

## **./ - ngnksource**

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## 0.c - ngnksource

### Global variables defined

- [r](#)

### Functions defined

- [\\_\\_getcwd](#)
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### Macros defined

- [SYS\\_getdents](#)
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## Source code

```

1 // ngn/k, (c) 2019-2022 ngn, GNU GPLv3 -
https://codeberg.org/ngn/k/raw/branch/master/LICENSE
2 #include "a.h"
3 #include <stdarg.h>
4 #include <stdio.h>
5 #include <fcntl.h>
6 #include <errno.h>
7 #include <sys/socket.h>
8 #include <sys/types.h>
9 #include <sys/wait.h>
10 #include <netinet/in.h>
11 #include <netinet/tcp.h>
12 #include <arpa/inet.h>
13 #include <unistd.h>
14 #include <sys/time.h>
15 #undef __USE_EXTERN_INLINES
16 #include <sys/stat.h>
17
18 // __builtin_ia32_ldmxcsr(__builtin_ia32_stmxcsr()) / 1 << 6 / 1 << 15); //daz,ftz
19 I main(I n, Q*a) { kinit(); kargs(n, a); I
r=0; I(n<2, repl()) J(!bsl(a[1]), r=1; epr(0)) Q(bsm("")); r
20
21 // __start()
22 #if defined(libc) || defined(wasm)
23 ;
24 #elif defined(__OpenBSD__) || defined(__FreeBSD__)
25 V __start(Q*a) { exit(main(*(I*)(V*)a, a+1)); }
26 #elif defined(i386)
27 asm(".globl __start; __start:pop %eax;push %esp;push %eax;call main;jmp
exit");
28 #else
29 asm(".globl __start; __start:pop %rdi;mov %rsp,%rsi;and $-16,%rsp;call
main;mov %rax,%rdi;jmp exit");
30 #endif
31
32 //syscall helper macros
33 #if !defined(libc) && !defined(wasm)
34 #include <sys/syscall.h>
35 #if defined(i386)
36 #define h(x,a...) ".globl "#x;"#x": "a" mov $"M2(SYS_##x)",%eax;int
$0x80;ret;"
37 #define h1(x,a...) h(x,a)"mov 4(%esp),%ebx;"
38 #define h2(x,a...) h1(x,a)"mov 8(%esp),%ecx;"
39 #define h3(x,a...) h2(x,a)"mov 12(%esp),%edx;"
40 #define h5(x) ".globl "#x;"#x":mov %esp,%ebx;add $4,%ebx;mov
$"M2(SYS_##x)",%eax;int $0x80;ret;"
41 #define h6 h5
42 #else
43 #define h(x,a...) ".globl "#x;"#x": "a" movq
$"M2(SYS_##x)",%rax;syscall;ret;"
44 #define h1 h
45 #define h2 h
46 #define h3 h

```

```

47     #define h4(x) h(x,"movq %rcx,%r10;")  

48     #define h5 h4  

49     #define h6 h4  

50 #endif  

51 #endif  

52  

53 //pipe()  

54 #if defined(wasm)  

55 I pipe(Iv[2])_(-1)  

56 #elif defined(libc)  

57 ;  

58 #elif defined(__FreeBSD__)  

59 asm(h(pipe2));I pipe(Iv[2])_(pipe2(v,0))  

60 #else  

61 asm(h(pipe));  

62 #endif  

63  

64 //directory iteration  

65 #if defined(wasm)  

66 V dir(If,void(*d)(V*,Q),V*x){}  

67 #elif defined(libc)  

68 #include<dirent.h>  

69 V dir(If,void(*d)(V*,Q),V*x){DIR*a=fdopendir(f);ST  

dirent*e;W((e=readdir(a)),d(x,e->d_name))closedir(a);} //thanks  

eightsixfivezero  

70 #else  

71 #if defined(__FreeBSD__)  

72 #define SYS_getdents SYS_freebsd11_getdents  

73 TD ST{UI d_ino;UH d_reclen;C d_type,d_namlen,d_name[255+1];}DE;  

74 #else  

75 TD ST{long d_ino;off_t d_off;UH d_reclen;C d_name[];}DE;  

76 #endif  

77 ssize_t getdents(I,C*,N);asm(h3(getdents));  

78 V dir(If,void(*d)(V*,Q),V*x){Cb[2P];Ik;W((k=getdents(f,b,SZ  

b))>0,Ii=0;W(i<k,DE*e=(V*)b+i;Qs=e->d_name;d(x,s);i+=e->d_reclen))}  

79 #endif  

80  

81 //getcwd()  

82 #if defined(wasm)  

83 C*getcwd(C*s,Nn)_((V*)0)  

84 #elif defined(libc)  

85 ;  

86 #elif defined(__FreeBSD__)  

87 asm(h(__getcwd));C*__getcwd(C*,N);C*getcwd(C*s,Nn)_(__getcwd(s,n))  

88 #else  

89 asm(h(getcwd));  

90 #endif  

91  

92 //other syscalls  

93 #if defined(__wasi__)  

94 #define WA(t,n,a)  

__attribute__((import_module("wasi_snapshot_preview1"),import_name(#n)))t n a;  

95 WA(__attribute__((noreturn))V,proc_exit,(N))WA(UH,fd_write,  

(I,V*,N,N*))WA(UH,fd_read,(I,V*,N,N*))WA(UH,fd_fdstat_set_flags,  

(I,UH))WA(UH,clock_time_get,(I,UL,UL*))WA(UH,args_sizes_get,  

(N*,N*))WA(UH,args_get,(C**,C*))  

96 I open(Qp,Iv,...)_(-1)I close(If)_(-1)I read(If,V*a,Nn)_(fd_read(f,(N[])  

{((N)a,n),1,&n)?-1:n})I write(If,OV*a,Nn)_(fd_write(f,(N[]){(N)a,n},1,&n)?-1:n)  

97 off_t lseek(If,off_t o,I w)_(-1)I fstat(If,ST stat*x)_(-1)V*mmap(V*a,Nn,I  

pr,I fl,If,off_t o)_((V*))(_builtin_wasm_memory_grow(0,n>>16)<<16))I  

munmap(If,In)_(-1)

```

```

98  I gettimeofday(ST timeval*a,V*b)_(UL t;clock_time_get(0,-1,&t)?-1:(a-
>tv_sec=t/1e9,a->tv_usec=t%(L)1e9/1e3,0))
99  V exit(I v){proc_exit(v);}V _start(){i(3,fd_fdstat_set_flags(i,0))N
i,j;args_sizes_get(&i,&j);C*v[i],b[j];args_get(v,b);exit(main(i,(Q*)v));}
100 I dup2(If,Iv)_(-1)I execve(Qp,char*O*a,char*O*e)_(-1)I fork()_(-1)I
socket(Ii,Ij,Ik)_(-1)
101 I setsockopt(If,I l,I s,OV*v,socklen_t n)_(-1)I connect(If,O ST
sockaddr*s,socklen_t n)_(-1)I chdir(Qp)_(-1)
102 I getdents(If,char*s,Nn)_(-1)I ftruncate(If,off_t o)_(-1)I wait4()_(-1)
103
104 #elif defined(wasm)
105 I js_in(V*,N);V
js_out(OV*,N),js_log(OV*),*js_alloc(N),js_time(I*,long*),js_exit(I);
106 S ST{C*a,p[16];Nn;}s[8]={{.a=""},{.a=""},//s:storage,
107 #include"o/w/fs.h"
108 };S ST{C i:N o;}d[8]={{.i=1},{.i=1},{.i=1}};S O I ns=ZZ(s),nd=ZZ(d);//d:fd
table
109 #define FI P((UI)f>=nd||!d[f].i,EBADF)Ii=d[f].i;//validate fd "f" and get
inode "i"
110 I open(Op,Iv,...)_(_Im=Ss(p);P(m)>=SZ
s[0].p,ENAMETOOLONG)Ii=0;W(i<ns&&SQ(s[i].p,p),i++)
111
I(i>=ns,P(O_CREAT&~v,ENOENT)i=0;W(i<ns&&s[i].a,i++)P(i>=ns,ENOSPC)s[i].a="";s[i]
].n=0;Mc(s[i].p,p,m))
112 If=0;W(f<nd&&d[f].i,f++)P(f>=nd,EMFILE)d[f].i=i;d[f].o=0;f)
113 I close(If)_(_FI d[f].i=0;0)
114 I read(If,V*a,Nn)_(_FI P(i==1,js_in(a,n))I o=d[f].o;n=max(0,min(n,s[i].n-
o));Mc(a,s[i].a+o,n);d[f].o+=n;n)
115 I write(If,OV*a,Nn)_(_FI;P(i==1,js_out(a,n);n)
116
Im=d[f].o+n;I(m>s[i].n,C*b=js_alloc(m);Mc(b,s[i].a,n);s[i].a=b;s[i].n=m)Mc(s[i]
.a+d[f].o,a,n);n)
117 off_t lseek(If,off_t o,I w)_(_FI;o=w==SEEK_CUR?o+d[f].o:w==SEEK_END?
o+s[i].n:w==SEEK_SET?o:-1;P(o<0,EINVAL)d[f].o=o)
118 I fstat(If,ST stat*r)_(_FI;In=s[i].n;
119 *r=(TY(*r))
{.st_ino=i,.st_mode=S_IFCHR,.st_nlink=1,.st_size=n,.st_blksize=512,.st_blocks=n
+511>>9};0)
120 V*mmap(V*a,Nn,I pr,I fl,If,off_t
o)_(_I(!a,a=js_alloc(n))P(f<0,a)P(f>=nd||!d[f].i,
(V*)-1)Ii=d[f].i;Mc(a,s[i].a+o,n);a)
121 I munmap(If,In)_(_0)
122 I gettimeofday(ST timeval*a,V*b)_(_js_time((V*)&a->tv_sec,(V*)&a-
>tv_usec);0)
123 V exit(Iv){js_exit(v);}
124 I dup2(If,Iv)_(-1)I execve(Qp,C*O*a,C*O*e)_(-1)I fork()_(-1)I
socket(Ii,Ij,Ik)_(-1)
125 I setsockopt(If,I l,I s,OV*v,socklen_t n)_(-1)I connect(If,O ST
sockaddr*s,socklen_t n)_(-1)I chdir(Qp)_(-1)
126 I ftruncate(If,off_t o)_(-1)
127 I wait4(I i,I*l,I o,ST rusage*u)_(-1)
128 #elif defined(libc)
129 ;
130 #else
131
asm(h3(read)h3(write)h3(open)h1(close)h2(fstat)h3(lseek)h2(unmap)h2(dup2)h3(so
cket)h5(setsockopt)h3(connect)
132
h(fork)h4(wait4)h3(execve)h1(exit)h2(gettimeofday)h6(mmap)h1(chdir)h2(ftruncate
));
133 #endif

```

```

134
135 //mem and str functions
136 #if !defined(libc)
137 V*memcpy (V*x,OV*y,Nn)_(_C*p=x ;Qq=y ;i(n,*p++=*q++)x)
138 V*memrcpy(V*x,OV*y,Nn)_(_C*p=x+n; Qq=y+n; i(n,*--p=---q)x)
139 V*memmove(V*x,OV*y,Nn)_((y<x&&x<y+n?memrcpy:memcpy)(x,y,n))
140 V*memset(V*x,Iv,Nn)_(_C*p=x; i(n,*p++=v)x)
141 V*memchr(OV*x,Iv,Nn)_(_Qs=x; i(n,P(s[i]==v,(V*)(s+i)))0)
142 V*memmem(OV*x,Nm,OV*y,Nn)_(_Qp=x,Qg=y; i((L)m-(L)n+1,P(!memcmp(p+i,g,n),(V*)(p+i)))0)
143 I memcmp(OV*x,OV*y,Nn)_(_Qs=x,t=y; i(n,Iv=*s++-*t++;P(v,v))0)
144 N strlen(Qs)_(_Qp=s;W(1,UL v=~*(UL*)(V*)p;v&=v>>1;v&=v>>2;v&=v>>4;v&=0x0101010101010101ll;B(v)p+=8)W(*p,p++)p-s)
145 C*strchr(Q C*s,Iv)_(_W(1,P(*s==v,(V*)s)P(!*s++,(V*)0))0)
146 C*strstr(Q C*p,Q C*q)_(_MM(p,Sn(p),q,Sn(q)))
147 I strcmp(Qp,Qq)_(_W(*p&&*p==*q,p++;q++)*p-*q)
148 #endif
149 #if !defined(libc)||!defined(GNU_SOURCE)
150 C*strchrnul(Qs,Iv)_(_W(1,P(*s==v,(V*)s)P(!*s,(V*)s)s++)(V*)s)
151 #endif
152
153 //mathematical functions
154 #if (!defined(wasm)||defined(__wasi__))&&!defined(libc)
155 D sin(Dv)_(_ND)D cos(Dv)_(_ND)D log(Dv)_(_ND)D exp(Dv)_(_ND)
156 #endif
157
158 //^js@
159 #if !defined(wasm)||defined(__wasi__)
160 I js_eval(C*s,Im,C*r,In)_(_0)
161 #endif

```

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## m.c - ngnksource

### Global variables defined

- [argv](#)
- [ce](#)
- [ci](#)
- [cn](#)
- [cns](#)
- [env](#)
- [gk](#)
- [gn](#)
- [gv](#)
- [lck](#)
- [nm](#)
- [x](#)
- [xB](#)

### Functions defined

- [A\\_AN\\_\(Nn,Ax\)\\_\(Q\(n<1||l<<48||n==1\);xL\[-1\]≡n;x\)](#)
- [k](#)
- [kargs](#)
- [kinit](#)
- [mRn](#)
- [mb](#)
- [os](#)
- [osd](#)
- [repl](#)

## Macros defined

- MAP\_NORESERVE
- mms
- obs
- rts
- sys

## Source code

```
1 // ngn/k, (c) 2019-2022 ngn, GNU AGPLv3 -
https://codeberg.org/ngn/k/raw/branch/master/LICENSE
2 #include "a.h"
3 #include <fcntl.h>
4 #include <sys/mman.h>
5 #ifndef MAP_NORESERVE
6 #define MAP_NORESERVE 0
7#endif
8 S I nm; S ST{V*p;Ln;}m[8];SN A0(oom,die("oom"))
9 S
V*mm(V*p,Nn,If)_-(p=mmap(p,n,PROT_READ|PROT_WRITE,MAP_NORESERVE|MAP_PRIVATE|(p?
MAP_FIXED:0)|(f<0?MAP_ANON:0),f,0);
10 P((L)p<ZP,eo0();(V*)0)P(f>0,p)I(nm==ZZ(m),die("mmap lmt"))*
(C*)p=nm;m[nm++]=(TY(*m)){p,n};p)
11 S A mu(V*p,Nn)_-(munmap(p,n);i(ZZ(m),B(m[i].p==p,Mc(m+i,m+i+1,(--nm-i)*SZ
m[0])));0)
12 S A mx(Nn)_-(V*p=mm(0,n,-1);P(!p,oom())*(C*)p=0;(A)(p+ZA))
13 A mf(IF,Nn)_-(V*p=mm(0,ZP+n,-1);P(!p,0)Ax=(A)(p+ZP);*
(C*)p=1;x=AT(tC,AN(n,x));xR;P(!mm(p+ZP,n,f),x(0))x)
14
15 S Az[SZ(N)==4?27:35];S I lck;
16 S A mb(Cb,Ax)_-(xX=0;xr=0;DBG(AN(-1,AT(0,x));*xL=0);xU=b;x)
17 V mrn(Nn,OA*a){i(n,Mr(a[i]))}V mrn(Nn,OA*a)
{i(n,R(a[i]))}A1(mRa,i(xn,R(xa))x)
18 A1(m0,DBG(lck++);Q(x);XP(0)Q(xr>0);P(--xr,0)Cb=xU;P(!b,x=AT(tn,x))xX=z[b];z[b]=(A)xV;XR(mrn(xn,xA);x)x)
19 A1(m1,DBG(lck--);P(!x,0)P(xt==tn,mu(xV-ZP,xn+ZP))DBG(Ms(xV,0xab,xZ);DBG(AN(-1,AT(0,x))));0)A1(mr,m1(m0(x)))
20 A an(Ct,Nn)_-(Q(!lck);Q(c3(tA,t,tn-1));Q(!TP(t));Cb=59-
_builtin_clzll(ZA|ZA-1+n*TZ[t]);P(n>1ull<<ZZ(z)||b>ZZ(z)-2,oom()))
21
Ax=z[b];Ii=b;W(!z[i],i++)I(i<ZZ(z)-1,x=z[i];z[i]=xx)E(x=mb(b,mx(ZA<<(i=max(b,24
)))))
22 I(b<i,xU=b;W(b<i--,z[i]=mb(i,(A)x+(ZA<<i)))xr=1;AT(t,AN(n,x)))
23 A av(Ct,Nn,OV*v)_-(Ax=an(t,n);Mc(xV,v,n*TZ[t]);x)A1(ax,xr>1?xr-
-,an(xt,xn):x)A0(aa0,am(enl(as(0)),enl(au)))
24 A a2t(Ax,Ay,Ct)_-(Az=an(t,2);zx=x;zy=y;z)
25
A1(a1,Ay=an(tA,1);yx=x;y)A3(a3,Au=an(tA,3);ux=x;uy=y;uz=z;u)A2(a2,a2t(x,y,tA))A
2(aM,a2t(x,y,tM))A2(am,a2t(x,y,tm))
26
AL(aA,an(tA,n))AL(aB,an(tB,n))AL(aC,an(tC,n))AL(aI,an(tI,n))AL(aL,an(tL,n))AL(a
D,an(tD,n))AL(aS,an(tS,n))
```

```

27  A al(Lv)_ (aV(tl,1,&v))A ad(Dv)_ (aV(td,1,&v))A aCn(Qs,Nn)_ (aV(tC,n,s))A
aCm(Op,Qq)_ (aCn(p,g-p))AQ(aCz,aCn(s,Sn(s)))
28  C tz(Lv)_ (v==(B)v?tB:v==(H)v?tH:v==(I)v?tI:tL)A
kv(A*p)_ (Ax=*p;Q(xn==2);P(xr>1,--xr;*p=R(xx);R(xy))*p=xx;AN(0,x);x(xy))
29  AL(az,n-(I)n?
al(n):ai(n))AL(mut,XP(x)P(xr==1,x)x=x(av(xt,xn,xV));XR(mRa(x))x)
30
ALA(room,P(xr==1&&n*xW<=xZ,AN(n,x))Ay=an(xt,n);Mc(yV,xV,xn*xW);I(ytR,I(xr==1,AN
(0,x))E(i(xn,R(ya))))x(y))
31  L gl_(Ax)_ (XP(xv)*xL)L gl(Ax)_ (Lv=gl_(x);x(0);v)D gd(Ax)_ (Dv=*xD;x(0);v)
32
33  S C s0[1<<16],*s1=s0+1;Q qs(O L*p)_ (*p<0?s0-*p:(V*)p)
34  AQ(sym,Nn=Sn(s);P(n<4||n==4&&!
(s[3]&128)),IV=0;Mc(&v,s,n);as(v))Qp=s0+1;W(p<s1,P(!SQ(p,s),as(s0-
p))p+=Sn(p)+1)
35  n++;P(s1+n>s0+SZ s0,die("syms oom"))Mc(s1,s,n);s1+=n;as(s0-s1+n))
36
37  S AQ(cps,Ax=N(pk(s));cpl(str0(aCz(s)),x,oS))
38  S AQ(bscd,P(!*s,Cb[256];getcwd(b,SZ b)?eo0():aCz(b))chdir(s)?eo0():au)
39  S AQ(bsbs,exit(0);0)
40  S
AQ(bsd,P(!*s,aCz(gp))s+=*s=='.';Nn=Sn(s);P(n+2>SZ(gp),ez0())Mc(gp,s,n+1);au)
41  S AQ(bsv,K("{`0:(${!h},`\\`:\\`,'`k'.`h:(&x=^`o`p`q`r`u`v`w`e?
`!h)`#h:``repl_.:0#`}","ai(!!s)))}
42  S AQ(bsf,bsv(0))
43  S AQ(bst,Ln=s[-1]=='t'&&*s==':'?
++s,pl(&s):1,t=now();Ax=N(cps(s));i(n,mr(Nx(run(x,0,0))))x(az((now()-
t+500)/1000)))
44  S C*skp(C*s)_ (W(!MQ(s,"/\n",2),C*p=SS(s+1,"\\n\\n"));s=p?p+3:s+Sn(s))s)
45  S I ln(Qs)_ (Ax=evs(s);P(x,x(out(x));1)epr(0))
46  S A lns(C*p,Nn)_ (Q(n)P(p[n-1]-10,eQ("eoleof"))p[n-
1]=0;I(!MQ(p,"#!",2),p=SC0(p+2,10))
47  C*v=p;W(p<v+n,C*q=p=skp(p);W(*q&&(*q-10||si(" }",q[1])-
<2),q++)*q=0;N(ln(p));p=q+1)au)
48
AQ(bsl,If=open(s,O_RDONLY,0600);P(f<0,eo0())Ln=lseek(f,0,2);P(n<0,ei0())C*p=mm(
0,n,f);close(f);P(!n,au)P(!p,0)Ax=lns(p,n);mu(p,n);x)
49  S AQ(bsL,Nm=SZ gp;C
p[m],q[m+3];Mc(p,qp,m);Ax=N(bsd(s));Nn=Sn(gp);Mc(q,qp,n);Mc(q+n,".k",3);bsl(q);
Mc(gp,p,m);x)
50  AQ(evs,P(*s-
'\\',Ax=N(cps(s));x(run(x,0,0)))Cc=s[1],d=s[2];P(c=='c'&&d=='d'&&
(!s[3]||s[3]==32),bscd(s+3+(s[3]==32)))
51  P(!d||d==32||d==':',T(&bsL,bsl,bst,bsd,bsbs,bsf,bsv,bsm,en0)
[si("Lltd\\fvm",c)](s+2+(d==32)))
52  K("0x0a\\`x(,,\\"/bin/sh\\"),:,aCz(s+1)))
53
54  C gp[32];I gn,gk[256];A gv[256],cns,ce[tn],cn[tn],ci[2][5];Q*argv,*env;
55  I rep_((Cb[256],*s=b,*q;W(1,Ln=read(0,s,b-s+SZ b);P(n<0,0)s+=n;q=MC(s-
n,10,n));
56                                     P(g,C*p=b;W(g,*g=0;ln(p);p=g+1;g=MC(p,10,s-
p))Mc(b,p,s-p);s+=b-p;1)
57                                     P(b+SZ b<=s,die("longline"))))1)
58  V repl(){W(rep())}
59  L k(Qs)_ (Ax=N(evs(s));Xz(gl(x))x(0))
60  V kf(Qs,L(*f)(L)){dmd(A(sym(s),au,av,AT(te,(A)f)),4);}
61  V kinit(){S I l;P(l)l=1;
62  z[Z(z)-1]=1;Ax=AN(0,aA(32)),*c=xA;i(tS-
tA+1,*c+=ce[tA+i]=an(tA+i,0))*c+=ce[tm]=am(oS,oA);
63
cn[tA]=ce[tC];*c+=cn[tB]=cn[tH]=cn[tI]=cn[tL]=cn[ti]=cn[tl]=al(NL);*c+=cn[tD]

```

```

=cn[td]=ad(ND);
64  cn[tC]=cn[tc]=ac(32);cn[tS]=cn[ts]=as(0);i(tn-to,cn[to+i]=au)
65      ci[0][0]=ai(0);      ci[0][1]=ai(1);*c++=ci[0][2]=al(WL);*c++=ci[0]
[3]=al(-WL);ci[0][4]=cn[tL];
66      *c++=ci[1][0]=ad(0);*c++=ci[1][1]=ad(1);*c++=ci[1][2]=ad(WD);*c++=ci[1]
[3]=ad(-WD);ci[1][4]=cn[tD];
67  xn=c-xA;Q(xn<=32);cns=x; }
68  V kargs(In,Q*a){argv=(Q*)a;env=(Q*)a+n+1;n=max(0,n-2);Ax=n?
aA(n):oA;i(n,xa=aCz(a[2+i]))gk[gn]='x';gv[gn++]=x; }
69
70  A AT(UL t,Ax)_((Q(c3(0,t,tn));P(TP(t),x=Lt(t)|x<<8>>8)_t1(x)=t;x)
71  A AV(UL v,Ax)_((Q(v<32);x&~3111|v)
72  A AW( C w,Ax)_((Q(w<6);xE=w;x)
73  A AK( C k,Ax)_((Q(k<9);xk=k;x)
74  A AO(UC o,Ax)_((Xs(x&~(0xff11<<32)|(UL)o<<32)xB[-13]=o;x)
75  A AN( Nn,Ax)_((Q(n<111<<48||n== -1);xL[-1]=n;x)
76  A1(R,Q(x);XP(x)Q(xr>=0);xr++;x)
77
78  SN I ow(Qs,Nn)_((write(1,s,n)))
79  SN V o8(Lv){Cb[16],*s=b;i(16,Cc=v>>4*(15-i)&15;*s++="0W"[9<c]+c)ow(b,16);}
80  I os(Qs)_((ow(s,Sn(s))))
81  L ov_(Qs,Lv)_((os(s);o8(v);ow("\n",1);v)
82
83 #define mms(a...) i(nm,V*p=m[i].p,*q=p+m[i].n;If=!=!*(C*)p;a)
84 #define obs(a...) mms(Ax=(A)p+ZA+ZP*f,y=(A)q;W(x<y,a;x+=xZ+ZA))
85 #define xys(a...) obs(I(xtR&xr,i(xn,Ay=xa;a)))
86 #define rts(a...) {i(gn,Ax=gv[i];I(x,a))Ax=cns;a;}
87 SN V od(Lv){Cb[32];ow(b,sl(b,v)-b);}
88 SN V osd(Qs,Lv){os(s);od(v);}
89 SN A1(ox,o8(x);osd(" U",xU);Ct=_t1(x);os(
t");I(c3(1,t,tn),ow(&TS[t],1))E(od(t))
90 osd(" x",xr);osd(" =",xm);osd(" n",xn);i(min(5,xZ/8),os(
"));o8(xl))os("\n");x)
91 AQ(bsm,obs(xm=0)xys(I(!ytP,m(y)++)rts(I(!xtP,xm++))
92 // In=0;obs(ox(x);n++);osd("nObjs:",n)
93 // os("mapped regions:");mms(o8((L)p);os("-");o8((L)q);osd(" F",*
(C*)p);osd(" N",q-p))
94 obs(I(!c3(tA,xt,tn-1)&xr,os("!type:");ox(x)))
95 obs(I(xr-xm,os("!refc:");ox(x)))
96 xys(I(!yt,os("!dngl:");ox(x);ox(y)))au)

```

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## t/t.c - ngnksource

### Global variables defined

- [a](#)
- [c](#)
- [e](#)
- [f](#)
- [m](#)
- [n](#)
- [o](#)
- [p](#)
- [p](#)
- [p](#)
- [p](#)
- [p](#)
- [p](#)
- [s](#)
- [u](#)

### Data types defined

- [C](#)
- [I](#)
- [L](#)

### Macros defined

- [B](#)
- [E](#)

- I
- P
- S
- SZ
- W
- -
- cl
- i
- pr
- wr

## Source code

```

1 #include<fcntl.h> // ngn/k, (c) 2019-2022 ngn, GNU AGPLv3 -
http://codeberg.org/ngn/k/raw/branch/master/LICENSE
2 #include<stdio.h>
3 #include<stdlib.h>
4 #include<string.h>
5 #include<unistd.h>
6 #include<sys/mman.h>
7 #include<sys/stat.h>
8 #include<sys/types.h>
9 #include<signal.h>
10 #define _(...){return{...};}
11 #define I(x,...) if(x){...}
12 #define E(...){...}
13 #define P(x,...) I(x,_(...))
14 #define B(x,...) I(x,...;break)
15 #define W(x,...) while(x){...}
16 #define i(x,...) for(I i=0,n_=(x);i<n_;i++){...}
17 #define S static
18 #define SZ sizeof
19 #define pr(x...) {printf(x);fflush(stdout);}
20 #define wr write
21 #define cl close
22 typedef char C;typedef int I;typedef long long L;
23 S C*mmap(C*s,C**e)(I f=open(s,0);struct stat h;fstat(f,&h);L
n=h.st_size;C*r=mmap(0,n,1,2,f,0);cl(f);*e=r+n;r)
24 S I nl(C*s,I n)(C*p=s;I i=0;W(i<n,I(s[i]==10&&i<n-
1&&s[i+1]==32,*p++=';';i+=2)E(*p++=s[i+1]))p-s)
25 S I t(C*s,I n)(wr(1,".",1);P(*s=='/'||*s==10,0)
26 C*u=strstr(s," /");P(!u,wr(1,"bad test: ",10);wr(1,s,n);-1)
27 C*a[ ]={"./k",0};I p[4];pipe(p);pipe(p+2);
28 I
c=fork();P(!c,dup2(*p,0);dup2(p[3],1);i(4,cl(p[i]))exit(execve(*a,a,0));0)
29 cl(*p);cl(p[3]);wr(p[1],s,u-s);wr(p[1],"\\n\\m\\n",4);cl(p[1]);
30 C o[256];L m=0;W(1,L k=read(p[2],o+m,SZ o-1-m);B(k<=0)m+=k;B(m<SZ o-1))
31 cl(p[2]);m=nl(o,m);u+=3;kill(c,SIGKILL);P(s+n==u+m&&!strcmp(o,u,m),1)

```

```
32  wr(1,"\\nfail: ",6);wr(1,s,n);wr(1,o,m);wr(1,"\\n",1);-1)
33  I main()_(pr("unit tests\\n");C*e,*s=mm("t/t.k",&e);I n=0,f=0;
34  W(s<e,C*u=strchr(s,10)+1;I r=t(s,u-s);n+=!r;f+=r<0;s=u)P(f,pr("\\nfail
%d/%d\\n",f,n);1)pr("\\n");0)
```

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## **t/ - ngnksource**

- [t.c](#)
- [t.k](#)

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## t/t.k - ngnksource

```
1 -1 23 -45 -0 0N          / -1 23 -45 0 0N
2 0 1 -1 0n 0w -0w 1e3      / 0.0 1.0 -1.0 0n 0w -0w 1000.0
3 0.0123 0.123 1.23 12.3 123.0 / 0.0123 0.123 1.23 12.3 123.0
4 1230.0 -12300.0 1.234e50 / 1230.0 -12300.0 1.234e50
5 0%0                         / -0n
6 -(,-128;,-32768)          / (,-128;,-32768)
7 (@0N 0N)-@(0;0N)           / 1
8 `abcdefgh``a012            / `abcdefgh``a012
9 `"a+b"`"cd"``*``       / `"a+b"`"cd"``*``
10 "a\b\t\r\n\"\\""        / "a\b\t\r\n\"\\"""
11 (0x;0x00094142;0x01094142) / (";"`\0\AB";0x01094142)
12 (/)                          / /
13 (\)                          / \
14 (')                          / '
15 (1-2;1--2;- 1)             / -1 3 -1
16 (-"A";-"BC";"-")     / (-65;-66 -67;!0)
17 "A"-1                   / 64
18 1 2 3+4 5 6                / 5 7 9
19 1 -2 3+-4                 / -3 -6 -1
20 (1;2 3)+(4 5;6)           / (5 6;8 9)
21 (7+();())+8)              / ((();()))
22 2+-3*- -4 5*6             / 74 -88
23 1+(2 3;4;(5 6;7 8;9))    / (3 4;5;(6 7;8 9;10))
24 1 2+(3;4 5)               / (4;6 7)
25 (1;2 3)+4                 / (5;6 7)
26 (1;2 3)+4 5               / (5;7 8)
27 (1 2;3;4 5)+(6;7 8 9;10 11) / (7 8;10 11 12;14 16)
28 0 1+0xff                  / -1 0
29 1%(0 1;2)                 / (0w 1.0;0.5)
30 !:'5 0 -1 -3              / (0 1 2 3 4;!0;,-1;-3 -2 -1)
31 (!3 2;!!0;!2 0 5)         / ((0 0 1 1 2 2;0 1 0 1 0 1);();(!0;!0;!0))
32 (1+!0;(!0)+2)              / (!0;!0)
33 3 3 17!`10 -1 23           / 1 2 6
34 -3!-7+!15                 / -3 -2 -2 -2 -1 -1 -1 0 0 0 1 1 1 2 2
35 +(1 2 3;4 5 6)             / (1 4;2 5;3 6)
36 +(`a;`b`c)          / (`a`b`c)
37 +("abc";"d";"efg")        / ("ade";"bdf";"cdg")
38 +(("ab";"cd");"e")      / (("ab";"eea";0);("b";1))
40 +(("ab",0;(c;+;2)))    / ("ac";("b";+);0 2)
41 ++(("ab",0;(c;+;2)))   / (("a";"b";0);("c";+;2))
42 (+0;+1 2;+(1;`a;"a")) / (,,0;,1 2;,(1;`a;"a"))
43 (+++;1+;+;-;+:-)           / (+++;1+;+;-;+:-)
44 (+/1 2 3;-/4 5;*/0.)      / 6 -1 0
45 (+/1 2 3.5;-/4 5.;*/0.)   / 6.5 -1.0 0.0
46 */(2 3;4 5)                / 8 15
47 +/'(!0;0#0n)                / (0;0.0)
48 -/'(!0;0#0n)                / (0;-0.0)
49 */'(!0;0#0n)                / (1;1.0)
50 &/'(!0;0#0n)                / (9223372036854775807;0w)
51 |/'(!0;0#0n)                / (-9223372036854775807;-0w)
52 ?/'(!0;0#0n)                / (0N;0n)
53 :/"abc"                     / "c"
54 :\`abc"                      / "abc"
55 10+/2 3 4                     / 19
56 10+\2 3 4                     / 12 15 19
```

```

57  10+/1                                / 11
58  10+\1                                / 11
59  2.+/3 4                               / 9.0
60  2+/3. 4.                             / 9.0
61  (*/*0#,();*/0#,2 3)                  / 1 1
62  "x"/("ab";"c";"def")                / "abxcxdef"
63  "xy"/("ab";"cd")                   / "abxycd"
64  "AB"/"ab"\\"abracadabra"           / "ABracadABra"
65  ""/("ab";"cd")                      / "abcd"
66  0xff/, "ab"                           / "ab"
67  "x"/()                                /
68  3(2*)/1                               / 8
69  */`a b c!2 3 4                      / 24
70  0{y}/!3                               / 2
71  ${$_=1;1;2!x;1+3*x;-2!x]}/17      / 1
72  ${$_=1;1;2!x;1+3*x;-2!x]}\17       / 17 52 26 13 40 20 10 5 16 8 4 2 1
73  {*}.'$+/1+!x}/2                     / 6
74  {*}.'$+/1+!x}\2                     / 2 3 6
75  (+\2 3;-\4 5;1+\2 3;*!\0)          / (2 5;4 -1;3 6;!\0)
76  -\1 2;3)                            / (1 2;-2 -1)
77  ,\0 1 2                            / (,0;0 1;0 1 2)
78  123*!\0                            / !0
79  +\1 2;3 4;5 6                      / (1 2;4 6;9 12)
80  +\+`a b!+(1 2;3 4;5 6)            / +`a b!(1 4 9;2 6 12)
81  {(\x;y;z)}/[1;2 3 4;5 6 7]        / ((1 2 5;3;6);4;7)
82  {(\x;y;z)}/[1;2 3 4;5 6 7]        / (1 2 5;(1 2 5;3;6);((1 2 5;3;6);4;7))
83  {(\x,y,z)}/[1;2 3 4]5 6 7         / 1 2 5 3 6 4 7
84  *\`a b c!2 3 4                     / `a b c!2 6 24
85  5*\`a b c!2 3 4                     / `a b c!10 30 120
86  ", "\", a, bc, , de, "           / (" , "a"; "bc"; " " ; "de"; " ")
87  "a"\ "bc"                           / , "bc"
88  "x"\ ""                            / ()
89  (, "x")\ ""                         / ()
90  ". "\ "ab.c."                      / ("ab"; "c"; " ")
91  (, ".")\ "ab.c."                  / ("ab"; "c"; " ")
92  "ab"\ "abcdeabfabab"              / ("", "cde"; "f"; " " ; " ")
93  "\n"\ "ab\ncd\n"                   / ("ab"; "cd")
94  5(2*)\1                            / 1 2 4 8 16 32
95  (20>)(2*)/1                      / 32
96  (20>)(2*)\1                      / 1 2 4 8 16 32
97  2/1 1 1 1 0 1 1                  / 123
98  3 5 2/2 4 0                      / 28
99  2/(1 1 0;0 1 0;1 0 1)            / 5 6 1
100 (8#2)\123                        / 0 1 1 1 1 0 1 1
101 (1+!8)\123                      / 0 0 0 0 0 2 1 3
102 (4#3)\16 17                      / (0 0;1 1;2 2;1 2)
103 2\7 8 9                           / (0 1 1;1 0 0;1 0 0;1 0 1)
104 5\!0                                / ()
105 10\0                                / !0
106 +/~(99#10)\12345                 / 94
107 #: '(1;2 3 4;!0;5 6)             / 1 3 0 2
108 #'0 0                                / 1 1
109 (!3)#'`a                          / (0#`;, `a;`a`a)
110 2 ON#"abcdef"                     / ("abc"; "def")
111 0N 2#"abcdef"                     / ("ab"; "cd"; "ef")
112 3 ON#"abcdefgh"                  / ("ab"; "cde"; "fgh")
113 0N 3#"abcdefgh"                  / ("abc"; "def"; "gh")
114 3 ON#`a b c d e f g             / (`a`b;`c`d;`e`f`g)
115 0N 3#`a b c d e f g             / (`a`b`c;`d`e`f;`g)
116 4 ON#9#1                           / (1 1;1 1;1 1;1 1 1)
117 4 ON#10#1                          / (1 1;1 1;1 1;1 1 1)

```

```

118 2 1 3#` / ( , `` `; `` ` )
119 ON#"abc" / "abc"
120 ON_"abc" / ""
121 0#(1;"b") / ()
122 1#`a`b!1 2 / ( , `a ) ! , 1
123 2 3 0#0 / ( ( ! 0 ; ! 0 ; ! 0 ) ; ( ! 0 ; ! 0 ; ! 0 ) )
124 {0=3!x}#!10 / 0 3 6 9
125 {0=3!x}_!10 / 1 2 4 5 7 8
126 {2!x}#12 4 -10 / ! 0
127 {2!x}_12 4 -10 / 12 4 -10
128 {x-"a" }#"abcd" / "bccddd"
129 {x-"a" }_abcd / , "a"
130 {(< '/')#x}@+!3 4 / ( 0 1 ; 0 2 ; 0 3 ; 1 2 ; 1 3 ; 2 3 )
131 {x=|/x}#`a`b`c`d`e!3 5 5 2 5 / `b`c`e!5 5 5
132 {x}_-1 0 1 / , 0
133 -' :2 3 8 99 / 2 1 5 91
134 -' :2.5 -5.0 0w / 2.5 -7.5 0w
135 *' :7 2 / 7 14
136 =' :"abbr" / 0 0 1 0
137 +' :`a`b`c!4 2 7 / `a`b`c!4 6 9
138 &' :"abc" / 97 97 98
139 3 | :': "abcde" / ( "cba" ; "dcb" ; "edc" )
140 4{x 3 0}': "abcde" / ( "da" ; "eb" )
141 #:'`a`b!("abr";"acada") / `a`b!3 5
142 1;2 / 2
143 #1 2 3 / 3
144 #4 / 1
145 #(1 2 ; 3) / 2
146 #, 1 2 / 1
147 #"" / 0
148 #() / 0
149 #`a`b`c!(!4;4#`;"abcd") / 3
150 #+`a`b`c!(!4;4#`;"abcd") / 4
151 #, () ! () / 1
152 #(+)
153 8#"abc" / "abcabca"
154 2#5 6 7 / 5 6
155 4#(1 2;"cd";`e`f`g) / ( 1 2 ; "cd" ; `e`f`g ; 1 2 )
156 1#!0 / , ON
157 2#"" / "
158 3#0#` / `` `
159 (`a`b!(0 1;"ab");0)@2 / `a`b!(ON ON;"")
160 0#!0 / ! 0
161 0#"abc" / "
162 3#(+)
163 (!0)#"abc" / ( + ; + ; + )
164 0#` / "a""
165 0#()
166 0 0#0 / ()
167 0 2#0 / ()
168 -1#"abc" / , "c""
169 -1#()
170 -1#((();()))
171 2 3#4 5 / , ( )
172 1 2 3#`a`b`c`d / ( 4 5 4 ; 5 4 5 )
173 2 3#("ab";"cd") / , ( `a`b`c ; `d`a`b )
174 ,1 / , 1
175 ,1 2 / , 1 2
176 (((),0),1 / 0 1
177 *(())
178 *"abc" / "a""

```

```

179 *"
180 ***(((((1 2;3);4)))
181 *3#, "ab"
182 *`a`b`c!1 2 3
183 *|`a`b`c!(0 1;2 3;4 5)
184 *|+`a`b`c!(0 1;2 3;4 5)
185 `a`b!1 2
186 `a`b!1
187 `a!1 2
188 `a!1
189 !`a`b!1 2
190 .`a`b!1 2
191 "abc"!"d"
192 !{x!x} `a`b
193 .{x!x} `a`b
194 |`a`b`c!(0 1 2;3;4)
195 |+`a`b`c!(0 1;2 3;4 5)
196 (+`a`b`c!(0 1;2 3;4 5))1
197 (+`a`b`c!(0 1;2 3;4 5))1 0 2
198 (+`a`b`c!3 2#!6)[`b;1]
199 (`a`b!0 1),`b`c!2 3
200 a:2;a:a+3;a*4
201 a:!4;b:3;c:a*b;c
202 {2;3 4}5 6 7
203 (::)~{()}0
204 a:2;{a}0
205 a:2;{a:3;(a)0
206 f:{a};a:2;f[]
207 a.b.c:1;`a.b.c
208 a.b.c:1;{a.b.c}0
209 a.b.c:1;{a.b.c:2;`a.b.c}0
210 {a.b.c:1}0;`a.b.c
211 {a.b.c:1}0;`a.b.c:2;`a.b.c
212 a.b!:12;{a.b,:x}2;`a.b
213 {x*x}2 3
214 {x+y*z}[1;2;3]
215 {x+y*z}[1][2;3]
216 {x[y;z] [+;2;3]
217 ("ab3";"X";1.2 -3.0 -4.5 0n) / ("ab3";"x";1 -3 -5 0N)
218 (`ab3;-12 34;())
219 ${[1;2;3]
220 ${[0;2;3]
221 ${[0;4;();5;;6;7]
222 (::)~${[0;4;();5;;6]
223 ${[;`y;`n]
224 b:1;${[b;b+2;b*5]
225 c:0;${[c;c+2;c*5]
226 ${("a";"ab";1;2 34;`sym)
227 ${(+;-*;%/;1+;\`)
228 `$`a`b!(0;1 2)
229 1:
230 2:::
231 a:0 0 0 0 0 0 0 0 0 0;a
232 (1+)^2
233 ((1;2 3)+)(4;5 6)
234 |!0
235 |()
236 |1
237 |"ab"
238 |`a`b`c
239 |!5

```

```

240 | (1;2 3) / (2 3;1)
241 0~0 / 1
242 1~2 / 0
243 aa:(3 ON; ``a; "") / 1
244 ()~() / 1
245 (0#~)~(0#`a`b) / 1
246 ()~0#, "" / 1
247 ""~() / 0
248 2~,2 / 0
249 (0;1;0 1 1 0 0 1;0#1 1) / (0;1;0 1 1 0 0 1;!0)
250 0,1 / 0 1
251 2,"" / ,2
252 0 1 2,3 4 / 0 1 2 3 4
253 `a,0 / (`a;0)
254 (!0),`a`b / `a`b
255 1 0 1,"" / 1 0 1
256 "ab", "c" / "abc"
257 "a", "" / ,"a"
258 "", "a" / ,"a"
259 ,/!:!4 / 0 0 1 0 1 2
260 (,/"";,/!0;,/(()) / ("";!0;())
261 ,/((1 2;3);(4;5 6)) / (1 2;3;4;5 6)
262 ,//(),0;((1 2;,,3);"";4 5);6 / 0 1 2 3 4 5 6
263 (0#,("ab";3)),0#,`a`b / ()
264 &:'(4;0 2 0 0 1;0 0;1) / (0 0 0 0;1 1 4;!0;,0)
265 &`a`b`c!2 0 1 / `a`a`c
266 &(0 1 0;1 0 0;1 1 1) / (0 1 2 2 2;1 0 0 1 2)
267 "abc"1 / "b"
268 "abc"1 1 0 / "bba"
269 `a`b`c[1 5 1 0 -10] / `b`b`a`
270 1+`:2 3 / 3 4
271 1 2+/:3 4 5 / (4 5;5 6;6 7)
272 "abc"*\:0 1 / (0 97;0 98;0 99)
273 3#/`:2 1 / (2 2 2;1 1 1)
274 3 2#\:\:1 / (1 1 1;1 1)
275 "abc"@\:1 4 / "b"
276 {1+#\u}@\:/:(4;5 6) / 2 3
277 (-:;#:)@\:2 / -2 1
278 "abcd"@\:(3 1;(1 7;2)) / ("db";("b";"c"))
279 "ab"@\!0 / ""
280 ("ab";`cd;5 6)@\:" / ()
281 (`a;`bc")1 / "bc"
282 (1_"abc";-2_`a`b`c;2_3 4) / ("bc";`a;!0)
283 (6_!5;-7_!0) / (!0;!0)
284 -7_((1 2;3);4 5) / ()
285 (2 3_"abcde";(!0)_"abcde") / (((,"c";"de"));())
286 (!0)_`a`b`c / ()
287 2 4 6_`a`b`c`d`e`f / (`c`d;`e`f;0#`)
288 1 2 4_0 1 0 1 0 1 0 1 0 1 0 1 1 0 / (,1;0 1;0 1 0 1 0 1 0 1 1 0)
289 2 2_0 1 / (!0;!0)
290 1_(`a;`b";"c") / "bc"
291 "abcd"_2 / "abd"
292 (,12)_0 / !0
293 ("a;1;"c*)_1 / "ac"
294 (`a;1;"c*)_1 / (`a;"c")
295 (`a;1;"c*)_3 / (`a;1;"c")
296 (`a;1;"c*)_1 / (`a;1;"c")
297 (,,")_0 / ()
298 1_`a`b`c!3 4 5 / `b`c!4 5
299 (`a`b`c!3 4 5)`b / `a`c!3 5
300 0 0 1 1&0 1 0 1 / 0 0 0 1

```

```

301 0 0 1 1|0 1 0 1          / 0 1 1 1
302 ~"a b\0c0"                / 0 0 0 1 0 0
303 ~0 1 1 0 0                / 1 0 0 1 1
304 ~(`;1 0 2;"")            / (1;0 1 0;!0)
305 ~0x00                      / 1
306 ~"ab"! "c\0"              / "ab"!0 1
307 ~(::::;+:+;+/;++)        / 1 0 0 0 0 0
308 ^ (1 2 0N -1;" a";`();)  / (0 0 1 0;1 0;1;())
309 ^ (0N;0 0N;0n;0n 0w 0.0) / (1;0 1;1;1 0 0)
310 ()^"ab"                   / ()
311 "abc"^1 2                 / "abc"
312 "abracadabra"^"ba"       / "rcdr"
313 `a b c^c d                / `a b
314 3 4 5^5 5                 / 3 4
315 2^`a b c!(0 1;0N 3;0N)   / `a b c!(0 1;2 3;2)
316 0^(:::)                   / 0
317 ?(1;`a;"aa";`a;`a;1)     / (1;`a;"aa")
318 ?()                        / ()
319 ?"abracadabra"           / "abrcd"
320 ?3 1 4 1 5 9 2 6 5 3 5 8 9 / 3 1 4 5 9 2 6 8
321 ?2 7 1 8 2 8 1 8 2 8 4 5 9 / 2 7 1 8 4 5 9
322 ?`a``aa`a`aa`aa``           / `a``aa
323 3?" "                      / " "
324 ~|/{(x<"a")&"z"<x}100?"a" / 1
325 ~|/{(x<"A")&"Z"<x}100?"A" / 1
326 +/-5?5                     / 10
327 {x@<x}0N?"abracadabra"    / "aaaaabbcdrr"
328 "abc"??"abracadabra"      / 0 1 0N 0 2 0 0N 0 1 0N 0
329 "abc"??"b"                 / 1
330 "abc"??(+)                 / 0N
331 ("ab";"cd")?("cd";"efg";,"h") / 1 0N 0N
332 ("car0";"car1")?"car1"     / 1
333 ($0 1;2 3))?(,"0";,"1")   / 0
334 `a b c?`b`z                / 1 0N
335 1 2??"a"                   / 0N
336 `c d?2 3                  / 0N 0N
337 (`a b c!3 5 8)?5 6        / `b
338 (`a b c!2 3 4)`b          / 3
339 (`a b c!2 3 4)`c`c`a       / 4 4 2
340 `c$(65 66 67;"de")        / ("ABC";"de")
341 `c$("")234;())             / ("";0xea;())
342 `i$("")0xff;"AB";2345;()) / (!0;-1;65 66;2345;())
343 `c$"A",66                  / "AB"
344 `i$1000.0                  / 1000
345 `d$1000                    / 1000.0
346 `i$12.34 -5.6              / 12 -5
347 `d$12 -5 0N                / 12.0 -5.0 0n
348 `I$("12";"-34";"12?";"") / 12 -34 0N 0N
349 `$" "
350 `$"a"                      / `a
351 `$" "                      / " "
352 `$, "a"                     / `a
353 `$"aa"                      / `aa
354 `$( "a";"aa";"")           / `a`aa` 
355 @ [3 4 5 6;1 3;::8 9]       / 3 8 5 9
356 @ [3 4 5 6;1;::8 9]         / (3;8 9;5;6)
357 @ [!6;(1 3;1 4);::;(6 7;8 9)] / 0 8 2 7 9 5
358 @ [("a";`b;3);1;::;("de";`f)] / ('a';("de";`f);3)
359 @ [( );!0;::0]               / ()
360 @ [8 0 0 9;1 0 1;::5 2 4]    / 2 4 0 9
361 @ [ `a`b`c`d;();:"e"]       / `a`b`c`d

```

```

362 @[ `a`b!1 2;`b`c:::3 4]      / `a`b`c!1 3 4
363 @[(0#`)!();`a:::1]           / (,`a)!,1
364 @[(0#`)!();`a:::1 2]         / (,`a)!,1 2
365 @["abcd";(0;1 2)::;"e"]    / "eed"
366 @["ab";,,1::;"c"]          / "ac"
367 @[3 4 5;1;+;1]             / 3 5 5
368 @[3 4 5;1 1 0;--;1]        / 2 2 5
369 @[`a`b!3 4;`b`c;*;2]       / `a`b`c!3 8 2
370 @[(1;2;`);0 1;#;3]         / (,3;3 3;`)
371 @["ABC";1;_:]              / "AbC"
372 @[+`a`b!2 3#!6;1;::;`a`b!8 9] / +`a`b!(0 8 2;3 9 5)
373 @[0,,,1;!2;::;3]           / 3 3
374 @![15;0x01;+;10]           / 0 11 2 3 4
375 @![15;0x0203;+;10]         / 0 1 12 13 4
376 a:0 1;.[`a;1;+;2];a       / 0 3
377 a.b:1 2;a.b[1]*:3;a.b     / 1 6
378 ="abracadabra"            / "abrcd"!(0 3 5 7 10;1 8;2 9;,4;,6)
379 =1 2                         / 1 2!(,0;,1)
380 =""
381 =()
382 #*= ""
383 =`a`b`c`d!5 7 6 7          / 5 7 6!(`a;`b`d;`c)
384 =:'3 1 0                     / ((1 0 0;0 1 0;0 0 1);,,1;())
385 (. "1+2";."3";.".3*4\";."") / (3;3;12;::)
386 {x@=x}"abracadabra"        / "abrcd"!("aaaaa";"bb";"rr";,"c";,"d")
387 {x@<x}"abracadabra"        / "aaaaaabbcdrr"
388 {x@>x}4 1 0 3 2           / 4 3 2 1 0
389 a:="abracadabra";#:`a      / "abrcd"!5 2 2 1 1
390 `r`b#=`a`b`r`a`c`a`d`a`b`r`a / `r`b!(2 9;1 8)
391 >#:='mississippi"          / "ispn"
392 <"aaabc"                      / 0 1 2 3 4
393 <(-;+)
394 {x@<x}`f`a``c`de`c`b`ghi / ``a`b`c`c`de`f`ghi
395 +/<' :{x@<x}100?0           / 0
396 +/>' :{x@>x}100?0           / 0
397 $-123                         / "-123"
398 $(ON -12345678;9;1 23;4)    / ((ON;"-12345678");,"9";("1";"23");,"4")
399 $(+;-:;0::2::;"a`bc")        / (,+;"-";;"0:";"2::";(`a;"bc";""))
400 ("abc";"def")[1;2 0]          / "fd"
401 (**|:)(ab;"cd")              / "c"
402 ((ab;"c");(ef;7)). 1 0 1    / "f"
403 (ab;"cd"). 1 1                / "d"
404 (1 2;3 4;5 6). 2 2#,0 1    / (((1 2;3 4);(1 2;3 4));((1 2;3 4);(1 2;3
4)))
405 (-).(5;3 1)                  / 2 4
406 0 1 .()                      / 0 1
407 {a:1}2;a                     / 1
408 a:1;{a:2}3;a                 / 2
409 a:1;{a:2}3;a                 / 1
410 a:1;{a:2;a+:3}4;a           / 1
411 a:1;{a+:2}3;a                 / 3
412 a:1;{a:2;a+:3;a}4           / 5
413 a:2;a+:3;a                 / 5
414 {a:2;a+:3;a}4               / 5
415 _%1000 100,!10              / 31 10 0 1 1 1 2 2 2 2 2 3
416 3':!6                         / (0 1 2;1 2 3;2 3 4;3 4 5)
417 6':!3
418 2' :"abcde"
419 4' :(`1;-;("ab";"c");!0)    / ((`1;-;(`ab";"c"));(1;-;("ab";"c");!0))
420 2' :("a";"b";3;4)           / ("ab";("b";3);3 4)
421 10 20 30'15                  / 0

```

```

422 10 20 30'99 5 9 10 11 31 20 / 2 -1 -1 0 0 2 1
423 {[a;bc;def]a+bc*def}[3;4;5 6] / 23 27
424 {[n] 1+!n}[3] / 1 2 3
425 ("ab";"cd")[];1] / "bd"
426 (~c$2 3 4#65+!26)[1 0;;!2;3 1] / ((("PN";"TR");("DB";"HF"))
427 .[("ab";"cd");1 0;;;"e"] / ("ab";("ce";"d"))
428 .[1 2;();+;3] / 4 5
429 .![12;();::`^a] / `^a
430 .[3 4#1;(2 1;1 3);+;2 2#!4] / (1 1 1 1;1 3 1 4;1 1 1 2)
431 .[{a:(!2 3)!1;a[1;2]:3};0;`e] / `e
432 {a:`a`b`c:a,:`d;a}0 / `a`b`c`d
433 (~a`b!(1;`c`d!3 4)).`b`c / 3
434 () / ()
435 (~a`b!1 2)+3 / ~a`b!4 5
436 2*("ab"!3 4) / "ab"!6 8
437 ("abc"!1 2 3)-"bda"!4 5 6 / "abcd"!-5 -2 3 -5
438 {f:+1+2*;f 3}0 / 7
439 f:-;f[1;2] / -1
440 {x+x}2 / 4
441 {[n]n*n}3 / 9
442 &{x!x}@!4 / 1 2 2 3 3 3
443 1+{x!x}@!2 / 0 1!1 2
444 -4!123 / 30
445 a:3;1+a*:2 / 7
446 .() / ()
447 .(+;1;2) / 3
448 .(-;:3) / -3
449 .:'(+;+;';++;+/) / (1;1;0;(+;:+);(+;/))
450 {s:"abcd";s[2]:"x";s}0 / "abxd"
451 s:"abcd";s[2]:"x";s / "abxd"
452 a:1 2;.[`a;1;+;3] / 1 5
453 {a:3 2#1;a[1;]:0;a}0 / (1 1;0 0;1 1)
454 a:3 2#1;a[1;]:0;a / (1 1;0 0;1 1)
455 {a:3 2#1;a[1;]:0;a}0 / (1 0;1 0;1 0)
456 a:3 2#1;a[1;]:0;a / (1 0;1 0;1 0)
457 1.2<2 / 1
458 3.4<1.2 3.4 5.6 / 0 0 1
459 1.0+2 3 / 3.0 4.0
460 ,1.5 / ,1.5
461 ,2.5 / ,2.5
462 f:"abracadabra"1+;(@f)~@(++) / 1
463 f:"abracadabra"1+;f 3 / "c"
464 {x[0]-1}3 4 5 / 2
465 a+:a:!2;a / 0 2
466 -`a`b`c`d!2 -3 4 0 / ~a`b`c`d!-2 3 -4 0
467 4$"xy" / "xy "
468 -5$"xy" / " xy"
469 a:0;(a;a:1;a) / 1 1 0
470 ("abc";"def";"ghi")[1 ;2 ] / "f"
471 ("abc";"def";"ghi")[1 ;2 0] / "fd"
472 ("abc";"def";"ghi")[1 2;2 ] / "fi"
473 ("abc";"def";"ghi")[1 2;2 0] / ("fd";"ig")
474 (1+)2 / 3
475 -[1;]2 / -1
476 -[;1]2 / 1
477 #[1 2;;] / 1 2#
478 #'[1 2;;] / 1 2#
479 2+ / 2+
480 *[2 3] / 2
481 +[2;;] / 2+
482 1 2#' / 1 2#

```

```

483 1 2+/
484 {[a;b;c;d;e;f;g] 3}..!7 / 1 2+/
485 {f:+';f[1 2]}0 / 1 2+' 
486 (`a`b!0 1;`a`b!2 3) / +`a`b!(0 2;1 3)
487 ((+;-)!((*;%)!2 3;4))[+;%] / 3
488 ,(::) / ,(::)
489 {-x,:x}@,!2 / (0 -1;0 -1)
490 (1;,2)=3.0 / (0;,0)
491 `k("")();0x410100;"abc") / "(\"\"";());0x410100;"abc\")"
492 `k(0#,`;a`bc`"dir/f.ext") / "(0#`;a`bc`\\"dir/f.ext\\")"
493 `k(+;-:+/+;++;1+;\`;':;{y-1}) / "(+;-:+/+;++;1+;\`;':;{y-1})"
494 `k(2::;2:::{}};:::) / "(2::;2:::{}};:::)"
495 {(a;b):2 3;`a`b}0 / -1
496 (a;b):3 4;{(c;d):!2;d+b}0 / 5
497 (+`a`b!(0 1;2 3))1 / `a`b!1 3
498 (+`a`b!(0 1;2 3))2 / `a`b!ON ON
499 (+`a`b!(0 1;2 3))`b / 2 3
500 ,`a`b!0 1 / +`a`b!(,0;,1)
501 ,`a`b!(0 1;2) / +`a`b!(,0 1;,2)
502 ,`a`b!(0 1;2 3) / +`a`b!(,0 1;,2 3)
503 `a`!b!1 / (,`a)!+(,`b)!,,1
504 ,`a!`b!1 / +(,`a)!,+(,`b)!,,1
505 `a!`b!`c!1 / (,`a)!+(,`b)!,+(,`c)!,,1
506 a:`a`b;`a`b;`a / `a`b
507 0w-0w / -0n
508 0*0w / -0n
509 .[-:;`;`e] / `e
510 .[+;`~;`e] / `e
511 .[.:;,"");`e] / `e
512 .[.:;,"(";`e] / `e
513 .[.:;,"(";`e] / `e
514 .[! :;`;`e] / `e
515 .[_. :;+;`e] / `e
516 .[?;(-9;!8);`e] / `e
517 .[?;(-9;!8);`e] / `e
518 .[" "\;1;`e] / `e
519 .[" "/1;`e] / `e
520 .[2 -3#;4;`e] / `e
521 .[<;(+;-);`e] / `e
522 .[_. :;(:;:::);`e] / `e
523 .[.;({x,y};`a`b!(!2;2 3));`e] / `e
524 .[.;(,"ab";3#,0 0);`e] / `e
525 .[+;:,`a`b!(1 2;3 4 5);`e] / `e
526 .[`abc$;1;`e] / `e
527 .[=;0.0,`;`e] / `e
528 .[@;("abc";0 3;::;"def");`e] / `e
529 .[@;("abc";0 1 -1;::;"d");`e] / `e
530 .[.:;,"`a:0";`e] / `e
531 .[=;:,`a`b!(1 2 3;0);`e] / `e
532 (-*)1 2 / -1
533 `hex@"abc" / "616263"
534 `hex?"616263" / "abc"
535 <(1;1.5;2) / 0 1 2
536 >(1;1.5;2) / 2 1 0
537 <(-2;-1.5;-1) / 0 1 2
538 >(-2;-1.5;-1) / 2 1 0
539 <1 1.5 2 / 0 1 2
540 >1 1.5 2 / 2 1 0
541 <-2 -1.5 -1 / 0 1 2
542 >-2 -1.5 -1 / 2 1 0
543 e:|!`;3 e\24 40 / (24 40;16 24;8 16;0 8)

```

```

544 {{z}1)2 / {z}[1;2]
545 ?["abcde";1 4;"xyz"] / "axyze"
546 ?[1 2 3;1;3] / 1 3 2 3
547 ?[1 2 3;1 2;6789] / 1 6789 3
548 ?["abcdefgh";0 5;"xy"] / "xyfgh"
549 ?["abcdefgh";6 8;"x"] / "abcdefx"
550 ?["abcdefgh";6;"xyz"] / "abcdefxyzgh"
551 ?["abcdefgh";0 8;"x"] / ,"x"
552 ?[++"abcdefgh";0 5;++"xy"] / (,"x";,"y";,"f";,"g";,"h")
553 ?[++"abcdefgh";6 8;++"x"] / (,"a";,"b";,"c";,"d";,"e";,"f";,"x")
554 ?[++"abcdefgh";6;++"xyz"] /
(,"a";,"b";,"c";,"d";,"e";,"f";,"g";,"h")
555 ?[++"abcdefgh";0 8;++"x"] / ,"x"
556 ?["abcdefghij";2 5;|:] / "abedcfg hij"
557 s:`prng[];a:9?0;`prng s;a~9?0 / 1
558 ${+`a!!1 1)!,2 / (+`a!(,0;,0))!,,,"2"
559 f:1+{x*y}@;f[2;3] / 7
560 <' :"abcd"!1 3 5 4 8 / "abcd"!0 0 1 0
561 +`a`b!0 1 / +`a`b!(,0;,1)
562 (%/(+/#:#:@\:)2 3 4 6 / 3.75
563 (,/(+;-)@\:)[7 8;9 1] / 16 9 -2 7
564 (0 1;2 3)[;] / (0 1;2 3)
565 (0 1!(0 1;2 3))[;] / 0 1!(0 1;2 3)
566 +/[5;0;1] / 8
567 +\/[5;0;1] / 0 1 1 2 3 5 8
568 +/[8>;0;1] / 8
569 +\/[8>;0;1] / 0 1 1 2 3 5 8
570 +/[5;,0;,1] / ,8
571 +\/[5;,0;,1] / (,0;,1;,1;,2;,3;,5;,8)
572 +\[*8>;,0;,1] / ,8
573 +\[*8>;,0;,1] / (,0;,1;,1;,2;,3;,5;,8)
574 {0 1 0 1}#`a`b`c`d!1 2 3 4 / `b`d!2 4
575 ("abc"!1 3 5)'0 2 / "a"
576 a:()!0;a["bc"]!:1;a"bc" / 1
577 (°):+;1°2 / 3
578 _0#` / 0#`
579 f:+;f.1 2 / 3
580 (,`b)#`a`b!2 3#!6 / (,`b)!,3 4 5
581 (,`b)#+`a`b!2 3#!6 / +(,`b)!,3 4 5
582 (,`b)_`a`b!2 3#!6 / (,`a)!,0 1 2
583 (,`b)_+`a`b!2 3#!6 / +(,`a)!,0 1 2
584 3 ON#!0 / (!0;!0;!0)
585 +\0.5 0.25 0.125 / 0.5 0.75 0.875
586 +\ "abc" / 97 195 294
587 1 :2 / 2
588 +/[-3;0;1] / 1
589 (,`a!0),(`b!1;`c!2) / ((,`a)!,0;(`b)!,1;(`c)!,2)
590 t:+d:`a`b!2 3#!6;t,t / +`a`b!(0 1 2 0 1 2;3 4 5 3 4 5)
591 t:+d:`a`b!2 3#!6;d,t / +`a`b!((0 1 2;0;1;2);(3 4 5;3;4;5))
592 t:+d:`a`b!2 3#!6;t,d / +`a`b!((0;1;2;0 1 2);(3;4;5;3 4 5))
593 `a`b`c<`b / 1 0 0
594 <0 / 0
595 (1+;2*)[1;3] / 6
596 (1+;2*).1 3 / 6
597 1702041551!1314424129 / 1314424129
598 5!-1 0 1 / 4 0 1
599 1(2)': / 2':[1;]
600 2\[;]1 2 3 4 / 2\[1 2 3 4;]
601 +/`pri@_1e7 / 3203324994356
602 *1_+`a`b!1 2 / `a`b!ON ON
603

```

```

604 `j?"123"                  / 123.0
605 `j?"4.5"                  / 4.5
606 `j?"[1,-23,[4],[[[5]],6]]" / (1.0;-23.0;,4.0;(;,5.0;6.0))
607 `j?"[true,false,null,[]]" / (+:;::;0n;())
608 `j?"{\\"k\\":\\"v\\",\\"k1\\":2}" / `k`k1!(", "v";2.0)
609 `j?"\u0412 \u0410\u0412\u041e\u041f\u0410 \u041f\u0415\u041d\u0410 \u041f\u0415\u0414\u0410" / 0xd090d091d09220c3a4c3b8c493c582c3b10a
610 `j?"[{\\a\\":1,\\b\\":{}}]" / +`a`b!{,1.0;+(0#`)!()}
611 `j@123                     / "123"
612 `j@`a,"b",2               / ["\\a\\", "\\b\\", 2]
613 `j@`a`bc!(3;(4 5,,()))  / "{\\a\\":3,\\bc\\":[4,5,[]]}"
614 `j@+`nm`a!((\"al\";"bo");23 34) / "[{\\nm\\":\\"al\\",\\a\\":23}, {\\nm\\":\\"bo\\",\\a\\":34}]"
615 `j@-1 0 1 2 ON            / "[-1,0,1,2,null]"
616 `0:`j@ "абвгдежзий"     / "абвгдежзий"
617 `0:`j@`j?"\u2022\u2022\u2022" / "\u2022\u2022\u2022"
618
619 `?(*`@0n),|0x0000000000000000 / 0.0
620 `?(*`@0n),|0x8000000000000000 / -0.0
621 `?(*`@0n),|0x3ff00000000000000 / 1.0
622 `?(*`@0n),|0xbff00000000000000 / -1.0
623 `?(*`@0n),|0x7ff8000000000000 / 0n
624 `?(*`@0n),|0x7ff0000000000000 / 0w
625 `?(*`@0n),|0xffff000000000000 / -0w
626 `?(*`@0n),|0x0010000000000000 / 2.2250738585072014e-308
627 `?(*`@0n),|0x7feffffffffff / 1.7976931348623157e308
628 `?(*`@0n),|0x0000000000000001 / 5e-324
629 `?(*`@0n),|0x3e60000000000000 / 2.9802322387695312e-8
630 `?(*`@0n),|0xc352bd2668e077c4 / -2.109808898695963e16
631 `?(*`@0n),|0x00000000000f4240 / 4.940656e-318
632 `?(*`@0n),|0x00000000016e3600 / 1.18575755e-316
633 `?(*`@0n),|0x0000008cdcdea440 / 2.989102097996e-312
634 `?(*`@0n),|0x434018601510c000 / 9060801153433600.0
635 `?(*`@0n),|0x43d055dc36f24000 / 4.708356024711512e18
636 `?(*`@0n),|0x43e052961c6f8000 / 9.409340012568248e18
637 `?(*`@0n),|0x3ff3c0ca2a5b1d5d / 1.2345678
638 `?(*`@0n),|0x4830f0cf064dd592 / 5.764607523034235e39
639 `?(*`@0n),|0x4840f0cf064dd592 / 1.152921504606847e40
640 `?(*`@0n),|0x4850f0cf064dd592 / 2.305843009213694e40
641 `?(*`@0n),|0x3ff333333333333 / 1.2
642 `?(*`@0n),|0x3ff3ae147ae147ae / 1.23
643 `?(*`@0n),|0x3ff3be76c8b43958 / 1.234
644 `?(*`@0n),|0x3ff3c083126e978d / 1.2345
645 `?(*`@0n),|0x3ff3c0c1fc8f3238 / 1.23456
646 `?(*`@0n),|0x3ff3c0c9539b8887 / 1.234567
647 `?(*`@0n),|0x3ff3c0ca2a5b1d5d / 1.2345678
648 `?(*`@0n),|0x3ff3c0ca4283de1b / 1.23456789
649 `?(*`@0n),|0x3ff3c0ca43db770a / 1.234567895
650 `?(*`@0n),|0x3ff3c0ca428abd53 / 1.2345678901
651 `?(*`@0n),|0x3ff3c0ca428c1d2b / 1.23456789012
652 `?(*`@0n),|0x3ff3c0ca428c51f2 / 1.234567890123
653 `?(*`@0n),|0x3ff3c0ca428c58fc / 1.2345678901234
654 `?(*`@0n),|0x3ff3c0ca428c59dd / 1.23456789012345
655 `?(*`@0n),|0x3ff3c0ca428c59f8 / 1.234567890123456
656 `?(*`@0n),|0x3ff3c0ca428c59fb / 1.2345678901234567
657 `?(*`@0n),|0x40112e0be8047a7d / 4.294967294
658 `?(*`@0n),|0x40112e0be815a889 / 4.294967295
659 `?(*`@0n),|0x40112e0be826d695 / 4.294967296
660 `?(*`@0n),|0x40112e0be83804a1 / 4.294967297
661 `?(*`@0n),|0x40112e0be84932ad / 4.294967298
662 `?(*`@0n),|0x0040000000000000 / 1.7800590868057611e-307
663 `?(*`@0n),|0x007ffffffffffff / 2.8480945388892175e-306

```

```
664 `?(*`@0n),|0x0290000000000000 / 2.446494580089078e-296
665 `?(*`@0n),|0x029fffffffffffff / 4.8929891601781557e-296
666 `?(*`@0n),|0x4350000000000000 / 1.8014398509481984e16
667 `?(*`@0n),|0x435fffffffffffff / 3.6028797018963964e16
668 `?(*`@0n),|0x1330000000000000 / 2.900835519859558e-216
669 `?(*`@0n),|0x133fffffffffffff / 5.801671039719115e-216
670 `?(*`@0n),|0x3a6fa7161a4d6e0c / 3.196104012172126e-27
671 `?(*`@0n),|0x433fffffffffffff / 9007199254740991.0
672 `?(*`@0n),|0x4340000000000000 / 9007199254740992.0
673 `?(*`@0n),|0x3ff000000000000 / 1.0
674 `?(*`@0n),|0x4028000000000000 / 12.0
675 `?(*`@0n),|0x405ec000000000000 / 123.0
676 `?(*`@0n),|0x4093480000000000 / 1234.0
677 `?(*`@0n),|0x40c81c8000000000 / 12345.0
678 `?(*`@0n),|0x40fe240000000000 / 123456.0
679 `?(*`@0n),|0x4132d68700000000 / 1234567.0
680 `?(*`@0n),|0x41678c29c0000000 / 12345678.0
681 `?(*`@0n),|0x419d6f3454000000 / 123456789.0
682 `?(*`@0n),|0x41d26580b4800000 / 1234567890.0
683 `?(*`@0n),|0x41d26580b5c00000 / 1234567895.0
684 `?(*`@0n),|0x4206fee0e1a80000 / 12345678901.0
685 `?(*`@0n),|0x423cbe991a140000 / 123456789012.0
686 `?(*`@0n),|0x4271f71fb04cb000 / 1234567890123.0
687 `?(*`@0n),|0x42a674e79c5fe400 / 12345678901234.0
688 `?(*`@0n),|0x42dc12218377de40 / 123456789012345.0
689 `?(*`@0n),|0x43118b54f22aebo0 / 1234567890123456.0
690 `?(*`@0n),|0x3ff000000000000 / 1.0
691 `?(*`@0n),|0x4024000000000000 / 10.0
692 `?(*`@0n),|0x4059000000000000 / 100.0
693 `?(*`@0n),|0x408f400000000000 / 1000.0
694 `?(*`@0n),|0x40c3880000000000 / 10000.0
695 `?(*`@0n),|0x40f86a0000000000 / 100000.0
696 `?(*`@0n),|0x412e848000000000 / 1000000.0
697 `?(*`@0n),|0x416312d000000000 / 10000000.0
698 `?(*`@0n),|0x4197d78400000000 / 100000000.0
699 `?(*`@0n),|0x41cdcd6500000000 / 1000000000.0
700 `?(*`@0n),|0x4202a05f20000000 / 10000000000.0
701 `?(*`@0n),|0x42374876e8000000 / 100000000000.0
702 `?(*`@0n),|0x426d1a94a2000000 / 100000000000.0
703 `?(*`@0n),|0x42a2309ce5400000 / 1000000000000.0
704 `?(*`@0n),|0x42d6bcc41e900000 / 10000000000000.0
705 `?(*`@0n),|0x430c6bf526340000 / 10000000000000.0
706 `?(*`@0n),|0x430c6bf526340008 / 100000000000001.0
707 `?(*`@0n),|0x430c6bf526340050 / 1000000000000010.0
708 `?(*`@0n),|0x430c6bf526340320 / 10000000000000100.0
709 `?(*`@0n),|0x430c6bf526341f40 / 10000000000001000.0
710 `?(*`@0n),|0x430c6bf526353880 / 10000000000010000.0
711 `?(*`@0n),|0x430c6bf526403500 / 10000000000100000.0
712 `?(*`@0n),|0x430c6bf526ae1200 / 1000000001000000.0
713 `?(*`@0n),|0x430c6bf52af8b400 / 1000000010000000.0
714 `?(*`@0n),|0x430c6bf555e30800 / 1000000100000000.0
715 `?(*`@0n),|0x430c6bf7030a5000 / 1000001000000000.0
716 `?(*`@0n),|0x430c6c07c6932000 / 1000010000000000.0
717 `?(*`@0n),|0x430c6caf69eb4000 / 1000100000000000.0
718 `?(*`@0n),|0x430c733bcb5c8000 / 1001000000000000.0
719 `?(*`@0n),|0x430cb4b799c90000 / 1010000000000000.0
720 `?(*`@0n),|0x430f438daa060000 / 1100000000000000.0
721 `?(*`@0n),|0x4020000000000000 / 8.0
722 `?(*`@0n),|0x4050000000000000 / 64.0
723 `?(*`@0n),|0x4080000000000000 / 512.0
724 `?(*`@0n),|0x40c0000000000000 / 8192.0
```

```

725 `?(*`@0n),|0x40f0000000000000 / 65536.0
726 `?(*`@0n),|0x4120000000000000 / 524288.0
727 `?(*`@0n),|0x4160000000000000 / 8388608.0
728 `?(*`@0n),|0x4190000000000000 / 67108864.0
729 `?(*`@0n),|0x41c0000000000000 / 536870912.0
730 `?(*`@0n),|0x4200000000000000 / 8589934592.0
731 `?(*`@0n),|0x4230000000000000 / 68719476736.0
732 `?(*`@0n),|0x4260000000000000 / 549755813888.0
733 `?(*`@0n),|0x42a0000000000000 / 8796093022208.0
734 `?(*`@0n),|0x42d0000000000000 / 70368744177664.0
735 `?(*`@0n),|0x4300000000000000 / 562949953421312.0
736 `?(*`@0n),|0x4340000000000000 / 9007199254740992.0
737 `?(*`@0n),|0x40bf4000000000000 / 8000.0
738 `?(*`@0n),|0x40ef4000000000000 / 64000.0
739 `?(*`@0n),|0x411f4000000000000 / 512000.0
740 `?(*`@0n),|0x415f4000000000000 / 8192000.0
741 `?(*`@0n),|0x418f4000000000000 / 65536000.0
742 `?(*`@0n),|0x41bf4000000000000 / 524288000.0
743 `?(*`@0n),|0x41ff4000000000000 / 8388608000.0
744 `?(*`@0n),|0x422f4000000000000 / 671088640000.0
745 `?(*`@0n),|0x425f4000000000000 / 536870912000.0
746 `?(*`@0n),|0x429f4000000000000 / 8589934592000.0
747 `?(*`@0n),|0x42cf4000000000000 / 68719476736000.0
748 `?(*`@0n),|0x42ff4000000000000 / 549755813888000.0
749 `?(*`@0n),|0x433f4000000000000 / 8796093022208000.0
750
751 `?`@"a" / "a"
752 `?`@"abra\0cadabra" / "abra\0cadabra"
753 `?`@"
754 `?`@-123 / -123
755 `?`@-1 23 ON / -1 23 ON
756 `?`@!0 / !0
757 `?`@12345 / 12345
758 `?`@1 2 ON -4 / 1 2 ON -4
759 `?`@!0 / !0
760 `?`@-1.23 / -1.23
761 `?`@3.14 2.71 1.618 -0w on / 3.14 2.71 1.618 -0w on
762 `?`@(+)
763 `?`@(%:)
764 `?`@(':')
765 `?`@("1";-2;3;4.0) / ("1";-2;3;4.0)
766 `?`@(",1";();(-2;3;4.0)) / (",1";();(-2;3;4.0))
767 `?`@(0;;;;+';-:\>;2*;/;+:-) / (0;;;;+';-:\>;2*;/;+:-)
768 `?`@(`;`a;`bc`^de;0#`)
769 `?`@+`a`b!(!3;!3) / +`a`b!(0 1 2;0 1 2)
770 `?`@1 2!3 4 / 1 2!3 4
771 `?`@{1+2*x} / {1+2*x}
772 (^?`@{1+2*x})3 / 7

```

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[Top Level](#)

[One Level Up](#)[Top Level](#)

## e.c - ngnksource

### Global variables defined

- b
- d
- r

### Functions defined

- e0
- eC

### Macros defined

- h

### Source code

```
1 #include "a.h" // ngn/k, (c) 2019-2022 ngn, GNU AGPLv3 -
https://codeberg.org/ngn/k/raw/branch/master/LICENSE
2 S C b[ZP],*r=b;S I d;
3 SN V eC(){r=b;d=0;}
4 NI A e0(Qs)_(_eC();Nn=min(Sn(s),32);r=b;*r++='\\';Mc(r,s,n);r+=n;*r++=10;0)
5 NI A e1(Ax,Qs)_(_x(e0(s)))
6 SN A e2(Ax,Ay,Qs)_(_y(e1(x,s)))
7 SN A eN(OA*a,In,Qs)_(_mrn(n,a);e0(s))
8 NI V eQ(Qs,Nn,Ni){I(++d>=5,I(d==5,Mc(r," ..\n",4);r+=4) return)
9 Qp=s+i,q=p,t=p;I h=64;W(p>s&&p>t-h&&p[-1]&&p[-1]-10,p-
-)W(g<s+n&&q<=t+h&&*q&&*q-10,q++)
10 *r++=32;Mc(r,p,q-p);I(p<=t-h,*r=r[1]='.')I(q>t+h,r[q-p-2]=r[q-p-
1]='.')r+=q-p;*r++=10;
11 Ms(r,32,t-p+1);r+=t-p+1;*r++='^';*r++=10;}
12 NI V eS(Ax/*0*/,_Ni)_(_eQ(xV,xn,i))
13 A3(try,x=dot(x,y);P(x,z(x))I(ztF&&zK<3,z=z1(aCn(b,r-b)))eC();z)
14 A1(epk,write(2,b,r-b);r=b;x)
15 A1(err,XC(x=str0(x);e1(x,xV))P(x==au,aCn(b,r-b))e1(x,"err"))
16 NI A die(Qs)_(_In=Sn(s);Cv[n+1];Mc(v,s,n);v[n]=10;write(2,v,n+1);exit(1);0)
17
18 #define h(t,m)\n
19 NI A0(e##t##0,e0(#m))\
20 NI A1(e##t##1,e1(x,#m))\
21 NI A2(e##t##2,e2(x,y,#m))\
22 NI AA(e##t##8,eN(a,n,#m))\
23 EA
```

[One Level Up](#)[Top Level](#)

[One Level Up](#)

[Top Level](#)

## a.h - ngnksource

### Global variables defined

- [A](#)
- [B](#)
- [C](#)
- [D](#)
- [H](#)
- [HEX](#)
- [I](#)
- [L](#)
- [N](#)
- [Q](#)
- [TT](#)
- [TX](#)
- [TZ](#)
- [Tk](#)
- [Tz](#)
- [UB](#)
- [UC](#)
- [UH](#)
- [UI](#)
- [UL](#)
- [V](#)
- [1](#)
- [2](#)

- [8](#)
- [R](#)
- [a1](#)
- [a2](#)
- [a3](#)
- [aA](#)
- [aB](#)
- [aC](#)
- [aCz](#)
- [aD](#)
- [aI](#)
- [aL](#)
- [aM](#)
- [aS](#)
- [aa0](#)
- [add](#)
- [adv](#)
- [al](#)
- [am](#)
- [am8](#)
- [ap1](#)
- [apd](#)
- [ara](#)
- [arf](#)
- [argv](#)
- [arp](#)
- [ars](#)

- [asc](#)
- [ax](#)
- [az](#)
- [bsl](#)
- [bsm](#)
- [cA](#)
- [cB](#)
- [cC](#)
- [cD](#)
- [cH](#)
- [cl](#)
- [cL](#)
- [cS](#)
- [cT](#)
- [cat](#)
- [ce](#)
- [ci](#)
- [cls](#)
- [cn](#)
- [cns](#)
- [cpl](#)
- [cst](#)
- [csti](#)
- [dct](#)
- [des](#)
- [dex](#)
- [die](#)

- [dm4](#)
- [dm8](#)
- [mdm](#)
- [dot](#)
- [drp](#)
- [dsc](#)
- [dvd](#)
- [eac](#)
- [ear2](#)
- [enl](#)
- [env](#)
- [epr](#)
- [eq1](#)
- [err](#)
- [evs](#)
- [exc](#)
- [fil](#)
- [fir](#)
- [fld](#)
- [fld1](#)
- [flp](#)
- [flr](#)
- [fnf](#)
- [frk](#)
- [gk](#)
- [gn](#)
- [gp](#)

- [grp](#)
- [gtn](#)
- [gv](#)
- [hex](#)
- [hsh](#)
- [id](#)
- [idx](#)
- [ii](#)
- [ins](#)
- [jS](#)
- [js0](#)
- [js1](#)
- [kcos](#)
- [kexp](#)
- [klog](#)
- [ksin](#)
- [kst](#)
- [las](#)
- [len](#)
- [ltn](#)
- [m0](#)
- [m1](#)
- [mRa](#)
- [mnm](#)
- [mod](#)
- [mr](#)
- [mtc](#)

- [mul](#)
- [mut](#)
- [mxm](#)
- [neg](#)
- [not](#)
- [nul](#)
- [opn](#)
- [out](#)
- [pk](#)
- [prj](#)
- [prng](#)
- [qpri](#)
- [que](#)
- [rev](#)
- [rndD](#)
- [room](#)
- [rsh](#)
- [run](#)
- [ser](#)
- [spl](#)
- [sqr](#)
- [sqz](#)
- [sqzZ](#)
- [str](#)
- [str0](#)
- [sub](#)
- [sym](#)

- [til](#)
- [till](#)
- [typ](#)
- [u0c](#)
- [u1c](#)
- [und](#)
- [unh](#)
- [unq](#)
- [v0c](#)
- [v1](#)
- [v1c](#)
- [v2](#)
- [v8](#)
- [val](#)
- [vc](#)
- [whr](#)

## Macros defined

- [A](#)
- [A0](#)
- [A1](#)
- [A2](#)
- [A3](#)
- [A4](#)
- [AA](#)
- [AAL](#)
- [AL](#)

- ALA
- AQ
- AX
- Ab8
- B
- C
- CR
- D
- DBG
- E
- EA
- EX
- I
- J
- K
- LN
- Lt
- M1
- M2
- MC
- MM
- MQ
- Mc
- Mm
- Ms
- N
- ND

- NI
- NL
- Q
- P
- PD
- Q
- RE
- S
- S4
- SC
- SC0
- SN
- SQ
- SS
- ST
- SW
- SWP
- SZ
- Sn
- T
- TD
- TF
- TP
- TS
- TTv
- TXv
- TY

- TZv
- Tkv
- Tzv
- V
- VS
- W
- WD
- WL
- XYmMA
- ZA
- ZP
- ZZ
- -
- E
- U
- V
- W
- X
- Z
- e
- k
- m
- n
- o
- q
- r
- t

- t0
- t1
- tF
- tP
- tR
- tT
- tZ
- tt
- tz
- v
- w
- ac
- ae
- ai
- as
- c09
- c3
- cA9
- cAz
- extr
- h
- h
- i
- ij
- in
- j
- max

- min
- nop
- oo
- ov
- rot

## Source code

```

1 // ngn/k, (C) 2019-2022 ngn, GNU AGPLv3 -
https://codeberg.org/ngn/k/raw/branch/master/LICENSE
2 #define DBG(a...) //a
3 #include<unistd.h>
4 #include"g.h"
5 #define _(a...) {return({a;});}
6 #define W(x,a...) while(x){a;}
7 #define V(x,a...) TY(a)x=(a);
8 #define B(x,a...) I(x,a;break)
9 #define P(x,a...) I(x,_(a))
10 #define I(x,a...) if(x){a;}
11 #define T(x,a...) (TY(x)[a])x,a
12 #define J(a...) else I(a)
13 #define E(a...) else{a;}
14 #define A(a...) (A[a])a
15 #define i(a...) ij(i,a)
16 #define j(a...) ij(j,a)
17 #define ij(i,n,a...) for(TY(n)n=(n),i=0;i<n;i++){a;}
18 #define SW(x,a...) switch(x){a}
19 #define C(x,a...) case x:{a;break;}
20 #define CR(x,a...) case x:return({a});
21 #define D(a...) default:{a;break;}
22 #define O const
23 #define S static
24 #define SZ sizeof
25 #define ZZ(x) (SZ(x)/SZ((x)[0]))
26 #define ZP 4096ll //page
27 #define ZA 32ll //hdr
28 #define NI __attribute__((noinline))
29 #define SN S NI
30 #define TD typedef
31 #define TY __typeof__
32 #define ST struct
33 #define RE restrict
34 #define SWP(x,y) {TY(x)t=x;x=y;y=t_;}
35 #define LN(x) {Q((!((L)x&ZA-1));x=__builtin_assume_aligned(x,ZA);}
//alignment
36 #define PD(n,p) ((n)+ZA/SZ(*p)-1-&-ZA/SZ(*p)) //pad
37 #define M1(x) #x
38 #define M2(x) M1(x)
39 #define EX extern
40 #define Q(x) DBG(I(!(x),die(__FILE__ ":" "M2(__LINE__)" : "#x))) //assert
41 #define Ab8 A b[8];
42 #define Ms(a...) __builtin_memset(a)
43 #define Mm(a...) __builtin_memmove(a)
44 #define Mc(a...) __builtin_memcpy(a)
45 #define MQ(a...) __builtin_memcmp(a)

```

```

46 #define MC(a...) __builtin_memchr(a)
47 #define Sn(a...) __builtin_strlen(a)
48 #define SC(a...) __builtin_strchr(a)
49 #define SS(a...) __builtin_strstr(a)
50 #define SQ(a...) __builtin_strcmp(a)
51 #define MM(a...) memmem(a)
52 #define SC0(a...) strchnul(a)
53 #define min(x,y) extr(x,y,<)
54 #define max(x,y) extr(x,y,>)
55 #define extr(x,y,c) ({TY(x) x_=(x),y_=(y);x_ <= y_?x_:y_;})
56 #define rot(x,y) ({TY(x) x_=(x);TY(y) y_=(y);y_<<x_|x_>>SZ(x)*8-y_:x;})
57 #define in(i,n) ((i)<(UL)(n))
58 #define c3(x,y,z) ((y)-(x)<=(UI)((z)-(x)))
59 #define c09(c) c3('0',c,'9')
60 #define cAz(c) c3('a',(c)|32,'z')
61 #define cA9(c) (cAz(c)||c09(c))
62 #define S4(i,a,b,c,d) switch(i){case 0:a;break;case 1:b;break;case
2:c;break;default:d;break;}
63
64 TD void V;TD char B,C;TD char unsigned UB,UC;TD O C*Q;TD short H;TD
unsigned short UH;TD int I;TD unsigned int UI;
65 TD long long L;TD double D;TD size_t N;
66 TD unsigned long long
UL,A,A0(),A1(A),A2(A,A),A3(A,A,A),A4(A,A,A,A),AA(OA*,I),AX(A,OA*,I),AL(L),ALA(L
,A),AAL(A,L),AQ(Q);
67 #define A0(f,b...) A f( )_(b)
68 #define A1(f,b...) A f(Ax )_(b)
69 #define A2(f,b...) A f(Ax,Ay )_(b)
70 #define A3(f,b...) A f(Ax,Ay,Az )_(b)
71 #define A4(f,b...) A f(Ax,Ay,Az,Au)_b)
72 #define AX(f,b...) A f(Ax,OA*a,In )_(b) //doesn't consume x
73 #define AA(f,b...) A f( OA*a,In )_(b)
74 #define AL(f,b...) A f(Ln )_(b)
75 #define ALA(f,b...) A f(Ln,Ax )_(b)
76 #define AAL(f,b...) A f(Ax,Li )_(b)
77 #define AQ(f,b...) A f(Qs )_(b)
78 A1
_R,a1,asc,ax,cA,cB,cC,cD,cH,cI,cL,cS,csti,des,dsc,enl,epr,err,fir,flp,flr,frk,g
rp,hex,jS,js0,js1,kcos,kexp,klog,ksin,
79
kst,las,len,m0,m1,mRa,mr,mut,neg,not,nul,opn,out,prng,qpri,rev,ser,spl,sqr,sqz,
sqzz,str,str0,til,typ,u0c,u1c,
80   unh,unq,val,whr;
81 A2
_1,a2,aM,add,am,ap1,apd,cat,cst,dct,dex,dot,dvd,eql,exc,fil,fld1,fnd,gtn,hsh,id
_,idx,ltn,mnm,mod,mtc,mul,mxm,
82   que,sub,und,v0c,v1c;
83 A0 aa0;A3 _2,a3,arf,arp,ars,cpl,ear2,try;A4 ara,dm4;AX
_8,adv,eac,fld,prj,run;AA am8,dm8,dmd,ins;
84 AL aa,ab,ac,aD,aI,aL,aS,a1,az,cls,rndD,till;ALA drp,room,rsh;AAL ii;AQ
aCz,bsl,bsm,die,evs,pk,sym;
85 A
a2t(A,A,C),ac(C),ai(I),as(I),ad(D),adm(A,A,I),aCm(Q,Q),aCn(Q,N),apc(A,C),apv(A,
OV*),an(C,N),aV(C,N,OV*),cts(A,Q,N),
86
eac1f(A,A1),eac2f(A,A,A2),e0(Q),e1(A,Q),evK(A*,Q,OA*,I),jc(C,A),jC(Q,N,A),kv(A*
),mf(I,N),pen(A,A1*),sur(C,A,C),
87 wdn(A,N,N,N),AT(UL,A),AV(UL,A),AW(C,A),AK(C,A),AO(UC,A),AN(N,A);
88 V cyc(V*,N,N),ccp(OV*,N,V*,N),dir(I,void(*)
(V*,Q),V*),eS(A,N),eQ(Q,N,N),exit(I),iW(A,I,L,L),kargs(I,Q*),kinit(),

```

89

```

126 #define _t1(x) _C(x)[-15]           //type(hdr)
127 #define _tF(x) _TF(_t(x))          // func?
128 #define _tP(x) _TP(_t(x))          // packed?
129 #define _tR(x) (_w(x)==4)           // ref?
130 #define _tT(x) (_t(x)<tM)          // list?
131 #define _tz(x) c3(tB,_t(x),tL)     // intlist?
132 #define _tt(x) (_t(x)>tm)          // atom?
133 #define _tz(x) c3(ti,_t(x),tl)     // intatom?
134 #define _U(x) _C(x)[-16]            //bucket
135 #define _v(x) (I)(x)                //value
136 #define _V(x) (V*)(x)               //ptr to data
137 #define _w(x) Tz[_t(x)]             //log2(item size in bytes)
138 #define _W(x) TZ[_t(x)]              //item size in bytes
139 #define _x(x) _A(x)[-3]              //next
140 #define _z(x) ((ZA<<_U(x))-ZA)    //capacity
141 #define XYmMA(a...) P((1<<xt|1<<yt)&(1<<tm|1<<tM|1<<tA),a)
142
143 #define Lt(t) (L)t<<56
144 #define ac(v) (Lt(tc)|(UI)(C)(v))
145 #define ai(v) (Lt(ti)|(UI)(v))
146 #define as(v) (Lt(ts)|(UI)(v))
147 #define ae(v,k) (Lt(te)|(UL)(k)<<48|(UL)(v)<<16>>16)
148 #define vs \
149     A1*y1[]=
{sam,fhp,neg,fir,sqr,t1,whr,rev,asc,dsc,grp,not,enl,nul,len,flr,str,unq,typ,va
l,u0c,u1c,sam,sam,las,out};\
150     A2*y2[]=
{dex,add,sub,mul,dvd,mod,mnm,mxm,ltm,gtn,eql,mtc,cat,exc,hsh,und,cst,que,apl,do
t,v0c,v1c,dex,dex,dex,dex};\
151     AA*y8[]=
{er8,er8,er8,er8,er8,er8,er8,er8,er8,er8,er8,er8,er8,er8,er8,er8,er8,er8,ins,am8,dm
d,er8,er8,er8,er8,er8,er8};\
152     OC vc[]={':','+', '-',
', '*', '%', '!', '&', '|', '<', '>', '=' , '~' , '!' , '^' , '#' , '_' , '$' , '?' , '@' , '.' , '0' , '1' ,
'2' , '3' , '4' , '5' };\
153
enum{au=Lt(tu),FLP,NEG,FIR,SQR,TIL,WHR,REV,ASC,DSC,GRP,NOT,ENL,NUL,LEN,FLR,STR,
UNQ,TYP,VAL,U0C,U1C,U2C,U3C,LAS,OUT,
154
av=Lt(tv),ADD,SUB,MUL,DVD,MOD,MNM,MXM,LTN,GTN,EQL,MTC,CAT,EXC,RSH,UND,CST,QUE,A
P1,DOT,V0C,V1C,V2C,V3C,MKL,PLH,
155     aw=Lt(tw)};
156 #define ND (*(D[])(L[]){0x7ff80000000000011})
157 #define WD __builtin_inf()
158 #define NL (1ll<<63)
159 #define WL (~NL)
160 #define K(s,a...) ({S A f;evK(&f,s,A(a)),ZZ(A(a));})
161
162 #define EA
h(c,compile)h(d, domain)h(i, index)h(l, length)h(n, nyi)h(o, io)h(p, parse)h(r, rank)h
(s, stack)h(t, type)h(v, value)h(z, limit)
163 #define h(t,m) A0 e##t##0;A1 e##t##1;A2 e##t##2;AA e##t##8;
164 EA
165 #undef h
166 #define N(x,a...) ({A r_=(x);P(!r_,a;0)r_;} ) //error pass-through
167
168 #define ov(x) ov_(#x":", (L)(x))
169 #define oo os("[ "__FILE__ ":"M2(__LINE__) " ]");
170 #define nop {asm volatile("fnop");}
171 I os(Q);L ov_(Q,L);

```

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## k.h - ngnksource

### Data types defined

- [C](#)
- [D](#)
- [I](#)
- [K](#)
- [N](#)
- [Q](#)
- [V](#)

### Macros defined

- [Kx](#)

### Source code

```
1 // https://github.com/ktye/i/blob/master/%2B/k.h
2 typedef long long K;typedef void V;typedef char C;typedef int I;typedef
double D;typedef size_t N;typedef const C*Q;
3 V
kinit(),unref(K),CK(C*,K),IK(I*,K),FK(D*,K),LK(K*,K),*dK(K),KA(Q/*todo*/,K),KR(
Q,V*,I);C TK(K),cK(K);N NK(K);I iK(K);D fK(K);
4 K
Kc(C),Ks(C*),Ki(I),Kf(D),KC(C*,N),KS(C**,N),KI(I*,N),KF(D*,N),ref(K),Kp(V*),KE(
Q),KL(K*,N),K0(K*,Q,K*,I);
5 #define Kx(s,a...) ({static K f;K0(&f,s,(K[]){a},sizeof((K[]))
{a}))/sizeof(K));})
```

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## k.c - ngnksource

### Functions defined

- [V KA\(Qs,K x\){x=dmd\(A\(as\(sym\(s\)\),oA,av,x\),4\);if\(x\)mr\(x\);}](#)
- [K KE\(Qs\)\\_ \(e0\(s\)\)](#)
- [Kc](#)
- [Kf](#)
- [K KL\(K\\*a,Nn\)\\_ \(a?aV\(tA,n,a\):aA\(n\)\) V LK\(K\\*a,K x\){VK\(tA,a,x\);}](#)
- [N NK\(K x\)\\_ \(xn\)](#)
- [sym](#)

### Source code

```

1 #include "a.h" // ngn/k, (c) 2019-2022 ngn, GNU AGPLv3 -
https://codeberg.org/ngn/k/raw/branch/master/LICENSE
2 #include "k.h"
3 C TK(K x)_ (Tk[xt])
4 N NK(K x)_ (xn)
5 V*dK(K x)_ (xV)
6 S V VK(Ct,V*a,K x){I(xtZ,x=cT[t]
(x))Mc(a,xV,xn*xTz[t]);I(xtR,I(xr==1,AN(0,x))E(mRn(xn,xV)))x(0);}
7
8 //           constructors
9 //           atom           list           atom
10 K Kc(Cv)_ (ac(v))      K KC(C*a,Nn)_ (aV(tC,n,a))          C cK(K
x)_ (xV)   V CK(C*a,K x){VK(tC,a,x);}
11 K Ks(C*s)_ (sym(s))    K KS(C**a,Nn)_ (Ax=aS(n);i(n,xi=sym(a[i]))x) I iK(K
x)_ (xV)   V IK(I*a,K x){VK(tI,a,x);}
12 K Ki(Iv)_ (az(v))     K KI(I*a,Nn)_ (aV(tI,n,a))          I iK(K
x)_ (xV)   V IK(I*a,K x){VK(tI,a,x);}
13 K Kf(Dv)_ (ad(v))    K KF(D*a,Nn)_ (aV(tD,n,a))          D fK(K
x)_ (*xD)  V FK(D*a,K x){VK(tD,a,x);}
14 K KL(K*a,Nn)_ (a?aV(tA,n,a):aA(n))          V LK(K*a,K
x){VK(tA,a,x);}
15 K Kp(V*p)_ (al((L)p))
16
17 V KA(Qs,K x){x=dmd(A(as(sym(s)),oA,av,x),4);if(x)mr(x);}
18 V KR(Qs,V*f,In)_ (KA(s,ae(f,n)))
19 K KE(Qs)_ (e0(s))
20
21 K ref(K x)_ (xR)
22 V unref(K x){mr(x);}
23
24 K K0(K*p,Qs,K*a,In)_ (evK(p,s,a,n))

```

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## j.c - ngnksource

### Global variables defined

- [EJ](#)
- [JE](#)
- [jx](#)
- [nX](#)
- [s](#)
- [t](#)

### Functions defined

- [it](#)
- [nC](#)
- [nX](#)
- [nl](#)
- [nx](#)

### Source code

```
1 #include "a.h" // ngn/k, (c) 2019-2022 ngn, GNU AGPLv3 -
https://codeberg.org/ngn/k/raw/branch/master/LICENSE
2 s Q JE="\"\\\"/b\f\n\r\t",EJ="\"\\\"/bfprt";s
C*s; //34=' ',44=',',48='0',92='\\',97='a'
3
4 s A0 jx;s I w(Cc)_(_c<33&&111<<c&0x100002600/*32\t\r\n*/)s C
jw()_(Cc;w(c=*s,s++)c)
5 s A0(jd,Im=*s=='-';s+=m;Cc=*s++;p(!c09(c),0)Dv=c-
48;w(c09(*s),v*=10;v+=*s++-48)
6 I(*s=='.',s++;D t=1;w(c09(*s),t/=10;v+=t*(*s++-48)))
7 I((*s|32)=='e',s++;s++*s=='+';L e=p1((V*)&s);D t=10;I(e<0,e=-
e;t=.1)p(e>308,0)i(e,v*=t)ad(m?-v:v))
8 s I ju(Qs)_(_Iv=0;i(4,UC c=*s++,d=c-48;v<<=4;v|=d<10?d:(d=(c|32)-97)<6?
d+10:-1)v)
9 s A0(jx,UC c;C*p=++s;Nn=0;
10
w((c==*p)-34,p(c<32,s=p;0)p++;I(c==92,c==p++;p(c<32,s=p;0)n++;I(c=='u',Lv=ju(p));


(v<0,s=p;0)p+=4;n+=4-(v>127)-(v>2047)))
11 Ax=aC(p-s-n);p=s;C*r=xC;
12 w((c==*p++)-34,I(c==92,c==p++);
13 I(c=='u',Ij=si(EJ,c);p(j)>=sz EJ,s=p-1;x(0))c=JE[j])


```

14

```

E(Iv=ju(p);p+=4;I(v<128,c=v)J(v<2048,*r++=192|v>>6;c=128|63&v))E(*r++=224|v>>12;
*r++=128|63&v>>6;c=128|63&v)))*r++=c)
15   s=p;x)
16   S
A0(ja,s++;Ax=oA;P(jw()==' ] ',s++;x)W(1,xq(Nx(jx()));P(*s==' ] ',s++;x)Nx(*s==44);s
++)0)
17   s A0(jo,s++;Ax=oS,y=oA;Cc=jw();P(c==' } ',s++;am(x,y))
18   W(c==34,Az=js();B(!z)xq(cs(z));B(jw()-
':')s++;z=jx();B(!z)yq(z);P(*s==' } ',s++;am(x,y))B(*s-44)s++;c=jw())x(y(0)))
19   s I jp(Qp)_(s++;W(*p&&*p==*s++)!*p)S A0(jt,jp("true"+1)?au+1:0)S
A0(jf,jp("false"+1)?au:0)S A0(jn,jp("null"+1)?R(cn[td]):0)
20   s A0(jx,Ax=T(&jf,jt,jN,ja,js,jd)[si("ftn[{\\"},jw()])());jw();x)
21   A1(js0,XC(x=str0(x);s=xV;Ay=jx();I(y&&*s,y=y(0))P(!y,ep0());eS(x,s-
xC);x(0)x(y))Xc(js0(enl(x)))et1(x))
22
23   s V JX(A);S N nX(A);S UC t[256];S V it(){Ms(t,5,32);t[127]=5;i(SZ
JE,t[JE[is N nC(Qp,Nn)_(I(!*t,it())Nm=2+n;i(n,m=t[UCp[im)
25   s V JC(Qp,Nn){I(!*t,it())*s+=34;UC c;
26
i(n,SW(t[c*p++],c(0,*s+=c)C(1,*s+=92;*s+=EJ[si(JE,c)]))D(Mc(s, "\u20ac",4);s+=
4;*s+=HEX[c>4];*s+=HEX[c&15]))
27   *s+=34;}
28   s N nl(Lv)_(P(v==NL,4)Nn=v<0?(v=-v),2:1;UL m=10;W(m<=v&&n<19,n++;m*=10)n)
29   s V Jl(Lv){s=v-NL?sl(s,v):Mc(s, "null",4)+4; }
30   s N nx(Ax/*0*/)_(Xi(nl(xv))Xl(nl(*xL))Xd(Dv=*xD;P(v==
(L)v,nl(v))P(v!=v,4)Cb[32];sd(b,*(L*)&v)-b)Xc(Cc=xv;nC(&c,1))
31   XC(nC(xC,xn))Xu(x-au?
4:5)Xm(nx(xx)+nx(xy)-1-_N(xx))XMT(Nn=xN,m=1+n!n;i(n,m=nX(ii(x,i)))m)nX(str(x
R)))
32   s V Jx(Ax/*0*/){switch(xt)
{C(ti,s=sl(s,xv))C(tl,Jl(*xL))C(tc,Cc=xv;JC(&c,1))C(tC,JC(xC,xn))
33   C(td,Dv=*xD;s=v==(L)v?sl(s,v):v!=v?Mc(s, "null",4)+4:sd(s,
(L*)&v))C(tu,Nn=x-au?4:5;Mc(s,x-au?"true":"false",n);s+=n)
34   C(tm,*s++='{' ;i(xN,I(i,*s+=44)JX(ii(xx,i));*s++=':' ;JX(ii(xy,i)))*s++=' } ')
35   D(I(xtMT,*s++='[' ;i(xN,I(i,*s+=44)JX(ii(x,i)))*s++=' ] ')E(JX(str(xR))))}
36   s N nX(Ax/*1*/)_(Nn=nx(x);x(0);n)
37   s V JX(Ax/*1*/){Jx(x);x(0);}
38   A1(js1,Ay=aC(nx(x));s=yC;JX(x);Q(s==yC+yn);y)

```

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## i.c - ngnksource

### Global variables defined

- [h](#)
- [p](#)

### Functions defined

- [skt](#)

### Macros defined

- [USE\\_EXTERN\\_INLINES](#)

### Source code

```
1 // ngn/k, (c) 2019-2022 ngn, GNU AGPLv3 -
https://codeberg.org/ngn/k/raw/branch/master/LICENSE
2 #include<sys/socket.h>
3 #include<sys/wait.h>
4 #include<netinet/in.h>
5 #include<netinet/tcp.h>
6 #include<fcntl.h>
7 #include<arpa/inet.h>
8 #include<unistd.h>
9 #include<sys/time.h>
10 #undef __USE_EXTERN_INLINES
11 #include<sys/stat.h>
12 #include<sys/mman.h>
13 #include"a.h"
14 S UI addr(Q\*p)\(Qs=\*p;P\(!\*s,0x0100007f\)UIC v[4];i\(4,I\(i,P\(\*s-
'.',ed0\(\)\)s++\)v\[i\]=pu\(&s\);P\(v\[i\]>255,ed0\(\)\)\)\*p=s;\*\(UI\*\)v\)
15 S I skt\(UI h,UH

\)\\(If=socket\\(AF\\_INET,SOCK\\_STREAM,0\\);P\\(f<0,eo0\\(\\)\\)Iv=setsockopt\\(f,IPPROTO\\_TCP,TC
P\\_NODELAY,\\(I\\[1\\]{1},4\\);P\\(v<0,eo0\\(\\)\\)\\)
16 ST sockaddr\\_in
a;a.sin\\_family=AF\\_INET;a.sin\\_addr.s\\_addr=h;a.sin\\_port=rot\\\(p,8\\\);P\\\(connect\\\(f,\\\(ST
sockaddr\\\*\\\)&a,SZ a\\\)<0,eo0\\\(\\\)\\\)f\\\)
17 I osf\\\(Qs,L fl\\\)\\\\(P\\\\(!SC\\\\(s,'.'\\\\),If=open\\\\(s,fl,0666\\\\);P\\\\(f<3/\\\\*fbbsd\\\\*/,
eo0\\\\(\\\\)\\\\)f\\\\)UIC
h=addr\\\\(&s\\\\);P\\\\(\\\\*s-'.',ed0\\\\(\\\\)\\\\)s++;UL p=pu\\\\(&s\\\\);P\\\\(\\\\*s,ed0\\\\(\\\\)\\\\)skt\\\\(h,p\\\\)\\\\)
18 S I Q\\\\(Ax/\\\\*1\\\\*/,I
fl\\\\\)\\\\\\(Xz\\\\\\(gl\\\\\\(x\\\\\\)\\\\\\)Xs\\\\\\(Lv=xv;P\\\\\\(!v,1\\\\\\)Qs=qs\\\\\\(&v\\\\\\);osf\\\\\\(s,fl\\\\\\)\\\\\\)XC\\\\\\(x=str0\\\\\\(x\\\\\\);xe\\\\\\(osf\\\\\\(xV,fl\\\\\\)\\\\\\)\\\\\\)e
t1\\\\\\(x\\\\\\)\\\\\\)
19 S I fmd\\\\\\(If\\\\\\)\\\\\\\(ST stat s;fstat\\\\\\\(f,&s\\\\\\\)<0?0:s.st\\\\\\\_mode\\\\\\\)
20 A1\\\\\\\(opn,Xz\\\\\\\(x\\\\\\\)az\\\\\\\(N\\\\\\\(o,x,O\\\\\\\_RDWR|O\\\\\\\_CREAT\\\\\\\)\\\\\\\)\\\\\\\)
21 A1\\\\\\\(cls,close\\\\\\\(n\\\\\\\);au\\\\\\\)
22 A1\\\\\\\(u0c,x=N\\\\\\\(spl\\\\\\\(N\\\\\\\(u1c\\\\\\\(x\\\\\\\)\\\\\\\)\\\\\\\)\\\\\\\);xn&&!n\\\\\\\(xA\\\\\\\[xn-1\\\\\\\]\\\\\\\)?drp\\\\\\\(-1,x\\\\\\\):x\\\\\\\)
23 S V d\\\\\\\(V\\\\\\\*p,Qs\\\\\\\){\\\\\\\*\\\\\\\(A\\\\\\\*\\\\\\\)p=apc\\\\\\\(cts\\\\\\\(\\\\\\\*\\\\\\\(A\\\\\\\*\\\\\\\)p,s,Sn\\\\\\\(s\\\\\\\)\\\\\\\),10\\\\\\\);}
24 A1\\\\\\\(u1c,Xz\\\\\\\(If=gl\\\\\\\(x\\\\\\\);Cb\\\\\\\[1024\\\\\\\];x=oC;W\\\\\\\(1,Ik=read\\\\\\\(f,b,SZ
b\\\\\\\);P\\\\\\\(k<0,eo1\\\\\\\(x\\\\\\\)\\\\\\\)x=cts\\\\\\\(x,b,k\\\\\\\);P\\\\\\\(k-SZ b,x\\\\\\\)\\\\\\\)0\\\\\\\)


```

```

25  If=_N(_O(x,O_RDONLY));P(f<3,_u1c(ai(f)))Im=fmd(f);
26  P(S_ISDIR(m),Ax=oC;dir(f,d,&x);close(f);x)
27
28  P(S_ISREG(m),Ln=lseek(f,0,SEEK_END);P(n<0,close(f);eo0())P(!n,oC)Ax=mf(f,n);clo
se(f);x)
29  Ay=_u1c(ai(f));close(f);y)
30  A2(y0c,YA(y0c(x,Nx(jc(10,y))))YC(vlc(x,apc(y,10)))et2(x,y))
31  A2(vlc,P(!ytC,et2(x,y)))
32
Xz(If=gl(x);Nn=yV;P(f<3|!S_ISREG(fmd(f)),ye(Az=au;W(n>0,Lk=write(f,s,n));
I(k<0,z=eo0())B(k<=0)s+=k;n-=k)z))
32
ftruncate(f,n);V*p=mmap(0,n,PROT_READ|PROT_WRITE,MAP_SHARED,f,0);Mc(p,s,n);munm
ap(p,n);y(au))
33  If=_N(_O(x,O_RDWR|O_CREAT|O_TRUNC));Az=vlc(ai(f),y);f>2&&close(f);z)
34
35  S A rda(If)-(Ax=aC(256-ZA);L m=0,k;
36  W((k=read(f,xV+m,xn-
m))>0,m+=k;I(m+1000000>xn&&2*m>xn,Ay=aC(2*xn+ZA);Mc(yV,xV,m);x=x(y)))close(f);A
N(m,x))
37  S I lC(Ax)-(P(!xtA,0)i(xn,P(t(xa)-tC,0))1) //list of strings?
38  A1(frk,P(!xtA|xn-
2,et1(x))Ay=kv(&x);P(!lC(x)||!ytC,ed2(x,y))x=Ny(eac1f(x,str0));Q
a[xn+1];i(xn,a[i]=V(xa))a[xn]=0;
39  I p[4];pipe(p);pipe(p+2);I
pid=fork();P(!pid,dup2(*p,0);dup2(p[3],1);i(4,close(p[i]))exit(execve(*a,
(C**)a,(C*O*)env));0)
40
close(*p);close(p[3]);N(y0c(ai(p[1]),x(y)));close(p[1]);Ax=rda(p[2]);wait4(pid,
0,0,0);x)
41  L now()-(ST timeval t;gettimeofday(&t,0);1000000000*t.tv_sec+t.tv_usec)

```

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## b.c - ngnksource

### Global variables defined

- [b](#)
- [lu](#)
- [m](#)
- [nb](#)
- [u](#)

### Macros defined

- [Nl](#)
- [Nr](#)
- [OK](#)
- [U](#)
- [fl](#)
- [h](#)
- [hc](#)

### Source code

```
1 #include "a.h" // ngn/k, (c) 2019-2022 ngn, GNU AGPLv3 -
https://codeberg.org/ngn/k/raw/branch/master/LICENSE
2
enum{bu,bv=32,bs=64,bg=72,bd=80,ba=88,bP,bi,bx,bI,bX,bm,bM,bG,bS,bl,bL,bz,bj,bA,
,bo,bp,bc};
3 #define h(a) {b[nb]=a;m[nb]=o;nb+=nb<255;}
4 #define hc(a) {N(lc(a,o));}
5 #define OK -1
6 #define Nr(a...) {I r=cr(a);P(r-OK,r);}
7 #define Nl(a...) {I r=cl(a);P(r-OK,r);}
8 #define fl ua[3]
9 S A u;S UC*b,*m;S I nb,lu[8];S A cr(A,I);
10 SN I lc(Ax/*1*/ ,I
o)_ (Ay=u;Nn=yn,i=5;W(i<n,B(mtc_(x,ya),x=x(0))i++)I(x,uq(x))h(i+bc-5)1)
11 SN I ig(Lv)_ (I(*gp,Qg=qss(&v);I(!SC(g,'.')),C
s[32];Nm=Sn(gp),n=Sn(g);P(m+n+2>=SZ s,-1)Mc(s,qp,m);s[m]='.';Mc(s+m+1,g,n+1);v=
(I)sym(s)))
12 Li=fI(gk,gn,v);P(i>=0,i)P(gn-(UC)gn,-1)gk[gn]=v;gv[gn]=0;gn++)
13 SN I il(Iv)_ (Li=fAI(fl,v);P(i>=0,lu[i]=nb;i)-1)
```

```

14  S A cl(Ax,Ay/*00*/,_I_r)(I_o=xo;Q(xx==av||_t(xx)==tu)Iv=_v(xx);
15  YsS(
16
17  I(yts,P(xx==av&&_n(f1),Li=fpI(&f1,yv);P(i>15,ez0())lu[i]=nb;h(bs+i)I(r,h(bg+i))OK)
18  E(P(yn==1,o)y=jS(yR))
19  Ii=ig(yv);P(i<0,ez0())h(v?bM:bS)h(i)I(v,h(v))I(r,h(bG)h(i))OK)
20  YA(In=yn-1;P(n-
21  (UC)n||n<1,o)Az=yx;P(z==MKL&&xx==av,h(bL)h(n)i(n,Nl(x,yA[i+1],0))I(!r,h(bp))OK)
22  P(ztSS,I(ztS,z=jS(zR))i(n,Nr(yA[n-
23  i],1))h(bl)h(n)Ii=il(zv);P(i<0,hc(z)h(r)?bx:bI)h(v)OK)h(r?bx:bi)h(i)h(v)OK)o)o)
24  S A cr(Ax/*0*/,_I_r)(I_o=xo;
25
26 Xss(I(xts,Ii=il(xv);P(i>0,h(bg+i)I(!r,h(bp))OK)P(xv=='o',I(r,h(bo))OK))E(P(xn=
27 =1,I(r,hc(ii(x,0)))OK)x=jS(xR))
28  Ii=ig(xv);P(i<0,ez0())h(bG)h(i)I(!r,h(bp))OK)
29  P(!xtA||!xn,I(r,hc(x-PLH?xR:au))OK)
30  Nn=xn;Ay=xx;
31  P(y==PLH,i(n-1,Nr(xA[i+1],i==n-2&&r))
32  P(n<2,I(r,hc(yR))OK)
33  P(n==3&&(ytu|y==av)&&_tsSA(xy),Nr(xz,1);Nl(x,xy,1);I(!r,h(bp))OK)
34  P(n>3&&y==CST,n--;I p[n];A*a=xA;i(n&~1,Nr(*++a,1);h(i&1?
35  bj:bz)p[i]=nb;h(0))Nr(n&1?*++a:au,1);
36  i(n&~1,I d=(i&1?nb-1:p[i+1])-p[i];I(i&1,Ij=
37  (n&~1)-1;W(i<j&&d>255,d=p[j]-1-p[i];j-
38  =2))P(d>255,ez0())b[p[i]]=d)I(!r,h(bp))OK)
39  I(n==2&&y==FIR,Az=xy;P(ztA&&zn==2&&zX==REV,Nr(zy,1);h(bu+LAS-
40  au)I(!r,h(bp))OK)
41  I p=0;i(n-1,Az=xA[n-1-i];I(z==PLH,p=1;hc(PLH))E(Nr(z,1)))
42  P(p,Nr(xx,1);h(bP)h(n-1)I(!r,h(bp))OK)
43  P(y==MKL,n--;P(n-(UC)n,o);h(bl)h(n)I(!r,h(bp))OK)
44  P(n==2&&ytu,h(bu+yv)I(!r,h(bp))OK)
45  P(n==3&&ytv,h(bv+yv)I(!r,h(bp))OK)
46  P(n>9,ez0();o)Nr(xx,1);h(ba)h(n-1)I(!r,h(bp))OK)
47  S
48 A2(f2,/*0*/P(xtw&&!ytsSA,1)/*P(x==TIL&&ytZ&&yn<4,i(yN,P(!in(gl(ii(y,i)),101),0)
49 )1)*/0)
50  S A3(f3,/*0*/P(ADD<=x&&x<=MUL&&ytL&&ztl&&yn==zn&&yn<101,1)0)
51  S A1(qt,/*1*/xtsSA?enl(x):x)
52  S A1(cf,XA(P(xx==MKL,i(xn,Ay=xA;YsSA(x))a1(drp(1,x)))
53  P(xn==2?f2(xx,xy):xn==3?f3(xx,xy,xz):0,qt(N(val(x))))
54
55 Ay=rsh(xn,au);i(xn,ya=cf(xa);xa=au;P(!ya,die("cf"))))AO(xo,x(y)))x) //preserve
56 src offsets
57  S I mxs(Ii,I s)(I r=s;W(1,UC
58  c=b[i++];Q(s>0)r=max(r,s);P(!c,r)P(c==bz,i++;s--;max(r,max(mxs(i,s),mxs(i+b[i-
59  1],s)))))
60  I(c==bc||c==bo||c-bg<8u||c-bd<8u||c==bG,s++)J(c-bs<8u||c-
61  bv<32u||c==bp||c==bm||c==bx||c==bM||c==bS,s--)
62  J(c==bi||c==bX,s-=2)J(c==bI||c==bA,s-
63  =3)J(c==bL,s+=b[i])J(c==b1||c==ba||c==bP,s-=b[i]-1)
64
65 I(c==bm||c==bx||c==bM||c==bi,i+=2)J(c==bx||c==bI||c==bL||c==b1||c==ba||c==bP||c
66 ==bG||c==bS,i++)J(c==bj,i+=b[i]+1))r)
67  S I shy(Ax/*0*/)(!xtA?0:xn&&xx==PLH?shy(xA[xn-1]):xn==3&&
68  (xx==av||_t(xx)==tu)&&_tsSA(xy))
69  A3(cpl,/*src,ast,loc*/UC
70  b0[256],m0[256];b=b0;m=m0;nb=1;Ik=zn;u=aV(tA,5,A(x,au,au,z,au));Ms(lu,-1,sz
71  lu);y=Nu(cf(y));

```

```

51  I s=shy(y),r=cr(y,1);y(0);I o=0;I(s,hc(au))h(bu)P(r-
OK,ec0();eS(ux,r);u(0))P(n(f1)>8 || nb>=255 || bc-4+un>255,eS(ux,0);u(0);ez0())
52
53
54 #define U(x,a...) B(! (x),a)
55 AX(run,Q(xto)P(n-xk,er8(a,n))S I
d;P(++d>1024,es8(a,n))UC*b=_V(xy),c,ns=*b++,nl=_n(xA[3]);A
t[ns+nl],*s=t+ns,*l=s;
56 Ms(t,0,SZ t);Mc(l,a,8*n);
57 W((c==*b++),
58 I(c>=bc,*--s=_R(xA[c-bc+5]))
59 J(c>=ba,
60 I(c>=ba,
61 I(c==bA,s+=3;U(*s=dmd(s-3,4)))
62 J(c==bo,*--s=xR)
63 E(Q(c==bp)mr(*s++))
64 E(Nn=*b++);
65 I(c==ba||c==bP,Ax=*s,*p=s+1;s+=n;U(*s=x((c==ba? 8:proj)(x,p,n))))
66 J(c==bi,Ax=l[n],y=*s++;U(x=l[n]=dm4(x?x:au,y ,av+b++,*s),*s=0)s++)
67 J(c==bx,Ax=l[n],y=*s++;U(x=l[n]=dm4(x?
x:au,yR,av+b++,*s),*s=y(0))U(*s=dot(xR,y)))
68 J(c==bI,Ax=*s++,y=*s++;U(x=dmd(A(x,y ,av+n,*s),4),*s=0)s++)
69
70 J(c==bX,Ax=*s++,y=*s++;U(x=dmd(A(x,yR,av+n,*s),4),*s=y(0))U(*s=dot(x,y)))
71 J(c==bm||c==bM,A*v=(c==bm? l:gv)+n,x=*v;U(x,*s=ev1(*s))U(x=*v=v2[*b++]
(x,*s++),*--s=0))
72 J(c==bG,Ax=*--s=gv[n];U(x,ev0())xR)
73 J(c==bS,Ax=*s++,y=gv[n];gv[n]=y?y(x):x)
74 J(c==bL,s+=n-1;*s=sqz(av(tA,n,s-n+1)))
75 J(c==bz,b+=n!*tru(*s++))
76 E(Q(c==bj)b+=n))
77 J(c>=bs,A*v=l+c%8,x=*v;
78 I(c>=bd,*--s=x;*v=0)
79 J(c>=bg,U(*--s=x)xR)
80 E(Q(c>=bs)Ay=*s++;*v=x?x(y):y)
81 J(c>=bv,Ax=*s++;U(*s=v2[c-bv](x,*s)))
82 E(U(*s=v1[c](*s)))
83 I(!*s,eS(xx,(UC)_C(xz)[(C*)b-1-_C(xy)]))i(t+ns+nl-s-
1,Ax=s[i+1];I(x,mr(x)))d--;/*Q(s==l-1)/*s)

```

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## s.c - ngnksource

### Global variables defined

- [Qq](#)

### Functions defined

- [inc2](#)
- [initp5](#)
- [pws5](#)
- [shr2](#)

### Macros defined

- [Mh](#)

### Source code

```
1 #include "a.h" // ngn/k, (c) 2019-2022 ngn, GNU AGPLv3 -
https://codeberg.org/ngn/k/raw/branch/master/LICENSE
2 #define Mh(x,y) (Mc(x,y,SZ(y)-1)+SZ(y)-1)
3 S
Qq="000102030405060708091011121314151617181920212223242526272829303132333435363
7383940414243444546474849"
4
"50515253545556575859606162636465667686970717273747576777879808182838485868788
8990919293949596979899";
5 S C*s8(C*s,UI v)_((i(4,Mc(s+6-2*i,g+v%100*2,2);v/=100)s+8)
6 S C*s8(C*s,UI v)_((Cb[8],*p=b+6;W(1,Mc(p,g+v%100*2,2);v/=100;p(!v)p-
=2)p+=*p=='0';In=b+8-p;Mc(s,p,n)+n)
7 S C*s16(C*s,UL v)_((S8(S8(s,v/(UI)1e8),v%(UI)1e8))
8 S C*s16(C*s,UL v)_((v<(UI)1e8?s8(s,v):S8(s8(s,v/(UI)1e8),v%(UI)1e8))
9 S C*su(C*s,UL v)_((v<(UL)1e16?s16(s,v):S16(s8(s,v/(UL)1e16),v%(UL)1e16))
10 C*sl(C*s,Lv)_((I(v<0,P(v==NL,Mh(s,"ON"))v=-v;*s++='-' )su(s,v))
11 // github.com/ulfjack/ryu (apache2/boost license)
12 #if defined(__SIZEOF_INT128__)
13 S UL msh(UL m,O UL*a,Ii)_((uint128_t g=m;((g**a>>64)+g*a[1])>>(i-64))
14 S UL msha(UL m,O UL*a,Ii,UL*v,UL*w,I sh)_(*v=msh(m+2,a,i);*w=msh(m-1-
sh,a,i);msh(m,a,i))
15 #else
16 S UL shr(UL l,UL h,UI d)_((h<<(64-d)|l>>d)
17 S UL mult(UL a,UL b,UL*rh)_((UI al=a,ah=a>>32,bl=b,bh=b>>32;UL c=
(UL)al*bl,u=(UI)(c>>32)+(UL)ah*bl,v=(UI)u+(UL)al*bh;
18 *rh=(UI)(u>>32)+(UI)(v>>32)+(UL)ah*bh;v<<32|(UI)c)
19 S UL msha(UL m,O UL*a,Ii,UL*v,UL*w,I sh)_((m>>=1;UL
t,l=mult(m,*a,&t),h,m0=t+mult(m,a[1],&h);h+=m0<t;
20 UL l2=l+*a,m2=m0+a[1]+(l2<l),h2=h+(m2<m0);*v=shr(m2,h2,i-65);
```

```

21     I(sh==1,UL 13=l-*a,m3=m0-a[1]-(l3>1),h3=h-(m3>m0);*w=shr(m3,h3,i-65))
22     E(UL 13=l+1,m3=m0+m0+(l3<1),h3=h+(m3<m0),l4=l3-*a,m4=m3-a[1]-
(l4>l3),h4=h3-(m4>m3);*w=shr(m4,h4,i-64))shr(m0,h,i-65))
23 #endif
24 S UL I5[342][2],P5[326][2];S UL addc1l(UL x,UL y,UL c,UL*p)(UL
u=x+y+c;*p=u<x|u<y|u) // or __builtin_addc1l
25 S V shr3(UL*x,UL*y,I d){i(2,x[i]=y[i]>>d|y[i+1]<<(64-d))x[2]=y[2]>>d;}S V
shr2(UL*a){*a>=1;*a|=a[1]<<63;a[1]>=1;}S V inc2(UL*a){a[1]+=!++*a;}
26 S V pws5(UL(*a)[2],In,L u,Lv,L w){UL x[ ]=
{u,v,w},y[3],c;i(n,Mc(a+i,x+1,16);shr3(y,x,2);c=0;i(3,x[i]=addc1l(x[i],y[i],c,&
c))I(x[2]>>61,shr3(x,x,1)))}
27 S V initp5()
{pws5(I5,ZZ(I5),0xebd5cf2016a52921,0x4ac7ca59a424c507,0x9558b4661b6565f8);pws5(
P5,ZZ(P5),0,0,111<<61);
28 I5[0][0]=0x0958f94b348498a0;I5[0]
[1]=0x12ab168cc36cacbf;shr2(I5[1]);shr2(I5[2]);shr2(I5[3]);i(ZZ(I5)
,inc2(&I5[i][0]));
29 inc2(I5[ZZ(I5)-1]);shr2(P5[0]);}
30 S UI dm(UL*p)(UL x=*p,q=x/10,*p=q; (UI)x-10*(UI)q)S I 110p2(I
x)(x*78913>>18)S I 110p5(I x)(x*732923>>20)S I p5b(I x)(x*1217359>>19)
31 S I mp5(UL x,UI p)(i(p,UL q=x/5;P((UI)x-5*(UI)q,0)x=q)1)S I mp2(UL x,UI
p)(!(x&((111<<p)-1)))
32 C*sd(C*s,L d)(UL x=d,m=x<<12>>12;I e=x<<1>>53;I(x>>63,*s+='-
')P(e==2047,m?Mh(s,"0n"):Mh(s,"0w"))P(!m&&!e,Mh(s,"0.0"))
33 m|=(UL)!e<<52;e+=!e-1077;I t,ev=! (m&1),h=m<<12| |e-<-1075,u0=0,w0=0;UL
u,v,w,m<<=2;I(!**I5,initp5())
34 I(e>1,t=110p2(e)-(e>7);u=msha(m,I5[ZZ(I5)-1-t],t-e+p5b(
t)+125,&v,&w,h);I(t<22,! (m%5)?u0=mp5(m,t):ev?w0=mp5(m-1-h,t):(v-=mp5(m+2,t)))
35 E( t=e+110p5(-e)-(e<3);u=msha(m,P5[
-t],t-e-p5b(-
t)+124,&v,&w,h);I(t<e+2,u0=1;ev?w0=h:--v)J(t<e+63,u0=mp2(m,t-e)))
36
I(w0| |u0,Cd=0;W((v/=10)>w/10,w0&=! dm(&w);u0&!=!d;d=dm(&u);t++)I(w0,W(!dm(&w),u0&
=!d;d=dm(&u);t++))I(u0&&d==5&&!(u&1),d=4)u+=d>=5|| (u==w&&!(ev| w0)))
37 E(Cd=0;W((v/=10)>(w/=10),d=dm(&u);t++)u+=u==w| |d>=5)
38 s++;I l=su(s,u)-s-1;s[-1]*s;t+=l;
39 P(in(t,16),Ik=l<t?l:t;Mm(s,s+1,k);Ms(s+1,'0',max(0,t-
1));s+=t;*s+='.';s+=l-k;I(t>=l,*s+='0')s)
40 P(-4<t&&t<0,i(l+1,s[l-t-i]=s[l-i])s[-1]='0';*s+='.';Ms(s,'0',-t-1)+l-t)
41 I(l>0,*s+='.';s+=l)*s+=e';I(t<0,t=-t;*s+=-'')su(s,t))
42 A1(str0,Q(xtC);Nn=xn;x=AN(n,room(n+1,x));xC[n]=0;x)
43 A1(str,Xzd(Ay=aC(24);V(f,xtd?sd:s1)AN(f(yC,g1(x))-
yC,y))Xs(Lv=xv;aCz(qs(&v)))Xc(enl(x))XF(kst(x))eacf(x,str))
44
45 S A pre(Cc,Ax)(cat(ac(c),x))A sur(Cc,Ax,Cd)(apc(pre(c,x),d))S
A1(par,sur(' ',x,' '))
46 S A1(raz,fld1(x,CAT))S I esc(Cc)(i(6,P(c=="\0\t\n\r\"\\ "[i],i))-1)S
A1(ek,eacf(x,kst))
47 S A1(kss,Nn=xn+2;Iv=1;I(xn,I
e=esc(xc)>=0;n+=e;v&=e| |c3(32,xc,126))P(!v,cat(aCz("0x"),hex(x)))
48
Ay=aC(n);C*s=yV;*s+="';i(xn,Ij=esc(xc);I(j<0,*s+=xc)E(*s+='\\"';*s+="0tnr\""
\\ "[j]))*s+="';x(y))
49 S A ksp(Ax,Qp,Qg,Qs)(Ct=TS[xt];(SC(p,t)?xn==1:SC(g,t)?xn<2:!!SC(s,t))?
par(kst(x)):kst(x))
50
A1(ks1,ksp(x,"AC","IDS","Mmqruvw"))A1(ksr,ksp(x,"","","","qruvw"))A1(ksw,ksp(x,"AC
","IDS","Mmpqw"))
51
A1(kst,P(xtT&&xn==1,pre(' ',' ',ksr(fir(x))))XA(par(jc(';',ek(x))))Xc(kss(enl(x)))X
C(kss(x)))

```

```

52 XZD(xn?jc(32,eac1f(x,str)):x(aCz(xtD?"0#0n":"!0"))XS(xn?
raz(ek(x)):x(aCz("0#`"))XM(pre('+',kst(f1p(x))))
53 Xm(Ay=kv(&x);cat(apc(ksl(x), '!'),ksr(y)))Xzd(str(x))
54
Xs(x=str(x);Iv=1;_i(xn,v&=c09(xc)| |cAz(xc))_I(!v,x=kst(x);_I(*xC==' ',',x=d1p(1,x)))
pre(`^',x)Xo(x.R(xx)))
55 Xp(x=val(x);Ay=xx,z=xy;
56 P(xn==3&&((ytv&&y-av)| |ytr)&&xy-PLH&&xz==PLH,
57 z=ksl(zR);y=kst(f1r(x));cA9(zC[zn-1])&&(cA9(*yC)| |*yC==' :'| |*yC==' -')?
cts(cat(apc(y,[' '],z),";",2):cat(z,y))
58 x=ek(x);Nm=_n(xx);x=apc(jc(';',x),[' ']);Q(xr==1);xC[m]=' [';x)
59
Xq(raz(ek(val(x))))Xr(x=val(x);Ay=R(xy);cat(ksw(f1r(x)),str(y)))Xw(aCn(&"':/:\
\:[xv%3*2],1+xv/3))
60 P(x==PLH,oC)Xu(apc(kst(au^av^x),':'))Xv(Ay=aCn(vc+xv,1);xv<20?
y:apc(y,' :'))aCz("???"')
61 A1(out,P(x==au,x).dex(v0c(ai(1),xtA&&l<xn?par(jC("\n
",2,ek(xR))):kst(xR)),x))
62 Q HEX="0123456789abcdef0123456789ABCDEF";
63
A1(hex,XC(Ay=aC(2*xn);C*s=yC;xe(_i(xn,*s++=HEX[ (UC)xc>>4];*s++=HEX[ xc&15 ])y))pen
(x,hex))
64 A1(unh,XC(P(xn&1,ell(x))S C
g[256];_I(!_g['1'],_I(32,g[HEX[i]]==15&_I))Ay=aC(xn/2);xe(_i(yn,yc=g[xC[2*i]])<<4|g[xC[2*i+1]]y))pen(x,unh))

```

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## w.c - ngnksource

### Global variables defined

- `q`

### Source code

```
1 #include "a.h" // ngn/k, (c) 2019-2022 ngn, GNU AGPLv3 -
https://codeberg.org/ngn/k/raw/branch/master/LICENSE
2 SN A2(enc, /*01*/P(!xtzz,en1(y))L(x==ai(2)&&ytz&&gl_(y)
<0,x=rsh(64,xR);x(enc(x,y)))
3 Ii=ytt;x=L("{$[0]&/x;`err\"domain\"; `i~@x;|x!-1_![~x;]\y; x!' |(,y),y{(-
y)!x}\|1_x} ",xR,y);!x||xN?x:x(i?OB:oA))
4 SN A2(dec, /*01*/K("z+x*y}/[0;;]",xR,y))
5 SN ALA(win,P(n<0,ed1(x))K("{{n;x}x(!n)+/:!0|1-n-#x}",az(n),x))
6 SN A2(bin, /*01*/ Xm(_1(xx,bin(xy,y)))Q(xtZC)Yt(fir(bin(x,en1(y))))
7 YZC(P(xn-(I)xn,ez1(y))L wx=xw,wy=yw;
8 P(!wx,wy?K("{@[x`c$127&y; &-128>y; :;-1]}",xR,y):K(
{(-1+\@ [&256;128+x;+;1])128+y}",xR,y))
9 Az=an(tZ(xn-1),yn);L wz=zw;
10 i(yn,Lv;S4(wy,v=yb,v=yh,v=yi,v=y1)Ij=-1,k=xn;S4(wx,W(j+1<k,C*m=xC+j+(k-
j>>1);v<*m?k=m-xC:(j=m-xC)),
11 W(j+1<k,H*m=xH+j+(k-
j>>1);v<*m?k=m-xH:(j=m-xH)),
12 W(j+1<k,I*m=xI+j+(k-
j>>1);v<*m?k=m-xI:(j=m-xI)),
13 W(j+1<k,L*m=xL+j+(k-
j>>1);v<*m?k=m-xL:(j=m-xL))
14 S4(wz,zb=j,zh=j,zi=j,zl=j.)y(z))
15 YMT(K("{x'y}",xR,y))ed1(y))
16 SN A sCC(Cc ,C*p,Ln)_ (Ax=oA;C*q;W((q=MC(p,c,n
)),xq(aCm(p,q));n-=q-p+1;p=q+1)L(n|c-10&&xn,xq(aCn(p,n)))x)
17 SN A
sCC(C*s,Lm,C*p,Ln)_ (P(!m,el0())Ax=oA;C*q;W((q=MM(p,n,s,m)),xq(aCm(p,q));n-=q+m-
p;p=q+m)L(n| xn,xq(aCn(p,n)))x)
18 SN A sc(Cc ,Ax)_ (XC(x(sCC(c, xV,xn)))et1(x))A1(spl,sc(10,x))
19 SN A sc(C*s,Lm,Ax)_ (XC(x(sCC(s,m,xV,xn)))et1(x))
20 SN L jN(Lm,Ax/*0*/)_ (P(!xtA,-1)Ln=
(xn-!xn)*m;i(xn,Ay=xa;P(!ytic,-1)n+=yN)n)//total length or -1
21 A jc(Cc, Ax)_ (Ln=jN(1,x);P(n<0,et1(x))Ay=aC(n);C*p=yV;i(xn,I(i,*p++=c
)Az=xa;I(ztc,*p++=zv)E(Mc(p,zV,zn);p+=zn))x(y))
22 A
jC(Qs,Nm,Ax)_ (Ln=jN(m,x);P(n<0,et1(x))Ay=aC(n);C*p=yV;i(xn,I(i,Mc(p,s,m);p+=m)A
z=xa;I(ztc,*p++=zv)E(Mc(p,zV,zn);p+=zn))x(y))
23 L cfm(OA*a/*0*/,_In)_ (Lm=-1;i(n,Ax=a[i];I(!xtt,Lv=xN;P(m>=0&&m-v,-2)m=v))m)
24 S A emp1f(Ax,A1 f/*0f*)_ (f==len?oB:f==til||f==str?oA:xR)S
A2(emp1,/*00*/ytu?emp1f(x,v1[yv]):oA)
25 S A emp2f(Ax,Ay,A2 f/*00f*)_ (f==mod?oB:oA) S
A3(emp2,/*000*/ztv?emp2f(x,y,v2[zv]):oA)
26 SN
AX(eacm,Az=oS;Ik=0;i(n,Ay=a[i];I(ytm,k++;z=cate(z,R(yx))))I(k>1,z=unq(z))
27 Ab8;i(n,Ay=b[i]=a[i];I(ytm,Au=kv(&y);uq(id(x,u));b[i]=apl(u,fil(ai(yn),fn(y,z
R))))AX eac;x=eac(x,b,n);P(!x,z(x))dct(z,x))
```

```

28  A eac1f(Ax,A1 f)_(Xt(f(x))Xm(Ay=kv(&x);am(x,Nx(eac1f(y,f))))I
b=xtA&&xr==1;Nn=xN;P(!n,x(emp1f(x,f)))
29  Ay=oA;i(n,Az=f(b?xa:ii(x,i));B(!z,I(b,mrn(xn-i-1,xA+i+1))y=y(0))yq(z))I(b,x=AN(0,x)x(y))
30  SN
A2(eac1,/*10*/Yu(eac1f(x,v1[yv]))Xt(y1(x)Xm(eacm(y,&x,1))Nm=xN;P(!m,x(emp1(x,y))))
31  P(xtA&&xr==1,x=AN(0,x);Au=oB;i(m,Az=y1(xa ));B(!z,u=u(0);mrn(m-i-1,xA+i+1))uq(z))x(u))
32  Au=oB;i(m,Az=y1(ii(x,i));B(!z,u=u(0))
)uq(z))x(u))
33  NI A eal2f(Ax,Ay,A2 f/*11f*/)_(          Xt(
f(x,y))Xm(Az=kv(&x);am(x,Nx(eal2f(z,y,f))))
34  Nn=xN;P(!n,x(y(emp2f(x,y,f)))Au=oA;i(xN,A v=
f(ii(x,i),yR);B(!v,u=u(0))uq(v))x(y(u)))
35  NI A ear2f(Ax,Ay,A2 f/*11f*/)_(          Yt(
f(x,y))Ym(Az=kv(&y);am(y,Ny(ear2f(x,z,f))))
36  Nn=yN;P(!n,x(y(emp2f(x,y,f)))Au=oA;i(yN,A v=
f(xR,ii(y,i));B(!v,u=u(0))uq(v))x(y(u)))
37  SN
A3(eal2,/*110*/P(ztv,eal2f(x,y,v2[zv]))Xt(z2(x,y))Xm(z=proj(z,A(PLH,y),2);z(eac1
(x,z))))
38  Nn=xN;P(!n,x(y(emp2 (x,y,z)))Au=oA;i(xN,A
v=z2(ii(x,i)),yR);B(!v,u=u(0))uq(v))x(y(u)))
39  NI
A3(ear2,/*110*/P(ztv,ear2f(x,y,v2[zv]))Yt(z2(x,y))Ym(z=proj(z,A(x,PLH),2);z(eac1
(y,z))))
40  Nn=yN;P(!n,x(y(emp2 (x,y,z)))Au=oA;i(yN,A
v=z2(xR,ii(y,i));B(!v,u=u(0))uq(v))x(y(u)))
41  SN AX(eal,Ab8;Mc(b,a,8*n);*b=PLH;x=proj(x,b,n);x(eac1(*a,x)))
42  SN
A3(eac2,/*110*/P(ztv,eac2f(x,y,v2[zv]))Xt(ear2(x,y,z))Yt(eal2(x,y,z))P(xtm|ytm
,eacm(z,A(x,y),2)))
43  Nm=xN;P(m-yN,el2(x,y))P(!m,y(ztv&&zv<11?
x:x(oA))Au=0;Ct=xtA&&xr==1,s=ytA&&yr==1;
44  i(m,A v=z2(t?xa:ii(x,i),s?ya:ii(y,i));B(!v,I(u,u=u(0))I(t,mrn(m-i-1,xA+i+1))I(s,mrn(m-i-1,yA+i+1)))
45  I(!u,u=v?AN(0,an(c3(ti,t(v),ts)?TT[t(v)]:tA,m)):0)uq(v))
46  mr(t?AN(0,x):x);mr(s?AN(0,y):y);u)
47  AX(eac,P(n==1,eac1(*a,x))P(n==2,eac2(*a,a[1],x)))
48  Ab8;Ct[8];Lm=-1;i(n,Ay=b[i]=a[i];Ym(eacm(x,a,n))t[i]=ytP?0:ytt?1:ytA?2+
(yr>1):4;I(t[i]>1,L l=yN;P(m>=0&&m-l,el8(a,n))m=l))
49  P(m<0,x8(a,n))i(n,I(t[i]==1,_r(a[i])+=m)) //t[i]
0:pkdatm,1:refatm,2:tA(r=1),3:tA,4:other
50  Au=0;I(!m,u=x==LEN?oB:n==2&&xtv&&xv<11?R(a[_N(a[1])]):oA)
51  j(m,i(n,Ay=a[i];I(t[i]==2,b[i]=yA[j])I(t[i]>2,b[i]=ii(y,j)))Az=x8(b,n);
52  B(!z,I(u,u=u(0))i(n,Ay=a[i];I(t[i]==1,yr-=m-j-1)I(t[i]==2,mrn(m-j-1,yA+j+1)))
53  I(!j,u=c3(ti,zt,ts)?AN(0,an(TT[zt],m)):oA)uq(z))
54  i(n,mr(t[i]-2?a[i]:AN(0,a[i])))u)
55  S I arf2(A2 f)_((SZ(V*)-8?fI:fL)(v2+1,10,(L)f)!=NL)
56  A eac2f(Ax,Ay,A2 f)_((Ik=2*xtt+ytt;P(k==3,f(x,y)))
57
P(xtm|ytm,P(xtm>ytm,Az=kv(&x);am(x,Nx(eac2f(z,y,f))))P(xtm<ytm,Az=kv(&y);am(y,
Ny(eac2f(x,z,f))))
58
Az=unq(cat(_R(xx),_R(yx)));x=apl(x,zR);y=apl(y,zR);I(arf2(f),Au=az(f==mul|f==d
vd);x=fil(u,x);y=fil(u,y))am(z,Nz(eac2f(x,y,f)))
59  P(!k&&xN-yN,el2(x,y))
60  Nn=k<2?
xN=yN;Az=emp2f(x,y,f);i(n,Au=f(ii(x,i),ii(y,i));B(!u,z=z(0))zq(u))x(y(z)))

```

```

61  SN
A2(cs, /*01*/Az=yR,v=yR,u=enl(y);W(1,z=yR;y=x1(y);P(!y,z(u=dex(v,0))))Im=mtc_(y,
z)| |mtc_(y,v);z(0);B(m)uq(yR))y(dex(v,u)))
62  SN
A2(cf, /*01*/Az=yR,u;W(1,zR;u=x1(z);B(!u)P(mtc_(u,y)| |mtc_(u,z),y(u(z)))z=z(u))y
(z(u)))
63  SN A w3(Ax,Ay,Az,Au/*011*/)(W(1,A w=y1(zR);B(!w,u?u(0):
(z=z(0)))B(!tru(w))z=x1(z);P(!z,y(u?u(0):0))I(u,uq(zR))u?y(z(u)):y(z))
64  SN A3(ws, /*011*/w3(x,y,z,enl(zR)))
65  SN A3(wf, /*011*/w3(x,y,z,0))
66  SN A n3(Ax,Lm,Ay,Az/*0m11*/)(i(m,I(z,zq(yR))y=x1(y);B(!y))z?y?
zq(y):z(y):y)
67  SN A ns(Ax,Lm,Ay/*0m1*/)(n3(x,m,y,oA))
68  SN A nf(Ax,Lm,Ay/*0m1*/)(n3(x,m,y,0))
69  SN A
nS(Ax,Lm,OA*a,Nn/*0m1n*/)(P(n=1,ns(x,m,*a))m=max(0,m);Az=aA(n+m),*b=zV;zn=n;M
c(b,a,8*n);i(m,Mn(n,b);b[n]=Nz(x8(b,n));zn++;b++)Sqz(z))
70  SN A nF(Ax,Lm,OA*a,Nn/*0m1n*/)(P(n=1,nf(x,m,*a))las(N(nS(x,m,a,n)))
71  SN A
wS(Ax,Ay,OA*a,Nn/*0m1n*/)(P(n=1,ws(x,y,*a))Ab8;Mc(b,a,8*n);Mn(n,b);Az=Sqz(aV
(tA,n,b));
72  W(1,Au=y1(ii(z,zn-1));B(!u,z=z(0))B(!tru(u))Mn(n-
1,b+1);u=x8(b,n);B(!u,*b=au;z=z(0))Mm(b,b+1,8*n-8);b[n-1]=u;zq(uR))
73  mrn(n,b);y(z))
74  SN A wF(Ax,Ay,OA*a,Nn/*011n*/)(P(n=1,wf(x,y,*a))las(N(wS(x,y,a,n))))
75  SN A3(nws2, /*011*/Yz(ns(x,gl(y),z))YF(ws(x,y,z))et2(y,z))
76  SN A3(nwf2, /*011*/Yz(nf(x,gl(y),z))YF(wf(x,y,z))et2(y,z))
77  SN AX(nws,Ay=*a;P(n=2,nws2(x,y,a[1]))Yz(nS(x,gl(y),a+1,n-
1))YF(ws(x,y,a+1,n-1))et8(a,n)
78  SN AX(nwf,Ay=*a;P(n=2,nwf2(x,y,a[1]))Yz(nF(x,gl(y),a+1,n-
1))YF(wF(x,y,a+1,n-1))et8(a,n)
79  SN
A3(fld2, /*110*/Yt(z2(x,y))P(ztv&&zv<11&&xtzdc&&ytZDC,arf(x,y,z))i(yN,x=z2(x,ii(y,i));B(!x)y(x))
80
A2(fld1, /*10*/Xt(x)P(ytv&&yv<11&&xtZDC,arf(0,x,y))P(!xN,x(id(y,x)))Az=ii(x,0);
i(xN-1,z=y2(z,ii(x,i+1));B(!z))x(z))
81  AX(fld,P(n=1,fld1(*a,x))P(n=2,fld2(*a,a[1],x))n-
;Ay=*a++,z=*a;Lm=cfm(a,n);
82  P(m===-1,y?x8(a-
1,n+1):z)P(m<0,I(y,y(0))el8(a,n))P(!m&&!y,x=id(x,z);mrn(n,a);x
83
Li!=y;I(i,y=ii(z,0))Ab8;W(i<m,*b=y;j(n,b[j+1]=ii(a[ji))y=x8(b,n+1);B(!y)i++)m
rn(n-1,a+1);z(y))
84  SN
A3(scn2, /*110*/Yt(z2(x,y))Ym(Au=kv(&y);am(y,Ny(scn2(x,u,z))))P(!yN,x(y))P(ztv&
zv<11&&xtzc&&ytZC,ars(x,y,z))
85  Au=oA;i(yN,x=z2(x,ii(y,i));P(!x,y(u(0)))uq(xR))x(y(u)))
86  SN
A2(scn1, /*10*/Xt(x)P(!xN,xXm(Az=kv(&x);am(x,Nx(scn1(z,y))))P(y==CAT,scn2(oA,x,
y))P(ytv&&yv<11&&xtZC,ars(0,x,y))
87  Ni=0,n=xN;Az=ii(x,0),u=enl(zR);W(++i<n,z=N(y2(z,ii(x,i)));uq(zR))z(x(u)))
88  SN AX(scn,P(n=1,scn1(*a,x))P(n=2,scn2(*a,a[1],x))Ay=*a++;n-
;Lm=cfm(a,n);P(m===-2,y(el8(a,n)))
89
Az=oA;Ab8;i(m,*b=y;j(n,b[j+1]=ii(a[ji))y=x8(b,n+1);P(!y,mrn(n,a);z(0))zq(yR))
mrn(n,a);y(z))
90  SN
A3(eap2, /*110*/Ym(Au=kv(&y);am(y,Ny(eap2(x,u,z))))Yt(et2(x,y))P(!yN,x(y))P(ztv&
zv<11&&xtzc&&ytZC,arp(x,y,z))
91  Au=oA;i(yN,x=z2(ii(y,i),x);P(!x,y(u(0)))uq(x);x=ii(y,i))x(y(u)))

```

```

92  SN A2(eap1,/*10*/eap2(id(y,x),x,y))
93  SN A3(ste,/*110*/K("{z'x':y}",x,y,zR))
94  AX(adv,Q(xtr)Ii=xE;x=xx;Ik=xK;
95  SW(i,
96    CR(0,P(n==1,Xt(eac1(*a,x)XZC(bin(x,*a))Xm(bin(x,*a))ed1(*a))eac(x,a,n))
97
98  CR(1,P(n==1,Ay=*a;P(xtzZ|xtdD,dec(x,y))Xc(jc(xv,y))XC(jC(xV,xn,y))P(k<2,cf(x,y)
))fld1(y,x))P(k<2,nwf(x,a,n))P(n-k==1,nwf(x,a,n))fld(x,a,n))
99
100 CR(2,P(n==1,Ay=*a;P(xtzZ|xtdD,enc(x,y))Xc(sc(xv,y))XC(sC(xV,xn,y))P(k<2,cs(x,y)
))scn1(y,x))P(k<2,nws(x,a,n))P(n-k==1,nws(x,a,n))scn(x,a,n))
101
102 CR(3,n==1?xtz?win(gl(x),*a):eap1(*a,x):n==2?k==1?
ste(*a,a[1],x):eap2(*a,a[1],x):er8(a,n))
100 CR(4,P(n==2,ear2(*a,a[1],x))er8(a,n))
101 CR(5,P(n==2,eal2(*a,a[1],x))eal(x,a,n)))
102 er8(a,n))

```

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## 2.c - ngnksource

### Global variables defined

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### Macros defined

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- [hiT](#)
- [hv](#)
- [i4](#)

### Source code

```

1  #include "a.h" // ngn/k, (c) 2019-2022 ngn, GNU AGPLv3 -
https://codeberg.org/ngn/k/raw/branch/master/LICENSE
2  // {dex add sub mul dvd mod mnm mxm ltn gtn eql} x {o0123fspl} x {BHILD} =
3  // = {:+-*%!&/<>} x {op a+a a+l l+a l+l f/ f\ f': @} x {byte short int long
double}
4  #define hv(v,T,R,f) S R v##o##T(T x,T y)_-(f)
5  #define hd(v,f,g) hv(v,B,B,f)hv(v,H,H,f)hv(v,I,I,f)hv(v,L,L,f)hv(v,D,D,g)
6  #define hc(v,f,g) hv(v,B,B,f)hv(v,H,B,f)hv(v,I,B,f)hv(v,L,B,f)hv(v,D,B,g)
7  #define h(v,f) hd(v,f,f)
8  h(dex,y)h(add,x+y)h(sub,x-y)h(mul,x*y)hv(dvd,D,D,x/y)
9  hd(mod,x>0?(y%(L)x+x)%Lx:!x?y:y<0?-1-(-1-y)/-x:y/-x,x>0?y-(L)
(y/x)*x:dvdod(y,-x))
10 h(mnm,min(x,y))h(mxm,max(x,y))hc(ltn,x<y,qD(x,y)
<0)hc(gtn,x>y,ltn(y,x))hc(eql,x==y,*(&x)==*(L*)&y)
11 #undef h
12 #define hv(f,T,R,e...) SN I f(OV*RE p,OV*RE q,V*RE s,Nn)_-(Q
T*a=p,*b=q;R*r=s;@)
13 #define h0(v,T,R) hv(v##0##T,T,R,*r=v##o##T(*a,*b);0)
14 #define h1(v,T,R)
hv(v##1##T,T,R,LN(b)LN(r)TY(*a)c=*a;i(PD(n,a),*r++=v##o##T(c,*b++))0)
15 #define h2(v,T,R)
hv(v##2##T,T,R,LN(a)LN(r)TY(*b)c=*b;i(PD(n,a),*r++=v##o##T(*a++,c))0)
16 #define h3(v,T,R) hv(v##3##T,T,R,LN(a)LN(b)LN(r)
i(PD(n,a),*r++=v##o##T(*a++,b++))0)
17 #define hS(v,T,R) hv(v##2##T,T,R,v##1##T(b,a,r,n))
18 #define h0123(a...) h0(a)h1(a)h2(a)h3(a)
19 #define h01S3(a...) h0(a)h1(a)hS(a)h3(a)
20 h0123(dvd,D,D)
21 h0123(mod,B,B)h0123(mod,H,H)h0123(mod,I,I)h0123(mod,L,L)h0123(mod,D,D)
22 h01S3(mnm,B,B)h01S3(mnm,H,H)h01S3(mnm,I,I)h01S3(mnm,L,L)h01S3(mnm,D,D)
23 h01S3(mxm,B,B)h01S3(mxm,H,H)h01S3(mxm,I,I)h01S3(mxm,L,L)h01S3(mxm,D,D)
24 h0123(ltn,B,B)h0123(ltn,H,B)h0123(ltn,I,B)h0123(ltn,L,B)h0123(ltn,D,B)
25 h01S3(eql,B,B)h01S3(eql,H,B)h01S3(eql,I,B)h01S3(eql,L,B)h01S3(eql,D,B)
26 #define hiT(i,T) mod##i##T,mnm##i##T,mxm##i##T,ltn##i##T,0,eql##i##T
27 #define hi(i) {{0,hiT(i,B)}, {0,hiT(i,H)}, {0,hiT(i,I)}, {0,hiT(i,L)}, 
{dvd##i##D,hiT(i,D)}}, 
28 TY(&mod0B)aro[ ][5][7]={hi(0)hi(1)hi(2)hi(3)}; // a+a a+l l+a l+l
29 S C tZx(Ax)_-(Ct=TX[xt];P(t,t)Xl(tZ(gl_(x)))tZ(xv))
30 C sup(A*p,A*q)_-(Ax=x*p,y=x*q;Ct=max(tZx(x),tZx(y));*p=x=Ny(cT[t]
(x));*q=y=Nx(cT[t](y));t)
31 S
A3(ar2,Q(ztv)XYmMA(eac2f(x,y,v2[zv]))N(sup(&x,&y));Ik=xtT<<1|ytT;P(k==3&&xn-
yn,el2(x,y))
32 Ct=k?min(xt,yt):max(xt,yt);V*a=xtP?(V*)&x:xV,*b=ytP?
(V*)&y:yV;t=TT[t];V(f,aro[k][t-tB][zv-4]);I(z>MXM,t=tB)
33 I(!k,t=max(ti,t+tc-tC);P(TP(t),Ii=0;f(a,b,&i,1);x(y(az(i))))) 
34 Az=xt==t&&xr==1?x:yt==t&&yr==1?y:an(t,k-1?xn:yn);f(a,b,zV,zn);x-z?x(y-z?
y(z):z):y(z))
35 S AIA(ext,XMT(x)rsh(n,xtm?enl(x):x))
36 A2(dct,P(rnk(x)<0,ed2(x,y))x=ext(yN,x);y=ext(xN,y);(xN-yN?el2:am)(x,y))
37 A2(dex,mr(x);y)
38 A2(add,adm(x,y,0))
39 A2(sub,add(x,Nx(neg(y))))
40 A2(mul,adm(x,y,1))
41 A2(dvd,XYmMA(eac2f(x,y,dvd))ar2(Ny(cD(x)),Nx(cD(y)),DVD))
42 A2(mod,Xzc(YdD(Ln=gl_(x));P(!n,y)P(n<0,ar2(x,Nx(csti(y)),MOD))K("y-x*(-
x)!^i$y",x,y))ar2(x,y,MOD))dct(x,y))
43 A2(mnm,ar2(x,y,MNM))
44 A2(mxm,ar2(x,y,MXM))
45 A2(ltn,P((1<<xt|1<<yt)&
(1<<tm|1<<tM|1<<tA|1<<tS),eac2f(x,y,ltn))P(xts&&yts,ai(qA(x,y)<0))ar2(x,y,LTN))

```

```

46  A2(gtn, ltn(y, x))
47  A2(eq1, XYmMA(eac2f(x, y, eq1))P(xtsS-ytsS, et2(x, y))P(xtsS, eq1(AT(xt+ti-
ts, mut(x)), AT(yt+ti-ts, mut(y))))ar2(x, y, EQL))
48
49  #define i4(w,n,a,b,c,d) S4(w, i(n,a), i(n,b), i(n,c), i(n,d))
50  #define MIN(x,y) (x)=min(x,y)
51  #define MAX(x,y) (x)=max(x,y)
52  SN A1(inv, x=mut(x); Nn=xn*xW; i(PD(n, xC), xc^=-1)x)
53
54  S A3(__f, Nn=yn, i!=x; I(i, x=ii(y, 0))W(i<n, x=z2(x, ii(y, i++)); B(!x))y(x))S A3
dекс;
55  S A3(dexf, las(dexs(x, y, z)))
56  S L mmmmfZ(Lv, Ax/*0*/ , Ii)_(Q(xtZDC)L l=-111<<8*xW-1, h=~1; Nn=xn; P( i?
v>=h:v<=l) | !n, v)v=v<1?1:v>h?h:v;
57
I(i, i4(xw, n, MAX(v, xb), MAX(v, xh), MAX(v, xi), MAX(v, xl)))E(i4(xw, n, MIN(v, xb), MIN(v,
xh), MIN(v, xi), MIN(v, xl)))v)
58  S A3(mmmmf, Ii=zv==7; P((x&&xtd) | | ytD, Lv=ofpd1(x?gd(cD(x)):i?-WD:WD); y=cD(y); ad(ye(OFP1(y); L r=mmmfZ(v, y, i); OFP0(y); ofpd0(r))))
59  Lv=x?gl(x):i?-WL:WL; az(ye(mmmmfZ(v, y, i))))
60  S A3(admf, Ii=zv==3; Nn=yn; P((x&&xtd) | | ytD, Dv=x?
gd(cD(x)):i; y=cD(y); ad(ye(I(i, i(n, v*=yd))E(i(n, v+=yd))v)))
61  Lv=x?
gl(x):i; az(ye(I(i, i4(yw, n, v*=yb, v*=yh, v*=yi, v*=yl))E(i4(yw, n, v+=yb, v+=yh, v+=yi,
v+=yl))v)))
62  S A3(subf, neg(admf(x?neg(x):yn?mul(ai(-2), ii(y, 0)):0, y, ADD)))
63
A3(arf, Q(ztv)Q(zv<11)Q(!x|xtzdc)Q(ytzdc)T(&dexf, admf, subf, admf, __f, __f, mmmmf,
mmmf, __f, __f, __f)[zv](x, y, z))
64
65  S A3(__s, Ni!=x; Au=i?
x=ii(y, 0), enl(xR):oA; Nn=yn; W(i<n, x=z2(x, ii(y, i++)); P(!x, y(u))uq(xR))x(y(u)))
66  S A3(dexs, x?x(y):y)
67  S A3(adds, L w=x?gl(x):0; Nn=yn;
68  W(1, I b=1; Lv=w; Ct=tB+yw; Au=an(t, n);
69  i4(yw, n, ub=v+=yb; B(v-(B)v, b=0), uh=v+=yh; B(v-(H)v, b=0), ui=v+=yi; B(v-
(I)v, b=0), ul=v+=yl)P(b, y(u))y=cT[t+1](u(y)))0
70  S A3(muls, L w=x?gl(x):1; Nn=yn;
71  W(1, I
b=1; Lv=w; Ct=yt; Au=an(t, n); I(t==tL, i(n, ul=v*=yl))J(t==tI, i(n, ui=v*=yi; B(v-
(I)v, b=0)))
72  J(t==tH, i(n, uh=v*=yh; B(v-(H)v, b=0)))J(t==tB, i(n, ub=v*=yb; B(v-
(B)v, b=0)))E(Q(0))P(b, y(u))y=cT[t+1](u(y)))0
73  S A3(subs, neg(adds(neg(x?x:mul(ai(2), ii(y, 0))), y, 0)))
74  S A3(mxms, P((!x|xtz)&ytz, Lv=x?gl(x):-WL, l=-111<<8*yW-
1, h=~1; Nn=yn; I(v<=1| h<=v, P(v>=0, y(rsh(n, az(v))))v=v<0?1:h)
75  Au=yr-1?
an(yt, n):y; i4(yw, n, ub=MAX(v, yb), uh=MAX(v, yh), ui=MAX(v, yi), ul=MAX(v, yl))y-u?
y(u):u) __s(x, y, z))
76  S A3(mnms, P((!x|xtz)&ytz, inv(mxms(x?
az(~gl(x)):0, inv(y, MXM)))__s(x, y, z)))
77  S A3(eqls, Lv=x?gl(x):~*yL; Au=ytB&&yr==1?
y:aB(yN); i4(yw, yn, ub=v=v==yb, ub=v=v==yh, ub=v=v==yi, ub=v=v==yl)y-u?y(u):u)
78
A3(ars, Q(ztv)Q(zv<11)Q(!x|xtzc)Q(ytzc)T(&dexs, adds, subs, muls, __s, __s, mnms, mx
ms, __s, __s, eqls)[zv](x, y, z))
79
80  S A3(dexp, cat(x, drp(-1, y)))
81  S A3(__p, v2[zv](y, dexp(x, yR, av)))
82  S A3(modp, eac2f(y, dexp(x, yR, av), mod))
83  S A3(mxmp, YC(mxmp(x, cB(y), z)))

```

```

84  I
w=yw;Lv=gl(x),l=-111<<(8<<w)-1,h=~l;MAX(v,l);Nn=yn;P(v>=h,rsh(n,y(az(v))))x=ax(
y);iW(y,w,-1,v);Nj=n-1;
85  i4(w,n,xB[j]=max(yB[j],yB[j-1]);j--,xH[j]=max(yH[j],yH[j-1]);j-
-,xI[j]=max(yI[j],yI[j-1]);j--,xL[j]=max(yL[j],yL[j-1]);j--
86  yn=n;x)
87  S A3(mnmp,inv(mxmp(az(~gl(x)),inv(y),M XM)))
88  S A3(cmp pp,I o=z-LTN,w=yw;Nn=yn;Au=aB(n);Lv=gl(x),p=iw(y,w,0);*uB!=o?
p<v:o==1?p>v:p==v;Lm=n-1,Lj=m;
89  S4(o,i4(w,m,uB[j]=yB[j]< yB[j-1];j--,uB[j]=yH[j]< yH[j-1];j--,uB[j]=yI[j]<
yI[j-1];j--,uB[j]=yL[j]< yL[j-1];j--),
90   i4(w,m,uB[j]=yB[j]> yB[j-1];j--,uB[j]=yH[j]> yH[j-1];j--,uB[j]=yI[j]>
yI[j-1];j--,uB[j]=yL[j]> yL[j-1];j--),
91   i4(w,m,uB[j]=yB[j]==yB[j-1];j--,uB[j]=yH[j]==yH[j-1];j-
-,uB[j]=yI[j]==yI[j-1];j--,uB[j]=yL[j]==yL[j-1];j--),)y(u))
92
A3(ar p,O(ztv)Q(zv<11)Q(xtzc)Q(ytZC)T(&dexp,____p,____p,____p,____p,modp,mnmp,mxmp,c
mpp,cmp pp,cmp pp)[zv](x,y,z))
93
94  S A4(dexa,/ *1101*/Ny(sup(&x,&u));x=mut(x);Nn=yn;I wx=xw,wy=yw,wu=utt?
-1:uw;Lv=wu<0?gl_(u):0;
95  ye(ue(I(utt,i4(wx,n,xB[iw(y,wy,i)]=v ,xH[iw(y,wy,i)]=v ,xI[iw(y,wy,i)]=v
,xL[iw(y,wy,i)]=v ))
96   E(
i4(wx,n,xB[iw(y,wy,i)]=ub,xH[iw(y,wy,i)]=uh,xI[iw(y,wy,i)]=ui,xL[iw(y,wy,i)]=ul
))x))
97  S A4(adma,/ *1101*/x=cL(x);u=cL(u);x=mut(x);I(!ytL,y=cI(y))Nn=yn;
98  I(utt,Lv=gl(u);ye(I(zv==1,I(ytL,i(n,xL[yl]+=v ))E(i(n,xL[yi]+=v
)))E(I(ytL,i(n,xL[yl]*=v ))E(i(n,xL[yi]*=v ))))O))
99  E(ue(
ye(I(zv==1,I(ytL,i(n,xL[yl]+=ul))E(i(n,xL[yi]+=ul)))E(I(ytL,i(n,xL[yl]*=ul))E(i
(n,xL[yi]*=ul))))x)
100 S A4(mmma,/ *1101*/Ny(sup(&x,&u));x=mut(x);I(!ytL,y=cI(y))y*v=utP?&u:uV;I
d=utt;Nn=yn;
101
ye(ue(I(zv==6,I(ytL,i4(xw,n,MIN(xB[yl],uB[d*i]),MIN(xH[yl],uH[d*i]),MIN(xI[yl],
uI[d*i]),MIN(xL[yl],uL[d*i]))))
102   E(
i4(xw,n,MIN(xB[yi],uB[d*i]),MIN(xH[yi],uH[d*i]),MIN(xI[yi],uI[d*i]),MIN(xL[yi],
uL[d*i]))) )
103   E(
I(ytL,i4(xw,n,MAX(xB[yl],uB[d*i]),MAX(xH[yl],uH[d*i]),MAX(xI[yl],uI[d*i]),MAX(x
L[yl],uL[d*i])))
104   E(
i4(xw,n,MAX(xB[yi],uB[d*i]),MAX(xH[yi],uH[d*i]),MAX(xI[yi],uI[d*i]),MAX(xL[yi],
uL[d*i]))))x))
105 S A4(suba,adma(x,y,ADD,neg(u)))
106 A4(ar a,/ *1101*/Q(xtzc)Q(ytZC)Q(ztv)Q(0xcf&1<<zv)Q(utzz|utcC)
107 P(utT&&yn-
un,e12(x(y),u))P(!ina(y,xn),ei2(x(y),u))T(&dexa,adma,suba,adma,0,0,mmma,mmma)
[zv](x,y,z,u))

```

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## o.c - ngnksource

### Functions defined

- [ascA](#)
- [ofpd0](#)
- [ofpd1](#)
- [t](#)

### Source code

```
1 #include "a.h" // ngn/k, (c) 2019-2022 ngn, GNU AGPLv3 -
https://codeberg.org/ngn/k/raw/branch/master/LICENSE
2 I mtc_(Ax,Ay/*00*/)(P(x==y,1)P(xtz&&ytz,gl_(x)==gl_(y))P(xts&&yts,xv==yv)
3 P(xtZ&&ytZ&&xt-yt&&xn==yn,xR;yR;sup(&x,&y);x(y(!MQ(xV,yV,xn*TZ[xt])))P(xt-
yt||xtP||(xtr&&xE-yE)||xn-yn,0)
4 P(!xtR,i(xn*xW,P(xc-
yc,0))(c3(tB,xt,tS)&&xt==yt&&xn==yn,!MQ(xV,yV,xn*TZ[xt]))i(xn,P(!mtc_(xa,ya),
,0))1)
5 A2(mtc,x(y(ai(mtc_(x,y))))))
6 S Q UL Q=(-lull>>12)-1;S L t(Lv)_-(v^(UL)(v>>63)>>1)S L ofp1(Lv)_-(t(v)+Q)S L
ofp0(Lv)_-(t(v-Q))//ordered floating point
7 V OFP1(Ax/*!*/){Q(xtdD||xtlL)i(PD(xn,xL),xl=ofp1(xl))}L ofpd1(Dv)_-(ofp1(*
(L*)&v))
8 V OFP0(Ax/*!*/){Q(xtdD||xtlL)i(PD(xn,xL),xl=ofp0(xl))}D ofpd0(Lv)_-(*
(D*)T(ofp0(v)))
9 A1(ordD,Q(xtdD);x=AT(xt-tD+tL,mut(x));OFP1(x);x)
10 S C ordt(Ax)_-(xtz?tl:xtZ?tL:xt)
11 S I qL(Li,Lj)_-(i<j?-1:i>j)
12 I qD(D u,Dv)_-(qL(ofpd1(u),ofpd1(v)))
13 I
qA(Ax,Ay/*00*/)(P(mtc_(x,y),0)P(xtd&&ytD,qD(*xD,*yD))P(xtzc&&ytD,qD(gl_(x),*yD
))P(xtd&&ytzc,qD(*xD,gl_(y)))
14 Iv=ordt(x)-ordt(y);P(v,v)Xzc(qL(gl_(x),gl_(y)))Xd(*xD<*yD?-1:*xD>*yD?
1:0)Xs(SQ(qs(&x),qs(&y)))
15 I(!xtP,Iv=qL(xn,yn);XT(i(min(xn,yn),Az=i(x,i),u=i(y,i);I
d=qA(z,u);mr(z(u));P(d,d))v))qL(x,y))
16 S I*ascZ(Q UC*v,UC*g,I*a,I*b,In,I w)_-(UI c[257];tilV(a,n,2);
17 j(w,Ms(c,0,SZ c);i(n,g[i]=v[w*a[i]+j])i(n,c[g[i]+1]++)I(c[1+*g]-
n,i(255,c[i+1]==c[i])i(n,b[c[g[i]]++]=a[i])SWP(b,a)))a)
18 S V mrg(OA*v,I*p,I*p1,I*q,I*q1,I*r){W(p<p1&&q<q1,*r++=qA(v[*p],v[*q])<=0?
*p++: *q++)Mc(r,p<p1?p:g,p1-p+q1-q<<2);}
19 S V ascA(OA*v,I*a,In,I*b){P(n<2,I(n,*b==a);)I m=n/2;ascA(v,a+m,n-
m,b+m);ascA(v,a,m,a+m);mrg(v,a+m,a+2*m,b+m,b+n,b);}
20 A1(asc,Xt(opn(x))Xm(K("{(!x)<. x}"),x))XM(K("{(!#x){x@<y
x}/|.+x}"),x))XS(asc(str(x)))XD(asc(ordD(x)))In=xn;P(n-xn,ezl(x))
21 XA(Im=n/2;OA*v=xA;Ay=aI(n),z=aI(n-m);I*a=yV,*b=zV;tilV(a,n,2);ascA(v,a+m,n-
m,b);ascA(v,a,m,a+n-m);mrg(v,a+n-m,a+n,b,b+n-m,a);x(z(y)))
22 x=N(K("{x-
&/x}"),x));Ay=aC(n),z=aI(n),u=aI(n);xe(ye(ascZ(xV,yV,zV,uV,n,xW)==zV?
u(z):z(u))))
```

```
23  A1(dsc,XMT(x=rev(asc(rev(x)));sub(ai(xN-  
1),x))Xm(Ay=kv(&x);idx(x,Nx(dsc(y))))Xz(cls(gl(x)))et1(x))  
24  A1(grp,Xz(K("  
{@ [&x; ; ; 1] '!x' ,x})Xt(et1(x))Xm(Ay=kv(&x);y=Nx(grp(y));yy=idx(x,yy);y)  
25  K("{(x[(!0),*'g])!g@:<g:(&(!0),~x~' :x i:<x} ",x))
```

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## h.c - ngnksource

### Functions defined

- [ccp](#)
- [flt](#)

### Source code

```
1 #include "a.h" // ngn/k, (c) 2019-2022 ngn, GNU AGPLv3 -
https://codeberg.org/ngn/k/raw/branch/master/LICENSE
2 SN A flt(Ax,Ay,Cb)_(_Q(xtF);P(xK-1,er2(x,y))Ym(K("{{(!y)[i]!(. y)i:&z~/:x@.
y}" ,x,y,ai(b))) )
3 x=Ny(apl(x,yR));x=xN?Ny(cL(x)):x(oB);P(!xtt&&xN-yN,el2(x,y))
4 Az=rsh(0,yR);i(yN,Ln=gl(i(x,i));B(b&&n-(UI)n,z=ed1(z)).j(b?
n:!n,zq(i(y,i))))x(y(z)))
5 V cyc(V*a,Nm,Nn){Q(m);W(2*m<=n,Mc(a+m,a,m):m*=2)I(n>m,Mc(a+m,a,n-m)) }
6 V ccp(OV*a,Nm,V*b,Nn){Q(m);Mc(b,a,min(m,n));cyc(b,m,n);}
7 ALA(rsh,Xt(rsh(n,enl(x)))
8 XT(P(!xn,rsh(n,enl(fir(x))))P(n<0,n-NL?rev(rsh(-
n,rev(x))):x)Ay=an(xt,n);ccp(xV,xn*xW,yV,n*xW);x(ytA?sqz(mRa(y)):y))
9
XM(Ay=kv(&x);aM(x,Nx(ear2(az(n),y,RSH))))Q(xtm)Ay=kv(&x);x=Ny(rsh(n,x));y=Nx(rs
h(n,y));am(x,y))
10 S A slc(Ax/*0*/ ,Ni,Nj)_(_Q(xtT&&i<=j&&i<=xn)Ay=an(xt,j-i);Mc(yV,xV+i*xW,(j-
i)*xW);XA(sqz(mRa(y)))y)
11 S ALA(chp,P(n<0,ed1(x))Lm=(xn+n-
1)/n;Ay=aA(m);i(m,ya=slc(x,n*i,min(xn,n*i+n)))x(y))
12 S A shp(Q L*s,Nn,Ax,Lm)_(_Q(xtT)Q(xn)Q(n)P(n==1,rsh(m**s,x))x=shp(s+1,n-
1,x,m**s);s[1]?chp(s[1],x):rsh(m**s,enl(x)))
13 S A rshL(Q
L*s,Nn,Ax)_(_Xt(rshL(s,n,enl(x)))XmM(en1(x))P(!n,fir(x))P(n>8,ez1(x))
14 P(n==1&&s==NL,x)I(n==2,P(*s==NL,chp(s[1],x))P(s[1]==NL,K("{{(-x) !
(#y)*!x}_y}" ,az(*s),x)))P(!xn,rshL(s,n,enl(fir(x))))
15 Lm=1;i(n,P(s[i]<0,ed1(x))m*=max(1,s[i]))x=N(rsh(m,x));shp(s,n,x,1))
16 A2(hsh,Xz(rsh(gl(x),y))XZ(x=Ny(cL(x));x(rshL(xL,xn,y)))XF(flt(x,y,1)))
17 XT(P(ytm)|ytM&&xtS,a2t(x,apl(y,xR),yt))et2(x,y)et2(x,y))
18 ALA(drp,XT(P(n==NL,rsh(0,x))P(-n<=(UL)xn&&xr==1,I(xtA,mrn(-
n,xA+xn+n))AN(xn+n,x))x(slc(x,max(0,min((L)xn,n)),max(0,min((L)xn,xn+n))))))
19
Xm(Ay=kv(&x);am(Ny(drp(n,x)),Nx(drp(n,y))))XM(Ay=kv(&x);aM(x,Nx(eac2f(az(n),y,u
nd))))er1(x))
20 S ALA(rmv,XT(P(!in(i,xn),x))Ay=an(xt,xn-
1);Mc(yV,xV,i*xW);Mc(yV+i*xW,xV+i*xW+xW,(xn-i-
1)*xW);I(xtA,y=sqz(mRa(y)))x(y))et1(x))
21 S A2(cut,Q(xtZ)Q(ytMT)K("{y$[|/0<':x,#y;`err`domain`";x+!`1_-
':x,#y}`",x,y))
22
A2(unD,Xz(drp(gl(x),y))XF(flt(x,y,0))Xm(Az=kv(&x);y=fnd(xR,y);P(!y,x(z(0)))yR;a
m(Nz(unD(x,y)),Nx(unD(z,y))))
23 P(xtZ&&ytMT,cut(x,y))P(xtMT&&ytZ,rmv(x,gl(y)))Ym(K(
{((!y)^x)y}" ,x,y))Ym(K("{+x+y}" ,x,y))et2(x,y))
24
A1(enl,Xi(av(tZ(xv),1,&x))XF(al(x))XP(av(TT[xt],1,&x))Xt(x(av(TT[xt],1,xV)))Xm(
Ay=kv(&x);aM(x,eacf(y,enl)))al(x))
```

25

```

A2(cat,P(xtm&&ytm,Az=kv(&y);L("@[;;:]",x,y,z))Xmt(cat(enl(x),y))Ymt(cat(x,enl(y)))
 26 P(xtM||ytM,
 27 P(xtT||ytT,x=Ny(cA(x));y=Nx(cA(y));cat(x,y))
 28 P(!xtM||!ytM,et2(x,y))
 29 P(!mtc_(xx,yx),ed2(x,y))
 30 Az=eac2f(R(xy),R(yy),cat);x(y(z?aM(R(xx),z):0)))
 31 P(!yn,y(x))P(!xn,x(y))I(xtZ&&ytZZ,N(sup(&x,&y)))I(xt-yt,x=cA(x);y=cA(y))
 32 Nm=xn,n=yn,w=xW;x=room(m+n,x);Mc(xV+m*w,yV,n*w);I(ytA,yr-1?
mRa(y):AN(0,y))y(x))
 33 A2(apd,Q(xtMT);Nn=xn;P(!n,enl(x(y)))
 34 P(xtB&&yti&&yv==(B)yv||xtC&&ytc,apc(x,yv))
 35 P(xtH&&yti&&yv==(H)yv,x=room(n+1,x);xH[n]=yv;x)
 36 P(xtI&&yti||xtS&&yts,x=room(n+1,x);xI[n]=yv;x)
 37 P(xtL&&yti,x=room(n+1,x);xL[n]=yv;x)
 38 P(xtL&&ytl||xtD&&ytd,x=room(n+1,x);xL[n]=gl(y);x)
 39 P(xtZ&&ytz,N(sup(&x,&y));apd(x,y))
 40

XM(P(!ytm||!mtc_(xx,yx),apd(Ny(cA(x)),y))x=mut(x);Az=xy=mut(xy);I(zn,q(za,ii(y,y,i)))y(x))
 41 P(!xtA&&(!ytt||xt-TT[yt]),apd(Ny(cA(x)),y))
 42 Lv=xtA?(L)y:gl(y);apv(x,&v))
 43 A apv(Ax,OV*v)_(Q(xtT);Nn=xn;x=room(n+1,x);Mc(xV+n*xW,v,xW);x)
 44 A apc(Ax,Cc)_(Q(xtC||xtB);Nn=xn;x=room(n+1,x);xC[n]=c;x)
 45 A cts(Ax,Qs,Nm)_(Q(xtC);Nn=xn;x=room(n+m,x);Mc(xV+n,s,m);x)
 46 S A
insL(Ax,Li,Lj,Ay)_(YF(insL(x,i,j,Nx(y(y1(slC(x,i,j))))))Xmt(et2(x,y))Ymt(insL(x,i,j,enl(y)))P(xtM||ytM,en2(x,y))
 47 P(!in(i,j+1)||!in(j,xN+1),ei2(x,y))P(xtZ&&ytZ&&xt-
yt,N(sup(&x,&y));insL(x,i,j,y))P(xt-yt,insL(cA(x),i,j,cA(y)))
 48 Az=an(xt,xn-j+i+yn);Mc(zV,xV,i*xW);Mc(zV+i*xW,yV,yn*xW);Mc(zV+
(i+yn)*xW,xV+j*xW,(xn-j)*xW);
 49 I(xtR,I(xr-1,mRn(i,xA);mRn(xn-j,xA+j))E(mrn(j-i,xA+i);AN(0,x))I(yr-
1,mRa(y))E(AN(0,y))x(y(z)))
 50 S A3(ins3,Yz(Li=gl(y);insL(x,i,i,z))YZ(P(yN-
2,el2(x,z(y)))Li=gl(ii(y,0)),j=gl(las(y));insL(x,i,j,z))et2(x,z(y)))
 51 AA(ins,n=3?ins3(*a,a[1],a[2]):en8(a,n))

```

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## a.c - ngnksource

### Global variables defined

- TT
- TX
- TZ
- Tk
- Tz

### Functions defined

- A1(mkn,XmMA(eac1f(x,mkn))Ay=\_R(cn[xt]);Xt(x(y))rsh(xN,x(y)))I\_K(Ax/\*0\*/\_(xtullxtw?1:xtv?2:xte?x>>48&7:xtF?xk:0) // K:arity.

### Macros defined

- G
- iC
- iD
- iF
- iS
- i
- j

### Source code

```
1 #include "a.h" // ngn/k, (c) 2019-2022 ngn, GNU AGPLv3 -
https://codeberg.org/ngn/k/raw/branch/master/LICENSE
2 S A1(sam,x)VS;OC Tz[ ]={Tzv},TZ[ ]={Tzv},TT[ ]={TTv},TX[ ]={TXv},Tk[ ]={Tkv};
3 A1(mkn,XmMA(eac1f(x,mkn))Ay=_R(cn[xt]);Xt(x(y))rsh(xN,x(y)))I_K(Ax/*0*/_(xtu||xtw?1:xtv?2:xte?x>>48&7:xtF?xk:0) // K:arity
4 A2(id,/*00*/x==CAT?_R(ce[ce[yt]?yt:tA]):xtv&&xv<11&&xv?_R(ci[ytdD]
[T((C)4,0,0,1,1,2,2,3,3,2,4)[xv]]):mkn(fir(yR)))
5 AX(prj,XmMA(x8(a,n))Ik=max(n,xK);i(n,k-=a[i])!=PLH)
6 x=(xtp?val:a)
(xR);i=0,j=1;W(i<n&&j<xn,I(xA[j]==PLH,xA[j]=a[i++])j++)W(i<n,xq(a[i++]))P(xn>9
,ez1(x))AT(tp,AK(k,x)))
```

```

7  S A
iM(Ax,Li,AAL*f)_(Q(xtM);Ay=xy,z=aA(yn);Q(ytA);j(zn,zA[j]=f(yA[j],i))am(R(xx),s
gZ(z)))
8
AAL(ii,/*0*/XA(R(xa))XC(ac(xc))XB(ai(xb))XH(ai(xh))XI(ai(xi))XL(al(xl))XD(ad(x
d))XS(as(xi))Xm(ii(xy,i))XM(iM(x,i,ii))xR)
9  S
AAL(io,/*0*/P(xtt)|in(i,xN),ii(x,i))P(xN,mkn(ii(x,0)))Xm(io(xy,i))XM(iM(x,i,io)
)R(cn[xt]))
10 A1(fix,x(io(x,0)))A1(las,x(io(x,xN-1)))
11 #define G(T,U) (32/(SZ(T)>SZ(U))?SZ(T):SZ(U))
12 #define iF(f,T,U,R,e...) S L f(OV*RE a,Lm,OV*RE b,V*RE c,Nn)_(Q T*p=a;O
U*q=b;R*r=c;LN(p)LN(q)LN(r)e;n)
13 #define iC_(U) iF( iC##U,C,U,C,i(PD(n,q),r[i]=in(g[i],m)?p[g[i]]:32)
14 #define iS_(U) iF( iS##U,I,U,I,i(PD(n,q),IV=in(g[i],m);r[i]=v*p[v*g[i]])
15 #define iD_(U) iF( iD##U,D,U,D,i(n,r[i]=in(g[i],m)?p[g[i]]:ND)
16 #define j_(T,U) iF(j##T##U,T,U,L,i(n,r[i]=in(g[i],m)?p[g[i]]:NL))
17 #define i_(T,U) iF(i##T##U,T,U,T,UI g=G(T,U);U k[g];\
18 i(n/g,j(g,k[j]=g[j])U
o=0;j(g,o!=in(k[j],m))P(o,i*g)j(g,r[j]=p[k[j]])g+=g;r+=g)\
19 L l=n/g*g;j(n-l,P(!in(g[j],m),l))j(n-l,r[j]=p[g[j]]))
20
iC(I)iC(L)i(B,I)j(B,I)i(B,L)j(B,L)i(H,I)j(H,L)i(H,L)i(I,I)j(I,L)j(I,I)j(L,I)j(L,L)
21 iD(I)iD(L)iS(I)iS(L)
22 S
A2(i1,/*01*/Xt(y(xR))P(y==PLH|y==au,xR)P(xtm|xtM&&ytsS,i1(xy,N(fnd(R(xx),y)))
))
23
Yzc(io(x,gl(y)))Yt(et1(y))YmM(Az=kv(&y);am(y,Ny(i1(x,z))))YA(ear2(xR,y,AP1))
24
I(!ytL&&!ytI,y=N(cI(y)))Nn=yn;P(xtA|xtM,Az=oA;I(ytL,i(n,zq(io(x,yl))))E(i(n,zq
(io(x,yi))))y(z))
25 Az=xtL&&ytL&&yr==1?
y:an(xt,n);Lm=T(&iBI,iHI,III,jLI,IDI,iCI,ISI,iBL,iHL,iIL,jLL,idL,iCL,iSL)[xt-
tB+7*ytL](xV,xn,yV,zV,n);
26 I(m<n,z=z(al(n));T(&jBI,jHI,jII,jBL,jHL,jIL)[xt-tB+3*ytL](xV,xn,yV,zV,n))y-
z?y(z):z)
27 S
A3(i2,/*011*/Cb=ytT|y==PLH|y==au;x=Nz(i1(x,y));P(!b,x(x1(z)))K(".\\"::x,al(z))
))
28 S AX(i8,Ay=*a;P(n==1,i1(x,y))P(n==2,i2(x,y,a[1]))
29 a++;n-
-Cb=ytT|y==PLH|y==au;x=i1(x,y);P(!n,x)P(!x,mrn(n,a);x)P(!b,x(i8(x,a,n)))K(".
\\::x,av(tA,n,a)))
30 L iw(Ax/*0*/,I w,Li)_S4(w,(xb),(xh),(xi),(xl))0
31 V iW(Ax/*0*/,I w,Li,Lv){S4(w,xb=v,xh=v,xi=v,xl=v)}
32 I ina(Ax/*0*/,Nn)_S4(xw,P(n-(B)n,1)i(xn,P(!in(xb,n),0)),
33 P(n-(H)n,1)i(xn,P(!in(xh,n),0)),
34 P(n-(I)n,1)i(xn,P(!in(xi,n),0)),
35 i(xn,P(!in(xl,n),0)))1
36 S A1(qt,x(al(now())))
37 S A1(qar,Ay=oA;Q*e=env;W(*e,Qp=*e++,g=p+si(p,'=');yq(cS(aCm(p,g)));zq(aCz(g+
!-*g)))y=am(y,z);x-au?apl(y,x):y)
38 S
A1(qex,exit(xtz?gl(x):1)
39 S A1(qr,x(ai(xr)))
40 S A1(qjs,XC(Cb[ZP];In=js_eval(xC,xn,b,SZ
b);x(0);aCn(b,n))XA(eac1f(x,qjs))et1(x))
42 S A1(qp,XC(x=str0(x);x(pk(xV)))et1(x))

```

```

43  A2(_1,/*01*/P(!xtt,i1(x,y))
44  Xs(S_O_C_S[])[4]=
{ "", "k", "j", "p", "t", "x", "hex", "err", "argv", "env", "exit", "js", "prng", "sin", "cos"
,"exp", "ln", "r", "pri"};
45
Li=fI(s,ZZ(s),xv);T(&ser,kst,js1,qp,qt,frk,hex,err,qar,qen,qex,qjs,prng,ksin,kc
os,kexp,klog,qr,qpri,ed1)[i<0?ZZ(s):i](y))
46  Ik=xK;P(1<k,k==2&&!xtp?
pj(x,A(y,PLH),2):pj(x,&y,1))Xo(run(x,&y,1))Xr(adv(x,&y,1))Xe(((A1*
(x<<16>>16))(y))
47  Xp(P(xn+k>9,er1(y))Im=xn-1,j=0;Ab8;i(m,b[i])=xA[i+1]==PLH&&!j?
j++,y:_R(xA[i+1]))I l=max(0,1-j);Mc(b+m,&y,8*l);_8(xx,b,m+l))
48  Xq(_1(xx,N(_1(xy,y))))P(1>k,er1(y))Xu(v1[xv](y))Xw(AK(0<xv&&xv<4&&yK==2?
1:ytF?yK:1,AW(xv,aV(tr,1,&y))))et1(y))
49  A3(_2,/*011*/P(!xtt,i2(x,y,z))A a[ ]=
{y,z};Ik=xK;P(2<k,pj(x,a,2))Xo(run(x,a,2))Xv(v2[xv](y,z))Xr(adv(x,a,2))
50  Xw(xv?en2(x,y):AK(zK,AT(tq,a2(y,z))))Xp(P(xn+k>9,er2(y,z))Im=xn-
1,j=0;Ab8;i(m,b[i])=xA[i+1]==PLH&&j<2?a[j++]:_R(xA[i+1]))
51  I l=max(0,2-
j);Mc(b+m,a+j,8*l);_8(xx,b,m+l))Xq(_1(xx,N(_2(xy,y,z))))P(2>k,er2(y,z))Xe(((A2*
(x<<16>>16))(y,z))et2(y,z))
52  AX(_8,Q(n)P(n==1,x1(*a))P(n==2,x2(*a,a[1]))P(!xtt,i8(x,a,n)))
53  Ik=xK;P(n<k,pj(x,a,n))Xo(run(x,a,n))Xv(v8[xv](a,n))Xr(adv(x,a,n))
54  Xp(P(xn+k>9,er8(a,n))Im=xn-1,j=0;Ab8;i(m,b[i])=xA[i+1]==PLH&&j<n?
a[j++]:_R(xA[i+1]))I l=max(0,n-j);Mc(b+m,a+j,8*l);_8(xx,b,m+l))
55  Xq(_1(xx,N(_8(xy,a,n))))P(n>k,er8(a,n))Xw(en8(a,n))Xe(en8(a,n))et8(a,n))
56  A1(jS,cs(jc('.',str(x))))//join symbols with "."
57
A1(val,XS(P(!xn,Ax=oS,y=oA;i(gn,I(gv[i]),xq(as(gk[i])));yq(_R(gv[i]))))am(x,y))va
l(jS(x)))
58  Xs(Li=fI(gk,gn,xv);i<0||!gv[i]?
ev0():_R(gv[i]))XC(x=_str0(x);x(evs(xV)))Xc(evs((V*)&x))XmM(x(_R(xy)))
59  XA(P(!xn,x)P(xn==1,fir(x))P(xn>9,ez1(x))x=mut(x);Ay=_8(xx,&xy,xn-
1);AN(1,x);x(y))
60
Xr(cat(AT(tA,mut(x)),aw+xE))P(c3(tu,xt,tw),ai(xv))P(c3(to,xt,tq),AT(tA,mut(x)))
et1(x))
61  A2(idx,x(i1(x,y)))
62  A2(apl,x(x1(y)))
63
A2(dot,Ym(et2(x,y))Nn=yN;P(!n,y(x))P(n>8,ez2(x,y))y=mRa(Nx(cA(y)));x(y(x8(yA,n
)))
)
64  S_I knd(Ax/*0*/)(Xz(ti)XZ(ti)xt)
65  S_A set(Ax,Li,Ay/*111*/)(Q(xr==1);XA(Az=xa;xa=z(y);ytT&&!ytF?sqz(x):x)
66  XM(Az=kv(&x);z=mut(z);Q(ztA);I(ytT&&yN-
zn,x(el2(y,z)))Ij=i;j:(zn,za=set(mut(za),j,ii(y,i));P(!za,za=au;x(y(z(0))))))y(am
(x,z)))
67  P(knd(x)-knd(y)-tC+tc,set(cA(x),i,y))
68  I(xtZ,N(sup(&x,&y))C w=xw;!w?xb=yv:w==1?xh=yv:w==2?xi=yv:(xl=gl(y));x)
69  AA(am8,Ax=*a,y=a[1];
70  XT(P(y==au,Ab8;Mc(b,a,n*8);b[1]=till(xN);am8(b,n)))
71
Yzc(Li=gl_(y);P(!in(i,xn),ei8(a,n))x=mut(y(x));Ab8;Az=a[2];*b=ii(x,i);Mc(b+1,a+
3,8*n-24);set(x,i,Nx(z(z8(b,n-2))))))
72  I(ytZC&&n==4,Az=a[2],u=a[3];
73  P(xtZ&&ztv&&utzZ&&(0xcf&1<<zv),ara(x,y,z,u))
74  P(xtC&&z==av&&utcC,cC(N(ara(x,y,z,u))))
75  Yt(et8(a,n))
76  fld(AP1,a,n))
77  XM(AB8;i(n,Ax=a[i]);b[i]=xtM?flp(x):x;Q(b[i]))flp(N(eac(AP1,b,n)))
78  Xm(Az=kv(&x),u=fnd(xR,yR);P(!u,mrn(n-1,a+1);x(z(0))))

```

```

79   I(utlL,Q(ur==1);i(uN,I(ul==NL,ul=xN;xq(utt?yR:i(y,i));zq(id(a[2],z)))))
80   Ab8;*b=y(z);b[1]=u;Mc(b+2,a+2,8*n-16);am(x,Nx(am8(b,n))))
81   XF(Q(n>1)x(_8(x,a+1,n-1)))
82   et8(a,n))
83   S A3(am3,am8(A(x,y,z),3))S A4(am4,am8(A(x,y,z,u),4))S A am5(Ax,Ay,Az,Au,A
v)_(am8(A(x,y,z,u,v),5))
84   A3(dm3,Nm=yN;P(y==au|!m,z(z1(y(x)  )))P(m==1,am3(x,fir(y),z
))yR;am4(x,fir(y),prj(DOT,A(PLH,drp(1,y)),2),z))
85
A4(dm4,Nm=yN;P(y==au|!m,z(z2(y(x),u)))P(m==1,am4(x,fir(y),z,u))yR;am5(x,fir(y
),prj(DOT,A(PLH,drp(1,y)),2),z,u))
86   AA(dm8,n==4?dm4(*a,a[1],a[2],a[3]):n==3?dm3(*a,a[1],a[2]):en8(a,n))
87   AA(dmd,Ax=*a;
88   XsS(Iv=v(xts?
x:jS(x));Li=fI(gk,gn,v);I(i<0,gk[i=gn++]=v)A*p=gv+i;I(!*p,*p=au)
89   Ab8;*b=*p;Mc(b+1,a+1,(n-1)*8);*p=au;*p=R(N(dm8(b,n))))
90   I(n==3,XF(try(x,a[1],a[2])))dm8(a,n))
91   SN A evKi(A*p,Qs)_(*p=evs(s);I(!*p,die(s))cns=apd(cns,*p))
92   A evK(A*p,Qs,OA*a,In)_(I(!*p,evKi(p,s))n?_8(*p,a,n):*p)

```

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## x/embed/a.c - ngnksource

### Functions defined

- [add](#)
- [init](#)
- [main](#)

### Source code

```
1 #include<stdio.h>
2 #include"../../k.h"
3
4 K add(K x,K y){
5 printf("add()\n");
6 int a=iK(x);
7 int b=iK(y);
8 int c=a+b;
9 return Ki(c);
10 }
11
12 static void init() __attribute__((constructor));
13 void init() {
14 printf("kinit()\n"); kinit();
15 printf("KR()\n"); KR("add",add,2);
16 }
17
18
19 int main(){
20 setbuf(stdout,0);
21 printf("Kx()\n"); Kx(`0:$add[2;3]');
22 printf("return\n"); return 0;
23 }
```

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## x/embed/ - ngnksource

- [a.c](#)
- [a.py](#)
- [makefile](#)
- [readme.txt](#)

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## **x/ - ngnksource**

- [embed/](#)

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## x/embed/a.py - ngnksource

### Global variables defined

- [K](#)
- [K2f](#)
- [K\\_p](#)
- [k](#)

### Functions defined

- [add](#)
- [main](#)
- [til](#)

### Source code

```
1  #!/usr/bin/env python3
2  # https://gist.github.com/effbiae/8e0710bd689d2abfdc15cc432b0a52ad
3
4  # - a python3 translation of x/embed/a.c
5  # - does not work in python2
6  # $ make libk.so
7  # $ LD_LIBRARY_PATH=. python3 x/embed/a.py
8
9  from ctypes import *
10 k=CDLL('libk.so')
11
12 # declare the function signatures
13 K=c_void_p
14 K_p=POINTER(K)
15 K2f=CFUNCTYPE(K,K,K)
16 iK=k.iK;iK.restype=c_int;iK.argtypes=[K]
17 Ki=k.Ki;Ki.restype=K; Ki.argtypes=[c_int]
18 KR=k.KR;KR.restype=K; KR.argtypes=[c_char_p,K2f,c_int]
19 KC=k.KC;KC.restype=K; KC.argtypes=[c_char_p,c_int]
20 K0=k.K0;K0.restype=K; K0.argtypes=[K_p,c_char_p,K_p,c_int]
21
22 def add(x,y):
23     print("add()")
24     a=iK(x)
25     b=iK(y)
26     c=a+b
27     return Ki(c)
28
29 def til(x):
30     import numpy as np
31     a=np.empty(x,np.int32)
```

```
32  IK=k.IK;IK.argtypes=[np.ctypeslib.ndpointer(np.int32),K]
33  b=(K*1)()      # args array
34  b[0]=Ki(x)
35  r=c_void_p()   # result
36  IK(a,K0(byref(r),b"!:",b,1))
37  return a
38
39 def main():
40     print("kinit()"); k.kinit()
41     print("KR()");    KR(b"add",K2f(add),2)
42     r=c_void_p()
43     print("K0()");   K0(byref(r),b"0:$add[2;3]",None,0)
44     print("til(5)"); print(til(5))
45     print("return"); return 0
46
47 if __name__=='__main__':
48     main()
```

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## x/embed/makefile - ngnksource

```
1  0:a makefile
2      LD_LIBRARY_PATH=.../.. ./a
3  a:../libk.so a.c makefile
4      $(CC) -L.../.. -lk a.c -o a
5
6  liba.so:a.c makefile
7      $(CC) -L.../.. a.c -o liba.so -g -march=native -Dlibc -fPIC -Dshared -
undefined -shared
8
9  ../../libk.so:../../*.c ../../*.h
10     $(MAKE) -C../../ libk.so
```

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## x/embed/readme.txt - ngnksource

```
1 Running make in this directory will build and run an executable which embeds  
the K, interpresster,  
2 installs a function and then calls that installed function.  
3  
4 To dynamically load foreign functions into the K repl, run make liba.so in  
this directory and run  
5 the REPL with LD_PRELOAD set to that library.  
6  
7 Note for linux, you'll also need to make the  
8 symbols in the REPL dynamic so they can be called from the library. Add -  
rdynamic to the end of the  
9 lopts file and rebuild the REPL.  
10  
11 If you're building a target other than the default you'll likely need to  
build a libk-<target>.so  
12 for that target and adjust the makefile accordingly.
```

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## w/http.c - ngnksource

### Global variables defined

- [m](#)

### Data types defined

- [C](#)
- [I](#)
- [UI](#)
- [UL](#)
- [V](#)

### Functions defined

- [ap](#)
- [main](#)
- [r404](#)

### Macros defined

- [I](#)
- [M1](#)
- [M2](#)
- [Mc](#)
- [Q](#)
- [P](#)
- [Q](#)
- [S](#)
- [SC0](#)
- [SR](#)

- SZ
- Sn
- W
- ZZ
- \_
- GNU\_SOURCE
- i
- port
- wr
- wrZ

## Source code

```

1 #define _GNU_SOURCE // ngn/k, (c) 2019-2022 ngn, GNU AGPLv3 -
https://codeberg.org/ngn/k/raw/branch/master/LICENSE
2 #include<stdlib.h> // apt-get install libc6-dev-i386
3 #include<unistd.h>
4 #include<string.h>
5 #include<fcntl.h>
6 #include<errno.h>
7 #include<sys/types.h>
8 #include<sys/socket.h>
9 #include<netinet/in.h>
10 #include<netinet/tcp.h>
11 #define _(a...) {return({a});}
12 #define I(x,a...) if(x){a;}
13 #define P(x,a...) if(x)_ (a)
14 #define W(x,a...) while(x){a;}
15 #define i(x,a...) for(I i=0,n_=(x);i<n_;i++){a;}
16 #define S static
17 #define O const
18 #define SZ sizeof
19 #define ZZ(x) (SZ(x)/SZ*(x))
20 #define Q(x) ({I r_=(x);r_-<0?die(#x):r_;})
21 #define Mc memcpy
22 #define wr write
23 #define wrZ(x,y) wr(x,y,SZ y)
24 #define Sn strlen
25 #define SC0 strchnul
26 #define SR strrchr
27 #define M1(x) #x
28 #define M2(x) M1(x)
29 typedef void V;typedef char C;typedef int I;typedef unsigned UI;typedef
unsigned long long UL;
30 S C*sk(C*s,C c)(W(*s==c,s++)S C*su(C*s,UL
x)(I(x>9,s=su(s,x/10))*s++='0'+x%10;s)
31 S I die(Q C*s)(I e=errno;wrZ(1,"ERR: ");wr(1,s,Sn(s));wrZ(1," ->
");s=strerror(e);wr(1,s,Sn(s));wrZ(1,"\\n");exit(e);0)

```

```

32  s o C*m[ ][2]={{ "html", "text/html"}, {"js", "application/javascript"}, {"css", "text/css"}, {"ogg", "application/ogg"}, {"wasm", "application/wasm"}};
33  s o C*x_(i(ZZ(m),P(!strcmp(x,*m[im[i][1]))(V*0)
34  s v r404(I f){{wrZ(f,"HTTP/1.1 404 Not Found\nContent-
Length:4\nConnection:close\nContent-Type:text/html\n\n404\n");}
35  s v ap(C**p,o C*s){{I n=Sn(s);Mc(*p,s,n);*p+=n;}}
36  s o C*web(I f)_({C b[4096];I r=read(f,b,SZ b-1);P(r<=0,"read
failed")b[r]=0;*SC0(b,10)=0;*SC0(b,13)=0;
37  wr(1,b,Sn(b));wrZ(1," - ");P(strncpy(b, "GET ",4), "not
GET ")C*s=b+4;s=sk(s,32);s+=*s=='/';*SC0(s,32)=0;
38  I(!*s,s="index.html")o C*d=SR(s, '.'),*m=d?mime(d+1):0;I(!m,m="text/plain")
39  I g=open(s,O_RDONLY);P(g<0,"not found")I
n=lseek(g,0,SEEK_END);lseek(g,0,SEEK_SET);s=b;
40  ap(&s, "HTTP/1.1 200 OK\nContent-
Length:");s=su(s,n);ap(&s, "\nConnection:close\nContent-
Type:");ap(&s,m);ap(&s, "\n\n");r=s-b;
41  W(r>0,wr(f,b,r);r=read(g,b,SZ b))close(g);wrZ(1,"ok\n");(V*0)
42  #define port 8080
43  I main(){struct sockaddr_in
a;a.sin_family=AF_INET;a.sin_addr.s_addr=0;a.sin_port=htons(port);
44  I l=Q(socket(AF_INET,SOCK_STREAM,0));
45  Q(setsockopt(l,SOL_SOCKET,SO_REUSEADDR,(I[]{1},4));
46  Q(setsockopt(l,IPPROTO_TCP,TCP_NODELAY,(I[]{1},4));
47  Q(bind(l,(V*)&a,SZ
a));Q(listen(l,64));wrZ(1,"http://127.0.0.1:"M2(port)/\n");
48  W(1,UI n=SZ a;I f=Q(accept(l,(V*)&a,&n));o
C*r=web(f);I(r,wr(1,r,Sn(r));wrZ(1,"\\n");r404(f))close(f))}
```

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## w/ - ngnksource

- [fs.k](#)
- [http.c](#)
- [inl.k](#)
- [k.js](#)
- [x/](#)

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## w/fs.k - ngnksource

### Functions defined

- [e](#)

### Source code

```
1  #!../k
2  /render a given set of files as c string literals for ../0.c
3  e:{$[~^i:`\0\u\u\r\n``\?x;``\`,"0trn``\`i;0x207f'x;"\x",`hex x;x]}
4  `0:,{(.{"p=\\"",x,"\",.n=",(#$a),",.a="}),
("\",'(./`e' '(0,1+&"\n"=a)_a:1:x),'"\"'),,"},,"}'x
```

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## I/runparts.k - ngnksource

### Functions defined

- [k](#)
- [u](#)

### Source code

```
1  #!../k
2  skip:(`I$,`\*x)^ON
3  k:{$[82<#x:`k x;(80#x),".";x]}
4  a@:<`I$-2_`a:(>/"/9"<\*:':)#+"\\\ls" /0:,"."
5  u:{(|6$|$-1000!500+x),"ms"}
6  OK:1
7  t:-`t[]
8  {`1:-2_x;e::,[1::,"o/",-2_x,""];t:-`t[];r:`x(,x,"");t+:+`t[];OK&:ok:e~r
9  `1:$[ok;u[t],"\\n";"\nFAIL\n expected:",k[e],"\\n"
actual:",k[r],"\\n"]}'a^{x,".k"}'\$skip;
10 t+:+`t\[\]
11 `1:"      ",u\[t\],\${#skip;" \(skipped: ",`k\[skip\],"\)";""\],"n";
12 `exit@~OK
```

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## **I/ - ngnksource**

- [fmt.k](#)
- [maths.k](#)
- [runparts.k](#)
- [utf8.k](#)

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## I/fmt.k - ngnksource

### Functions defined

- [cnv](#)
- [dflt](#)
- [e0](#)
- [f](#)
- [filln](#)
- [fills](#)
- [fmt](#)
- [fmti](#)
- [fmts](#)
- [grp](#)
- [grp0](#)
- [init](#)
- [lex](#)
- [lvl](#)
- [m](#)
- [prs](#)
- [prs0](#)
- [r](#)
- [rl](#)
- [sign](#)
- [sp](#)
- [spl](#)

### Source code

```

1  \d fmt
2  cls:@[&256;cls::;1+!#c:( "0"+!10;" ." ;"<>="^";"+- ";"_,";"bcdeEfFgGnosxX%")]
3  CLS:`other`digit`dot`align`sign`group`type@cls@
4  spec:`chr`align`sign`digit`group`dot`digit`type
5  mtch:`fill`align`sign`width`group`dot`prec`type
6  lex:{s:((p:1-cls@*x)#+,<>),(&~=':1=cls@x)_x;p_`|,/((#s)#'ON 2#
7  ((,/:,;,CLS;{`digit}))@'\:;s}
8
9  init:{$[`align~x[0;1];((0 1;2#*|x);2_`x);(((();"");x)]}
10 prs0:{{(a;cs):x;$[(spec@y)~cs[0;0];(a,'(y;-1#*`cs);1_`cs);x]}/{i;
11 (#**i:_init@x)_!#spec}}
12 prs:{$[#**|r:prs0@lex@x;`err@"prs: ",`k@r;>/`dot`digit=spec@s@0 1+(s:**r)?
13 `dot;`err@"prs";(mtch@**r)!*|*r]}
14
15 DFLT:`fill`align`sign`width`type!(" <-0s")
16 dflt:{x[`aligndef]:^(!x)?`align
17   x[f@w]:(.DFLT)@w:&^(!x)?f:!DFLT
18   x[f]:*`x[f]:`fill`align`sign`group`dot`type`prec]
19   x[f]:..`x[f]:`prec];
20   x}
21
22 D: `c$"0"+!10
23 fills:{(f;a;l):x;@[(l|#y)#f;(!#y)+-2!0|(l-#y)*<^>?a;:;y]}
24 filln:{(f;l):x;(c#y),fills[(f;">";l-c)]}(c:^D?*y)_y
25 sign:{r;z;s:ON 2#"+- ";$[~x~-";$[~x~";s[^x;y],r;((";"-")y),r]}
26 grp0:{r;z,(c:(-y)!#1_z)#x;r@<<@[&#r;(#r)-(y+1)*1+!c;:;1]}
27 grp:{(c#z),grp0[x;y]@(c:^D?*z)_z}
28
29 A: `c$, /("0"+!10;"A"+!6)
30 cnv:{_A@(2 8 10 16@2^"bodx"?x)\y}
31
32 fmti:{r:sign[x`sign; y<0;cnv[x`type]{x|-x}y]
33   r:$[`group;r;grp[x`group;4-^"box"?x`type;r]]
34   (f;a):$["0"~*x`width;"0=";(x`fill),">"]
35   a:$[x`aligndef;a;x`align]
36   $[ "="~a;:filln[f,.x`width]r;fills[(f,a),.x`width]r]}
37 fmts:{fills[(x`fill`align),.x`width;y]}
38 fmt:{f:$[`c~_t:@y;fmts;`i~t;fmti;:`err@"nyi"];f[dflt@prs@x;y]}
39
40 e0:{$[`c~@*x;x;`k x]}:
41 /e1:e0@.:
42 r:{<\~^"\{}"?x}_
43 lvl:{s:+\((0 -1 1 0@&'b)@g:<, /b:4#x;s@&(#s)#1 0}
44 m:{$[*|r:lvl@b:&'"{}"=:\x;`err@"mismatched";];!/+(@/1<:@,/b)ON 2#,/.=r}
45 rl:{op^:op@&|':(~^?/1(-1+)\d@op)&(~^?/1(1+)\op:@/1<:@!\d@m x);(op;\d@op)}
46 sp:{1_(,/_0,(@/1<:@,/r)@&~lvl@r:rl x)_x}
47 spl:{${|/^c:0,*|"=x;:.x;};(v;f):(-1 1*~:@":<~
48 (*|:;@[,1])@'sp)_`sp:c_x;fmt[f;.v]}
49
50 e:e0@spl@
51 f:{p:sp@x; ,/((#p)##(r;e))@'p}@" "
52 \d .
53
54 f" {245+352346:~^25x}"
55 fmt[".> 25,";-234234]
56 \

```

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## w/x/tetris.k - ngnksource

### Functions defined

- [c](#)
- [d](#)
- [draw](#)
- [f](#)
- [i](#)
- [kd](#)
- [q](#)
- [w](#)

### Source code

```
1 A:( #####|##|###|## |###| ##|###"
2 " |##| # | ##|# |##| #
3 T:& '3(|+:)'(| '/')#'+#"=" | \'A /tетrominos by type and rotation
4 C: `cyan`yellow`magenta`green`blue`red`orange /colours by piece type
5 a:20 10#0 /grid (boolean matrix without the falling piece)
6 g:0N?#T /randomized bag of 0..6
7 s:0 /score
8
9 /falling piece (p:position,t:type,r:rotation)
10 i:{$[f[3 0;*g;3];;tick::(::)];g::1_g;$[g;;g::0N?#T];0} /init piece
11 f:{$[*/~a ./:+|x+T[y]z /try to set position,type,rotation
12 [p::x;t::y;r::z;1];0]} /return 1 for success, 0 for collision
13 d:{$[f[p+0 1;t;r];;1;] /try to move it down. if successful, return 1
14 a::a .[;;;;1]/+|p+T[t]r /freeze fallen blocks
15 n:+/m:*'a /number of and mask of completed lines
16 a::(0*n#a),a@&~m /clear completed lines, replenish with empty
17 s+:-1+*/n#2 /update score
18 i[] /respawn
19 tick:d /periodically call d[]
20
21 /rendering
22 b:0.9*B:1%#a /block size
23 c:{"g.fillStyle='',(x),'';"} /set colour
24 q:{"g.fillRect(",(,"/$(B*x),2#b),");"} /draw a square(block)
25 w:{"g.fillText(",(,"/(`k[x]),$y),");"} /write text
26 draw:{`js@, //("g.clearRect(0,0,1,1);"
27     c` "#80808020";g'+|&1|a /semi-transparent grid background
28     c t;g'+p+T[t]r /draw falling piece
29     c`white;g'+|&a /draw stationary blocks
30     w["score:",$s;1%2 16] /draw score
31     [$tick;c C@*g;g'+(2+##a;4)+T[*g]3 /shadow piece..
32         w["game over";1%2 2]]}) /..or "game over"
```

```
33
34 /key down event handler
35 kd:{$[32=x;(::)d/1      /space(drop)
36     37=x;f[p-1 0;t;r] /left
37     38=x;f[p;t;4!1+r] /up(rotate)
38     39=x;f[p+1 0;t;r] /right
39     40=x;d[]]}        /down
40
41 i[];
42 `js"tickPeriod=500";      /tick[] will be called every half second
43 `js"hgr()";              /enter graphics mode
44
45 /for a similar language with more advanced graphics capabilities see:
46 / https://johnearnest.github.io/ok/ike/ike.html
```

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## w/x/ - ngnksource

- [fractals.k](#)
- [tetris.k](#)

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## w/x/fractals.k - ngnksource

### Functions defined

- [brl](#)
- [crv](#)
- [u8](#)

### Source code

```
1  crv:{.{[x;y;z;;;1]}/[(1+/'x)#0]. x-:&/'x}@+\` /curve as (dxs;dys) -> bool
matrix
2  brl:{,/['u8''10240++/''0N 2#/:+/'0N 4#x*(#x)#(#*x)#{(1 8;2 16;4 32;64 128)}
/bool matrix -> braille
3  u8:{`c$(0x00c0e0f0[c],c#128)+(0,64+&c:1+128 2048 65536'x)\x} /utf8 encode
4  f:`0:brl@ /display
5
6  f@~=\\&64                                /sierpinski triangle
7  f@*//*/:'/2#,~1!=4#3                  /cantor dust
8  f@crv 11{x,'| '|-1 1*x}/!2            /dragon curve
9  f@6{+2(x,(,~!#*x),|:')/x}/1          /peano curve
10 f@5{b,'1_ '|'b:,:/(|+x,0;,a,0;x,'a:~!#x)}/1 /hilbert curve
11 f@n{((|(8#2)\30)@2/+3':0,x,0}\n=!2*n:32   /rule30
12 f@1>n#+/*/2#,12((/3*-0.5 -0.7+(!n)%n:2#64)+{(-/x*x;2*/x})@)/0 /mandelbrot
set
```

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## dy/a.k - ngnksource

### Functions defined

- [p132](#)
- [p134](#)
- [p136](#)
- [p137](#)
- [p138](#)
- [p139](#)
- [p141](#)
- [p142](#)
- [p143](#)
- [p146](#)
- [p153](#)
- [p154](#)
- [p155](#)
- [p158](#)
- [p159](#)
- [p15X](#)
- [p161](#)
- [p162](#)
- [p163](#)
- [p164](#)
- [p166](#)
- [p168](#)
- [p169](#)

- [p172](#)
- [p174](#)
- [p175](#)
- [p176](#)
- [p17X](#)
- [p182](#)
- [p183](#)
- [p184](#)
- [p185](#)
- [p186](#)
- [p187](#)
- [p189](#)
- [p191](#)
- [p193](#)
- [p197](#)
- [p198](#)
- [p199](#)
- [p19X](#)
- [p201](#)
- [p202](#)
- [p204](#)
- [p205](#)
- [p206](#)
- [p207](#)
- [p211](#)
- [p213](#)
- [p214](#)

- [p215](#)
- [p216](#)
- [p217](#)
- [p21X](#)
- [rot](#)
- [t](#)

## Source code

```

1  #!../k
2  / https://github.com/xpqz/dyalog
3  pi:3.14159265359;AZ: `c$"A"+!26
4
5  p131:-1+1_2*!1+                                /
https://problems.tryapl.org/psets/2013.html?goto=P1_Seems_a_Bit_Odd_To_Me
6  p132:{100*(+/x>64)%#x}                      /
https://problems.tryapl.org/psets/2013.html?goto=P2_Making_The_Grade
7  p133:+/1<':^:                                /
https://problems.tryapl.org/psets/2013.html?goto=P3_What_Is_In_a_Word
8  p134:{~(*|0,x)|/0>x:+\-/()"=\:x}           /
https://problems.tryapl.org/psets/2013.html?goto=P4_Keeping_Things_In_Balance
9  p135:=                                         /
https://problems.tryapl.org/psets/2013.html?goto=P5_Identity_Crisis
10 p136:{x[0]-*|x@:>x:(!0),/x}                  /
https://problems.tryapl.org/psets/2013.html?goto=P6_Home_On_The_Range
11 p137:{x=_x}_                                     /
https://problems.tryapl.org/psets/2013.html?goto=P7_Float_Your_Boat
12 p138:{x*/:x:1+!x}                            /
https://problems.tryapl.org/psets/2013.html?goto=P8_Go_Forth_And_Multiply
13 p139:{(+/'x':y)%x}                           /
https://problems.tryapl.org/psets/2013.html?goto=P9_It_Is_a_Moving_Experience
14
15 p141:{~-/*/2#,|x,y,z}                         /
https://problems.tryapl.org/psets/2014.html?goto=P1_It_Is_All_Right
16 p142:{(2(|/|':)/"0">x)|^"aeiou"?_x}#       /
https://problems.tryapl.org/psets/2014.html?goto=P2_How_Tweet_It_Is_(via
@chrisspn, @coltim)
17 p143:1_*+(/+\)\[;!]2]@                        /
https://problems.tryapl.org/psets/2014.html?goto=P3_Tell_a_Fib
18 p143:{-1_*+/x(/+)\)\1_1}                      /
https://problems.tryapl.org/psets/2014.html?goto=P3_Tell_a_Fib
19 p144:" "/(~#:')_"\                                /
https://problems.tryapl.org/psets/2014.html?goto=P4_Space_The_Final_Frontier
20 p145:1=#/: \(~"a{''})#:_                      /
https://problems.tryapl.org/psets/2014.html?goto=P5_Mirror_Mirror
21 p146:{+(!x;.x)}@#=+=/1+!(),                 /
https://problems.tryapl.org/psets/2014.html?goto=P6_Roll_The_Dice
22 p147:%/(*|(*:)(/!\)/,,)\,                   /
https://problems.tryapl.org/psets/2014.html?goto=P7_Revolutionary_Thinking
23 p148:%+/*/2#, -/                               /
https://problems.tryapl.org/psets/2014.html?goto=P8_Go_The_Distance
24 /p149:{(x*x*`sin@2*y*pi%180)%9.8}          /
https://problems.tryapl.org/psets/2014.html?goto=P9_Going_Ballistic

```

```

25 p14X:100*|/1_-1%': /
https://problems.tryapl.org/psets/2014.html?goto=P10_Sales_Are_Up
26
27 p151:~/{{x@<x^:x^_AZ}'_:_ / 
https://problems.tryapl.org/psets/2015.html?goto=P1_Nag_A_Ram
28 p152:|/{y*x+y}\>':(:!0), / 
https://problems.tryapl.org/psets/2015.html?goto=P2_Longest_Streak (via
@coltim)
29 p153:{?(,!2),x@*'<=%/'x}1_+&+|\=1+ / 
https://problems.tryapl.org/psets/2015.html?goto=P3_Farey_Tale (via @coltim)
30 p154:{((#x)#<y)?(#y)#<x} / 
https://problems.tryapl.org/psets/2015.html?goto=P4_PDI_Progressive_Dyadic_Iota
31 p155:{%(x y*y)-a*a:x y}{(+/x)%#x} / 
https://problems.tryapl.org/psets/2015.html?
goto=P5_Hes_so_mean_he_has_no_standard_deviation
32 p156:&/~-/2#+-2!<'+,/ / 
https://problems.tryapl.org/psets/2015.html?goto=P6_Hey_This_is_My_Space (via
@ngn)
33 p157:~^?/_|: / 
https://problems.tryapl.org/psets/2015.html?goto=P7_Just_In_Upper_Case
34 p158:{@[x;&13=x;::;12.99]} / 
https://problems.tryapl.org/psets/2015.html?goto=P8_Unlucky_13
35 p159:{(x@0,(,/-'ON 2#1+-2+#x),-1+#x)^" " } / 
https://problems.tryapl.org/psets/2015.html?
goto=P9_Id_Like_Mine_Scrambled_Please
36
37 p15X:{(--2!x+|/x:#'x)$x:`k'x(+':|0,)`1} / 
https://problems.tryapl.org/psets/2015.html?goto=P10_Blaiseing_a_Trail (via
@ngn)
38
39 p161:{(+/x)%#x} / 
https://problems.tryapl.org/psets/2016.html?goto=P1_Statistics_Mean
40 p162:{{{(+/x)%#x}x[<x]@-2!{#x}-!2} / 
https://problems.tryapl.org/psets/2016.html?goto=P2_Statistics_Median (via
@coltim)
41 p163:{&x=|/x:#'=x} / 
https://problems.tryapl.org/psets/2016.html?goto=P3_Statistics_Mode
42 p164:{(,/x)@<,/(#!)'x} / 
https://problems.tryapl.org/psets/2016.html?goto=P4_Just_Meshing_Around
43 p165:&1=#': / 
https://problems.tryapl.org/psets/2016.html?
goto=P5_Youre_Unique_Just_Like_Everyone_Else
44 p166:{#'x} / 
https://problems.tryapl.org/psets/2016.html?goto=P6_Shorter_ones_to_the_Front
45 p167:(|/~3 5!`:)# / 
https://problems.tryapl.org/psets/2016.html?goto=P7_3s_and_5s (via @traws)
46 p168:{.|x@=x<0} / 
https://problems.tryapl.org/psets/2016.html?goto=P8_Separating_Out_the_Negative
(@coltim)
47 p169:{x\y} / 
https://problems.tryapl.org/psets/2016.html?goto=P9_Delimited_Text
48 p16X:+/*/ / 
https://problems.tryapl.org/psets/2016.html?goto=P10_Order_Total_Dot_Product
49
50 p171:1+2*!: / 
https://problems.tryapl.org/psets/2017.html?goto=P1_What_an_Odd_Bunch (via
@razetime)
51 p172:{x+2!x} / 
https://problems.tryapl.org/psets/2017.html?goto=P2_Good_Evening
52 p173:"\""/{2#!#x}_"\""\ / 
https://problems.tryapl.org/psets/2017.html?goto=P3_Miss_Quoted (@coltim)

```

```

53  p174:{x*y*y*pi%1440}           /
https://problems.tryapl.org/psets/2017.html?goto=P4\_Slices\_of\_Pies
54  p175:{~#x^"ACGT"}              /
https://problems.tryapl.org/psets/2017.html?goto=P5\_DNA
55  p176:{?x':y}                  /
https://problems.tryapl.org/psets/2017.html?goto=P6\_k\_mers
56  p177:+/'"ACGT"=:\             /
https://problems.tryapl.org/psets/2017.html?goto=P7\_Counting\_DNA\_Nucleotides
57  p178:>':|\\1=                /
https://problems.tryapl.org/psets/2017.html?goto=P8\_Be\_the\_First\_1\_\(via@chrispsn\)
58  p179:/:| "",                 /
https://problems.tryapl.org/psets/2017.html?goto=P9\_Double\_Trouble\_\(via@coltim\)
59  p17X:{x@s#!*/s:2#-_-%#x}    /
https://problems.tryapl.org/psets/2017.html?goto=P10\_Squaring\_Off\_\(via@traws\)
60
61  signsC:`Monkey`Rooster`Dog`Pig`Rat`Ox`Tiger`Rabbit`Dragon`Snake`Horse`Goat
62  cutoffs:+(1+!12;20 19 21 20 21 21 23 23 10 23 22 22)
63
signsW:`~Capricorn`Aquarius`Pisces`Aries`Taurus`Gemini`Cancer`Leo`Virgo`Libra`Scorpio`Sagittarius`Capricorn
64  p181:#?|\ \
https://problems.tryapl.org/psets/2018.html?goto=P1\_Oh\_Say\_Can\_You\_See
65  p182:{(f;x-f:_x)}           /
https://problems.tryapl.org/psets/2018.html?goto=P2\_Number\_Splitting
66  p183:{"/'+($'!m;.x#"*)'m:#'=+/1+!(),x)}   /
https://problems.tryapl.org/psets/2018.html?goto=P3\_Rolling\_Along
67  p184:{signsC@12!x+0>x}      /
https://problems.tryapl.org/psets/2018.html?goto=P4\_Whats\_Your\_Sign
68  p185:{signsW(x@<x:cutoffs,,x)?x}          /
https://problems.tryapl.org/psets/2018.html?goto=P5\_Whats\_Your\_Sign\_Revisited
69  p186:{(~*|x)&&/~0>x:+\0^1 -1"<>"?x}   /
https://problems.tryapl.org/psets/2018.html?goto=P6\_Whats\_Your\_Angle
70  p187:{0^y(-x)+!#y}           /
https://problems.tryapl.org/psets/2018.html?goto=P7\_Unconditionally\_Shifty
71 /p8: very APL-specific; skipping   /
https://problems.tryapl.org/psets/2018.html?goto=P8\_Making\_a\_Good\_Argument
72  p189:{*(-/0<:-\(-x)^0),0}       /
https://problems.tryapl.org/psets/2018.html?goto=P9\_Earlier\_Later\_or\_the\_Same
73  p18X:~/{=x@<x^:" "}'          /
https://problems.tryapl.org/psets/2018.html?goto=P10\_Anagrammatically\_Correct
74
75  p191:{(0N,x)#y}               /
https://problems.tryapl.org/psets/2019.html?goto=P1\_Chunky\_Monkey
76  p192:"FDCBA"@0 65 70 80 90'   /
@coltim, @chrispsn\)
77  p193:{+(!x;.x;0.1*_0.5+1e3*.x%+/x)}0^"ABCDF"##'=:= / 
@coltim, @chrispsn\)
78  p194:(&/'0<#(+,/|:\\2 1*1 -1@!2 2)+:\\           /
https://problems.tryapl.org/psets/2019.html?goto=P4\_Knight\_Moves
79  p195:(|/':":",)'           /
https://problems.tryapl.org/psets/2019.html?goto=P5\_Doubling\_Up
80  p196:10!((/,/$!10),"AAADGJMPTW")'           /
https://problems.tryapl.org/psets/2019.html?goto=P6\_Telephone\_Names
81  p197:{?{x$"";-2!x-:#y;y}}[x] '(x&'#y)#'y}   /
https://problems.tryapl.org/psets/2019.html?goto=P7\_In\_the\_Center\_of\_It\_All
82  p198:{+/%+/'x*x:(*|x)-':x}           /
@chrispsn\)

```

```

@coltim)
83  rot:{@[x;(2!)-#x;|:]} /flip pairs at odd indices
84  p199:{x|-x:0.5*-/-\+/\rot 1_*':\rot x,,*x} /
https://problems.tryapl.org/psets/2019.html?goto=P9_Area_Code_a_la_Gauss
85  p19X:{(#;_)[,;2!#:';x]} /
https://problems.tryapl.org/psets/2019.html?goto=P10_Odd_and_Evens (via
@coltim)
86
87  p201:{$[x<0;o[x+#y;y];(x;x-#y)#\:y]} /
https://problems.tryapl.org/psets/2020.html?goto=P1_Lets_Split
88  p202:{(&-2=-64!x)_x} /
https://problems.tryapl.org/psets/2020.html?goto=P2_Characters
89  p203:26/1+AZ? /
https://problems.tryapl.org/psets/2020.html?goto=P3_Columns
90  p204:{x|y<z}.~400 100 4!\: / https://problems.tryapl.org/psets/2020.html?goto=P4_Take_a_Leap
91  p205:{(x<y)|:/((x-!x-y),x&y)} /
https://problems.tryapl.org/psets/2020.html?goto=P5_Integer_Range (-4 via
@bubbler)
92  p206:{,/(#;_)[,;x=;y]} /
https://problems.tryapl.org/psets/2020.html?goto=P6_Move_To_Front
93  p207:{|/&((#2\|/x)#2)\'x} /
https://problems.tryapl.org/psets/2020.html?goto=P7_Bits
94  p208:*/0>1_*':1_-':10\ /
https://problems.tryapl.org/psets/2020.html?goto=P8_Zigzag
95  p209:&/{x~*\x=:|\x}'|:\ /
https://problems.tryapl.org/psets/2020.html?goto=P9_Rise_and_Fall
96  p20X:`k /very APL-specific /
https://problems.tryapl.org/psets/2020.html?goto=P10_Stacking_It_Up
97
98  p211:{100*(+/|"GC"=\:x)%#x} /
https://problems.tryapl.org/psets/2021.html?goto=P11
99  p212:?
https://problems.tryapl.org/psets/2021.html?goto=P12
100 p213:{y@&'~x!\:y} /
https://problems.tryapl.org/psets/2021.html?goto=P13
101 p214:{x*x*(pi-2)%4} /
https://problems.tryapl.org/psets/2021.html?goto=P14
102 p215:{a,_x%a:![,;x](-1+)/_~x} /
https://problems.tryapl.org/psets/2021.html?goto=P15
103 p216:{(2!+/x"B")>(<,/(x:=x)"KR")1} /
https://problems.tryapl.org/psets/2021.html?goto=P16
104 p217:{1=#=+/`x,(+x),(/`x*/:(\i;|\i:=#x))^`\:0} /
https://problems.tryapl.org/psets/2021.html?goto=P17
105 p218:|/-\/-0 24 60'/-3#'(‐3),/: /
https://problems.tryapl.org/psets/2021.html?goto=P18
106 p219:|/#'{(&‐=:x)_x}@1_-/-0<‐:‐: /
https://problems.tryapl.org/psets/2021.html?goto=P19
107 p21X:{(‐x)$y} /
https://problems.tryapl.org/psets/2021.html?goto=P110
108
109
110 t:{[g;f;a;e] `1:‐k$[g[e;r:f a];.;(`fail;f;g;a;e;r)]} /assert
111 M:t[~];A:t{1e-6>x|-x-:y};D:t{‐/_1000000*(x;y)} /A:approx equal,D:approx
float deep-match
112
113 M[p131].'((10;1 3 5 7 9 11 13 15 17 19);(1;,1);(0;!0));
114 M[p132].'((25 90 100 64 65;60.0);(,50;0.0);(80 90 100;100.0)); /Dyalog
wants 100% instead of On, but that makes no sense
115 M[-2#$p132@;!0;"On"]; /Dyalog wants 100% instead of On, but that makes no
sense

```

```

116 M[p133].('("Testing one, two, three";4);("")';0);(" this vector has extra
blanks ";5));
117 M[p134].('(("((2×3)+4";1);("")';1);("hello world!";1);(")(2×3)+4";0);(
());0);("")';0));
118 /skipping p135, as =: is a primitive k function
119 M[p136].('((19 -3 7.6 22;25.0);,(101;0);((10 20 30;40 50 60);50);(!0;0));
120 M[p137].('((14.2 9 -3 3.1 0 -1.1;14.2 3.1 -1.1);(1 3 5;!0);
(3.1415;,3.1415));
121 M[p138].('((5;5 5#1 2 3 4 5 2 4 6 8 10 3 6 9 12 15 4 8 12 16 20 5 10 15 20
25);(1;+1);(0;0 #0));
122 sa:200 300 2700 3400 100 2000 400 2100 3500 3000 4700 4300.0 /sales
123 M[p139 .].('((2;sa);250 1500 3050 1750 1050 1200 1250 2800 3250 3850
4500.0);((10;sa);1770 2220 2620.0);((1;sa);sa));
124 M[p141 .].('((3 4 5;1);(2 3 4;0));
125 M[p142].('("if you can read this, it worked!";"if yu cn rd ths, it
wrkd!");("APL is REALLY cool";"APL is RLLY cl"));
126 M[p142];,"a";,"a"] /dyalog wants it to work on raw scalars
127 M[p143].('((10;1 1 2 3 5 8 13 21 34 55);(1;,1);(0;!0));
128 M[p144].('(" this is a test ";"this is a test");("";");("hello
world!";"hello world!");("";""));
129 M[p145].('("a man, a plan, a canal, panama!";1);("")';1);("a";1);("APL";0));
130 M[p146].('((6 6;11 2#2 1 3 2 4 3 5 4 6 5 7 6 8 5 9 4 10 3 11 2 12 1);(6 4;9
2#2 1 3 2 4 3 5 4 6 4 7 4 8 3 9 2 10 1)
131 (3;3 2#1 1 2 1 3 1));
132 M[p147 .].('((10 10;1.0);(10 5;2.0);(5 7;5.0));
133 M[p148].('((2 5;3.0);((2 2;5 6);5.0);(!0;0.0);((2 2 3 4;3 7 10 9);10.0));
134 /A[p149[100];45;1020.408163];A[p149[0];45;0];A[p149[100];90;0.0]
135 A[p14X].('((80 100 120 140;25);(3#123;0);(101 102 114 117 101 110 102 111
118 115 124 122;11.76470588);(200 180 160 140 120;-10));
136 M[p151].('(((anagram";"Nag A Ram");1);(("Dyalog APL";"Dog Pay All");1);
(("";"#!");1);(("abcde";"zyxwvu");0));
137 M[p152].('((1+!9;8);(1;0);(9-!6;0);(1 5 3 4 2 6 7 8;3));
138 M[p153].('((0;,0 1);(1;(0 1;1 1));(5;(0 1;1 5;1 4;1 3;2 5;1 2;3 5;2 3;3 4;4
5;1 1)));
139 M[p154 .].('(((DYALOG APL";"AAALLLB");2 7 ON 3 9 ON ON);
(("";"test");4#0N);(("test";!0);!0));
140 A[p155].('((1+!5;1.414213562);(10 10#1+!100;28.86607005));
141 M[p156].('((((1 1;5 5);(3 3;7 7));1);((((1 1;5 5);(5 5;1 1));1);(((1 1;3 3);
(4 4;7 7));0);(((1.1 1.1;5.5 5.5);(3.3 3.3;4.4 4.4));1));
142 M[p157].('($`dyalog`APL;001100b);($`bramley`HAMPSHIRE;0111010b));
143 M[p158].('((,13;,12.99);(10+!5;(10;11;12;12.99;14));(13 130 13.13 1300;
(12.99;130.0;13.13;1300.0)));
144 M[p159].'$(`argument`agrmunet;`this`tihs;`is`is;`awesome`aewosome);
145 M[p15X;10]("                                1"
146 "                                1 1"
147 "                                1 2 1"
148 "                                1 3 3 1"
149 "                                1 4 6 4 1"
150 "                                1 5 10 10 5 1"
151 "                                1 6 15 20 15 6 1"
152 "                                1 7 21 35 35 21 7 1"
153 "                                1 8 28 56 70 56 28 8 1"
154 "                                1 9 36 84 126 126 84 36 9 1"
155 "                                1 10 45 120 210 252 210 120 45 10 1")
156 A[p161].('((1+!6;3.5);17 17;(5 3#1+!15;7 8 9.0));
157 A[p161].('(!0;0n); /dyalog wants 0 instead of 0n, which makes no sense
158 M[p162].('((1+!9;5.0);(1 8 2 7 3 6 4 5;4.5);(!0;0.0);(,7;7.0));
159 M[p163].('((2 1 4 3 2 5 1 2;,2);(!0;,!0);(1 2 3 4 1 2;1 2)); /result ,!0 is
dubious
160
M[p164].'($(`MENS`EKES;`MEEKNESS);$(`Dyalog`APL;`DAyPaLlog);$(`APL`Dyalog;`ADPy

```

```

Lalog)
161  ((1 3 5 7;2 4 6 8);1 2 3 4 5 6 7 8);$(`Hello;`Hello));
162  M[p165].'((1+!5;1+!5);(1 2 3 4 5 4 3 2 1;,5);("hello world";"he wrd"));
163  M[p166].'($(`one`two`three`four`five`six;`one`two`six`four`five`three);((2
4 3;4 5;,1;7 3);,(1;4 5;7 3;2 4 3));(!0;!0)
164  (("one";,2;"three";," ";"four";5 6 7 8);,(2;," ";"one";"four";5 6 7
8;"three"))); /fudge; soln incorrect for empty vectors
165  M[p167].'((1+!10;3 5 6 9 10);(!0;!0));
166  M[p168].'((0 1 -2 3 -4 -5 6 7 8 -9 10;(-2 -4 -5 -9;0 1 3 6 7 8 10))
167      (1 2 3 4 5;,1 2 3 4 5) /this isn't the behaviour Dyalog wants,
but unsure how that maps to k's array model
168      (!0;())); /same here
169  /skipping p169 as split is a built-in k verb
170  A[p16X].'(((5 0 2;2.99 4.99 1.99);18.93);((&3;2.99 4.99 1.99);0));
171  M[p171].'((5;1 3 5 7 9);(1;,1);(0;!0));
172  M[p172].'((1 2 3 4 5;2 2 4 4 6);(!0;!0);(4 4#1+!16;(2 2 4 4;6 6 8 8;10 10
12 12;14 14 16 16)));
173  M[p173].'(("this \"is\" a test";"this \"\" a test");("this is a
test";"this is a test")
174      ("this \"is\" a \"test\"";"this \"\" a \"\"");(""; ""));
175  A[p174 .].'((60 12;18.84955592);(0 12;0);(60 0;0);((60;9 12
15);10.60287521 18.84955592 29.45243113)
176  ((60 90 120;12);18.84955592 28.27433388 37.69911184);((60 90 120;9 12
15);10.60287521 28.27433388 58.90486225));
177  M[p175].'(("ATGCTTCAGAAAGGTCTTACG";1);("Dyalog";0);("";1);(, "T";1));
178  M[p176]
.].'(((4;"ATCGAAGGTCGT");$`ATCG`TCGA`CGAA`GAAG`AAGG`AGGT`GGTC`GTCG`TCGT);
((4;"AC"));());
179  M[p177].'(("AGCTTTCAATTCTGACTGCTGTCTTAAAAAAAGAGTGTCTGATAGCAG";14 8 10
17);("CCAAATGGGG";3 2 4 1);("";&4);(, "G";0010b));
180  M[p178].'((0101001b;0100000b);(!0;!0);(0000b;0000b));
181  M[p179].'(("bookkeeper";0101010000b);(""; "");("aaaaaa";111110b);("d";,0));
/" as result arguably dogdy?
182  M[p17X].'((1 2 3 4;2 2#1 2 3 4);(1 2 3 4 5;3 3#1 2 3 4 5 ON ON ON ON);
("Dyalog APL";4 4#"Dyalog APL
"));
183  M[p181].'((5 5 2 10 3 15 10;3);(|5 5 2 10 3 15 10;2);(!0;0);(,10;1));
184  A[p182].'((1.234;1 0.234);(12;12 0);(0;0 0));
185  M[p183].'((6 6;"|"\2 *|3 **|4 ***|5 *****|6 *****|7 *****|8 *****|9
****|10 ****|11 ***|12 *)
186  (6;"|"\1 *|2 *|3 *|4 *|5 *|6 *)
187  (5 3 4;"|"\3 *|4 ***|5 *****|6 *****|7 *****|8 *****|9
*****|10 *****|11 ***|12 *)
188  (0;())); /Dyalog expects ("0 *) which is dubious
189  M[p184].'((2018,`Dog;1564,`Rat;-551,`Dog);
190  M[p185].'((2 23;`Pisces);(10 31;`Scorpio));
191  M[p186].'(("<name><first>Drake</first><last>Mallard</last></name>";1);(""
<math><relation>2<3</relation></math>";0)
192      ("";0);(">stuff</>/stuff<";0)); /dyalog wants 1 for input "" --
not sure
193  M[p187 .].'(((3;10111011b),00010111b);((-3;10111011b),11011000b));
194  /skipping p188
195  M[p189].'(((ts;2018 4 1 16 45 12 800);-1);((ts;2018 4 1 12 34 56 789);0));
((ts;2018 4 1 12 34 56 789;2017 4 1 12 34 56 789);1));
196  M[p18X].'(((("ALBERT EINSTEIN";"TEN ELITE BRAINS");1);(, "", "");1);
((,"d";,"d");1);($`mesas`seam;0);($`apple`lapel;0));
197  M[p191 .].'(((3;1+!9);(1 2 3;4 5 6;7 8 9));((3;1+!11);(1 2 3;4 5 6;7 8
9;10 11));((10;"Dyalog"));,"Dyalog")
198  ((2;$`the`cat`in`the`hat`sat`pat);$(`the`cat;`in`the;`hat`sat;`pat))
199  (4 5;+5)); /dyalog expects ,5 but this seems inconsistent, as every other
example returns vector of vectors

```

```

200 M[p192].'((0 64 65 69 70 79 80 89 90 100;"FFDDCCBAA");(!0;"");(2 3#71 82
81 82 84 59;$`CBB`BBF));
201 /floating point CT is too annoying at depth
202 tmp:+p193@{9 3 8 4 7}#"DABFC";M[::;tmp@0;"ABCDF"];M[::;tmp@1;3 8 7 9
4];A[::;tmp@2;9.7 25.8 22.6 29.0 12.9]
203 M[p194].'((5 4;(7 5;7 3;3 5;3 3;6 6;4 6;6 2;4 2));(1 1;(3 2;2 3)));
204 M[p195].'((($`I`feed`the`bookkeeper;0101b);("I";,0);("feed";,1);
($`MY`LLAMAS`HAVE`BEEN`GOOD;01011b));
205 M[p196].'(("IAMYY4U";4 2 6 9 9 4 8);("")!0);("UR2CUTE";8 7 2 2 8 8 3));
206 M[p197 .;10,,,$`APL`Problem`Solving`Competition;(" APL      ";" Problem
";" Solving ";"Competitio")]
207 A[p198].'(((1 -1;1 3);8);((1 1;1 2;2 2;2 1);4);(5 5;0);((1 1;3
3);5.656854249));
208 A[p199].'(((2 4;3 -8;1 2);7);(,1 1;0);((1 1;2 2);0));
209 M[p19X].'((($`the`plan`is`great;$(`the`great;`plan`is));($`all`odd;
($`all`odd;()));($`only`even`here;();$`only`even`here)));
210 M[p201 .].'(((9;"SplittingHairs");$`Splitting`Hairs);
((-3;"DyalogAPL");$`Dyalog`APL);((10;1+!10);(1+!10;!0))
211 ((1;$`works`with`words`also);$(`works`with`words`also)));
212 M[p202].'((68 194 165 226 141 186 226 140 138 240 159 148 178 57;,(68;194
165;226 141 186;226 140 138;240 159 148 178;,57))
213 (68 121 97 108 111 103;+,68 121 97 108 111 103) /dyalog expects 68 121 97
108 111 103, but this seems inconsistent
214 (!0;()));
215 M[p203].'(("A";1);("APL";1104));
216 M[p204].'(2020 1;(1901+10 10#!100;10 10#100#0001b));
217 M[p205 .].'((3 10;3 4 5 6 7 8 9 10);(4 -3;4 3 2 1 0 -1 -2 -3);(42
42;,,42));
218 M[p206 .].'(((3;1 2 3 4 1 3 1 4 5);3 3 1 2 4 1 1 4 5);((3;,1);,1);
(42;!0);!0));
219 M[p207].'((2 7;1);(4 11;0);(3 11;1);(4 0;0));
220 M[p208].'(123 0;31115 0;3141514131415 1;132 1);
221 M[p209].'((1 3 3 4 5 2 1;1);(,42;1);(1 3 2 4;0);(23 23 23;1);(!0;1));
222 /skipping p20X; too APL-specific
223 A[p211].'(("GCGCGCGCCCGGGGCCG";100);("ACGTACGTACGTACGT";50);("ACGT"@(10 12
16 10;58.3333333));
224 /skipping p212, as `?` is a k primitive
225 /M[p212["DYALOG"]; "APL"; 2 ON 3]
226 /M[p212[5 5#AZ]; ("UVWXY"; "FGHIJ"; "XYZZY"); 4 1 ON]
227 M[p213 .].'(((2 4 7 3 9;5 7 8 1 12 10 20 16 11 4 2 15 3 18 14 19 13 9 17
6);(8 12 10 20 16 4 2 18 14 6;8 12 20 16 4;7 14;12 15 3 18 9 6;18 9))
228 ((,3;1+!10);,3 6 9);((6 7;,42);(,42;,42));((2 3 5;!0);(!0;!0;!0));
(!0;1+!10);!0));
229 D[p214].'((2*1+!5;1.141592654 4.566370614 10.27433388 18.26548246
28.53981634)
230 ((%2)*3 3#1+!9;3 3#0.5707963268 2.283185307 5.137166941 9.132741229
14.26990817 20.54866776 27.96902001 36.53096491 46.23450247));
231 M[p215].'((12;3 4);(16;4 4),+(1+!19;(1 1;1 2;1 3;2 2;1 5;2 3;1 7;2 4;3
3;2 5;1 11;3 4;1 13;2 7;3 5;4 4;1 17;3 6;1 19));
232 M[p215].'((999999;999 1001);(1000000;1000 1000));
233 M[p216].'(("RNBQKBNR";1);("BBNRKNRQ";1);("RBBNQNRK";0);("BRBKRNQN";0));
234 M[p217].'((+42;1);((4 9 2;3 5 7;8 1 6);1);((1 2;3 4);0));
235 M[p218].'(((2 30;5 15);165);((5 15;2 30);165);((100b;,0);1440));
236 M[p219].'((1 2 3 5 5 5 6 4 3;3);(1 2 3 4 4 4 4 5 4 3;4);(1 2;1));
237 M[p21X .].'(((6;">");" >")
238 ((8;("K";"E";"Iverson"));(" K";" E";" Iverson"))
239 ((8;("Longer Phrase";"APL";"Parade")));(" R Phrase";"
APL";" Parade")));
240 `1:,"\\n"

```

[One Level Up](#)

[Top Level](#)

[One Level Up](#)

[Top Level](#)

## **dy/ - ngnksource**

- [a.k](#)
- [a.sh](#)

[One Level Up](#)

[Top Level](#)

[One Level Up](#)

[Top Level](#)

## dy/a.sh - ngnksource

```
1 #!/usr/bin/env sh
2 cd "$(dirname "$0")"
3 echo 'dyalog competition tests'
4 ./a.k
```

[One Level Up](#)

[Top Level](#)

[One Level Up](#)[Top Level](#)

## repl.k - ngnksource

### Functions defined

- [dirname](#)
- [fmt](#)
- [joinpath](#)
- [line0](#)
- [line1](#)

### Source code

```
1  #!k
2  `1:"ngn/k, (c) 2019-2022 ngn, GNU AGPLv3. type \\ for more info\n"
3  \d repl
4  `1:prompt," " /use 0x0720 for emacs integration
5  cmd:({,"a"}!`1:1:joinpath[dirname`argv 0]"LICENSE";}
6  dirname:{${#x:"/-1_"/"\x;x;,."}}
7  joinpath:{${x~(.::);";";(`A~@x)&1<#x;"(",("`n `/^k'x),")\n";`k[x],`\n"]}
8  fmt:{${x~(.::);";";(`A~@x)&1<#x;"(",("`n `/^k'x),")\n";`k[x],`\n"]}
9  line0:{c:{0x07~*-2#*x}{(l;u):x;(1:1;u,,(-2_1))}/(x());`\n"/(*|c),,*c}
10  line1:{${#x;;:0};x:-1_x;${(3>#x)&("``"==*x)&~^(!cmds)?x 1;cmds[x 1]x 1;.
[`1:fmt@:::,x;{`0:`err[]}]};`1:prompt;`1}
11  line:line1@line0@
12  {cmds:@[cmds;x[1]1:::{y;`0:x}2_x]}'{(&x~\:80#"-"_)x:
(1+*&x~\:, "/")_1_x}@0: `argv 1;
13  \d .
14  ${["kw"]~`argv 0;:{repl.line@1:`}:::/`];
15
16 /
17 -----
18
19  \ help          \\      exit
20  \a  license(APLv3)  \l file.k  load
21  \0  types         \d foo.bar set namespace; restore with \d .
22  \+  verbs         \t:n expr time(elapsed milliseconds after n runs)
23  \:  I/O verbs     \v      variables
24  \'  adverbs       \f      functions
25  \`  symbols        \cd path  change directory
26  \h  summary        \other   command(through /bin/sh)
27 -----
28 \0
29 Types:
30 list atom
31 `A      generic list  () , "ab"  (0;`1;"2";{3};%)
32 `I      `i      int    0N -9223372036854775807 01b
33 `D      `d      float   -0w -0.0 0.0 0w 1.2e308 0n
34 `C      `c      char    "a"  0x6263  "\d\0\"`n\r\t"
35 `S      `s      symbol   ` `a  ``"file.txt"  `b`cd`"ef"
```

```

36 `M  `m  table&dict      +`a`b!(0 1;"23")  (0#`)!()
37   `o  lambda           {1+x*y#z}  {[a;b]+/*/2#,a,b}
38   `p  projection        1+  {z}[0;1]  @[;i;;]
39   `q  composition       */:  {1+x*y}@
40   `r  derived verb     +/  2\  {y,x}':
41   `u  monadic verb    +:  0::
42   `v  dyadic verb     +  0:
43   `w  adverb           '  /:
44   `e  external func
45 -----
46 `:
47 I/O verbs
48   0:x read  lines
49   x 0:y write lines
50   1:x read  bytes
51   x 1:y write bytes
52     <s open          fd:<"file.txt"
53     >i close         >fd
54
55 x can be a file descriptor (int) or symbol or string such as
56 "file.txt"
57 "/path/to/file"
58 "host:port"
59 ":port"           /host defaults to 127.0.0.1
60 -----
61 `+
62 Verbs: : + - * % ! & | < > = ~ , ^ # _ $ ? @ . 0: 1:
63 notation: [c]har [i]nt [n]umber(int/float) [s]ymbol [a]tom [d]ict
64 [f]unc(monad) [F]unc(dyad) [xyz]any
65 special: var:y set a:1;a -> 1
66   (v;...):y unpack (b;(c;d)):(2 3;4 5);c -> 4
67   :x return {:x+1;2}[3] -> 4
68   ${x;y;...} cond ${0;"`a;\"0";`b;`c;();`d;`e} -> `e
69   o[...] recur ${[x<2;x;+/o'x-1 2]}9 -> 34
70   [...] progn [0;1;2;3] -> 3
71
72 :: self    ::12 -> 12
73 : right    1 :2 -> 2   "abc":'"d" -> "ddd"
74 +x flip    +( "ab";"cd") -> ("ac";"bd")
75 N+N add    1 2+3 -> 4 5
76 -N negate  - 1 2 -> -1 -2
77 N-N subtract 1-2 3 -> -1 -2
78 *x first   *`a`b -> `a   *(0 1;"cd") -> 0 1
79 N*N multiply 1 2*3 4 -> 3 8
80 %N sqrt    %25 -> 5.0  %-1 -> 0n
81 N%N divide 2 3%4 -> 0.5 0.75
82 !i enum    !3 -> 0 1 2  !-3 -> -3 -2 -1
83 !I odometer !2 3 -> (0 0 0 1 1 1;0 1 2 0 1 2)
84 !d keys    !`a`b!0 1 -> `a`b
85 !S ns keys a.b.c:1;a.b.d:2;!`a`b -> ``c`d
86 x!y dict   `a`b!1 2 -> `a`b!1 2
87 i!I div    -10!1234 567 -> 123 56
88 i!I mod    10!1234 567 -> 4 7
89 &I where   &3 -> 0 0 0  &1 0 1 4 2 -> 0 2 3 3 3 3 4 4
90 &x deepwhere &(0 1 0;1 0 0;1 1 1) -> (0 1 2 2 2;1 0 0 1 2)
91 N&N min/and 2&-1 3 -> -1 2  0 0 1 1&0 1 0 1 -> 0 0 0 1
92 |x reverse  | "abc" -> "cba"  |12 -> 12
93 N/N max/or 2|-1 3 -> 2 3  0 0 1 1|0 1 0 1 -> 0 1 1 1
94 <X ascend  <"abacus" -> 0 2 1 3 5 4

```

```

95  >X descend    >"abacus" -> 4 5 3 1 0 2
96  <s open      fd:<~/path/to/file.txt"
97  >i close     >fd
98  N<N less     0 2<1 -> 1 0
99  N>N more     0 1>0 2 -> 0 0
100 =X group     ="abracadabra" -> "abrcd"!(0 3 5 7 10;1 8;2 9;,4;,6)
101 =i unitmat   =3 -> (1 0 0;0 1 0;0 0 1)
102 N=N equal    0 1 2=0 1 3 -> 1 1 0
103 ~x not       ~(0 2;``a;"a \0";:::{}) -> (1 0;1 0;0 0 1;1;0)
104 x-y match   2 3~2 3 -> 1 "4"~4 -> 0 0~0.0 -> 0
105 ,x enlist   ,0 -> ,0 ,0 1 -> ,0 1 ,`a!1 -> +(,`a)!,,1
106 x,y concat  0,1 2 -> 0 1 2 "a",1 -> ("a";1)
107 d,d merge   (`a`b!0 1),`b `c!2 3 -> `a`b`c!0 2 3
108 ^x null      ^(" a";0 1 0N;`a;0.0 0n) -> (1 0;0 0 1;1 0;0 1)
109 a^y fill     1^0 0N 2 3 0N -> 0 1 2 3 1 "b"^- " -> "b"
110 X^y without  "abracadabra"^-"bc" -> "araadara"
111 #x length    #abc" -> 3 #4 -> 1 #`a`b`c!0 1 0 -> 3
112 i#y reshape  3#2 -> 2 2 2
113 I#y reshape  2 3#` -> (``;``)
114 f#y replicate (3>#:')#(0;2 1 3;5 4) -> (0;5 4) {2}#"ab" -> "aabb"
115 x#d take     `c`d`f#a`b`c`d!1 2 3 4 -> `c`d`f!3 4 0N
116 _n floor     _12.34 -12.34 -> 12 -13
117 _c lowercase _"Ab" -> "ab"
118 i_Y drop     2_"abcde" -> "cde" `a`c_`a`b`c!0 1 2 -> (,`b)!,,1
119 I_Y cut      2 4 4_"abcde" -> ("cd";";,"e")
120 f_Y weed out (3>#:')_(0;2 1 3;5 4) -> ,2 1 3
121 X_i delete   "abcde"_2 -> "abde"
122 $x string    $(12;"ab";`cd;+) -> ("12";(, "a";, "b");"cd";, "+")
123 i$C pad      5$"abc" -> "abc" -3$"a" -> " a"
124 s$y cast     `c$97 -> "a" `i$-1.2 -> -1 `"$a" -> `a
125 s$y int      `I$"-12" -> -12
126 ?X uniq     ?"abacus" -> "abcus"
127 ?i uniform   ?2 -> 0.6438163747387873 0.8852656305774402 /random
128 X?y find     "abcde"? "bfe" -> 1 0N 4
129 i?x roll     3?1000 -> 11 398 293 1?0 -> ,-8164324247243690787
130 i?x deal     -3?1000 -> 11 398 293 /guaranteed distinct
131 @x type      @1 -> `b @"ab" -> `C @() -> `A @(@) -> `v
132 x@y apply(1) {x+1}@2 -> 3 "abc">@1 -> "b" (`a`b!0 1)@`b -> 1
133 .S get       a:1;. `a -> 1 b.c:2;. `b`c -> 2
134 .C eval      ."1+2" -> 3
135 .d values    .`a`b!0 1 -> 0 1
136 x.y apply(n) {x*y+1}. 2 3 -> 8 (`a`b`c;`d`e`f). 1 0 -> `d
137 -----
138 @ [x;y;f] amend @["ABC";1;_] -> "AbC" @[2 3;1;{-x}] -> 2 -3
139 @ [x;y;F;z] amend @["abc";1;:"x"] -> "axc" @[2 3;0;+;4] -> 6 3
140 . [x;y;f] drill .[("AB";"CD");1 0;_] -> ("AB";"CD")
141 . [x;y;F;z] drill .[("ab";"cd");1 0;:"x"] -> ("ab";"xd")
142 . [f;Y;f] try .[+;1 2;"E:",] -> 3 .[+;1,;"E:",] -> "E: 'type\n"
143 ? [x;y;z] splice ?["abcd";1 3;"xyz"] -> "axyzd"
144 -----
145 \\
146 Special symbols:
147   `@x serialize   ` 7 8 9 -> 0x02030000000000000000000070809
148   `?C deserialize `?0x02030000000000000000000070809 -> 7 8 9
149   `j?C parse json `j?"{\"a\":1,\"b\":[true,\"c\"]}" -> `a`b!(1.0;
(1;,"c"))
150   `k@x pretty-print `k("ab";2 3) -> "(\"ab\");2 3)"
151   `p@C parse k
152   `hex@C hexadecimal `hex"ab" -> "6162"
153   `x@x fork-exec   `x((""/bin/wc";"-l");"a\nbc\nnd\n") -> "3\n"

```

```

154     `t[] current time (microseconds)
155     `argv[] list of cmd line args
156     `env[] dict of env variables
157     `prng[] `prng@I get/set pseudo-random number generator internal state
158             s:`prng[];x:9?0;`prng s;x~9?0 -> 1
159             `prng@0 use current time to set state
160     `err@C throw error
161 Special symbols available only in an interpreter built with "make k-libc":
162     `sin@N trigonometry `sin 12.34 -> -0.22444212919135995
163     `exp@N exponential   `exp 1 -> 2.7182818284590455
164     `ln@N logarithm      `ln 2 -> 0.6931471805599453
165 -----
166 -----
167     \
168 Adverbs:   ' / \ ': /: \:
169     f' each1      #'("abc";3 4 5 6) -> 3 4
170     x F' each2      2 3#"ab" -> ("aa";"bbb")
171     X' binsearch    1 3 5 7 9'8 9 0 -> 3 4 -1
172     F/ fold        +/1 2 3 -> 6
173     F\ scan        +\1 2 3 -> 1 3 6
174     x F/ seeded /  10+/1 2 3 -> 16
175     x F\ seeded \  10+\1 2 3 -> 11 13 16
176     i f/ n-do      5(2*)/1 -> 32
177     i f\ n-dos     5(2*)\1 -> 1 2 4 8 16 32
178     f f/ while     (1<){$[2!x;1+3*x;-2!x]}/3 -> 1
179     f f\ whiles    (1<){$[2!x;1+3*x;-2!x]}\3 -> 3 10 5 16 8 4 2 1
180     f/ converge    {1+1.0%x}/1 -> 1.618033988749895
181     f\ converges   (-2!)\100 -> 100 50 25 12 6 3 1 0
182     C/ join        "ra"/("ab";"cadab";"") -> "abracadabra"
183     C\ split       "ra"\ "abracadabra" -> ("ab";"cadab";"")
184     I/ decode      24 60 60/1 2 3 -> 3723 2/1 1 0 1 -> 13
185     I\ encode      24 60 60\3723 -> 1 2 3 2\13 -> 1 1 0 1
186     i': window     3': "abcdef" -> ("abc";"bcd";"cde";"def")
187     i f': stencil   3{x,"."}': "abcde" -> ("abc.;" "bcd.;" "cde. ")
188     F': eachprior  -':12 13 11 17 14 -> 12 1 -2 6 -3
189     x F': seeded   ': 10-':12 13 11 17 14 -> 2 1 -2 6 -3
190     x F/: eachright 1 2*/:3 4 -> (3 6;4 8)
191     x F\!: eachleft 1 2*\\":3 4 -> (3 4;6 8)
192 -----
193     \h
194     : SET      RETURN      '  each|slide|bin
195     + add      flip        /  fold|join |dec|comment
196     - subtract negate     \  scan|split|enc|trace
197     * multiply first      ': eachprior
198     % divide   sqrt        /: eachright
199     ! mod|dict enum|key  \: eachleft
200     & min|and where
201     | max|or  reverse     /
202     < less    ascend      multiline comment
203     > more    descend     \
204     = equal   group
205     ~ match   not         0: lines i/o
206     , concat  enlist     1: bytes i/o
207     ^ without null
208     # reshape length
209     _ drop|cut floor
210     $ cast    string      ${c;t;f]      COND
211     ? find|rnd uniq      ?[a;i;b]      splice
212     @ apply(1 type      @[{x;i;[f;y] amend
213     . apply(n) eval      .[{x;i;[f;y] drill

```

```
213 grammar: E:E;e|e e:nve|te| t:n|v v:tA|V n:t[E]|(E)|{E}|N  
214 limits: 8 locals/args, 256 bytecode  
215 \
```

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## I/math.k - ngnksource

### Functions defined

- [cmb](#)
- [inv](#)
- [isp](#)
- [lcm](#)
- [prm](#)

### Source code

```
1 pi:3.14159265359
2 abs:|/-:\ 
3 sgn:-/0<-:\ 
4 gcd:*|( *:)( | !\ )/, 
5 lcm:{x*(-gcd[x]y)!y}
6 prm:{$[x~*x;;:x@o@#x];(x-1){,/((,(#*x)##x),x)(~i=:\i)*i+i<\:i:!1+#x}/0}
/permutations(non-lexicographic)
7 cmb:{$[y~*y;;:y@o[x;#y]];*|(y-x){((,(1|#*x)#+_1+**y),x),'y}\//,'y+!'-!1+x}
/combinations(lexicographic)
8 isp:{p:2 3 5 7 11 13 17 19 23 29 31 37 41 43 47 53 59 61 /is x prime?
9 ${x<62;~^p?x;+/~p!'x;0;&/(1=a)|/x=1+(s-1)g\aa:(x!*)/((-1+#d)(g:x!*/2#,:)`2 7
61)@&d:(s:*&b)_b:|2\x-1]}
10 mmu:(+/*)\:/ matrix multiplication
11 inv:{y!*/{x-y*(-y)!*x}/{1<**:;y,0;x,1}} /multiplicative inverse of x
modulo y (extended Euclidean algorithm)
```

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## I/utf8.k - ngnksource

### Functions defined

- [u8d](#)
- [u8e](#)

### Source code

```
1  #!/usr/bin/env k
2  u8d:{i:-1+\0<_t:0 2 3 4 1@0x80c0e0f000'x;@[&1+-1|*|i;i;+;(x-0x8000c0e0f0 _t)*1
1 64 4096 262144@|/(-!4)+(#t)':(&3),t]}
3  u8e:{@[(`c$x)@&m;,/,/1 2 3(1+)\'(0,+`m)i;::,/`c$0xc080e08080f0808080+,/(0
64\;0 64 64\;0 64 64 64\)\@'x i:&'2 3 4=\:@m:2+128 2048 65536'x]}
4
5 /
6 x~u8e u8d x:"Salut Привет 你好 🙌"
7 X~u8e Y:@u8d X:(#x)*(-#x)!_1e6)#x
8 -
9 \t:100 u8d x
10 \t:100 u8e y
```

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## w/inl.k - ngnksource

```
1  #!../k
2  /inline script tags in index.html
3  `1:(1:*x){"<script>\n", (1:y), "\n</script>"} / ("<script src=", y, ">
</script>")\u{x}/1_x
```

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## w/k.js - ngnksource

```
1  'use strict' // ngn/k, (c) 2019-2021 ngn, GNU AGPLv3 -
https://codeberg.org/ngn/k/raw/branch/master/LICENSE
2  const{min,max}=Math,{now}=Date,U8=x=>new Uint8Array(x),doc=document,
3  T1=new TextEncoder,t1=x=>T1.encode(x),z1=pako.deflate,
4  T0=new TextDecoder,t0=x=>T0.decode(x),z0=pako.inflate,
5  c1=x=>{let r='';for(let
i=0;i<x.length;i++)r+=String.fromCharCode(x[i]);return r},
6  c0=x=>(const r=U8(x.length);for(let
i=0;i<x.length;i++)r[i]=x.charCodeAt(i);return r),
7  p0=x=>{try{return x?t0(z0(c0(atob(x)))):' '}catch(x)
{console.error(x);return''}},
8  p1=x=>x?btoa(c1(z1(t1(x)))):'',
9  kc=x=>x.which+1000*(x.ctrlKey+10*(x.shiftKey+10*x.altKey)),
10 hsh=x=>x.split``.reduce((x,y)=>0|(x<<5)-x+y.charCodeAt(0),0),
11 hx8=x=>('0000000'+x.toString(16)).slice(-8),
12 rdy=f=>['complete','interactive'].indexOf(doc.readyState)<0?
doc.addEventListener('DOMContentLoaded',f):setTimeout(f,1),
13 thr=(f,d)=>{let i,l=0,g=_=>
{i=0;l=now();f()};return()=>i=i||setTimeout(g,max(1,l+d-now()))}
14
15 let app,heap,inp=''
16 const kw=fetch`k.wasm`.then(x=>x.arrayBuffer()),
17 M=(p,n)=>U8(app.memory.buffer).subarray(p,p+n),
18 g1=p=>new DataView(app.memory.buffer).getUint8(p),
19 gb=p=>{let q=p;while(g1(q))q++;return M(p,q-p)},
20 gs=p=>t0(gb(p)),
21 s4=(p,x)=>new DataView(app.memory.buffer).setUint32(p,x,1),
22 S4=(p,a)=>a.forEach((x,i)=>s4(p+4*i,x)),
23 ma=n=>{heap+=n;let m=app.memory,l=m.buffer.byteLength;heap>l&&m.grow((heap-
l-1>>16)+1);return heap-n},
24 msn=s=>(s=t1(s);let
p=ma(s.length);M(p,s.length).set(s);return[p,s.length]),
25 ms=s=>msn(s)[0],
26 wa=_=>kw.then(x=>WebAssembly.instantiate(x,{env})),
27 env={sin:Math.sin,cos:Math.cos,log:Math.log,exp:Math.exp,
28 js_in:(a,n)=>{const s=inp||prompt`stdin:\n`;inp='';return
T1.encodeInto(s,M(a,n)).written},
29 js_out:(a,n)=>(ap(t0(M(a,n))),n),
30 js_log:a=>console.log(t0(gb(a))),
31 js_time:(a,b)=>{const t=now();s4(a,t/1000);s4(b,t%1000*1000)},
32 js_exit:x=>{throw Error(`exit(${x})`)},
33 js_alloc:n=>{const p=4096,r=heap%p;r&&ma(p-r);return ma(n)},
34 js_eval:(a,m,r,n)=>T1.encodeInto(`'+eval(t0(M(a,m))),M(r,n)).written}
35
36 let w=wa(),out=ou;const cur=(ta,i)=>ta.setSelectionRange(i,i),
37 cpy=x=>{let c=navigator.clipboard;c&&c.writeText(out.value)},ap=s=>
{out.value+=s;cur(out,out.value.length)},
38
kst=s=>s.replace(/\0\t\n\r\\]/g,c=>'\\''+'0tnr"\\'[\0\t\n\r\\'].indexOf(c])
)
39 rdy=_=>{
40 if(location.hash==='#r'){ //repl mode
41 doc.body.classList.add`repl`;ed.value='';out=ed;let ha=[''],hi=0
//ha,hi:history array and index
42 w.then(x=>{app=x.instance.exports;heap=app.__heap_base
```

```

43     let p=ms('kw\0repl.k\0'),argv=ma(16);S4(argv,
[p,p+3,0,0]);app.kinit();app.kargs(1,argv);inp='\\l repl.k\n';app.rep())
44     ed.onkeydown=x=>{const k=kc(x),skp/*skip prompt*/=i=>i+(ed.value[i]=='')
')
45     if(k==38||k==40){let
s=ed.value,i=s.lastIndexOf`\n`+1;ha[hi]=s.slice(i);hi=max(0,min(ha.length-
1,hi+k-39))
46     ed.value=s.slice(0,i)+ha[hi];cur(ed,skp(i));return!1}
47     if(k==13){let s=ed.value,p=ed.selectionStart,g=ed.selectionEnd
48     if(p==g){p=s.slice(0,p).lastIndexOf`\n`+1;g=(s+'\n').indexOf(`\n`,g)
49     ha[hi]=s.slice(p,g);inp=s.slice(skp(p),g)+`\n`;let l=ha.length-1;hi<l&&
(ha[l]=ha[hi]);hi=ha.push``-1
50     ap(g-s.length?inp+'\n':`\n`);inp=_repel.line@${inp.length-
1?'`:',}`"${kst(inp)}";`\n`
51     try{app.rep()}catch(x){ed.disabled=1;console.error(x);return!1}}
52   else{ //editor mode
53     const ubc=_=>{let s=ed.value,i=s.indexOf`\n\n`,r=[] //update byte count
and return the counted part
54     if(i>0){s=s.slice(0,i);r.push`till empty line`}
55     if(s.slice(0,2)==='f:'){s=s.slice(2);r.push`not counting initial "f:"`}
56     bc.textContent=s.length+'bytes'+(r.length?`(${r.join` `}`)`:'');return
s
57     out.value='';ed.value=p0(location.hash.slice(1).replace(/-$/,`'))
58   const ev=s=>w.then(x=>
{app=x.instance.exports;heap=app.__heap_base;txt();out.value='';ubc()
59     const O_RDWR=2,O_CREAT=64/*512 on freebsd*/
60     const f=app.open(ms('a.k\0'),O_RDWR|O_CREAT,438/*0666*/),
[g,nq]=msn(s);app.write(f,g,nq);app.close(f)
61     const h=heap,a=heap+=T1.encodeInto('k\0a.k\0',M(heap,8)).written;S4(a,
[h,h+2,0,0]);heap+=16;
62     let e;try{app.main(2,a)}catch(x){e=x}if(e&&e.message!=='exit(0)')throw
e;w=wa()})
63     const evp=_=>{const v=ed.value,s=v.slice(-1)=='\n'?
v:v+'\n',p=p1(v);location.hash=p'-';ev(s).then(_=>location.hash=p)
64     bEval.onclick=evp;if(location.hash.slice(-1)!=='-')evp()
65     bGolf.onclick=_=>{const s=ed.value,h='ngn-'+hx8(hsh(s)),g=ubc()
66     cpyp(out.value=`# [K (ngn/k)], ${g.length} bytes\n\n
${g.replace(/\n/g,'`')}\n\n[Try it online!](${h})\n+
67     `)\n[K (ngn/k)]: https://codeberg.org/ngn/k\n[$h]:\n${location.origin}/k#${p1(s)}\n`)
68     bLink.onclick=_=>{const
s=ed.value,g=ubc(),u=g.replace(/^\//g,'\\`').replace(/\$\//,'\\ ')
69     cpyp(out.value=`ngn/k, ${g.length} bytes: [\`$u\`]
${location.origin}/k#${p1(s)}`)
70     bHelp.onclick=_=>{ev(`^0:,/(,80#"-"),/:2_\`(&--`~/:2#\`x_0:"repl.k`\n').then(_=>setTimeout(_=>{out.scrollTop=0},1))}
71     selEx.onchange=_=>{const v=selEx.selectedOptions[0].value
72     if(v){fetch(v).then(x=>x.text()).then(x=>
{ed.value=x;evp();selEx.blur())}}
73     ed.onkeydown=x=>{const b=1013:bEval,1071:bGolf,1075:bLink,112:bHelp
[kc(x)];if(b){b.onclick();return!1}}
74     ed.onkeyup=thr(ubc,1000)})
75
76   let cnv,g,iid,tid,aid,tickPeriod=50
77   const pi=Math.PI,tau=2*pi,K=s=>app.evs(ms(s+'\0')),
78   tick=_=>K('tick[]'),
79   draw=_=>{K('draw[]');tid=setTimeout(raf,40)},
80   raf=_=>aid=requestAnimationFrame(draw),
81   hgr=_=>
{if(g)return;doc.body.appendChild(cnv=doc.createElement('canvas'));g=cnv.getContext('2d')}

```

```

82  onresize();g.font='0.05px monospace';iid=setInterval(tick,tickPeriod);raf()
83  onkeydown=onkeyup=e=>g&&K('k'+e.type[3]+'@'+e.keyCode)
84  onkeypress=e=>{if(g){let c=e.charCodeAt;K('kx@'+c);
(c==10||c==13)&&K('kr@10');c==8&&K('kb@8')}}
85  cnv.onmousedown=cnv.onmouseup=cnv.onmousemove=
86  e=>{const r=cnv.getBoundingClientRect();K('m'+e.type[5]+'@'+[e.clientX-
r.x,e.clientY-r.y])},
87  txt=_=>
88  {if(!g)return;cnv.parentNode.removeChild(cnv);clearInterval(iid);clearTimeout(t
id);cancelAnimationFrame(aid)
89  cnv=g=iid=tid=aid=null}
90  onresize=_=>{if(!cnv)||!out) return;let
s=cnv.style,e=out;s.left=e.offsetLeft+'px';s.top=e.offsetTop+'px'
91  const
k=cnv.width=cnv.height=min(e.offsetWidth,e.offsetHeight);g.scale(k,k)}

```

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## 1.c - ngnksource

### Global variables defined

- [F1](#)

### Macros defined

- [F1](#)
- [NG](#)
- [h](#)
- [hf](#)

### Source code

```

1 #include<math.h> // ngn/k, (c) 2019-2022 ngn, GNU AGPLv3 -
https://codeberg.org/ngn/k/raw/branch/master/LICENSE
2 #include"a.h"
3 #define hf(f,T,a...) S N f(OV*RE a0,V*RE r0,Nn)_(_
T*a=a0;T*r=r0;LN(a)LN(r)a)
4 #define NG(T) hf(neg##T,T,Ni=0;I g=ZA/SZ(T);W(i<n,I o=0;j(g,o|=a[j]==(T)
(1<<SZ(T)*8-1))E(o,i)j(g,r[j]=-a[j])a+=g;r+=g;i+=g)n)
5 #define F1(f,T,c...) hf(f##T,T,i(PD(n,a),r[i]=(c;))n)
6 TD size_t(*F1)(OV*,V*,N);NG(B)NG(H)NG(I)F1(neg,I,-a[i])F1(neg,D,-a[i])
7
8 A pen(Ax,A1*f)_(_XmMA(eac1f(x,f))et1(x))
9 A1(neg,XmMA(eac1f(x,neg))Xzc(az(-gl(x)))Xd(ad(-gd(x)))XC(neg(cB(x)))
10 XZD(S O F1 f[ ]={negB,negH,negI,negL,negD};Nn=xn;Ay=xr>1?an(xt,n):x;Nm=f[xt-
tB](xV,yV,n);
11 I(m<n,I(x-y,x=wdn(x,m,n,n-m);y=wdn(y,0,m,n))E(x=y=wdn(y,0,n,n))N
mw=m*yW;f[xt-tB](xV+(x-y?0:mw),yV+mw,n-m))x-y?x(y):y
12 et1(x))
13 A1(not,XmMA(eac1f(x,not))XF(x(ai(x==au)))eql(xtsS?as(0):ai(0),x))
14
A1(nul,XmMA(eac1f(x,nul))XF(x(ai(x==au)))XD(Ay=aB(xn);xe(i(xn,yb=xd!=xd);y))Xd(
x(ai(*xD!=xD)))eql(R(cn[xt]),x))
15
A1(flr,XmMA(eac1f(x,flr))XcC(K(`c$@[!256;65+!26;+;32]",cB(x)))Xss(cs(flr(str(x
))))Xzz(x)
16 XdD(Ay=an(xt+tl-td,xn);xe(i(yn,yl=xd<0?(L)xd-(xd<(L)xd):(L)xd)y))et1(x))
17
18 #define h(k,f) A1(k,XdD(Ay=xr-1?an(xt,xn):x;i(PD(xn,xd),yd=f(xd));x-y?
x(y):y)XmMA(eac1f(x,k))k(N(cD(x))))
19 h(ksin,sin)h(kcos,cos)h(klog,log)h(kexp,exp)h(sqr,__builtin_sqrt)

```

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## 3.c - ngnksource

### Macros defined

- [B2](#)
- [GZ](#)
- [H2](#)
- [I2](#)
- [hA](#)
- [hM](#)
- [hN](#)
- [hO](#)
- [hf](#)
- [hn](#)
- [ho](#)

### Source code

```
1 #include "a.h" // ngn/k, (c) 2019-2022 ngn, GNU AGPLv3 -
https://codeberg.org/ngn/k/raw/branch/master/LICENSE
2 #define B2 H
3 #define H2 I
4 #define I2 L
5 #define GZ(T) (ZA/SZ(T))
6 #define hf(f,T,e...) S N f(OV*RE a0,OV*RE b0,V*RE r0,Nn)_(_Q
T*a0,*b=b0;T*r=r0;LN(b)LN(r)e)
7 #define hN(f,T,l,Q) hf(f,T,I(l,LN(a))i(PD(n,a),r[i]=a[l*i]o b[i])n) //+
and * for widest types, no overflow
8 #define hO(f,T,l,g,e...)
hf(f,T,I(l,LN(a))Li=0;W(i<n,e;i+=g;a+=l*g;b+=g;r+=g)i) //support overflows
9 #define hA(f,T,l,g) hO(f,T,l,g,T v[g],Q=0;j(g,T u=a[l*j]+b[j];Q|=
(a[l*j]^u)&(b[j]^u);v[j]=u)P(Q>>SZ(T)*8-1,i)Mc(r,v,ZA))
10 #define hM(f,T,l,g) hO(f,T,l,g,T##2 v[g];j(g,v[j]=a[l*j]*
(T##2)b[j])j(g,P(v[j]-(T)v[j],i))j(g,r[j]=v[j]))
11 #define ho(t,T)
hA(a##t##T,T,0,GZ(T))hA(a##t##T,T,1,GZ(T))hM(m##t##T,T,0,GZ(T))hM(m##t##T,T,1,G
Z(T))
12 #define hn(t,T)
hN(a##t##T,T,0,+)
hN(a##t##T,T,1,+)
hN(m##t##T,T,0,*)
hN(m##t##T,T,1,*)
13 ho(b,B)ho(h,H)ho(i,I)hn(l,L)hn(d,D)
14 S C tZx(Ax)_(_Xz(tZ(gl_(x)))Xd(tD)XZD(xt)tn)
15 A adm(Ax,Ay,IV)_(_
16 P(xti&tyt, Lm=xv, n=yv;az(v?m*n:m+n))
```

```

17  P(xtz&ytz,Lm=gl(x),n=gl(y);az(v?m*n:m+n))
18  XYmMA(eac2f(x,y,v?mul:add))
19  XcC(adm(cB(x),y,v))
20  YcC(adm(x,cB(y),v))
21  P(xtdD-ytdD,adm(Ny(cD(x)),Nx(cD(y)),v))
22  Ct=max(tzx(x),tzx(y));P(t==tn,et2(x,y))
23  x=Ny(cT[t](x));
24  y=Nx(cT[t](y));
25  Ik=2*xT+ytT;
26  P(!k,Xd(ad(v?gd(x)*gd(y):gd(x)+gd(y)))az(v?gl(x)*gl(y):gl(x)+gl(y)))
27  I(k==2||(k==3&&xr==1),SWP(x,y))
28  S Q TY(&abB)f[][2][5]={{abB,ahH,aiI,alL,adD},{aBB,aHH,aII,aLL,aDD}},{{mbB,mhH,miI,mLI,mdD},{mBB,mHH,mII,mLL,mDD}}};
29  Nn=yn;P(k==3&&xn-n,el2(x,y))Az=yr-1?an(yt,n):y;Lm=f[v][k==3][yt-tB](xtP?(V*)&x:xV,yV,zV,n);
30  I(m<n,I(k-3,x=cT[xt+1+tC-tc](x))E(x=wdn(x,m,n,n-m))
31      I(y-z,y=wdn(y,m,n,n-m);z=wdn(z,0,m,n))E(y=z=wdn(z,0,n,n))
32      N l=m*zW;f[v][k==3][yt-tB](xtP?(V*)&x:xV,yV+(y-z?0:l),zV+l,n-m))
33  x(y-z?y(z):z))

```

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## 4.c - ngnksource

### Functions defined

- [f](#)

### Source code

```
1 #include "a.h"
2 S I f(I*x,I n){
3 S Q UI s[ ]=
{2,3,5,7,11,13,17,19,23,29,31,37,41,43,47,53,59,61,67,71,73,79,83,89,97,101,103
,107,109,113,127,131,137,139,
4
149,151,157,163,167,173,179,181,191,193,197,199,211,223,227,229,233,239,241,251
,257,263,269,271,277,281,283,293,
5 307,311,313,317,331,337,347,349,353,359,367,373,379,383,389,397};
6 I nr=ZZ(s);W(nr&&n<=s[nr-1],nr--)Mc(x,s,4*nr);P(nr<ZZ(s),nr)I
k=4,m=3*5*7*11,w=722;C t[2*m-1],a[1<<14];
7 i(k,I p=r[i+1],j=p>>1;W(j<m<<3,t[j>>3]|=1<<(j&7);j+=p))cyc(t,m,SZ t);
8 for(I u=r[nr-1]+2;u<n;u+=8*SZ a){I v=min(n,u+8*SZ a),l=(v-
u+1)>>1;ccp(t+u/2%m*w%m,m,a,SZ a);I i=k+1;
9 W(1,I p=r[i++];B((L)p*p>=v)for(I j=(2*p-1-(u+p-1)%
(2*p))>>1;j<l;j+=p)a[j>>3]|=1<<(j&7))
10 UI*b=(V*)a;I(l&31,b[l-1>>5]|=-1<<(l&31))
11 i(l+31>>5,UL x=~b[i];I j=-1;W(x,I
d=__builtin_ctz(x)+1;x>>=d;j+=d;x[nr++]=u+64*i+2*j))}
12 return nr;
13 A1(qpri,
14 S Q I h[ ]=
{19,89,263,659,1571,3607,8087,17783,38791,83911,180391,385991,821479,1742443,36
81017,7753909,16289947,
15 34135883,71378467,148948021,310248149,645155087,1339483993,-1u>>1};
16 P(!xtz,et1(x))L n=gl(x);P(n-(I)n,ez0())P(n<0,ed0())I i=0;W(h[i]
<n,i++)Ax=aI((16<<i)-8);xn=f(xI,n);x
```

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## f.c - ngnksource

### Global variables defined

- [a](#)

### Functions defined

- [shf](#)

### Macros defined

- [h](#)

### Source code

```
1 #include "a.h" // ngn/k, (c) 2019-2022 ngn, GNU AGPLv3 -
https://codeberg.org/ngn/k/raw/branch/master/LICENSE
2 //prng: xoshiro256+ (public domain) http://vigna.di.unimi.it/xorshift/
seeded with the central column of rule30, little-endian:
3 // ,"/abcd",'=0x',/:+"0123456789abcdef"@(16#16)\2/+4 64#(n{(|(
8#2)\30)\2/'3'0,x,0}\n!=2*n)\n'256
4 S UL a[] =
{0xd5a986ae75c9a33b,0x1016d8e3483a8f0f,0x81f9e6260eb8e5df,0xfa9b718d8d0769bf};
5 UL rnd1()_(Lv=a[1]
<<17;a[2]^=a[0];a[3]^=a[1];a[1]^=a[2];a[0]^=a[3];a[2]^=v;a[3]=rot(a[3],45);a[0]
+a[3])
6 A1(prng,P(x==au,aV(tL,4,a))XZ(x=cL(rsh(4,x));Mc(a,xV,SZ a);x(au))
7 Xz(UL
v=gl(x);I_(!v,v=now())i(ZZ(a),a[i])=v=v*6364136223846793005+1442695040888963407)a
u)et1(x) //knuth mmix
8 S UL rm(UL m)_((UL)rnd1()*m>>32)
9 S V shf(L*x,Nn){i(n,Ij=rm(i+1);SWP(r[i],r[j]))}
10 S A ro(UL n,UL m)_((Ct=m?tz(m-
1):tL;Ax=an(t,n);P(t==tB,i(n,xb=rm(m))x)P(t==tH,i(n,xh=rm(m))x)P(t==tI,i(n,xi=r
m(m))x)
11 i(n,xl=rnd1())I(m,i(n,xl=(UL)xl%m))x)
12 S A de(UL n,UL m)_((P(n>m,e10())Ax=ro(n,0);i(n,UL k=m-
n+i;xl%=k+1;j(i,B(xL[j]==xl,xl=k)))shf(xV,n);x)
13 S A rd(Ln,Lm)_((P(m<0,ed0())n<0?de(n-NL?-n:m,m):ro(n,m)))
14 AL(rndD,add(ai(-1),AT(tD,add(al(102311<<52),N(rd(n,111<<52))))))
15 S ALA(rnd,Xz(rd(n,gl(x)))Xc(cC(add(xv-'A'?
ac('a'):x,Nx(rd(n,26))))))Xd(mul(x,Nx(rndD(n))))XMT(idx(x,Nx(rd(n,xN))))et1(x))
16
17 #define h(T) \
18 NI L f##T(OV*p,Nn,Lv)_((O T*a=p,g=v;P(v-
g||!n,NL)i=0,g=ZA/SZ(*a),f=0;W(i<n&&!f,j(g,f|=a[i++]==g))i-
=g;j(g,B(a[i]==g)i++)i<n?i:NL)\ \
19 NI V F##T(OV*p,Nm,TY(fB)f,OV*g,Nn,L*x)_((O T*a=g;i(n,r[i]=f(p,m,a[i])))\ \
20 NI L fp##T(A*p,T v)_((Ax=*p;Nn=xn;Li=f##T(xV,n,v);P(i<0,*p=apv(x,&v);n)i)
21 h(B)h(H)h(I)h(L)
```

```

22  S L
fA(Ax,Ay/*00*/)_ (XA(i(xn,P(mtc_(xa,y),i))NL)i(xN,Az=ii(x,i);P(mtc_(z,y),z(0);i)
z(0))NL)
23  I fAI(Ax/*0*/,_ (fI(xV,xn,v))
24  I rnk(Ax/*0*/)_ (XA(P(!xn,2)Iv=rnk(xx);P(v<0,v)i(xn,P(v-
rnk(xa),-1))v+1)XmM(rnk(xy))xtT) // -1 for mixed rank
25  I urnk(Ax/*0*/)_ (XA(xn?urnk(xx)+1:2)XmM(urnk(xy))xtT) //assuming unirank
26  S A2(sdf,K("{a:&/x; b:1+|/x;@[(b-a)#0N;|x-a::;|!#x]y-a}",x,y)) //small-
domain find
27  A2(fd,
28  P(xtT&&!xtA&&!ytmA,
29  P(xtZ&&ytzz | xt==TT[yt],
30  P(xw<2&&xn>99&&yN>99,sdf(x,y))
31  V(f,T(&fB,fH,fI,fL)[xw])Yt(x(az(f(xV,xn,gl(y)))))
32  Az=aL(yn);Ii=yw;xe(ye(T(&FB,FH,FI,FL)[i](xV,xn,f,yV,yn,zV);z))
33  Az=cn[tl];zR;x(y(ytt?z:rsh(yN,z)))
34  Xm(Az=kv(&x);idx(x,Nx(fd(z,y))))
35
Ik=urnk(x,l=urnk(y);P(k==l+1,x(y(az(fA(x,y)))))P(k<=l,ear2(x,y,QUE))er2(x,y))
36
37  A2(que,Xs(S O C s[] [4]={ "", "j.", "hex"};Li=fI(s,ZZ(s),xv);T(&des,js0,unh,ed1)
[i<0?ZZ(s):i](y))
38  Xz(rnd(gl(x,y))Xt(et2(x,y))fd(x,y))

```

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## g.k - ngnksource

```
1  #!k
2  r://"// ngn/k, (c) 2019-2022 ngn, license: GNU AGPLv3 -
https://codeberg.org/ngn/k/raw/branch/master/LICENSE"
3  // generated by g.k")
4  R:,:{$[x~"@";*y;x~"$";y 1;x~"%";_*y;x}]\:;d:{r,:">#define
",:x[0]R:+a@'!#'a:1_x;}
5
v:"xyzu";t:"ABHILDC";T:t,"SMmildscopqruvwe";U:T,"FPRtTZZ",${_cC`lL`dD`ss`zZ`mM`m
t`MT`zd`ZD`zc`ZC`zdc`ZDC`mMA`sSA
6  /@:arg[0],$:@arg[1],%:lower(arg[0])
7  d("@$_$(@)";v;"EKkmNnoRrtUVvWwXxyZz",t,(t),"t",'U)
8  d("@$_(a...)$(@,a)";v;"qe128")
9  d("@$_(a...)$(@,a)";"XY";U)
10 d("@$_(a)_dex(@,a)";v)
11 d("@$_@($x) ((@*)$_V($x))";t)
12 d("@$_%($x) $_@($x)[i]";t)
13 d("@$_@($x) (@$_@($x)==$_@)";"ABHILDCSMmlodopqr")
14 d("@$_@($x) (@$_0($x)==$_@)";"iscuvwe")
15 d("@$_@($x) N($x,$@($0))";v)
16 d("@$_@$_R($ce[$t@])";"ABLDGS")
17 d'("@$_@$_$"),/:":":\""\ \"$_:bcdt ILN:ijkmn CBHILD:v I:f A:xyzu Q:ACV
Q:spq";
18 r:{#define _"$_,x,"$_((A*)$_V($x))["$_Y,"$_"]}{["xyz";"012"]
19 r:{#define _t"$_,x,"$_((t$_,(-1_x),"(x)|$_t",(-1#x),"(x))"}'(1<#:')#U
20 "g.h"0:r
```

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## makefile - ngnksource

```
1 #faster builds: export MAKEFLAGS=-j8
2 M=mkdir -p $(@D)
3 STRIP ?= strip
4
5 O:;$(MAKE) k-dflt && $(MAKE) t #default target
6 t:o/t;o/t;dy/a.sh;cd g;./a.k;cd -;a21/a.sh;a20/a.sh;a16/a.sh;a19/a.sh;e/a.sh
#test
7 c:;rm -rf o k libk.so #clean
8 k:k-dflt
9 w:k o/w/fs.h o/w/k.wasm o/w/index.html $(patsubst
w/x/%.k,o/w/x/%.k,$(wildcard w/x/*.k))
10 h:w o/w/http;cd o/w;./http
11
12 k-dflt:; $(MAKE) a N=$@ R=k O=' -O3 -march=native -nostdlib -
ffreestanding' L=''
13 k-libc:; $(MAKE) a N=$@ R=k O=' -O3 -march=native -Dlibc'
L=' -lm' STRIP=true
14 k-obsd:; $(MAKE) a N=$@ R=k O=' -fPIC -Dlibc=1 -DSYS_getcwd=304 -
Dstrchrnul=strchr' L=' --static -fno-pie -lm -lc' STRIP=true
15 k-wasi:; $(MAKE) a N=$@ R=k O=' -O3 -target wasm32-wasi -nostdlib -
ffreestanding -Dwasm -U __SIZEOF_INT128__ -I/usr/include' STRIP=true CC=clang
16 libk.so:;$(MAKE) a N=$@ R=$@ O=' -O3 -march=native -nostdlib -ffreestanding
-fPIC -Dshared' L=' -shared' STRIP=true
17 o/$N%.o: %.c *.h;$M;$(CC) @opts $O -o $@ -c $<
18 o/$N/bin:$ (patsubst %.c,o/$N%.o,$(wildcard *.c));$(CC) $O -o $@ $^ @opts
$L;$(STRIP) -R .comment $@ -R '.note*'
19 a:o/$N/bin;cp o/$N/bin $R
20
21 o/t:t/t.c;$(CC) $< -o $@ -Wall -Wno-unused-result -Werror
22 o/asm/%.s: %.c *.h;$M;$(CC) -O3 @opts -march=native -nostdlib -ffreestanding
-c $< -o $@ -S -masm=intel
23
24 #/usr/lib/llvm-10/bin/wasm-ld must be on $PATH
25 O_WASM=@opts -Oz -nostdlib -ffreestanding --target=wasm32 -U
__SIZEOF_INT128__ -Dwasm -I/usr/include
26 o/w/%.o: %.c *.h o/w/fs.h;$M;clang $(O_WASM) -o $@ -c $<
27 o/w/k.wasm0:$ (patsubst %.c,o/w/%.o,$(wildcard *.c));clang $(O_WASM) -o $@
$^ \
28 -Wl,--export=main,--export=kinit,--export=kargs,--export=rep,--
export=open,--export=close,--export=write,--export=evs\
29 -Wl,--export=__heap_base,--no-entry,--initial-memory=33554432,--allow-
undefined
30 o/w/k.wasm:o/w/k.wasm0;wasm-opt -Oz $< -o $@ && ls -l $@
31 o/w/fs.h:repl.k LICENSE|k w/fs.k;$M;./k w/fs.k $^ >$@
32 o/w/x/%.k:w/x/%.k;$M;ln -f $< $@
33 o/w/index.html:w/index.html k w/inlk w/*.js;$M;cd w && ./inlk index.html
*.js >../$@ && cd -
34 o/w/http:w/http.c;$(CC) $< -o $@
35
36 # O_32=@opts -m32 -Dlibc
37 # o/32/%.o: %.c *.h;$M;$(CC) $(O_32) -o $@ -c $<
38 # k32:$ (patsubst %.c,o/32/%.o,$(wildcard *.c));$(CC) $(O_32) -o $@ $^ -lgcc
-lm
39
40 .PHONY: o t c k w h a k-dflt k-libc k-obsd
```

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## p.c - ngnksource

```
1 #include"gnk.h" // ngn/k, (c) 2019-2022 ngn, GNU AGPLv3 -
https://codeberg.org/ngn/k/raw/branch/master/LICENSE
2 I si(Qs,IV)_(SC0(s,v)-(C*)s)S D p10(In)_(Dv=1;i(n,v*=10)v)s Q
pw(Qs)_(W(*s==32,s++)s)
3 L pu(Q*p)_(Qs==*p;Lv=0;Cc=*s;W(c09(c),v=10*v+c-'0';c==*++s)*p=s;v)L
pl(Q*p)_(Im==*p=='-';*p+=m;(1-2*m)*pu(p))
4 S D pdu(Q*p)_(UL v=pu(p);Qs==*p;Cc=*s;P(c=='n'||c=='w',(*p)+++;c=='n'?ND:WD)I
e=0;
5 I(c=='.' ,c==*++s;W(c09(c),I(v<(1ull<<63)/10,v=10*v+c-'0';e-
-)c==*++s))I(c=='e' ,s++;e+=pl(&s))*p=s;e<0?v/p10(-e):v*p10(e))
6 S D pd(Q*p)_(Im==*p=='-';(*p)+=m;Dv=(1-2*m)*pdu(p);(*p)+==*p=='f';v)
7 S Qs,s0;S I k;S I num(Qs)_(c09(s[*s=='-'])))
8 S A0(pZ,Qp=s;W(*p-'0'<2u,p++)P(*p=='b',Ax=aB(p-s);i(xn,xb=*s++&1)s++;x)
9
Ax=oL;W(1,Lv=pl(&s);I(!v&&s=='N',v=NL;s++)x=apv(x,&v);Qp=pw(s);B(p==s||!num(p)
)s=p)sqzz(x)
10 S A0(pD,Ax=oD;W(1,x=apv(x,(D[]){pd(&s)});Qp=pw(s);B(p==s||!num(p))s=p)x)
11 S A0(pC,Ax=oC,Cc==*++s;W(c&c-
'',I(c=='\\',c==*++s;Ii=si("tnr0",c);I(i<4,c=="\t\n\r"
[i]))x=apc(x,c);c==*++s)P(!c,ep1(x))c==*++s;x)
12 S C ph()_(Cc==*s;c09(c)?c-'0':c-'a'<6u?c+10-'a':16)
13 S
A0(p0x,Ax=oC;s+=2;W(1,Cc=ph();P(c>15,x)s++;Cd=ph();P(d>15,ep1(x))s++;x=apc(x,c<
<4|d))x)
14 S
A0(ps,Qp=s;Cc==*s;I(c>>7,W(*++s<-64)s==*s==':')I(cAz(c),W(cA9(c),c==*++s))aCm(p,s
))
15 S A0(pS,Ax=oS;W(1,Ay==*s-' ')
ps():Nx(pC());y=str0(y);xq(y(sym(yV)));Qp=pw(s);P(*p-' ',x)s=p+1)0
16 S A0(pP,Ax=oS;W(1,Ay=str0(ps()));y(xq(sym(yV)));P(*s-
'.'||!cAz(s[1]),x)++s)0
17 S A px(In)_(Q(n<4u);Ax=aS(n);i(xn,xi='x'+i)x)s A1(p1,x&&xn==1?fir(x):x)s A
pb(A,C);
18 S A pt(C*v)_(Cc==*s;P(c==' ',s++;Ax=pS();x&&xn>1?
enl(x):x)P(c==' ',p1(pC()))P(c=='[ ',s++;pb(al(PLH),' ]'))
19 P(c=='(' ,s++;P(*s==' ') ,s++;oA)Ax=N(pb(enl(MKL),' '));xn-2?x:las(x))
20 P(c=='{ ',C k0=k;k=1;O s1=s0,t=s0=s++;Ay;I(*s-
'[ ',y=au)E(s++;y=sqz(N(pb(oA,' ]')));P(!ytS,ep1(y))P(yN>8,s--;ez1(y)))
21
Az=pb(al(PLH),' ') ;P(!z,s0=s1;y(0))I(y==au,y=px(k))Ax=N(cpl(aCn(t,s-
t),z,y));s0=s1;k=k0;x)
22 P(cAz(c),Qp=s;Ax=pP());I(s-p==1&&c-'y'<2u,k=max(k,c-'w'))AO(p-s0,p1(x)))
23 P(c09(c)&&s[1]==':',I u=s[2]==':';s+=2+u;Ii=20+c-
'0';P(i>25,ep0())*v=1;AT(tv-u,i))
24 P(c=='0'&&s[1]=='x',p1(p0x()))
25 P(num(s)&&(c=='-'||s==s0||(!cA9(s[-1])&&si(" ")]}\\"",s[-1])==4)),L
d=0;Qp=s;c==*p;
26 W(1,p+=*p==32;B(!num(p))p+=*p=='-
';c==*p;B(!cA9(c))W(cA9(c)||c=='.'||c==':',d)=si(".nwe",c)<5;c==*++p)p1(d?
pD()):pZ()))
27 P(c>>7,Qp=s;Ax=pP();*v=1;AO(p-s0,p1(x)))
28 Ii=si("'/\\",c);P(i<3,c==*++s;I
h=c==' ':s+=h;*v=1;aw+i+3*h)i=si(vc,c);P(i>19,PLH)I
u==*++s==' ':s+=u;*v=1;AT(tv-u,i))
29 S A1(pm,Xv(x^au^av)XA(I(xx==aw,x=mut(x);xA[xn-1]=pm(xA[xn-1]))x) //monadify
```

```

30   Xs(Lv=xv;Qs=qs(&v);Nn;P(*s>>7&&s[ (n=Sn(s))-1 ]-
':',Cb[8];Mc(b,s,n);b[n]=':';b[n+1]=0;sym(b))x)x)
31   S A pT(C*v)_-(Ax=N(pt(v)));
32   W(1,Cc=*s;Ii=si("'\\"[,c]);P(i>3,x)s++;
33   I(i>2,x=AO(s-1-
s0,N(pb(al(x),'])));I(xn==2,I(xy==PLH,xy=au)E(xx=pm(xx))*v=0)
34   E(I u=*s=='';s+=u;x=a2(aw+i+3*u,x);*v=1))x)
35   S A pe(Ax,C*v)_-(s=pw(s);Cc=*s;I(c=='/' &&
(s==s0||s[-1]==32||s[-1]==10),W((c==++s)&&c-10))
36   P(s>s0&&s=='\''&&s[-1]==32,s++;Ay=pe(0,v);P(!y,x?
x(0):0);*v=0;y=a2(OUT,y);I(x,y=a2(pm(x),y))y)
37   UH o=s-s0;Cb=0;Ay=pt(&b);P(!y,x?x(0):0)P(y==PLH,x?
x:y)P(!b,Az=pe(y,v);P(!x,z)Nx(z);*v?a3(aw,x,z):AO(o,a2(pm(x),z)))
38   Az=pe(0,v);P(!z,y(x?
x(0):0))P(z==PLH,*v=1;P(!x,y)Yu(ep1(x))AO(o,a3(y,x,z)))*v&=y!=av;I(!x,y=pm(y))
39   *v?a3(aw,x?AO(o,a3(y,x,PLH)):y,z):AO(o,x?a3(y,x,z):a2(pm(y),z)))
40   S A pb(Ax,Cc)_-(W(1,Cv=0;Ay=Nx(pe(0,&v));I(y==PLH&&c-
')',P(c==''),ep2(x,y))y=au)xq(y);B(*s-' ;' &&*s-10)s++)P(*s-c,ep1(x))s++;x)
41   A pk(Qp)_-(s0=s;p;Ax=pb(al(PLH),0);P(!x,eQ(s0,Sn(s0),s-s0);0)xn-2?x:las(x))

```

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## readme.txt - ngnksource

```
1  I've decided to stop working on my free reimplementation of k6 for an
2  indefinite period.
3
4
5
6  ngn/k is a simple fast vector programming language
7  license: GNU AGPLv3 (v3 only) -
https://codeberg.org/ngn/k/raw/branch/master/LICENSE
8  build: make CC=clang-12 # or CC=gcc-10
9  (for unusual platforms or compilers, if that doesn't work, try "make k-libc"
10 instead of "make")
11 usage: rlwrap ./k repl.k
12 try online: https://ngn.codeberg.page/k or https://ngn.bitbucket.io/k
13 related projects:
14 https://github.com/gitonthescene/ngnk-mode - emacs mode
15 https://github.com/razetime/ngn-k-tutorial - tutorial (work in progress)
16 https://xpqz.github.io/kbook/ - book (work in progress)
17 https://github.com/secwang/ngnkcart - searchable database of
snippets
18 https://github.com/xpqz/ngnk\_mirror - continuous integration for
osx
19 https://github.com/traws0/ngnk-windows - windows port
20 https://github.com/nathyong/ngnk-nix - nix package
21 https://code.golf/rankings/holes/all/k/bytes - code golf
22 https://copy.sh/k/ - aoc20 and aoc21 solutions
23 https://github.com/chrispsn/aoc2017 - aoc17 solutions
24 https://github.com/xpqz/dyalogk - dyalog competition solutions
25 https://codeberg.org/CptJimKirk/kpl - kpl, apl-like extensions for
k
26
27
28 0.c syscalls and main()           k.h embedding api
29 m.c memory manager                  a.h common header
30 p.c parser                          g.h header generated by g.k
31 b.c bytecode compiler and vm       t/ unit tests
32 a.c eval, apply, amend, drill: . @ w/ web ui
33 h.c shape-related: x#y ,x x,y     x/ example for using libk.so
34 o.c order and equivalence          o/ build output
35 s.c string formatting: $x `k@x    l/ k libraries
36 f.c find, random: x?y             g/
https://codegolf.stackexchange.com/
37 1.c monadic arithmetic            e/ https://projecteuler.net/
38 2.c dyadic arithmetic except + and * dy/ https://problems.tryapl.org/
39 3.c dyadic arithmetic + and *      a19/ https://adventofcode.com/2019
40 i.c i/o and \cmds                 a20/ https://adventofcode.com/2020
41 v.c the rest of the verbs        a21/ https://adventofcode.com/2021
42 w.c adverbs
43 j.c json: `j@x `j?x
44 x.c serialization: `@x `?x
45 e.c error handling
46 k.c impl of embedding api
```

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## v.c - ngnksource

### Functions defined

- [c](#)

### Macros defined

- [cN](#)
- [c](#)

### Source code

```
1 #include "a.h" // ngn/k, (c) 2019-2022 ngn, GNU AGPLv3 -
https://codeberg.org/ngn/k/raw/branch/master/LICENSE
2 #define c_(T,R,p) SN V c##T##R(OV*RE v,V*RE w,Nn)_(_O T*RE a=v;R*RE
r=w;i(PD(n,p),r[i]=a[i]))
3 #define cN(T,R,p) SN V c##T##R(OV*RE v,V*RE w,Nn)_(_O T*RE a=v;R*RE
r=w;i(PD(n,p),r[i]=a[i]==N##T?N##R:a[i]))
4
c_(B,H,r)c_(H,B,a)c_(B,I,r)c_(I,B,a)c_(L,B,a)c_(H,I,r)c_(I,H,a)c_(H,L,r)c_(L,H,
a)c_(I,L,r)c_(L,I,a)cN(L,D,a)cN(D,L,a)
5 A1(flp,Xm(Ay=kv(&x);am(x,y))
6
Xm(Ay=kv(&x);I(ytT>ytA,y=flp(flp(y)))P(!ytA,et2(x,y))Ln=cfm(yA,yn);P(n<0,el2(x,
y))i(yn,Az=ya;I(ztt,y=mut(y);ya=rsh(n,z)))aM(x,y))
7 Xt(enl(enl(x)))P(!xtA||xn,enl(x))Ln=cfm(xA,xn);P(n===-1,enl(x))P(n<0,el1(x))
8 Ct=_t(*xA);I(t<tM,i(xn,Ay=xa;B(yt-
t,t=0)))E(t=0)Ay=aA(n);P(!t,i(n,Az=aA(xn);j(xn,zA[j]=i(xA[j],i))ya=sqz(z))x(y)
)
9 I w=Tz[t];j(n,Az=yA[j]=an(t,xn);
10 S4(w,i(xn,zb=_B(xa)[j]),i(xn,zh=_H(xa)[j]),i(xn,zi=_I(xa)
[j]),i(xn,zl=_L(xa)[j])I(w==4,yA[j]=sqz(mRa(z))))x(y))
11 V tilV(V*p,Ln,I w)
{L*a=p,v=T(0x70605040302010011,0x300020001000011,111<<32,0)[w],
12 d=T(0x80808080808080811,0x400040004000411,211<<32|2,1)[w];LN(a)i(PD((n-
1>>3-w)+1),a),a[i]=v;v+=d})
13 A1(till,P(n<0,n-NL?add(az(n),N(till(-n))):ed0())P(n>1<<30,ez0())Ax=an(tZ(n-
1),n);tilV(xV,n,xt-tB);x)
14 A1(til,Xz(till(gl(x)))XZ(K"
{x((*a)##)'1_a:|*\\|_x,1} ",x))XmM(x(_R(xx)))Xo(val(x))P(!xtA||xn,et1(x))x)
15 A1(whr,Xz(whr(enl(x)))XA(K("${`A~@x;
(&#'*'x), '/x@\\:\\!0|/#'x:@'x;,&x} ",x))Xm(Ay=kv(&x);idx(x,Nx(whr(y))))XM(et1(x
)))
16 XZ(I w=xt-
tB;Ln=0;i(xn,Lv=iw(x,w,i);n+=v;P(n<0||v<0,ed1(x)))Ct=tZ(xn-!xn);P(t>tI,ez1(x))
Ay=an(t,n);
17 xe(S4(Tz[t],{B*a=yV;i(xn,j(iw(x,w,i),*a+=i)}),
{H*a=yV;i(xn,j(iw(x,w,i),*a+=i)}),{I*a=yV;i(xn,j(iw(x,w,i),*a+=i)}),)Y))
18 et1(x))
19
A1(rev,Xm(Ay=kv(&x);am(rev(x),rev(y)))XM(Ay=kv(&x);aM(x,Nx(eac1f(y,rev))))Xt(x)
x=mut(x);Ii=0,j=xn-1,w=xw;
```

```

20
W(i<j,I(!w,SWP(xb,xB[j]))J(w==1,SWP(xh,xH[j]))I(w==2,SWP(xi,xI[j]))E(SWP(xl,xL[j]))I(++;j--)
21 A1(tYP,x(as(TS[xt])))
22 A1(len,x(az(xN)))N_N(Ax/*0*)_(XT(xn)Xm(_N(xy))XM(_n(xy)?_N(*_A(xy)):1)1)
23 S A1(cSI,Q(xtS|xtI)Ct=tS^tI^xt;xr-1?x(aV(t,xn,xV)):AT(t,x))
24 A1(unq,
25 XT(P(xn<2,x)
26 P(xn<<xn<ZP&&!xtA,K("{x@&(x?x)!=#x}",x))
27 P(xtB|xtC,C a[256]=
{}) ;Ay=an(xt,0);i(xn,I(!a[UI)xc],a[UI)xc]=1;y=apc(y,xc))x(y))
28 XS(cSI(unq(cSI(x))))
29 K("{x@i@<i@:&@[;0::;1]@~~':x@i:<x}",x)
30 XM(enl(x))
31 Xm(unq(val(x)))
32 Xz(Ln=gl(x);P(n<0,ed0())rndD(n))
33 et1(x))
34 A2(fil,YmMA(eac2f(x,y,exc))YF(y==au?x:x(y))Yt(fir(fil(x,enl(y))))K("
{@[y;&^y::;x]}",x,y))
35 A2(exc,Xt(fil(x,y))P(xtmM|ytmM,en2(x,y))Yt(exc(x,enl(y)))P(!xn||!yn,y(x))
36 Ik=rnk(x);k>0&&k==rnk(y)?K("{x@&^y?x}",x,y):K("{x@~&(~!0),x~\y}/",x,y))
37 A wdn(Ax,Ni,Nj,Nn)(Ct=xt;Q(xtZC);Ay=an(t+1,n);xe(T(&cBH,cHI,cIL,cLD,0,cBH)
[t-tB](xv+TZ[t]*i,yV,j-1);y))
38 A1(cC, XC(x)x=N(cb(x));Xt(ac((C)xv))AT(tC,mut(x)))
39 A1(cb, XB(x)x=N(cl(x));Xt(x)Ay=an(tB,xn);xe(cIB(xV,yV,yn);y))
40 A1(ch, XH(x)x=N(cl(x));Xt(x)Ay=an(tH,xn);xe(cIH(xV,yV,yn);y))
41 A1(cl, XI(x)Xzc(ai(gl(x)))Xdd(cl(N(cl(x))))XZC(Ay=aI(xn);Ii=xt-
tB;xe(T(&cBI,cHI,0,cLI,0,cBI)[i](xV,yV,yn);y))et1(x))
42
A1(cl,XLL(x)Xzc(al(gl(x)))Xt(fir(N(cl(enl(x)))))XD(Ay=aL(xn);xe(cDL(xV,yV,yn);y
))x=N(cl(x));Ay=aL(xn);xe(cIL(xV,yV,yn);y))
43
A1(cD,XdD(x)Xzc(ad(gl(x)))Xt(fir(N(cd(enl(x)))))x=N(cl(x));Ay=aD(xn);xe(cLD(xV,
yV,yn);y))
44 A1(cs,Xss(x)XC(x=str0(x);x(sym(xV)))Xc(as(xv))P(xtA&&!xn,x(oS))pen(x,cs))
45 A1(pI,Xc(pI(enl(x)))XC(x=str0(x);Qs=xV;P(!*s,x(R(cn[tl])))Lv=pl(&s);x(*s?
_R(cn[tl]):az(v)))pen(x,pI))
46 A1*cT[ ]={[tA]=[ca,cb,ch,cl,cd,cc,cs];
47 A1(csti,XD(sqzz(cl(x)))Xd(az(gd(x)))XC(sqzz(cb(x)))Xc(ai(xv))Xzz(x)et1(x))
48 A2(cst,P(xtS|ytmMA,eac2f(x,y,cst)))
49 Xz(YC(K("{y@(!x)+(x<0)*#y"),x,y))Yc(cst(x,enl(y)))et2(x,y))
50 Xs(Iv=xV;P(v-(C)v,ed1(y))T(&csti,cd,cc,cs,pI,ed1)[si("idcsI",v+'s'*!v)](y))
51 et2(x,y))
52 A1(sqzz,XH(i(xn,P(xh-(B)xh,x))cb(x))XI(i(xn,P(xi-
(H)xi,x))sqzz(ch(x)))XL(i(xn,P(xl-(I)xl,x))sqzz(cl(x)))x)
53
A1(sqz,P(!xtA|!xn,x)Nn=xn;Ay=xx;Ct=yt;Ym(y=oA;i(n,yq(R(xa)))x(y))P(!c3(ti,t,s),x)
54 I(ytz,I l=0;i(n,Ay=xa;I(yt1,l=1)E(P(!yti,x)))
55 I(l,t=tL)E(I
a=0,b=0;i(n,Ay=xa;a=min(a,yV);b=max(b,yV))t=max(tZ(a),tZ(b)))
56 E(i(n,P(t-t(xa),x)))
57 y=an(TT[t],n);Iv=yw;I(v<3,T(&cLB,cLH,cLI)[v]
(xV,yV,n))E(i(n,yl=gl_(xa)))x(y))
58 A1(ca,XA(x)Xt(al(x))Xm(et1(x))Nn=xN;Ay=aA(n);i(yn,ya=ii(x,i))x(y))
59 L tru(Ax/*1*)_(Lv=xtF?x!=au:xtt?gl_(x):xN;x(0);v)

```

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## **vim-c/ - ngnksource**

- [ftdetect/](#)
- [ftplugin/](#)
- [syntax/](#)

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## **vim-c/ftdetect/ - ngnksource**

- [n.vim](#)

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## **vim-c/ftdetect/n.vim - ngnksource**

```
1 au bufread,bufnewfile *.{c,h} if getline(1).getline(2) =~ 'ngn' |se ft=n|en
```

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## **vim-c/ftplugin/ - ngnksource**

- [n.vim](#)

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## vim-c/ftplugin/n.vim - ngnksource

```
1 setl cms="//%s sw=1 ts=1 sts=1 pa+=/usr/include
2 inore a #i #include
3 inore a #d #define
4 inore a #u #undef
```

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## **vim-c/syntax/ - ngnksource**

- [n.vim](#)

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## vim-c/syntax/n.vim - ngnksource

### Global variables defined

- [b:current syntax](#)

### Source code

```
1 sy clear |sy sync fromstart |sy case match
2
3 fu!s:R(x)
4 let x=a:x|let r=[['\<g=','matchgroup='],[ '\<s=','start='],[ '\<e=','end=' ],
[ '\<c=','contains='],[ '\<sk=','skip=']]
5 for[u,v]in r|let x=substitute(x,u,v,'g')|endfo
6 exe 'sy region '.x
7 endf
8 com -nargs=1 H hi def link <args>
9 com -nargs=1 M sy match <args>
10 com -nargs=1 K sy keyword <args>
11 com -nargs=1 R cal s:R(<f-args>)
12 M n_comment "//[^r\n]*\\|/*_.\\{-}\\*/"
    |H n_comment comment
13 R n_h s="# sk="\\\n" e="\r\\|\n" c=n_comment
    |H n_h preproc
14 M n_string '/\\\\=.\\|\"\\([^\\""]\\|\\.\\)*"/ contains=n_e
    |H n_string string
15 M n_e "\\\\"(x\x\x\\|.\\)" contained
    |H n_e special
16 K n_k TD S SN NI O ST EX BR CO SW CA __attribute__ asm enum do struct union
for if else extern
17     \ switch case default break continue return goto
        |H n_k statement
18 K n_t A0 A1 A2 A3 A4 AA AX AL AAL AQ nextgroup=n_vv
    |H n_t normal
19 K n_r return continue
    |H n_r n_d_rr
20 R n_aa g=n_a s="( "
    contained |H n_a nontext
21 R n_bb g=n_b s="\[ "
    contained |H n_b n_a
22 R n_cc g=n_c s="{" "
    contained |H n_c n_a
23 R n_pp g=n_p s="\v<(P|E[a-z]|XY)\w{,4})\\(" "
    contained |H n_p function
24 R n_ff g=n_f s="\<\\([ijWF]\\|i4\\)("
    contained |H n_f special
25 R n_ii g=n_i s="\<\\([IJEBUCD]\\|C\\d\\)("
    contained |H n_i type
26 R n_vv g=n_v s="(\\\w\\|\\ )*,"
    |H n_v statement
27 R n_uu g=n_u s="\<_("
    |H n_u n_v
28 sy cluster n_x
contains=n_comment,n_h,n_string,n_k,n_t,n_r,n_aa,n_bb,n_cc,n_pp,n_ff,n_ii
29 delc H|delc M|delc K|delc R|delf!s:R
30 let b:current_syntax='n'
```

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## **vim-k/ - ngnksource**

- [ftdetect/](#)
- [ftplugin/](#)
- [syntax/](#)

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## **vim-k/ftdetect/ - ngnksource**

- [k.vim](#)

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## **vim-k/ftdetect/k.vim - ngnksource**

```
1 au bufread,bufnewfile *.k se ft=k
```

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## **vim-k/ftplugin/ - ngnksource**

- [k.vim](#)

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## vim-k/ftplugin/k.vim - ngnksource

```
1 setl sw=1 ts=1 sts=1 inc=^\\" cms=/%s inde=KIndent(v:lnum)
2 fu!KIndent(l)
3 let p=prevnonblank(v:lnum-1)|let s=getline(p)
4 if s=~'[(\{\} *\\(.*)\\=$'|retu indent(p)+1|en
5 if s=~'[]\\}]*\\(.*)\\=$'|retu 0|en
6 let n=len(s)|let i=0|let t=[]
7 wh i<n
8   let c=s[i]
9   if c=='' | let i+=1|wh i<n&&s[i]!=' '|let i+=1+
(s[i]=='\')|endw
10  elsei c=='/'&&(!i||s[i-1]==' ')|break
11  elsei c==='[({}' |cal add(t,i+1)
12  elsei c==='[]}')' |if len(t)>0|cal remove(t,-1)|en
13  en
14  let i+=1
15 endw
16 retu len(t)?t[-1]:indent(p)
17 endf
```

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## **vim-k/syntax/ - ngnksource**

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## vim-k/syntax/k.vim - ngnksource

### Global variables defined

- [b:current syntax](#)

### Source code

```
1 if exists('b:current_syntax')|fini|en|sy clear|sy case match |sy sync
fromstart |if&l:syn=='k'|setl com=:/ isk=a-z,A-Z,48-57 isi=a-z,A-Z,48-57|en
2 sy match k_e /\i\+\|\s/
3 sy match k_s /\^\(\I\i*\>\|:[A-Za-z0-9.:/]*\)\=\)/
nextgroup=@k_vw |hi link k_s constant
4 sy match k_w /[\\\\\']/\=/
nextgroup=k_w contained |hi link k_w operator
5 sy match k_c1 /.+/
contained |hi link k_c1 special
6 sy match k_c0 /\\\(\w\+\|\\\\|$\\)/
nextgroup=k_c1 |hi link k_c0 statement
7 sy match k_c0 /\\\[tw]\>(:\d\+\)\=/
8 sy match k_e //"
nextgroup=k_es |hi link k_e error
9 sy match k_es /.*/
nextgroup=@k_vw contained |hi link k_es k_string
10 sy match k_string /\(\.\|\[^"\n]\)*"/
nextgroup=@k_vw contains=k_q |hi link k_string string
11 sy match k_q /\.\/
contained |hi link k_q specialchar
12 sy match k_u /[+-*%!&|>=~,\#$_?@.\x80-\U000fffff]:\=/
nextgroup=k_w |hi link k_u function
13 sy match k_v /[+-*%!&|>=~,\#$_?@.\x80-\U000fffff]:\=/
nextgroup=k_w contained |hi link k_v type
14 sy match k_n /\v=\d+([bNnw]|(\.\d+)=(e=\d+)=)=/
nextgroup=@k_vw |hi link k_n number
15 sy match k_i /\I\i*\(\.\|=|\I\i*\)*/
nextgroup=@k_vw |hi link k_i variable
16 sy match k_x /\<[oxyz]\>/
nextgroup=@k_vw |hi link k_x special
17 sy match k_string /\<0x\(\x\x\)*\>/
nextgroup=@k_vw
18 sy match k_u /\d::\=/
nextgroup=k_w
19 sy match k_v /\s*\d::\=/
nextgroup=k_w contained
20 sy match k_g /:/ |hi link k_g statement
21 sy region k_ar matchgroup=k_a start=/() end=// noncontext
nextgroup=@k_vw contains=@k_k,k_aj,k_ae |hi link k_a
22 sy region k_br matchgroup=k_b start=/\[ end=]/ k_a
nextgroup=@k_vw contains=@k_k,k_bj,k_be |hi link k_b
23 sy region k_cr matchgroup=k_c start=/\(\[\^]\]*\)\=\) end=// special
nextgroup=@k_vw contains=@k_k,k_cj,k_ce |hi link k_c
24 sy match k_ae /[]\}/ contained |hi link k_ae k_e
25 sy match k_be /[]\}/ contained |hi link k_be k_e
```

```

26 sy match k_ce /[]]/|
  contained           |hi link k_ce      k_e
27 sy match k_aj //|
  contained           |hi link k_aj      k_a
28 sy match k_bj //|
  contained           |hi link k_bj      k_b
29 sy match k_cj //|
  contained           |hi link k_cj      k_c
30 sy match k_t  /\|/
  contained           |hi link k_t       k_u
31 sy region k_comment matchgroup=k_comment start=/\(^\/\| \|\^|\%#\!\/)/
end=/$/               |hi link k_comment comment
32 sy region k_comment matchgroup=k_comment start=/^\/$/|
end=/^\\\$/|
33 sy region k_comment matchgroup=k_comment start=/^\\\$/|
end=/^%\$/|
34 sy cluster k_vw contains=k_v,k_w
35 sy cluster k_k
contains=k_e,k_s,k_u,k_w,k_c0,k_i,k_x,k_comment,k_n,k_string,k_g,k_ar,k_br,k_cr
,k_t
36 let b:current_syntax='k'

```

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## x.c - ngnksource

### Macros defined

- [h](#)
- [h1](#)
- [h8](#)

### Source code

```
1 #include "a.h" // ngn/k, (c) 2019-2022 ngn, GNU AGPLv3 -
https://codeberg.org/ngn/k/raw/branch/master/LICENSE
2
3 //serialize
4 S A f8(Lv,Ay)_cts(y,(V*)&v,8))
5 S A2(f,y=Nx(apc(y,xt));
6 P(xtA|xtS,y=Nx(f8(xn,y));i(xn,y=Nx(f(ii(x,i),y)))x(y))
7 XmMA(f(AT(tA,mut(x)),y))
8 Xs(Lv=xv;Qs=qs(&v);In=Sn(s)+1;y=Nx(apc(y,n));cts(y,s,n))
9 XP(f8(x,y))
10 Xr(f(AT(tA,mut(x)),Nx(apc(y,xE<<3|xk))))
11 XF(f(AT(tA,mut(x)),Nx(apc(y,xv<<3|xk))))
12 In=8*xtT;x(cts(y,xV-n,n+xn*xW)))
13 A1(des,f(x,OC))
14
15 //deserialize
16 S C*s,*p;
17 #define h(n) ({P(p-s<n,ed0());C*r=s;s+=n;r;})
18 #define h1 (*(C*)h(1))
19 #define h8 (*(L*)h(8))
20 S A0(g,Ct=h1;P(!in(t,tn),ed0()))
21
22 P(t==tA|t==tS,Ln=h8;P(!in(n,111<<45),ed0())Ax=AN(0,an(t,n));i(n,xq(Nx(g()))))x
23 P(t==tm|t==tM,Ax=N(g()));P(!xtA|xn-2||t(xx)>tM||t(xy)>tM||_N(xx)-
_N(xy),ed0())AT(t,mut(x)))
24 P(t==ts,Nn=h1;sym(h(n)))
25 P(TP(t),h8)
26 P(t==tr,Cc=h1;AT(t,AK(c&7,AW(c>>3,N(g())))))
27 P(TF(t),Cc=h1;AT(t,AK(c&7,AV(c>>3,N(g())))))
28 Ln=t<tm?h8:1;P(!in(n,111<<45),ed0())aV(t,n,h(n*TZ[t])))
29 A1(des,XC(s=xV;p=s+xn;x(g())))ed1(x))
```

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