

TMUA Mock Paper 2

20 questions. Recreated from the publicly available paper.

Question 1

Exactly one of the following statements is true. Which one?

A. $\sqrt{144} = \pm 12$.

B. For every real number x , $\sqrt{x^2} = x$.

C. $0.\bar{9} = 1$.

D. $3^0 = 0$.

E. The product of any two irrational numbers is irrational.

Question 2

Let n be a positive integer. Consider statement P: ' n is prime', and statement Q: ' n is of the form $6k \pm 1$ for some integer k '. Then Q is:

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

Question 3

Consider the claim: 'For every integer $n \geq 2$, the value $n^2 - n + 11$ is prime.' Which of the following is a counterexample?

A. $n = 5$

B. $n = 10$

C. $n = 11$

D. $n = 2$

E. there is no counterexample

Question 4

Let x and y be real numbers. Consider statement P: ' $x + y > 0$ ', and statement Q: ' $x^3 + y^3 > 0$ '. Then Q is:

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

Question 5

f is a function defined for all real numbers, with $f(1) = 3$ and $f(4) = -2$. Consider the statements:
I: $f(x) = 0$ has a solution with $1 < x < 4$; II: $f(x) = 0$ has an odd number of solutions with $1 < x < 4$; III: f takes the value 1 somewhere in $1 < x < 4$. Which of these must be true?

A. none of them

B. I only

C. I and II only

D. I and III only

E. I, II and III

Question 6

f is a differentiable function. Consider statement P: ' $x = 2$ is a turning point of f ', and statement Q: ' $f'(2) = 0$ '. Then Q is:

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

Question 7

The following argument claims to show that every real number equals 0. Line 1: Let $a = b$. Line 2: Then $a^2 = ab$. Line 3: So $a^2 - b^2 = ab - b^2$. Line 4: Factorising, $(a - b)(a + b) = b(a - b)$. Line 5: Dividing by $a - b$, $a + b = b$. Line 6: Hence $a = 0$. At which line does the first error occur?

A.Line 2

B.Line 3

C.Line 4

D.Line 5

E.Line 6

Question 8

Consider the statement: 'If a function g is defined on $[0, 1]$, then $\int_0^1 g(x) dx$ equals the area enclosed between the graph of g and the x -axis over $[0, 1]$.' Which of the following is a counterexample?

A. $g(x) = x^2$

B. $g(x) = x - 1$

C. $g(x) = \frac{1}{x}$

D. $g(x) = 1$

E. there is no counterexample

Question 9

Which of the following statements are true? I: There exists a real y such that for all real x , $x^2 \geq y$. II: For all real x , there exists a real y such that $y > x^2$. III: There exists a real y such that for all real x , $y > x^2$.

A.none of them

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

Question 10

How many real solutions with $x > 0$ does the equation $(\ln x)^2 - 3 \ln x + 1 = 0$ have?

A.0

B.1

C.2

D.3

E.infinitely many

Question 11

For a positive integer n , let R_n be the repunit consisting of n ones (so $R_1 = 1$, $R_2 = 11$, $R_3 = 111$, and so on). The statement '3 divides R_n ' is true if and only if:

- A. n is even
- B. 3 divides n
- C. 9 divides n
- D. n is odd
- E. $n > 3$

Question 12

What is the maximum value of $f(x) = 2x^3 - 9x^2 + 12x + 1$ on the closed interval $0 \leq x \leq 3$?

- A.6
- B.10
- C.5
- D.1
- E.12

Question 13

$S(x)$ is a property of a real number x , and exactly one of the following four claims about S is true. Which one? A: $S(x)$ holds whenever $x^2 < 4$. B: $S(x)$ holds precisely when $x^2 < 4$. C: $S(x)$ holds whenever $x^2 < 9$. D: $S(x)$ holds precisely when $x^2 < 9$.

A.A

B.B

C.C

D.D

Question 14

b is a real number, and $x = b$ is a root of the equation $bx^2 - (b^2 + 1)x + b = 0$. Which of the following describes the complete set of possible values of b ?

A. $b = 0$ or $b = 1$

B. $b = \pm 1$

C. all real numbers

D. $b \neq 0$

E. there is no such b

Question 15

What is the maximum value of $x + 2y$ subject to $x^2 + y^2 \leq 5$?

A.5

B. $\sqrt{5}$

C. $2\sqrt{5}$

D.3

E.10

Question 16

Consider the statement about an integer n : 'if n^2 is even then n is even'. Which of the following is its contrapositive?

A.If n is even then n^2 is even.

B.If n is odd then n^2 is odd.

C.If n^2 is odd then n is odd.

D.If n is odd then n^2 is even.

E.If n^2 is even then n is odd.

Question 17

Which of the following statements are true? I: no integer of the form $4k + 3$ is the sum of two perfect squares. II: the product of two integers, each of the form $4k + 1$, is again of the form $4k + 1$. III: every prime number is of the form $4k + 1$ or $4k + 3$.

- A. none of them
- 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

Question 18

f is a continuous function and $a < b$. Consider statement P: ' $f(a)$ and $f(b)$ have opposite signs', and statement Q: ' f has a root in the open interval (a, b) '. Then P is:

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

Question 19

For which of these functions is it true that $f'(x) > 0$ for all real x ? I: $f(x) = x^3$. II: $f(x) = e^x$. III: $f(x) = x + \sin x$.

A.none of them

B.I only

C.II only

D.III only

E.I and II only

F.II and III only

G.I, II and III

H.I and III only

Question 20

A sequence of integers satisfies $u_{n+1} = 3u_n - 4$, with u_1 an integer. Which of the following statements are true? I: $u_n - 2$ is a multiple of 3^{n-1} for every n . II: if u_1 is even then every term is even. III: u_{10} is divisible by 3.

A. none of them

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

Answer key

1. Answer: C
2. Answer: D
3. Answer: C
4. Answer: C
5. Answer: A
6. Answer: A
7. Answer: D
8. Answer: B
9. Answer: E
10. Answer: C
11. Answer: B
12. Answer: B
13. Answer: A
14. Answer: C
15. Answer: A
16. Answer: B
17. Answer: E
18. Answer: B
19. Answer: C
20. Answer: E

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