



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education
Advanced Subsidiary Level and Advanced Level

Mathematics (9709)

Paper 1: Pure Mathematics 1 (P1)

2020-2021



UNIVERSITY *of* CAMBRIDGE
International Examinations

PURE MATHEMATICS

Mensuration

$$\text{Volume of sphere} = \frac{4}{3}\pi r^3$$

$$\text{Surface area of sphere} = 4\pi r^2$$

$$\text{Volume of cone or pyramid} = \frac{1}{3} \times \text{base area} \times \text{height}$$

$$\text{Area of curved surface of cone} = \pi r \times \text{slant height}$$

$$\text{Arc length of circle} = r\theta \quad (\theta \text{ in radians})$$

$$\text{Area of sector of circle} = \frac{1}{2}r^2\theta \quad (\theta \text{ in radians})$$

Algebra

For the quadratic equation $ax^2 + bx + c = 0$:

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

For an arithmetic series:

$$u_n = a + (n-1)d, \quad S_n = \frac{1}{2}n(a+l) = \frac{1}{2}n\{2a + (n-1)d\}$$

For a geometric series:

$$u_n = ar^{n-1}, \quad S_n = \frac{a(1-r^n)}{1-r} \quad (r \neq 1), \quad S_\infty = \frac{a}{1-r} \quad (|r| < 1)$$

Binomial series:

$$(a+b)^n = a^n + \binom{n}{1}a^{n-1}b + \binom{n}{2}a^{n-2}b^2 + \binom{n}{3}a^{n-3}b^3 + \dots + b^n, \text{ where } n \text{ is a positive integer}$$

$$\text{and } \binom{n}{r} = \frac{n!}{r!(n-r)!}$$

$$(1+x)^n = 1 + nx + \frac{n(n-1)}{2!}x^2 + \frac{n(n-1)(n-2)}{3!}x^3 + \dots, \text{ where } n \text{ is rational and } |x| < 1$$

Trigonometry

$$\tan \theta \equiv \frac{\sin \theta}{\cos \theta}$$

$$\cos^2 \theta + \sin^2 \theta \equiv 1, \quad 1 + \tan^2 \theta \equiv \sec^2 \theta, \quad \cot^2 \theta + 1 \equiv \operatorname{cosec}^2 \theta$$

$$\sin(A \pm B) \equiv \sin A \cos B \pm \cos A \sin B$$

$$\cos(A \pm B) \equiv \cos A \cos B \mp \sin A \sin B$$

$$\tan(A \pm B) \equiv \frac{\tan A \pm \tan B}{1 \mp \tan A \tan B}$$

$$\sin 2A \equiv 2 \sin A \cos A$$

$$\cos 2A \equiv \cos^2 A - \sin^2 A \equiv 2 \cos^2 A - 1 \equiv 1 - 2 \sin^2 A$$

$$\tan 2A \equiv \frac{2 \tan A}{1 - \tan^2 A}$$

Principal values:

$$-\frac{1}{2}\pi \leq \sin^{-1} x \leq \frac{1}{2}\pi,$$

$$0 \leq \cos^{-1} x \leq \pi,$$

$$-\frac{1}{2}\pi < \tan^{-1} x < \frac{1}{2}\pi$$

Differentiation

$\mathbf{f(x)}$	$\mathbf{f'(x)}$
x^n	nx^{n-1}
$\ln x$	$\frac{1}{x}$
e^x	e^x
$\sin x$	$\cos x$
$\cos x$	$-\sin x$
$\tan x$	$\sec^2 x$
$\sec x$	$\sec x \tan x$
$\operatorname{cosec} x$	$-\operatorname{cosec} x \cot x$
$\cot x$	$-\operatorname{cosec}^2 x$
$\tan^{-1} x$	$\frac{1}{1+x^2}$
uv	$v \frac{du}{dx} + u \frac{dv}{dx}$
$\frac{u}{v}$	$\frac{v \frac{du}{dx} - u \frac{dv}{dx}}{v^2}$

If $x = f(t)$ and $y = g(t)$ then $\frac{dy}{dx} = \frac{dy}{dt} \div \frac{dx}{dt}$

Integration

(Arbitrary constants are omitted; a denotes a positive constant.)

$\mathbf{f(x)}$	$\int \mathbf{f(x)} \, \mathbf{dx}$	
x^n	$\frac{x^{n+1}}{n+1}$	$(n \neq -1)$
$\frac{1}{x}$	$\ln x $	
e^x	e^x	
$\sin x$	$-\cos x$	
$\cos x$	$\sin x$	
$\sec^2 x$	$\tan x$	
$\frac{1}{x^2 + a^2}$	$\frac{1}{a} \tan^{-1}\left(\frac{x}{a}\right)$	
$\frac{1}{x^2 - a^2}$	$\frac{1}{2a} \ln \left \frac{x-a}{x+a} \right $	$(x > a)$
$\frac{1}{a^2 - x^2}$	$\frac{1}{2a} \ln \left \frac{a+x}{a-x} \right $	$(x < a)$

$$\int u \frac{dv}{dx} dx = uv - \int v \frac{du}{dx} dx$$

$$\int \frac{f'(x)}{f(x)} dx = \ln|f(x)|$$

Vectors

If $\mathbf{a} = a_1\mathbf{i} + a_2\mathbf{j} + a_3\mathbf{k}$ and $\mathbf{b} = b_1\mathbf{i} + b_2\mathbf{j} + b_3\mathbf{k}$ then

$$\mathbf{a} \cdot \mathbf{b} = a_1b_1 + a_2b_2 + a_3b_3 = |\mathbf{a}| |\mathbf{b}| \cos \theta$$

MECHANICS

Uniformly accelerated motion

$$v = u + at, \quad s = \frac{1}{2}(u + v)t, \quad s = ut + \frac{1}{2}at^2, \quad v^2 = u^2 + 2as$$

FURTHER MECHANICS

Motion of a projectile

Equation of trajectory is:

$$y = x \tan \theta - \frac{gx^2}{2V^2 \cos^2 \theta}$$

Elastic strings and springs

$$T = \frac{\lambda x}{l}, \quad E = \frac{\lambda x^2}{2l}$$

Motion in a circle

For uniform circular motion, the acceleration is directed towards the centre and has magnitude

$$\omega^2 r \quad \text{or} \quad \frac{v^2}{r}$$

Centres of mass of uniform bodies

Triangular lamina: $\frac{2}{3}$ along median from vertex

Solid hemisphere of radius r : $\frac{3}{8}r$ from centre

Hemispherical shell of radius r : $\frac{1}{2}r$ from centre

Circular arc of radius r and angle 2α : $\frac{r \sin \alpha}{\alpha}$ from centre

Circular sector of radius r and angle 2α : $\frac{2r \sin \alpha}{3\alpha}$ from centre

Solid cone or pyramid of height h : $\frac{3}{4}h$ from vertex

PROBABILITY & STATISTICS

Summary statistics

For ungrouped data:

$$\bar{x} = \frac{\Sigma x}{n}, \quad \text{standard deviation} = \sqrt{\frac{\Sigma(x - \bar{x})^2}{n}} = \sqrt{\frac{\Sigma x^2}{n} - \bar{x}^2}$$

For grouped data:

$$\bar{x} = \frac{\Sigma xf}{\Sigma f}, \quad \text{standard deviation} = \sqrt{\frac{\Sigma(x - \bar{x})^2 f}{\Sigma f}} = \sqrt{\frac{\Sigma x^2 f}{\Sigma f} - \bar{x}^2}$$

Discrete random variables

$$E(X) = \Sigma xp, \quad \text{Var}(X) = \Sigma x^2 p - \{E(X)\}^2$$

For the binomial distribution $B(n, p)$:

$$p_r = \binom{n}{r} p^r (1-p)^{n-r}, \quad \mu = np, \quad \sigma^2 = np(1-p)$$

For the geometric distribution $\text{Geo}(p)$:

$$p_r = p(1-p)^{r-1}, \quad \mu = \frac{1}{p}$$

For the Poisson distribution $\text{Po}(\lambda)$

$$p_r = e^{-\lambda} \frac{\lambda^r}{r!}, \quad \mu = \lambda, \quad \sigma^2 = \lambda$$

Continuous random variables

$$E(X) = \int x f(x) dx, \quad \text{Var}(X) = \int x^2 f(x) dx - \{E(X)\}^2$$

Sampling and testing

Unbiased estimators:

$$\bar{x} = \frac{\Sigma x}{n}, \quad s^2 = \frac{\Sigma(x - \bar{x})^2}{n-1} = \frac{1}{n-1} \left(\Sigma x^2 - \frac{(\Sigma x)^2}{n} \right)$$

Central Limit Theorem:

$$\bar{X} \sim N\left(\mu, \frac{\sigma^2}{n}\right)$$

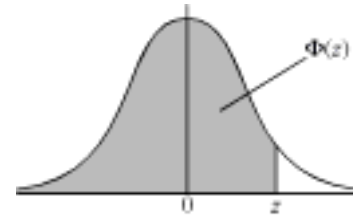
Approximate distribution of sample proportion:

$$N\left(p, \frac{p(1-p)}{n}\right)$$

THE NORMAL DISTRIBUTION FUNCTION

If Z has a normal distribution with mean 0 and variance 1, then, for each value of z , the table gives the value of $\Phi(z)$, where

$$\Phi(z) = P(Z \leq z).$$



For negative values of z , use $\Phi(-z) = 1 - \Phi(z)$.

z	0	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
											ADD								
0.0	0.5000	0.5040	0.5080	0.5120	0.5160	0.5199	0.5239	0.5279	0.5319	0.5359	4	8	12	16	20	24	28	32	36
0.1	0.5398	0.5438	0.5478	0.5517	0.5557	0.5596	0.5636	0.5675	0.5714	0.5753	4	8	12	16	20	24	28	32	36
0.2	0.5793	0.5832	0.5871	0.5910	0.5948	0.5987	0.6026	0.6064	0.6103	0.6141	4	8	12	15	19	23	27	31	35
0.3	0.6179	0.6217	0.6255	0.6293	0.6331	0.6368	0.6406	0.6443	0.6480	0.6517	4	7	11	15	19	22	26	30	34
0.4	0.6554	0.6591	0.6628	0.6664	0.6700	0.6736	0.6772	0.6808	0.6844	0.6879	4	7	11	14	18	22	25	29	32
0.5	0.6915	0.6950	0.6985	0.7019	0.7054	0.7088	0.7123	0.7157	0.7190	0.7224	3	7	10	14	17	20	24	27	31
0.6	0.7257	0.7291	0.7324	0.7357	0.7389	0.7422	0.7454	0.7486	0.7517	0.7549	3	7	10	13	16	19	23	26	29
0.7	0.7580	0.7611	0.7642	0.7673	0.7704	0.7734	0.7764	0.7794	0.7823	0.7852	3	6	9	12	15	18	21	24	27
0.8	0.7881	0.7910	0.7939	0.7967	0.7995	0.8023	0.8051	0.8078	0.8106	0.8133	3	5	8	11	14	16	19	22	25
0.9	0.8159	0.8186	0.8212	0.8238	0.8264	0.8289	0.8315	0.8340	0.8365	0.8389	3	5	8	10	13	15	18	20	23
1.0	0.8413	0.8438	0.8461	0.8485	0.8508	0.8531	0.8554	0.8577	0.8599	0.8621	2	5	7	9	12	14	16	19	21
1.1	0.8643	0.8665	0.8686	0.8708	0.8729	0.8749	0.8770	0.8790	0.8810	0.8830	2	4	6	8	10	12	14	16	18
1.2	0.8849	0.8869	0.8888	0.8907	0.8925	0.8944	0.8962	0.8980	0.8997	0.9015	2	4	6	7	9	11	13	15	17
1.3	0.9032	0.9049	0.9066	0.9082	0.9099	0.9115	0.9131	0.9147	0.9162	0.9177	2	3	5	6	8	10	11	13	14
1.4	0.9192	0.9207	0.9222	0.9236	0.9251	0.9265	0.9279	0.9292	0.9306	0.9319	1	3	4	6	7	8	10	11	13
1.5	0.9332	0.9345	0.9357	0.9370	0.9382	0.9394	0.9406	0.9418	0.9429	0.9441	1	2	4	5	6	7	8	10	11
1.6	0.9452	0.9463	0.9474	0.9484	0.9495	0.9505	0.9515	0.9525	0.9535	0.9545	1	2	3	4	5	6	7	8	9
1.7	0.9554	0.9564	0.9573	0.9582	0.9591	0.9599	0.9608	0.9616	0.9625	0.9633	1	2	3	4	4	5	6	7	8
1.8	0.9641	0.9649	0.9656	0.9664	0.9671	0.9678	0.9686	0.9693	0.9699	0.9706	1	1	2	3	4	4	5	6	6
1.9	0.9713	0.9719	0.9726	0.9732	0.9738	0.9744	0.9750	0.9756	0.9761	0.9767	1	1	2	2	3	4	4	5	5
2.0	0.9772	0.9778	0.9783	0.9788	0.9793	0.9798	0.9803	0.9808	0.9812	0.9817	0	1	1	2	2	3	3	4	4
2.1	0.9821	0.9826	0.9830	0.9834	0.9838	0.9842	0.9846	0.9850	0.9854	0.9857	0	1	1	2	2	2	3	3	4
2.2	0.9861	0.9864	0.9868	0.9871	0.9875	0.9878	0.9881	0.9884	0.9887	0.9890	0	1	1	1	2	2	2	3	3
2.3	0.9893	0.9896	0.9898	0.9901	0.9904	0.9906	0.9909	0.9911	0.9913	0.9916	0	1	1	1	1	2	2	2	2
2.4	0.9918	0.9920	0.9922	0.9925	0.9927	0.9929	0.9931	0.9932	0.9934	0.9936	0	0	1	1	1	1	1	2	2
2.5	0.9938	0.9940	0.9941	0.9943	0.9945	0.9946	0.9948	0.9949	0.9951	0.9952	0	0	0	1	1	1	1	1	1
2.6	0.9953	0.9955	0.9956	0.9957	0.9959	0.9960	0.9961	0.9962	0.9963	0.9964	0	0	0	0	1	1	1	1	1
2.7	0.9965	0.9966	0.9967	0.9968	0.9969	0.9970	0.9971	0.9972	0.9973	0.9974	0	0	0	0	0	1	1	1	1
2.8	0.9974	0.9975	0.9976	0.9977	0.9977	0.9978	0.9979	0.9979	0.9980	0.9981	0	0	0	0	0	0	0	1	1
2.9	0.9981	0.9982	0.9982	0.9983	0.9984	0.9984	0.9985	0.9985	0.9986	0.9986	0	0	0	0	0	0	0	0	0

Critical values for the normal distribution

If Z has a normal distribution with mean 0 and variance 1, then, for each value of p , the table gives the value of z such that

$$P(Z \leq z) = p.$$

p	0.75	0.90	0.95	0.975	0.99	0.995	0.9975	0.999	0.9995
z	0.674	1.282	1.645	1.960	2.326	2.576	2.807	3.090	3.291

Cambridge International AS & A Level

CANDIDATE
NAME

--

CENTRE
NUMBER

--	--	--	--	--

CANDIDATE
NUMBER

--	--	--	--

MATHEMATICS

9709/12

Paper 1 Pure Mathematics 1

February/March 2020

1 hour 50 minutes

You must answer on the question paper.

You will need: List of formulae (MF19)

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- If additional space is needed, you should use the lined page at the end of this booklet; the question number or numbers must be clearly shown.
- You should use a calculator where appropriate.
- You must show all necessary working clearly; no marks will be given for unsupported answers from a calculator.
- Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place for angles in degrees, unless a different level of accuracy is specified in the question.

INFORMATION

- The total mark for this paper is 75.
- The number of marks for each question or part question is shown in brackets [].

This document has **20** pages. Blank pages are indicated.

- 1** The function f is defined by $f(x) = \frac{1}{3x+2} + x^2$ for $x < -1$.

Determine whether f is an increasing function, a decreasing function or neither.

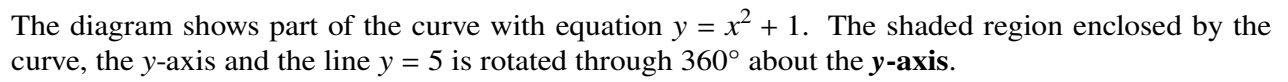
[3]

This image shows a single page of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

- 2** The graph of $y = f(x)$ is transformed to the graph of $y = 1 + f(\frac{1}{2}x)$.

Describe fully the two single transformations which have been combined to give the resulting transformation. [4]

[illegible]



[4]

This image shows a full page of white paper with horizontal dashed lines, typical of primary school handwriting practice paper. The lines are evenly spaced and run across the entire width of the page. There are no margins, text, or other markings present.

- 4** A curve has equation $y = x^2 - 2x - 3$. A point is moving along the curve in such a way that at P the y -coordinate is increasing at 4 units per second and the x -coordinate is increasing at 6 units per second.

Find the x -coordinate of P .

[4]

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

5 Solve the equation

$$\frac{\tan \theta + 3 \sin \theta + 2}{\tan \theta - 3 \sin \theta + 1} = 2$$

for $0^\circ \leq \theta \leq 90^\circ$.

[5]

This image shows a full page of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page, typical of notebook or legal stationery. There are no margins, text, or other markings on the page.

- 6 The coefficient of $\frac{1}{x}$ in the expansion of $\left(2x + \frac{a}{x^2}\right)^5$ is 720.

(a) Find the possible values of the constant a . [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(b) Hence find the coefficient of $\frac{1}{x^7}$ in the expansion. [2]

.....

.....

.....

.....

.....

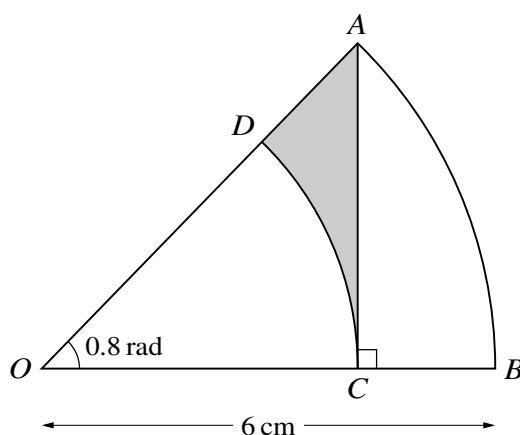
.....

.....

.....

.....

.....



The diagram shows a sector AOB which is part of a circle with centre O and radius 6 cm and with angle $AOB = 0.8$ radians. The point C on OB is such that AC is perpendicular to OB . The arc CD is part of a circle with centre O , where D lies on OA .

Find the area of the shaded region.

[6]

This image shows a full page of white paper with horizontal dashed lines, typical of primary-ruled notebook paper. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings present.

- 8 A woman's basic salary for her first year with a particular company is \$30 000 and at the end of the year she also gets a bonus of \$600.

- (a) For her first year, express her bonus as a percentage of her basic salary. [1]

.....

.....

.....

.....

At the end of each complete year, the woman's basic salary will increase by 3% and her bonus will increase by \$100.

- (b) Express the bonus she will be paid at the end of her 24th year as a percentage of the basic salary paid during that year. [5]

This image shows a full page of white paper with horizontal dashed lines, typical of primary school writing paper. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

- 9 (a) Express $2x^2 + 12x + 11$ in the form $2(x + a)^2 + b$, where a and b are constants. [2]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

The function f is defined by $f(x) = 2x^2 + 12x + 11$ for $x \leq -4$.

- (b) Find an expression for $f^{-1}(x)$ and state the domain of f^{-1} . [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

The function g is defined by $g(x) = 2x - 3$ for $x \leq k$.

- (c) For the case where $k = -1$, solve the equation $fg(x) = 193$. [2]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- (d) State the largest value of k possible for the composition fg to be defined. [1]

.....

.....

.....

.....

.....

- 10** The gradient of a curve at the point (x, y) is given by $\frac{dy}{dx} = 2(x + 3)^{\frac{1}{2}} - x$. The curve has a stationary point at $(a, 14)$, where a is a positive constant.

(a) Find the value of a . [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(b) Determine the nature of the stationary point. [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(c) Find the equation of the curve.

[4]

[illegible]

- 11 (a)** Solve the equation $3 \tan^2 x - 5 \tan x - 2 = 0$ for $0^\circ \leq x \leq 180^\circ$. [4]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- (b)** Find the set of values of k for which the equation $3 \tan^2 x - 5 \tan x + k = 0$ has no solutions. [2]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- (c) For the equation $3 \tan^2 x - 5 \tan x + k = 0$, state the value of k for which there are three solutions in the interval $0^\circ \leq x \leq 180^\circ$, and find these solutions. [3]

This image shows a full page of a handwriting practice worksheet. It consists of approximately 20 horizontal rows. Each row is defined by two parallel dotted lines, creating a series of uniform gaps for letter height. The entire page is otherwise blank, with no margins, text, or other markings.

12 A diameter of a circle C_1 has end-points at $(-3, -5)$ and $(7, 3)$.

(a) Find an equation of the circle C_1 .

[3]

.....

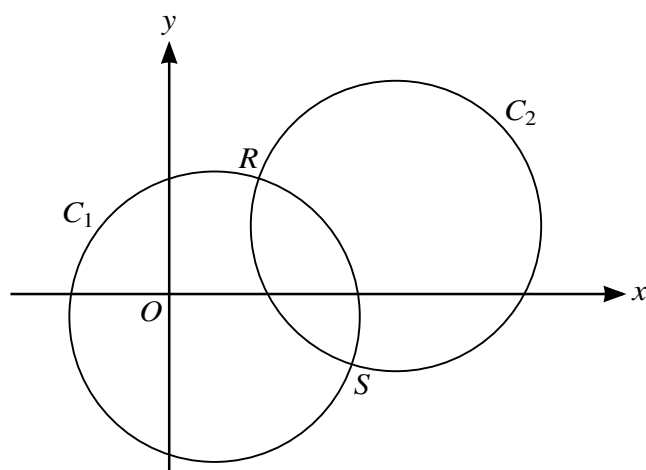
.....

.....

.....

.....

.....



The circle C_1 is translated by $\begin{pmatrix} 8 \\ 4 \end{pmatrix}$ to give circle C_2 , as shown in the diagram.

(b) Find an equation of the circle C_2 .

[2]

.....

.....

.....

.....

.....

.....

.....

.....

.....

The two circles intersect at points R and S .

- (c) Show that the equation of the line RS is $y = -2x + 13$. [4]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- (d) Hence show that the x -coordinates of R and S satisfy the equation $5x^2 - 60x + 159 = 0$. [2]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

Cambridge International AS & A Level

CANDIDATE
NAME

--

CENTRE
NUMBER

--	--	--	--	--

CANDIDATE
NUMBER

--	--	--	--

MATHEMATICS

9709/11

Paper 1 Pure Mathematics 1

May/June 2020

1 hour 50 minutes

You must answer on the question paper.

You will need: List of formulae (MF19)

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- If additional space is needed, you should use the lined page at the end of this booklet; the question number or numbers must be clearly shown.
- You should use a calculator where appropriate.
- You must show all necessary working clearly; no marks will be given for unsupported answers from a calculator.
- Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place for angles in degrees, unless a different level of accuracy is specified in the question.

INFORMATION

- The total mark for this paper is 75.
- The number of marks for each question or part question is shown in brackets [].

This document has **20** pages. Blank pages are indicated.

- 1 The sum of the first nine terms of an arithmetic progression is 117. The sum of the next four terms is 91.

Find the first term and the common difference of the progression.

[4]

This image shows a single page of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page, typical of notebook or legal stationery. There are no margins, text, or other markings on the page.

- 2** The coefficient of $\frac{1}{x}$ in the expansion of $\left(kx + \frac{1}{x}\right)^5 + \left(1 - \frac{2}{x}\right)^8$ is 74.

Find the value of the positive constant k .

[5]

[illegible]

- 3** Each year the selling price of a diamond necklace increases by 5% of the price the year before. The selling price of the necklace in the year 2000 was \$36 000.

- (a)** Write down an expression for the selling price of the necklace n years later and hence find the selling price in 2008. [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- (b)** The company that makes the necklace only sells one each year. Find the total amount of money obtained in the ten-year period starting in the year 2000. [2]

.....

.....

.....

.....

.....

.....

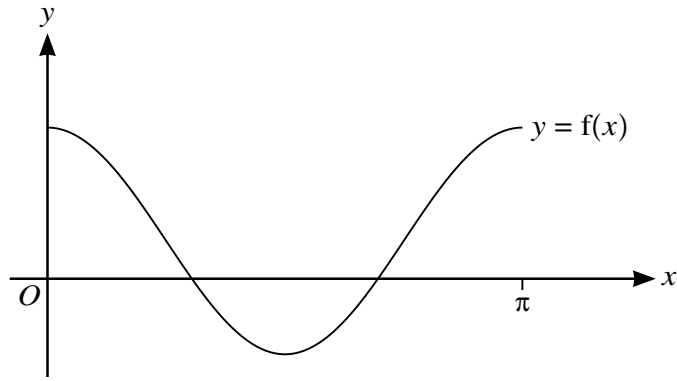
.....

.....

.....

.....

4



The diagram shows the graph of $y = f(x)$, where $f(x) = \frac{3}{2} \cos 2x + \frac{1}{2}$ for $0 \leq x \leq \pi$.

- (a) State the range of f . [2]

.....

.....

.....

A function g is such that $g(x) = f(x) + k$, where k is a positive constant. The x -axis is a tangent to the curve $y = g(x)$.

- (b) State the value of k and hence describe fully the transformation that maps the curve $y = f(x)$ on to $y = g(x)$. [2]

.....

.....

.....

.....

.....

.....

- (c) State the equation of the curve which is the reflection of $y = f(x)$ in the x -axis. Give your answer in the form $y = a \cos 2x + b$, where a and b are constants. [1]

.....

.....

.....

.....

- 5 The equation of a line is $y = mx + c$, where m and c are constants, and the equation of a curve is $xy = 16$.

(a) Given that the line is a tangent to the curve, express m in terms of c . [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(b) Given instead that $m = -4$, find the set of values of c for which the line intersects the curve at two distinct points. [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

6 Functions f and g are defined for $x \in \mathbb{R}$ by

$$\begin{aligned} f &: x \mapsto \frac{1}{2}x - a, \\ g &: x \mapsto 3x + b, \end{aligned}$$

where a and b are constants.

(a) Given that $gg(2) = 10$ and $f^{-1}(2) = 14$, find the values of a and b . [4]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(b) Using these values of a and b , find an expression for $gf(x)$ in the form $cx + d$, where c and d are constants. [2]

.....

.....

.....

.....

.....

.....

.....

.....

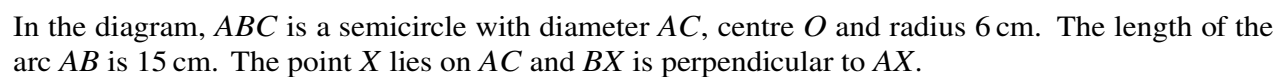
.....

.....

7 (a) Prove the identity $\frac{1 + \sin \theta}{\cos \theta} + \frac{\cos \theta}{1 + \sin \theta} \equiv \frac{2}{\cos \theta}$. [3]

[illegible]

[illegible]



[6]

[illegible]

9 The equation of a curve is $y = (3 - 2x)^3 + 24x$.

(a) Find expressions for $\frac{dy}{dx}$ and $\frac{d^2y}{dx^2}$. [4]

[illegible]

(b) Find the coordinates of each of the stationary points on the curve.

[3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(c) Determine the nature of each stationary point.

[2]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- 10** The coordinates of the points A and B are $(-1, -2)$ and $(7, 4)$ respectively.

(a) Find the equation of the circle, C , for which AB is a diameter.

[4]

This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.

- (b) Find the equation of the tangent, T , to circle C at the point B . [4]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- (c) Find the equation of the circle which is the reflection of circle C in the line T . [3]

.....

.....

.....

.....

.....

.....

.....

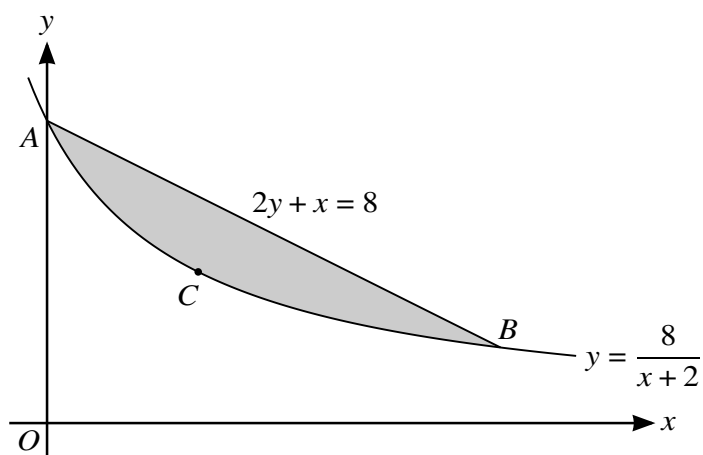
.....

.....

.....

.....

.....



(a) Find, by calculation, the coordinates of A , B and C . [6]

This image shows a full page of white paper with horizontal dotted lines, typical of primary school handwriting practice paper. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

- (b)** Find the volume generated when the shaded region, bounded by the curve and the line, is rotated through 360° about the x -axis. [6]

[illegible]

Cambridge International AS & A Level

CANDIDATE
NAME

--

CENTRE
NUMBER

--	--	--	--	--

CANDIDATE
NUMBER

--	--	--	--

MATHEMATICS

9709/12

Paper 1 Pure Mathematics 1

May/June 2020

1 hour 50 minutes

You must answer on the question paper.

You will need: List of formulae (MF19)

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- If additional space is needed, you should use the lined page at the end of this booklet; the question number or numbers must be clearly shown.
- You should use a calculator where appropriate.
- You must show all necessary working clearly; no marks will be given for unsupported answers from a calculator.
- Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place for angles in degrees, unless a different level of accuracy is specified in the question.

INFORMATION

- The total mark for this paper is 75.
- The number of marks for each question or part question is shown in brackets [].

This document has **16** pages. Blank pages are indicated.

- 1 (a)** Find the coefficient of x^2 in the expansion of $\left(x - \frac{2}{x}\right)^6$. [2]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- (b)** Find the coefficient of x^2 in the expansion of $(2 + 3x^2)\left(x - \frac{2}{x}\right)^6$. [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- 2 (a) Express the equation $3 \cos \theta = 8 \tan \theta$ as a quadratic equation in $\sin \theta$. [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- (b) Hence find the acute angle, in degrees, for which $3 \cos \theta = 8 \tan \theta$. [2]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- 3** A weather balloon in the shape of a sphere is being inflated by a pump. The volume of the balloon is increasing at a constant rate of 600 cm^3 per second. The balloon was empty at the start of pumping.

(a) Find the radius of the balloon after 30 seconds. [2]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(b) Find the rate of increase of the radius after 30 seconds. [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- 4** The n th term of an arithmetic progression is $\frac{1}{2}(3n - 15)$.

Find the value of n for which the sum of the first n terms is 84.

[5]

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

5 The function f is defined for $x \in \mathbb{R}$ by

$$f : x \mapsto a - 2x,$$

where a is a constant.

(a) Express $ff(x)$ and $f^{-1}(x)$ in terms of a and x . [4]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(b) Given that $ff(x) = f^{-1}(x)$, find x in terms of a . [2]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

6 The equation of a curve is $y = 2x^2 + kx + k - 1$, where k is a constant.

- (a)** Given that the line $y = 2x + 3$ is a tangent to the curve, find the value of k . [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

It is now given that $k = 2$.

- (b)** Express the equation of the curve in the form $y = 2(x + a)^2 + b$, where a and b are constants, and hence state the coordinates of the vertex of the curve. [3]

.....

.....

.....

.....

.....

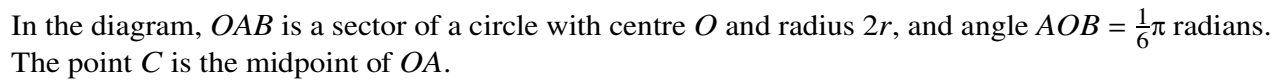
.....

.....

.....

.....

.....



- [illegible]

(b) Find the exact perimeter of the shaded region.

[2]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(c) Find the exact area of the shaded region.

[3]

.....

.....

.....

.....

.....

.....

.....

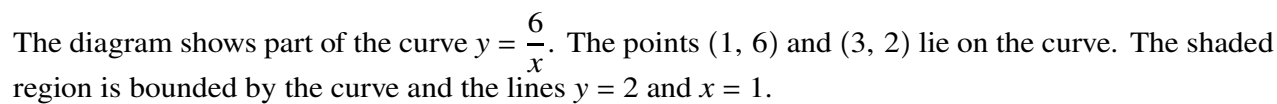
.....

.....

.....

.....

.....



- [illegible]

- (b)** The tangent to the curve at a point X is parallel to the line $y + 2x = 0$. Show that X lies on the line $y = 2x$. [3]

[illegible]

- 9 Functions f and g are such that

$$f(x) = 2 - 3 \sin 2x \quad \text{for } 0 \leq x \leq \pi,$$

$$g(x) = -2f(x) \quad \text{for } 0 \leq x \leq \pi.$$

- (a) State the ranges of f and g .

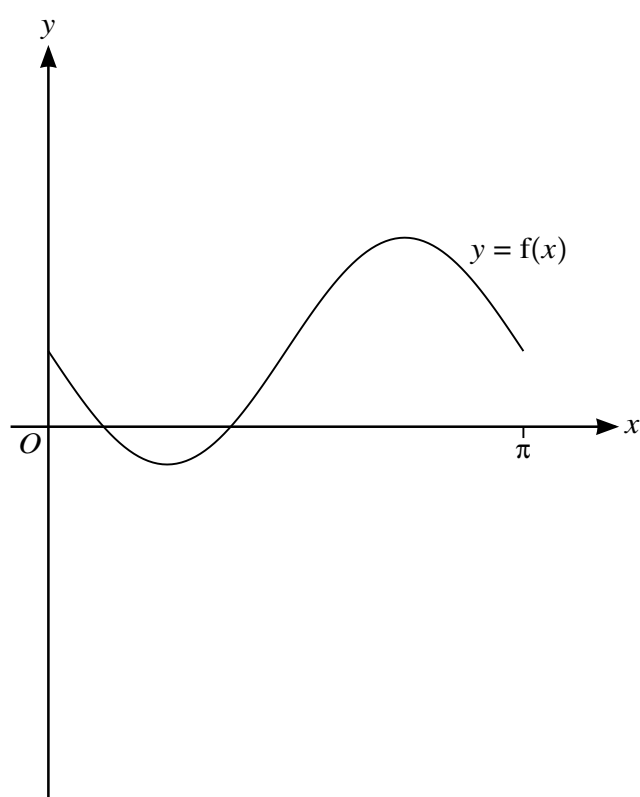
[3]

.....

.....

.....

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



- (b) Sketch, on this diagram, the graph of $y = g(x)$.

[2]

The function h is such that

$$h(x) = g(x + \pi) \quad \text{for } -\pi \leq x \leq 0.$$

- (c) Describe fully a sequence of transformations that maps the curve $y = f(x)$ on to $y = h(x)$.

[3]

.....

.....

.....

10 The equation of a curve is $y = 54x - (2x - 7)^3$.

- (a)** Find $\frac{dy}{dx}$ and $\frac{d^2y}{dx^2}$. [4]

.....

.....

.....

.....

.....

.....

.....

.....

- (b)** Find the coordinates of each of the stationary points on the curve. [3]

.....

.....

.....

.....

.....

.....

.....

.....

- (c)** Determine the nature of each of the stationary points. [2]

.....

.....

.....

.....

.....

11 The equation of a circle with centre C is $x^2 + y^2 - 8x + 4y - 5 = 0$.

- (a)** Find the radius of the circle and the coordinates of C . [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

The point $P(1, 2)$ lies on the circle.

- (b)** Show that the equation of the tangent to the circle at P is $4y = 3x + 5$. [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

The point Q also lies on the circle and PQ is parallel to the x -axis.

- (c) Write down the coordinates of Q . [2]

.....

.....

.....

.....

.....

The tangents to the circle at P and Q meet at T .

- (d) Find the coordinates of T . [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

Cambridge International AS & A Level

CANDIDATE
NAME

--

CENTRE
NUMBER

--	--	--	--	--

CANDIDATE
NUMBER

--	--	--	--

MATHEMATICS

9709/13

Paper 1 Pure Mathematics 1

May/June 2020

1 hour 50 minutes

You must answer on the question paper.

You will need: List of formulae (MF19)

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- If additional space is needed, you should use the lined page at the end of this booklet; the question number or numbers must be clearly shown.
- You should use a calculator where appropriate.
- You must show all necessary working clearly; no marks will be given for unsupported answers from a calculator.
- Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place for angles in degrees, unless a different level of accuracy is specified in the question.

INFORMATION

- The total mark for this paper is 75.
- The number of marks for each question or part question is shown in brackets [].

This document has **20** pages. Blank pages are indicated.

- 1** Find the set of values of m for which the line with equation $y = mx + 1$ and the curve with equation $y = 3x^2 + 2x + 4$ intersect at two distinct points. [4]

[illegible]

- 2** The equation of a curve is such that $\frac{dy}{dx} = 3x^{\frac{1}{2}} - 3x^{-\frac{1}{2}}$. It is given that the point (4, 7) lies on the curve.

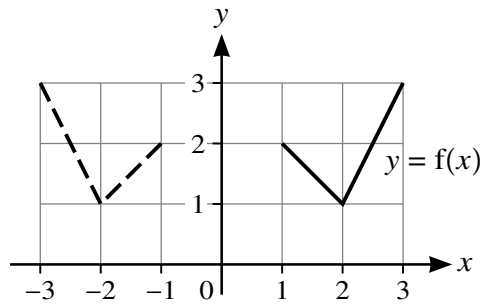
Find the equation of the curve.

[4]

[illegible]

- 3 In each of parts (a), (b) and (c), the graph shown with solid lines has equation $y = f(x)$. The graph shown with broken lines is a transformation of $y = f(x)$.

(a)

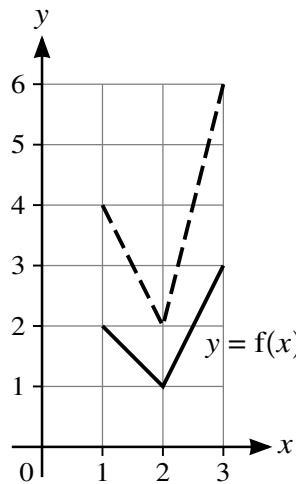


State, in terms of f , the equation of the graph shown with broken lines.

[1]

.....

(b)

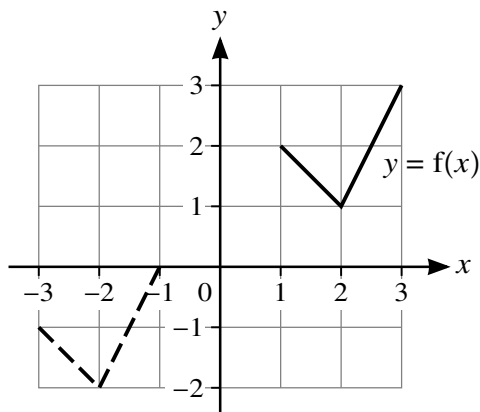


State, in terms of f , the equation of the graph shown with broken lines.

[1]

.....

(c)



State, in terms of f , the equation of the graph shown with broken lines.

[2]

.....

- 4 (a) Expand $(1 + a)^5$ in ascending powers of a up to and including the term in a^3 . [1]

.....

.....

.....

.....

.....

.....

.....

.....

- (b) Hence expand $[1 + (x + x^2)]^5$ in ascending powers of x up to and including the term in x^3 , simplifying your answer. [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

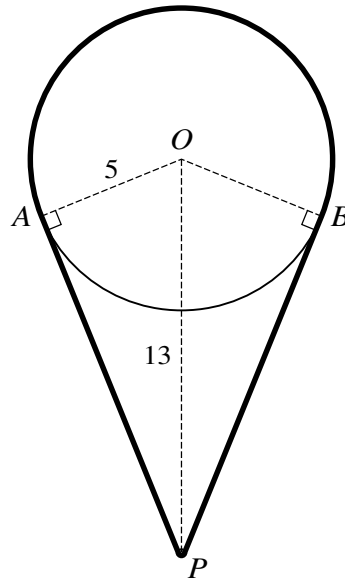
.....

.....

.....

.....

.....



The diagram shows a cord going around a pulley and a pin. The pulley is modelled as a circle with centre O and radius 5 cm. The thickness of the cord and the size of the pin P can be neglected. The pin is situated 13 cm vertically below O . Points A and B are on the circumference of the circle such that AP and BP are tangents to the circle. The cord passes over the major arc AB of the circle and under the pin such that the cord is taut.

Calculate the length of the cord.

[6]

[illegible]

- 6 A point P is moving along a curve in such a way that the x -coordinate of P is increasing at a constant rate of 2 units per minute. The equation of the curve is $y = (5x - 1)^{\frac{1}{2}}$.

(a) Find the rate at which the y -coordinate is increasing when $x = 1$. [4]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

© UCLES 2020

7 (a) Show that $\frac{\tan \theta}{1 + \cos \theta} + \frac{\tan \theta}{1 - \cos \theta} \equiv \frac{2}{\sin \theta \cos \theta}$. [4]

[illegible]

© UCLES 2020

- 8** The first term of a progression is $\sin^2 \theta$, where $0 < \theta < \frac{1}{2}\pi$. The second term of the progression is $\sin^2 \theta \cos^2 \theta$.
- (a)** Given that the progression is geometric, find the sum to infinity. [3]

[illegible]

It is now given instead that the progression is arithmetic.

- (b) (i) Find the common difference of the progression in terms of $\sin \theta$. [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- (ii) Find the sum of the first 16 terms when $\theta = \frac{1}{3}\pi$. [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- 9 The functions f and g are defined by

$$f(x) = x^2 - 4x + 3 \quad \text{for } x > c, \text{ where } c \text{ is a constant,}$$

$$g(x) = \frac{1}{x+1} \quad \text{for } x > -1.$$

- (a) Express $f(x)$ in the form $(x - a)^2 + b$. [2]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

It is given that f is a one-one function.

- (b) State the smallest possible value of c . [1]

.....

.....

.....

.....

.....

.....

.....

.....

.....

It is now given that $c = 5$.

- (c) Find an expression for $f^{-1}(x)$ and state the domain of f^{-1} . [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- (d) Find an expression for $gf(x)$ and state the range of gf . [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- 10 (a)** The coordinates of two points A and B are $(-7, 3)$ and $(5, 11)$ respectively.

Show that the equation of the perpendicular bisector of AB is $3x + 2y = 11$.

[4]

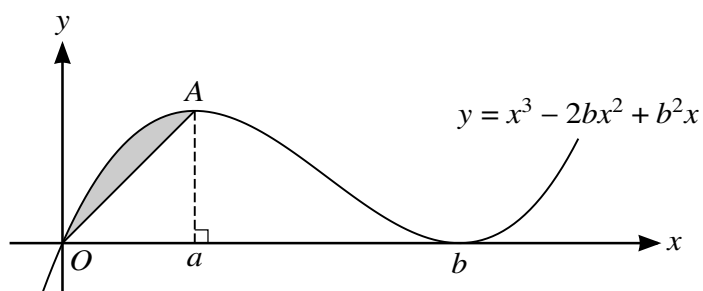
[illegible]

- (b)** A circle passes through A and B and its centre lies on the line $12x - 5y = 70$.

Find an equation of the circle.

[5]

[illegible]



The diagram shows part of the curve with equation $y = x^3 - 2bx^2 + b^2x$ and the line OA , where A is the maximum point on the curve. The x -coordinate of A is a and the curve has a minimum point at $(b, 0)$, where a and b are positive constants.

- (a) Show that $b = 3a$. [4]

This image shows a full page of a handwriting practice worksheet. It consists of multiple sets of three horizontal dashed lines, providing a guide for letter height and placement. The lines are evenly spaced across the entire page, which is otherwise blank white space.

- (b)** Show that the area of the shaded region between the line and the curve is ka^4 , where k is a fraction to be found. [7]

This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.

Cambridge International AS & A Level

CANDIDATE
NAME

--

CENTRE
NUMBER

--	--	--	--	--

CANDIDATE
NUMBER

--	--	--	--

MATHEMATICS

9709/11

Paper 1 Pure Mathematics 1

October/November 2020

1 hour 50 minutes

You must answer on the question paper.

You will need: List of formulae (MF19)

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- If additional space is needed, you should use the lined page at the end of this booklet; the question number or numbers must be clearly shown.
- You should use a calculator where appropriate.
- You must show all necessary working clearly; no marks will be given for unsupported answers from a calculator.
- Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place for angles in degrees, unless a different level of accuracy is specified in the question.

INFORMATION

- The total mark for this paper is 75.
- The number of marks for each question or part question is shown in brackets [].

This document has **20** pages. Blank pages are indicated.

- 1** Find the set of values of m for which the line with equation $y = mx - 3$ and the curve with equation $y = 2x^2 + 5$ do not meet. [3]

This image shows a single page of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

- 2** The equation of a curve is such that $\frac{dy}{dx} = \frac{1}{(x-3)^2} + x$. It is given that the curve passes through the point (2, 7).

Find the equation of the curve.

[4]

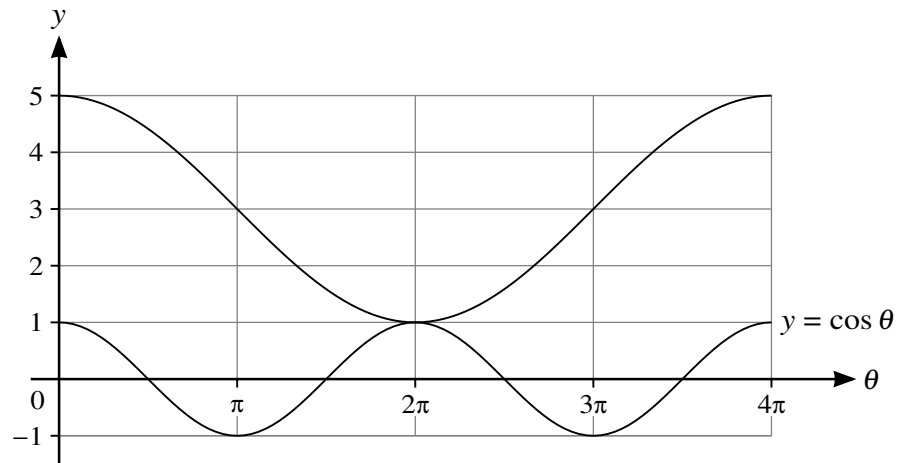
This image shows a single page of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page, typical of notebook or legal stationery. There are no margins, text, or other markings on the page.

- 3** Air is being pumped into a balloon in the shape of a sphere so that its volume is increasing at a constant rate of $50 \text{ cm}^3 \text{ s}^{-1}$.

Find the rate at which the radius of the balloon is increasing when the radius is 10 cm. [3]

[illegible]

4



In the diagram, the lower curve has equation $y = \cos \theta$. The upper curve shows the result of applying a combination of transformations to $y = \cos \theta$.

Find, in terms of a cosine function, the equation of the upper curve.

[3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

5 In the expansion of $\left(2x^2 + \frac{a}{x}\right)^6$, the coefficients of x^6 and x^3 are equal.

(a) Find the value of the non-zero constant a .

[4]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(b) Find the coefficient of x^6 in the expansion of $(1 - x^3)\left(2x^2 + \frac{a}{x}\right)^6$.

[1]

.....

.....

.....

.....

.....

- 6** The equation of a curve is $y = 2 + \sqrt{25 - x^2}$.

Find the coordinates of the point on the curve at which the gradient is $\frac{4}{3}$. [5]

[illegible]

7 (a) Show that $\frac{\sin \theta}{1 - \sin \theta} - \frac{\sin \theta}{1 + \sin \theta} \equiv 2 \tan^2 \theta$. [3]

This image shows a full page of a document template. It consists of approximately 28 horizontal dotted lines spaced evenly across the page, providing a guide for handwriting or typing. The lines are light gray and extend from the left margin to the right edge of the page. There is no text or other content on the page.

(b) Hence solve the equation $\frac{\sin \theta}{1 - \sin \theta} - \frac{\sin \theta}{1 + \sin \theta} = 8$, for $0^\circ < \theta < 180^\circ$. [3]

- 8** A geometric progression has first term a , common ratio r and sum to infinity S . A second geometric progression has first term a , common ratio R and sum to infinity $2S$.

(a) Show that $r = 2R - 1$.

[3]

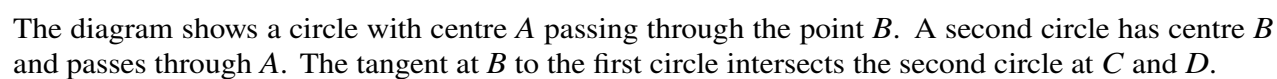
This image shows a full page of a handwriting practice worksheet. It consists of multiple sets of three horizontal dotted lines, providing a guide for letter height and placement. The lines are evenly spaced across the entire page, leaving ample room for writing practice. There is no text or other markings on the page.

It is now given that the 3rd term of the first progression is equal to the 2nd term of the second progression.

(b) Express S in terms of a .

[4]

[illegible]



(a) Find the equation of the tangent CBD . [2]

[illegible]

- (b) Find an equation of the circle with centre B . [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- (c) Find, by calculation, the x -coordinates of C and D . [3]

.....

.....

.....

.....

.....

.....

.....

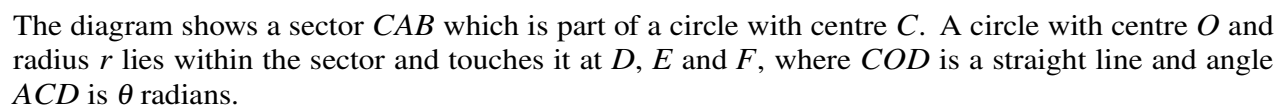
.....

.....

.....

.....

.....



- [illegible]

It is now given that $r = 4$ and $\theta = \frac{1}{6}\pi$.

- (b) Find the perimeter of sector CAB in terms of π . [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- (c) Find the area of the shaded region in terms of π and $\sqrt{3}$. [4]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

11 The functions f and g are defined by

$$\begin{aligned} f(x) &= x^2 + 3 \quad \text{for } x > 0, \\ g(x) &= 2x + 1 \quad \text{for } x > -\frac{1}{2}. \end{aligned}$$

(a) Find an expression for $fg(x)$. [1]

.....

.....

.....

.....

.....

(b) Find an expression for $(fg)^{-1}(x)$ and state the domain of $(fg)^{-1}$. [4]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

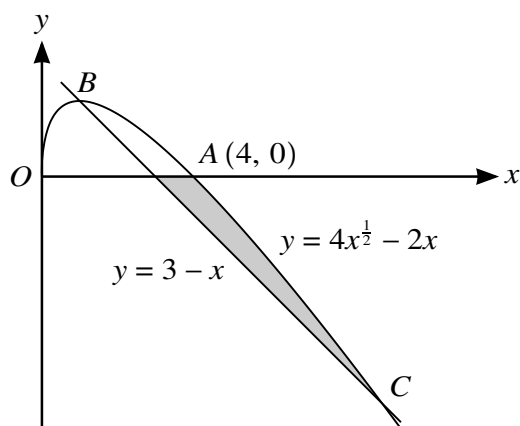
.....

(c) Solve the equation $fg(x) - 3 = gf(x)$.

[4]

[illegible]

12



The diagram shows a curve with equation $y = 4x^{\frac{1}{2}} - 2x$ for $x \geq 0$, and a straight line with equation $y = 3 - x$. The curve crosses the x -axis at $A(4, 0)$ and crosses the straight line at B and C .

- (a) Find, by calculation, the x -coordinates of B and C . [4]

.....

.....

.....

.....

.....

.....

.....

.....

.....

- (b) Show that B is a stationary point on the curve. [2]

.....

.....

.....

.....

.....

.....

9709/11/O/N/20

Cambridge International AS & A Level

CANDIDATE
NAME

--

CENTRE
NUMBER

--	--	--	--	--

CANDIDATE
NUMBER

--	--	--	--

MATHEMATICS

9709/12

Paper 1 Pure Mathematics 1

October/November 2020

1 hour 50 minutes

You must answer on the question paper.

You will need: List of formulae (MF19)

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- If additional space is needed, you should use the lined page at the end of this booklet; the question number or numbers must be clearly shown.
- You should use a calculator where appropriate.
- You must show all necessary working clearly; no marks will be given for unsupported answers from a calculator.
- Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place for angles in degrees, unless a different level of accuracy is specified in the question.

INFORMATION

- The total mark for this paper is 75.
- The number of marks for each question or part question is shown in brackets [].

This document has **20** pages. Blank pages are indicated.

BLANK PAGE

- 1** The coefficient of x^3 in the expansion of $(1 + kx)(1 - 2x)^5$ is 20.

Find the value of the constant k .

[4]

[illegible]

- 2** The first, second and third terms of a geometric progression are $2p + 6$, $-2p$ and $p + 2$ respectively, where p is positive.

Find the sum to infinity of the progression.

[5]

This image shows a single page of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

- 3** The equation of a curve is $y = 2x^2 + m(2x + 1)$, where m is a constant, and the equation of a line is $y = 6x + 4$.

Show that, for all values of m , the line intersects the curve at two distinct points. [5]

This image shows a full page of white paper with horizontal ruling lines. The lines are evenly spaced and extend across the width of the page, typical of notebook or legal stationery. There are no margins, text, or other markings on the page.

- 4 The sum, S_n , of the first n terms of an arithmetic progression is given by

$$S_n = n^2 + 4n.$$

The k th term in the progression is greater than 200.

Find the smallest possible value of k .

[5]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

5 Functions f and g are defined by

$$f(x) = 4x - 2, \quad \text{for } x \in \mathbb{R},$$

$$g(x) = \frac{4}{x+1}, \quad \text{for } x \in \mathbb{R}, x \neq -1.$$

(a) Find the value of $fg(7)$.

[1]

.....

.....

.....

.....

.....

(b) Find the values of x for which $f^{-1}(x) = g^{-1}(x)$.

[5]

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

- 6 (a)** Prove the identity $\left(\frac{1}{\cos x} - \tan x\right)\left(\frac{1}{\sin x} + 1\right) \equiv \frac{1}{\tan x}$. [4]

[illegible]

- (b)** Hence solve the equation $\left(\frac{1}{\cos x} - \tan x\right)\left(\frac{1}{\sin x} + 1\right) = 2 \tan^2 x$ for $0^\circ \leq x \leq 180^\circ$. [2]

[illegible]

7 The point (4, 7) lies on the curve $y = f(x)$ and it is given that $f'(x) = 6x^{-\frac{1}{2}} - 4x^{-\frac{3}{2}}$.

- (a) A point moves along the curve in such a way that the x -coordinate is increasing at a constant rate of 0.12 units per second.

Find the rate of increase of the y -coordinate when $x = 4$.

[3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- (b) Find the equation of the curve.

[4]

.....

.....

.....

.....

.....

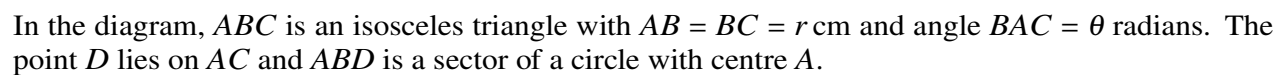
.....

.....

.....

.....

.....



- [illegible]

© UCLES 2020

- 9 A circle has centre at the point $B(5, 1)$. The point $A(-1, -2)$ lies on the circle.

(a) Find the equation of the circle. [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

Point C is such that AC is a diameter of the circle. Point D has coordinates $(5, 16)$.

(b) Show that DC is a tangent to the circle. [4]

.....

.....

.....

.....

.....

.....

.....

.....

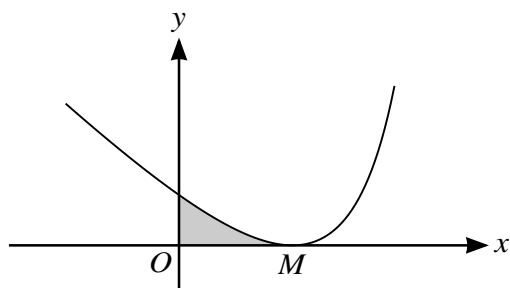
.....

.....

.....

[2]

[illegible]



(a) Find expressions for $\frac{dy}{dx}$, $\frac{d^2y}{dx^2}$ and $\int y dx$. [6]

[illegible]

- (b) Find, by calculation, the x -coordinate of M . [2]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- (c) Find the area of the shaded region bounded by the curve and the coordinate axes. [2]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

11 A curve has equation $y = 3 \cos 2x + 2$ for $0 \leq x \leq \pi$.

(a) State the greatest and least values of y . [2]

.....

.....

.....

.....

(b) Sketch the graph of $y = 3 \cos 2x + 2$ for $0 \leq x \leq \pi$. [2]

(c) By considering the straight line $y = kx$, where k is a constant, state the number of solutions of the equation $3 \cos 2x + 2 = kx$ for $0 \leq x \leq \pi$ in each of the following cases.

(i) $k = -3$ [1]

.....

.....

(ii) $k = 1$ [1]

.....

.....

(iii) $k = 3$ [1]

.....

.....

Functions f , g and h are defined for $x \in \mathbb{R}$ by

$$f(x) = 3 \cos 2x + 2,$$

$$g(x) = f(2x) + 4,$$

$$h(x) = 2f\left(x + \frac{1}{2}\pi\right).$$

- (d) Describe fully a sequence of transformations that maps the graph of $y = f(x)$ on to $y = g(x)$. [2]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- (e) Describe fully a sequence of transformations that maps the graph of $y = f(x)$ on to $y = h(x)$. [2]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

Cambridge International AS & A Level

CANDIDATE
NAME

--

CENTRE
NUMBER

--	--	--	--	--

CANDIDATE
NUMBER

--	--	--	--

MATHEMATICS

9709/13

Paper 1 Pure Mathematics 1

October/November 2020

1 hour 50 minutes

You must answer on the question paper.

You will need: List of formulae (MF19)

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- If additional space is needed, you should use the lined page at the end of this booklet; the question number or numbers must be clearly shown.
- You should use a calculator where appropriate.
- You must show all necessary working clearly; no marks will be given for unsupported answers from a calculator.
- Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place for angles in degrees, unless a different level of accuracy is specified in the question.

INFORMATION

- The total mark for this paper is 75.
- The number of marks for each question or part question is shown in brackets [].

This document has **20** pages. Blank pages are indicated.

- 1 (a)** Express $x^2 + 6x + 5$ in the form $(x + a)^2 + b$, where a and b are constants. [2]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- (b)** The curve with equation $y = x^2$ is transformed to the curve with equation $y = x^2 + 6x + 5$.

Describe fully the transformation(s) involved. [2]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- 2 The function f is defined by $f(x) = \frac{2}{(x+2)^2}$ for $x > -2$.

(a) Find $\int_1^{\infty} f(x) \, dx$. [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

- (b) The equation of a curve is such that $\frac{dy}{dx} = f(x)$. It is given that the point $(-1, -1)$ lies on the curve.

Find the equation of the curve. [2]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- 3** Solve the equation $3 \tan^2 \theta + 1 = \frac{2}{\tan^2 \theta}$ for $0^\circ < \theta < 180^\circ$. [5]

[illegible]

- 4** A curve has equation $y = 3x^2 - 4x + 4$ and a straight line has equation $y = mx + m - 1$, where m is a constant.

Find the set of values of m for which the curve and the line have two distinct points of intersection.

[5]

This image shows a full page of white paper with horizontal dashed lines, typical of primary-ruled notebook paper. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

- 5** In the expansion of $(a + bx)^7$, where a and b are non-zero constants, the coefficients of x , x^2 and x^4 are the first, second and third terms respectively of a geometric progression.

Find the value of $\frac{a}{b}$.

[5]

This image shows a single page of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

- 6 The function f is defined by $f(x) = \frac{2x}{3x-1}$ for $x > \frac{1}{3}$.

(a) Find an expression for $f^{-1}(x)$. [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

(b) Show that $\frac{2}{3} + \frac{2}{3(3x-1)}$ can be expressed as $\frac{2x}{3x-1}$. [2]

.....

.....

.....

.....

.....

.....

.....

.....

.....

(c) State the range of f . [1]

.....

.....

.....

- 7** The first and second terms of an arithmetic progression are $\frac{1}{\cos^2 \theta}$ and $-\frac{\tan^2 \theta}{\cos^2 \theta}$, respectively, where $0 < \theta < \frac{1}{2}\pi$.

(a) Show that the common difference is $-\frac{1}{\cos^4 \theta}$. [4]

This image shows a full page of white paper with horizontal dashed lines, typical of primary-ruled notebook paper. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

[Turn over

8 The equation of a curve is $y = 2x + 1 + \frac{1}{2x+1}$ for $x > -\frac{1}{2}$.

(a) Find $\frac{dy}{dx}$ and $\frac{d^2y}{dx^2}$. [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

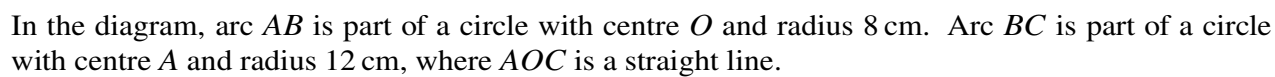
.....

.....

.....

.....

[illegible]



-
- This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.

(b) Find the area of the shaded region.

[4]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(c) Find the perimeter of the shaded region.

[3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- Find the value of k .

[4]

This image shows a full page of white paper with horizontal dashed lines, typical of primary school handwriting practice paper. The lines are evenly spaced and run across the entire width of the page. There are no margins, text, or other markings present.

[5]

[illegible]

11 A circle with centre C has equation $(x - 8)^2 + (y - 4)^2 = 100$.

(a) Show that the point $T(-6, 6)$ is outside the circle. [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

Two tangents from T to the circle are drawn.

(b) Show that the angle between one of the tangents and CT is exactly 45° . [2]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

The two tangents touch the circle at A and B .

- (c) Find the equation of the line AB , giving your answer in the form $y = mx + c$. [4]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- (d) Find the x -coordinates of A and B . [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

Cambridge International AS & A Level

CANDIDATE
NAME

--	--

CENTRE
NUMBER

--	--	--	--	--

CANDIDATE
NUMBER

--	--	--	--

MATHEMATICS

9709/12

Paper 1 Pure Mathematics 1

February/March 2021

1 hour 50 minutes

You must answer on the question paper.

You will need: List of formulae (MF19)

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- If additional space is needed, you should use the lined page at the end of this booklet; the question number or numbers must be clearly shown.
- You should use a calculator where appropriate.
- You must show all necessary working clearly; no marks will be given for unsupported answers from a calculator.
- Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place for angles in degrees, unless a different level of accuracy is specified in the question.

INFORMATION

- The total mark for this paper is 75.
- The number of marks for each question or part question is shown in brackets [].

This document has **20** pages. Any blank pages are indicated.

BLANK PAGE

- 1 (a) Find the first three terms in the expansion, in ascending powers of x , of $(1 + x)^5$. [1]

.....

.....

.....

.....

.....

.....

- (b) Find the first three terms in the expansion, in ascending powers of x , of $(1 - 2x)^6$. [2]

.....

.....

.....

.....

.....

.....

- (c) Hence find the coefficient of x^2 in the expansion of $(1 + x)^5(1 - 2x)^6$. [2]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

2 By using a suitable substitution, solve the equation

$$(2x-3)^2 - \frac{4}{(2x-3)^2} - 3 = 0. \quad [4]$$

[illegible]

- 3** Solve the equation $\frac{\tan \theta + 2 \sin \theta}{\tan \theta - 2 \sin \theta} = 3$ for $0^\circ < \theta < 180^\circ$. [4]

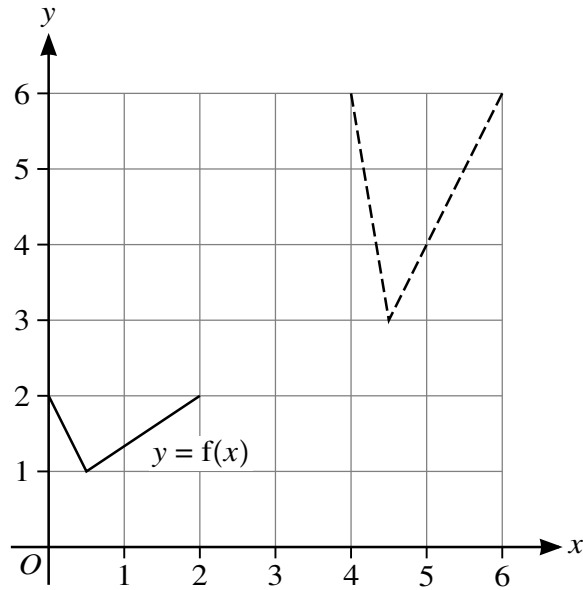
This image shows a full page of white paper with horizontal dashed lines, typical of primary school writing paper. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

- 4** A line has equation $y = 3x + k$ and a curve has equation $y = x^2 + kx + 6$, where k is a constant.

Find the set of values of k for which the line and curve have two distinct points of intersection. [5]

This image shows a full page of primary-ruled paper. It features multiple sets of horizontal dashed lines spaced evenly down the page, providing a guide for handwriting practice. The background is white, and there are no other markings or text present.

5



In the diagram, the graph of $y = f(x)$ is shown with solid lines. The graph shown with broken lines is a transformation of $y = f(x)$.

- (a) Describe fully the two single transformations of $y = f(x)$ that have been combined to give the resulting transformation. [4]

.....

.....

.....

.....

.....

.....

.....

.....

- (b) State in terms of y , f and x , the equation of the graph shown with broken lines. [2]

.....

.....

.....

.....

.....

- 6** A curve is such that $\frac{dy}{dx} = \frac{6}{(3x-2)^3}$ and $A(1, -3)$ lies on the curve. A point is moving along the curve and at A the y -coordinate of the point is increasing at 3 units per second.

(a) Find the rate of increase at A of the x -coordinate of the point. [3]

[illegible]

[Turn over

7 Functions f and g are defined as follows:

$$f : x \mapsto x^2 + 2x + 3 \text{ for } x \leq -1,$$

$$g : x \mapsto 2x + 1 \text{ for } x \geq -1.$$

(a) Express $f(x)$ in the form $(x + a)^2 + b$ and state the range of f . [3]

[illegible]

- (b) Find an expression for $f^{-1}(x)$. [2]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- (c) Solve the equation $gf(x) = 13$. [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- 8** The points $A(7, 1)$, $B(7, 9)$ and $C(1, 9)$ are on the circumference of a circle.

(a) Find an equation of the circle.

[5]

[illegible]

.....

.....

.....

.....

.....

.....

.....

(b) Find an equation of the tangent to the circle at B . [2]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

9 The first term of a progression is $\cos \theta$, where $0 < \theta < \frac{1}{2}\pi$.

(a) For the case where the progression is geometric, the sum to infinity is $\frac{1}{\cos \theta}$.

(i) Show that the second term is $\cos \theta \sin^2 \theta$. [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(ii) Find the sum of the first 12 terms when $\theta = \frac{1}{3}\pi$, giving your answer correct to 4 significant figures. [2]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

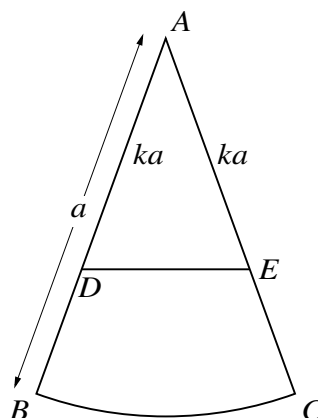
.....

- (b)** For the case where the progression is arithmetic, the first two terms are again $\cos \theta$ and $\cos \theta \sin^2 \theta$ respectively.

Find the 85th term when $\theta = \frac{1}{3}\pi$.

[4]

[illegible]



(a) For the case where angle $BAC = \frac{1}{6}\pi$ radians, find k correct to 4 significant figures. [5]

[illegible]

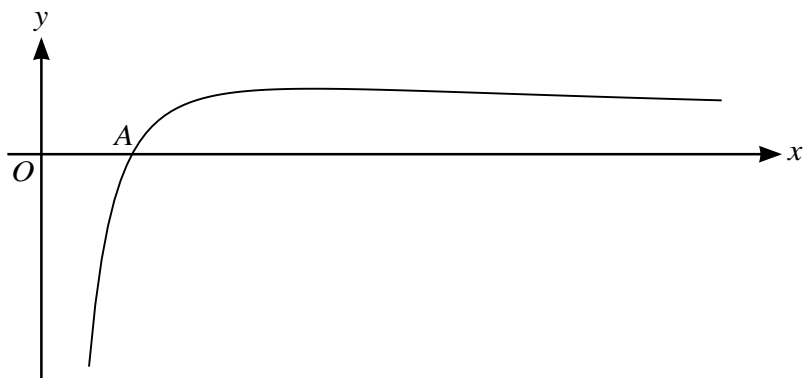
- (b) For the general case in which angle $BAC = \theta$ radians, where $0 < \theta < \frac{1}{2}\pi$, it is given that $\frac{\theta}{\sin \theta} > 1$.

Find the set of possible values of k .

[3]

This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.

11



The diagram shows the curve with equation $y = 9(x^{-\frac{1}{2}} - 4x^{-\frac{3}{2}})$. The curve crosses the x -axis at the point A .

- (a) Find the x -coordinate of A . [2]

.....

.....

.....

.....

.....

.....

.....

- (b) Find the equation of the tangent to the curve at A . [4]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(d) Find the area of the region bounded by the curve, the x -axis and the line $x = 9$. [4]

9709/12/F/M/21

Cambridge International AS & A Level

CANDIDATE
NAME

--

CENTRE
NUMBER

--	--	--	--	--

CANDIDATE
NUMBER

--	--	--	--

MATHEMATICS

9709/11

Paper 1 Pure Mathematics 1

May/June 2021

1 hour 50 minutes

You must answer on the question paper.

You will need: List of formulae (MF19)

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- If additional space is needed, you should use the lined page at the end of this booklet; the question number or numbers must be clearly shown.
- You should use a calculator where appropriate.
- You must show all necessary working clearly; no marks will be given for unsupported answers from a calculator.
- Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place for angles in degrees, unless a different level of accuracy is specified in the question.

INFORMATION

- The total mark for this paper is 75.
- The number of marks for each question or part question is shown in brackets [].

This document has **20** pages. Any blank pages are indicated.

- 1** The equation of a curve is such that $\frac{dy}{dx} = \frac{3}{x^4} + 32x^3$. It is given that the curve passes through the point $(\frac{1}{2}, 4)$.

Find the equation of the curve.

[4]

This image shows a full page of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page, typical of notebook or legal stationery. There are no margins, text, or other markings on the page.

- 2** The sum of the first 20 terms of an arithmetic progression is 405 and the sum of the first 40 terms is 1410.

Find the 60th term of the progression.

[5]

[illegible]

- 3 (a) Find the first three terms in the expansion of $(3 - 2x)^5$ in ascending powers of x . [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- (b) Hence find the coefficient of x^2 in the expansion of $(4 + x)^2(3 - 2x)^5$. [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

This image shows a full page of white paper with horizontal dashed lines, typical of primary school writing paper. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

- 5 The fifth, sixth and seventh terms of a geometric progression are $8k$, -12 and $2k$ respectively.

Given that k is negative, find the sum to infinity of the progression.

[4]

This image shows a full page of white paper with horizontal dashed lines, typical of primary school writing paper. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

- 6** The equation of a curve is $y = (2k - 3)x^2 - kx - (k - 2)$, where k is a constant. The line $y = 3x - 4$ is a tangent to the curve.

Find the value of k .

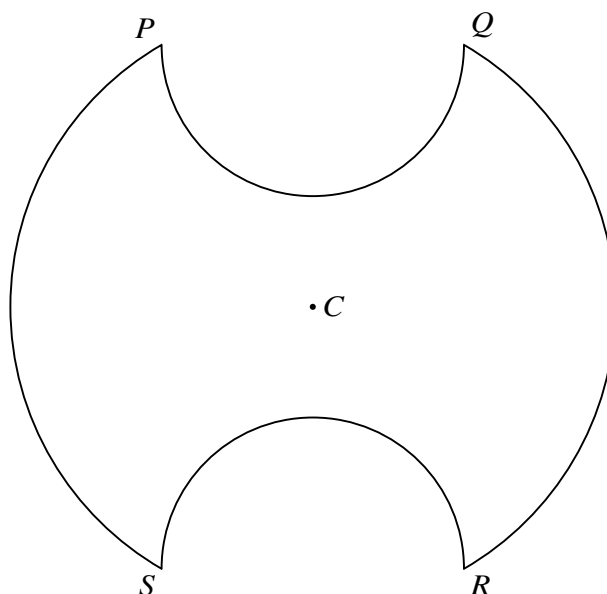
[5]

This image shows a full page of a handwriting practice worksheet. It consists of multiple sets of three horizontal dashed lines, providing a guide for letter height and placement. The lines are evenly spaced across the entire page, leaving ample room for practicing various letters and words. There is no text or other markings on the page.

7 (a) Prove the identity $\frac{1 - 2 \sin^2 \theta}{1 - \sin^2 \theta} \equiv 1 - \tan^2 \theta$. [2]

This image shows a full page of a handwriting practice worksheet. It consists of approximately 20 horizontal rows. Each row is defined by two parallel dotted lines, creating a series of uniform gaps for letter height. The entire page is otherwise blank, with no margins, text, or other markings.

[illegible]



The diagram shows a symmetrical metal plate. The plate is made by removing two identical pieces from a circular disc with centre C . The boundary of the plate consists of two arcs PS and QR of the original circle and two semicircles with PQ and RS as diameters. The radius of the circle with centre C is 4 cm, and $PQ = RS = 4$ cm also.

- (a) Show that angle $PCS = \frac{2}{3}\pi$ radians. [2]

.....

.....

.....

.....

- (b) Find the exact perimeter of the plate. [3]

.....

.....

.....

.....

.....

.....

.....

.....

[5]

This image shows a full page of white paper with horizontal dashed lines, typical of primary-ruled notebook paper. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

- 9 Functions f and g are defined as follows:

$$f(x) = (x - 2)^2 - 4 \text{ for } x \geq 2,$$

$$g(x) = ax + 2 \text{ for } x \in \mathbb{R},$$

where a is a constant.

- (a) State the range of f . [1]

.....

.....

.....

- (b) Find $f^{-1}(x)$. [2]

.....

.....

.....

.....

.....

.....

.....

- (c) Given that $a = -\frac{5}{3}$, solve the equation $f(x) = g(x)$. [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

[illegible]

10 The equation of a circle is $x^2 + y^2 - 4x + 6y - 77 = 0$.

- (a)** Find the x -coordinates of the points A and B where the circle intersects the x -axis. [2]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- (b)** Find the point of intersection of the tangents to the circle at A and B . [6]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

11 The equation of a curve is $y = 2\sqrt{3x + 4} - x$.

- (a)** Find the equation of the normal to the curve at the point (4, 4), giving your answer in the form $y = mx + c$. [5]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- (b)** Find the coordinates of the stationary point. [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(c) Determine the nature of the stationary point.

[2]

.....

.....

.....

.....

.....

.....

(d) Find the exact area of the region bounded by the curve, the x -axis and the lines $x = 0$ and $x = 4$. [4]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....



Cambridge International AS & A Level

CANDIDATE
NAME

--

CENTRE
NUMBER

--	--	--	--	--

CANDIDATE
NUMBER

--	--	--	--

MATHEMATICS

9709/11

Paper 1 Pure Mathematics 1

May/June 2021

1 hour 50 minutes

You must answer on the question paper.

You will need: List of formulae (MF19)

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- If additional space is needed, you should use the lined page at the end of this booklet; the question number or numbers must be clearly shown.
- You should use a calculator where appropriate.
- You must show all necessary working clearly; no marks will be given for unsupported answers from a calculator.
- Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place for angles in degrees, unless a different level of accuracy is specified in the question.

INFORMATION

- The total mark for this paper is 75.
- The number of marks for each question or part question is shown in brackets [].

This document has **20** pages. Any blank pages are indicated.



- 1** The equation of a curve is such that $\frac{dy}{dx} = \frac{3}{x^4} + 32x^3$. It is given that the curve passes through the point $(\frac{1}{2}, 4)$.

Find the equation of the curve.

[4]

This image shows a single page of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

- 2** The sum of the first 20 terms of an arithmetic progression is 405 and the sum of the first 40 terms is 1410.

Find the 60th term of the progression.

[5]

[illegible]

- 3 (a)** Find the first three terms in the expansion of $(3 - 2x)^5$ in ascending powers of x . [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- (b)** Hence find the coefficient of x^2 in the expansion of $(4 + x)^2(3 - 2x)^5$. [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

[illegible]

- 5 The fifth, sixth and seventh terms of a geometric progression are $8k$, -12 and $2k$ respectively.

Given that k is negative, find the sum to infinity of the progression.

[4]

[illegible]

- 6** The equation of a curve is $y = (2k - 3)x^2 - kx - (k - 2)$, where k is a constant. The line $y = 3x - 4$ is a tangent to the curve.

Find the value of k .

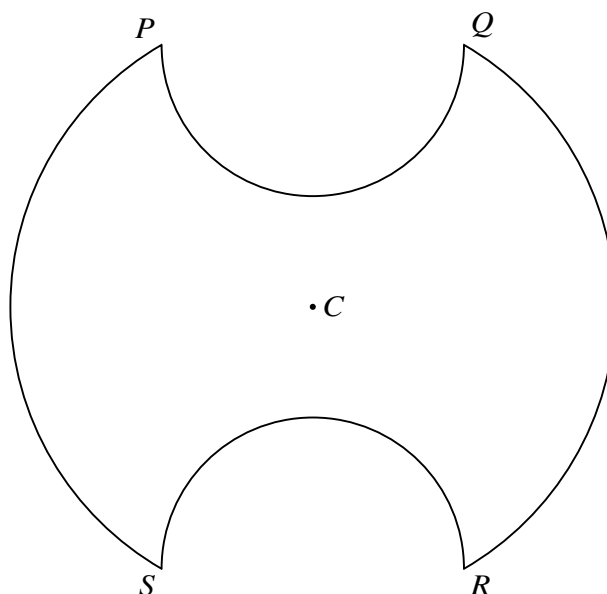
[5]

[illegible]

7 (a) Prove the identity $\frac{1 - 2 \sin^2 \theta}{1 - \sin^2 \theta} \equiv 1 - \tan^2 \theta$. [2]

[illegible]

[Turn over



The diagram shows a symmetrical metal plate. The plate is made by removing two identical pieces from a circular disc with centre C . The boundary of the plate consists of two arcs PS and QR of the original circle and two semicircles with PQ and RS as diameters. The radius of the circle with centre C is 4 cm, and $PQ = RS = 4$ cm also.

- (a) Show that angle $PCS = \frac{2}{3}\pi$ radians. [2]

.....

.....

.....

.....

- (b) Find the exact perimeter of the plate. [3]

.....

.....

.....

.....

.....

.....

.....

.....

[5]

[illegible]

- 9 Functions f and g are defined as follows:

$$f(x) = (x - 2)^2 - 4 \text{ for } x \geq 2,$$

$$g(x) = ax + 2 \text{ for } x \in \mathbb{R},$$

where a is a constant.

- (a) State the range of f . [1]

.....

.....

.....

- (b) Find $f^{-1}(x)$. [2]

.....

.....

.....

.....

.....

.....

.....

- (c) Given that $a = -\frac{5}{3}$, solve the equation $f(x) = g(x)$. [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

This image shows a full page of a worksheet designed for handwriting practice. It consists of approximately 20 horizontal dotted lines spaced evenly across the page, providing a guide for letter height and placement. The background is plain white, and there are no other markings or text present.

10 The equation of a circle is $x^2 + y^2 - 4x + 6y - 77 = 0$.

- (a)** Find the x -coordinates of the points A and B where the circle intersects the x -axis. [2]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- (b)** Find the point of intersection of the tangents to the circle at A and B . [6]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

11 The equation of a curve is $y = 2\sqrt{3x + 4} - x$.

- (a)** Find the equation of the normal to the curve at the point (4, 4), giving your answer in the form $y = mx + c$. [5]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- (b)** Find the coordinates of the stationary point. [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(c) Determine the nature of the stationary point.

[2]

.....

.....

.....

.....

.....

.....

(d) Find the exact area of the region bounded by the curve, the x -axis and the lines $x = 0$ and $x = 4$.

[4]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

Cambridge International AS & A Level

CANDIDATE
NAME

--

CENTRE
NUMBER

--	--	--	--	--

CANDIDATE
NUMBER

--	--	--	--

MATHEMATICS

9709/12

Paper 1 Pure Mathematics 1

May/June 2021

1 hour 50 minutes

You must answer on the question paper.

You will need: List of formulae (MF19)

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- If additional space is needed, you should use the lined page at the end of this booklet; the question number or numbers must be clearly shown.
- You should use a calculator where appropriate.
- You must show all necessary working clearly; no marks will be given for unsupported answers from a calculator.
- Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place for angles in degrees, unless a different level of accuracy is specified in the question.

INFORMATION

- The total mark for this paper is 75.
- The number of marks for each question or part question is shown in brackets [].

This document has **20** pages. Any blank pages are indicated.

- 1 (a) Express $16x^2 - 24x + 10$ in the form $(4x + a)^2 + b$. [2]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- (b) It is given that the equation $16x^2 - 24x + 10 = k$, where k is a constant, has exactly one root.

Find the value of this root. [2]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- 2 (a) The graph of $y = f(x)$ is transformed to the graph of $y = 2f(x - 1)$.

Describe fully the two single transformations which have been combined to give the resulting transformation. [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- (b) The curve $y = \sin 2x - 5x$ is reflected in the y -axis and then stretched by scale factor $\frac{1}{3}$ in the x -direction.

Write down the equation of the transformed curve. [2]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- 3** The equation of a curve is $y = (x - 3)\sqrt{x + 1} + 3$. The following points lie on the curve. Non-exact values are rounded to 4 decimal places.

$A(2, k)$ $B(2.9, 2.8025)$ $C(2.99, 2.9800)$ $D(2.999, 2.9980)$ $E(3, 3)$

- (a)** Find k , giving your answer correct to 4 decimal places. [1]

.....

.....

.....

.....

- (b)** Find the gradient of AE , giving your answer correct to 4 decimal places. [1]

.....

.....

.....

.....

.....

.....

The gradients of BE , CE and DE , rounded to 4 decimal places, are 1.9748, 1.9975 and 1.9997 respectively.

- (c)** State, giving a reason for your answer, what the values of the four gradients suggest about the gradient of the curve at the point E . [2]

.....

.....

.....

.....

.....

.....

.....

.....

- 4** The coefficient of x in the expansion of $\left(4x + \frac{10}{x}\right)^3$ is p . The coefficient of $\frac{1}{x}$ in the expansion of $\left(2x + \frac{k}{x^2}\right)^5$ is q .

Given that $p = 6q$, find the possible values of k . [5]

[illegible]

5 The function f is defined by $f(x) = 2x^2 + 3$ for $x \geq 0$.

(a) Find and simplify an expression for $ff(x)$. [2]

.....

.....

.....

.....

.....

.....

(b) Solve the equation $ff(x) = 34x^2 + 19$. [4]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- 6** Points A and B have coordinates $(8, 3)$ and (p, q) respectively. The equation of the perpendicular bisector of AB is $y = -2x + 4$.

Find the values of p and q .

[4]

[illegible]

- 7 The point A has coordinates $(1, 5)$ and the line l has gradient $-\frac{2}{3}$ and passes through A . A circle has centre $(5, 11)$ and radius $\sqrt{52}$.

(a) Show that l is the tangent to the circle at A . [2]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(b) Find the equation of the other circle of radius $\sqrt{52}$ for which l is also the tangent at A . [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- 8** The first, second and third terms of an arithmetic progression are a , $\frac{3}{2}a$ and b respectively, where a and b are positive constants. The first, second and third terms of a geometric progression are a , 18 and $b + 3$ respectively.

(a) Find the values of a and b .

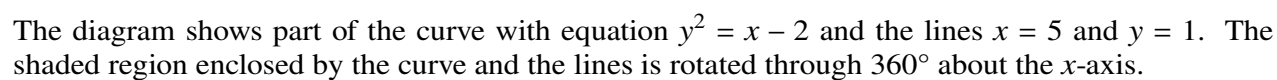
[5]

This image shows a full page of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page, typical of notebook or legal stationery. There are no margins, text, or other markings on the page.

(b) Find the sum of the first 20 terms of the arithmetic progression.

[3]

[illegible]



[6]

[illegible]

10 (a) Prove the identity $\frac{1 + \sin x}{1 - \sin x} - \frac{1 - \sin x}{1 + \sin x} \equiv \frac{4 \tan x}{\cos x}$. [4]

[illegible]

- (b)** Hence solve the equation $\frac{1 + \sin x}{1 - \sin x} - \frac{1 - \sin x}{1 + \sin x} = 8 \tan x$ for $0 \leq x \leq \frac{1}{2}\pi$. [3]

This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.

- 11 The gradient of a curve is given by $\frac{dy}{dx} = 6(3x - 5)^3 - kx^2$, where k is a constant. The curve has a stationary point at $(2, -3.5)$.

(a) Find the value of k . [2]

.....

.....

.....

.....

.....

(b) Find the equation of the curve. [4]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- (c) Find $\frac{d^2y}{dx^2}$. [2]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- (d) Determine the nature of the stationary point at $(2, -3.5)$. [2]

.....

.....

.....

.....

.....

.....

.....

.....

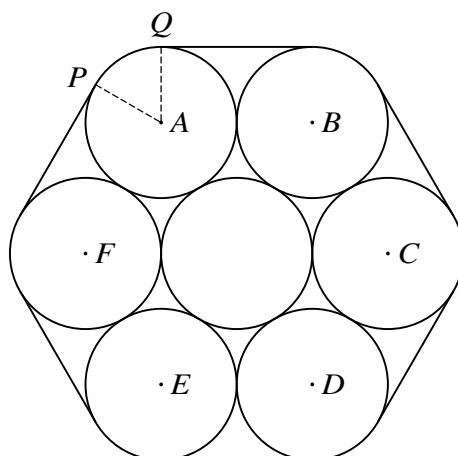
.....

.....

.....

.....

12



The diagram shows a cross-section of seven cylindrical pipes, each of radius 20 cm, held together by a thin rope which is wrapped tightly around the pipes. The centres of the six outer pipes are A , B , C , D , E and F . Points P and Q are situated where straight sections of the rope meet the pipe with centre A .

- (a) Show that angle $PAQ = \frac{1}{3}\pi$ radians. [2]

.....

.....

.....

.....

.....

.....

- (b) Find the length of the rope. [4]

.....

.....

.....

.....

.....

.....

.....

.....

- (c) Find the area of the hexagon $ABCDEF$, giving your answer in terms of $\sqrt{3}$. [2]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- (d) Find the area of the complete region enclosed by the rope. [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

Cambridge International AS & A Level

CANDIDATE
NAME

--	--

CENTRE
NUMBER

--	--	--	--	--

CANDIDATE
NUMBER

--	--	--	--

MATHEMATICS

9709/13

Paper 1 Pure Mathematics 1

May/June 2021

1 hour 50 minutes

You must answer on the question paper.

You will need: List of formulae (MF19)

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- If additional space is needed, you should use the lined page at the end of this booklet; the question number or numbers must be clearly shown.
- You should use a calculator where appropriate.
- You must show all necessary working clearly; no marks will be given for unsupported answers from a calculator.
- Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place for angles in degrees, unless a different level of accuracy is specified in the question.

INFORMATION

- The total mark for this paper is 75.
- The number of marks for each question or part question is shown in brackets [].

This document has **20** pages. Any blank pages are indicated.

BLANK PAGE

- 1** A curve with equation $y = f(x)$ is such that $f'(x) = 6x^2 - \frac{8}{x^2}$. It is given that the curve passes through the point $(2, 7)$.

Find $f(x)$.

[3]

[illegible]

- 2** The function f is defined by $f(x) = \frac{1}{3}(2x - 1)^{\frac{3}{2}} - 2x$ for $\frac{1}{2} < x < a$. It is given that f is a decreasing function.

Find the maximum possible value of the constant a .

[4]

[illegible]

- 3** A line with equation $y = mx - 6$ is a tangent to the curve with equation $y = x^2 - 4x + 3$.

Find the possible values of the constant m , and the corresponding coordinates of the points at which the line touches the curve. [6]

This image shows a single page of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page, typical of notebook or legal stationery. There are no margins, text, or other markings on the page.

- 4 (a) Show that the equation

$$\frac{\tan x + \sin x}{\tan x - \sin x} = k,$$

where k is a constant, may be expressed as

$$\frac{1 + \cos x}{1 - \cos x} = k. \quad [2]$$

.....

.....

.....

.....

.....

.....

.....

- (b) Hence express $\cos x$ in terms of k . [2]

.....

.....

.....

.....

.....

.....

- (c) Hence solve the equation $\frac{\tan x + \sin x}{\tan x - \sin x} = 4$ for $-\pi < x < \pi$. [2]

.....

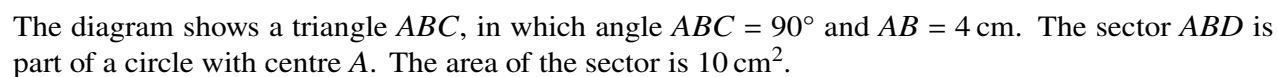
.....

.....

.....

.....

.....



- [illegible]

- [illegible]

6 Functions f and g are both defined for $x \in \mathbb{R}$ and are given by

$$f(x) = x^2 - 2x + 5,$$

$$g(x) = x^2 + 4x + 13.$$

- (a) By first expressing each of $f(x)$ and $g(x)$ in completed square form, express $g(x)$ in the form $f(x + p) + q$, where p and q are constants. [4]

This image shows a full page of white paper with horizontal dashed lines, typical of primary school writing paper. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

- (b)** Describe fully the transformation which transforms the graph of $y = f(x)$ to the graph of $y = g(x)$. [2]

[illegible]

(b) Given that the coefficient of x^2 in the expansion of $\left(1 + \frac{2}{ax}\right)(a - x)^6$ is -20 , find in exact form the possible values of the constant a . [5]

[Turn over

8 Functions f and g are defined as follows:

$$f : x \mapsto x^2 - 1 \text{ for } x < 0,$$

$$g : x \mapsto \frac{1}{2x+1} \text{ for } x < -\frac{1}{2}.$$

(a) Solve the equation $fg(x) = 3$.

[4]

This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.

[illegible]

- 9 (a)** A geometric progression is such that the second term is equal to 24% of the sum to infinity.

Find the possible values of the common ratio.

[3]

[illegible]

- (b) An arithmetic progression P has first term a and common difference d . An arithmetic progression Q has first term $2(a + 1)$ and common difference $(d + 1)$. It is given that

$$\frac{\text{5th term of } P}{\text{12th term of } Q} = \frac{1}{3} \quad \text{and} \quad \frac{\text{Sum of first 5 terms of } P}{\text{Sum of first 5 terms of } Q} = \frac{2}{3}.$$

Find the value of a and the value of d .

[6]

This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.

10 Points $A(-2, 3)$, $B(3, 0)$ and $C(6, 5)$ lie on the circumference of a circle with centre D .

(a) Show that angle $ABC = 90^\circ$. [2]

.....

.....

.....

.....

.....

.....

(b) Hence state the coordinates of D . [1]

.....

.....

.....

(c) Find an equation of the circle. [2]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

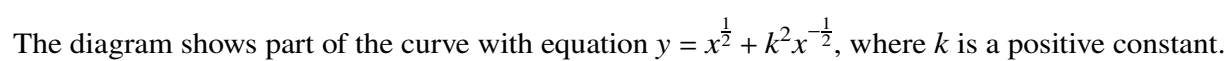
.....

.....

.....

.....

-
- This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.



- [illegible]

The tangent at the point on the curve where $x = 4k^2$ intersects the y -axis at P .

- (b) Find the y -coordinate of P in terms of k . [4]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

The shaded region is bounded by the curve, the x -axis and the lines $x = \frac{9}{4}k^2$ and $x = 4k^2$.

- (c) Find the area of the shaded region in terms of k . [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

Cambridge International AS & A Level

CANDIDATE
NAME

--

CENTRE
NUMBER

--	--	--	--	--

CANDIDATE
NUMBER

--	--	--	--

MATHEMATICS

9709/11

Paper 1 Pure Mathematics 1

October/November 2021

1 hour 50 minutes

You must answer on the question paper.

You will need: List of formulae (MF19)

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- If additional space is needed, you should use the lined page at the end of this booklet; the question number or numbers must be clearly shown.
- You should use a calculator where appropriate.
- You must show all necessary working clearly; no marks will be given for unsupported answers from a calculator.
- Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place for angles in degrees, unless a different level of accuracy is specified in the question.

INFORMATION

- The total mark for this paper is 75.
- The number of marks for each question or part question is shown in brackets [].

This document has **20** pages. Any blank pages are indicated.

BLANK PAGE

- 1 (a)** Expand $\left(1 - \frac{1}{2x}\right)^2$. [1]

.....

.....

.....

.....

- (b)** Find the first four terms in the expansion, in ascending powers of x , of $(1 + 2x)^6$. [2]

.....

.....

.....

.....

.....

.....

.....

.....

- (c)** Hence find the coefficient of x in the expansion of $\left(1 - \frac{1}{2x}\right)^2 (1 + 2x)^6$. [2]

.....

.....

.....

.....

.....

.....

.....

.....

- 2** A curve has equation $y = kx^2 + 2x - k$ and a line has equation $y = kx - 2$, where k is a constant.

Find the set of values of k for which the curve and line do not intersect.

[5]

[illegible]

3 Solve, by factorising, the equation

$$6 \cos \theta \tan \theta - 3 \cos \theta + 4 \tan \theta - 2 = 0,$$

for $0^\circ \leq \theta \leq 180^\circ$.

[4]

[illegible]

- 4 The first term of an arithmetic progression is a and the common difference is -4 . The first term of a geometric progression is $5a$ and the common ratio is $-\frac{1}{4}$. The sum to infinity of the geometric progression is equal to the sum of the first eight terms of the arithmetic progression.

(a) Find the value of a .

[4]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

The k th term of the arithmetic progression is zero.

(b) Find the value of k .

[2]

.....

.....

.....

.....

.....

.....

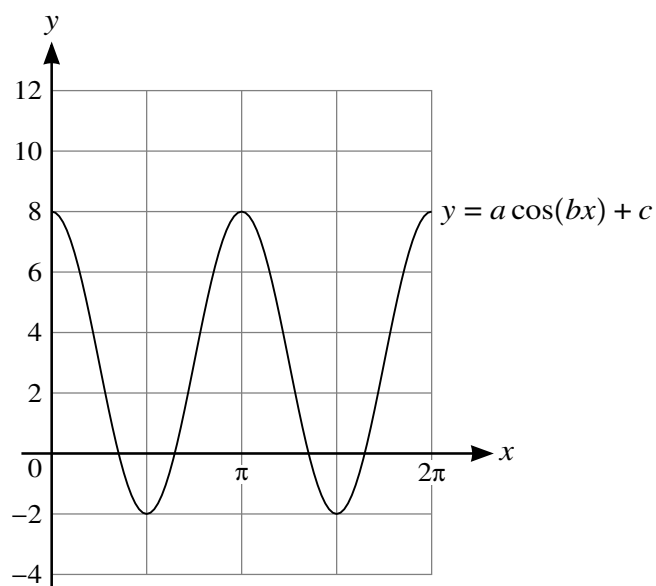
.....

.....

.....

.....

5



The diagram shows part of the graph of $y = a \cos(bx) + c$.

- (a) Find the values of the positive integers a , b and c . [3]

.....

.....

.....

.....

.....

.....

- (b) For these values of a , b and c , use the given diagram to determine the number of solutions in the interval $0 \leq x \leq 2\pi$ for each of the following equations.

(i) $a \cos(bx) + c = \frac{6}{\pi}x$ [1]

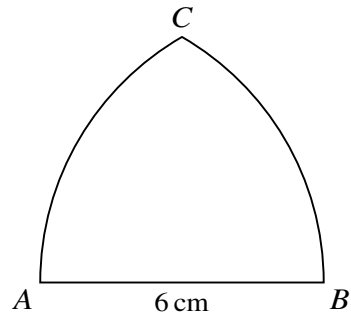
.....

.....

(ii) $a \cos(bx) + c = 6 - \frac{6}{\pi}x$ [1]

.....

.....



The diagram shows a metal plate ABC in which the sides are the straight line AB and the arcs AC and BC . The line AB has length 6 cm. The arc AC is part of a circle with centre B and radius 6 cm, and the arc BC is part of a circle with centre A and radius 6 cm.

- (a) Find the perimeter of the plate, giving your answer in terms of π . [3]

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

[Turn over

- 7 A circle with centre $(5, 2)$ passes through the point $(7, 5)$.

(a) Find an equation of the circle. [2]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

The line $y = 5x - 10$ intersects the circle at A and B .

(b) Find the exact length of the chord AB . [7]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- 8 (a) Express $-3x^2 + 12x + 2$ in the form $-3(x - a)^2 + b$, where a and b are constants. [2]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

The one-one function f is defined by $f : x \mapsto -3x^2 + 12x + 2$ for $x \leq k$.

- (b) State the largest possible value of the constant k . [1]

.....

.....

.....

.....

It is now given that $k = -1$.

- (c) State the range of f . [1]

.....

.....

.....

.....

- (d) Find an expression for $f^{-1}(x)$. [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

The result of translating the graph of $y = f(x)$ by $\begin{pmatrix} -3 \\ 1 \end{pmatrix}$ is the graph of $y = g(x)$.

- (e) Express $g(x)$ in the form $px^2 + qx + r$, where p , q and r are constants. [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- 9 A curve has equation $y = f(x)$, and it is given that $f'(x) = 2x^2 - 7 - \frac{4}{x^2}$.

(a) Given that $f(1) = -\frac{1}{3}$, find $f(x)$.

[4]

This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.

- (b) Find the coordinates of the stationary points on the curve. [5]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- (c) Find $f''(x)$. [1]

.....

.....

.....

.....

- (d) Hence, or otherwise, determine the nature of each of the stationary points. [2]

.....

.....

.....

.....

.....

.....

10 (a) Find $\int_1^{\infty} \frac{1}{(3x-2)^{\frac{3}{2}}} dx$.

[4]

.....

.....

.....

.....

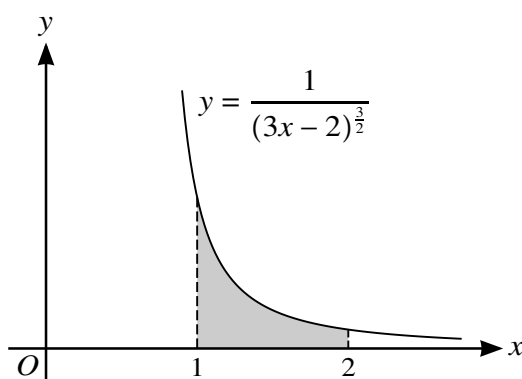
.....

.....

.....

.....

.....



The diagram shows the curve with equation $y = \frac{1}{(3x-2)^{\frac{3}{2}}}$. The shaded region is bounded by the curve, the x -axis and the lines $x = 1$ and $x = 2$. The shaded region is rotated through 360° about the x -axis.

(b) Find the volume of revolution.

[4]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

The normal to the curve at the point $(1, 1)$ crosses the y -axis at the point A .

(c) Find the y -coordinate of A .

[4]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.

Cambridge International AS & A Level

CANDIDATE
NAME

--

CENTRE
NUMBER

--	--	--	--	--

CANDIDATE
NUMBER

--	--	--	--

MATHEMATICS

9709/12

Paper 1 Pure Mathematics 1

October/November 2021

1 hour 50 minutes

You must answer on the question paper.

You will need: List of formulae (MF19)

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- If additional space is needed, you should use the lined page at the end of this booklet; the question number or numbers must be clearly shown.
- You should use a calculator where appropriate.
- You must show all necessary working clearly; no marks will be given for unsupported answers from a calculator.
- Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place for angles in degrees, unless a different level of accuracy is specified in the question.

INFORMATION

- The total mark for this paper is 75.
- The number of marks for each question or part question is shown in brackets [].

This document has **20** pages.

- 1** Solve the equation $2 \cos \theta = 7 - \frac{3}{\cos \theta}$ for $-90^\circ < \theta < 90^\circ$. [4]

[illegible]

2 The graph of $y = f(x)$ is transformed to the graph of $y = f(2x) - 3$.

- (a) Describe fully the two single transformations that have been combined to give the resulting transformation. [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

The point $P(5, 6)$ lies on the transformed curve $y = f(2x) - 3$.

- (b) State the coordinates of the corresponding point on the original curve $y = f(x)$. [2]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

3 The function f is defined as follows:

$$f(x) = \frac{x+3}{x-1} \text{ for } x > 1.$$

(a) Find the value of $ff(5)$.

[2]

.....

.....

.....

.....

.....

.....

(b) Find an expression for $f^{-1}(x)$.

[3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- 4** A curve is such that $\frac{dy}{dx} = \frac{8}{(3x+2)^2}$. The curve passes through the point $(2, 5\frac{2}{3})$.

Find the equation of the curve.

[4]

This image shows a single page of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

- 5 The first, third and fifth terms of an arithmetic progression are $2 \cos x$, $-6\sqrt{3} \sin x$ and $10 \cos x$ respectively, where $\frac{1}{2}\pi < x < \pi$.

(a) Find the exact value of x . [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(b) Hence find the exact sum of the first 25 terms of the progression. [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

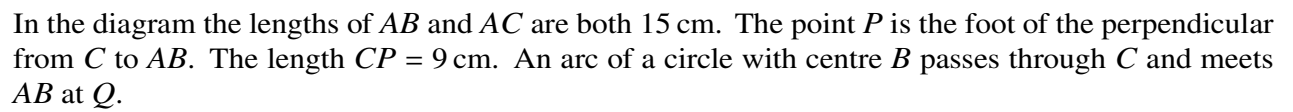
.....

- 6** The second term of a geometric progression is 54 and the sum to infinity of the progression is 243. The common ratio is greater than $\frac{1}{2}$.

Find the tenth term, giving your answer in exact form.

[5]

[illegible]



- [illegible]

[illegible]

- 8 (a)** It is given that in the expansion of $(4 + 2x)(2 - ax)^5$, the coefficient of x^2 is -15 .

Find the possible values of a .

[4]

This image shows a full page of a handwriting practice worksheet. It consists of multiple sets of three horizontal dotted lines, providing a guide for letter height and placement. The lines are evenly spaced across the entire page, leaving ample room for writing practice. There is no text or other markings on the page.

- (b)** It is given instead that in the expansion of $(4 + 2x)(2 - ax)^5$, the coefficient of x^2 is k . It is also given that there is only one value of a which leads to this value of k .

Find the values of k and a .

[4]

This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.

- 9** The volume $V \text{ m}^3$ of a large circular mound of iron ore of radius $r \text{ m}$ is modelled by the equation $V = \frac{3}{2}\left(r - \frac{1}{2}\right)^3 - 1$ for $r \geq 2$. Iron ore is added to the mound at a constant rate of 1.5 m^3 per second.
- (a)** Find the rate at which the radius of the mound is increasing at the instant when the radius is 5.5 m .
- [3]

This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.

- (b) Find the volume of the mound at the instant when the radius is increasing at 0.1 m per second. [3]

[illegible]

- 10** The function f is defined by $f(x) = x^2 + \frac{k}{x} + 2$ for $x > 0$.

- (a)** Given that the curve with equation $y = f(x)$ has a stationary point when $x = 2$, find k . [3]

[illegible]

- (b) Determine the nature of the stationary point. [2]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- (c) Given that this is the only stationary point of the curve, find the range of f . [2]

.....

.....

.....

.....

.....

.....

.....

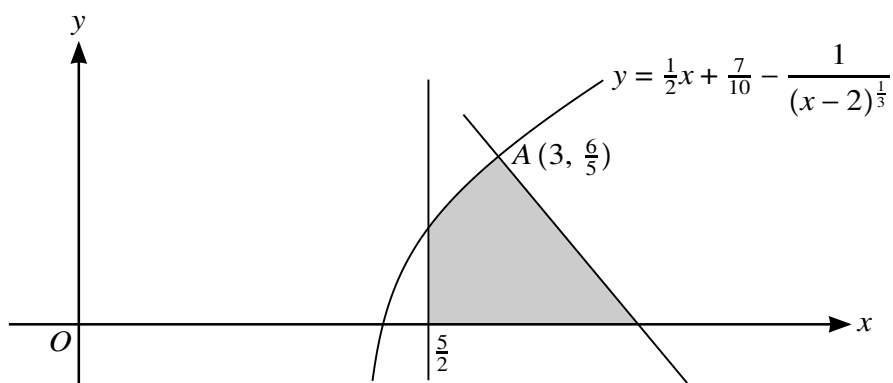
.....

.....

.....

.....

.....



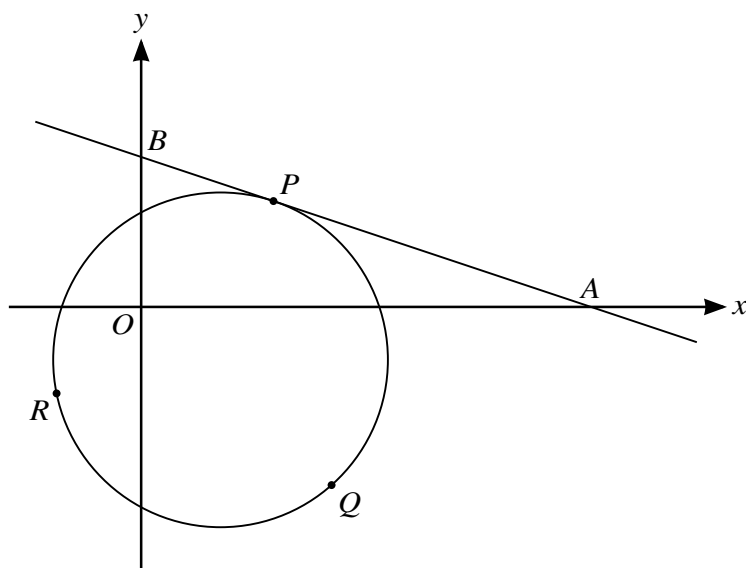
The diagram shows the line $x = \frac{5}{2}$, part of the curve $y = \frac{1}{2}x + \frac{7}{10} - \frac{1}{(x-2)^{\frac{1}{3}}}$ and the normal to the curve at the point A $(3, \frac{6}{5})$.

- (a) Find the x -coordinate of the point where the normal to the curve meets the x -axis. [5]

[illegible]

- (b)** Find the area of the shaded region, giving your answer correct to 2 decimal places. [6]

[illegible]



(a) The tangent to the circle at P meets the x -axis at A and the y -axis at B .

[5]

[illegible]

[3]

[illegible]

This image shows a full page of handwriting practice paper. It features multiple sets of horizontal dashed lines spaced evenly down the page, providing a guide for letter height and placement. The background is plain white, and there are no margins or additional markings.

Cambridge Assessment International Education is part of the Cambridge Assessment Group. Cambridge Assessment is the brand name of the University of Cambridge Local Examinations Syndicate (UCLES), which itself is a department of the University of Cambridge.

Cambridge International AS & A Level

CANDIDATE
NAME

--

CENTRE
NUMBER

--	--	--	--	--

CANDIDATE
NUMBER

--	--	--	--

MATHEMATICS

9709/13

Paper 1 Pure Mathematics 1

October/November 2021

1 hour 50 minutes

You must answer on the question paper.

You will need: List of formulae (MF19)

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- If additional space is needed, you should use the lined page at the end of this booklet; the question number or numbers must be clearly shown.
- You should use a calculator where appropriate.
- You must show all necessary working clearly; no marks will be given for unsupported answers from a calculator.
- Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place for angles in degrees, unless a different level of accuracy is specified in the question.

INFORMATION

- The total mark for this paper is 75.
- The number of marks for each question or part question is shown in brackets [].

This document has **20** pages. Any blank pages are indicated.

- 1** The graph of $y = f(x)$ is transformed to the graph of $y = 3 - f(x)$.

Describe fully, in the correct order, the two transformations that have been combined. [4]

[illegible]

- 2 (a)** Find the first three terms, in ascending powers of x , in the expansion of $(1 + ax)^6$. [1]

.....

.....

.....

.....

.....

- (b)** Given that the coefficient of x^2 in the expansion of $(1 - 3x)(1 + ax)^6$ is -3 , find the possible values of the constant a . [4]

[illegible]

- 3 (a)** Express $5y^2 - 30y + 50$ in the form $5(y + a)^2 + b$, where a and b are constants. [2]

.....

.....

.....

.....

.....

.....

.....

.....

- (b)** The function f is defined by $f(x) = x^5 - 10x^3 + 50x$ for $x \in \mathbb{R}$.

Determine whether f is an increasing function, a decreasing function or neither. [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- 4 The first term of an arithmetic progression is 84 and the common difference is -3 .

(a) Find the smallest value of n for which the n th term is negative. [2]

.....

.....

.....

.....

.....

.....

.....

.....

.....

It is given that the sum of the first $2k$ terms of this progression is equal to the sum of the first k terms.

(b) Find the value of k . [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

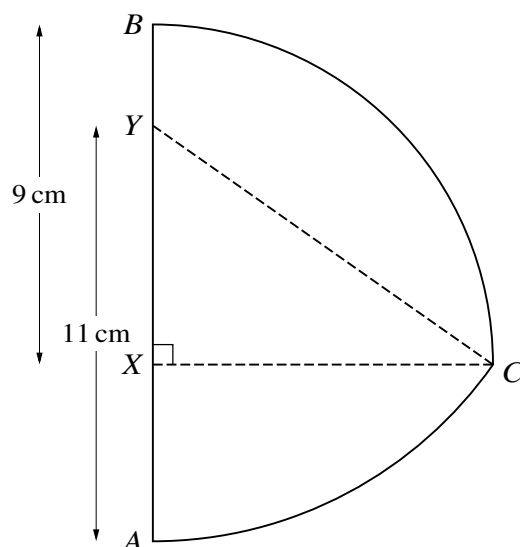
.....

.....

.....

.....

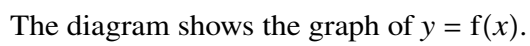
.....



(a) Show that angle $XYC = 0.9582$ radians, correct to 4 significant figures. [1]

[illegible]

This image shows a full page of white paper with horizontal dashed lines, typical of primary school writing paper. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.



- It is now given that $f(x) = -\frac{x}{\sqrt{4-x^2}}$ where $-2 < x < 2$.

-
- This image shows a blank sheet of white paper with horizontal dashed lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no other markings or text on the page.

.....

.....

.....

.....

.....

.....

.....

The function g is defined by $g(x) = 2x$ for $-a < x < a$, where a is a constant.

- (c) State the maximum possible value of a for which fg can be formed. [1]

.....

.....

.....

.....

.....

- (d) Assuming that fg can be formed, find and simplify an expression for $fg(x)$. [2]

.....

.....

.....

.....

.....

.....

.....

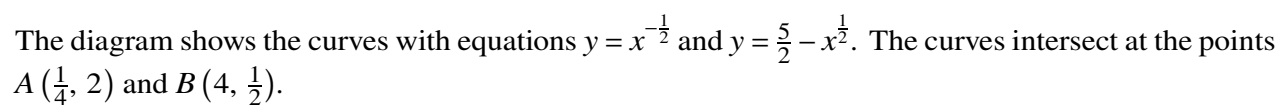
.....

.....

.....

[illegible]

[Turn over



-
- This image shows a full page of white paper with horizontal dotted lines, typical of primary school handwriting practice paper. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

- (b)** The normal to the curve $y = x^{-\frac{1}{2}}$ at the point $(1, 1)$ intersects the y -axis at the point $(0, p)$.

Find the value of p .

[4]

[illegible]

- 9** The line $y = 2x + 5$ intersects the circle with equation $x^2 + y^2 = 20$ at A and B .

- (a)** Find the coordinates of A and B in surd form and hence find the exact length of the chord AB .

[7]

[illegible]

[5]

[illegible]

- 10** A curve has equation $y = f(x)$ and it is given that

$$f'(x) = \left(\frac{1}{2}x + k\right)^{-2} - (1 + k)^{-2},$$

where k is a constant. The curve has a minimum point at $x = 2$.

- (a)** Find $f''(x)$ in terms of k and x , and hence find the set of possible values of k . [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

It is now given that $k = -3$ and the minimum point is at $(2, 3\frac{1}{2})$.

- (b)** Find $f(x)$. [4]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- (c) Find the coordinates of the other stationary point and determine its nature. [4]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.