

CS381 HW6

Problem 1. Runtime Stack

```
3  [z=4, x=?]
4  [f={}, z=4, x=?]
11 >>
5  [x=3, f={}, z=4, x=?]
8  >>
5  [x=2, x=3, f={}, z=4, x=?]
8  >>
5  [x=1, x=2, x=3, f={}, z=4, x=?]
8  >>
5  [x=0, x=1, x=2, x=3, f={}, z=4, x=?]
6  [x=0, x=1, x=2, x=3, f={}, z=1, x=?]
9  [res=1 x=0, x=1, x=2, x=3, f={}, z=1, x=?]
    <<
8  [x=1, x=2, x=3, f={}, z=3, x=?]
9  [res=3 x=1, x=2, x=3, f={}, z=3, x=?]
    <<
8  [x=2, x=3, f={}, z=11, x=?]
9  [res=11 x=2, x=3, f={}, z=11, x=?]
    <<
8  [x=3, f={}, z=123, x=?]
9  [res=123 x=3, f={}, z=123, x=?]
    <<
11 [f={}, z=123, x=123]
12 [z=123, x=123]
13 []
```

Problem 2. Static and Dynamic Scope

STATIC

```
4  [z=?, y=?, x=4]
5  [z=?, y=6, x=4]
6  [f={}, z=?, y=6, x=4]
8  [y=13, f={}, z=?, y=6, x=4]
9  [g={}, y=13, f={}, z=?, y=6, x=4]
11 [y=14, g={}, y=13, f={}, z=?, y=6, x=4]
12 >>
9  [x=3, y=14, g={}, y=13, f={}, z=?, y=6, x=4]
    >>
    [y=13, x=3, y=14, g={}, y=13, f={}, z=?, y=6, x=4]
```

```

6      [res=52 y=13, x=3, y=14, g={}, y=13, f={}, z=?, y=6, x=4]
      <<
      [x=3, y=14, g={}, y=13, f={}, z=?, y=6, x=4]
9      [res=52 x=3, y=14, g={}, y=13, f={}, z=?, y=6, x=4]
      <<
12     [y=14, g={}, y=13, f={}, z=52, y=6, x=4]
13     [g={}, y=13, f={}, z=52, y=6, x=4]
14     [y=13, f={}, z=52, y=6, x=4]
15     [z=52, y=6, x=4]
16     []

```

DYNAMIC

```

4     [z=?, y=?, x=4]
5     [z=?, y=6, x=4]
6     [f={}, z=?, y=6, x=4]
8     [y=13, f={}, z=?, y=6, x=4]
9     [g={}, y=13, f={}, z=?, y=6, x=4]
11    [y=14, g={}, y=13, f={}, z=?, y=6, x=4]
12    >>
9     [x=3, y=14, g={}, y=13, f={}, z=?, y=6, x=4]
      >>
      [y=14, x=3, y=14, g={}, y=13, f={}, z=?, y=6, x=4]
6     [res=42 y=14, x=3, y=14, g={}, y=13, f={}, z=?, y=6, x=4]
      <<
      [x=3, y=14, g={}, y=13, f={}, z=?, y=6, x=4]
9     [res=42 x=3, y=14, g={}, y=13, f={}, z=?, y=6, x=4]
      <<
12    [y=14, g={}, y=13, f={}, z=42, y=6, x=4]
13    [g={}, y=13, f={}, z=42, y=6, x=4]
14    [y=13, f={}, z=42, y=6, x=4]
15    [z=42, y=6, x=4]
16    []

```

ANSWER:

- a. z = 52
- b. z = 42

Problem 3. Parameter Passing

Call-by-Name (a and x)

```
3   [z=?, y=6]
4   [f={}, z=?, y=6]
8   [g={}, f={}, z=?, y=6]
13  >>
9      [x=y*2, g={}, f={}, z=?, y=6]    |    x=>12
      >>
          [a=x+1, x=y*2, g={}, f={}, z=?, y=6]    |    a=>13, x=>12
5      [a=x+1, x=y*2, g={}, f={}, z=?, y=14]    |    a=>29, x=>28
6      [res=43, a=x+1, x=y*2, g={}, f={}, z=?, y=14]    |    a=>29,
x=>28
      <<
9      [x=y*2, g={}, f={}, z=?, y=45]    |    x=>90
10     >>
          [a=x-y+2, x=y*2, g={}, f={}, z=?, y=45]    |    a=>47, x=>90
5      [a=x-y+2, x=y*2, g={}, f={}, z=?, y=48]    |    a=>50, x=>96
6      [res=98, a=x-y+2, x=y*2, g={}, f={}, z=?, y=48]    |    a=>50,
x=>96
      <<
10     [x=y*2, g={}, f={}, z=98, y=48]    |    x=>96
11     [res=99, x=y*2, g={}, f={}, z=98, y=48]    |    x=>96
      <<
13     [g={}, f={}, z=99, y=48]
14     [z=99, y=48]
15     []
```

Call-by-Need (a and x)

```
3   [z=?, y=6]
4   [f={}, z=?, y=6]
8   [g={}, f={}, z=?, y=6]
13  >>
      [x=y*2, g={}, f={}, z=?, y=6]
9      >>
          [a=x+1, x=y*2, g={}, f={}, z=?, y=6]
5      [a=13, x=12, g={}, f={}, z=?, y=14]
6      [res=27, a=13, x=12, g={}, f={}, z=?, y=14]
      <<
9      [x=12, g={}, f={}, z=?, y=29]
10     >>
```

```
    [a=x-y+2, x=12, g={}, f={}, z=?, y=29]
5    [a=-15, x=12, g={}, f={}, z=?, y=-14]
6    [res=-29, a=-15, x=12, g={}, f={}, z=?, y=-14]
    <<
10   [x=12, g={}, f={}, z=-29, y=-14]
11   [res=-28, x=12, g={}, f={}, z=-29, y=-14]
    <<
13   [g={}, f={}, z=-28, y=-14]
14   [z=-28, y=-14]
15   []
```

ANSWER:

- a. $z = 99, y = 48$
- b. $z = -28, y = -14$