receive data, while the OutputStream and Writer classes are the topmost abstract classes that send data. A low-level stream is one that operates directly on the underlying resource, such as a file or network connection. A high-level stream operates on a low-level or other high-level stream to filter data, convert data, or improve performance.

Understand how to use Java serialization. A class is considered serializable if it implements the java.io.Serializable interface and contains instance members that are either serializable or marked transient. All Java primitives and the String class are serializable. The ObjectInputStream and ObjectOutputStream classes can be used to read and write a Serializable object from and to an I/O stream, respectively.

Be able to interact with the user. Be able to interact with the user using the system streams (System.out, System.err, and System.in) as well as the Console class. The Console class includes special methods for formatting data and retrieving complex input such as passwords.

Manage file attributes. The NIO.2 Files class includes many methods for reading single file attributes, such as its size or whether it is a directory, a symbolic link, hidden, etc. NIO.2 also supports reading all of the attributes in a single call. An attribute type is used to support operating system–specific views. Finally, NIO.2 supports updatable views for modifying selected attributes.

Review Questions

The answers to the chapter review questions can be found in the Appendix.

1. Which class would be best to use to read a binary file into a Java object?

   A. BufferedStream

   B. FileReader

   C. ObjectInputStream

   D. ObjectReader

   E. ObjectOutputStream

   F. ObjectWriter

   G. None of the above

2. Assuming that / is the root directory within the file system, which of the following are true statements? (Choose all that apply.)

   A. /home/parrot is an absolute path.

   B. /home/parrot is a directory.

   C. /home/parrot is a relative path.

D. new File("/home") will throw an exception if /home does not exist.

E. new File("/home").delete() will throw an exception if /home does not exist.

F. A Reader offers character encoding, making it more useful when working with String data than an InputStream.

G. A Reader offers multithreading support, making it more useful than an InputStream.

3. What are possible results of executing the following code? (Choose all that apply.)

```
public static void main(String[] args) throws IOException {
  String line;
  var c = System.console();
  Writer w = c.writer();
  try (w) {
    if ((line = c.readLine("Enter your name: ")) != null)
      w.append(line);
      w.flush();
  }
}
```

A. The code runs, but nothing is printed.

B. The code prints what was entered by the user.

C. The code behaves the same if throws IOException is removed.

D. A NullPointerException may be thrown.

E. A NullPointerException will always be thrown.

F. A NullPointerException will never be thrown.

G. The code does not compile.

4. For which values of path sent to this method would it be possible for the following code to output Success? (Choose all that apply.)

```
public void removeBadFile(Path path) {
  if(Files.isDirectory(path))
    System.out.println(Files.deleteIfExists(path)
      ? "Success": "Try Again");
}
```

A. path refers to a regular file in the file system.

B. path refers to a symbolic link in the file system.

C. path refers to an empty directory in the file system.

D. path refers to a directory with content in the file system.

E. path does not refer to a record that exists within the file system.

F. The code does not compile.

5. Assume that the directory /animals exists and is empty. What is the result of executing the following code?

```
Path path = Path.of("/animals");
try (var z = Files.walk(path)) {
  boolean b = z
    .filter((p,a) -> a.isDirectory() && !path.equals(p)) // x
    .findFirst().isPresent();  // y
  System.out.print(b ? "No Sub": "Has Sub");
}
```

A. It prints No Sub.

B. It prints Has Sub.

C. The code will not compile because of line x.

D. The code will not compile because of line y.

E. The output cannot be determined.

F. It produces an infinite loop at runtime.

6. What would be the value of name if the instance of Eagle created in the main() method were serialized and then deserialized?

```
import java.io.Serializable;
class Bird {
  protected transient String name;
  public void setName(String name) { this.name = name; }
  public String getName() { return name; }
  public Bird() {
    this.name = "Matt";
  }
}
public class Eagle extends Bird implements Serializable {
  { this.name = "Olivia"; }
  public Eagle() {
    this.name = "Bridget";
  }
  public static void main(String[] args) {
    var e = new Eagle();
    e.name = "Adeline";
  }
}
```

A. Adeline

B. Bridget

C. Matt

D. Olivia

E. null

F. The code does not compile.

G. The code compiles but throws an exception at runtime.

7. Assume that /kang exists as a symbolic link to the directory /mammal/kangaroo within the file system. Which of the following statements are correct about this code snippet? (Choose all that apply.)

```
var path = Paths.get("/kang");
if(Files.isDirectory(path) && Files.isSymbolicLink(path))
  Files.createDirectory(path.resolve("joey"));
```

A. A new directory will always be created.

B. A new directory may be created.

C. If the code creates a directory, it will be reachable at /kang/joey.

D. If the code creates a directory, it will be reachable at /mammal/joey.

E. The code does not compile.

F. The code will compile but will always throw an exception at runtime.

8. Assuming that the /fox/food-schedule.csv file exists with the specified contents, what is the expected output of calling printData() on it?

/fox/food-schedule.csv

```
6am,Breakfast
9am,SecondBreakfast
12pm,Lunch
6pm,Dinner
```

```
void printData(Path path) throws IOException {
  Files.readAllLines(path) // r1
    .flatMap(p -> Stream.of(p.split(","))) // r2
    .map(q -> q.toUpperCase())  // r3
    .forEach(System.out::println);
}
```

A. The code will not compile because of line r1.

B. The code will not compile because of line r2.

C. The code will not compile because of line r3.

D. It throws an exception at runtime.

E. It does not print anything at runtime.

F. None of the above

9. Given the following method, which statements are correct? (Choose all that apply.)

```
public void copyFile(File file1, File file2) throws Exception {
  var reader = new InputStreamReader(new FileInputStream(file1));
  try (var writer = new FileWriter(file2)) {
    char[] buffer = new char[10];
    while(reader.read(buffer) != -1) {
      writer.write(buffer);
      // n1
    }
  }
}
```

A. The code does not compile because reader is not a buffered stream.

B. The code does not compile because writer is not a buffered stream.

C. The code compiles and correctly copies the data between some files.

D. The code compiles and correctly copies the data between all files.

E. If we check file2 on line n1 within the file system after five iterations of the while loop, it may be empty.

F. If we check file2 on line n1 within the file system after five iterations, it will contain exactly 50 characters.

G. This method contains a resource leak.

10. Which of the following correctly create Path instances? (Choose all that apply.)

A. new Path("jaguar.txt")

B. FileSystems.getDefault().getPath("puma.txt")

C. Path.get("cats","lynx.txt")

D. new java.io.File("tiger.txt").toPath()

E. new FileSystem().getPath("lion")

F. Paths.getPath("ocelot.txt")

G. Path.of(Path.of(".").toUri())

11. Which classes will allow the following to compile? (Choose all that apply.)

```
var is = new BufferedInputStream(new FileInputStream("z.txt"));
InputStream wrapper = new _____ (is);
try (wrapper) {}
```

A. BufferedInputStream

B. BufferedReader

C. BufferedWriter

D. FileInputStream

E. ObjectInputStream

F. ObjectOutputStream

G. None of the above, as the first line does not compile

12. What is the result of executing the following code? (Choose all that apply.)

```
4: var p = Paths.get("sloth.schedule");
5: var a = Files.readAttributes(p, BasicFileAttributes.class);
6: Files.mkdir(p.resolve(".backup"));
7: if(a.size()>0 && a.isDirectory()) {
8:    a.setTimes(null,null,null);
9: }
```

A. It compiles and runs without issue.

B. The code will not compile because of line 5.

C. The code will not compile because of line 6.

D. The code will not compile because of line 7.

E. The code will not compile because of line 8.

F. None of the above

13. Which of the following are true statements about serialization in Java? (Choose all that apply.)

A. All non-null instance members of the class must be serializable or marked transient.

B. Records are automatically serializable.

C. Serialization involves converting data into Java objects.

D. Serializable is a functional interface.

E. The class must declare a static serialVersionUID variable.

F. The class must extend the Serializable class.

G. The class must implement the Serializable interface.

14. What is the output of the following code? (Choose three.)

```
22: var p1 = Path.of("/zoo/./bear","../food.txt");
23: p1.normalize().relativize(Path.of("/lion"));
24: System.out.println(p1);
25:
26: var p2 = Paths.get("/zoo/animals/bear/koala/food.txt");
27: System.out.println(p2.subpath(1,3).getName(1));
28:
29: var p3 = Path.of("/pets/../cat.txt");
30: var p4 = Paths.get("./dog.txt");
31: System.out.println(p4.resolve(p3));
```

A. ../../lion

B. /zoo/./bear/../food.txt

C. animal

D. bear

E. /pets/../cat.txt

F. /pets/../cat.txt/./dog.txt

15. Suppose that the working directory is /weather and the absolute path /weather/winter/snow.dat represents a file that exists within the file system. Which of the following lines of code create an object that represents the file? (Choose all that apply.)

A. new File("/weather", "winter", "snow.dat")

B. new File("/weather/winter/snow.dat")

C. new File("/weather/winter", new File("snow.dat"))

D. new File("weather", "/winter/snow.dat")

E. new File(new File("/weather/winter"), "snow.dat")

F. Path.of("/weather/winer/snow.dat").toFile();

G. None of the above

16. Assuming zoo-data.txt exists and is not empty, what statements about the following method are correct? (Choose all that apply.)

```
private void echo() throws IOException {
  var o = new FileWriter("new-zoo.txt");
  try (var f = new FileReader("zoo-data.txt");
    var b = new BufferedReader(f); o) {
```

```
    o.write(b.readLine());
  }
  o.write("");
}
```

A. When run, the method creates a new file with one line of text in it.

B. When run, the method creates a new file with two lines of text in it.

C. When run, the method creates a new file with the same number of lines as the original file.

D. The method compiles but will produce an exception at runtime.

E. The method does not compile.

F. The method uses byte stream classes.

17. Which are true statements? (Choose all that apply.)

A. NIO.2 includes a method to delete an entire directory tree.

B. NIO.2 includes a method to traverse a directory tree.

C. NIO.2 includes methods that are aware of symbolic links.

D. Files.readAttributes() cannot access file-system dependent attributes.

E. Files.readAttributes() is often more performant since it reads multiple attributes rather than accessing individual attributes.

F. Files.readAttributes() works with the File object.

18. Assume that reader is a valid stream whose next characters are PEACOCKS. What is true about the output of the following code snippet? (Choose all that apply.)

```
var sb = new StringBuilder();
sb.append((char)reader.read());
reader.mark(10);
for(int i=0; i<2; i++) {
  sb.append((char)reader.read());
  reader.skip(2);
}
reader.reset();
reader.skip(0);
sb.append((char)reader.read());
System.out.println(sb.toString());
```

A. The code may print PEAE.

B. The code may print PEOA.

C. The code may print PEOE.

D. The code may print PEOS.

E. The code will always print PEAE.

F. The code will always print PEOA.

G. The code will always print PEOE.

H. The code will always print PEOS.

19. Assuming that the directories and files referenced exist and are not symbolic links, what is the result of executing the following code?

```
var p1 = Path.of("/lizard",".").resolve(Path.of("walking.txt"));
var p2 = new File("/lizard/./actions/../walking.txt").toPath();
System.out.print(Files.isSameFile(p1,p2));
System.out.print(" ");
System.out.print(p1.equals(p2));
System.out.print(" ");
System.out.print(Files.mismatch(p1,p2));
```

A. true true -1

B. true true 0

C. true false -1

D. true false 0

E. false true -1

F. false true 0

G. The code does not compile.

H. The result cannot be determined.

20. Assume that monkey.txt is a file that exists in the current working directory. Which statements about the following code snippet are correct? (Choose all that apply.)

```
Files.move(Path.of("monkey.txt"), Paths.get("/animals"),
  StandardCopyOption.ATOMIC_MOVE,
  LinkOption.NOFOLLOW_LINKS);
```

A. If /animals/monkey.txt exists, it will be overwritten at runtime.

B. If /animals exists as an empty directory, /animals/monkey.txt will be the new location of the file.

C. If monkey.txt is a symbolic link, the file it points to will be moved at runtime.

D. If the move is successful and another process is monitoring the file system, it will not see an incomplete file at runtime.

E. None of the above

21. Assume that /monkeys exists as a directory containing multiple files, symbolic links, and subdirectories. Which statement about the following code is correct?

```
var f = Path.of("/monkeys");
try (var m =
  Files.find(f, 0, (p,a) -> a.isSymbolicLink())) { // y1
    m.map(s -> s.toString())
      .collect(Collectors.toList())
      .stream()
      .filter(s -> s.toString().endsWith(".txt")) // y2
      .forEach(System.out::println);
}
```

A. It will print all symbolic links in the directory tree ending in .txt.

B. It will print the target of all symbolic links in the directory ending in .txt.

C. It will print nothing.

D. It does not compile because of line y1.

E. It does not compile because of line y2.

F. It compiles but throws an exception at runtime.

22. Which of the following fields will be null after an instance of the class created on line 17 is serialized and then deserialized using ObjectOutputStream and ObjectInputStream? (Choose all that apply.)

```
1: import java.io.Serializable;
2: import java.util.List;
3: public class Zebra implements Serializable {
4:   private transient String name = "George";
5:   private static String birthPlace = "Africa";
6:   private transient Integer age;
7:   List<Zebra> friends = new java.util.ArrayList<>();
8:   private Object stripes = new Object();
9:   { age = 10;}
10:  public Zebra() {
11:    this.name = "Sophia";
12:  }
13:  static Zebra writeAndRead(Zebra z) {
14:    // Implementation omitted
15:  }
16:  public static void main(String[] args) {
17:    var zebra = new Zebra();
18:    zebra = writeAndRead(zebra);
19:  }
```

A. age

B. birthplace

C. friends

D. name

E. stripes

F. The code does not compile.

G. The code compiles but throws an exception at runtime.

23. What are some possible results of executing the following code? (Choose all that apply.)

```
var x = Path.of("/animals/fluffy/..");
Files.walk(x.toRealPath().getParent())     // u1
  .map(p -> p.toAbsolutePath().toString()) // u2
  .filter(s -> s.endsWith(".java"))
  .forEach(System.out::println);
```

A. It prints some files in the root directory.

B. It prints all files in the root directory.

C. FileSystemLoopException is thrown at runtime.

D. Another exception is thrown at runtime.

E. The code will not compile because of line u1.

F. The code will not compile because of line u2.

24. Assume that the source instance passed to the following method represents a file that exists. Also assume that /flip/sounds.txt exists as a file prior to executing this method. When this method is executed, which statement correctly copies the file to the path specified by /flip/sounds.txt?

```
void copyIntoFlipDirectory(Path source) throws IOException {
  var dolphinDir = Path.of("/flip");
  dolphinDir = Files.createDirectories(dolphinDir);
  var n = Paths.get("sounds.txt");
  _____________________;
}
```

A. Files.copy(source, dolphinDir)

B. Files.copy(source, dolphinDir.resolve(n), StandardCopyOption.REPLACE_EXISTING)

C. Files.copy(source, dolphinDir, StandardCopyOption.REPLACE_EXISTING)

D. Files.copy(source, dolphinDir.resolve(n))

E. The method does not compile, regardless of what is placed in the blank.

F. The method compiles but throws an exception at runtime, regardless of what is placed in the blank.

25. Suppose that you need to read text data from a file and want the data to be performant on large files. Which two java.io stream classes can be chained together to best achieve this result? (Choose two.)

A. BufferedInputStream

B. BufferedReader

C. FileInputStream

D. FileReader

E. PrintInputStream

F. ObjectInputStream

G. PrintReader