A-Level Mathematics

Edexcel

2024 Predicted Paper

Paper 1

Pure Mathematics

Primrose Kitten
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Name:.....

Date:.....

2 hours allowed

You may use a calculator

Rough Grade Boundaries

These do not guarantee you the same mark in the exam.

A* - 75%
A - 55%
B - 45%
C - 35%
D - 25%
E - 15%

Mark scored	
Total	**100**




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01 Point A has a position vector of $4\mathbf{i} - 2\mathbf{j} + \mathbf{z}$ and point B has a position vector of $5\mathbf{i} - 2\mathbf{z}$.

Find $\left|\overrightarrow{AB}\right|$.

[3 marks]

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02 Solve $e^{10x} = 5e^{5x} - 6$.

Give your solutions to 3 decimal places.

[4 marks]

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03

a) If $|x| = 2$, find the possible values of $|3x + 1|$

[3 marks]

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b) Find the set of values of x for which $|3x + 1| > |x - 3|$
Give your answer in set notation.

[4 marks]

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04

$$g(x) = \frac{2x+4}{x-3}, \quad x \geq 4$$

$$f(x) = x^2 - 4x - 4, \; x \geq 2$$

a) Find $fg(4)$

[2 marks]

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b) State the range of g.

[1 mark]

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c) Find $f^{-1}(x)$ and state its range.

[4 marks]

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d) Describe the relationship between the graph of the function, $f(x) = x^2 - 4x - 4$, $x \geq 2$ and the graph of its inverse.

[1 mark]

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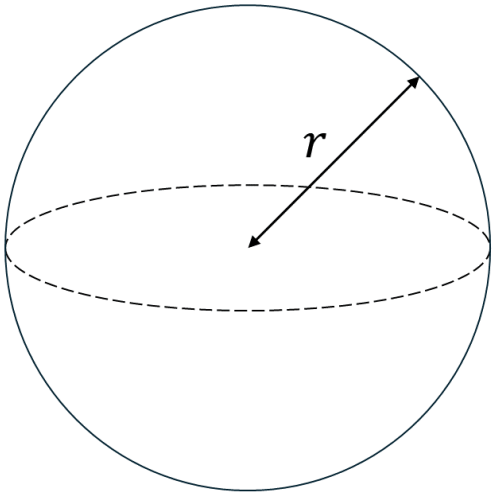
05 When metal spheres are heated they expand.



The volume of a sphere increases at a constant rate of 0.2π m^3 per minute.

a) Show that:

$$\frac{dr}{dt} = \frac{1}{20r^2}$$

[3 marks]

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After 20 minutes, the sphere has a radius of 1.50 m.

b) Find the radius of the sphere after 1 hour of being heated.
Give your answer to 2 decimal places.

[6 marks]

c) Find the rate that the surface area of the sphere increases in this sphere when $r = 2\,m$.
Give your answer to 2 decimal places.

[3 marks]

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d) State an assumption that has been made when modelling the rate of increase of the surface area of the sphere.

[1 mark]

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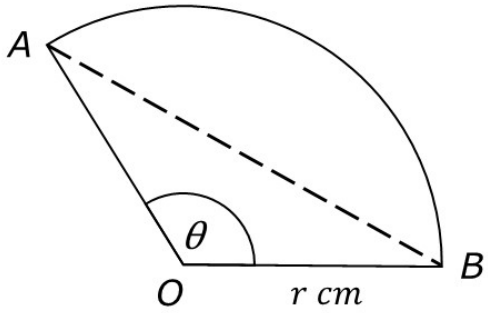
06 The diagram shows a sector AOB of a circle with centre O and radius r cm.



The angle AOB is θ radians. The arc length AB is 14 cm and the area of the sector is 56 cm^2.

a) Find the values of r and θ.

[4 marks]

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b) Find the area of the segment bounded by the arc AB and the chord AB.

[3 marks]

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07

a) Express $2\sin\theta + \cos\theta$ in the form $R\sin(\theta + \alpha)$, where $R > 0$ and $0 < \alpha < \frac{\pi}{2}$.

Give the value of α to 3 decimal places.

[3 marks]

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A swimming pool at a water park was a wave machine.

A model was developed to show the height H (m) of the waves at different times (minutes).

$$H = 1.8 + \sin\left(\frac{7\pi t}{25}\right) + 0.5\cos\left(\frac{7\pi t}{25}\right) \qquad 0 \leq t < 12$$

b) Calculate the maximum depth of the swimming pool when the wave machine is on and find the value of t when the first maximum occurs.

[4 marks]

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The wave machine was turned on at 12pm.

c) Calculate the first time after 12pm that the height of the water in the swimming pool reaches 1.5 m.
Give your answer to the nearest minute.

[4 marks]

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Some people complained the waves move too fast.

d) Describe how the model could be adapted to slow down the waves.

[1 mark]

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08 Show that $\int_0^2 3x\sqrt{x+3}\ \ dx = \frac{36\sqrt{3}}{5}$

[7 marks]

09 In a geometric series, the first term is a and the common ratio is r.

The third term of the geometric series is equal to $\frac{4}{9}$.

The sum to the first 4 terms is equal to 5 times the sum of the first 2 terms.

Show that:

$$S_5 = \frac{31}{9}$$

Where $r > 0$.

[5 marks]

10 A curve C has equation

$$y = x^2 - 5x - 12\sqrt{x}, \qquad x > 0$$

a) Find $\frac{dy}{dx}$ and $\frac{d^2y}{dx^2}$

[3 marks]

b) Verify that C has a stationary point when $x = 4$ and determine its nature.

[4 marks]

11 A curve has equation $x = (y + 4)ln(2y - 6)$

a) Find $\frac{dx}{dy}$ in terms of y.

[3 marks]

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b) Find the gradient of the curve where it crosses the y-axis.

[5 marks]

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12 Differentiate $f(x) = \sin x$ from first principles and find the exact value of $f'\left(\frac{\pi}{3}\right)$

[6 marks]

13 A teacher buys a car for £7500. After t weeks, the car is worth £C.

The rate of depreciation of C is directly proportional to C.

a) Write down a differential equation in terms of t, C and a constant k.

[1 mark]

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The teacher wants to know what their car will be worth in the future.

After 4 weeks the car is valued at £7450.

They realise if they solve the differential equation, they will find an equation for the value of the car £C as a function of the number of weeks t.

b) Solve the differential equation to find the value of the car after 100 weeks.
Give your answer to the nearest pound.

[8 marks]

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c) Assuming the model is correct find the amount of time it will take for the car's value to halve.

Given that 52 weeks are in a year, give your answer to the nearest number of years.

[3 marks]

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d) Give a reason why this model may not be correct.

[1 mark]

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END OF QUESTIONS

MARKING GUIDANCE

Question	Solution
1	A1M for attempting $\overrightarrow{OB} - \overrightarrow{OA}$ or similar A1M for $\overrightarrow{AB}$ = i + 2j - 3z A1M for $\left\|\overrightarrow{AB}\right\| = \sqrt{14}$
2	A2M for $(e^{5x} - 2)(e^{-5x} - 3) = 0$ A1M for $e^{5x} = 2$ and $e^{5x} = 3$ A1M for 0.139 and 0.220
3 (a)	A1M for $\|3(2) + 1\| = 7$ A2M for $\|3(-2) + 1\| = 5$
3 (b)	A1M for $-3x - 1 > -x + 3$ therefore $x < -2$ A2M for $3x + 1 > -x + 3$ therefore $x > \frac{1}{2}$ A1M for $\{x: x < -2\} \cup \left\{x: x > \frac{1}{2}\right\}$
4 (a)	A1M for $g(4) = \frac{2(4)+4}{(4)-3} = 12$ A1M for $fg(4) = (12)^2 - 4(12) - 4 = 92$
4 (b)	A1M for $2 < y \leq 12$ Or $2 < f(x) \leq 12$
4 (c)	A1M for reversal of x and y. $x = y^2 - 4y - 4$ A1M for completing the square: $x = (y - 2)^2 - 8$ A1M for $f^{-1}(x) = \sqrt{x + 8} + 2$, A1M for range $y \geq 2$
4 (d)	A1M for reflection in the line y=x
5 (a)	A1M for $\frac{dV}{dt} = 0.2\pi$ A1M for $\frac{dV}{dr} = 4\pi r^2$ A1M for $\frac{dr}{dt} = \frac{dV}{dt} \div \frac{dV}{dr} = 0.2\pi \div 4\pi r^2$

5 (b)	A1M for $\int r^2 dr \int \frac{1}{20} dt$ A2M for $\frac{r^3}{3} = \frac{1}{20}t + c$ A1M for correct substitution r=1.50 and t=20 $$\frac{1.50^3}{3} = \frac{1}{20} \times 20 + c$$ A1M correctly finding c = 0.125 $$\frac{r^3}{3} = \frac{1}{20}t + 0.125$$ A1M for correctly finding r = 2.11m $$\frac{r^3}{3} = \frac{1}{20} \times 60 + 0.125$$ $$r = 2.11m$$
5 (c)	A1M for $\frac{dA}{dr} = 8\pi r$ A1M for $\frac{dA}{dt} = \frac{dA}{dr} \times \frac{dr}{dt} = 8\pi r \times \frac{1}{20r^2}$ A1M for $\frac{dA}{dt} = 8\pi \times 2 \times \frac{1}{20 \times 2^2} = 0.628cm^2 \ per \ minute$
5 (d)	A1M for Assumes the sphere expands at the same rate as it gets hotter.
6 (a)	A1M for $r\theta = 14$ A1M for $\frac{1}{2}r^2\theta = 56$ A1M for $\frac{1}{2}r(14) = 56$ A1M for $r = 8$ and $\theta = \frac{7}{4}$
6 (b)	A1M for $\frac{1}{2}(8)^2 sin(\frac{7}{4})$ A1M for $56 - \frac{1}{2}(8)^2 sin(\frac{7}{4})$ A1M for 24.51… cm^2
7 (a)	A1M for $R = \sqrt{5}$ A1M for $\tan\alpha = \frac{1}{2}$ A1M for $\alpha = 0.464$ so $\sqrt{5}\sin(\theta + 0.464)$

7 (b)	A1M for $H = 1.8 + \frac{\sqrt{5}}{2} = 2.918$ A1M for $\sin\left(\frac{7\pi t}{25} + 0.464\right) = 1$ A1M for $\frac{7\pi t}{25} + 0.464 = \frac{\pi}{2}$ A1M for $t = 1.258$ minutes
7 (c)	A1M for $1.5 = 1.8 + \frac{\sqrt{5}}{2}\sin\left(\frac{7\pi t}{25} + 0.464\right)$ A1M for $\sin\left(\frac{7\pi t}{25} + 0.464\right) = -\frac{3\sqrt{5}}{25}$ A1M for $\frac{7\pi t}{25} + 0.464 = 3.413249777$ A1M for 12.03pm as $t = 3.35\ minutes$
7 (d)	A1M for Decrease $\frac{7\pi}{25}$ in the formula
8	A1M for choosing a suitable method for $\int_0^2 3x\sqrt{x+3}\,dx$ A1M for $u = x + 3$ and $\frac{du}{dx} = 1$ and $du = dx$ A1M for $x = u - 3$ and $3x = 3u - 9$ A2M for $\int_3^5 (3u - 9)u^{\frac{1}{2}}\,du = \int_3^5 (3u^{\frac{3}{2}} - 9u^{\frac{1}{2}})\,du$ A1M for $[\frac{6}{5}u^{\frac{5}{2}} - 6u^{\frac{3}{2}}]_3^5$ A1M for $\frac{36\sqrt{3}}{5}$
9	A1M for $\frac{a(1-r^4)}{1-r} = \frac{5a(1-r^2)}{1-r}$ A1M for $r = 2$ A1M for $a \times (2)^2 = \frac{4}{9}$ A1M for $a = \frac{1}{9}$ A1M for $\frac{\frac{1}{9}\times(1-2^5)}{1-2} = \frac{31}{9}$ allow alternative methods
10 (a)	A2M for $\frac{dy}{dx} = 2x - 5 - 6x^{-\frac{1}{2}}$ A1M for $\frac{d^2y}{dx^2} = 2 + 3x^{-\frac{3}{2}}$
10 (b)	A2M for substitution $2(4) - 5 - 6(4)^{-\frac{1}{2}} = 0$ therefore it is a stationary point A2M for substitution $2 + 3(4)^{-\frac{3}{2}} = 2.375$ which is more than zero, therefore it's a minimum

11 (a)	A1M for use of product rule A2M for $\frac{dx}{dy} = \frac{y+4}{y-3} + ln(2y-6)$
11 (b)	A1M for $y = -4$ and $y = 3.5$ A1M for substitution $\frac{dx}{dy} = \frac{(3.5)+4}{(3.5)-3} + ln(2(3.5)-6)$ A1M for $\frac{dx}{dy} = 15$ and $\frac{dy}{dx} = \frac{1}{15}$ A1M for substitution $\frac{dx}{dy} = \frac{(-4)+4}{(-4)-3} + ln(2(-4)-6)$ A1M for $ln(-14)$ does not exist so no second answer
12	A1M for $f'(x) = \frac{sin(x+h)-sin(x)}{h}$ A1M for $f'(x) = \frac{sin\,x\,cos\,h + sin\,h\,cos\,x - sin(x)}{h}$ A1M for $f'(x) = \frac{sin\,x\,(cos\,h-1)}{h} + \frac{sin\,h\,cos\,x}{h}$ A1M for $f'(x) = sin\,x\,\frac{(cos\,h-1)}{h} + cos\,x\,\frac{sin\,h}{h}$ A1M for $\frac{(cos\,h-1)}{h} = 0$ and $\frac{sin\,h}{h} = 1$ A1M for $cos\,\frac{\pi}{3} = \frac{1}{2}$
13 (a)	A1M for $\frac{dC}{dt} = -kC$
13 (b)	A1M for separation of variables $\frac{dC}{C} = -kdt$ A1M for $ln\,C = -kt + c$ A1M for $ln\,7500 = 0 + c$ A1M for $C = 7500e^{-kt}$ or $lnC = -kt + ln7500$ A1M for correct substitution of t = 4 and C = 7450 A1M for $k = 1.67 \times 10^{-3}$ A1M for correct substitution of t = 100 A1M for C = £6345. Allow £6346
13 (c)	A1M for $ln3750 = -1.67 \times 10^{-3}t + ln7500$ A1M for correct rearranging $t = \frac{ln3750 - ln7500}{-1.67\times10^{-3}} = 415.058192$ OR $t = \frac{\ln(0.5)}{-1.67\times10^{-3}} = 415.058192$ A1M for 8 years
13 (d)	A1M for it assumes constant rate of depreciation – doesn't allow for named example (e.g. damage to car etc)
Total	**100**