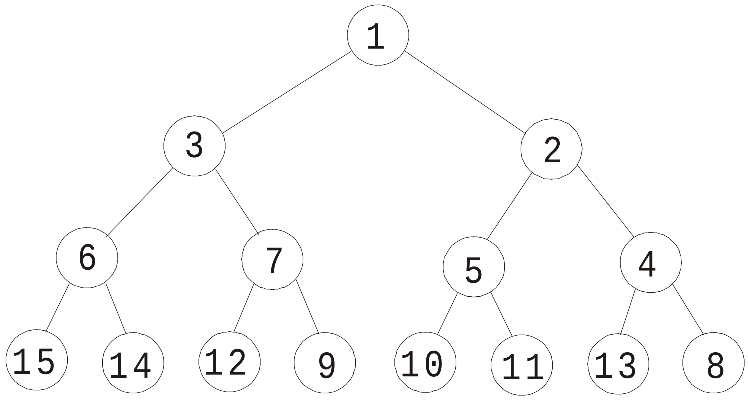
p.212 6.2

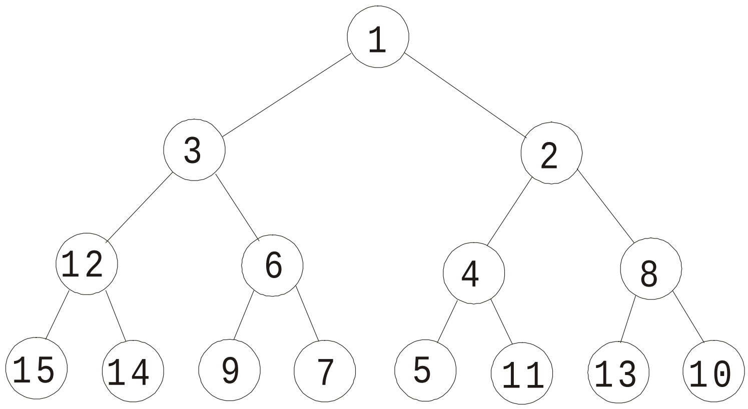
a. Show the result of inserting 10, 12, 1, 14, 6, 5, 8, 15, 3, 9, 7, 4, 11, 13, and 2, one at a time, into an initially empty binary heap.

b. Show the result of using the linear-time algorithm to build a binary heap using the same input.

a.



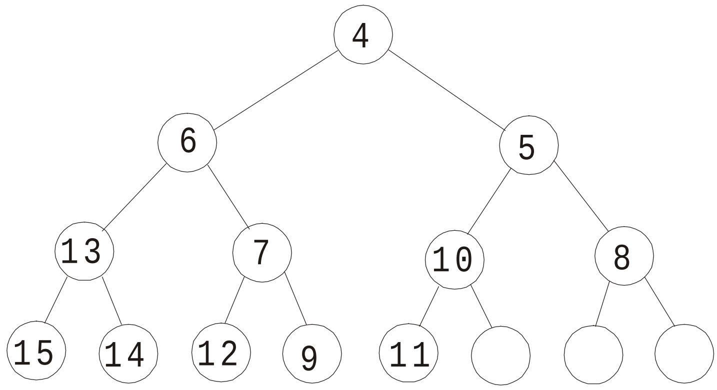
b.



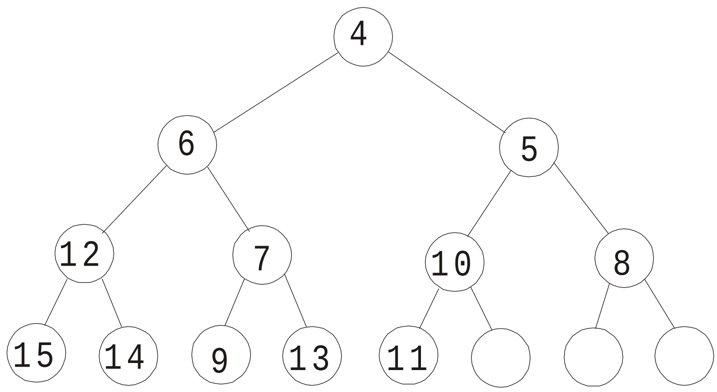
p.212 6.3

Show the result of performing three DeleteMin operations in the heap of the previous exercise.

a.



b.



p.212 6.4

Write the routines to do a "percolate up" and a "percolate down" in a binary heap.

```
void PercolateUp( int p, PriorityQueue H )
{
      ElementType   Tmp = H->Elements[ p ];    /* save this key */

      for ( ; H->Elements[ p / 2 ] > Tmp; p /= 2 )    /* as long as parent is larger */
              H->Elements[ p ] = H->Elements[ p / 2 ]; /* percolate up */

      H->Elements[ p ] = Tmp;    /* save this key at the proper position */
}
```

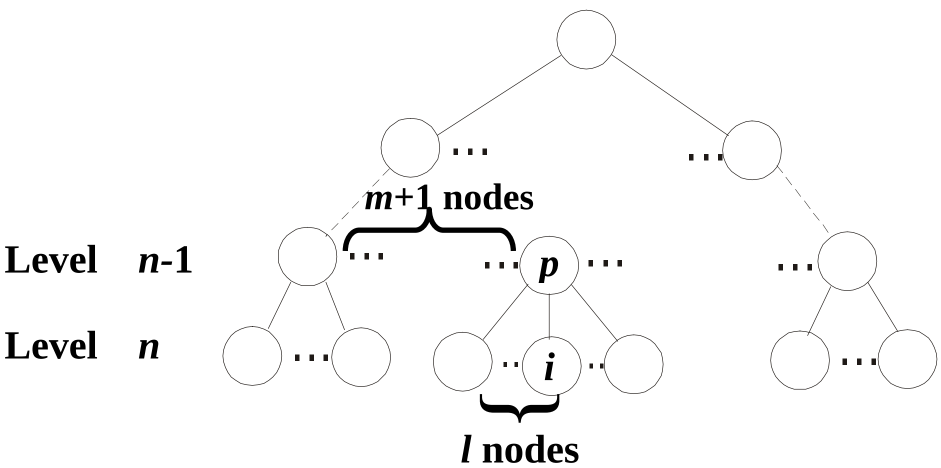
```
void PercolateDown( int p, PriorityQueue H )
{
    int   child;
    ElementType   Tmp = H->Elements[ p ];    /* save this key */

    for ( ; p * 2 <= H->Size; p = child ) {
        /* Find smaller child */
        child = p * 2;
        if ( child != H->Size && H->Elements[ child + 1 ] < H->Elements[ child ] )
            child++;
        /* percolate down one level */
        if ( H->Elements[ child ] < Tmp )
            H->Elements[ p ] = H->Elements[ child ];
        else
            break;
    }
    H->Elements[ p ] = Tmp; /* save this key at the proper position */
}
```

p.213 6.13

If a d-heap is stored as an array, for an entry located in position i, where are the parents and children?

Answer



Assume k_n to be the number of nodes in a full d-heap of height n. Then

$$k_n = 1 + d + d^2 ... + d^n = \frac{d^{n+1} - 1}{d - 1}$$

That is, $k_{n-1} = \frac{d^n - 1}{d - 1}$. For any node on level n, there exist integers m and l such that $i = k_{n-1} + md + l$.

Since $p = k_{n-2} + m + 1 \quad \Rightarrow \quad m = p - \frac{d^{n-1} - 1}{d - 1} - 1$, **we obtain**

$$i = \frac{d^n - 1}{d - 1} + (p - \frac{d^{n-1} - 1}{d - 1} - 1)d + l$$

That is, $i = (p-1)d + 1 + l$, **where** $l = d$ **if** $i \,\%\, d = 0$, **or** $l = i \,\%\, d$ **otherwise.**