The generator object keeps track of where it is in the sequence, so the for loop picks up where next left off. Once the generator is exhausted, it continues to raise StopException:

```
>>> next(g)
StopIteration
```

Generator expressions are often used with functions like sum, max, and min:

```
>>> sum(x**2 for x in range(5))
30
```

any and all

Python provides a built-in function, any, that takes a sequence of boolean values and returns True if any of the values are True. It works on lists:

```
>>> any([False, False, True])
True
```

But it is often used with generator expressions:

```
>>> any(letter == 't' for letter in 'monty')
True
```

That example isn't very useful because it does the same thing as the in operator. But we could use any to rewrite some of the search functions we wrote in "Search" on page 101. For example, we could write avoids like this:

```
def avoids(word, forbidden):
    return not any(letter in forbidden for letter in word)
```

The function almost reads like English: "word avoids forbidden if there are not any forbidden letters in word."

Using any with a generator expression is efficient because it stops immediately if it finds a True value, so it doesn't have to evaluate the whole sequence.

Python provides another built-in function, all, that returns True if every element of the sequence is True. As an exercise, use all to rewrite uses_all from "Search" on page 101.

Sets

In "Dictionary Subtraction" on page 156 I use dictionaries to find the words that appear in a document but not in a word list. The function I wrote takes d1, which contains the words from the document as keys, and d2, which contains the list of words. It returns a dictionary that contains the keys from d1 that are not in d2:

```
def subtract(d1, d2):
    res = dict()
    for key in d1:
        if key not in d2:
            res[key] = None
    return res
```

In all of these dictionaries, the values are `None` because we never use them. As a result, we waste some storage space.

Python provides another built-in type, called a `set`, that behaves like a collection of dictionary keys with no values. Adding elements to a set is fast; so is checking membership. And sets provide methods and operators to compute common set operations.

For example, set subtraction is available as a method called `difference` or as an operator, `-`. So we can rewrite `subtract` like this:

```
def subtract(d1, d2):
    return set(d1) - set(d2)
```

The result is a set instead of a dictionary, but for operations like iteration, the behavior is the same.

Some of the exercises in this book can be done concisely and efficiently with sets. For example, here is a solution to `has_duplicates`, from Exercise 10-7, that uses a dictionary:

```
def has_duplicates(t):
    d = {}
    for x in t:
        if x in d:
            return True
        d[x] = True
    return False
```

When an element appears for the first time, it is added to the dictionary. If the same element appears again, the function returns `True`.

Using sets, we can write the same function like this:

```
def has_duplicates(t):
    return len(set(t)) < len(t)
```

An element can only appear in a set once, so if an element in `t` appears more than once, the set will be smaller than `t`. If there are no duplicates, the set will be the same size as `t`.

We can also use sets to do some of the exercises in Chapter 9. For example, here's a version of `uses_only` with a loop:

```
def uses_only(word, available):
    for letter in word:
        if letter not in available:
            return False
    return True
```

`uses_only` checks whether all letters in `word` are in `available`. We can rewrite it like this:

```
def uses_only(word, available):
    return set(word) <= set(available)
```

The `<=` operator checks whether one set is a subset or another, including the possibility that they are equal, which is true if all the letters in `word` appear in `available`.

As an exercise, rewrite `avoids` using sets.

Counters

A Counter is like a set, except that if an element appears more than once, the Counter keeps track of how many times it appears. If you are familiar with the mathematical idea of a **multiset**, a Counter is a natural way to represent a multiset.

Counter is defined in a standard module called `collections`, so you have to import it. You can initialize a Counter with a string, list, or anything else that supports iteration:

```
>>> from collections import Counter
>>> count = Counter('parrot')
>>> count
Counter({'r': 2, 't': 1, 'o': 1, 'p': 1, 'a': 1})
```

Counters behave like dictionaries in many ways; they map from each key to the number of times it appears. As in dictionaries, the keys have to be hashable.

Unlike dictionaries, Counters don't raise an exception if you access an element that doesn't appear. Instead, they return 0:

```
>>> count['d']
0
```

We can use Counters to rewrite `is_anagram` from Exercise 10-6:

```
def is_anagram(word1, word2):
    return Counter(word1) == Counter(word2)
```

If two words are anagrams, they contain the same letters with the same counts, so their Counters are equivalent.

Counters provide methods and operators to perform set-like operations, including addition, subtraction, union and intersection. And they provide an often-useful