Differential equations – 2023 Nov CIE Mathematics

1. Nov/2023/Paper_9709/31/No.7

The variables x and θ satisfy the differential equation

$$\frac{x}{\tan\theta}\frac{\mathrm{d}x}{\mathrm{d}\theta} = x^2 + 3.$$

It is given that $x = 1$ when $\theta = 0$.

Solve the differential equation, obtaining an expression for x^2 in terms of θ. [7]

2. Nov/2023/Paper_9709/32/No.11

The variables x and y satisfy the differential equation

$$x^2\frac{dy}{dx} + y^2 + y = 0.$$

It is given that $x = 1$ when $y = 1$.

(a) Solve the differential equation to obtain an expression for y in terms of x. [8]

(b) State what happens to the value of y when x tends to infinity. Give your answer in an exact form. [1]

3. Nov/2023/Paper_9709/33/No.8

The variables x and y satisfy the differential equation

$$e^{4x}\frac{dy}{dx} = \cos^2 3y.$$

It is given that $y = 0$ when $x = 2$.

Solve the differential equation, obtaining an expression for y in terms of x. [7]