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Edexcel A Level Maths: Pure



5.9 Modelling with Trigonometric Functions

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5.9.1 Modelling with Trigonometric Functions

Your notes

Modelling with Trigonometric Functions

Modelling with trigonometric functions

- Various real-life situations can be modelled using trigonometric functions
- You need to be able to interpret the equations used in the model
- If you need to identify maximum or minimum values of a formula, remember the bounds of the **sin** and **cos** functions:
 - -1≤sin x≤1
 - -1≤cos x≤1

e.g. WHAT ARE THE MINIMUM AND MAXIMUM VALUES OF
$$y=15-23\sin 3x$$

WHEN $\sin 3x=1$, $y=15-23(1)=-8$

WHEN $\sin 3x=-1$, $y=15-23(-1)=38$

SO $y_{max}=38$ AND $y_{min}=-8$

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• You may need to simplify trigonometric expressions to make the behaviour of an equation clearer

e.g. WHAT ARE THE MAXIMUM AND MINIMUM VALUES OF y = 0.15 sinx + 0.2 cosx ?



$$R\sin(x+d) = R\cos d \sin x + R\sin d \cos x$$

$$R\cos d = 0.15$$
 $R\sin d = 0.2$

$$R = \sqrt{0.15^2 + 0.2^2} = 0.25$$

$$tan \lambda = \frac{Rsin \lambda}{Rcos \lambda} = \frac{0.2}{0.15} = \frac{4}{3}$$

$$\lambda = \tan^{-1}(\frac{4}{3}) = 53.1^{\circ}$$
 (1 d.p.)

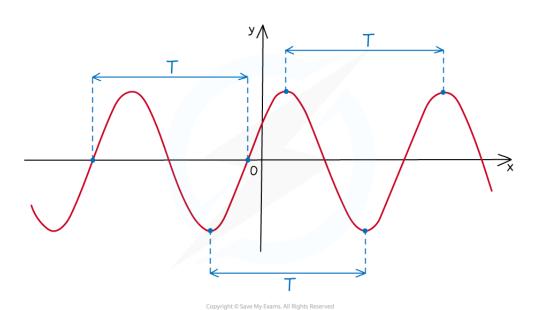
SO
$$y = 0.25 \sin(x + 53.1)$$

$$y_{max} = 0.25$$
 $y_{min} = -0.25$

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- You may also need to discuss the **period** of an equation
 - The period is often indicated by **T**
 - For a periodic function in **x** like **sin** or **cos**, the **period** is how much **x** has to change by for the function to go through one complete cycle





• For functions of the form $\cos(qx+r)$ or $\sin(qx+r)$ the period T is:

$$T = \frac{360}{q}$$
 (for angles in degrees)

$$T = \frac{2\pi}{q} \text{ (for angles in radians)}$$

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e.g. WHAT IS THE PERIOD OF $y = cos(\frac{7}{8}x - 1.5)$ WHERE THE ANGLE IS MEASURED IN RADIANS?

THE PERIOD IS

$$T = \frac{2\pi}{\frac{7}{8}} = \frac{16\pi}{7}$$

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Examiner Tip

- The variable in these questions is often **t** for time.
- Read the question carefully to make sure you know what you are being asked to solve.





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✓ Worked example	i
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	i







An amusement park builds a large circular wheel as a tourist attraction. The height of a passenger on the wheel is modelled by the equation

$$H = 50 - 48\cos\left(\frac{\pi}{15}t + 0.3\right)$$

where H is the height of the passenger above the ground in metres, t is the number of minutes after boarding, and angles are given in radians.

- a) What is the maximum height that the passenger reaches above the ground?
- b) How many minutes after boarding the ride will the passenger reach that height for the first time?
- c) How long does it take the wheel to make a complete revolution?
- a) THE MAXIMUM VALUE OF H OCCURS WHEN THE COSINE IS EQUAL TO -1

$$H_{\text{max}} = 50 - 48(-1) = 98 \text{m}$$

b)
$$\cos(\frac{\Im}{45}t + 0.3) = -1$$

$$\frac{\Im}{45}t + 0.3 = \cos^{-1}(-1) = \Im$$
REMEMBER TO USE RADIANS!
$$\frac{\Im}{45}t = \Im - 0.3$$

$$t = \frac{15}{45}(\Im - 0.3) = 13.6 \text{ MINUTES (1 d.p.)}$$

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