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2027
Math Methods

Year 11
Topic Assessment Task

Circular, exponential and logarithmic functions

(Time allowed: 1 hour plus)

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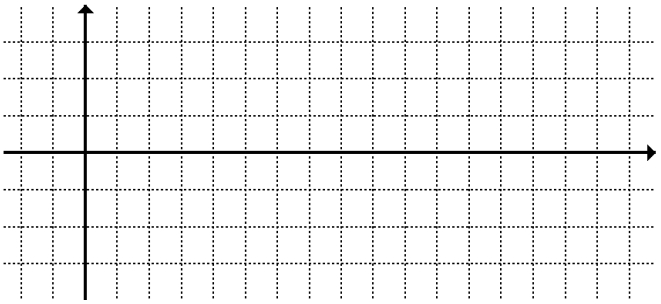
Year 11 Topic Assessment Task
Topic: Circular, exponential and logarithmic functions

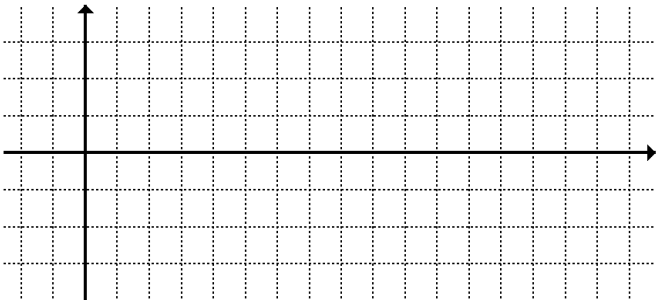
Question 1 (22 marks)

The path of a particle moving in anticlockwise direction is a unit circle centred at $O(0,0)$. The Cartesian equation of the path is $x^2 + y^2 = 1$. The x and y coordinates can be expressed in terms of θ which is the angle between the radius of the unit circle and the positive *x*-axis. The values of θ (radian/degree measure) can be positive or negative corresponding to anticlockwise or clockwise motion of the particle.

a Sketch (i) a graph of *y*-coordinate versus θ and (ii) a graph of *x*-coordinate versus θ for one anticlockwise revolution of the particle. Label and scale the axes. Label each graph with the correct equation of a circular function.

4 marks





b. The particle completes one revolution in 12 seconds at constant speed.
Find time t to complete the first quarter revolution, half revolution and three quarters revolution.
Express θ in terms of t.

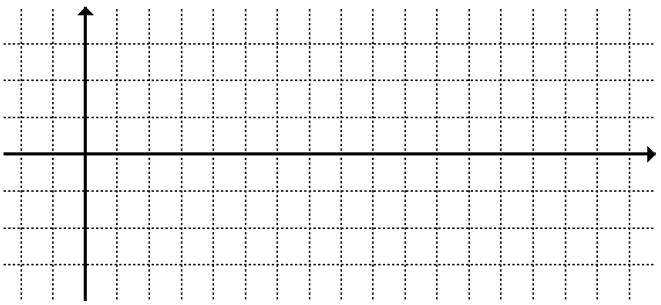
2 marks

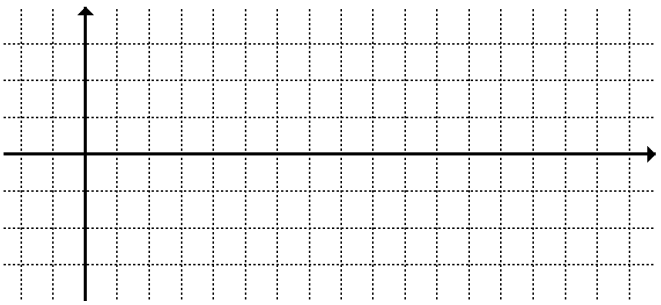
c. Express (i) the *y*-coordinate of the particle as a circular function of t and (ii) the *x*-coordinate of the particle as a circular function of t.
Hence, find (iii) the exact *x* and *y* coordinates of the particle at $t = 16\text{s}$ and (iv) the *x* and *y* coordinates of the particle at $t = 17\text{s}$, correct to 4 decimal places.

4 marks

d. Sketch (i) a graph of *y*-coordinate versus t and (ii) a graph of *x*-coordinate versus t for one anticlockwise revolution of the particle. Label and scale the axes. Label each graph with the correct equation of a circular function.

4 marks





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e. Verify that (i) $\sin^2\theta+\cos^2\theta=1$ at $t=16\text{s}$, and (ii) $\sin^2\theta+\cos^2\theta=1$ at any t. 2 marks

f. Find the gradient of the radius of the unit circle at $t=16\text{s}$ using (i) gradient $=\dfrac{\text{rise}}{\text{run}}$, and (ii) gradient $=\tan\theta$.

2 marks

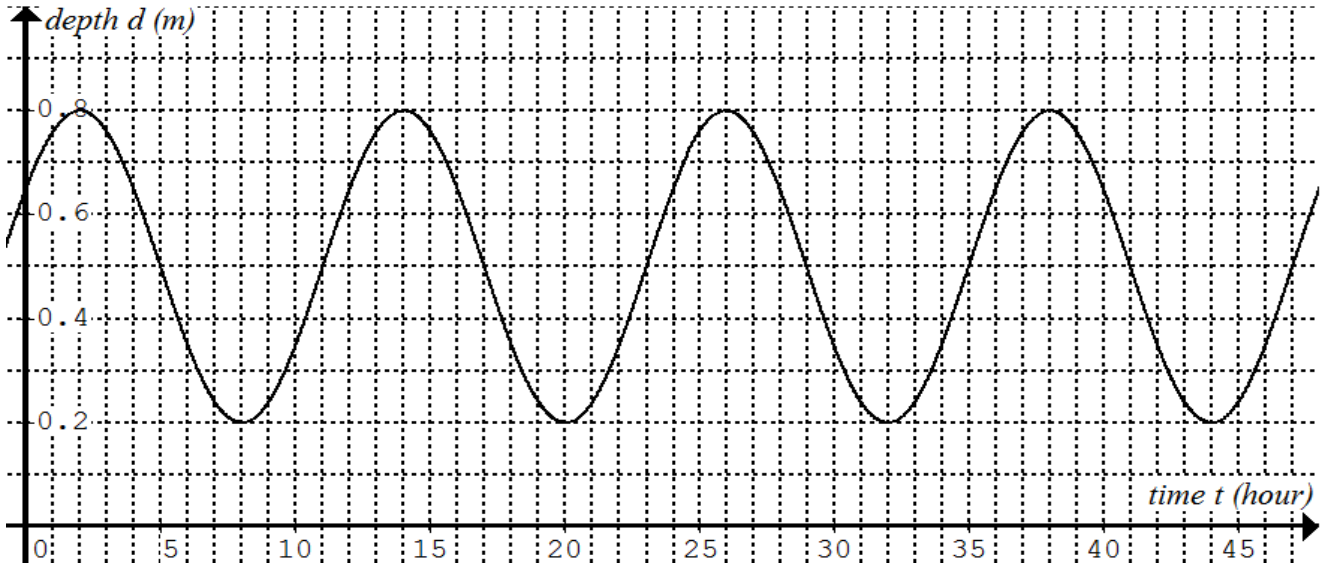
g. Without using CAS, solve $x\sin(x)-0.1x+0.0025=0$ for x correct to 2 decimal places, given $0<x<0.1$.

2 marks

h. Find a value for each of α and β such that the equalities $\sin(x+\alpha)=\sin(x)$ and $\tan(x-2\beta)=\tan(x)$ show the translational symmetry properties for sine function and tangent function.

2 marks

Question 2 (6 marks)
The following graph shows the variation in the depth of water over two days somewhere in Port Phillip Bay. The variation can be modelled by $d=A\cos k(t-\alpha)+\beta$. It was 12 midnight at $t=0$. The first high tide (maximum depth) was at $t=2$.



a. State the period, amplitude and mean value of the variation. 2 marks

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b. What was the depth at $t=0$? Determine the values of A, k, α and β in the mathematical model.

3 marks

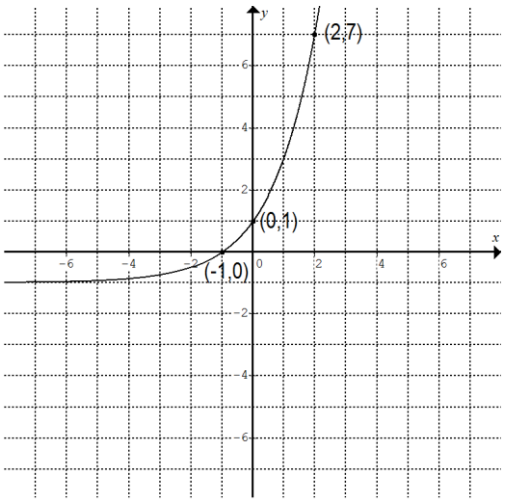
c. Determine the following four times after $t=0$ (in am or pm) when the tide was lowest. 1 mark

Question 3 (7 marks)

The graph of $y=Aa^x+c$ is shown below.

a. Set up and solve equations to show $A=2$, $a=2$ and $c=-1$.

2 marks



b. Sketch on the same grid on the right the graph of $y=2\times\left(\sqrt{2}\right)^x-1$. 2 marks

c. State the equation of the asymptote of the graph of $y=2\times\left(\sqrt{2}\right)^x-1$. 1 mark

d. State the equation of the inverse of $y=2\times 2^x-1$. 1 mark

e. Evaluate $8\times 10^{3\log_{10}(5)}$. 1 mark

End of Topic Assessment Task

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