Year 13 Maths - Exam Question-a-Day Revision Plan

Aims:

The idea of this plan is that it provides an exam question for you to do every day in the run up to your exams.

These questions could be used as a starter for some more general revision that day.

The topics for the questions each day will cycle allowing revision of every topic to take place. The first couple of weeks will contain questions taken from AS papers and after that questions from both AS and full A-Level papers will be used to ensure broad coverage of the syllabus.

February 2019

Day	Date	Topic
1	1st February	Integration of Polynomials
2	2nd February	Decreasing Functions
3	3rd February	Straight Lines
4	4th February	Solving Trigonometric Equations
5	5th February	Simultaneous Equations
6	6th February	Factor Theorem
7	7th February	Algebraic Proof
8	8th February	Vector Geometry
9	9th February	Non Right Angle Trigonometry
10	10th February	Velocity-Time Graphs
11	11th February	Using the Discriminant
12	12th February	Discrete Probability
13	13th February	Completing the Square
14	14th February	Kinematics
15	15th February	Graph Transformations
16	16th February	Surds
17	17th February	Perpendicular Lines
18	18th February	Exponential Models
19	19th February	Inverse Functions
20	20th February	Equations of Tangents
21	21st February	Venn Diagrams
22	22nd February	Factor Theorem
23	23rd February	Binomial Expansion
24	24th February	Quadratics and Graph Transformations
25	25th February	Differentiation and Tangents
26	26th February	Iterative Methods
27	27th February	Counter Examples & Direct Proof
28	28th February	Connected Rates of Change

March 2019

Day	Date	Topic
1	1st March	Differentiation of Simple Functions
2	2nd March	Turning Points and Transformations
3	3rd March	Vectors (with Modelling)
4	4th March	Simultaneous Equations
5	5th March	Modelling with Differential Equations
6	6th March	Projectiles
7	7th March	Logarithms
8	8th March	Small Angle Approximations
9	9th March	Trapezium Rule and Integration
10	10th March	Integration by Parts
11	11th March	Parametric Equations
12	12th March	Newton-Raphson Method
13	13th March	Factor Theorem
14	14th March	Inequality
15	15th March	Integration
16	16th March	Resolving Forces
17	17th March	Modelling and Maximisation
18	18th March	Arc Length and Area of Sectors
19	19th March	Function Notation
20	20th March	Trigonometric Identities
21	21st March	Calculus and Maximisation
22	22nd March	Stationary Points
23	23rd March	Geometric Series
24	24th March	Graph Transformations
25	25th March	Differentiation from First Principles
26	26th March	Modelling and Exponential Functions
27	27th March	Proof by Contradiction
28	28th March	Moments
29	29th March	Differentiation
30	30th March	Logarithmic Models
31	31st March	Differential Equations

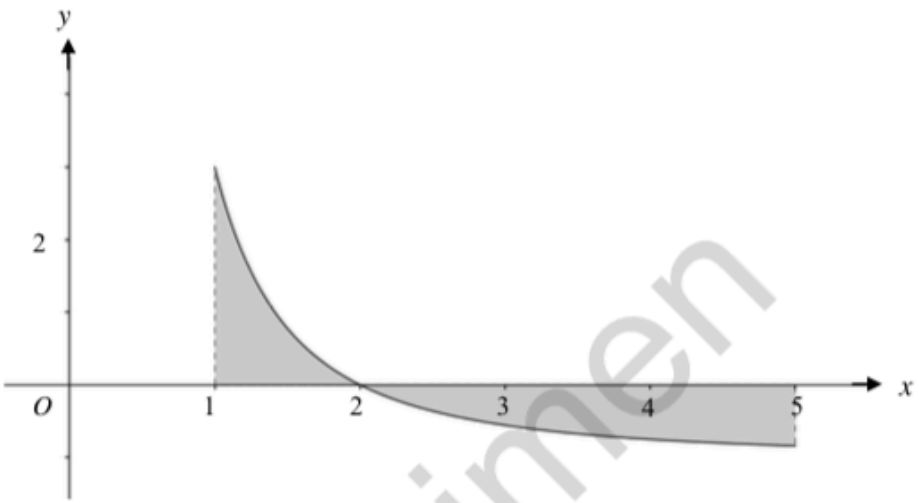
February Questions

1st February

5 **(a)** Find $\int \left(x^3 - 6x\right) dx$. **[3]**

(b) **(i)** Find $\int \left(\frac{4}{x^2} - 1\right) dx$. **[3]**

(ii) The diagram shows part of the curve $y = \frac{4}{x^2} - 1$.



The curve crosses the x-axis at (2, 0).
The shaded region is bounded by the curve, the x-axis, and the lines $x = 1$ and $x = 5$.

Calculate the area of the shaded region. **[3]**

OCR AS Level Mathematics (H230) SAMS, Paper 1

2nd February

8 Prove that the function $f(x) = x^3 - 3x^2 + 15x - 1$ is an increasing function.

[6 marks]

AQA AS SAMS Paper 2

3rd February

1. The line l passes through the points A (3, 1) and B (4, −2).

Find an equation for l.

(3)

Pearson Edexcel SAMS AS Paper 1

4th February

5 Jessica, a maths student, is asked by her teacher to solve the equation $\tan x = \sin x$, giving all solutions in the range $0° \leq x \leq 360°$

The steps of Jessica's working are shown below.

		$\tan x = \sin x$	
Step 1	$\Rightarrow$	$\dfrac{\sin x}{\cos x} = \sin x$	Write $\tan x$ as $\dfrac{\sin x}{\cos x}$
Step 2	$\Rightarrow$	$\sin x = \sin x \cos x$	Multiply by $\cos x$
Step 3	$\Rightarrow$	$1 = \cos x$	Cancel $\sin x$
	$\Rightarrow$	$x = 0°$ or $360°$	

The teacher tells Jessica that she has not found all the solutions because of a mistake.

Explain why Jessica's method is not correct.

[2 marks]

AQA AS SAMS Paper 1

5th February

11 **In this question you must show detailed reasoning.**

Determine for what values of k the graphs $y = 2x^2 - kx$ and $y = x^2 - k$ intersect. **[6]**

OCR AS Level Mathematics (H630) SAMS Paper 1

6th February

4.

$$f(x) = 4x^3 - 12x^2 + 2x - 6$$

(a) Use the factor theorem to show that $(x - 3)$ is a factor of $f(x)$.

(2)

(b) Hence show that 3 is the only real root of the equation $f(x) = 0$

(4)

Pearson Edexcel SAMS AS Paper 1

7th February

12 (a) Given that n is an even number, prove that $9n^2 + 6n$ has a factor of 12

[3 marks]

12 (b) Determine if $9n^2 + 6n$ has a factor of 12 for any integer n.

[1 mark]

AQA AS SAMS Paper 2

8th February

4 The points A, B and C have position vectors $\begin{pmatrix} -2 \\ 1 \end{pmatrix}$, $\begin{pmatrix} 2 \\ 5 \end{pmatrix}$ and $\begin{pmatrix} 6 \\ 3 \end{pmatrix}$ respectively.

M is the midpoint of BC.

(a) Find the position vector of the point D such that $\overrightarrow{BC} = \overrightarrow{AD}$. **[3]**

(b) Find the magnitude of $\overrightarrow{AM}$. **[3]**

9th February

8.

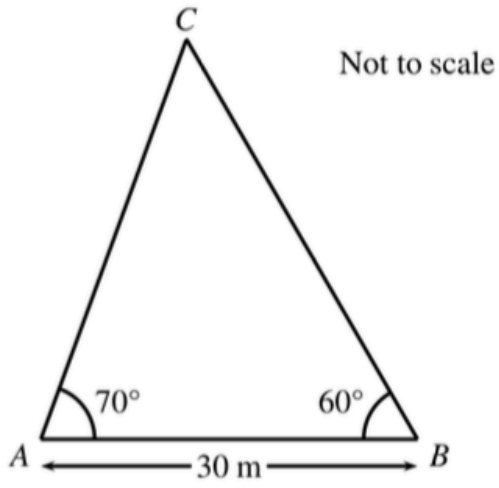


Figure 1

A triangular lawn is modelled by the triangle ABC, shown in Figure 1. The length AB is to be 30 m long.

Given that angle $BAC = 70°$ and angle $ABC = 60°$,

(a) calculate the area of the lawn to 3 significant figures.

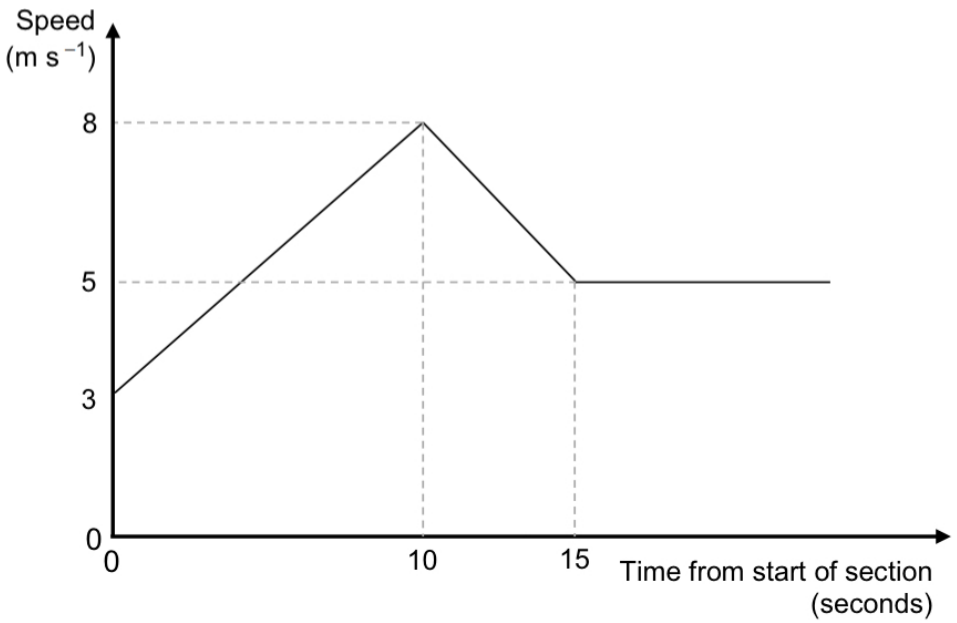
(4)

(b) Why is your answer unlikely to be accurate to the nearest square metre?

(1)

10th February

15 The graph shows how the speed of a cyclist varies during a timed section of length 120 metres along a straight track.



15 (a) Find the acceleration of the cyclist during the first 10 seconds.

[1 mark]

15 (b) After the first 15 seconds, the cyclist travels at a constant speed of 5 m s^{-1} for a further T seconds to complete the 120-metre section.

Calculate the value of T.

[4 marks]

AQA AS SAMS Paper 1

11th February

10. The equation $kx^2 + 4kx + 3 = 0$, where k is a constant, has no real roots.

Prove that

$$0 \leqslant k < \frac{3}{4}$$

(4)

Pearson Edexcel SAMS AS Paper 1

12th February

9 The probability distribution of a random variable X is given in the table.

x	1	2	3
$P(X = x)$	0.6	0.3	0.1

Two values of X are chosen at random.

Find the probability that the second value is greater than the first. **[3]**

OCR AS Level Mathematics (H230) SAMS Paper 1

13th February

4 **(a)** Express $x^2 + 4x + 7$ in the form $(x+b)^2 + c$. **[2]**

(b) Explain why the minimum point on the curve $y = (x+b)^2 + c$ occurs when $x = -b$. **[1]**

OCR AS Level Mathematics (H630) SAMS Paper 1

14th February

16 A particle, of mass 400 grams, is initially at rest at the point O.

The particle starts to move in a straight line so that its velocity, v m s^{-1}, at time t seconds is given by

$$v = 6t^2 - 12t^3 \text{ for } t > 0$$

16 (a) Find an expression, in terms of t, for the force acting on the particle.

[3 marks]

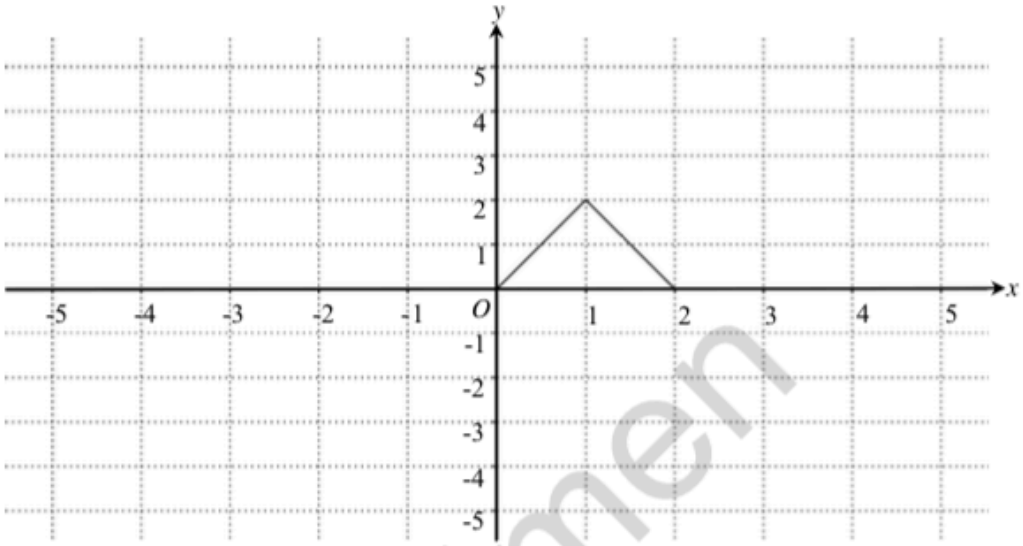
16 (b) Find the time when the particle next passes through *O*.

[5 marks]

AQA AS Mathematics SAMS Paper 1

15th February

1 **(a)** The diagram below shows the graph of $y = f(x)$.



(i) On the diagram in the Printed Answer Booklet draw the graph of $y = f(x+3)$. **[2]**

(ii) Describe fully the transformation which transforms the graph of $y = f(x)$ to the graph of $y = -f(x)$. **[1]**

(b) The point (2, 3) lies on the graph of $y = g(x)$.

State the coordinates of its image when $y = g(x)$ is transformed to

(i) $y = 4g(x)$ **[1]**

(ii) $y = g(4x)$. **[1]**

OCR AS Level Mathematics (H230) SAMS Paper 2

16th February

1 Simplify fully.

(a) $\sqrt{a^3} \times \sqrt{16a}$ **[2]**

(b) $(4b^6)^{\frac{5}{2}}$ **[2]**

OCR A-Level Mathematics (H240) SAMS Paper 1

17th February

7 Determine whether the line with equation $2x + 3y + 4 = 0$ is parallel to the line through the points with coordinates (9, 4) and (3, 8).

[4 marks]

AQA A-Level Mathematics SAMS Paper 1

18th February

14.

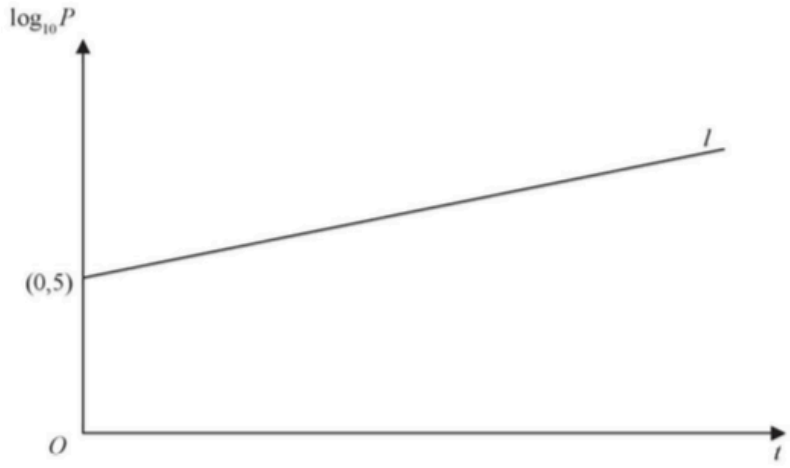


Figure 2

A town's population, P, is modelled by the equation $P = ab^t$, where a and b are constants and t is the number of years since the population was first recorded.

The line l shown in Figure 2 illustrates the linear relationship between t and $\log_{10} P$ for the population over a period of 100 years.

The line l meets the vertical axis at (0, 5) as shown. The gradient of l is $\frac{1}{200}$.

(a) Write down an equation for l.

(2)

(b) Find the value of a and the value of b.

(4)

(c) With reference to the model interpret

(i) the value of the constant a,

(ii) the value of the constant b

(2)

(d) Find

(i) the population predicted by the model when $t = 100$, giving your answer to the nearest hundred thousand,

(ii) the number of years it takes the population to reach 200 000, according to the model.

(3)

(e) State two reasons why this may not be a realistic population model.

(2)

Pearson Edexcel SAMS AS Paper 1

19th February

11 For all real values of x, the functions f and g are defined by $f(x) = x^2 + 8ax + 4a^2$ and $g(x) = 6x - 2a$, where a is a positive constant.

(a) Find $fg(x)$.
Determine the range of $fg(x)$ in terms of a. **[4]**

(b) If $fg(2) = 144$, find the value of a. **[3]**

(c) Determine whether the function fg has an inverse. **[2]**

OCR A-Level Mathematics (H240) SAMS Paper 1

20th February

3. A curve has the equation $y = \ln 3x - e^{-2x}$.

Show that the equation of the tangent at the point with an x-coordinate of 1 is

$$y = \left(\frac{e^2 + 2}{e^2}\right)x - \left(\frac{e^2 + 3}{e^2}\right) + \ln 3.$$

(6 marks)

Pearson Edexcel A-Level Mathematics Practice Paper B

21st February

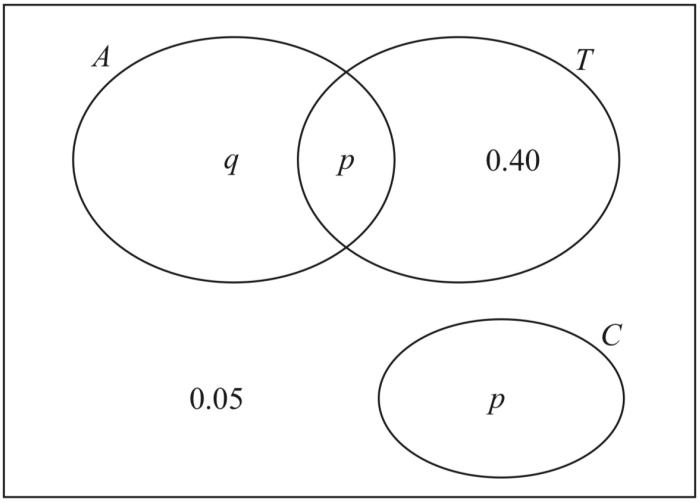
3. The Venn diagram shows the probabilities for students at a college taking part in various sports.

A represents the event that a student takes part in Athletics.

T represents the event that a student takes part in Tennis.

C represents the event that a student takes part in Cricket.

p and q are probabilities.



The probability that a student selected at random takes part in Athletics or Tennis is 0.75

(a) Find the value of p.

(1)

(b) State, giving a reason, whether or not the events A and T are statistically independent. Show your working clearly.

(3)

(c) Find the probability that a student selected at random does not take part in Athletics or Cricket.

(1)

Pearson Edexcel AS SAMS Paper 2

22nd February

1 $p(x) = x^3 - 5x^2 + 3x + a$, where a is a constant.

Given that $x - 3$ is a factor of $p(x)$, find the value of a

Circle your answer.

[1 mark]

-9 -3 3 9

AQA AS-Level Mathematics SAMS Paper 2

23rd February

5 **(a)** Find the first three terms in the expansion of $(1+px)^{\frac{1}{3}}$ in ascending powers of x. **[3]**

(b) The expansion of $(1+qx)(1+px)^{\frac{1}{3}}$ is $1 + x - \frac{2}{9}x^2 + \ldots$.

Find the possible values of the constants p and q. **[5]**

OCR A-Level Mathematics (H240) SAMS Paper 3

24th February

4.

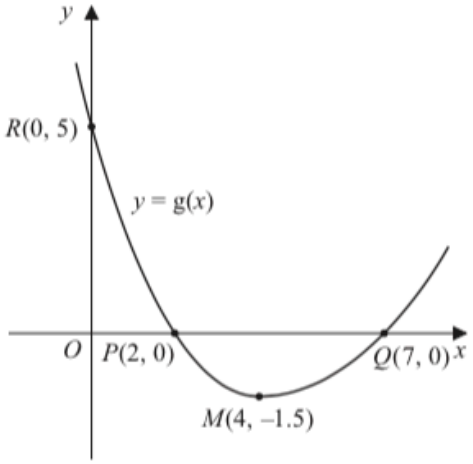


Figure 1

Figure 1 shows a sketch of the curve with equation $y = \mathrm{g}(x)$.

The curve has a single turning point, a minimum, at the point $M(4, -1.5)$.
The curve crosses the x-axis at two points, $P(2, 0)$ and $Q(7, 0)$.
The curve crosses the y-axis at a single point $R(0, 5)$.

(a) State the coordinates of the turning point on the curve with equation $y = 2\mathrm{g}(x)$.

(1)

(b) State the largest root of the equation

$$\mathrm{g}(x + 1) = 0$$

(1)

(c) State the range of values of x for which $\mathrm{g}'(x) \leqslant 0$

(1)

Given that the equation $\mathrm{g}(x) + k = 0$, where k is a constant, has no real roots,

(d) state the range of possible values for k.

(1)

Pearson AS Mathematics Specimen Papers Paper 1

25th February

12 A curve has equation $y = 6x\sqrt{x} + \dfrac{32}{x}$ for $x > 0$

12 (a) Find $\dfrac{\mathrm{d}y}{\mathrm{d}x}$

[4 marks]

12 (b) The point A lies on the curve and has x-coordinate 4

Find the coordinates of the point where the tangent to the curve at A crosses the x-axis.

[5 marks]

AQA AS-Level SAMS Paper 1

26th February

9 The equation $x^3 - x^2 - 5x + 10 = 0$ has exactly one real root α.

(a) Show that the Newton-Raphson iterative formula for finding this root can be written as

$$x_{n+1} = \frac{2x_n^{\ 3} - x_n^{\ 2} - 10}{3x_n^{\ 2} - 2x_n - 5}.$$ **[3]**

(b) Apply the iterative formula in part (a) with initial value $x_1 = -3$ to find x_2, x_3, x_4 correct to 4 significant figures. **[1]**

(c) Use a change of sign method to show that $\alpha = -2.533$ is correct to 4 significant figures. **[3]**

(d) Explain why the Newton-Raphson method with initial value $x_1 = -1$ would not converge to α. **[2]**

OCR A-Level Mathematics (H240) SAMS Paper 3

27th February

6. (i) Use a counter example to show that the following statement is false.

"$n^2 - n - 1$ is a prime number, for $3 \leqslant n \leqslant 10$."

(2)

(ii) Prove that the following statement is always true.

"The difference between the cube and the square of an odd number is even."

For example $5^3 - 5^2 = 100$ is even.

(4)

Pearson AS Mathematics Specimen Papers Paper 1

28th February

11 The circle with equation $(x-7)^2+(y+2)^2=5$ has centre C.

11 (a) (i) Write down the radius of the circle.

[1 mark]

11 (a) (ii) Write down the coordinates of C.

[1 mark]

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11 (b) The point P (5, −1) lies on the circle.

Find the equation of the tangent to the circle at P, giving your answer in the form $y=mx+c$

[4 marks]

11 (c) The point Q (3, 3) lies outside the circle and the point T lies on the circle such that QT is a tangent to the circle. Find the length of QT.

[4 marks]

AQA AS-Level SAMS Paper 2

March Questions

1st March

2 A curve has equation $y = \frac{2}{\sqrt{x}}$

Find $\frac{dy}{dx}$

Circle your answer.

[1 mark]

$\frac{\sqrt{x}}{3}$ $\quad$ $\frac{1}{x\sqrt{x}}$ $\quad$ $-\frac{1}{x\sqrt{x}}$ $\quad$ $-\frac{1}{2x\sqrt{x}}$

AQA A-Level Mathematics SAMS Paper 1

2nd March

15.

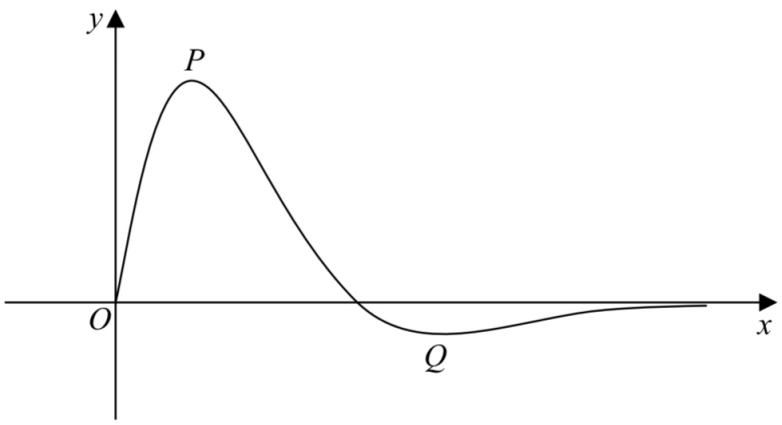


Figure 5

Figure 5 shows a sketch of the curve with equation $y = f(x)$, where

$$f(x) = \frac{4\sin 2x}{e^{\sqrt{2}x-1}}, \quad 0 \leqslant x \leqslant \pi$$

The curve has a maximum turning point at P and a minimum turning point at Q as shown in Figure 5.

(a) Show that the x coordinates of point P and point Q are solutions of the equation

$$\tan 2x = \sqrt{2}$$

(4)

(b) Using your answer to part (a), find the x-coordinate of the minimum turning point on the curve with equation

(i) $y = f(2x)$.

(ii) $y = 3 - 2f(x)$.

(4)

Pearson Edexcel A-Level Mathematics SAMS Paper 1

3rd March

12 A model boat has velocity $\mathbf{v} = \left((2t-2)\mathbf{i}+(2t+2)\mathbf{j}\right)$ m s^{-1}, where **i** and **j** are unit vectors east and north respectively and t is the time in seconds, where $t \geq 0$. The position vector of the boat is $(3\mathbf{i} + 14\mathbf{j})$ m when $t = 3$.

(i) Show that the boat is never instantaneously at rest. **[2]**

(ii) Determine any times at which the boat is moving directly northwards. **[2]**

(iii) Determine any times at which the boat is north-east of the origin. **[5]**

OCR B (H640) A-Level Mathematics SAMS Paper 1

4th March

1 Solve the simultaneous equations.

$$x^2 + 8x + y^2 = 84$$
$$x - y = 10$$

[4]

OCR A (H240) A-Level Mathematics SAMS Paper 1

5th March

6 Sam goes on a diet. He assumes that his mass, m kg after t days, decreases at a rate that is inversely proportional to the cube root of his mass.

6 (a) Construct a differential equation involving m , t and a positive constant k to model this situation.

[3 marks]

6 (b) Explain why Sam's assumption may not be appropriate.

[1 mark]

AQA A-Level Mathematics SAMS Paper 1

6th March

7 **In this question take $g = 10$.**

A small stone is projected from a point O with a speed of $26\,\text{m s}^{-1}$ at an angle θ above the horizontal. The initial velocity and part of the path of the stone are shown in Fig. 7. You are given that $\sin\theta = \frac{12}{13}$. After t seconds the horizontal and vertical displacements of the stone from O are x metres and y metres.

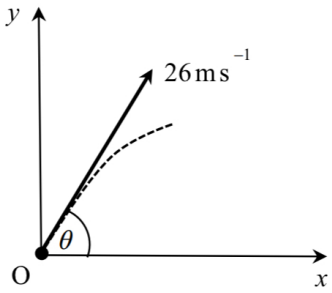


Fig. 7

(i) Using the standard model for projectile motion,

- show that $y = 24t - 5t^2$,
- find an expression for x in terms of t. **[4]**

The stone passes through a point A which is 16 m above the level of O.

(ii) Find the two possible horizontal distances of A from O. **[4]**

Suppose that a toy balloon is projected from O with the same initial velocity as the small stone.

(iii) Suggest two ways in which the standard model could be adapted. **[2]**

OCR B (H640) A-Level Mathematics SAMS Paper 1

7th March

5 **In this question you must show detailed reasoning.**

Use logarithms to solve the equation

$$3^{2x+1} = 4^{100},$$

giving your answer correct to 3 significant figures. **[4]**

OCR A (H240) A-Level Mathematics SAMS Paper 1

8th March

3 When θ is small, find an approximation for $\cos 3\theta + \theta \sin 2\theta$, giving your answer in the form $a + b\theta^2$

[3 marks]

AQA A-Level Mathematics SAMS Paper 1

9th March

14.

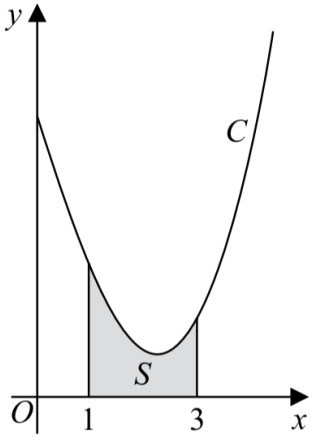


Figure 4

Figure 4 shows a sketch of part of the curve C with equation

$$y = \frac{x^2 \ln x}{3} - 2x + 5, \quad x > 0$$

The finite region S, shown shaded in Figure 4, is bounded by the curve C, the line with equation $x = 1$, the x-axis and the line with equation $x = 3$

The table below shows corresponding values of x and y with the values of y given to 4 decimal places as appropriate.

x	1	1.5	2	2.5	3
y	3	2.3041	1.9242	1.9089	2.2958

(a) Use the trapezium rule, with all the values of y in the table, to obtain an estimate for the area of S, giving your answer to 3 decimal places.

(3)

(b) Explain how the trapezium rule could be used to obtain a more accurate estimate for the area of S.

(1)

(c) Show that the exact area of S can be written in the form $\frac{a}{b} + \ln c$, where a, b and c are integers to be found.

(6)

(In part c, solutions based entirely on graphical or numerical methods are not acceptable.)

10th March

8 Find $\int x^2 e^{2x}\,dx$. **[7]**

OCR B (H640) A-Level Mathematics SAMS Paper 1

11th March

13. The curve C has parametric equations

$$x = 2\cos t, \quad y = \sqrt{3}\cos 2t, \quad 0 \leqslant t \leqslant \pi$$

(a) Find an expression for $\frac{dy}{dx}$ in terms of t.

(2)

The point P lies on C where $t = \frac{2\pi}{3}$

The line l is the normal to C at P.

(b) Show that an equation for l is

$$2x - 2\sqrt{3}y - 1 = 0$$

(5)

The line l intersects the curve C again at the point Q.

(c) Find the exact coordinates of Q.

You must show clearly how you obtained your answers.

(6)

Pearson Edexcel A-Level Mathematics SAMS Paper 1

12th March

9 The equation $x^3 - x^2 - 5x + 10 = 0$ has exactly one real root α.

(i) Show that the Newton-Raphson iterative formula for finding this root can be written as

$$x_{n+1} = \frac{2x_n^{\ 3} - x_n^{\ 2} - 10}{3x_n^{\ 2} - 2x_n - 5}.$$

[3]

(ii) Apply the iterative formula in part **(i)** with initial value $x_1 = -3$ to find x_2, x_3, x_4 correct to 4 significant figures. **[1]**

(iii) Use a change of sign method to show that $\alpha = -2.533$ is correct to 4 significant figures. **[3]**

(iv) Explain why the Newton-Raphson method with initial value $x_1 = -1$ would not converge to α. **[2]**

OCR A (H240) A-Level Mathematics SAMS Paper 1

13th March

4 $\mathrm{p}(x) = 2x^3 + 7x^2 + 2x - 3$

4 (a) Use the factor theorem to prove that $x + 3$ is a factor of $\mathrm{p}(x)$

[2 marks]

4 (b) Simplify the expression $\dfrac{2x^3 + 7x^2 + 2x - 3}{4x^2 - 1}$, $x \neq \pm \dfrac{1}{2}$

[4 marks]

AQA A-Level Mathematics SAMS Paper 1

14th March

3 Solve the inequality $|2x - 1| \geq 4$. **[4]**

OCR A (H260) A-Level Mathematics SAMS Paper 1

15th March

Given that a is a positive constant and

$$\int_a^{2a} \frac{t+1}{t}\,\mathrm{d}t = \ln 7$$

show that $a = \ln k$, where k is a constant to be found.

(4)

Pearson Edexcel A-Level Mathematics SAMS Paper 1

16th March

5 Dora is trying to pull a loaded sledge along horizontal ground. The only resistance to motion of the sledge is due to friction between it and the ground.

Fig. 5

Initially she pulls with a force of 100 N inclined at 32° to the horizontal, as shown in Fig.5, but the sledge does not move.

(i) Determine the frictional force between the ground and the sledge. Give your answer correct to 3 significant figures. **[2]**

(ii) Next she pulls with a force of 100 N inclined at a smaller angle to the horizontal. The sledge still does not move. Compare the frictional force in this new situation with that in part **(i)**, justifying your answer. **[2]**

OCR B(H640) A-Level Mathematics SAMS Paper 1

17th March

14 An open-topped fish tank is to be made for an aquarium.

It will have a square horizontal base, rectangular vertical sides and a volume of 60 m^3

The materials cost:

- £15 per m^2 for the base
- £8 per m^2 for the sides.

14 (a) Modelling the sides and base of the fish tank as laminae, use calculus to find the height of the tank for which the overall cost of the materials has its minimum value.

Fully justify your answer.

[8 marks]

14 (b) (i) In reality, the thickness of the base and sides of the tank is 2.5 cm

Briefly explain how you would refine your modelling to take account of the thickness of the sides and base of the tank of the tank.

[1 mark]

14 (b) (ii) How would your refinement affect your answer to part **(a)**?

[1 mark]

AQA A-Level Mathematics SAMS Paper 1

18th March

2.

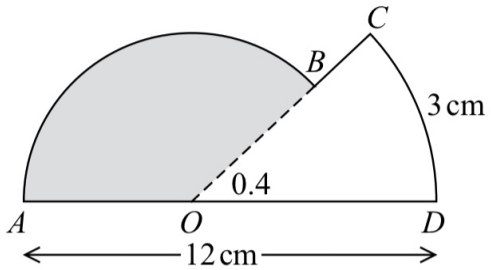


Figure 1

The shape *ABCDOA*, as shown in Figure 1, consists of a sector *COD* of a circle centre *O* joined to a sector *AOB* of a different circle, also centre *O*.

Given that arc length *CD* = 3 cm, $\angle COD = 0.4$ radians and *AOD* is a straight line of length 12 cm,

(a) find the length of *OD*,

(2)

(b) find the area of the shaded sector *AOB*.

(3)

Pearson Edexcel A-Level Mathematics SAMS Paper 1

19th March

11 For all real values of x, the functions f and g are defined by $\mathrm{f}(x) = x^2 + 8ax + 4a^2$ and $\mathrm{g}(x) = 6x - 2a$, where a is a positive constant.

(i) Find $\mathrm{fg}(x)$. Determine the range of $\mathrm{fg}(x)$ in terms of a. **[4]**

(ii) If $\mathrm{fg}(2) = 144$, find the value of a. **[3]**

(iii) Determine whether the function fg has an inverse. **[2]**

OCR A (H240) A-Level Mathematics SAMS Paper 1

20th March

13 Prove the identity $\cot^2\theta - \cos^2\theta \equiv \cot^2\theta\cos^2\theta$

[3 marks]

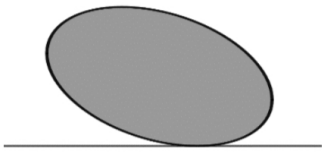
AQA A-Level Mathematics SAMS Paper 1

21st March

12 A sculpture formed from a prism is fixed on a horizontal platform, as shown in the diagram.

The shape of the cross-section of the sculpture can be modelled by the equation $x^2 + 2xy + 2y^2 = 10$, where x and y are measured in metres.

The x and y axes are horizontal and vertical respectively.



Find the maximum vertical height above the platform of the sculpture.

[8 marks]

AQA A-Level Mathematics SAMS Paper 1

22nd March

1. The curve C has equation

$$y = 3x^4 - 8x^3 - 3$$

(a) Find (i) $\dfrac{dy}{dx}$

(ii) $\dfrac{d^2y}{dx^2}$

(3)

(b) Verify that C has a stationary point when $x = 2$

(2)

(c) Determine the nature of this stationary point, giving a reason for your answer.

(2)

Pearson Edexcel A-Level Mathematics SAMS Paper 1

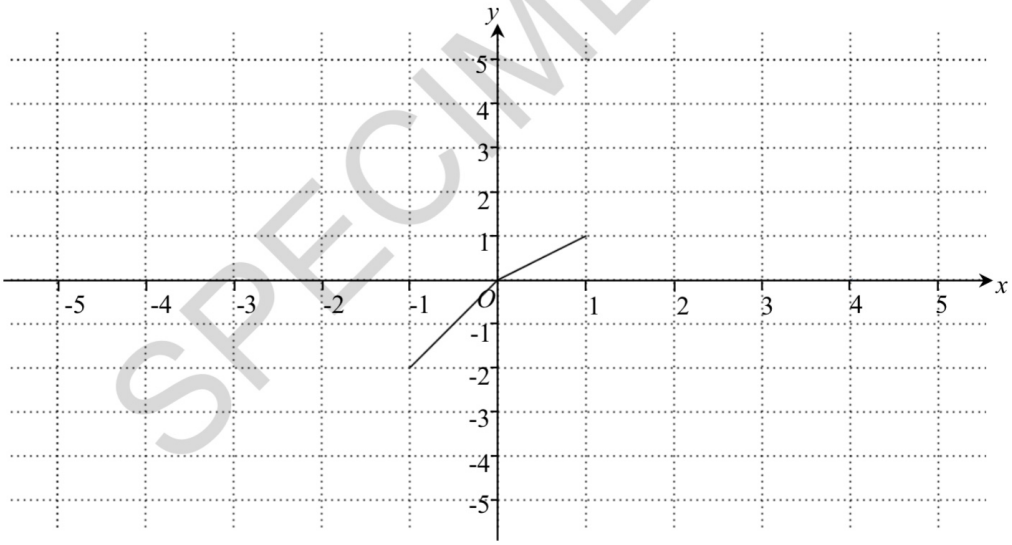
23rd March

2 A geometric series has first term 3. The sum to infinity of the series is 8. Find the common ratio. **[3]**

OCR A (H260) A-Level Mathematics SAMS Paper 1

24th March

3 The diagram below shows the graph of $y = \mathrm{f}(x)$.



(i) On the diagram in your Printed Answer Booklet, draw the graph of $y = \mathrm{f}(\frac{1}{2}x)$. **[1]**

(ii) On the diagram in your Printed Answer Booklet, draw the graph of $y = \mathrm{f}(x-2)+1$. **[2]**

OCR A (H240) A-Level Mathematics SAMS Paper 1

25th March

17 $\mathrm{f}(x) = \sin x$

Using differentiation from first principles find the exact value of $\mathrm{f}'\left(\frac{\pi}{6}\right)$

Fully justify your answer.

[6 marks]

AQA A-Level Mathematics SAMS Paper 1

26th March

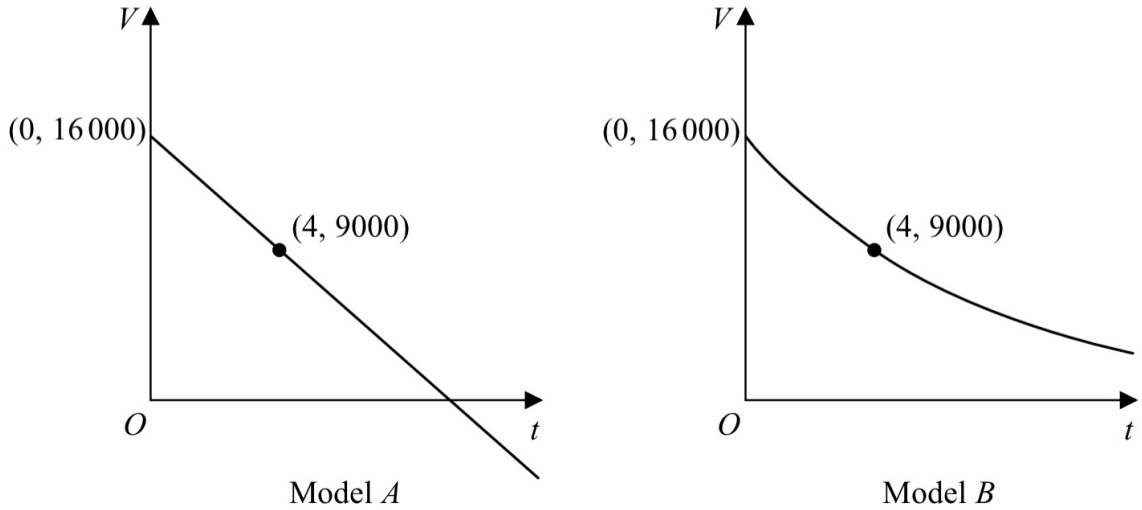
6. A company plans to extract oil from an oil field.

The daily volume of oil V, measured in barrels that the company will extract from this oil field depends upon the time, t years, after the start of drilling.

The company decides to use a model to estimate the daily volume of oil that will be extracted. The model includes the following assumptions:

- The initial daily volume of oil extracted from the oil field will be 16 000 barrels.
- The daily volume of oil that will be extracted exactly 4 years after the start of drilling will be 9000 barrels.
- The daily volume of oil extracted will decrease over time.

The diagram below shows the graphs of two possible models.



(a) (i) Use model A to estimate the daily volume of oil that will be extracted exactly 3 years after the start of drilling.

(ii) Write down a limitation of using model A.

(2)

(b) (i) Using an exponential model and the information given in the question, find a possible equation for model B.

(ii) Using your answer to (b)(i) estimate the daily volume of oil that will be extracted exactly 3 years after the start of drilling.

(5)

27th March

6 Prove by contradiction that there is no greatest even positive integer. **[3]**

OCR A (H240) A-Level Mathematics SAMS Paper 1

28th March

15 Fig. 15 shows a uniform shelf AB of weight W N which is 180 cm long and rests on supports at points C and D. C is 30 cm from A and D is 60 cm from B.

side view

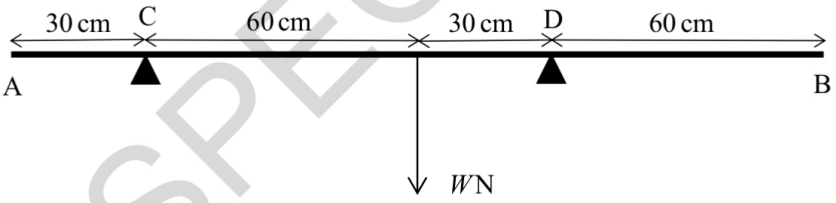


Fig. 15

Determine the range of positions a point load of 3 W could be placed on the shelf without it tipping. **[6]**

OCR A (H260) A-Level Mathematics SAMS Paper 1

29th March

10 A curve has equation $x = (y+5)\ln(2y-7)$.

(a) Find $\frac{dx}{dy}$ in terms of y. **[3]**

(b) Find the gradient of the curve where it crosses the y-axis. **[5]**

OCR A (H240) A-Level Mathematics SAMS Paper 1

30th March

12. In a controlled experiment, the number of microbes, N, present in a culture T days after the start of the experiment were counted.

N and T are expected to satisfy a relationship of the form

$$N = aT^b, \qquad \text{where } a \text{ and } b \text{ are constants}$$

(a) Show that this relationship can be expressed in the form

$$\log_{10} N = m \log_{10} T + c$$

giving m and c in terms of the constants a and/or b.

(2)

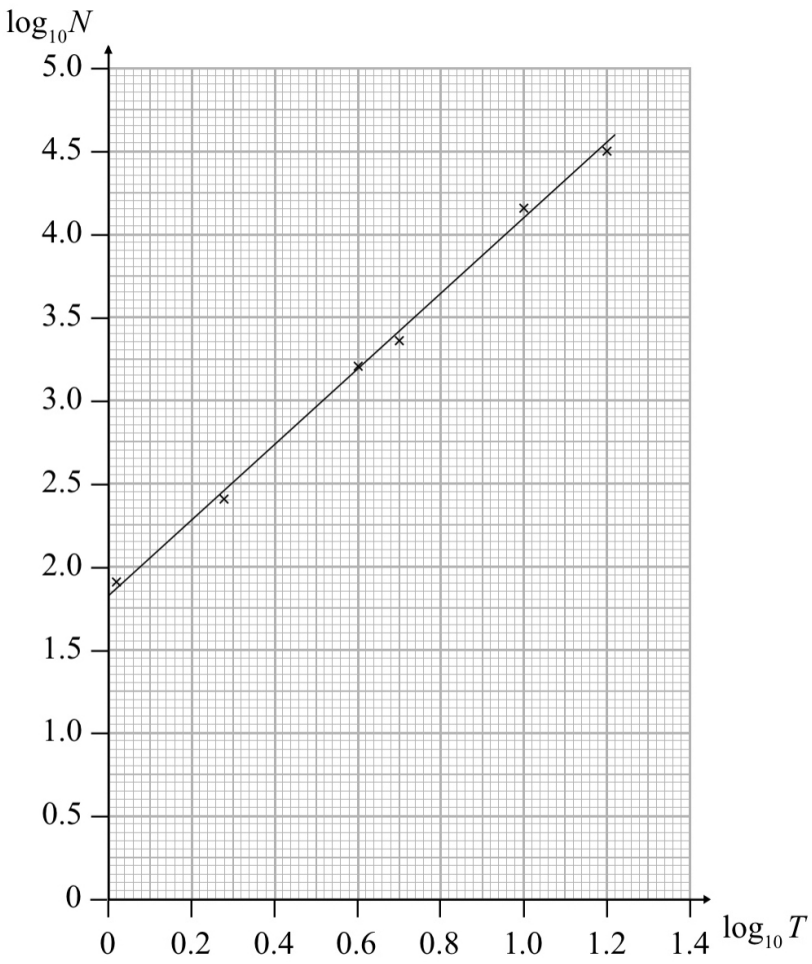


Figure 3

Figure 3 shows the line of best fit for values of $\log_{10} N$ plotted against values of $\log_{10} T$

(b) Use the information provided to estimate the number of microbes present in the culture 3 days after the start of the experiment.

(4)

(c) Explain why the information provided could not reliably be used to estimate the day when the number of microbes in the culture first exceeds 1 000 000.

(2)

(d) With reference to the model, interpret the value of the constant a.

(1)

Pearson Edexcel A-Level Mathematics SAMS Paper 1

31st March

15 The height x metres, of a column of water in a fountain display satisfies the differential equation $\frac{dx}{dt} = \frac{8\sin 2t}{3\sqrt{x}}$, where t is the time in seconds after the display begins.

15 (a) Solve the differential equation, given that initially the column of water has zero height.

Express your answer in the form $x = f(t)$

[7 marks]

15 (b) Find the maximum height of the column of water, giving your answer to the nearest cm.

[1 mark]

AQA A-Level Mathematics SAMS Paper 1