Section 1: Introduction to differential equations

Solutions to Exercise level 1

1. (i) $\frac{dx}{dt} = \frac{k}{t^3}$

(ii) $\frac{dx}{dt} = -k\sqrt{x}$, where k is a positive constant.

2. (i) $\frac{dy}{dx} = 3x^2 + 2$

$y = x^2 + 2x + c$

(ii) $2\frac{dy}{dx} - x = 10$

$2\frac{dy}{dx} = 10 + x$

$\frac{dy}{dx} = 5 + \frac{1}{2}x$

$y = 5x + \frac{1}{4}x^2 + c$

(iii) $x^2\frac{dy}{dx} = 3 + x$

$\frac{dy}{dx} = \frac{3}{x^2} + \frac{1}{x}$

$y = -\frac{3}{x} + \ln|x| + c$

3. (i) $\frac{dy}{dx} = y^2$

$\int y^{-2}\,dy = \int 1\,dx$

$-y^{-1} = x + c$

$\frac{1}{y} = k - x$

Replacing $-c$ with k

$y = \frac{1}{k - x}$

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(ii) $\frac{dy}{dx} = 2xy^2$

$\int \frac{1}{y^2} dy = \int 2x\,dx$

$-\frac{1}{y} = x^2 + c$

$y = \frac{1}{k - x^2}$

Replacing $-c$ with k

(iii) $\frac{dy}{dx} = 2xy$

$\int \frac{1}{y} dy = \int 2x\,dx$

$\ln|y| = x^2 + c$

$y = e^{x^2+c} = e^{x^2}e^c$

$y = Ae^{x^2}$

Replacing e^c with A