

TMUA EUCLID

PREDICTED PAPER

PAPER 1 + PAPER 2 COMBINED VERSION • 75 MINUTES

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WRITTEN BY TMUA EUCLID

1. The graph of $y = f(x)$ is a straight line passing through $(1, 2)$ and $(5, 4)$.
The graphs

$$y = f(x) \quad \text{and} \quad y = f(6 - x) + 1$$

intersect at P . What is the y -coordinate of P ?

A 1

B $\frac{5}{2}$

C 3

D $\frac{7}{2}$

E 4

2. Two circles have radii 2 and 5. A student claims:

If the circles have exactly one common point, then the distance between their centres is 7.

Which distance between the centres gives a counterexample to this claim?

A 0

B 1

C 3

D 5

E 7

3. The polynomials f and g satisfy

$$\int_0^3 f(x) \, dx = 4, \quad \int_0^3 g(x) \, dx = 7, \quad \int_0^3 |f(x) - g(x)| \, dx = 5.$$

For each real x , define $h(x)$ to be the larger of $f(x)$ and $g(x)$; if they are equal, $h(x)$ is their common value.

What is $\int_0^3 h(x) \, dx$?

- A 3
- B 4
- C 7
- D 8
- E 11
- F 16

4. The following two statements are true for a pair of real numbers a and b :

If $a > 0$, then $b > 0$.

If $a < 0$, then $b < 0$.

Which of the following must also be true?

A If $a = 0$, then $b = 0$.

B If $b > 0$, then $a > 0$.

C If $b = 0$, then $a = 0$.

D If $b < 0$, then $a < 0$.

E a and b are both nonzero.

5. In the expansion of

$$(1 + ax + bx^2)^5,$$

where a and b are real constants, the coefficient of x is 10 and the coefficient of x^2 is 30.

What is the coefficient of x^3 ?

A -80

B 0

C 40

D 80

E 160

6. Let $a < b$ be rational numbers. You may use the fact that $\sqrt{2}$ is irrational.

A proof that there is an irrational number strictly between a and b is to begin by defining a number t .

Which choice of t is guaranteed to be irrational and to satisfy $a < t < b$, for every such pair a, b ?

A $a + \frac{b-a}{\sqrt{2}}$

B $\frac{a+b}{\sqrt{2}}$

C $a + \frac{(b-a)^2}{\sqrt{2}}$

D $\frac{a+b}{2} + \frac{1}{\sqrt{2}}$

E $\sqrt{\frac{a^2+b^2}{2}}$

7. Which of the following is the real solution of

$$\log_2(2^x - 1) + \log_2(2^x - 3) = x + 1 ?$$

A $\log_2(3 - \sqrt{6})$

B $\log_2(2 + \sqrt{3})$

C $\log_2(3 + \sqrt{6})$

D $\log_2 6$

E $3 + \sqrt{6}$

8. A list contains six positive real numbers, not necessarily distinct. Its median is m . Each entry is squared to form a new list.

Consider the condition:

m is equal to at least one entry in the original list.

For the median of the new list to equal m^2 , this condition is

- A necessary but not sufficient.
- B sufficient but not necessary.
- C both necessary and sufficient.
- D neither necessary nor sufficient.

9. The tangent to the curve

$$y = x^2 + \frac{4}{x}, \quad x > 0,$$

at P passes through the origin.

The normal to the curve at P meets the y -axis at Q . What is the y -coordinate of Q ?

A 0

B 2

C $\frac{16}{3}$

D 6

E $\frac{20}{3}$

F 12

10. Bag A contains three red balls and one blue ball. Bag B contains one red ball and three blue balls.

One bag is chosen, each with probability $\frac{1}{2}$. Two balls are drawn at random from that same bag, with replacement and thorough mixing between draws. The bag is not chosen again.

A student gives this argument:

1. The probability that the first ball is red is $\frac{1}{2}$.
2. The probability that the second ball is red is also $\frac{1}{2}$.
3. For either choice of bag, replacement restores its original composition before the second draw.
4. Therefore the events “first ball red” and “second ball red” are independent.
5. Hence the probability that both balls are red is $\frac{1}{4}$.

Which is the first incorrect line?

- A Line 1
- B Line 2
- C Line 3
- D Line 4
- E Line 5
- F There is no incorrect line.

11. Two faces of a cuboid share an edge. Their perimeters are 16 cm and 20 cm. A diagonal joining two opposite vertices through the interior of the cuboid has length $\sqrt{59}$ cm.

What is the sum of all possible values of the volume of the cuboid, in cm^3 ?

- A 21
- B 54
- C 75
- D 96
- E 150

12. Let a, d be positive integers, and define

$$u_n = a + (n - 1)d \quad (n = 1, 2, 3, \dots).$$

Two positive integers are called coprime when their only common positive divisor is 1. Consider the following statements.

- I. If a and d are coprime, then u_n and u_{n+1} are coprime for every positive integer n .
- II. If u_1 and u_2 are coprime, then u_1 and u_n are coprime for every integer $n \geq 2$.
- III. If $a > 1$, then u_1 and u_{a+1} are not coprime.

Which statements are true?

- A None of I, II and III
- B I only
- C II only
- D III only
- E I and II only
- F I and III only
- G II and III only
- H I, II and III

13. For every real number x , let

$$f(x) = A \sin(Bx) + C,$$

where $A > 0$ and $B > 0$. Angles are measured in radians.

The maximum value of f is 3, and its minimum value is -1 . The values $x = \pi/6$ and $x = 5\pi/6$ are consecutive points at which f attains its maximum.

What is the total length, measured along the x -axis, of the parts of $0 \leq x \leq \pi$ for which $f(x) \geq 2$?

A $\frac{\pi}{9}$

B $\frac{2\pi}{9}$

C $\frac{\pi}{3}$

D $\frac{4\pi}{9}$

E $\frac{5\pi}{9}$

F $\frac{2\pi}{3}$

14. In a non-degenerate triangle ABC , the points M and N are the midpoints of BC and CA , respectively. The lines AM and BN are perpendicular.

Consider the following statements.

- I. AB is shorter than both AC and BC .
- II. Triangle ABC is acute-angled.
- III. $AC^2 + BC^2 = 5AB^2$.

Which statements must be true?

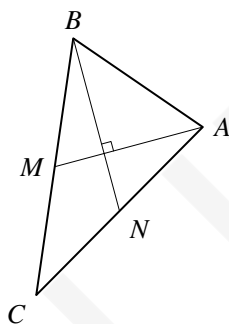


Diagram not to scale.

- A None of I, II and III
- B I only
- C II only
- D III only
- E I and II only
- F I and III only
- G II and III only
- H I, II and III

15. A real geometric progression has a nonzero first term and common ratio r . Let S_n be the sum of its first n terms.

It is known that

$$S_4 = 15, \quad S_8 = 255.$$

For a positive integer n ,

$$S_n = -129.$$

What is n ?

A 5

B 6

C 7

D 8

E 9

16. For which real values of k is the following statement true?

For every real number x , if

$$x^2 - 2kx + k^2 \leq k,$$

then $0 \leq x \leq 6$.

A $1 \leq k \leq 4$

B $k \leq 0$ or $1 \leq k \leq 2$

C $k \leq 0$ or $1 \leq k \leq 4$

D $k \leq 0$ or $1 \leq k \leq 6$

E $k \leq 4$

F $k \leq 0$ or $1 < k < 4$

17. The curve $y = 6x - x^2$ and the x -axis enclose a region.

A horizontal line $y = k$, where $0 < k < 9$, cuts the curve at two points. The area enclosed between this line and the curve is one eighth of the area enclosed between the curve and the x -axis.

What is k ?

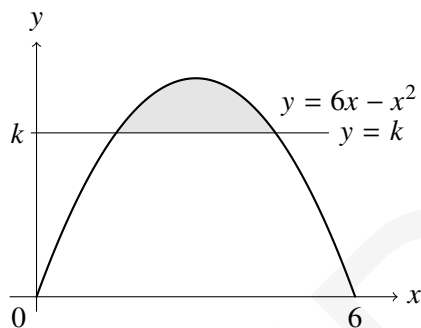


Diagram not to scale.

- A $\frac{9}{8}$
- B $\frac{9}{4}$
- C $\frac{9}{2}$
- D $\frac{27}{4}$
- E $\frac{63}{8}$

18. A student is solving

$$\sin \theta + \cos \theta = a, \quad 0 \leq \theta \leq \frac{\pi}{2},$$

where a is a real constant.

After squaring both sides and simplifying, the student obtains

$$2 \sin \theta \cos \theta = a^2 - 1.$$

For which values of a does the new equation have exactly two solutions in the stated interval, neither of which satisfies the original equation?

A $-\sqrt{2} \leq a \leq -1$

B $-\sqrt{2} < a \leq -1$

C $-\sqrt{2} < a < -1$

D $-\sqrt{2} \leq a < -1$

E $1 \leq a < \sqrt{2}$

F $-\sqrt{2} < a < 0$

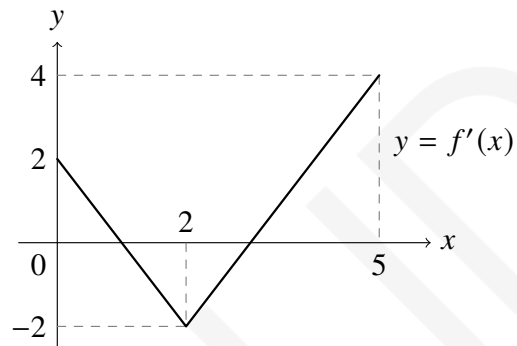
19. A differentiable function f satisfies $f(0) = 0$. On $0 \leq x \leq 5$, the graph of $y = f'(x)$ consists of the two straight-line segments joining

$$(0, 2), \quad (2, -2), \quad (5, 4).$$

For which real values of k does the equation

$$f(x)(f(x) - 2) = k$$

have exactly four distinct solutions in $0 \leq x \leq 5$?



- A** $-1 \leq k < 0$
- B** $-1 < k < 0$
- C** $-1 < k \leq 0$
- D** $-1 \leq k \leq 0$
- E** $0 < k < 3$
- F** $k = 0$

20. Consider all quadratic polynomials

$$f(x) = x^2 + bx + c,$$

where b, c are real numbers, that satisfy

$$\int_{-1}^1 f(x) dx = 0, \quad f(-1) > 0, \quad f(1) > 0.$$

Which is the complete set of real numbers t for which $f(t) < 0$ for every polynomial satisfying these conditions?

A $-1 < t < 1$

B $-\frac{1}{\sqrt{3}} < t < \frac{1}{\sqrt{3}}$

C $-\frac{1}{3} < t < \frac{1}{3}$

D $-\frac{1}{3} \leq t \leq \frac{1}{3}$

E $t = 0$

END OF QUESTIONS

Stop the timer before turning over.

ANSWER KEY

01	D
02	C
03	D
04	C
05	B
06	A
07	C
08	C
09	E
10	D

11	D
12	F
13	D
14	F
15	C
16	C
17	D
18	B
19	C
20	D

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A MESSAGE FROM TEAM EUCLID

To everyone who made it this far,

First of all, thank you for taking the time to complete our paper. We genuinely appreciate your support, and we hope these questions have challenged you and helped you see mathematics from a different perspective.

Before you go, we'd like to share something with you.

Euclid was founded with ambitions that extend far beyond mathematics education.

We dream of contributing to the next great chapter of human progress. Of pushing the boundaries of science, mathematics and technology, challenging what we believe is possible, and helping humanity achieve things that today exist only in our imagination.

Perhaps those ambitions sound unrealistic. We know how far we have to go, and how much we still have to learn. But we believe that every great achievement in history began with someone who refused to accept the limits of their time.

And that brings us to you.

Among the thousands of students preparing for the TMLA today may be the people who will shape the world tomorrow.

Perhaps the next great mathematician, scientist, or inventor is reading this very message.

We find that thought quite extraordinary.

Right now, your greatest concern might be an examination, a university offer, or a question you couldn't quite solve. But we hope that, years from now, these will become small chapters in a much greater story.

There is an entire world beyond these examinations, filled with unanswered questions, undiscovered ideas, and problems waiting for someone curious enough to solve them.

We hope you become one of those people.

And perhaps, one day, our paths will cross again. Not as a student and a team creating practice papers, but as people working together to build something that neither of us can yet imagine.

Until then, stay curious, keep questioning, and never stop learning.

The future has not been written yet. Perhaps you'll be among those who write it.

Thank you for being part of our journey.

With our very best wishes,

Team Euclid