References

Object-Oriented Design Heuristics, Chapter 2

Designing Object-Oriented Software, Wirfs-Brock, Wilkerson, Wiener
Question a

Using your favorite OO programming language (Java, C++, Ruby, etc) in which class would you place the following method?

A method that computes the area of a circle.
Question b

Using your favorite OO programming language (Java, C++, Ruby, etc) in which class would you place the following method?

A reverse method that reverses the order of the characters in a string.
Question c

Using your favorite OO programming language (Java, C++, Ruby, etc) in which class would you place the following method?

A method that computes the checksum of a sequence of bits.
char* reverse(char *aString)
{
    int stringLength = strlen(aString);
    char reverse[stringLength + 1];
    for (k = 0; k < stringLength; k++)
    {
        reverse[k] = aString[stringLength-k-1];
    }
    return reverse;
}
C++

Is this OO?

class MyString
{
    public static char* reverse(char *aString);
}

char* MyString :: reverse(char *aString)
{
    int stringLength = strlen(aString);
    char reverse[stringLength + 1];
    for (k = 0; k < stringLength; k++)
        reverse[k] = aString[stringLength-k-1]
    return reverse;
}
class MyString
{
    public String reverse(String toReverse)
    {
        StringBuilder string = new StringBuilder(toReverse);
        StringBuilder reverse = string.reverse();
        return reverse.toString();
    }
}
Java
Is this OO?

class MyString
{
    public static String reverse(String toReverse)
    {
        StringBuilder string = new StringBuilder(toReverse);
        StringBuilder reverse = string.reverse();
        return reverse.toString();
    }
}
2.8 A class should capture one and only one key abstraction

2.9 Keep related data and behavior in one place

2.10 Spin off nonrelated information into another class
java.lang.Math

package java.lang;
import java.util.Random;

public final strictfp class Math {
    public static double abs(double a) {
        return (a <= 0.0D) ? 0.0D - a : a;
    }

    public static double toDegrees(double angrad) {
        return angrad * 180.0 / PI;
    }

    etc.
}

So what do we lose doing this?
One disease long life
No disease short life
Heuristic

A method to help solve a problem, commonly informal

"rules of thumb"
Heuristic 2.3

Minimize the number of messages in the protocol of a class

"The problem with large public interfaces is that you can never find what you are looking for"

Is this a design issue or a tool issue?

What do you do when the class does not have the method you need?
2.1 All data should be hidden within its class

public class Foo {
    public int x;
    public int y;
}

public class Foo {
    private int x;
    private int y;
    
    public int getX() {return x;}
    public int getY() {return y;}
    
    public void setX(int newX){
        x = newX
    }
    
    public void setY(int newY){
        y = newY
    }
}
Role Versus Class

Is Mother a subclass of a Person class or an instance of it?
Inheritance verses Data Members

class Car { ...
    Wheel[] tires;
    ...
}

class Wheel extends Car { ...
}

Wheel is a type of car

Car has wheels

To test for inheritance ask "Is A a type of B" if yes then A is likely to be a subclass of B. If the answer to the question "does C have Ds" is true then it is likely that C has data members of type D.
Coupling

Strength of interaction between objects in system

"Unnecessary object coupling needlessly decreases the reusability of the coupled objects"

"Unnecessary object coupling also increases the chances of system corruption when changes are made to one or more of the coupled objects"

Design Goal

The interaction or other interrelationship between any two components at the same level of abstraction within the system be as weak as possible
Types of Coupling

Nil Coupling
   No interaction between two classes

Export Coupling
   One class uses the public interface of another

Overt Coupling
   One class uses implementation details of another class with permission

Covert Coupling
   One class uses implementation details of another class without permission

There are other categories of coupling. See Wikipedia on Coupling
Cohesion

Degree to which the tasks performed by a single module are functionally related

Each element in the module should be essential to the module's purpose
Coupling & Cohesion Heuristics

Classes should only exhibit nil or export coupling with other classes

A class should capture one and only one key abstraction

Keep related data and behavior in one place

Spin off nonrelated information into another class
Design Process
One OO Design Process

Exploratory Phase

Who is on the team?
What are their tasks, responsibilities?
Who works with whom?

Analysis Phase

Who's related to whom?
Finding sub teams
Putting it all together

This is known as the Responsibility-Driven process. See the Wirfs-Brock book listed in the references.
Exploratory Phase

Who is on the team?

What are the goals of the system?
What must the system accomplish?
What objects are required to model the system and accomplish the goals?

Finding the initial list of classes for the system
Exploratory Phase

What are their tasks, responsibilities?

What does each object have to know in order to accomplish its tasks?
What steps toward accomplishing each goal is it responsible for?

Candidate list of fields and methods
Exploratory Phase

Who works with whom?

With whom will each object collaborate in order to accomplish each of its responsibilities? What is the nature of the objects' collaboration?

How do the objects interact
Analysis Phase
Who's related to whom?

Determine which classes are related via inheritance
Finding abstract classes
Determine class contracts
Analysis Phase
Finding sub teams

Divide responsibilities into subsystems
Designing interfaces of subsystems and classes
Analysis Phase
Putting it all together

Construct protocols for each class
Produce a design specification for each class and subsystem
Write a design specification for each contract