

Java Programming (4343203) - Summer 2025 Solution

4343203 – Summer 2025

Semester 1 Study Material

Detailed Solutions and Explanations

Question 1(a) [3 marks]

List out the rules to name an identifier in Java with valid and invalid examples.

Solution

Rules for Java Identifiers:

Rule	Description	Valid Example	Invalid Example
Start Character	Must begin with letter, underscore, or dollar sign	name, _value, \$cost	2name, #id
Following Characters	Can contain letters, digits, underscore, dollar	student123, user_name	my-var, class@
Keywords Restriction	Cannot use Java reserved words	myClass, userName	class, int
Case Sensitivity	Identifiers are case-sensitive	Name ≠ name	-
Length	No length limit (practically reasonable)	verylongvariablename	-

Mnemonic

“Letters First, Keywords Never, Case Counts”

Question 1(b) [4 marks]

List out different types of operators in Java. Explain Arithmetic and Logical Operators in detail.

Solution

Java Operator Types:

Operator Type	Examples
Arithmetic	+, -, *, /, %
Relational	==, !=, <, >, <=, >=
Logical	&&, , !
Assignment	=, +=, -=, *=, /=
Unary	++, --, +, -, !
Bitwise	&, , ^, ~, <<, >>
Ternary	condition ? value1 : value2

Arithmetic Operators:

- **Addition (+)**: Adds two operands
- **Subtraction (-)**: Subtracts second from first
- ****Multiplication (*)****: Multiplies two operands
- **Division (/)**: Divides first by second
- **Modulus (%)**: Returns remainder of division

Logical Operators:

- **AND (&&)**: Returns true if both conditions are true
- **OR (||)**: Returns true if at least one condition is true
- **NOT (!)**: Reverses the logical state

Mnemonic

“Add Subtract Multiply Divide Remainder, And Or Not”

Question 1(c) [7 marks]

Write a program in Java to reverse the digits of a number for number having three digits. Like reverse of 653 is 356.

Solution

```
1 import java.util.Scanner;
2
3 public class ReverseNumber {
4     public static void main(String[] args) {
5         Scanner sc = new Scanner(System.in);
6
7         System.out.print("Enter 3-digit number: ");
8         int num = sc.nextInt();
9
10        int reverse = 0;
11        int temp = num;
12
13        while (temp > 0) {
14            reverse = reverse * 10 + temp % 10;
15            temp = temp / 10;
16        }
17
18        System.out.println("Original: " + num);
19        System.out.println("Reversed: " + reverse);
20    }
21}
```

Algorithm:

- **Extract last digit**: Use modulus operator (%)
- **Build reversed number**: Multiply by 10 and add digit
- **Remove last digit**: Use integer division (/)
- **Repeat**: Until original number becomes 0

Mnemonic

“Extract, Build, Remove, Repeat”

Question 1(c OR) [7 marks]

Write a program in Java to add two 3*3 matrices.

Solution

```
1 import java.util.Scanner;
2
3 public class MatrixAddition {
4     public static void main(String[] args) {
5         Scanner sc = new Scanner(System.in);
6         int[][] matrix1 = new int[3][3];
7         int[][] matrix2 = new int[3][3];
8         int[][] result = new int[3][3];
9
10        // Input first matrix
11        System.out.println("Enter first matrix:");
12        for (int i = 0; i < 3; i++) {
13            for (int j = 0; j < 3; j++) {
14                matrix1[i][j] = sc.nextInt();
15            }
16        }
17
18        // Input second matrix
19        System.out.println("Enter second matrix:");
20        for (int i = 0; i < 3; i++) {
21            for (int j = 0; j < 3; j++) {
22                matrix2[i][j] = sc.nextInt();
23            }
24        }
25
26        // Add matrices
27        for (int i = 0; i < 3; i++) {
28            for (int j = 0; j < 3; j++) {
29                result[i][j] = matrix1[i][j] + matrix2[i][j];
30            }
31        }
32
33        // Display result
34        System.out.println("Sum of matrices:");
35        for (int i = 0; i < 3; i++) {
36            for (int j = 0; j < 3; j++) {
37                System.out.print(result[i][j] + " ");
38            }
39            System.out.println();
40        }
41    }
42 }
```

Matrix Addition Steps:

- **Create arrays:** Three 3x3 integer arrays
- **Input matrices:** Read values for both matrices
- **Add corresponding elements:** $\text{result}[i][j] = \text{matrix1}[i][j] + \text{matrix2}[i][j]$
- **Display result:** Print the sum matrix

Mnemonic

“Create, Input, Add, Display”

Question 2(a) [3 marks]

Write a program in Java that shows the use of parameterized Constructor.

Solution

```
1 class Student {
2     private String name;
```

```

3     private int rollNo;
4
5     // Parameterized Constructor
6     public Student(String name, int rollNo) {
7         this.name = name;
8         this.rollNo = rollNo;
9     }
10
11    public void display() {
12        System.out.println("Name: " + name);
13        System.out.println("Roll No: " + rollNo);
14    }
15
16 }
17
18 public class ParameterizedConstructor {
19     public static void main(String[] args) {
20         Student s1 = new Student("John", 101);
21         s1.display();
22     }
23 }
```

Parameterized Constructor Features:

- **Takes parameters:** Accepts values during object creation
- **Initializes instance variables:** Sets object state
- **Same name as class:** Constructor name matches class name
- **No return type:** Constructors don't have return type

Mnemonic

“Parameters Initialize Same-name No-return”

Question 2(b) [4 marks]

Give the basic syntax of the following terms with an example: (1) To create a Class, (2) To create an Object, (3) To define a Method, (4) To declare a Variable.

Solution

Java Basic Syntax:

Component	Syntax	Example
Class Creation	class ClassName { }	class Car { }
Object Creation	ClassName objectName = new ClassName();	Car myCar = new Car();
Method Definition	returnType methodName(parameters) { }	public void start() { }
Variable Declaration	dataType variableName;	int age;

Complete Example:

```
1 class Car {                                // Class Creation
2     int speed;                            // Variable Declaration
3
4     public void accelerate() {           // Method Definition
5         speed += 10;
6     }
7 }
8
9 public class Main {
10    public static void main(String[] args) {
11        Car myCar = new Car();          // Object Creation
12    }
13 }
```

Mnemonic

“Class Object Method Variable - COMV”

Question 2(c) [7 marks]

Write a program in Java which has a class Student having two instance variables enrollmentNo and name. Create 3 objects of Student class in main method and display student's name.

Solution

```
1 class Student {
2     String enrollmentNo;
3     String name;
4
5     // Constructor to initialize student data
6     public Student(String enrollmentNo, String name) {
7         this.enrollmentNo = enrollmentNo;
8         this.name = name;
9     }
10
11     // Method to display student name
12     public void displayName() {
13         System.out.println("Student Name: " + name);
14     }
15 }
16
17 public class StudentDemo {
18     public static void main(String[] args) {
19         // Creating 3 objects of Student class
20         Student s1 = new Student("CS001", "Alice");
21         Student s2 = new Student("CS002", "Bob");
22         Student s3 = new Student("CS003", "Charlie");
23
24         // Displaying student names
25         s1.displayName();
26         s2.displayName();
27         s3.displayName();
28     }
29 }
```

Program Structure:

- **Class definition:** Student class with instance variables
- **Constructor:** Initialize enrollmentNo and name
- **Method:** displayName() to show student name
- **Object creation:** Three Student objects in main method

- **Method calling:** Display names using displayName()

Mnemonic

“Define Initialize Display Create Call”

Question 2(a OR) [3 marks]

Write a program in Java that shows the use of Default Constructor.

Solution

```

1 class Rectangle {
2     int length;
3     int width;
4
5     // Default Constructor
6     public Rectangle() {
7         length = 5;
8         width = 3;
9         System.out.println("Default constructor called");
10    }
11
12    public void displayArea() {
13        System.out.println("Area: " + (length * width));
14    }
15 }
16
17 public class DefaultConstructor {
18     public static void main(String[] args) {
19         Rectangle r1 = new Rectangle();
20         r1.displayArea();
21     }
22 }
```

Default Constructor Features:

- **No parameters:** Takes no arguments
- **Default values:** Sets default values for instance variables
- **Automatic call:** Called when object is created
- **Same name as class:** Constructor name matches class name

Mnemonic

“No-parameters Default Automatic Same-name”

Question 2(b OR) [4 marks]

Give four Difference between Procedure Oriented Programming and Object-Oriented Programming.

Solution

POP vs OOP Comparison:

Aspect	Procedure Oriented Programming	Object-Oriented Programming
Approach	Top-down approach	Bottom-up approach
Focus	Functions and procedures	Objects and classes

Data Security	No data hiding, global access	Data encapsulation and hiding
Problem Solving	Divide into functions	Divide into objects
Code Reusability	Limited reusability	High reusability through inheritance
Maintenance	Difficult to maintain	Easy to maintain and modify

Key Differences:

- Structure:** POP uses functions, OOP uses classes
- Security:** OOP provides better data protection
- Reusability:** OOP supports inheritance and polymorphism
- Maintenance:** OOP code is easier to maintain

Mnemonic

“Structure Security Reusability Maintenance”

Question 2(c OR) [7 marks]

Write a program in Java which has a class Shape having 2 overloaded methods area (float radius) and area (float length, float width). Display the area of circle and rectangle using overloaded methods.

Solution

```

1  class Shape {
2      // Method to calculate area of circle
3      public void area(float radius) {
4          float circleArea = 3.14f * radius * radius;
5          System.out.println("Area of Circle: " + circleArea);
6      }
7
8      // Overloaded method to calculate area of rectangle
9      public void area(float length, float width) {
10         float rectangleArea = length * width;
11         System.out.println("Area of Rectangle: " + rectangleArea);
12     }
13 }
14
15 public class MethodOverloading {
16     public static void main(String[] args) {
17         Shape shape = new Shape();
18
19         // Calculate area of circle with radius 5
20         shape.area(5.0f);
21
22         // Calculate area of rectangle with length 4 and width 6
23         shape.area(4.0f, 6.0f);
24     }
25 }
```

Method Overloading Concepts:

- Same method name:** Both methods named “area”
- Different parameters:** One takes radius, other takes length and width
- Compile-time polymorphism:** Method selected at compile time
- Parameter differentiation:** Different number or type of parameters

Mnemonic

“Same-name Different-parameters Compile-time Parameter-differentiation”

Question 3(a) [3 marks]

Write a program in Java to demonstrate single inheritance.

Solution

```
1 // Parent class
2 class Animal {
3     public void eat() {
4         System.out.println("Animal is eating");
5     }
6
7     public void sleep() {
8         System.out.println("Animal is sleeping");
9     }
10 }
11
12 // Child class inheriting from Animal
13 class Dog extends Animal {
14     public void bark() {
15         System.out.println("Dog is barking");
16     }
17 }
18
19 public class SingleInheritance {
20     public static void main(String[] args) {
21         Dog dog = new Dog();
22
23         // Inherited methods from Animal class
24         dog.eat();
25         dog.sleep();
26
27         // Own method of Dog class
28         dog.bark();
29     }
30 }
```

Single Inheritance Features:

- **One parent:** Child class inherits from one parent class
- **extends keyword:** Used to establish inheritance relationship
- **Method inheritance:** Child class inherits parent methods
- **IS-A relationship:** Dog IS-A Animal

Mnemonic

“One-parent Extends Method IS-A”

Question 3(b) [4 marks]

Define abstract class in JAVA with example.

Solution

Abstract Class Definition: An abstract class is a class that cannot be instantiated and may contain abstract methods (methods without implementation).

```
1 // Abstract class
2 abstract class Vehicle {
3     String brand;
4
5     // Regular method
```

```

6     public void displayBrand() {
7         System.out.println("Brand: " + brand);
8     }
9
10    // Abstract method (no implementation)
11    public abstract void start();
12    public abstract void stop();
13 }
14
15 // Concrete class extending abstract class
16 class Car extends Vehicle {
17     public Car(String brand) {
18         this.brand = brand;
19     }
20
21     // Must implement abstract methods
22     public void start() {
23         System.out.println("Car started with key");
24     }
25
26     public void stop() {
27         System.out.println("Car stopped with brake");
28     }
29 }
30
31 public class AbstractDemo {
32     public static void main(String[] args) {
33         Car car = new Car("Toyota");
34         car.displayBrand();
35         car.start();
36         car.stop();
37     }
38 }
```

Abstract Class Features:

- **Cannot instantiate:** Cannot create objects directly
- **Abstract methods:** Methods without body
- **Concrete methods:** Regular methods with implementation
- **Must extend:** Child classes must implement abstract methods

Mnemonic

“Cannot-instantiate Abstract-methods Concrete-methods Must-extend”

Question 3(c) [7 marks]

Write a program in Java to implement multiple inheritance using interfaces.

Solution

```

1 // First interface
2 interface Flyable {
3     void fly();
4 }
5
6 // Second interface
7 interface Swimmable {
8     void swim();
9 }
10
11 // Class implementing multiple interfaces
12 class Duck implements Flyable, Swimmable {
13     private String name;
```

```

4
5     public Duck(String name) {
6         this.name = name;
7     }
8
9     // Implementing fly method from Flyable interface
10    public void fly() {
11        System.out.println(name + " is flying in the sky");
12    }
13
14     // Implementing swim method from Swimmable interface
15    public void swim() {
16        System.out.println(name + " is swimming in water");
17    }
18
19    public void walk() {
20        System.out.println(name + " is walking on land");
21    }
22
23 }
24
25 public class MultipleInheritance {
26     public static void main(String[] args) {
27         Duck duck = new Duck("Donald");
28
29         // Methods from interfaces
30         duck.fly();
31         duck.swim();
32
33         // Own method
34         duck.walk();
35     }
36 }

```

Multiple Inheritance via Interfaces:

- **Multiple interfaces:** Class can implement multiple interfaces
- **implements keyword:** Used to implement interfaces
- **Must implement all methods:** All interface methods must be implemented
- **Solves diamond problem:** Avoids ambiguity of multiple inheritance

Mnemonic

“Multiple-interfaces Implements Must-implement Solves-diamond”

Question 3(a OR) [3 marks]

Write a program in Java to demonstrate multilevel inheritance.

Solution

```

1 // Grandparent class
2 class Animal {
3     public void breathe() {
4         System.out.println("Animal is breathing");
5     }
6 }
7
8 // Parent class inheriting from Animal
9 class Mammal extends Animal {
10    public void giveBirth() {
11        System.out.println("Mammal gives birth to babies");
12    }
13 }

```

```

5 // Child class inheriting from Mammal
6 class Dog extends Mammal {
7     public void bark() {
8         System.out.println("Dog is barking");
9     }
10 }
11
12 public class MultilevelInheritance {
13     public static void main(String[] args) {
14         Dog dog = new Dog();
15
16         // Method from Animal class (grandparent)
17         dog.breathe();
18
19         // Method from Mammal class (parent)
20         dog.giveBirth();
21
22         // Own method of Dog class
23         dog.bark();
24     }
25 }
```

Multilevel Inheritance Features:

- **Chain of inheritance:** Child → Parent → Grandparent
- **Multiple levels:** More than two levels of inheritance
- **Transitive inheritance:** Properties passed through levels
- **extends keyword:** Each level uses extends

Mnemonic

“Chain Multiple Transitive Extends”

Question 3(b OR) [4 marks]

Define package and write the syntax to create a package with example.

Solution

Package Definition: A package is a namespace that organizes related classes and interfaces. It provides access protection and namespace management.

Package Syntax:

```
1 package packageName;
```

Example:

File: mypackage/Calculator.java

```

1 package mypackage;
2
3 public class Calculator {
4     public int add(int a, int b) {
5         return a + b;
6     }
7
8     public int subtract(int a, int b) {
9         return a - b;
10    }
11 }
```

File: TestCalculator.java

```

1 import mypackage.Calculator;
2
3 public class TestCalculator {
```

```

4  public static void main(String[] args) {
5      Calculator calc = new Calculator();
6
7      System.out.println("Addition: " + calc.add(10, 5));
8      System.out.println("Subtraction: " + calc.subtract(10, 5));
9  }
0

```

Package Benefits:

- **Namespace management:** Avoids naming conflicts
- **Access control:** Controls class visibility
- **Code organization:** Groups related classes
- **Reusability:** Easy to reuse packaged classes

Mnemonic

“Namespace Access Organization Reusability”

Question 3(c OR) [7 marks]

Write a program in Java to demonstrate method overriding.

Solution

```

1 // Parent class
2 class Animal {
3     public void makeSound() {
4         System.out.println("Animal makes a sound");
5     }
6
7     public void move() {
8         System.out.println("Animal moves");
9     }
0
1
2 // Child class overriding parent methods
3 class Dog extends Animal {
4     // Method overriding
5     @Override
6     public void makeSound() {
7         System.out.println("Dog barks: Woof! Woof!");
8     }
9
10    @Override
11    public void move() {
12        System.out.println("Dog runs on four legs");
13    }
14
15
16 class Cat extends Animal {
17     // Method overriding
18     @Override
19     public void makeSound() {
20         System.out.println("Cat meows: Meow! Meow!");
21     }
22
23     @Override
24     public void move() {
25         System.out.println("Cat walks silently");
26     }
27
28
29 public class MethodOverriding {

```

```

10 public static void main(String[] args) {
11     Animal animal;
12
13     // Dog object
14     animal = new Dog();
15     animal.makeSound();    // Calls Dog's makeSound()
16     animal.move();        // Calls Dog's move()
17
18     System.out.println();
19
20     // Cat object
21     animal = new Cat();
22     animal.makeSound();    // Calls Cat's makeSound()
23     animal.move();        // Calls Cat's move()
24 }
25 }
```

Method Overriding Features:

- **Same method signature:** Same name, parameters, and return type
- **Runtime polymorphism:** Method decided at runtime
- **@Override annotation:** Optional but recommended
- **IS-A relationship:** Child class overrides parent method

Mnemonic

“Same-signature Runtime Override IS-A”

Question 4(a) [3 marks]

List and explain different types of errors in Java.

Solution

Java Error Types:

Error Type	Description	Example
Compile-time Errors	Detected during compilation	Syntax errors, missing semicolons
Runtime Errors	Occur during program execution	Division by zero, null pointer
Logical Errors	Program runs but gives wrong output	Incorrect algorithm logic

Detailed Explanation:

- **Compile-time:** Prevented by compiler, must fix before running
- **Runtime:** Program crashes during execution, handled by exceptions
- **Logical:** Hardest to find, program works but results are incorrect

Common Examples:

- **Syntax Error:** Missing semicolon, wrong brackets
- **RuntimeException:** ArrayIndexOutOfBoundsException, NullPointerException
- **Logic Error:** Wrong formula, incorrect condition

Mnemonic

“Compile Runtime Logic - CRL”

Question 4(b) [4 marks]

What is wrapper class? Explain use of any two wrapper class.

Solution

Wrapper Class Definition: Wrapper classes provide object representation of primitive data types. They convert primitives into objects.

Wrapper Class Table:

Primitive	Wrapper Class
int	Integer
double	Double
boolean	Boolean
char	Character

Example - Integer Wrapper:

```
1 // Primitive to Object (Boxing)
2 int num = 100;
3 Integer intObj = Integer.valueOf(num);
4
5 // Object to Primitive (Unboxing)
6 int value = intObj.intValue();
7
8 // Utility methods
9 String str = "123";
10 int parsed = Integer.parseInt(str);
```

Example - Double Wrapper:

```
1 // Creating Double object
2 Double doubleObj = Double.valueOf(45.67);
3
4 // Converting string to double
5 String str = "123.45";
6 double value = Double.parseDouble(str);
7
8 // Checking special values
9 boolean isNaN = Double.isNaN(doubleObj);
```

Wrapper Class Uses:

- **Collections:** Store primitives in collections
- **Null values:** Can store null unlike primitives
- **Utility methods:** Parsing, conversion methods
- **Generics:** Use with generic types

Mnemonic

“Collections Null Utility Generics”

Question 4(c) [7 marks]

Write a program in Java to develop Banking Application in which user deposits the amount Rs 25000 and then start withdrawing of Rs 20000, Rs 4000 and it throws exception “Not Sufficient Fund” when user withdraws Rs. 2000 thereafter.

Solution

```
1 // Custom Exception class
2 class InsufficientFundException extends Exception {
3     public InsufficientFundException(String message) {
4         super(message);
```

```

5     }
6 }
7
8 // Bank Account class
9 class BankAccount {
10    private double balance;
11
12   public BankAccount(double initialBalance) {
13       this.balance = initialBalance;
14   }
15
16   public void deposit(double amount) {
17       balance += amount;
18       System.out.println("Deposited: Rs." + amount);
19       System.out.println("Current Balance: Rs." + balance);
20   }
21
22   public void withdraw(double amount) throws InsufficientFundException {
23       if (amount > balance) {
24           throw new InsufficientFundException("Not Sufficient Fund");
25       }
26       balance -= amount;
27       System.out.println("Withdrawn: Rs." + amount);
28       System.out.println("Remaining Balance: Rs." + balance);
29   }
30
31   public double getBalance() {
32       return balance;
33   }
34 }
35
36 public class BankingApplication {
37    public static void main(String[] args) {
38        BankAccount account = new BankAccount(0);
39
40        try {
41            // Deposit Rs. 25000
42            account.deposit(25000);
43            System.out.println();
44
45            // Withdraw Rs. 20000
46            account.withdraw(20000);
47            System.out.println();
48
49            // Withdraw Rs. 4000
50            account.withdraw(4000);
51            System.out.println();
52
53            // Try to withdraw Rs. 2000 (will throw exception)
54            account.withdraw(2000);
55
56        } catch (InsufficientFundException e) {
57            System.out.println("Exception: " + e.getMessage());
58            System.out.println("Available Balance: Rs." + account.getBalance());
59        }
60    }
61 }

```

Exception Handling Components:

- **Custom exception:** InsufficientFundException extends Exception
- **throw keyword:** Throws exception when balance insufficient
- **try-catch block:** Handles the exception
- **Exception message:** Displays “Not Sufficient Fund”

Banking Operations:

- **Deposit:** Adds money to balance
- **Withdraw:** Subtracts money if sufficient balance

- **Balance check:** Validates before withdrawal
- **Exception handling:** Prevents program crash

Mnemonic

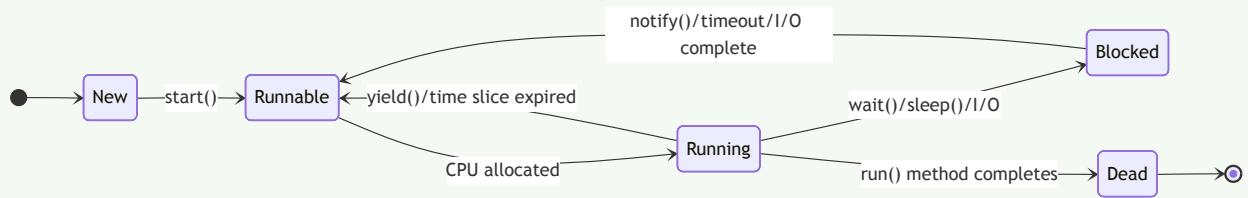
“Custom Throw Try-catch Message, Deposit Withdraw Check Handle”

Question 4(a OR) [3 marks]

Describe the complete lifecycle of a thread.

Solution

Thread Lifecycle States:



Thread States:

- **New:** Thread object created but not started
- **Runnable:** Thread ready to run, waiting for CPU
- **Running:** Thread currently executing
- **Blocked:** Thread waiting for resource or condition
- **Dead:** Thread execution completed

State Transitions:

- **start():** New → Runnable
- **CPU allocation:** Runnable → Running
- **wait() / sleep():** Running → Blocked
- **notify() / timeout:** Blocked → Runnable
- **completion:** Running → Dead

Mnemonic

“New Runnable Running Blocked Dead”

Question 4(b OR) [4 marks]

List access specifiers and describe their purpose in JAVA.

Solution

Java Access Specifiers:

Access Specifier	Same Class	Same Package	Subclass	Other Package
private				
default				
protected				
public				

Access Specifier Purposes:

Private:

- **Encapsulation:** Hides implementation details
- **Data security:** Protects sensitive data
- **Class-only access:** Accessible within same class only

Default (Package-private):

- **Package access:** Accessible within same package
- **Module organization:** Groups related classes
- **No keyword needed:** Default when no specifier mentioned

Protected:

- **Inheritance support:** Accessible to subclasses
- **Package + inheritance:** Same package + subclasses
- **Controlled access:** More access than private, less than public

Public:

- **Universal access:** Accessible from anywhere
- **Interface methods:** Used for public APIs
- **Maximum visibility:** No access restrictions

Mnemonic

“Private Encapsulates, Default Packages, Protected inherits, Public Universal”

Question 4(c OR) [7 marks]

Write a program that executes two threads. One thread displays “Thread1” every 1000 milliseconds, and the other displays “Thread2” every 2000 milliseconds. Create the threads by extending the Thread class.

Solution

```
1 // First thread class
2 class Thread1 extends Thread {
3     public void run() {
4         try {
5             for (int
6
7                 i = 1; i <= 10; i++) {
8
9                     System.out.println("Thread1 - Count: " + i);
10                    Thread.sleep(1000); // Sleep for 1000 milliseconds
11                }
12            } catch (InterruptedException e) {
13                System.out.println("Thread1 interrupted: " + e.getMessage());
14            }
15        }
16    }
17
18 // Second thread class
19 class Thread2 extends Thread {
20     public void run() {
21         try {
22             for (int
23
24                 i = 1; i <= 5; i++) {
25
26                     System.out.println("Thread2 - Count: " + i);
27                     Thread.sleep(2000); // Sleep for 2000 milliseconds
28                }
29            } catch (InterruptedException e) {
30                System.out.println("Thread2 interrupted: " + e.getMessage());
31            }
32        }
33    }
34 }
```

```

12 }
13 }
14
15 public class MultiThreadDemo {
16     public static void main(String[] args) {
17         // Create thread objects
18         Thread1 t1 = new Thread1();
19         Thread2 t2 = new Thread2();
20
21         System.out.println("Starting both threads...");
22
23         // Start both threads
24         t1.start();
25         t2.start();
26
27         try {
28             // Wait for both threads to complete
29             t1.join();
30             t2.join();
31         } catch (InterruptedException e) {
32             System.out.println("Main thread interrupted: " + e.getMessage());
33         }
34
35         System.out.println("Both threads completed execution");
36     }
37 }

```

Multithreading Concepts:

- **Thread class extension:** Both classes extend Thread
- **run() method:** Contains thread execution code
- **sleep() method:** Pauses thread for specified time
- **start() method:** Begins thread execution
- **join() method:** Waits for thread completion

Thread Synchronization:

- **Concurrent execution:** Both threads run simultaneously
- **Independent timing:** Each thread has its own sleep interval
- **Exception handling:** InterruptedException caught and handled
- **Thread coordination:** join() ensures main waits for completion

Mnemonic

“Extend Run Sleep Start Join”

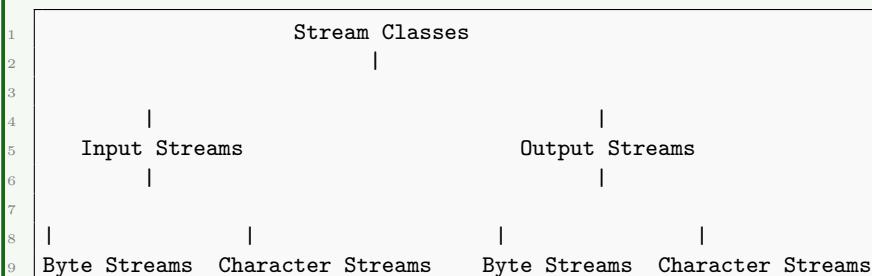
Question 5(a) [3 marks]

What is stream class? How are the stream classes classified?

Solution

Stream Class Definition: Stream classes in Java provide a way to handle input and output operations. They represent a flow of data from source to destination.

Stream Classification:



0	InputStream	Reader	OutputStream	Writer
---	-------------	--------	--------------	--------

Stream Types:

Stream Type	Purpose	Example Classes
InputStream	Read bytes	FileInputStream, BufferedInputStream
OutputStream	Write bytes	FileOutputStream, BufferedOutputStream
Reader	Read characters	FileReader, BufferedReader
Writer	Write characters	FileWriter, BufferedWriter

Classification Features:

- **Direction:** Input (read) vs Output (write)
- **Data type:** Byte streams vs Character streams
- **Functionality:** Basic vs Buffered streams

Mnemonic

“Direction Data-type Functionality”

Question 5(b) [4 marks]

Illustrate purpose of method overriding with example.

Solution

Method Overriding Purpose: Method overriding allows a subclass to provide specific implementation of a method that is already defined in its parent class.

```

1 // Parent class
2 class Shape {
3     public void draw() {
4         System.out.println("Drawing a generic shape");
5     }
6
7     public double area() {
8         return 0.0;
9     }
10 }
11
12 // Child class overriding parent methods
13 class Circle extends Shape {
14     private double radius;
15
16     public Circle(double radius) {
17         this.radius = radius;
18     }
19
20     // Overriding draw method
21     @Override
22     public void draw() {
23         System.out.println("Drawing a circle with radius " + radius);
24     }
25
26     // Overriding area method
27     @Override
28     public double area() {
29         return 3.14 * radius * radius;
30     }
31 }
32
33 class Rectangle extends Shape {

```

```

14     private double length, width;
15
16     public Rectangle(double length, double width) {
17         this.length = length;
18         this.width = width;
19     }
20
21     @Override
22     public void draw() {
23         System.out.println("Drawing rectangle " + length + "x" + width);
24     }
25
26     @Override
27     public double area() {
28         return length * width;
29     }
30
31 }
32
33 public class OverridingDemo {
34     public static void main(String[] args) {
35         Shape[] shapes = {
36             new Circle(5.0),
37             new Rectangle(4.0, 6.0)
38         };
39
40         for (Shape shape : shapes) {
41             shape.draw();           // Calls overridden method
42             System.out.println("Area: " + shape.area());
43             System.out.println();
44         }
45     }
46 }

```

Method Overriding Benefits:

- **Runtime polymorphism:** Method selection at runtime
- **Specific implementation:** Child class provides specific behavior
- **Code flexibility:** Same interface, different implementations
- **Dynamic method dispatch:** Correct method called based on object type

Mnemonic

“Runtime Specific Flexibility Dynamic”

Question 5(c) [7 marks]

Write a program in Java to perform read and write operations on a Text file named Abc.txt.

Solution

```

1 import java.io.*;
2
3 public class FileOperations {
4     public static void main(String[] args) {
5         String fileName = "Abc.txt";
6
7         // Write operation
8         writeToFile(fileName);
9
10        // Read operation
11        readFromFile(fileName);
12    }
13
14    // Method to write data to file

```

```

5   public static void writeToFile(String fileName) {
6     try {
7       FileWriter writer = new FileWriter(fileName);
8
8   // Writing data to file
9   writer.write("Hello, this is Java file handling.\n");
10  writer.write("This is line 2 of the file.\n");
11  writer.write("File operations in Java are easy.\n");
12  writer.write("End of file content.");
13
14  writer.close();
15  System.out.println("Data written to file successfully.");
16
17 } catch (IOException e) {
18   System.out.println("Error writing to file: " + e.getMessage());
19 }
20
21
22 // Method to read data from file
23 public static void readFromFile(String fileName) {
24   try {
25     FileReader reader = new FileReader(fileName);
26     BufferedReader bufferedReader = new BufferedReader(reader);
27
28     System.out.println("\nReading from file:");
29     System.out.println("-----");
30
31     String line;
32     int lineNumber = 1;
33
34     // Reading file line by line
35     while ((line = bufferedReader.readLine()) != null) {
36       System.out.println("Line " + lineNumber + ": " + line);
37       lineNumber++;
38     }
39
40     bufferedReader.close();
41     reader.close();
42
43   } catch (FileNotFoundException e) {
44     System.out.println("File not found: " + e.getMessage());
45   } catch (IOException e) {
46     System.out.println("Error reading file: " + e.getMessage());
47   }
48 }
49
50 }
```

Alternative using try-with-resources:

```

1 // More efficient way using try-with-resources
2 public static void writeToFileImproved(String fileName) {
3   try (FileWriter writer = new FileWriter(fileName)) {
4     writer.write("Hello from improved method!\n");
5     writer.write("Using try-with-resources.\n");
6     System.out.println("Data written successfully.");
7   } catch (IOException e) {
8     System.out.println("Error: " + e.getMessage());
9   }
10
11
12 public static void readFromFileImproved(String fileName) {
13   try (BufferedReader reader = new BufferedReader(new FileReader(fileName))) {
14     String line;
15     while ((line = reader.readLine()) != null) {
16       System.out.println(line);
17     }
18   } catch (IOException e) {
```

```

9     System.out.println("Error: " + e.getMessage());
10    }
11}

```

File Operation Components:

- **FileWriter**: Used for writing character data to file
- **FileReader**: Used for reading character data from file
- **BufferedReader**: More efficient reading with buffering
- **Exception handling**: IOException and FileNotFoundException
- **Resource management**: Close streams to prevent memory leaks

File Handling Steps:

- **Create stream**: FileWriter/FileReader object
- **Perform operation**: write()/readLine() methods
- **Handle exceptions**: try-catch blocks
- **Close resources**: close() method or try-with-resources

Mnemonic

“Create Perform Handle Close”

Question 5(a OR) [3 marks]

Explain InputStream.

Solution

InputStream Definition: InputStream is an abstract class that represents an input stream of bytes. It is the superclass of all classes representing an input stream of bytes.

InputStream Hierarchy:

```

1      InputStream
2      |
3
4      |      |      |
5 FileInputStream  ByteArrayInputStream  FilterInputStream
6
7
8      |      |
9      BufferedInputStream  DataInputStream

```

Common InputStream Methods:

Method	Description	Example
read()	Reads single byte	int b = in.read();
read(byte[])	Reads bytes into array	in.read(buffer);
available()	Returns available bytes	int count = in.available();
close()	Closes the stream	in.close();
skip(long)	Skips specified bytes	in.skip(10);

Example Usage:

```
1 try (FileInputStream fis = new FileInputStream("data.txt")) {
2     int data;
3     while ((data = fis.read()) != -1) {
4         System.out.print((char) data);
5     }
6 } catch (IOException e) {
7     e.printStackTrace();
8 }
```

InputStream Features:

- **Abstract class:** Cannot be instantiated directly
- **Byte-oriented:** Handles byte data
- **Input operations:** Reading data from various sources
- **Resource management:** Must be closed after use

Mnemonic

“Abstract Byte Input Resource”

Question 5(b OR) [4 marks]

Define package in JAVA. Write how package can be implemented in Java with proper syntax and one example.

Solution

Package Definition: A package in Java is a namespace that organizes related classes and interfaces together. It provides access protection and namespace management.

Package Implementation Syntax:

```
1 // 1. Package declaration (must be first line)
2 package packageName;
3
4 // 2. Import statements
5 import java.util.*;
6 import anotherPackage.ClassName;
7
8 // 3. Class definition
9 public class ClassName {
10     // class body
11 }
```

Package Creation Steps:

Step	Action	Example
1. Create directory	Make folder with package name	mkdir mypackage
2. Package declaration	Add package statement	package mypackage;
3. Compile	Compile with proper classpath	javac -d . ClassName.java
4. Run	Run with fully qualified name	java mypackage.ClassName

Complete Example:

File: utilities/MathOperations.java

```
1 package utilities;
2
3 public class MathOperations {
4     public static int add(int a, int b) {
5         return a + b;
6     }
7
8     public static int multiply(int a, int b) {
9         return a * b;
10    }
11
12    public static double calculateArea(double radius) {
13        return 3.14 * radius * radius;
14    }
15}
```

File: utilities/StringOperations.java

```
1 package utilities;
2
3 public class StringOperations {
4     public static String reverse(String str) {
5         return new StringBuilder(str).reverse().toString();
6     }
7
8     public static boolean isPalindrome(String str) {
9         String reversed = reverse(str);
10        return str.equals(reversed);
11    }
12}
```

File: TestPackage.java

```
1 import utilities.MathOperations;
2 import utilities.StringOperations;
3
4 public class TestPackage {
5     public static void main(String[] args) {
6         // Using MathOperations
7         int sum = MathOperations.add(10, 20);
8         int product = MathOperations.multiply(5, 4);
9         double area = MathOperations.calculateArea(7.0);
10
11         System.out.println("Sum: " + sum);
12         System.out.println("Product: " + product);
13         System.out.println("Area: " + area);
14
15         // Using StringOperations
16         String original = "hello";
17         String reversed = StringOperations.reverse(original);
18         boolean isPalindrome = StringOperations.isPalindrome("madam");
19
20         System.out.println("Original: " + original);
21         System.out.println("Reversed: " + reversed);
22         System.out.println("Is 'madam' palindrome? " + isPalindrome);
23     }
24}
```

Package Benefits:

- **Namespace management:** Avoids naming conflicts
- **Access control:** Package-private access level
- **Code organization:** Groups related functionality
- **Reusability:** Easy to import and use

Mnemonic

“Namespace Access Organization Reusability”

Question 5(c OR) [7 marks]

Write a program in Java to demonstrate use of List. 1) Create ArrayList and add weekdays (in string form), 2) Create LinkedList and add months (in string form). Display both List.

Solution

```
1 import java.util.*;
2
3 public class ListDemo {
4     public static void main(String[] args) {
5         // Demonstrate ArrayList with weekdays
6         demonstrateArrayList();
7
8         System.out.println("\n" + "=".repeat(50) + "\n");
9
10        // Demonstrate LinkedList with months
11        demonstrateLinkedList();
12
13        System.out.println("\n" + "=".repeat(50) + "\n");
14
15        // Compare both lists
16        compareListOperations();
17    }
18
19    // Method to demonstrate ArrayList
20    public static void demonstrateArrayList() {
21        System.out.println("ARRAYLIST DEMONSTRATION");
22        System.out.println("=====");
23
24        // Create ArrayList and add weekdays
25        ArrayList< String > weekdays = new ArrayList< String >();
26
27        // Adding weekdays
28        weekdays.add("Monday");
29        weekdays.add("Tuesday");
30        weekdays.add("Wednesday");
31        weekdays.add("Thursday");
32        weekdays.add("Friday");
33        weekdays.add("Saturday");
34        weekdays.add("Sunday");
35
36        // Display ArrayList
37        System.out.println("Weekdays in ArrayList:");
38        for (int i = 0; i < weekdays.size(); i++) {
39            System.out.println((i + 1) + ". " + weekdays.get(i));
40        }
41
42        // ArrayList specific operations
43        System.out.println("\nArrayList Operations:");
44        System.out.println("Size: " + weekdays.size());
45        System.out.println("First day: " + weekdays.get(0));
46        System.out.println("Last day: " + weekdays.get(weekdays.size() - 1));
47        System.out.println("Contains 'Friday': " + weekdays.contains("Friday"));
48
49        // Enhanced for loop
50        System.out.println("\nUsing Enhanced For Loop:");
51        for (String day : weekdays) {
52            System.out.print(day + " ");
53        }
54    }
55}
```

```

44     System.out.println();
45 }
46
47 // Method to demonstrate LinkedList
48 public static void demonstrateLinkedList() {
49     System.out.println("LINKEDLIST DEMONSTRATION");
50     System.out.println("=====");
51
52     // Create LinkedList and add months
53     LinkedList< String > months = new LinkedList< String >();
54
55     // Adding months
56     months.add("January");
57     months.add("February");
58     months.add("March");
59     months.add("April");
60     months.add("May");
61     months.add("June");
62     months.add("July");
63     months.add("August");
64     months.add("September");
65     months.add("October");
66     months.add("November");
67     months.add("December");
68
69     // Display LinkedList
70     System.out.println("Months in LinkedList:");
71     for (int i = 0; i < months.size(); i++) {
72         System.out.println((i + 1) + ". " + months.get(i));
73     }
74
75     // LinkedList specific operations
76     System.out.println("\nLinkedList Operations:");
77     System.out.println("Size: " + months.size());
78     System.out.println("First month: " + months.getFirst());
79     System.out.println("Last month: " + months.getLast());
80
81     // Add at specific positions
82     months.addFirst("START");
83     months.addLast("END");
84
85     System.out.println("\nAfter adding at first and last:");
86     System.out.println("First element: " + months.getFirst());
87     System.out.println("Last element: " + months.getLast());
88     System.out.println("Total size: " + months.size());
89
90     // Remove the added elements
91     months.removeFirst();
92     months.removeLast();
93
94     // Using Iterator
95     System.out.println("\nUsing Iterator:");
96     Iterator< String > iterator = months.iterator();
97     while (iterator.hasNext()) {
98         System.out.print(iterator.next() + " ");
99     }
100    System.out.println();
101 }
102
103 // Method to compare list operations
104 public static void compareListOperations() {
105     System.out.println("LIST COMPARISON");
106     System.out.println("=====");
107
108     // Create both lists with sample data
109     ArrayList< String > arrayList = new ArrayList< String >();
110     LinkedList< String > linkedList = new LinkedList< String >();

```

```

131
132     // Add sample data
133     String[] data = {"A", "B", "C", "D", "E"};
134
135     for (String item : data) {
136         arrayList.add(item);
137         linkedList.add(item);
138     }
139
140     System.out.println("ArrayList: " + arrayList);
141     System.out.println("LinkedList: " + linkedList);
142
143     // Performance comparison info
144     System.out.println("\nPerformance Characteristics:");
145     System.out.println("ArrayList - Better for: Random access, Memory efficient");
146     System.out.println("LinkedList - Better for: Insertion/Deletion, Dynamic size");
147 }
148 }
```

List Interface Features:

Feature	ArrayList	LinkedList
Internal Structure	Dynamic array	Doubly linked list
Access Time	O(1) random access	O(n) sequential access
Insertion/Deletion	O(n) at middle	O(1) at ends
Memory	Less memory overhead	More memory for pointers

Common List Methods:

- **add()**: Adds element to list
- **get()**: Retrieves element by index
- **size()**: Returns number of elements
- **contains()**: Checks if element exists
- **remove()**: Removes element
- **iterator()**: Returns iterator for traversal

List Benefits:

- **Dynamic size**: Grows and shrinks automatically
- **Ordered collection**: Maintains insertion order
- **Duplicate elements**: Allows duplicate values
- **Index-based access**: Access elements by position

Mnemonic

“Dynamic Ordered Duplicate Index-based”