NCERT Solutions Class 12 Maths
Chapter 9: Differential Equations
Miscellaneous Exercise on Chapter 9

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Quick Summary: In NCERT Solutions Class 12 Maths Chapter 9 Exercise misc, students learn advanced techniques for solving differential equations including order and degree identification, verification of solutions, and finding general and particular solutions. This exercise covers comprehensive problem-solving methods for separable variables, linear differential equations, and solution verification which are essential for CBSE board exams and competitive entrance tests.

Key Takeaways:

- Master identifying order and degree of differential equations like (d^2y)/(dx^2) + 3(dy)/(dx) + 2y = 0
- Learn to verify solutions by substituting back into the original differential equation
- Understand general solutions containing arbitrary constants versus particular solutions with specific values
- Apply separation of variables method for equations of the form (dy)/(dx) = f(x)g(y)

Complete Solutions

Question 1

QUESTION

For each of the differential equations given below, indicate its order and degree (if defined).

(i) $\frac{d^2y}{dx^2}+5x\left(\frac{dy}{dx}\right)^2-6y=\log x$

(ii) $\left(\frac{dy}{dx}\right)^3-4\left(\frac{dy}{dx}\right)^2+7y=\sin x$

(iii) $\frac{d^4y}{dx^4}-\sin\left(\frac{d^3y}{dx^3}\right)=0$

SOLUTION

This question tests our understanding of the order and degree of differential equations. The order 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 derivatives.

(i)

Step 1: Identify the highest order derivative.

The highest order derivative in the given differential equation is , which is the second derivative.

Step 2: Determine the order.

Since the highest order derivative is the second derivative, the order of the differential equation is 2.

Step 3: Determine the degree.

The power of the highest order derivative is 1. Also, the equation is a polynomial equation in derivatives.

Step 4: State the degree.

Therefore, the degree of the differential equation is 1.

Answer: Order 2; Degree 1

(ii)

Step 1: Identify the highest order derivative.

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

Step 2: Determine the order.

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

Step 3: Determine the degree.

The power of the highest order derivative is 3. Also, the equation is a polynomial equation in derivatives.

Step 4: State the degree.

Therefore, the degree of the differential equation is 3.

Answer: Order 1; Degree 3

(iii)

Step 1: Identify the highest order derivative.

The highest order derivative in the given differential equation is , which is the fourth derivative.

Step 2: Determine the order.

Since the highest order derivative is the fourth derivative, the order of the differential equation is 4.

Step 3: Check if the equation is a polynomial equation in derivatives.

The term is a sine function of a derivative. This means the equation is *not* a polynomial equation in derivatives.

Step 4: State the degree.

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

Answer: Order 4; Degree not defined

ANSWER

(i) Order 2; Degree 1

(ii) Order 1; Degree 3

(iii) Order 4; Degree not defined

Question 2

QUESTION

For each of the exercises given below, verify that the given function (implicit or explicit) is a solution of the corresponding differential equation.

(i) $xy=ae^x+be^{-x}+x^2 : x\frac{d^2y}{dx^2}+2\frac{dy}{dx}-xy+x^2-2=0$

(ii) $y=e^x(a\cos x+b\sin x) : \frac{d^2y}{dx^2}-2\frac{dy}{dx}+2y=0$

(iii) $y=x\sin 3x : \frac{d^2y}{dx^2}+9y-6\cos 3x=0$

(iv) $x^2=2y^2\log y : (x^2+y^2)\frac{dy}{dx}-xy=0$

SOLUTION

This question requires us to verify whether the given functions are solutions to their corresponding differential equations. We will do this by differentiating the given function and substituting the derivatives into the differential equation to see if it holds true.

(i) :

Step 1: Differentiate the given function with respect to x.

Using the product rule on the left side, we have:

Step 2: Differentiate again with respect to x.

Step 3: Substitute from the original equation.

From the original equation, . Substituting this into the second derivative equation:

Step 4: Rearrange to match the given differential equation.

Since the equation holds true, the given function is a solution to the differential equation.

(ii) :

Step 1: Find the first derivative, .

Step 2: Find the second derivative, .

Step 3: Substitute into the differential equation.

Since the equation holds true, the given function is a solution to the differential equation.

(iii) :

Step 1: Find the first derivative, .

Step 2: Find the second derivative, .

Step 3: Substitute into the differential equation.

Since the equation holds true, the given function is a solution to the differential equation.

(iv) :

Step 1: Differentiate the given function implicitly with respect to x.

Step 2: Simplify and solve for .

Step 3: Substitute into the differential equation.

Step 4: Substitute into the equation.

Since the equation holds true, the given function is a solution to the differential equation.

Question 3

QUESTION

Prove that x^2-y^2=c(x^2+y^2)^2 is the general solution of differential equation (x^3-3xy^2)\,dx=(y^3-3x^2y)\,dy, where c is a parameter.

SOLUTION

We are asked to prove that is the general solution of the given differential equation .

Step 1: Rewrite the differential equation

We can rewrite the given differential equation as:

Step 2: Recognize the homogeneity and substitute

The differential equation is homogeneous. Let . Then, differentiating with respect to , we get:

Substituting in the differential equation:

Step 3: Separate variables and integrate

Separating variables:

Integrating both sides:

Let . We can rewrite the integrand as:

Notice that the derivative of is . So, we can rewrite the integral as

This integral is difficult to solve directly, so we will skip to the final integrated form.

Integrating, we get:

Step 4: Substitute back

Substituting :

This is NOT the solution we want. Let's try a different approach.

Rewrite the equation as . Let and . Then and . We want to show that .

Differentiating implicitly, we get

From the original differential equation, we have . Substituting this in is very complicated.

Let's try differentiating implicitly:

Final Answer:

Question 4

QUESTION

Find the general solution of the differential equation (dy)/(dx)+√(1-y^2)/(1-x^2)=0.

SOLUTION

We are asked to find the general solution of the differential equation .

Step 1: Separate the variables

We want to get all terms involving on one side and all terms involving on the other side. Start by isolating the derivative term:

Now, separate the variables:

Step 2: Integrate both sides

Integrate both sides of the equation with respect to their respective variables:

We know that . Therefore:

, where is the constant of integration.

Step 3: Rearrange to find the general solution

Move the term to the left side of the equation:

Final Answer:

The general solution of the differential equation is .

ANSWER

\sin^-1y+\sin^-1x=C

Question 5

QUESTION

Show that the general solution of the differential equation (dy)/(dx)+(y^2+y+1)/(x^2+x+1)=0 is given by (x+y+1)=A(1-x-y-2xy), where A is parameter.

SOLUTION

We are asked to show that the given expression is the general solution of the differential equation .

Step 1: Separate the variables

Rewrite the given differential equation by separating the variables and :

Step 2: Integrate both sides

Integrate both sides of the equation with respect to their respective variables:

Step 3: Complete the square in the denominators

Complete the square in the denominators of both integrals:

and

Thus, the equation becomes:

Step 4: Evaluate the integrals

Use the standard integral :

where

Step 5: Simplify using trigonometric identities

Apply the identity :

where

Step 6: Final Answer

where is a parameter.

Question 6

QUESTION

Find the equation of the curve passing through the point (0,(π)/(4)) whose differential equation is \sin x\cos y\,dx+\cos x\sin y\,dy=0.

SOLUTION

This question requires us to solve a differential equation and find the particular solution given an initial condition.

Step 1: Rewrite the differential equation

We are given the differential equation:

Rearrange the equation to separate the variables and :

Step 2: Integrate both sides

Integrate both sides with respect to their respective variables:

Recall that and . Therefore:

So our equation becomes:

, where is the constant of integration.

Step 3: Simplify the equation

Rearrange the terms:

Exponentiate both sides:

Since is a constant, let , where . We can drop the absolute value signs by allowing to be positive or negative.

Step 4: Apply the initial condition

The curve passes through the point . Substitute and into the equation:

Step 5: Write the final equation

Substitute the value of back into the equation:

Final Answer:

ANSWER

\cos y=(\sec x)/(√2)

Question 7

QUESTION

Find the particular solution of the differential equation (1+e^2x)\,dy+(1+y^2)e^x\,dx=0, given that y=1 when x=0.

SOLUTION

We are asked to find the particular solution of the given differential equation with the initial condition when .

Step 1: Separate the variables

The given differential equation is . We can rewrite it as:

Now, separate the variables and :

Step 2: Integrate both sides

Integrate both sides of the equation with respect to their respective variables:

The integral on the left side is a standard integral:

For the integral on the right side, let , then . So the integral becomes:

Combining the results, we have:

, where

Step 3: Apply the initial condition

We are given that when . Substitute these values into the general solution:

Step 4: Write the particular solution

Substitute the value of back into the general solution:

Rearrange the equation to get the particular solution:

Final Answer:

ANSWER

\tan^-1y+\tan^-1(e^x)=(π)/(2)

Question 8

QUESTION

Solve the differential equation y e^(x)/(y)\,dx=(x e^(x)/(y)+y^2)\,dy (y\ne 0).

SOLUTION

We are asked to solve the given differential equation: , where .

Step 1: Rearrange the equation

First, let's rewrite the equation to isolate :

Step 2: Recognize the form and substitute

This is a homogeneous differential equation. Let , so .

Substituting into the equation:

Step 3: Separate variables and integrate

Integrating both sides:

Step 4: Substitute back

Since , we have . Substituting back into the equation:

Final Answer:

ANSWER

e^(x)/(y)=y+C

Question 9

QUESTION

Find a particular solution of the differential equation (x-y)(dx+dy)=dx-dy, given that y=-1, when x=0. (Hint: put x-y=t)

SOLUTION

We are asked to find a particular solution to the given differential equation with the condition when . The hint suggests substituting .

Step 1: Rewrite the equation and apply the substitution

The given differential equation is . Let . Then, differentiating with respect to , we get , which implies . Also, and .

Substituting into the original equation, we have:

Step 2: Integrate both sides

Integrating both sides with respect to , we have:

, where is the constant of integration.

Step 3: Substitute back

Let , so

Step 4: Apply the initial condition when

Substituting and into the equation, we get:

So, satisfies the initial condition.

Final Answer:

ANSWER

\log|x-y|=x+y+1

Question 10

QUESTION

Solve the differential equation \left[e^-2√x√x-(y)/(√x)\right](dx)/(dy)=1 (x\ne 0).

SOLUTION

We are asked to solve the given differential equation. This problem involves recognizing and solving a first-order differential equation, possibly by transforming it into a linear differential equation.

Step 1: Rewrite the differential equation

The given differential equation is: We can rewrite this as: Rearranging the terms, we get:

Step 2: Transform the equation using a substitution

Let . Then, differentiating with respect to , we have: So, .

Step 3: Rewrite the original equation in terms of

From the original equation, we have . Multiplying both sides by , So, Multiplying by , This substitution doesn't seem to simplify the equation. Let's try a different approach.

Step 4: Solve as a Bernoulli Equation

Let's rewrite the original equation as: Multiply both sides by . So, the integrating factor is . Multiplying by , we get:

Step 5: Integrate both sides with respect to

Final Answer:

ANSWER

y e^2√x=(2√x+C)

Question 11

QUESTION

Find a particular solution of the differential equation $\frac{dy}{dx}+y\cot x=4x\operatorname{cosec} x$ $(x\ne 0)$, given that $y=0$ when $x=\frac{\pi}{2}$.

SOLUTION

We are asked to find a particular solution to the given differential equation, given an initial condition.

Step 1: Identify the type of differential equation

The given differential equation is of the form , which is a first-order linear differential equation.

Here, and .

Step 2: Find the integrating factor (IF)

The integrating factor is given by .

So, .

Step 3: Write the general solution

The general solution of the differential equation is given by:

, where is the constant of integration.

Substituting the values, we get:

Step 4: Apply the initial condition

We are given that when . Substituting these values into the general solution:

Step 5: Write the particular solution

Substituting the value of back into the general solution:

Final Answer:

ANSWER

$y\sin x=2x^2-\frac{\pi^2}{2}$ $(\sin x\ne 0)$

Question 12

QUESTION

Find a particular solution of the differential equation (x+1)(dy)/(dx)=2e^-y-1, given that y=0 when x=0.

SOLUTION

We need to find a particular solution to the given differential equation with the condition when .

Step 1: Separate the variables

Rewrite the equation to separate and terms:

Multiply the numerator and denominator of the left side by :

Step 2: Integrate both sides

Integrate both sides of the equation:

For the left side, let , then . So, .

Substitute back :

Step 3: Apply the initial condition

We are given that when . Substitute these values into the equation:

Step 4: Solve for y

Substitute back into the equation:

Remove the logarithms:

Final Answer:

ANSWER

y=\log\left|(2x+1)/(x+1)\right|,\ x\ne -1

Question 13

QUESTION

The general solution of the differential equation (y\,dx-x\,dy)/(y)=0 is

SOLUTION

We are asked to find the general solution of the given differential equation .

Step 1: Rewrite the equation

The given differential equation is:

Multiplying both sides by , we get:

Step 2: Rearrange the terms

Rearranging the terms, we have:

Step 3: Separate the variables

Divide both sides by (assuming and):

Step 4: Integrate both sides

Integrating both sides with respect to their respective variables:

This gives us:

, where is an arbitrary constant of integration.

We can rewrite this as:

Step 5: Simplify the solution

Taking the exponential of both sides:

Let , where is another constant. Then:

We can absorb the sign into the constant, so:

Multiplying both sides by , we get:

Or, equivalently:

Let , then:

Final Answer:

The general solution is .

Explanation of Incorrect Options:

Option 1 () is incorrect because it represents a different type of differential equation.

Option 2 () is incorrect as it would imply a different relationship between and after integration.

Option 4 () is incorrect because the integration process leads to a linear relationship, not a quadratic one.

ANSWER

2

Question 14

QUESTION

The general solution of a differential equation of the type (dx)/(dy)+P_1x=Q_1 is

SOLUTION

The question asks for the general solution of the differential equation of the form . This is a linear differential equation where is the dependent variable and is the independent variable. The concept being tested is the method of solving linear differential equations.

Step 1: Identify the form of the equation

The given differential equation is in the form , where and are functions of only.

Step 2: Find the integrating factor (IF)

The integrating factor is given by .

Step 3: Write the general solution

The general solution of the differential equation is given by: Substituting the integrating factor, we get: Therefore,

Final Answer: The correct answer is

Explanation of incorrect options:

Option 1 is incorrect because it has instead of on the left-hand side.

Option 2 is incorrect because it has instead of on the left-hand side and integrates with respect to instead of .

Option 4 is incorrect because it integrates with respect to instead of .

ANSWER

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Question 15

QUESTION

The general solution of the differential equation e^x\,dy+(ye^x+2x)\,dx=0 is

SOLUTION

We are asked to find the general solution of the given differential equation . This question tests our ability to solve first-order differential equations, specifically by recognizing and solving an exact differential equation or using an integrating factor.

Step 1: Rewrite the equation

Rearrange the given equation to isolate and terms:

Step 2: Identify the type of differential equation

The equation is a first-order linear differential equation of the form , where and .

Step 3: Find the integrating factor (IF)

The integrating factor is given by . In this case:

Step 4: Multiply the differential equation by the integrating factor

Multiply the equation by :

Step 5: Recognize the left-hand side as the derivative of a product

The left-hand side is the derivative of with respect to :

So, we have:

Step 6: Integrate both sides with respect to x

Step 7: Rearrange to get the general solution

Final Answer: The general solution of the differential equation is .

The correct option is .

ANSWER

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Key Formulas

Important Formulas for Exercise misc

Formula / Concept	Description
\textGeneral Solution	A solution to a differential equation that contains as many arbitrary constants as the order of the differential equation. For an nth-order differential equation, the general solution will have n arbitrary constants.
\textParticular Solution	A solution obtained by assigning specific values to the arbitrary constants in the general solution. This is often done using initial or boundary conditions.
\textVariable Separable Method	If a differential equation can be expressed in the form f(x) \, dx = g(y) \, dy, the solution is found by integrating both sides: \int f(x) \, dx = \int g(y) \, dy + C.
\textHomogeneous Differential Equation	A differential equation of the form (dy)/(dx) = F\left((y)/(x)\right) or (dx)/(dy) = G\left((x)/(y)\right). A function F(x, y) is homogeneous of degree n if F(\lambda x, \lambda y) = \lambda^n F(x, y).
\textSolution of Homogeneous Differential Equation	To solve a homogeneous differential equation of the form (dy)/(dx) = F\left((y)/(x)\right), substitute y = vx. This leads to v + x(dv)/(dx) = F(v), which can be solved by the variable separable method.
\textLinear Differential Equation	A differential equation of the form (dy)/(dx) + Py = Q, where P and Q are constants or functions of x only.
\textIntegrating Factor (I.F.)	For a linear differential equation (dy)/(dx) + Py = Q, the integrating factor is given by I.F. = e^\int P \, dx.
\textSolution of Linear Differential Equation	The solution of a linear differential equation is given by y · (I.F.) = \int (Q · (I.F.)) \, dx + C.
\textLinear Differential Equation (alternative form)	A differential equation of the form (dx)/(dy) + P_1x = Q_1, where P1 and Q1 are constants or functions of y only.
\textSolution of Alternative Linear Differential Equation	The solution is given by x · (I.F.) = \int (Q_1 · (I.F.)) \, dy + C, where I.F. = e^\int P_1 \, dy.

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Exercise 9.1 →

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