



DPiD Maths Mock Set 1 Paper 1

Recommended time: 75 minutes

Calculators: not permitted

Format: 20 multiple-choice questions

This community paper is presented in a clean, print-ready format. The wording, mathematics, answer choices, and diagrams are preserved from the source paper.

Paper guidance

- Attempt every question. Select the best answer from the choices given.
- If a diagram is shown, it is reproduced from the source material and may not be drawn to scale.
- This question paper does not include worked solutions or a marked answer key.

Best of luck, and enjoy the challenge!

Source credit: DPiD

Question 1

Let k be a real number. The equation $|x^2 + 3kx| = 2k|x - 3|$ has n solutions for a given k . Find the sum of all values of n in $\{0, 1, 2, 3, 4, 5\}$ that are possible.

A 6

B 9

C 10

D 12

E 14

F 15

Question 2

Find the complete set of x for which $\frac{1}{\sqrt{6-\log_3(x^4)}}$ is defined.

- A** $-27 < x < 27, x \neq 0$
- B** $-3\sqrt{3} < x < 3\sqrt{3}, x \neq 0$
- C** $-9 < x < 9, x \neq 0$
- D** $0 < |x| < 27$
- E** $-3 < x < 3, x \neq 0$
- F** $|x| \geq 27$
- G** $-27 \leq x \leq 27$
- H** $-3\sqrt{3} \leq x \leq 3\sqrt{3}$

Question 3

A circle of radius 7 is drawn centred at the origin. How many squares of side length 1 and integer coordinate vertices intersect the interior of this circle?

- A** 156
- B** 164
- C** 168
- D** 172
- E** 176
- F** 180
- G** 184
- H** 196

Question 4

Let x be a real number. Find the maximum value of 3^{6x-2x^2-5} .

A $\frac{\sqrt{3}}{3}$

B $\sqrt{3}$

C 3

D $\frac{1}{3}$

E $\frac{1}{9}$

F $\frac{\sqrt{2}}{2}$

G 1

H $3\sqrt{3}$

Question 5

Define $P(x) = (x - 1^2)(x - 2^2) \cdots (x - 100^2)$. How many integers n are there such that $P(n) \leq 0$?

- A** 4900
- B** 4950
- C** 5000
- D** 5050
- E** 5100

Question 6

Find the constant term of $\left(|x| + \frac{1}{|x|} - 3\right)^3$.

- A** 20
- B** -30
- C** -45
- D** -27
- E** 45
- F** 18
- G** -18
- H** 27

Question 7

Real numbers a, b, c satisfy $a+b+c = 0$ with $0 < a < c$. Find the number of solutions to $c \sin^2 \theta + b \sin \theta + a = 0$ in $0 < \theta < \pi$.

- A** 3
- B** 1
- C** 2
- D** 4
- E** 0
- F** 5
- G** 6
- H** Infinite

Question 8

The ellipse is $\frac{x^2}{9} + y^2 = 1$. Given point $M(2, 0)$ and point P on the ellipse, find the minimum value of $|PM|$.

A $\frac{\sqrt{2}}{3}$

B $\frac{\sqrt{3}}{3}$

C $\frac{\sqrt{6}}{3}$

D $\frac{2\sqrt{2}}{3}$

E $\frac{\sqrt{2}}{2}$

F 1

G $\frac{1}{3}$

H $\frac{1}{2}$

Question 9

Given $f(x) = |x^2 - 10x + 13|$ and $g(x) = 6x + \frac{6}{x}$. With constant $m \in \mathbb{R}$, let $\epsilon = f(x) - g(m)$, where $\epsilon^2 + 12\epsilon = 0$. Find the maximum number of solutions of x .

A 1

B 2

C 3

D 4

E 5

F 6

G 7

H 8

Question 10

Let $a_n = \frac{n \cdot 2^{n+1}}{(n+1)(n+2)}$, where n is a positive integer. Find $a_1 + a_2 + a_3 + \cdots + a_{254}$.

A $\frac{2^{256}}{256}$

B $\frac{2^{256}}{256} - 2$

C -2

D $\frac{2^{256}}{256} + 2$

E 2

F $\frac{2^{255}}{255} - 2$

G $\frac{2^{256}}{255} - 2$

H $\frac{2^{254}}{256} - 2$

Question 11

A curve $y = x^2 - 4x$ is rotated 180° about the origin, then translated by $\begin{pmatrix} 2 \\ 3 \end{pmatrix}$. Find the equation of the new curve.

A $y = 7 - x^2$

B $y = 1 - x^2$

C $y = -1 - x^2$

D $y = 3 - x^2$

E $y = 7 - (x - 2)^2$

F $y = 7 + x^2$

G $y = -7 - x^2$

H $y = 4 - x^2$

Question 12

Suppose x and y are positive reals such that $x - y^2 = 1$ and $x^2 + y^4 = 41$. Find x .

A 4

B 5

C $\sqrt{41}$

D 6

E $\frac{-1+\sqrt{17}}{2}$

F 3

G 20

H 9

Question 13

A rectangular sheet of paper is folded along its diagonal, making a pentagon that has an area of $\frac{11}{16}$ of the area of the original rectangle. Find the ratio of the longer side of the rectangle to the shorter side.

A $\frac{11}{16}$

B $\sqrt{3}$

C 2

D $\frac{5}{2}$

E $\sqrt{5}$

F $\frac{3}{2}$

G 4

H $\sqrt{2}$

Question 14

Tom needs to pay £100 for his dinner. He has an unlimited supply of £2 coins and £5 and £10 notes. In how many ways can he pay?

- A** 60
- B** 63
- C** 66
- D** 55
- E** 121
- F** 36
- G** 72
- H** 100

Question 15

What are the last 6 digits of $11 \times 101 \times 1001 \times 10001 \times 11$?

A 344321

B 443221

C 222111

D 443321

E 344421

F 421443

G 434221

H 442321

Question 16

Let O be the point $(0,0)$. Let A, B, C be three points in the plane such that $OA = 30$, $OB = 30$, and $OC = 14$, chosen so that the area of triangle ABC is maximal. What is the length of the shortest side of ABC ?

A 44

B 40

C 48

D 34

E 30

F 42

G 38

H 36

Question 17

Alice and Bob repeatedly flip a fair coin. Alice wins if 1 head followed by 3 tails appears. Bob wins if 5 heads in a row appears. They flip until someone wins. What is the probability that Alice wins?

A $\frac{1}{2}$

B $\frac{15}{19}$

C $\frac{7}{11}$

D $\frac{3}{5}$

E $\frac{15}{16}$

F $\frac{8}{23}$

G $\frac{16}{31}$

H $\frac{31}{47}$

Question 18

Let $p(x)$ and $q(x)$ be two cubic polynomials such that $p(0) = -6$, $q(0) = 10$, and $p(q(x)) = q(p(x))$ for all real numbers x . Find the ordered pair $(p(2), q(4))$.

- A** $(2, -6)$
- B** $(-6, 2)$
- C** $(2, 6)$
- D** $(-6, 10)$
- E** $(6, -6)$
- F** $(2, -10)$
- G** $(-2, 6)$
- H** $(10, -6)$

Question 19

An ant starts at the origin, facing in the positive x -direction. Each second, it moves 1 unit forward, then turns counterclockwise by $\sin^{-1}\left(\frac{5}{13}\right)$ degrees. What is the least upper bound on the distance between the ant and the origin?

A $\sqrt{13}$

B $\sqrt{26}$

C $\frac{13}{5}$

D 5

E $\frac{13}{2}$

F $\sqrt{10}$

G $2\sqrt{13}$

H $\frac{26}{5}$

Question 20

Ava and Ben play a game on a 12×12 board. For some positive integer k , Ava chooses k squares and writes an A in each of them. Ben then chooses $k + 3$ squares and writes a B in each. After Ben is done, Ava wins if there is a sequence of letters forming “ BAA ” or “ AAB ” when read either horizontally (left-to-right) or vertically (top-to-bottom), and Ben wins otherwise. Determine the smallest value of k for which Ava has a winning strategy.

- A** 24
- B** 34
- C** 35
- D** 36
- E** 37
- F** 40
- G** 48
- H** 18