxyzABCDEFGHIJKLMNOPQRSTUVWXYZ`	`--0w2.04AfS.G8xqc`
@sx	*Signed hexadecimal* `0123456789abcdef`	`--0x2004.90fd`
@t	*UTF-8 text (cord)*	`'urbit'`
@ta	*ASCII text (knot)*	`~.urbit`
@tas	*ASCII text symbol (term)*	`%urbit`
@u	*Integer, unsigned*	
@ub	*Unsigned binary*	`0b10.1011`
@uc	*Bitcoin address from set* `123456789abcdefghijklmnopqrstuvwxyzABCDEFGHJKLMNPQRSTUVWXYZ`	`0c1A1zP1eP5QGefi2DMPTfTL5SLmv7DivfNa`
@ud	*Unsigned decimal*	`8.675.309`
@ui	*Unsigned decimal*	`0i123456789`
@uv	*Unsigned base-32* `0123456789abcdefghijklmnopqrstuv`	`0v88nvd`
@uw	*Unsigned base-64* `0123456789abcdefghijklmnopqrstuvwxyzABCDEFGHIJKLMNOPQRSTUVWXYZ-~`	`0wx5~J`
@ux	*Unsigned hexadecimal* `0123456789abcdef`	`0x84.5fed`

Capital letters at the end of auras indicate the bitwidth in binary powers of two, starting from `A`.

`@tD`	8-bit ASCII text
`@rhE`	half-precision (16-bit) floating-point number
`@uxG`	unsigned 64-bit hexadecimal
`@uvJ`	unsigned 512-bit integer (frequently used for entropy)

Nock 4K

A noun is an atom or a cell. An atom is a natural number. A cell is an ordered pair of nouns.

Reduce by the first matching pattern; variables match any noun.

```
nock(a)             *a
[a b c]             [a [b c]]

?[a b]              0
?a                  1
+[a b]              +[a b]
+a                  1 + a
=[a a]              0
=[a b]              1

/[1 a]              a
/[2 a b]            a
/[3 a b]            b
/[(a + a) b]        /[2 /[a b]]
/[(a + a + 1) b]    /[3 /[a b]]
/a                  /a

#[1 a b]            a
#[(a + a) b c]      #[a [b /[(a + a + 1) c]] c]
#[(a + a + 1) b c]  #[a [/[(a + a) c] b] c]
#a                  #a

*[a [b c] d]        [*[a b c] *[a d]]

*[a 0 b]            /[b a]                              slot operator (noun at tree address)
*[a 1 b]            b                                   constant
*[a 2 b c]          *[*[a b] *[a c]]                    evaluate
*[a 3 b]            ?*[a b]                             test for atom
*[a 4 b]            +*[a b]                             increment
*[a 5 b c]          =[*[a b] *[a c]]                    distribution

*[a 6 b c d]        *[a *[[c d] 0 *[[2 3] 0 *[a 4 4 b]]]]   if-then-else
*[a 7 b c]          *[*[a b] c]                         compose
*[a 8 b c]          *[[*[a b] a] c]                     extend
*[a 9 b c]          *[*[a c] 2 [0 1] 0 b]               invoke
*[a 10 [b c] d]     #[b *[a c] *[a d]]                  edit noun

*[a 11 [b c] d]     *[[*[a c] *[a d]] 0 3]              hint
*[a 11 b c]         *[a c]

*a                  *a                                  interpret
```