**9B Differentiating Exponentials**

ex

ln(x)

ax

1. Find $\frac{dy}{dx}$ given that:

$$y=e^{3x}+2^{3x}$$

1. Find $\frac{dy}{dx}$ given that:

$$y=ln\left(x^{3}\right)+ln7x$$

1. Find $\frac{dy}{dx}$ given that:

$$y=\frac{2-3e^{7x}}{4e^{3x}}$$

**9C (Part 2) The Chain Rule**

1. Given that $y=\left(3x^{4}+x\right)^{5}$, find $\frac{dy}{dx}$ using the chain rule.
2. Given that $y=sin^{4}x$, find $\frac{dy}{dx}$
3. Given that $y=\sqrt{5x^{2}+1}$, find the gradient of the curve at $\left(4,9\right)$.

**9D The Product Rule**

1. Given that $f\left(x\right)=x^{2}\sqrt{3x-1}$, find $f'(x)$.
2. Given that $y=e^{4x}sin^{2}3x$, show that $\frac{dy}{dx}=e^{4x}sin3x\left(Acos3x+Bsin3x\right)$, where $A$ and $B$ are constants to be found.

**9E The Quotient Rule**

1. Given that $y=\frac{x}{2x+5}$, find $\frac{dy}{dx}$
2. A curve $C$ has equation $y=\frac{sinx}{e^{2x}},    0<x<π$.

The curve has a stationary point at $P$. Find the coordinates of $P$, to 3 significant figures.

**9A Differentiating Sine & Cosine**

Small angle notes

Differentiating Sine from First Principles

Differentiating Sin(kx) from First Principles

1. Find $\frac{dy}{dx}$ given that:

$$y=sin2x$$

$$y=3sin2x$$

$$y=3cosx+2sin4x$$

1. A curve has equation:

$$y=\frac{1}{2}x-cos2x$$

Find the stationary points on the curve in the interval $0\leq x\leq π$.

**9F Trigonometric Derivatives**

1. Given that $y=tanx$, find $\frac{dy}{dx}$
2. Given that $y=cosecx$, find $\frac{dy}{dx}$.
3. Given that $y=secx$, find $\frac{dy}{dx}$.
4. Given that $y=cotx$, find $\frac{dy}{dx}$.
5. Differentiate:

$$y=xtan2x$$

1. Differentiate:

$$y=tan^{4}x$$

1. Differentiate:

$$y=\frac{cosec2x}{x^{2}}$$

1. Differentiate:

$$y=sec^{3}x$$

No Arc derivatives on new Spec

**9C (Part 1) dx/dy**

1. Find the value of $\frac{dy}{dx}$ at the point $(2,1)$ on the curve with equation $y^{3}+y=x$

**9G Differentiating Parametric Equations**

1. Find the gradient at the point $P$ where $t=2$, on the curve given parametrically by:

$x=t^{3}+t$, $y=t^{2}+1$, $t\in R$

1. Find the equation of the normal at the point $P$, where $θ=\frac{π}{6}$, to the curve with parametric equations $x=3sinθ$ and $y=5cosθ$.

**9H Implicit Differentiation**

1. Differentiate the following equation implicitly:

$$y^{3}=3x^{2}$$

1. Below is a sketch of the circle with equation $x^{2}+y^{2}=25$, $-5\leq x\leq 5$, $-5\leq y\leq 5$.

Find the gradient of the curve where $x=4$



1. Find $\frac{dy}{dx}$ in terms of $x$ and $y$ when:

$$x^{3}+x+y^{3}+3y=6$$

1. Given that $4xy^{2}+\frac{6x^{2}}{y}=10$, find the value of $\frac{dy}{dx}$ at the point (1,1)
2. Find the value of $\frac{dy}{dx}$ at the point (1,1), when:

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

**9I Concave & Convex Functions**

1. Find the interval on which the function $f\left(x\right)=x^{3}+4x+3$ is concave.
2. Show that the function $f\left(x\right)=e^{2x}+x^{2}$ is convex for all real values of $x$.
3. The curve $C$ has equation $y=x^{3}-2x^{2}-4x+5$
4. Show that C is concave on the interval $\left[-2,0\right]$ and convex on the interval $\left[1,3\right]$
5. Find the coordinates of the point of inflection

**9J Chain Rule in Context**

1. Given that the area of a circle $A cm^{2}$ is related to its radius $r cm$ by the formula $A=πr^{2}$, and that the rate of change of its radius in $cm s^{-1}$ is given by $\frac{dr}{dt}=5$, find $\frac{dA}{dt}$ when $r=3$
2. The volume of a hemisphere $V cm^{3}$ is related to its radius $r cm$ by the formula $V=\frac{2}{3}πr^{3}$, and the total surface area $S cm^{2}$ is given by the formula $S=3πr^{2}$. Given that the rate of increase of volume, in $cm^{3} s^{-1}$, $\frac{dV}{dt}=6$, find the rate of increase of the surface area, $\frac{dS}{dt}$.
3. In the decay of radioactive particles, the rate at which particles decay is proportional to the number of particles remaining. Write down a differential equation for the rate of change of the number of particles.
4. Newton’s law of cooling states that the rate of loss of temperature of a body is proportional to the excess temperature of the body compared to its surroundings. Write an equation that expresses this law.
5. The head of a snowman of radius $R cm$ loses volume by evaporation at a rate proportional to its surface area. Assuming that the head is spherical, that the volume of a sphere is given by $V=\frac{4}{3}πR^{3} cm^{3}$ and that the surface area is$A=4πR^{2} cm^{2}$, write down a differential equation for the rate of change of radius of the snowman’s head.