NCERT Solutions Class 12 Maths Chapter 9: Differential Equations Exercise 9.5

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Quick Summary: In NCERT Solutions Class 12 Maths Chapter 9 Exercise 9.5, students learn to solve homogeneous differential equations and find general solutions of first-order linear differential equations. This exercise covers essential methods for solving differential equations of the form (dy)/(dx) = f((y)/(x)) and provides step-by-step solutions for finding both general and particular solutions. These concepts are crucial for CBSE Class 12 board exams and form the foundation for advanced calculus applications.

Key Takeaways:

- Master the substitution method y = vx for solving homogeneous differential equations where (dy)/(dx) = f((y)/(x))
- Learn to identify and solve first-order linear differential equations using integrating factors
- Understand the difference between general solutions (with arbitrary constants) and particular solutions (with specific initial conditions)
- Practice variable separation techniques essential for CBSE board exam problems and competitive entrance tests

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Question 1

QUESTION

For the differential equation, find the general solution:

(dy)/(dx)+2y=\sin x

SOLUTION

We are asked to find the general solution of the given first-order linear differential equation.

Step 1: Identify the type of differential equation

The given differential equation is of the form:

where and . This is a first-order linear differential equation.

Step 2: Find the integrating factor (IF)

The integrating factor is given by:

In our case, , so:

Step 3: Multiply the differential equation by the integrating factor

Multiplying the given equation by , we get:

Step 4: Recognize the left-hand side as the derivative of a product

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

Step 5: Integrate both sides with respect to x

Integrating both sides, we get:

To evaluate , we use integration by parts twice.

Let . Then, integrating by parts:

Integrating by parts again:

So,

Step 6: Solve for y

Let .

Final Answer:

ANSWER

y=(1)/(5)(2\sin x-\cos x)+Ce^-2x

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Question 2

QUESTION

For the differential equation, find the general solution:

(dy)/(dx)+3y=e^-2x

SOLUTION

We are asked to find the general solution of the given first-order linear differential equation.

Step 1: Identify the type of differential equation

The given differential equation is:

This is a first-order linear differential equation of the form:

where and .

Step 2: Find the integrating factor

The integrating factor (IF) is given by:

In our case, , so:

Step 3: Multiply the differential equation by the integrating factor

Multiplying the given differential equation by , we get:

Step 4: Recognize the left-hand side as the derivative of a product

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

Step 5: Integrate both sides with respect to x

Integrating both sides with respect to , we have:

where is the constant of integration.

Step 6: Solve for y

Divide both sides by to isolate :

Final Answer:

The general solution of the differential equation is:

ANSWER

y=e^-2x+Ce^-3x

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Question 3

QUESTION

For the differential equation, find the general solution:

(dy)/(dx)+(y)/(x)=x^2

SOLUTION

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

Step 1: Identify the type of differential equation

The given equation is a first-order linear differential equation of the form:

Here, and .

Step 2: Find the integrating factor (IF)

The integrating factor is given by:

In our case, , so:

Therefore, the integrating factor is:

Step 3: Multiply the differential equation by the integrating factor

Multiplying the given equation by , we get:

Step 4: Recognize the left-hand side as the derivative of a product

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

So, we can rewrite the equation as:

Step 5: Integrate both sides with respect to x

where is the constant of integration.

Final Answer:

The general solution of the differential equation is:

ANSWER

xy=(x^4)/(4)+C

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Question 4

QUESTION

For the differential equation, find the general solution:

(dy)/(dx)+(\sec x)y=\tan x (0\le x<(π)/(2))

SOLUTION

We are asked to find the general solution of the given first-order linear differential equation.

Step 1: Identify the type of differential equation

The given differential equation is of the form:

where and .

This is a first-order linear differential equation.

Step 2: Find the integrating factor (IF)

The integrating factor is given by:

In our case, , so we need to find .

We know that .

Therefore, (since , is positive).

Step 3: Write the general solution

The general solution of the differential equation is given by:

Substituting the values, we get:

We know that and .

So, .

Therefore,

Final Answer:

ANSWER

y(\sec x+\tan x)=\sec x+\tan x-x+C

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Question 5

QUESTION

For the differential equation, find the general solution:

\cos^2 x\,(dy)/(dx)+y=\tan x (0\le x<(π)/(2))

SOLUTION

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

Step 1: Rewrite the equation in standard form

To solve this, we first need to rewrite the differential equation in the standard form of a first-order linear differential equation, which is . Divide the entire equation by :

Since and , the equation becomes:

Step 2: Find the integrating factor

The integrating factor (IF) is given by . In this case, . So, we need to find , which is . Therefore, the integrating factor is:

Step 3: Multiply the equation by the integrating factor

Multiply both sides of the differential equation by the integrating factor :

Step 4: Integrate both sides

The left side is the derivative of with respect to . So, we can write:

Now, integrate both sides with respect to :

Let , then . The integral on the right becomes:

Using integration by parts, . Substituting back :

Step 5: Solve for y

Divide both sides by :

Final Answer: The general solution is .

ANSWER

y=(\tan x-1)+Ce^-\tan x

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Question 6

QUESTION

For the differential equation, find the general solution:

x(dy)/(dx)+2y=x^2\log x

SOLUTION

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

Step 1: Rewrite the equation in standard form

To solve this, we first need to rewrite the given equation in the standard form of a first-order linear differential equation, which is . Divide the entire equation by :

Now we have and .

Step 2: Find the integrating factor

The integrating factor (IF) is given by . In our case:

Step 3: Multiply the standard form equation by the integrating factor

Multiply the standard form equation by the integrating factor :

Notice that the left side is the derivative of with respect to :

Step 4: Integrate both sides with respect to x

Integrate both sides with respect to :

To solve the integral on the right, we use integration by parts. Let and . Then and . So:

Thus, we have:

Step 5: Solve for y

Divide both sides by :

Final Answer:

ANSWER

y=(x^2)/(16)(4\log|x|-1)+Cx^-2

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Question 7

QUESTION

For the differential equation, find the general solution:

x\log x\,(dy)/(dx)+y=(2)/(x)\log x

SOLUTION

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

Step 1: Rewrite the equation in standard form

To solve this, we first need to rewrite the given differential equation in the standard form of a first-order linear differential equation, which is . Divide the entire equation by :

Step 2: Identify P(x) and Q(x)

Now we can identify and :

and

Step 3: Calculate the integrating factor (IF)

The integrating factor is given by . So, we need to calculate . Let , then , so . Therefore,

The integrating factor is .

Step 4: Find the general solution

The general solution is given by:

Substitute the values of IF and Q(x):

Step 5: Evaluate the integral

To evaluate , we use integration by parts. Let and . Then and . So,

Step 6: Write the final solution

Substitute the integral back into the general solution:

Final Answer:

ANSWER

y\log x=-(2)/(x)(1+\log|x|)+C

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Question 8

QUESTION

For the differential equation, find the general solution:

(1+x^2)\,dy+2xy\,dx=\cot x\,dx (x\ne 0)

SOLUTION

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

Step 1: Rewrite the equation in standard form

First, divide the entire equation by :

Then, rearrange to get the form :

Step 2: Identify P(x) and Q(x)

Here, and .

Step 3: Calculate the integrating factor (IF)

The integrating factor is given by . So, we need to find :

Let , then . So the integral becomes:

Since is always positive, we can write .

Therefore, the integrating factor is:

Step 4: Write the general solution

The general solution is given by:

Substituting the values of and :

We know that . Therefore:

Step 5: Solve for y

Divide both sides by :

Final Answer:

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ANSWER

y=(1+x^2)^-1\log|\sin x|+C(1+x^2)^-1

Question 9

QUESTION

For the differential equation, find the general solution:

x(dy)/(dx)+y-x+xy\cot x=0 (x\ne 0)

SOLUTION

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

Step 1: Rewrite the differential equation in standard form

The given differential equation is:

Rearrange the terms to isolate the derivative term:

Divide the entire equation by (since):

This is a linear differential equation of the form , where and .

Step 2: Find the integrating factor (IF)

The integrating factor is given by . So we need to calculate :

The integrating factor is:

Step 3: Find the general solution

The general solution of the linear differential equation is given by:

Substituting the values, we get:

We integrate using integration by parts:

So,

Step 4: Solve for y

Divide by :

Final Answer:

ANSWER

y=(1)/(x)-\cot x+(C)/(x\sin x)

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Question 10

QUESTION

For the differential equation, find the general solution:

(x+y)(dy)/(dx)=1

SOLUTION

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

Step 1: Rewrite the differential equation

We can rewrite the given differential equation as:

Taking the reciprocal of both sides, we get:

Step 2: Rearrange the equation into a linear form

Rearranging the equation, we get a linear differential equation in terms of and :

This is a linear differential equation of the form , where and .

Step 3: Find the integrating factor (IF)

The integrating factor is given by:

Step 4: Multiply the differential equation by the integrating factor

Multiplying the linear differential equation by the integrating factor , we get:

The left-hand side is the derivative of with respect to , so we can write:

Step 5: Integrate both sides with respect to y

Integrating both sides with respect to , we get:

To evaluate the integral on the right-hand side, we use integration by parts. Let and . Then and . So,

Thus, we have:

Step 6: Solve for the general solution

Multiplying both sides by , we get:

Rearranging the terms, we get the general solution:

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

ANSWER

x+y+1=Ce^y

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Question 11

QUESTION

For the differential equation, find the general solution:

y\,dx+(x-y^2)\,dy=0

SOLUTION

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

Step 1: Rearrange the equation

First, let's rearrange the given equation to isolate and terms:

Step 2: Express in terms of

Divide both sides by to get:

Step 3: Rearrange into a linear differential equation form

Rearrange the equation to the standard form of a linear differential equation:

This is a linear differential equation of the form , where and .

Step 4: Find the integrating factor (IF)

The integrating factor is given by . In this case:

Step 5: Multiply the differential equation by the integrating factor

Multiply the entire equation by the integrating factor :

Step 6: Integrate both sides with respect to

The left side is the derivative of with respect to , so we have:

Step 7: Solve for

Divide both sides by to solve for :

Final Answer:

The general solution of the differential equation is:

ANSWER

x=(y^2)/(3)+(C)/(y)

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Question 12

QUESTION

For the differential equation, find the general solution:

(x+3y^2)(dy)/(dx)=y (y>0)

SOLUTION

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

Step 1: Rewrite the equation

First, we rewrite the given differential equation to isolate :

Step 2: Rearrange into a linear differential equation

Now, rearrange the equation to the standard form of a linear differential equation:

This is a linear differential equation in the form , where and .

Step 3: Find the integrating factor (IF)

The integrating factor is given by . So,

Since , we can write .

Step 4: Find the general solution

The general solution of the linear differential equation is given by:

Substituting the values, we get:

Step 5: Simplify the solution

Multiply both sides by to get the general solution:

Final Answer:

ANSWER

x=3y^2+Cy

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Question 13

QUESTION

Find a particular solution satisfying the given condition:

(dy)/(dx)+2y\tan x=\sin x;\ y=0\ \textwhen\ x=(π)/(3)

SOLUTION

We are asked to find a particular solution to the given differential equation that satisfies the initial condition when .

Step 1: Identify the type of differential equation

The given differential equation is a first-order linear differential equation of the form:

Here, and .

Step 2: Find the integrating factor (IF)

The integrating factor is given by:

So,

Since , we have:

Step 3: Write the general solution

The general solution of the differential equation is given by:

Substituting the values, we get:

Let , then . So, the integral becomes:

Step 4: Apply the initial condition

Given when , we substitute these values into the general solution:

Step 5: Write the particular solution

Substitute into the general solution:

Final Answer:

ANSWER

y=\cos x-2\cos^2 x

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Question 14

QUESTION

Find a particular solution satisfying the given condition:

$(1+x^2)\frac{dy}{dx}+2xy=\frac{1}{1+x^2};\ y=0\ \text{when}\ x=1$

SOLUTION

We are asked to find a particular solution to the given differential equation with the specified initial condition.

Step 1: Rewrite the differential equation in standard form

The given differential equation is:

Divide the entire equation by to get it into the standard form :

Step 2: Identify P(x) and Q(x)

Here, and

Step 3: Calculate the integrating factor (IF)

The integrating factor is given by . So,

Let , then . So, the integral becomes:

Therefore,

Step 4: Find the general solution

The general solution is given by:

Step 5: Apply the initial condition

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

Step 6: Write the particular solution

Substitute the value of back into the general solution:

Final Answer:

ANSWER

$y(1+x^2)=\tan^{-1}x-\frac{\pi}{4}$

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Question 15

QUESTION

Find a particular solution satisfying the given condition:

(dy)/(dx)-3y\cot x=\sin 2x;\ y=2\ \textwhen\ x=(π)/(2)

SOLUTION

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

Step 1: Identify the type of differential equation

The given differential equation is a first-order linear differential equation of the form:

Here, and .

Step 2: Find the integrating factor (IF)

The integrating factor is given by:

So, we need to calculate :

Therefore, the integrating factor is:

Step 3: Find the general solution

The general solution is given by:

Substituting the values, we get:

Since , we have:

Let , then . So,

Thus, . Multiplying by , we get:

Step 4: Apply the initial condition

We are given that when . Substituting these values, we get:

So, .

Step 5: Write the particular solution

Substituting into the general solution, we get the particular solution:

Final Answer:

ANSWER

y=4\sin^3 x-2\sin^2 x

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Question 16

QUESTION

Find the equation of a curve passing through the origin given that the slope of the tangent to the curve at any point (x,y) is equal to the sum of the coordinates of the point.

SOLUTION

This question asks us to find the equation of a curve given its slope at any point and that it passes through the origin. This involves solving a differential equation.

Step 1: Formulate the differential equation

The slope of the tangent at any point is given by . According to the problem, this slope is equal to the sum of the coordinates of the point, i.e., . Therefore, we have the differential equation:

Step 2: Rearrange the equation into a standard form

We can rewrite the equation as:

This 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 our case:

Step 4: Multiply the differential equation by the integrating factor

Multiplying both sides of the equation by , we get:

The left side is the derivative of with respect to :

Step 5: Integrate both sides with respect to x

To evaluate , we use integration by parts: . Let and . Then and . So:

Thus, .

Step 6: Solve for y

Multiply both sides by :

Step 7: Apply the initial condition

The curve passes through the origin , so we substitute and into the equation:

Step 8: Write the final equation

Substituting into the equation for , we get:

Rearranging, we get the equation of the curve:

Final Answer:

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ANSWER

x+y+1=e^x

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Question 17

QUESTION

Find the equation of a curve passing through the point (0,2) given that the sum of the coordinates of any point on the curve exceeds the magnitude of the slope of the tangent to the curve at that point by 5.

SOLUTION

This question involves forming and solving a differential equation based on the given geometric condition. We need to find the equation of a curve that satisfies a condition relating its coordinates and the slope of its tangent.

Step 1: Formulate the differential equation

Let be any point on the curve. The slope of the tangent at this point is given by . According to the problem, the sum of the coordinates exceeds the magnitude of the slope by 5. This can be written as:

Rearranging the terms, we get the differential equation:

Step 2: Solve the linear differential equation

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

The integrating factor (IF) is given by:

The general solution is given by:

Step 3: Evaluate the integral

We need to evaluate . We can use integration by parts:

Step 4: Substitute back into the general solution

Multiplying by , we get:

Step 5: Apply the initial condition

The curve passes through the point . Substituting and :

Step 6: Write the final equation

Substituting into the general solution, we get:

Final Answer:

ANSWER

y=4-x-2e^x

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Question 18

QUESTION

The Integrating Factor of the differential equation x(dy)/(dx)-y=2x^2 is

SOLUTION

We are asked to find the integrating factor of the given differential equation.

Step 1: Rewrite the differential equation in standard form

The standard form for a first-order linear differential equation is:

The given equation is:

Divide the entire equation by to get the standard form:

Now, we can identify and :

Step 2: Calculate the integrating factor (IF)

The integrating factor is given by:

In our case:

We know that , so:

Using the property and :

Since we are looking for a general solution, we can consider and take:

Final Answer:

The integrating factor is .

Therefore, the correct option is .

Option is incorrect because it would require .

Option is incorrect because the integrating factor should be a function of only.

Option is incorrect because the sign of was not considered during integration.

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ANSWER

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Question 19

QUESTION

The Integrating Factor of the differential equation (1-y^2)(dx)/(dy)+yx=ay (-1<y<1) is

SOLUTION

We are asked to find the integrating factor of the given differential equation.

The given differential equation is:

Step 1: Rewrite the equation in standard form

To find the integrating factor, we first need to rewrite the equation in the standard form: . Divide the entire equation by :

Now, we can identify and :

Step 2: Calculate the integrating factor (IF)

The integrating factor is given by:

So, we need to calculate

Let , then , so

Substituting, we get:

Since , we have , so we can drop the absolute value:

Now, we can find the integrating factor:

Final Answer: The integrating factor is

Therefore, the correct option is .

ANSWER

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Key Formulas

Important Formulas for Exercise 9.5

Formula / Concept	Description
Homogeneous Function	A function F(x, y) is a homogeneous function of degree n if F(\lambda x, \lambda y) = \lambda^n F(x, y) for any non-zero constant \lambda.
Homogeneous Differential Equation	A differential equation of the form (dy)/(dx) = F(x, y) is homogeneous if F(x, y) is a homogeneous function of degree zero. It can also be expressed in the form (dy)/(dx) = g\left((y)/(x)\right) or (dx)/(dy) = h\left((x)/(y)\right).
Method of Solving (for (dy)/(dx) form)	To solve a homogeneous differential equation of the form (dy)/(dx) = g\left((y)/(x) \right): 1. Substitute y = vx. 2. Differentiate with respect to x to get (dy)/(dx) = v + x(dv)/(dx). 3. Substitute for y and (dy)/(dx) in the original equation to get v + x(dv)/(dx) = g(v). 4. Separate the variables: (dv)/(g(v) - v) = (dx)/(x). 5. Integrate both sides to find the general solution in terms of v and x. 6. Replace v with (y)/(x) to get the solution in terms of x and y.
Method of Solving (for (dx)/(dy) form)	To solve a homogeneous differential equation of the form (dx)/(dy) = h\left((x)/(y) \right): 1. Substitute x = vy. 2. Differentiate with respect to y to get (dx)/(dy) = v + y(dv)/(dy). 3. Substitute for x and (dx)/(dy) in the original equation. 4. Separate the variables and integrate. 5. Replace v with (x)/(y) to get the final solution.
General Solution	The solution which contains as many arbitrary constants as the order of the differential equation. It represents a family of curves.
Particular Solution	A solution obtained by giving particular values to the arbitrary constants in the general solution. This is usually found using given initial conditions.

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