JZ Mock Set B Paper 1

Recommended time: 2 hours

Calculators: not permitted

Format: 20 multiple-choice questions

This is a TMUA-style mock paper modelled on the Test of Mathematics for University Admission. The TMUA is used in admissions for mathematics, economics, computer science, and engineering courses at universities including Cambridge, Oxford, Imperial College London, UCL, LSE, Warwick, and Durham.

Paper Guidance

- These papers contain only hard, very hard, and occasionally *unreasonably hard* TMUA-style questions :). I have deliberately left out the routine and easier material, so please do not be discouraged if you find a paper difficult or need longer than the recommended time. That is exactly how it is meant to feel. Take your time, enjoy the challenge, and remember that struggling with difficult problems is one of the best ways to get better.
- As a rough and deliberately conservative guide, a student who scores above 27 out of 40 across one full set, meaning both papers in four hours, is very likely already working at around the 7.0+ level on the current TMUA scale. However, this is only intended as a guide, not something to worry about too much. The main purpose of these papers is improvement rather than measurement: meet difficult problems, struggle with them, learn from them, and focus on getting better each time.

Best of luck, and enjoy the challenge!

Last updated: 5 September 2026 at 23:13

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Question 1

The equation

$$x^{\log_2 x} = \frac{x^3}{4}$$

has exactly two solutions for $x > 0$. Find their product.

A 2

B 4

C 6

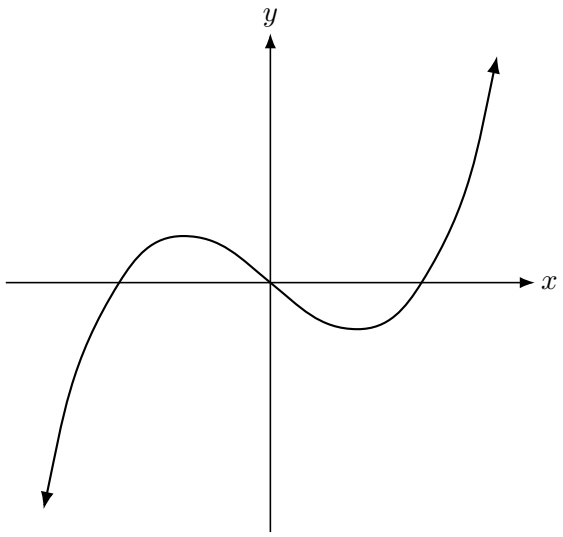
D 8

E 16

F 20

Question 2

The curve $y = x^3 - 4x$ is shown below.



What is the total area enclosed between the curve, the x-axis and the lines $x = -3$ and $x = 3$?

A 0

B $\frac{9}{2}$

C 8

D $\frac{25}{2}$

E $\frac{41}{2}$

F $\frac{33}{2}$

Question 3

Evaluate

$$\sum_{n=0}^{20} \log_{\frac{1}{2}}(8^{-n}).$$

A 630

B $231 \log_{\frac{1}{2}} 8$

C $-231 \log_{\frac{1}{2}} 8$

D -693

E $-210 \log_2 8$

F 693

G $210 \log_{\frac{1}{2}} 8$

H $231 \log_2 8$

Question 4

A circle has equation

$$x^2 + y^2 - 4x + 6y - 3 = 0.$$

The circle is first translated by 5 units in the positive x-direction, then reflected in the line $y = x$, then reflected in the x-axis, and finally enlarged by a scale factor of 3 about the origin. The equation of the final circle is

A $(x + 9)^2 + (y + 21)^2 = 144$

B $(x + 9)^2 + (y + 21)^2 = 48$

C $(x + 9)^2 + (y + 21)^2 = 16$

D $(x + 9)^2 + (y - 21)^2 = 144$

E $(x - 9)^2 + (y + 21)^2 = 144$

F $(x + 21)^2 + (y + 9)^2 = 144$

G $(x + 3)^2 + (y + 7)^2 = 144$

H $(x + 9)^2 + (y + 21)^2 = 90$

Question 5

The function f is continuous for all real x, and

$$I = \int_1^5 f(x)\,dx.$$

Which one of the following is **necessarily** equal to I?

A

$$\int_{-2}^{2} \left[f(x+3) + x^2\right] dx$$

B

$$\int_{-2}^{2} \left[f(x+3) + x^3\right] dx$$

C

$$\int_{-2}^{2} \left[f(x-3) + x^3\right] dx$$

D

$$\int_{-2}^{2} \left[f(x-3) + x^2\right] dx$$

E

$$\int_{-1}^{3} f(x-2)dx$$

F

$$\int_{-1}^{3} \left[f(x+2) + x^2\right] dx$$

Question 6

Which of the following represents the set of x satisfying: $x^2 > x$ and $1 < 17 - 4x$.

A $(x-1)(x-4) < 0$

B $x^2 - 5x + 4 > 0$

C $\dfrac{3}{x-1} > x - 3$

D $x^3 - 5x^2 + 4x > 0$

E $x(x-1) < 0$

F $x^2 - x > 0$

Question 7

Given $-3 < x < 3$, find the total length of the intervals in which

$$\sqrt{(x-2)^2} \leq x^2 - 3x.$$

A $4 - \sqrt{3}$

B 3

C $5 - \sqrt{2}$

D $\sqrt{2} + 1$

E $\sqrt{3} + 2$

F $6 - 2\sqrt{3}$

Question 8

Evaluate the following integral.

$$\int_{-2}^{2} x^2|1-x^2|\,dx$$

A 6

B 2

C 4

D 8

E 0

F $\frac{13}{2}$

Question 9

Let a, b and c be non-zero integers. The expression

$$\frac{6^{a+b+c} \cdot 10^{a-b-c}}{15^{a-b+c}}$$

is a positive integer if which of the following is true?

A $a > 0$, $b > 0$ and $c < 0$

B $a > 0$, $b > 0$ and $c > 0$

C $a > 0$, $b < 0$ and $c < 0$

D $a < 0$, $b > 0$ and $c < 0$

E $a < 0$, $b < 0$ and $c > 0$

F $a < 0$, $b < 0$ and $c < 0$

G $a > 0$ and $c < 0$ (no condition on b)

H $c < 0$ only (no conditions on a or b)

Question 10

Which of the following integrals has the **greatest** value?

A

$$\int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} (\sin^{\frac{1}{3}} x)\, dx$$

B

$$\int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} |\cos(\frac{\pi}{2} - x)|\, dx$$

C

$$\int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} (\sin^2 x)\, dx$$

D

$$\int_0^{\pi} \sqrt{|\sin\left(x - \frac{\pi}{2}\right)|}\, dx$$

E

$$\int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} \sqrt{1 - \cos^2 x}\, dx$$

Question 11

Given

$$a_n = \sin\left(\frac{2\pi}{3}n\right) + \cos\left(\frac{\pi}{6}(1+4n)\right)$$

and

$$S = \sum_{n=1}^{k} a_n.$$

For how many values of positive integer k such that $1 \leq k \leq 100$, is $S = 0$.

A 0

B 33

C 34

D 66

E 67

F 100

Question 12

In the expansion of $(1+x)^n$, the coefficients of three consecutive terms are in the ratio $1:2:3$. Find n.

A 9

B 10

C 11

D 12

E 13

F 14

G 15

Question 13

Three sectors of circles are similar (they share the same central angle) and their radii form an arithmetic progression. The smallest sector has arc length 6. The area of the middle sector exceeds the area of the smallest sector by 21. The area of the largest sector exceeds the area of the middle sector by 27. Find the positive difference between the perimeters of the largest and smallest sectors.

A 7

B 8

C 10.5

D 12

E 14

F 16

G 18

Question 14

How many solutions does the equation

$$\sqrt{1-\cos^2(2x)} = \left(x - \frac{3\pi}{4}\right)\cos(2x)$$

have for x in the interval $0 < x < \pi$?

A 0

B 1

C 2

D 3

E 4

F 5

Question 15

The circles C_1 and C_2 are defined by the equations

$$C_1 : \ (x-2)^2 + (y-3)^2 = 9$$

$$C_2 : \ (x-11)^2 + (y-15)^2 = 16$$

A common tangent to C_1 and C_2 touches C_1 at X and C_2 at Y. Find the sum of the squares of all distinct possible lengths of XY.

A 1

B 49

C 176

D 224

E 400

F 450

Question 16

An arithmetic sequence (a_n) and a convergent geometric sequence (g_n) are combined to form a new sequence (T_n), where $T_n = a_n + g_n$. Given that

$$T_1 = 3, \quad T_2 = 2, \quad T_3 = \frac{3}{2}, \quad T_4 = \frac{9}{8},$$

find the sum to infinity of the geometric sequence (g_n).

A $\frac{8}{9}$

B $\frac{32}{27}$

C $\frac{4}{3}$

D $\frac{3}{2}$

E $\frac{27}{8}$

F 4

Question 17

Evaluate

$$\int_0^{\pi/2} \frac{1}{1+\tan x}\, dx.$$

You may find the identity

$$\tan\left(\frac{\pi}{2} - x\right) = \frac{1}{\tan x}$$

useful.

A $\frac{\pi}{2}$

B $\frac{\pi}{4}$

C $\frac{\pi}{2\sqrt{2}}$

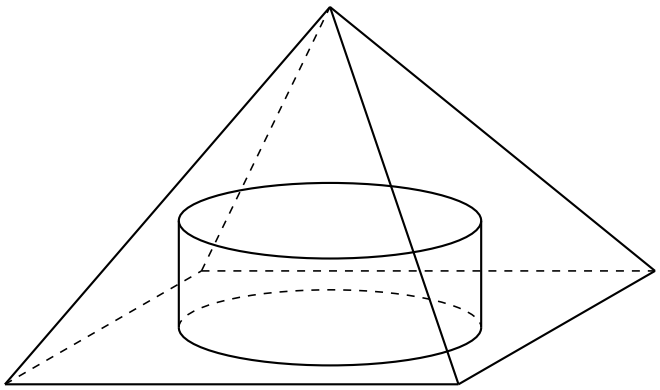
D $\frac{\pi}{4\sqrt{2}}$

E $\frac{\pi}{3}$

F $\frac{\pi}{6}$

Question 18

A right circular cylinder is placed inside a regular square-based pyramid. One circular face of the cylinder lies in the square base of the pyramid, and the other circular face is parallel to it. All edges of the pyramid have the same length.



What is the largest possible value of

$$\frac{\text{volume of the cylinder}}{\text{volume of the pyramid}}?$$

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

B $\frac{\pi}{10}$

C $\frac{\sqrt{2}\pi}{9}$

D $\frac{\pi}{12}$

E $\frac{2\sqrt{2}\pi}{27}$

Question 19

Let p be a real number, and let n denote the number of points of intersection of the curves $y = |x^3 - p^3|$ and $y = p^3|x - 1|$. n **cannot** take which of the following values?

A 0

B 1

C 4

D 3

E 2

Question 20

Let $y = t^{\sin 2x} - 2\,t^{-\sin 2x}$, where $t > 0$ and x is real. For what values of t, is the product between the maximum value of y and the minimum value of y positive.

A $0 < t < \frac{1}{\sqrt{2}}$

B $t > \sqrt{2}$

C $\frac{1}{\sqrt{2}} < t < \sqrt{2}$

D $\frac{1}{\sqrt{2}} \leq t \leq \sqrt{2}$

E $0 < t < \sqrt{2}$

F $1 \geq t < \sqrt{2}$