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SEC 4 ADDITIONAL MATHEMATICS

UNIT 11: DIFFERENTIATION AND ITS APPLICATION

11.1 DERIVATIVE AS A GRADIENT FUNCTION

11.1 CONCEPTUAL BRIDGING – DERIVATIVE AS A GRADIENT FUNCTION

Function	Gradient (Function)
$y = 3$	
$y = 2x$	
$y = 2x - 3$	
$y = x^2$	

From Elementary Mathematics Syllabus:

$$\text{Gradient of Straight Line} = \frac{y_2 - y_1}{x_2 - x_1}$$

11.1.1 WORKED EXAMPLE 1 (DERIVATIVE OF POWER FUNCTIONS)

$$\frac{d}{dx}(x^n) = nx^{n-1}, \text{ where } n \text{ is a constant.}$$

Find the derivative of each of the following,

(a) $y = x^6$

(b) $y = \frac{1}{x^5}$

(c) $y = \sqrt{x}$

(d) $y = 1$

11.1.1 PRACTICE NOW 1

QUESTION 1

Find the derivative of each of the following,

(a) $y = x^3$

(b) $y = \frac{1}{x^7}$

(c) $y = \frac{1}{\sqrt{x}}$

(d) $y = \frac{x}{\sqrt[3]{x^5}}$

11.1.2 WORKED EXAMPLE 1 (SCALAR MULTIPLE)

Scalar Multiple

$$\frac{d}{dx}(kx^n) = k \frac{d}{dx}(x^n) = knx^{n-1}, \text{ where } k \text{ is a constant.}$$

Find the derivative of each of the following,

(a) $y = 4\sqrt{x}$

(b) $f(x) = -\frac{2}{x^5}$

(c) $f(x) = -\frac{3x^2}{\sqrt{x^5}}$

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11.1.2 PRACTICE NOW 1

QUESTION 1

Find the derivative of each of the following,

(a) $y = 7x^{11}$

(b) $y = 2\sqrt[3]{x}$

(c) $f(x) = -\frac{10\sqrt{x}}{x^3}$

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11.1.3 WORKED EXAMPLE 1 (ADDITION AND SUBTRACTION RULE)

Addition and Subtraction Rule

$$\frac{d}{dx}(kx^n + qx^m) = k \frac{d}{dx}(x^n) + q \frac{d}{dx}(x^m) = knx^{n-1} + qmx^{m-1}, \text{ where } k \text{ and } q \text{ are constants.}$$

(a) $f(x) = 6x^5 - x^6 - 10$

(b) $f(x) = 2 - 5x^3 - 4\sqrt{x}$

(c) $f(x) = 6x - 5x^2 + 3\sqrt{x}$

11.1.3 PRACTICE NOW 1

QUESTION 1

Find the derivative of each of the following,

(a) $f(x) = -5x^8 + 4\sqrt[3]{x}$

(b) $f(x) = \sqrt[3]{x} - 2x^5 + 3$

(c) $y = 7x^3 + \frac{2}{\sqrt{x}} + \frac{3}{x^5}$

11.1.3 PRACTICE NOW 2

QUESTION 1

Find the derivative of each of the following,

(a) $y = 4x^2 - \frac{3}{\sqrt{x}} + \frac{5}{2x^2}$

(b) $y = \frac{3\sqrt{x} - 3x^2 - 6x}{x}$

(c) $y = \frac{\sqrt{x} - x^7 + 5x}{\sqrt{x}}$

11.2 CHAIN RULE

11.2 CONCEPTUAL BRIDGING – CHAIN RULE

Chain Rule

$$\frac{dy}{dx} = \frac{dy}{du} \times \frac{du}{dx}$$

$$y = (x^2 + 1)^{10}$$

11.2 WORKED EXAMPLE 1

Find the derivative of each of the following,

(a) $y = (7x^3 + x)^4$

(b) $f(x) = \frac{1}{\sqrt{3x^2 - 1}}$

(c) $y = \frac{2}{(3 - \sqrt{x})^3}$

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11.2 PRACTICE NOW 1**QUESTION 1**

Find the derivative of each of the following,

(a) $y = (5x^2 - x + 3)^9$

(b) $y = (3x^3 + x - 1)^5$

(c) $y = \sqrt{(5x^2 - 4x + 1)^9}$

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11.2 EXERCISE

QUESTION 1

Find the derivative of each of the following,

(a) $f(x) = (2x^2 - 1)^5$ (b) $y = \sqrt[3]{2x^3 - 8}$ (c) $f(x) = (2\sqrt{x} + 2x)^2$

QUESTION 2

Find the derivative of each of the following,

(a) $f(x) = \sqrt{(4x^2 + 2)^3}$ (b) $f(x) = \sqrt{x + \frac{1}{x}}$ (c) $\frac{1}{(x^2 + 2)^3}$

QUESTION 3

Find the derivative of each of the following,

(a) $y = \left(x + \frac{1}{\sqrt{x}}\right)^4$ (b) $y = \left(\frac{x^4}{2} + x\right)^5$ (c) $\left(\sqrt{x^5} - \frac{4}{7x^2}\right)^7$

QUESTION 4

Differentiate $\frac{1}{\sqrt{x^3 - 2}}$ with respect to x .

QUESTION 5

Differentiate $(4x^3 + 1)^{\frac{1}{3}}$ with respect to x .

QUESTION 6

Differentiate $y = \frac{7}{(8x + 3)^3}$ with respect to x .

QUESTION 7

Differentiate $\left(\frac{x^4}{2} + x\right)^5$ with respect to x .

QUESTION 8

Differentiate $\sqrt{1+x^3}$ with respect to x .

QUESTION 9

Differentiate $2(5x-3x^2)^4$.

QUESTION 10

Differentiate $(3-2x^3)^{10}$ with respect to x .

QUESTION 11

Differentiate $y = \sqrt[3]{2x^3-8}$ with respect to x .

QUESTION 12

Differentiate $y = \frac{1}{4\sqrt{1-x^2}}$ with respect to x .

QUESTION 13

Find $\frac{dy}{dx}$ for $y = \left(x + \frac{1}{\sqrt{x}}\right)^4$.

QUESTION 14

Find $\frac{dy}{dx}$ for $y = \left(\sqrt{x} + \frac{1}{\sqrt{x}}\right)^2$.