NCERT Solutions Class 12 Maths
Chapter 9: Differential Equations
Exercise 9.1

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Quick Summary: In NCERT Solutions Class 12 Maths Chapter 9 Exercise 9.1, students learn the fundamental concepts of differential equations including order, degree, general and particular solutions. This exercise covers basic definitions and methods for identifying the characteristics of differential equations, which form the foundation for advanced calculus problems in CBSE board exams and competitive tests like JEE.

Key Takeaways:

- Order of a differential equation is the highest derivative present, like (d^2y)/(dx^2) gives order 2
- Degree is the power of the highest order derivative when the equation is polynomial in derivatives
- General solution contains arbitrary constants while particular solution has specific values
- Mastering order and degree identification is crucial for solving complex differential equations in board exams

Complete Solutions

Question 1

QUESTION

Determine order and degree (if defined) of the differential equation (d^4y)/(dx^4) + \sin(y''') = 0.

SOLUTION

We are asked to find the order and degree of the given differential equation: .

Step 1: Define Order of a Differential Equation

The order of a differential equation is the highest order derivative present in the equation.

Step 2: Identify the Highest Order Derivative

In the given equation, , we have two derivative terms:

which is the fourth derivative of with respect to , and which is the third derivative of with respect to .

The highest order derivative is , which is of order 4.

Therefore, the order of the differential equation is 4.

Step 3: Define Degree of a Differential Equation

The degree of a differential equation is the power of the highest order derivative, provided the equation is a polynomial equation in its derivatives.

Step 4: Check if the Equation is a Polynomial Equation in Derivatives

In the given equation, , the term involves a trigonometric function of a derivative ().

Because of the presence of the term, the given differential equation is *not* a polynomial equation in its derivatives.

Step 5: Determine the Degree

Since the equation is not a polynomial equation in derivatives, the degree of the differential equation is not defined.

Final Answer:

Order 4; Degree not defined

ANSWER

Order 4; Degree not defined

Question 2

QUESTION

Determine order and degree (if defined) of the differential equation y' + 5y = 0.

SOLUTION

We are asked to find the order and degree of the given differential equation .

Step 1: Understand the terms 'order' and 'degree'

The **order** of a differential equation is the highest order derivative present in the equation.

The **degree** of a differential equation is the power of the highest order derivative, provided the equation is a polynomial equation in its derivatives.

Step 2: Rewrite the equation to identify the derivatives clearly

The given differential equation is . We can rewrite as . So the equation becomes:

Step 3: Identify the highest order derivative

In the equation , the only derivative present is , which is the first derivative of with respect to .

Therefore, the highest order derivative is 1.

Step 4: Determine the order of the differential equation

Since the highest order derivative is 1, the order of the differential equation is 1.

Step 5: Determine the degree of the differential equation

The power of the highest order derivative in the equation is 1.

Therefore, the degree of the differential equation is 1.

Final Answer: Order 1; Degree 1

ANSWER

Order 1; Degree 1

Question 3

QUESTION

Determine order and degree (if defined) of the differential equation \left((ds)/(dt)\right)^4 + 3s(d^2s)/(dt^2) = 0.

SOLUTION

We are asked to find the order and degree of the given differential equation: .

Step 1: Define Order

The order of a differential equation is the highest order derivative present in the equation. In simpler terms, it's the highest number of times the dependent variable is differentiated with respect to the independent variable.

Step 2: Identify the highest order derivative

In the given equation, we have two derivatives:

which is the first derivative (order 1)

which is the second derivative (order 2)

The highest order derivative is , which is of order 2.

Step 3: Determine the Order

Therefore, the order of the given differential equation is 2.

Step 4: Define Degree

The degree of a differential equation is the power of the highest order derivative in the equation, provided the equation is a polynomial equation in its derivatives. This means we need to make sure there are no radicals or fractions involving the derivatives.

Step 5: Identify the power of the highest order derivative

In the given equation, the highest order derivative is . Its power is 1, since it appears as , which is equivalent to .

Step 6: Determine the Degree

Therefore, the degree of the given differential equation is 1.

Final Answer:

Order 2; Degree 1

ANSWER

Order 2; Degree 1

Question 4

QUESTION

Determine order and degree (if defined) of the differential equation \left((d^2y)/(dx^2)\right)^2 + \cos\left((dy)/(dx)\right) = 0.

SOLUTION

We are asked to find the order and degree of the given differential equation: .

Step 1: Determine the order of the differential equation

The order of a differential equation is the highest order derivative present in the equation. In the given equation, we have two derivatives: (first derivative) and (second derivative). The highest order derivative is , which is the second derivative. Therefore, the order of the differential equation is 2.

Step 2: Determine the degree of the differential equation

The degree of a differential equation is the highest power of the highest order derivative, provided the equation is a polynomial equation in its derivatives. In the given equation, we have . Notice that the term is a trigonometric function of a derivative. Since the equation involves a trigonometric function of a derivative, it is not a polynomial equation in its derivatives. Therefore, the degree of this differential equation is not defined.

Step 3: State the final answer

The order of the differential equation is 2, and the degree is not defined.

ANSWER

Order 2; Degree not defined

Question 5

QUESTION

Determine order and degree (if defined) of the differential equation (d^2y)/(dx^2) = \cos 3x + \sin 3x.

SOLUTION

We are asked to find the order and degree of the given differential equation: .

Step 1: Define Order

The **order** of a differential equation is the highest order derivative present in the equation. In simpler terms, it's the highest number of times the dependent variable (in this case,) is differentiated with respect to the independent variable (in this case,).

Step 2: Identify the highest order derivative

In the given equation, is the only derivative present. The superscript '2' in indicates that is differentiated twice with respect to .

Therefore, the order of the differential equation is 2.

Step 3: Define Degree

The **degree** of a differential equation is the power of the highest order derivative, provided the equation is a polynomial equation in its derivatives. This means that we should be able to express the differential equation without any fractional powers or radicals involving the derivatives.

Step 4: Determine the power of the highest order derivative

The given differential equation is: . The highest order derivative is , and its power is 1 (since it's implicitly raised to the power of 1).

Step 5: State the order and degree

Order: 2

Degree: 1

Final Answer: Order 2; Degree 1

ANSWER

Order 2; Degree 1

Question 6

QUESTION

Determine order and degree (if defined) of the differential equation (y''')^2 + (y'')^3 + (y')^4 + y^5 = 0.

SOLUTION

This question asks us to determine the order and degree of the given differential equation. The order of a differential equation is the highest order derivative present in the equation, and the degree is the power of the highest order derivative, provided the equation is a polynomial equation in its derivatives.

Step 1: Identify the highest order derivative

The given differential equation is: Here, represents the third derivative of with respect to , represents the second derivative, and represents the first derivative.

The highest order derivative present in the equation is .

Step 2: Determine the order of the differential equation

Since the highest order derivative is , which is the third derivative, the order of the differential equation is 3.

Step 3: Determine the degree of the differential equation

The degree of a differential equation is the power to which the highest order derivative is raised, provided the equation is a polynomial equation in derivatives. In our equation, the highest order derivative is raised to the power of 2.

Step 4: State the final answer

Therefore, the order of the differential equation is 3 and the degree is 2.

Order 3; Degree 2

ANSWER

Order 3; Degree 2

Question 7

QUESTION

Determine order and degree (if defined) of the differential equation y''' + 2y'' + y' = 0.

SOLUTION

We are asked to find the order and degree of the given differential equation: .

Step 1: Define Order of a Differential Equation

The order of a differential equation is the highest order derivative present in the equation. In other words, it's the highest number of times the dependent variable (in this case,) is differentiated with respect to the independent variable (usually).

Step 2: Identify the Highest Order Derivative

In the given equation, , we have the following derivatives:

- (first derivative)
- (second derivative)
- (third derivative)

The highest order derivative is , which is the third derivative.

Step 3: Determine the Order

Therefore, the order of the differential equation is 3.

Step 4: Define Degree of a Differential Equation

The degree of a differential equation is the power of the highest order derivative, provided the equation is a polynomial equation in derivatives. This means we should be able to express the equation without fractional or negative exponents on the derivatives.

Step 5: Determine the Power of the Highest Order Derivative

In the given equation, , the highest order derivative is . The power of is 1 (since it's to the power of 1).

Step 6: Determine the Degree

Since the power of the highest order derivative is 1, the degree of the differential equation is 1.

Final Answer:

Order 3; Degree 1

ANSWER

Order 3; Degree 1

Question 8

QUESTION

Determine order and degree (if defined) of the differential equation y' + y = e^x.

SOLUTION

We are asked to find the order and degree of the given differential equation .

Step 1: Understand the terms 'order' and 'degree'

The **order** of a differential equation is the highest order derivative present in the equation.

The **degree** of a differential equation is the power of the highest order derivative, provided the equation is a polynomial equation in its derivatives.

Step 2: Rewrite the equation to identify the derivatives

The given differential equation is:

Here, represents the first derivative of with respect to , which can also be written as .

So, the equation can be rewritten as:

Step 3: Determine the order

The highest order derivative present in the equation is , which is the first derivative.

Therefore, the order of the differential equation is 1.

Step 4: Determine the degree

The power of the highest order derivative in the equation is 1.

Since the equation is a polynomial equation in its derivatives, the degree is defined.

Therefore, the degree of the differential equation is 1.

Final Answer:

Order 1; Degree 1

ANSWER

Order 1; Degree 1

Question 9

QUESTION

Determine order and degree (if defined) of the differential equation y'' + (y')^2 + 2y = 0.

SOLUTION

This question asks us to find the order and degree of the given differential equation. The order refers to the highest order derivative present in the equation, and the degree is the power of the highest order derivative, provided the equation is a polynomial equation in its derivatives.

Step 1: Identify the highest order derivative

The given differential equation is: Here, represents the second derivative of with respect to , and represents the first derivative. The highest order derivative present is , which is the second derivative. Therefore, the order of the differential equation is 2.

Step 2: Determine the degree of the differential equation

To find the degree, we look at the power of the highest order derivative in the equation. In this case, the highest order derivative is , and its power is 1 (since is the same as). The equation is a polynomial equation in derivatives.

Step 3: State the order and degree

Therefore, the order of the differential equation is 2, and the degree is 1.

Final Answer: Order 2; Degree 1

ANSWER

Order 2; Degree 1

Question 10

QUESTION

Determine order and degree (if defined) of the differential equation y'' + 2y' + \sin y = 0.

SOLUTION

We are asked to find the order and degree of the given differential equation: .

Step 1: Define Order of a Differential Equation

The order of a differential equation is the highest order derivative present in the equation. In other words, it's the highest number of times the dependent variable is differentiated with respect to the independent variable.

Step 2: Identify the Highest Order Derivative

In the given equation, , we have the following derivatives:

- which represents the first derivative,
- which represents the second derivative,

The highest order derivative present is , which is the second derivative.

Therefore, the order of the differential equation is 2.

Step 3: Define Degree of a Differential Equation

The degree of a differential equation is the power of the highest order derivative, provided the equation is a polynomial equation in derivatives. This means we need to be able to express the equation without fractional or negative exponents on the derivatives, and without transcendental functions (like sine, cosine, tangent, exponentials, logarithms) of the derivatives.

Step 4: Determine the Power of the Highest Order Derivative

In the equation , the highest order derivative is . The power of is 1.

Also, note that the term does not involve derivatives of , so it does not affect the degree of the differential equation.

Therefore, the degree of the differential equation is 1.

Final Answer:

Order 2; Degree 1

ANSWER

Order 2; Degree 1

Question 11

QUESTION

The degree of the differential equation \left((d^2y)/(dx^2)\right)^3 + \left((dy)/(dx)\right)^2 + \sin\left((dy)/(dx)\right) + 1 = 0 is

SOLUTION

We are asked to find the degree of the given differential equation: .

Step 1: Understand the definition of degree

The degree of a differential equation is the highest power of the highest order derivative in the equation, provided the equation is a polynomial equation in its derivatives. This means that no transcendental functions (like sine, cosine, exponential, etc.) should involve any of the derivatives.

Step 2: Analyze the given equation

The given differential equation is .

Notice the term . Here, the sine function is applied to the first derivative . This means the equation is *not* a polynomial equation in its derivatives.

Step 3: Determine if the degree is defined

Since the equation contains a transcendental function (sine) of a derivative, the degree of the differential equation is not defined.

Final Answer: not defined

Conclusion: The presence of the term makes the given differential equation a non-polynomial equation in its derivatives. Therefore, the degree of the differential equation is not defined.

ANSWER

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Question 12

QUESTION

The order of the differential equation 2x^2(d^2y)/(dx^2) - 3(dy)/(dx) + y = 0 is

SOLUTION

The question asks us to find the order of the given differential equation: . The order of a differential equation is the highest order derivative present in the equation.

Step 1: Identify the derivatives in the equation

The given differential equation is:

We can see two derivative terms:

- , which is the first derivative of with respect to .
- , which is the second derivative of with respect to .

Step 2: Determine the order of each derivative

- The order of is 1.
- The order of is 2.

Step 3: Find the highest order derivative

Comparing the orders of the derivatives present in the equation, the highest order is 2, which corresponds to the term .

Therefore, the order of the given differential equation is 2.

Correct Answer: 2

Why the other options are incorrect:

- 1: This is the order of the first derivative, but not the highest order in the equation.
- 0: This would imply no derivatives are present, which is false.
- not defined: The order is clearly defined as the highest order derivative present.

ANSWER

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📐 Key Formulas

Important Formulas for Exercise 9.1

Formula / Concept	Description
Differential Equation	An equation involving the derivative of a dependent variable with respect to an independent variable. For example, (d^2y)/(dx^2) + y = 0.
Order of a Differential Equation	The order of the highest order derivative present in the differential equation. For instance, in \left((d^3y)/(dx^3)\right) + x^2\left((d^2y)/(dx^2)\right)^3 = 0, the highest order derivative is (d^3y)/(dx^3), so the order is 3.
Degree of a Differential Equation	The highest power (positive integer) of the highest order derivative, provided the differential equation is a polynomial equation in its derivatives. For the equation \left((d^2y)/(dx^2)\right)^2 + \left((dy)/(dx)\right)^3 + y = 0, the order is 2, and the degree is 2.
Condition for Degree	The degree of a differential equation is defined only if it can be expressed as a polynomial equation in its derivatives.
Undefined Degree	If a differential equation cannot be expressed as a polynomial in its derivatives, its degree is not defined. For example, the degree of (dy)/(dx) + \sin\left((dy)/(dx)\right) = 0 is not defined.
General Form of a First Order, First Degree Differential Equation	(dy)/(dx) + Py = Q, where P and Q are constants or functions of x only.

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