CS 2112 Lab: JUnit
Setting up JUnit with Eclipse is fairly simple. Eclipse should have come with JUnit support, so all that you need to do is include the appropriate library.

To do this, right-click on your project and go to **Build Path → Add Libraries**. Select JUnit 4. Once you have done this, Eclipse should be able to run any Java class that is properly set up as a JUnit test class. You may need to right-click on the file and select **Run As → JUnit Test**.

The JUnit website is: http://junit.sourceforge.net/
Your JUnit test classes should have the following import declarations:

```
1 import static org.junit.Assert.*;
2 import org.junit.*;
```

The keyword static makes it so that instead of having to write org.junit.Assert.assertTrue(...), you can just write assertTrue(...).

If you are creating a test suite, the imports that are needed are different (see slides for test suites).
Any method that is preceded by @Test, is public, returns void and has no arguments will be run as a test case. The actual testing in the test case is done using assertion statements such as assertTrue.
Useful Assertion Statements

- `assertFalse(boolean cond)`
- `assertNotNull(Object o)`
- `assertNull(Object o)`
- `assertTrue(boolean cond)`
- `fail()`

`fail()` is useful when you have code that is supposed to be unreachable, e.g. if you’re expecting an exception to be thrown.

Each of these methods can also take a description as the first argument: `assertTrue(String msg, boolean cond)`

For a complete list, go to:

http://kentbeck.github.com/junit/javadoc/latest/org/junit/Assert.html
If a test is expected to throw an exception, change the `@Test` annotation to `@Test(expected = ExpectedException.class)`. Now the test case will be considered to have passed if that exception was thrown. However, the test case will not fail if the exception isn’t thrown, so if you want to check that the exception is always thrown, you have to explicitly fail the test.
import static org.junit.Assert.*;
import org.junit.*;

public class BasicTestClass {
    @Test
    public void basicTest() {
        assertTrue("true is true", true);
    }

    @Test(expected = NumberFormatException.class)
    public void exceptionTest() {
        Integer.parseInt("error");
        fail("expected a NumberFormatException");
    }
}
Ignoring Tests

If you want to temporarily disable a test case (this might come up if you have test cases for parts of your program that aren't fully implemented yet, for instance), you can do so by putting `@Ignore` above `@Test`. When running tests, JUnit will distinguish between tests that pass, tests that fail due to an assertion, tests that fail due to an unexpected and uncaught exception, and tests that were ignored.
Example: IgnoredTestClass

```java
import static org.junit.Assert.*;
import org.junit.*;

public class IgnoredTestClass {
    @Test
    public void basicTest() {
        assertFalse("false is false", false);
    }

    @Ignore
    @Test
    public void ignoredTest() {
        fail("ignore me");
    }
}
```
Test Fixtures

Sometimes you have a specific setup that you want to run several tests on. Rather than copy and paste the code to recreate that setup, you can create a test fixture.

A test fixture is just an ordinary test class, but with some special functions that are called at certain times: before and after each test, and also before and after the entire set of tests. Instead of being labeled with `@Test`, these special functions are labeled with `@Before`, `@After`, `@BeforeClass`, and `@AfterClass`, respectively. Class members are used to store environment variables and make them available to the tests.
Test Fixture Special Methods

Just like a normal test method, the @Before and @After methods are expected to be public, void, and have no arguments. The @BeforeClass and @AfterClass methods are expected to be public static void and have no arguments.

The purpose of the @Before method is to set up the environment for each test case. The purpose of the @After method is to clean up any external resources used by the test, such as deleting temporary files. @BeforeClass and @AfterClass are used for one-time setup and cleanup for the entire test fixture. If your test fixture does not require some of these methods, you can just leave them out.
import static org.junit.Assert.*;
import org.junit.*;

public class BasicTestFixture {

    private int x, y;

    @Before
    public void setup() {
        x = 3; y = 5;
    }

    @Test
    public void sumTest() {
        assertTrue("x + y = " + (x + y), x + y == 8);
    }
}
Suppose you have a lot of separate test classes for each piece of your program. How do you run all of them at the same time?

A test suite is just a list of test classes which all get run together. Test suites require different imports from test classes and test fixtures. To write a test suite, start with an empty Java class, and put the following above the class definition:

```java
@RunWith(Suite.class)
@Suite.SuiteClasses({
    TestClass1.class,
    TestClass2.class,
    ...
})
```
Example: BasicTestSuite

```java
import org.junit.runner.RunWith;
import org.junit.runners.Suite;

@RunWith(Suite.class)
@Suite.SuiteClasses({
    BasicTestClass.class,
    IgnoredTestClass.class,
    BasicTestFixture.class
})

public class BasicTestSuite {}
```

In addition to running test classes and test fixtures, test suites can also run other test suites.
When writing test cases, try to make them as small as possible. If you have e.g. one test that checks three things, consider breaking it into three tests that each check one thing.

This is especially helpful with JUnit because JUnit stops test execution at the first failure, so having three checks in one test makes it difficult to figure out if more than one of the checks is failing. Furthermore, test fixtures make it easy to break tests up into smaller pieces.
Corner Cases

Make sure to cover all corner cases with your tests. When writing tests for data structures, always test with structures that have one or zero elements in them. When writing numerical tests, always test 0 and 1, and so on.

With Java, it’s also a good idea to add tests for null objects. Without proper testing, a NullPointerException might not be noticed until enough code has been written to make it difficult to track down where in the program the nulls are coming from.
When a new bug is discovered, it’s very helpful to write a test case covering that bug. Not only does this provide an easy way to check that the bug has been fixed, it also ensures that if the bug is ever reintroduced into the program, you’ll know exactly where and when.
Writing Test Cases

Keep Track of Control Flow

With that said, it’s also important to not write superfluous test cases. If a method has a check that a variable \( x \) is not \( \texttt{null} \), it’s pointless to add in test cases for \( x \) being \( \texttt{null} \) between that check and the next time \( x \) gets assigned to.

Keeping track of control flow can give you an idea of how many test cases a method should have. In general, one test case per possible control flow is sufficient, although it can be tricky to count all of the possible paths of execution.
Test case exercises

Try writing some test cases for the following interfaces:

1. List<E>
   1.1 void insert(int index, E e)
   1.2 void remove(int index)
   1.3 void get(int index)

2. Set<E>
   2.1 boolean add(E e)
   2.2 boolean remove(E e)
   2.3 boolean contains(E e)

3. Map<K, V>
   3.1 V put(K key, V value)
   3.2 V remove(K key)
   3.3 V get(K key)

What would be some good corner cases to test for each interface?
Testing/debugging exercise