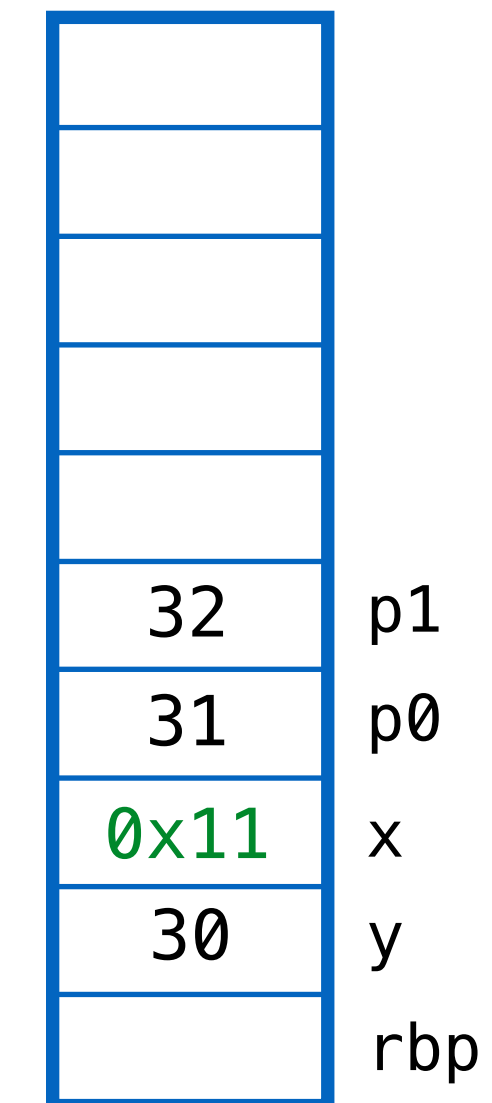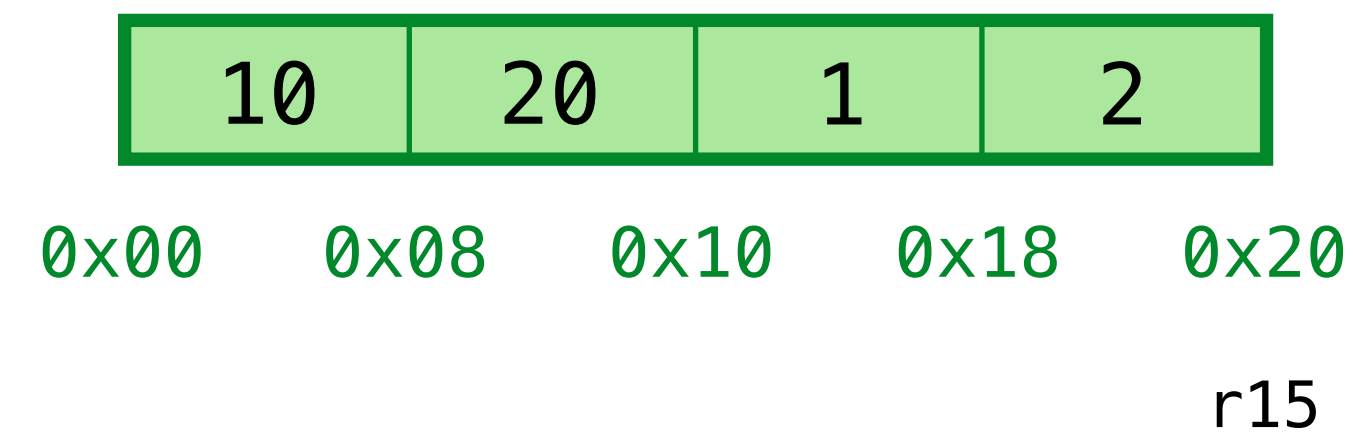ex2: garbage in the middle

```
let y  = let tmp = (10, 20)
          in tmp[0] + tmp[1]
  , x  = (1, 2)
  , p0 = x[0] + y
  , p1 = x[1] + y
in
  (p0, p1)
```

32	p1
31	p0
0x11	x
30	y
	rbp

Lets reclaim & recycle garbage!

10	20	1	2

0x00   0x08   0x10   0x18   0x20

r15
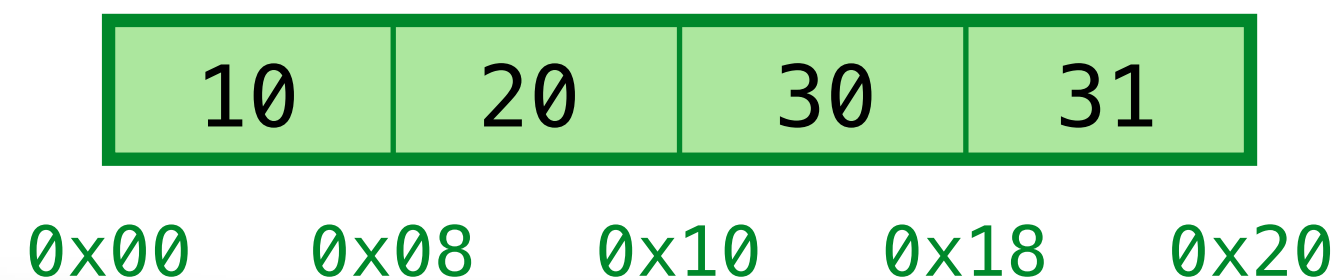
QUIZ: Which cells are garbage?

(A) `0x00, 0x08` (B) `0x08, 0x10` (C) `0x18, 0x20` (D) None (E) All

ex3: garbage in the middle (with stack)

```
def foo(p, q):
    let tmp = (p, q)
    in tmp[0] + tmp[1]

let y  = foo(10, 20)
  , x  = (y, y + 1)
  , z  = foo(100, 200)
in
    x[0] + z
```

	rsp
rbp0	rbp
retaddr1	
100	p
200	q
0x11	x
30	y

rbp0

Lets reclaim & recycle garbage!

10	20	30	31
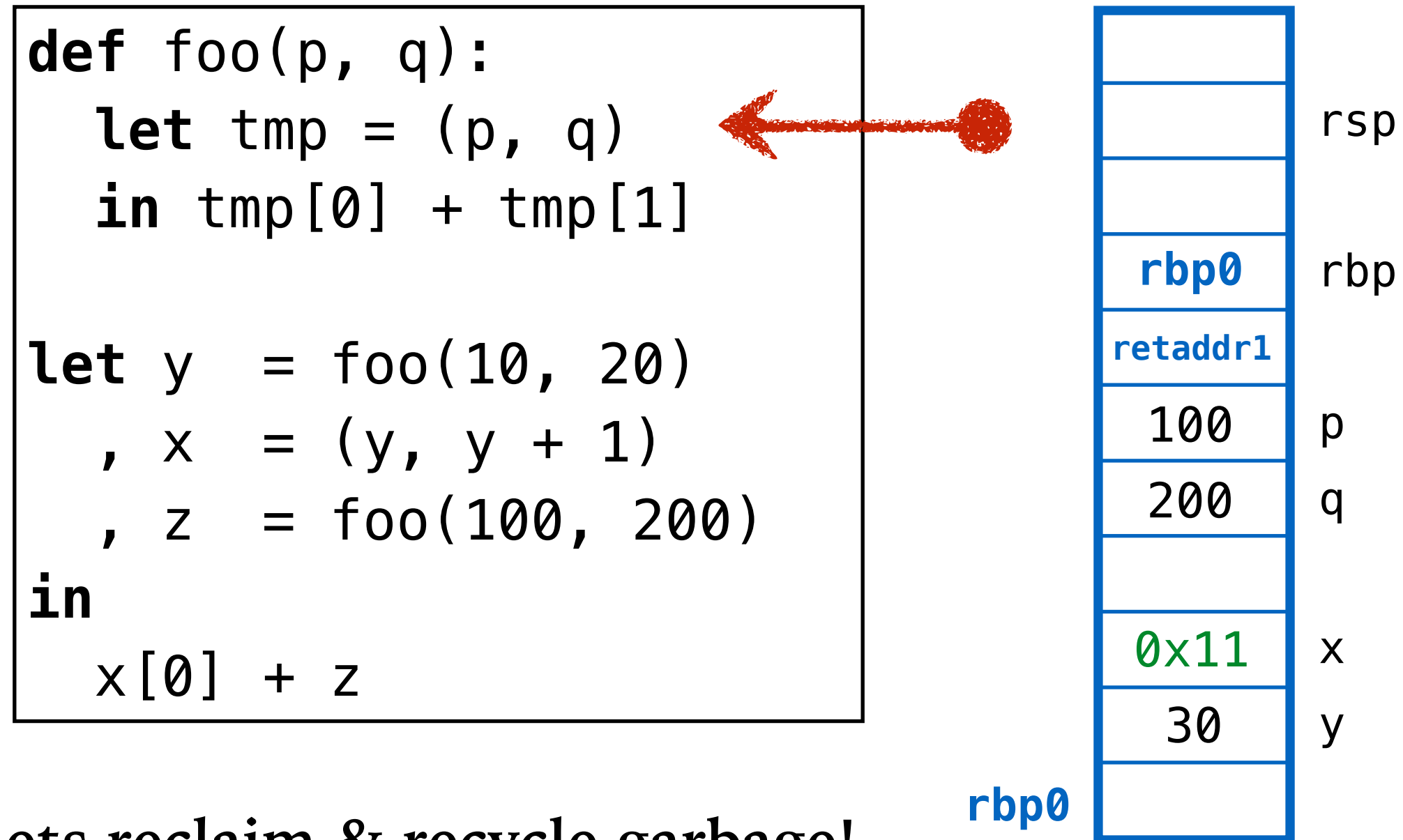
0x00   0x08   0x10   0x18   0x20

QUIZ: Which cells are garbage?

(A) `0x00, 0x08` (B) `0x08, 0x10` (C) `0x10, 0x18` (D) None (E) All

ex4: recursive data

```
def range(i, j):
  if (j <= i): false else: (i,range(i+1, j))

def sum(l):
  if l == false: 0 else: l[0] + sum(l[1])

let t1 =
        let l1 = range(0, 3)     ⟵————————————⬤
        in sum(l1)
   , l  = range(t1, t1 + 3)
in
  (1000, l)
```

rsp

rbp
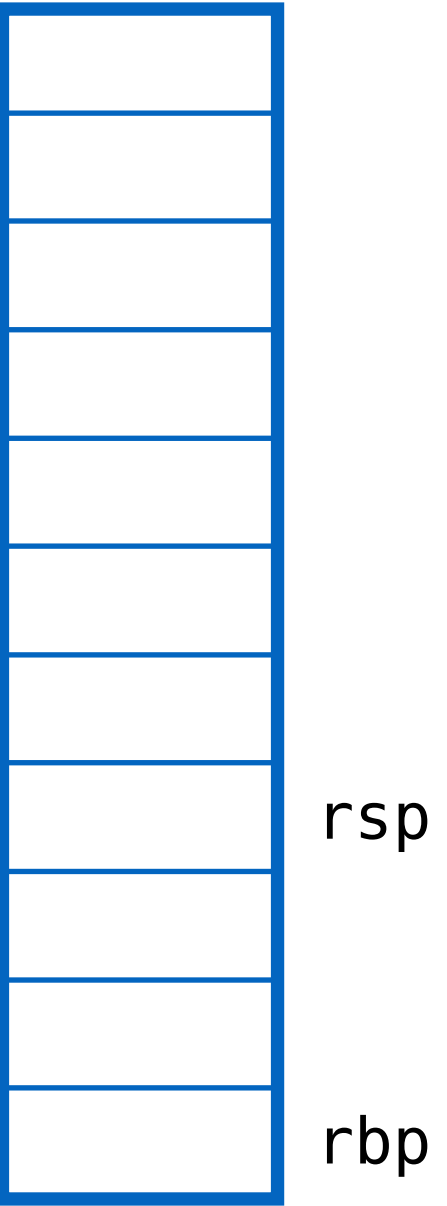
QUIZ: What is heap when `range(0,3)` returns?

r15

(A)

0	0x11	1	0x21	2	false							

0x00   0x08   0x10   0x18   0x20   0x28   0x30   0x38   0x40   0x48   0x50   0x58   0x60

r15

(B)

2	false	1	0x01	0	0x11							

0x00   0x08   0x10   0x18   0x20   0x28   0x30   0x38   0x40   0x48   0x50   0x58   0x60

ex4: recursive data

```
def range(i, j):
  if (j <= i): false else: (i, range(i+1, j))

def sum(l):
  if l == false: 0 else: l[0] + sum(l[1])

let t1 =
        let l1 = range(0, 3)
        in sum(l1)
  , l  = range(t1, t1 + 3)
in
  (1000, l)
```
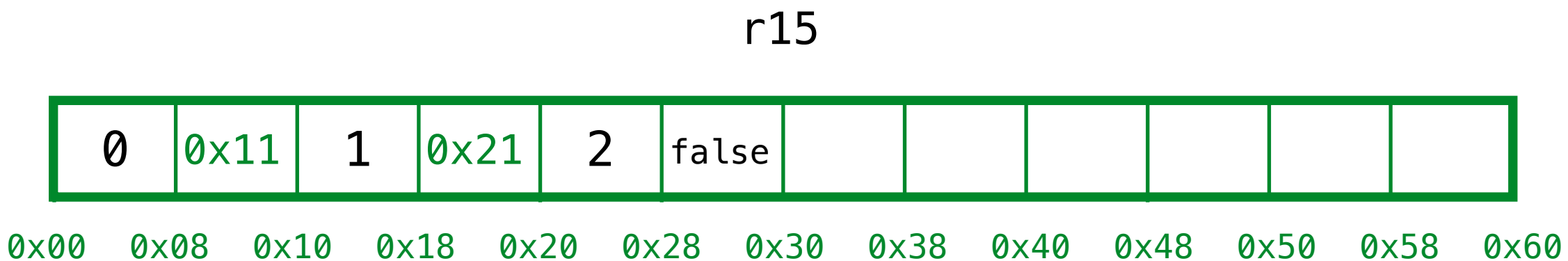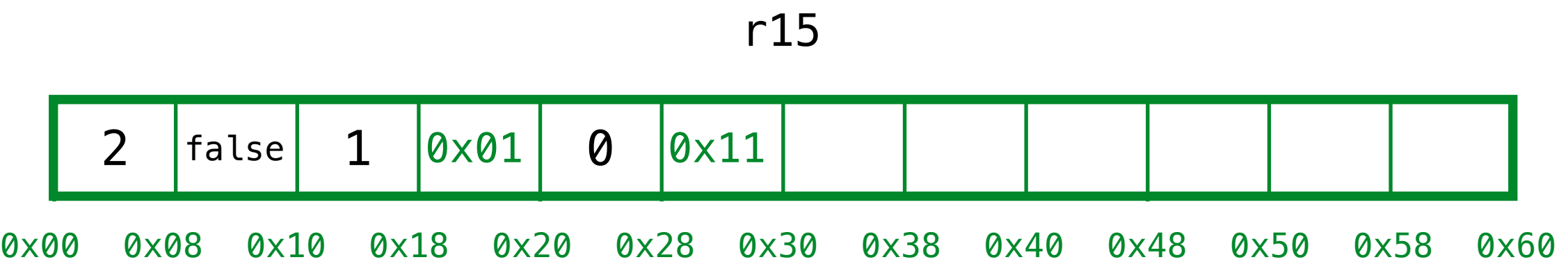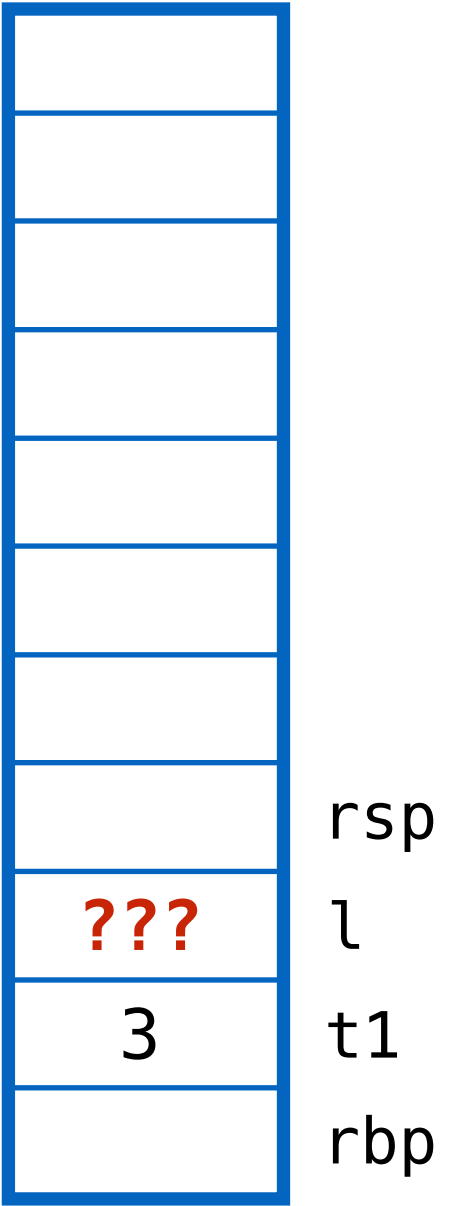
call range(3,6)

	rsp
???	l
3	t1
	rbp

r15

2	false	1	0x01	0	0x11	5	false	4	0x31	3	0x41

0x00   0x08   0x10   0x18   0x20   0x28   0x30   0x38   0x40   0x48   0x50   0x58   0x60
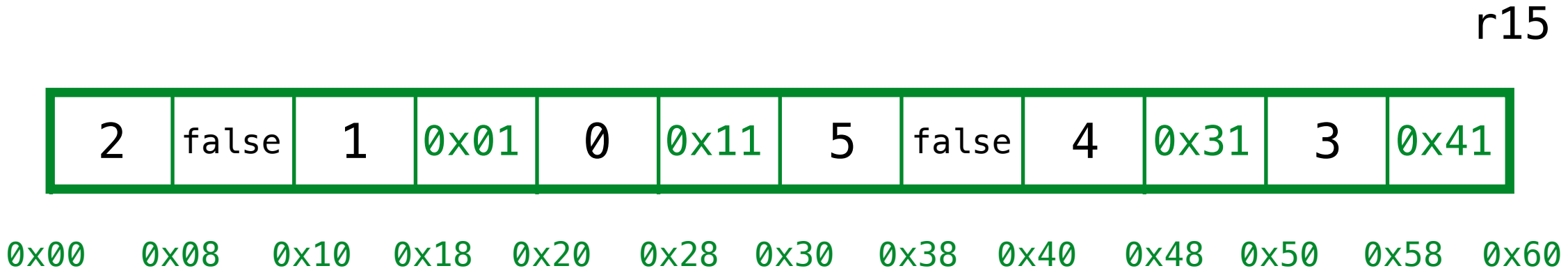
QUIZ: What is the value of l?

(A) 0x30 (B) 0x31 (C) 0x50 (D) 0x51 (E) 0x60

ex4: recursive data

QUIZ: Which cells are "live" on the heap?

(A) 0x00

(B) 0x10

(C) 0x20

(D) 0x30

(E) 0x40

(F) 0x50

	rsp
0x51	l
3	t1
	rbp

r15

2	false	1	0x01	0	0x11	5	false	4	0x31	3	0x41

0x00   0x08   0x10   0x18   0x20   0x28   0x30   0x38   0x40   0x48   0x50   0x58   0x60

QUIZ: What should `print(0x21)` **show?**

```
(A) (0, (1, (2, false)))
(B) (3, (4, (5, false)))
(C) (0, (1, (2, (3, (4, (5, false))))))
(D) (3, (4, (5, (0, (1, (2, false))))))
(E) (2, (1, (0, (3, (4, (5, false))))))
```

rsp

0x21	l
3	t1
	rbp

r15

2	0x51	1	0x01	0	0x11	5	false	4	0x31	3	0x41

0x00   0x08   0x10   0x18   0x20   0x28   0x30   0x38   0x40   0x48   0x50   0x58   0x60

ex4: recursive data

QUIZ: Which cells are "live" on the heap?

(A) 0x00

(B) 0x10

(C) 0x20

(D) 0x30

(E) 0x40

(F) 0x50

	rsp
0x51	l
3	t1
	rbp

r15

2	0x51	1	0x01	0	0x11	5	false	4	0x31	3	0x41

0x00 0x08 0x10 0x18 0x20 0x28 0x30 0x38 0x40 0x48 0x50 0x58 0x60